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Mr. John Linehan
Repository Projects Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
Mail Stop 623-SS
Washington, D.C. 20555

Dear Mr. Linehan:

On December 9 and 10 1985, the Basalt Waste Isolation Project (BWIP) held a workshop with the Nuclear Regulatory Commission (NRC) staff to discuss the proposed Rocky Coulee Large-scale Hydraulic Stress (LHS) test at the Hanford site. Subsequent to the workshop, NRC provided BWIP with comments on the LHS test plan by letter, dated April 10, 1986.

After the meeting of December 1985, the NRC staff commented that the test plan presented by BWIP was inconsistent with NRC's Site Technical Position (STP) 1.1. In particular, the staff was concerned that a hydrologic baseline had not been reached and the proposed LHS test would not satisfy all the testing objectives of STP 1.1. Since that time, the Department has reevaluated its approach to LHS testing, taking into account the staff's comments. We have adopted a strategy based on the Department's issues hierarchy (DOE/RW-0101) to plan our hydrologic testing program. Although this strategy has produced a testing program somewhat different from the one outlined in STP 1.1, we believe the program is responsive to the intent of STP 1.1, and should supercede it. We further believe that the planned testing program adequately addresses the concerns expressed by the NRC staff on hydraulic-head baseline, scale and related issues.

In the near term, we propose a series of two workshops to inform you of the geohydrologic testing program we have developed for the Hanford site. During the first workshop the discussions will be focused on two topics: (1) the pre-exploratory shaft (pre-ES) geohydrologic test plan and (2) the Department's response to your letter of April 10, 1986, with special emphasis on the pre-ES time period. A tentative agenda is enclosed (Enclosure A): the suggested dates of the workshop are April 7-9, 1987, in Richland, Washington. A second workshop will be held after the Site Characterization Plan (SCP) and associated study plans are released. The second workshop will address the full geohydrologic testing program and its operational details (QA plans, procedures, etc.) to the extent they have been developed.

In arriving at a preferred plan for pre-ES geohydrologic testing, the Department considered a number of options. Those options and their perceived advantages and disadvantages are presented in the enclosed paper (Enclosure B). The option we chose served as the basis for the pre-ES testing program. This program consists of: (1) expansion of the hydraulic-head baseline monitoring network with two new multi-level monitoring wells, (2) additional multi-level observation wells at intermediate distances between the RRL-2 wells and existing monitoring

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wells, (3) testing of four separate horizons at the RRL-2 location at the largest scale achievable, (4) hydrochemical sampling and analysis in conjunction with each LHS test, (5) radial convergence tracer tests in conjunction with each LHS test, and (6) reconfiguration of existing facilities to provide additional observation points. The program is further explained in Enclosure B and will be discussed at some length during the first workshop.

The NRC staff has requested to be consulted during plan development and in pre-test readiness reviews. These workshops constitute a part of that consultation. The NRC staff will be appraised of readiness review status through their Onsite Representative. In addition, NRC staff are invited to observe the geohydrologic testing.

As for specific issues raised in your letter of April 1986, our responses may be found in Enclosure C. The NRC staff stated that resolution of their comments is necessary prior to the initiation of testing and exploratory shaft construction. By this letter and the two workshops, we expect to make you fully informed of our revised geohydrology testing program. Should you have any questions about the enclosures or the upcoming workshop, please feel free to contact Dr. Allan Jelacic (586-9362).

I look forward to working with the NRC staff on this most important planning effort.

Sincerely,

James Knight, Director
Siting, Licensing and Quality
Assurance Division
Office of Geologic Repositories
Office of Civilian Radioactive
Waste Management

Enclosures

Encl. to 102.3: Ltr. John Linehan

ENCLOSURE A

DOE-NRC MEETING ON THE GEOHYDROLOGY TESTING PROGRAM FOR THE HANFORD SITE BEFORE CONSTRUCTION OF THE EXPLORATORY SHAFT

Richland, Washington
April 7-9, 1987

-AGENDA-

The purpose of this meeting is: (1) for the DOE to present the planned program of geohydrologic testing at the Hanford site that would precede construction of the exploratory shaft; (2) for the DOE to respond to concerns raised by the NRC staff, States and Tribes at the December, 1985, meeting on BWIP's geohydrology program and in the staff's letter dated April 10, 1986; (3) for all interested parties to discuss the planned testing program; (4) for all interested parties to reach agreement on the planned testing program or to reach agreement on how to resolve any major concerns with the planned program.

April 7, 1987

8:30 - 9:00	Introduction - Welcome - Identification of participants - Scope and Objectives of meeting - Procedures to be followed - Review of agenda	DOE/NRC
9:00 - 9:30	Geohydrologic Testing Strategy - Issue resolution strategy - Geohydrologic issues in Site Characterization Plan (SCP) - SCP organization	DOE
9:30 - 10:15	Overview of Geohydrology Program - Planning Logic - Components of pre-exploratory shaft (pre-ES) program - Components of post-ES program - Program integration - Implementation procedures	DOE
10:15 - 10:30	Break	
10:30 - 11:15	Options Paper for Pre-ES Testing Program - Background - Approach - Identification of options - Recommendation	DOE

11:15 - 12:15	Planned Pre-ES Testing Program - Baseline monitoring - Large-scale hydrologic testing and associated data collection - Implementation procedures (Readiness reviews, test criteria, QA plans, interactions) - Schedule	DOE
12:15 - 1:30	Lunch	
1:30 - 2:30	NRC Caucus	All parties
2:30 - 3:30	Presentation of Preliminary Comments on Pre-ES Testing Program	NRC/States/ Tribes
3:30 - 5:00	Discussion of Preliminary Comments on Pre-ES Testing Program	All parties
5:00 - 6:00	Identification of Concerns for Further Discussion	All parties

April 8, 1987

8:30 - 9:00	Initial Response to Concerns Raised During First Day	DOE
9:00 - 12:00	Response to Previous NRC Concerns - Meeting of December 1985 - Letter of April 10, 1986	DOE
12:00 -1:30	Lunch	
1:30 - 2:30	NRC Caucus	All parties
2:30 - 3:30	Presentation of Preliminary Comments on Response to NRC Concerns	NRC
3:30 - 4:30	Discussion of Preliminary Comments on Response to NRC Concerns	All parties
4:30 - 6:00	Identification of Preliminary Observations, Agreements, and Open Items	All parties
6:00 - 8:00	Dinner	
8:00 - 11:00	NRC Caucus Identify and Draft Observations, Agreements, and Open Items	All parties

April 9, 1987

8:30 - 10:00	Exchange and Discussion of Observations, Agreements, and Open Items	All parties
10:00 - 10:30	Break	
10:30 - 12:00	Preparation and Signing of Summary Meeting Minutes	All parties

ENCLOSURE B

OPTION PAPER

GEOHYDROLOGIC TESTING PROGRAM FOR THE HANFORD SITE BEFORE CONSTRUCTION OF THE FIRST EXPLORATORY SHAFT

EXECUTIVE SUMMARY

Purpose: To define the geohydrologic testing program to be conducted at the Hanford site before construction of the first exploratory shaft (ES).

Objectives of testing program: The principal objectives of the pre-ES geohydrologic testing program are as follows:

- To collect data on geohydrologic conditions that will be changed by site characterization activities.
- To collect data having the potential for providing an early indication of the presence of disqualifying conditions.
- To collect data on geohydrologic conditions in order to identify the effects of the ESF on the geohydrologic system and on subsequent geohydrologic tests.
- To collect data on geohydrologic conditions that may affect the design of the ESF or the repository.

Types of tests that are needed: Four types of tests are needed before shaft construction:

- Baseline hydraulic-head monitoring.
- Large-scale hydraulic stress (LHS) tests.
- Hydrochemical sampling in conjunction with LHS tests.
- Tracer tests in conjunction with LHS tests.

Options evaluated: Five options for the pre-ES geohydrology testing program were evaluated. As shown below, each has a different degree of risk of not attaining the objectives of the pre-ES testing program:

	Option	Risk
a.	Baseline hydraulic-head only	Very high
b.	Baseline hydraulic-head and LHS testing of one flow top (Rocky Coulee) with hydrochemical sampling and tracer tests	High
c.	Baseline hydraulic-head and LHS testing of one flow top (Birkett) with hydrochemical sampling and tracer tests	High
d.	Baseline hydraulic-head and LHS testing in multiple horizons at the RRL-2 location with hydrochemical sampling and tracer tests	Low

e. Baseline hydraulic-head and LHS testing in multiple horizons at multiple locations with hydrochemical sampling and tracer tests — Very low

<u>Recommendation</u>: Option d, consisting of baseline hydraulic-head monitoring, LHS tests, hydrochemical sampling and tracer tests at the RRL-2 location in multiple horizons (Rocky Coulee, Cohassett, and Birkett flow tops and the Cohassett vesicular zone).

<u>Principal strengths of recommended option:</u> The principle strengths of the recommended option can be summarized as follows:

- Provides predisturbance hydraulic-head baseline;
- Documents geohydrologic conditions at the RRL-2 site before changes by ES construction;
- Has potential to indicate the presence of disqualifying conditions;
- Provides engineering design data for ESF before the start of construction;
- Provides hydraulic-stress data base to identify the effects of the ESF on the geohydrologic system and later geohydrologic tests.

<u>Proposed pre-ES testing program</u>: The principal activities of the pre-ES testing program include:

- Drill and install multilevel piezometers in DC-24 and DC-25 and allow system equilibration;
- Drill and install multilevel piezometers in DC-32 and DC-33 and allow system equilibration;
- Modify existing monitoring wells DC 4/5, RRL-2A, RRL-6, RRL-14, RRL-17, DC-16, and McGee;
- Use well RRL-2B to perform LHS tests, hydrochemical sampling, and tracer tests in the Rocky Coulee, Cohassett, and Birkett flows.

<u>Expected schedule impact:</u> The proposed pre-ES geohydrologic testing program will require approximately 22 months from the start of drilling.

DOE F 1325.8
(12-84)

United States Government

Department of Energy

memorandum

DATE:

REPLY TO
ATTN OF: RW-23.3

SUBJECT: Geohydrologic Testing Program for the Hanford Site Before Construction of the First Exploratory Shaft

TO: Stephen Kale, Associate Director
Office of Geologic Repositories

FROM: Geohydrology Working Group
Allan Jelacic (Chairman), DOE/HQ
Glen Faulkner, DOE/USGS
David Dahlem, DOE/RL
Michael Thompson, DOE/RL
David Siefken, Weston
John Robertson, Weston
Sam Panno, Weston
Phil Rogers, RHO
Peter Clifton, RHO

A. ISSUE

The construction and operation of an exploratory shaft facility (ESF) at the Hanford site will significantly alter the existing geohydrologic system. These changes could compromise the results of some key geohydrologic tests if performed after ESF construction starts. Given this circumstance, a problem exists to define a pre-ES geohydrologic testing program which provides necessary data before the disruptive events caused by the ESF and provides reliable information for resolving licensing issues.

B. BACKGROUND

1. <u>Current Understanding of the Geohydrology at Hanford Site</u>

The candidate site for a geologic repository at Hanford is in the Cold Creek valley, a topographic and structural basin that slopes southeastward and opens toward the Columbia River. The Hanford site is underlain by at least 50 basalt flows with a cumulative thickness greater than 3,000 m (Exhibit I). The candidate repository horizon (dense interior of the Cohassett flow) lies between 807 and 1,100 m below ground surface in the Grande Ronde Basalt. Basalt flows generally consist of an upper vesicular and/or brecciated flow top overlying a dense, jointed interior. Flow tops typically account for about 15-percent of the total flow thickness.

The main ground-water occurrence and horizontal movement in the basalt formations is within the flow tops and the sedimentary interbeds that separate some flows. Vertical ground-water movement between flow tops is constrained by the basalt flow interiors, which appear to act as aquitards. Current geohydrologic understanding allows more than one conceptual flow model. One model being considered has hydraulic boundaries coincident with the anticlines that bound the Cold Creek syncline. The model has both horizontal and vertical components of flow, with a horizontal pattern of flow that tends to reflect the shape of the Cold Creek syncline. Although not controlled by the structural dip, the direction of horizontal flow tends to be similar to the direction of dip of the basalt, with flow paths that trend southwest beneath the candidate repository and may turn southeastward in the vicinity of the synclinal axis (see the conceptualized potentiometric map in Exhibit II). Some upward movement of ground water through fractures in the Grande Ronde Basalt is thought to occur at least up through the lower part of the overlying Wanapum Basalt. Above the Wanapum, vertical flow is thought to be mostly downward through the Saddle Mountains Basalt into the upper part of the Wanapum. In addition to available hydraulic-head data, hydrochemical data support the concept of vertical ground-water movement.

Horizontal hydraulic conductivities in flow tops and interbeds have been estimated from more than 200 single-hole, small-scale hydraulic stress tests in some 35 boreholes across the Hanford site. About 40 of these tests are from flow tops in the Grande Ronde Basalt. The radius of influence of each of these tests is probably small and representative of very local conditions around the borehole.

Measured flow top conductivities have ranged over 10 orders of magnitude. A more well-defined hydraulic conductivity field is necessary for improved confidence in calculations of radionuclide transport and ground-water travel time.

For the dense flow interiors, horizontal hydraulic conductivities estimated from field tests have a range of 6 orders of magnitude, the highest value being about 7 orders of magnitude lower than the highest value estimated for the flow tops. No measurements of vertical hydraulic conductivity in the dense interiors have been made, and thus a low level of confidence exists over what constitutes a representative range for purposes of calculating flux, travel time across flow interiors, and inflow to the ESF and repository. The ratio of vertical to horizontal hydraulic conductivity for flow interiors is unknown but is currently estimated to be approximately 3 to 1.

Two small-scale tracer tests have been conducted in the McCoy Canyon flow top of the Grande Ronde Basalt. From these tests, longitudinal dispersivity values have been calculated and effective-thickness estimates have been made. Dispersivity and effective thickness are important variables in calculating ground-water travel time and radionuclide transport. However, because of the limited data base, a large uncertainty is associated with what constitutes representative ranges of values for these variables.

A more detailed discussion of current knowledge about the geohydrology at Hanford, including numerical ranges of hydraulic parameters, is given in Appendix A.

2. Concerns Raised by the Nuclear Regulatory Commission

The geohydrologic testing program at Hanford has been the subject of criticism by various organizations outside the Department. The concerns expressed by the staff of the Nuclear Regulatory Commission (NRC) typify many of the criticisms. In December 1985, DOE/RL held a workshop to inform the NRC staff about plans for the first large-scale hydraulic stress (LHS) tests; summary meeting minutes and a subsequent letter (Appendix B) document the staff's concerns. Some of the concerns that have affected the pre-ES testing program are briefly summarized below.

Limitations of current monitoring facilities need to be assessed; if necessary, facilities should be upgraded. Numerical modeling of the monitoring network's adequacy would be desirable before testing.

Monitoring facilities were considered inadequate for the LHS tests due to the lack of wells at intermediate distances (150 to 2250 m) from the pumping well and the small number of observation wells in the Birkett flow.

The NRC staff agreed that the DOE had demonstrated the ability to predict water-level trends well enough to support LHS testing. However, those trends would have to be reestablished after drilling new monitoring wells. They recommended sequential activities in order to minimize mutual interference (e.g., establish hydraulic-head baseline before LHS testing). The NRC staff called on DOE to establish conservative baseline acceptance criteria.

As for LHS testing, the NRC staff favored tests of the Cohassett flow top and vesicular zone. They also recommended a very large pump test of a highly transmissive unit in order to investigate the boundaries of the geohydrologic system. Further details about NRC's concerns may be found in Appendix B. Those concerns were considered in defining the recommended pre-ES geohydrologic testing program in this option paper.

C. DISCUSSION

1. Objectives of the Pre-ES Testing Program

The overall objective of the geohydrologic testing program is to provide sufficient data to determine whether the site is qualified for licensing in terms of the governing regulations (10 CFR 60, 10 CFR 960, and 40 CFR 191). The pre-ES testing program will satisfy some of the information needs derived from the above regulations. Initially the program focuses on collecting information about conditions that may be significantly changed or rendered unobtainable (i.e., conditions that are "perishable") after shaft construction. In addition, the pre-ES testing program is structured to provide an early indication of whether disqualifying conditions (as defined in 10 CFR 960) are present before proceeding with construction of the ES, to provide data on geohydrologic conditions that may affect the design of the ESF or the repository, and to collect data on geohydrologic conditions in order to identify the effects of the ESF on the geohydrologic system and on subsequent geohydrologic tests.

2. Identification of Pre-ES Tests

The geohydrologic testing needs for the Hanford site were determined by examining the Department's Issues Hierarchy for a Mined Geologic Disposal System (DOE/RW-0101, September 1986) for issues whose resolution require geohydrologic tests. Those issues having geohydrologic test requirements are listed in Exhibit III. For each issue, the geohydrologic information needs that comprise the issue, the types of geohydrologic parameters that comprise the information need, the kind(s) of test(s) needed to obtain the parameter values, and the timing or sequencing of each test are identified. The timing of each test--that is, before or after ES construction--was determined by consideration of the following factors: a) potential for monitoring "perishable" conditions, b) potential for obtaining an early estimate of important design parameters, c) potential for early recognition of disqualifying conditions, and d) potential for unacceptable interference from the ESF.

Only two issues contain disqualifying conditions which can be evaluated solely with geohydrologic information. These are postclosure geohydrology (Issue 1.9.1 with respect pre-waste emplacement ground-water travel time) and preclosure hydrology (Issue 4.1.4 with respect to engineering measures beyond reasonably available technology). Criteria for evaluating the presence of disqualifying conditions are given in Exhibit IV; tests needed to provide data to evaluate the site against these criteria are also identified. Should the testing program provide data that exceed the evaluation criteria and thereby indicate the potential presence of a disqualifying condition, all available data related to that criterion will be evaluated and/or additional testing will be performed to confirm whether the data are representative of the site and the condition is pervasive across the site.

The approach described herein led to the identification of four types of tests that will be conducted before ES construction: (1) baseline hydraulic-head monitoring, (2) large-scale hydraulic stress (LHS) tests, (3) hydrochemical sampling in conjunction with the LHS tests, and 4) tracer tests in conjunction with the LHS tests.

Baseline hydraulic-head monitoring establishes the horizontal and vertical hydraulic-head distribution in and near the site. This test will provide the potentiometric surfaces of key hydrostratigraphic horizons before disturbances of the ground-water flow system by other site-characterization activities. Such activities include LHS testing, shaft sinking, construction of the ESF, and subsequent dewatering for underground testing in the ESF. Establishment of the hydraulic-head baseline for undisturbed conditions is necessary to evaluate the postclosure performance of the repository. Baseline monitoring should also enable test-induced perturbations to the geohydrologic system to be distinguished from background changes from other causes (e.g., seasonal fluctuations).

Large-scale hydraulic stress (LHS) tests will yield hydraulic parameter values that contribute to the evaluation of ground-water flux, ground-water travel time, and solute transport characteristics of hydrostratigraphic units at, above, and below the proposed repository horizon. Such tests must be performed at the repository location prior to ESF construction because these construction activities will disrupt the site geohydrologic system. The disruption could be such that subsequent LHS tests in the area of the ESF cannot be analyzed to an acceptable level of confidence.

Hydrochemical sampling would be conducted in conjunction with ground-water withdrawal during LHS tests. Such sampling and analysis will aid in defining the hydrochemical baseline for interpreting ground-water flow conditions. In addition, radioisotope analyses of samples taken for age-dating purposes will be used along with existing data to evaluate the presence of a disqualifying condition.

Tracer tests in conjunction with LHS tests would yield values for the effective porosity of selected flow tops. Effective porosity is necessary in order to calculate travel times along ground-water flow paths. Effective porosity in the vicinity of ESF construction may be considered a perishable condition due to the potential effects of dewatering and grouting. The tracer tests would also provide dispersivity values needed for solute-transport modeling.

3. Impacts of the ESF on the Local Ground-Water System

As already mentioned, the pre-ES geohydrology testing program should be designed, in part, to collect data on geohydrologic conditions needed to predict and interpret the effects of the ESF on the geohydrologic system and on subsequent geohydrologic tests.

Possibly the most significant change in the local ground-water flow system that could result from drilling the exploratory shafts is an increase of several orders of magnitude in the vertical hydraulic conductivity within the zone of damaged rock adjacent to the shafts. If the pressure grouting of the shaft liner does not effectively seal the annular space or penetrate the damaged-rock zone, the increased vertical hydraulic conductivity could cause individual heads in successive flow tops to reach a common hydraulic head or could lead to an overestimation of the natural system's vertical leakage across the intervening dense flow interior during subsequent LHS tests. The most effective solution is to avoid any problem resulting from drilling the ES by completing the necessary geohydrologic testing before shaft construction. Post-ES geohydrologic tests, especially in regard to the ability to demonstrate effective sealing of shafts, are planned in order to quantify these potential effects.

Construction, operation, and testing of the underground testing facility could also have significant effects on geohydrologic conditions (e.g., hydraulic head) and hydraulic properties (e.g., vertical hydraulic conductivity of the Cohassett flow interior). These effects may include:

- Creation of a damaged rock zone around the drifts induced by drilling and blasting. The vertical hydraulic conductivity in the damaged-rock zone may be significantly increased as the apertures of existing fractures are increased or as new fractures are opened. This damaged rock zone may extend several drift diameters in any direction, potentially intersecting both the Cohassett vesicular zone and the Birkett flow top.

- Fracturing around the underground workings induced by stress redistribution over a period of several months. Such fracturing may also significantly increase the vertical hydraulic conductivity in the Cohassett dense interior, potentially intersecting both the Cohassett vesicular zone and the Birkett flow top.

- Hydraulic-head changes. The ESF workings will be at atmospheric pressure, whereas the ground water within fractures in the Cohassett dense interior and in adjacent flow tops is confined at 1300 to 1500 psi. A very large head differential towards the underground workings will result in inflow to the underground workings and an attendant reduction in hydraulic head in the Cohassett and other flows to distances as great as several kilometers (Exhibit V). In essence, the dewatering of the underground testing facility will have the effect of a long, horizontal well, with the volume of water withdraw (estimated to range from less than 1 gpm to more than 1000 gpm) potentially much greater than the pumping rates of the small-diameter wells used for post-ES LHS testing. This is especially true if any discrete, through-going, highly transmissive, vertical features are encountered in the excavation for the underground testing facility.

D. OPTIONS

Several options have been considered for the pre-ES geohydrologic testing program, ranging from establishing only the site hydraulic-head baseline to performing virtually the entire surface-based geohydrology testing program for the Hanford site. For purposes of this analysis, five options are considered:

Option (a) Establish the site hydraulic-head baseline only. This option would provide information on hydraulic-head conditions that may be significantly changed by subsequent site-characterization activities.

Option (b) Establish the baseline, conduct one LHS test in the Rocky Coulee flow top (the basalt flow immediately above the proposed repository flow), collect hydrochemical data and perform tracer tests in the Rocky Coulee flow top at the RRL-2 location. This option would test what is presently considered the first transmissive flow top above the repository horizon.

Option (c) Establish the baseline, conduct one LHS test in the Birkett flow top (the basalt flow immediately below the repository horizon), collect hydrochemical data and perform tracer tests in the Birkett flow top at the RRL-2 location. This option would provide for the investigation of the most transmissive unit in proximity to the repository horizon.

Option (d) Establish the baseline, conduct LHS tests, collect hydrochemical data and perform tracer tests in multiple horizons at the RRL-2 location. This option would allow direct testing of transmissive intervals in the Grande Ronde Basalts above, below, and including the repository horizon at the ESF site.

Option (e) Establish the baseline, conduct LHS tests, collect hydrochemical data and perform tracer tests in multiple horizons at several different locations around the candidate site. This option would provide areally-distributed information on the geohydrologic properties of basalt flows around and including the repository horizon.

These options and their apparent advantages and disadvantages are compared below and summarized in Exhibit VI.

1. Option (a)

Description. This option assumes that all hydraulic testing can be performed and adequately interpreted after the exploratory shafts and the underground testing facility are completed. Measurements of water levels would be taken in about 35 existing facilities. Two new nested piezometers, DC-24 and DC-25, would be added to this network in order to meet minimal needs for the hydraulic-head baseline. The establishment of a baseline would provide information on three-dimensional flow direction, which is important in calculating the pre-waste emplacement ground-water travel time and, hence, in performance assessment.

Advantages. This option would have the least effect on the ESF schedule and would yield data on conditions that may be changed by shaft construction.

Disadvantages. Option (a) would provide insufficient information for identifying disqualifying conditions and no information for the design of the exploratory shaft facility or the repository. Furthermore, this option would provide no geohydrologic testing data on which to base interpretations of post-ES geohydrologic test results or to predict the effects of ESF construction. Such a limited program would draw little support from the technical community.

2. Option (b)

Description. This option would consist of option (a) plus one LHS test, collection of hydrochemical data and tracer tests in the Rocky Coulee flow top. The Rocky Coulee flow top (Exhibit I) is currently considered the first unit above the Cohassett flow having sufficiently high hydraulic conductivity to provide an important lateral flow path to the accessible environment.

Site facilities are presently configured for the LHS test in the Rocky Coulee flow top and include RRL-2 (A, B, C), DC-19, DC-20, DC-22, DC-23, RRL-14, and RRL-17. However, two new nested piezometers, DC-32 and DC-33, would be installed about 1000 meters southwest and southeast of the RRL-2B location, respectively, before the Rocky Coulee LHS test. In addition, several monitoring points will be established in the Birkett flow top. The test would be conducted by pumping from the Rocky Coulee flow top (at RRL-2B) and measuring drawdowns and pressures in the monitoring facilities listed above. Responses to pumping would be monitored in the Ginkgo flow top, the Rocky Coulee flow top, flow tops above and below the pumped zone, and in the Cohassett dense interior.

Advantages. Option (b) requires no major reprogramming of site activities, because the Rocky Coulee test conforms to the current test plan and existing or planned facilities, except for wells DC-32 and-33; thus, disruption of the ES schedule would be minimal. Tests conducted under this option would yield data on geohydrologic conditions in the Rocky Coulee flow top that may changed by shaft construction and would produce some of the information needed to identify the presence of disqualifying conditions.

Disadvantages. The tests would provide little information for engineering design, little information on the repository horizon and adjacent horizons, and limited information on the effects of the shafts and the underground testing facility on future geohydrologic tests. In addition, there are reasons to believe that a pre-ES test program of such limited scope would not be acceptable to much of the technical community.

3. Option (c)

Description. Option (c) consists of option (a) plus a single LHS test, the collection of hydrochemical data, and tracer tests in the Birkett flow top. There are indications that the Birkett flow top (Exhibit I) (immediately below the Cohassett dense interior) is more transmissive than the Cohassett and Rocky Coulee flow tops and could yield a more a really-extensive LHS test. Limited data indicate that the Birkett flow top could be the major contributor to water inflow to the underground testing facility. Because of the proximity of the flow top to the repository horizon, it is important to characterize the Birkett in order to assess site performance and to obtain data for ESF and repository design.

Site facilities are presently not set up for an LHS test in the Birkett flow top; a pumping well would have to be provided by deepening RRL-2B. In addition, several monitoring boreholes (i.e., RRL-2A, RRL-6, RRL-17, RRL-14, DC 4/5, and DC-16) would need to be reconfigured and two new nested piezometers, DC-32 and DC-33, would be installed about 1000 meters southwest and southeast of RRL-2B, respectively. The Birkett could probably be pumped at a greater rate than that expected for the Rocky Coulee test of option (b). The effects of the test on hydraulic heads would be monitored in the Birkett flow top, the Cohassett dense interior and flow top, the Rocky Coulee flow top, and the Umtanum flow top.

Advantages. Because the Birkett flow top may be the most transmissive of the flow tops in the upper part of the Grande Ronde Basalt at the candidate site, and because it is immediately adjacent to the base of the Cohassett flow, an LHS test in the Birkett flow top has the best potential for assessing the hydraulic characteristics of the Cohassett dense interior, particularly the vertical hydraulic conductivity. This test has some potential for indicating the presence of disqualifying conditions and would provide engineering information.

Disadvantages. Option (c) would require a significant effort to drill and reconfigure boreholes for pumping or monitoring. Some delay in the ES schedule may occur. Because of the limited scope of LHS testing in the vicinity of the exploratory shafts before the start of shaft construction, option (c) would not be acceptable to some of the technical community.

4. Option (d)

Description. This option consists of option (a) plus LHS tests, the collection of hydrochemical data, and tracer tests in the Rocky Coulee, Cohassett and Birkett flow tops and the Cohassett vesicular zone. It is based on the assumption that the drilling and construction of the exploratory shafts and the underground testing facilities will result in a significant disruption of the geohydrologic system.

Existing boreholes and planned piezometer nests DC-24 and DC-25 would provide the necessary hydraulic-head baseline data. As in option (c), several existing boreholes would need to be reconfigured to optimize monitoring locations in the horizon being tested. Furthermore, it will be necessary to install new nested piezometers DC-32 and DC-33 about 1000 meters southwest and southeast of RRL-2, respectively. The sequence of testing would be the Rocky Coulee flow top, the Cohassett flow top, the Cohassett dense interior (vesicular zone), and the Birkett flow top, unless further and more detailed planning identifies a technically more advantageous approach. LHS tests would be performed in each unit capable of adequate sustained yield for an appropriate duration. Small-scale injection tests would be performed in those units not sufficiently transmissive for an LHS test.

Advantages. Option (d) would establish the necessary hydrologic baseline and provide for "perishable" geohydrologic conditions in key basalt flow tops and dense interiors (especially the proposed repository horizon, the Cohassett dense interior) prior to sinking the exploratory shafts. The tests would provide information on whether disqualifying conditions are present near the ESF and would yield a substantial amount of information important to ESF and repository design. In addition, the tests would provide information useful in evaluating the effects of ESF construction on the hydraulic characteristics of the geohydrologic system. The tests would establish a data base that could be essential for interpreting subsequent LHS tests conducted during underground testing activities. This option is considered more technically defensible and one that would receive appreciable acceptance from the technical community.

Disadvantages. Option (d) would result in delays in the ES schedule, largely because of the time needed to prepare for and carry out the full series of LHS tests at the RRL-2 location.

5. Option (e)

<u>Description</u>. This option differs from option (d) only in that it incorporates LHS tests at other pumping centers in addition to RRL-2. These other pumping centers would serve to better define potential heterogeneities in the basalt flows tested at RRL-2. Whereas all of the facilities outlined in option (d) would be needed, the number of additional pumping and monitoring wells necessary for option (e) has not been determined.

<u>Advantages</u>. Option (e) would yield definitive data on perishable geohydrologic conditions, information needed for ESF and repository design, and information on whether disqualifying conditions are present at the site. In addition, the tests would cover much of the candidate-area study zone and help define geohydrologic boundaries. Option (e) would have the greatest support of the technical community.

<u>Disadvantages</u>. Option (e) would cause major delays in the ES schedule and expenditure of substantial funds before the start of ES construction.

E. RECOMMENDATION

The five options described in the preceeding section are associated with various degrees of risk of not attaining the objectives of the pre-ES geohydrology testing program.

Option (a) has very high risk because it satisfies only one of the several objectives of the pre-ES geohydrology testing program -- establishing the hydraulic-head baseline. Under this option, definitive testing results necessary to resolve some licensing issues would be subject to the uncertainty caused by interference from the ESF. This uncertainty may be sufficiently large to cast doubt on all subsequent test results and prevent issue resolution. Such an outcome may compromise the site's licensability.

Option (b) is deemed to have a high risk. Whereas the results of a single test of the Rocky Coulee flow top could provide some data indicative of the presence of disqualifying conditions, the test would have limited value in meeting other objectives. The single test will not define the hydraulic properties sufficiently to discriminate subsequent test results from the disruptive effects of the ESF. At best, the hydraulic characteristics of the Rocky Coulee flow top will be well defined while the potential for a good estimate of the hydraulic characteristics of adjacent flows may be very limited.

Option (c) is also considered to have a high risk for much the same reasons as option (b). However, this option does have the potential for yielding more useful information over a broader areal extent if the Birkett flow top proves to be as transmissive as expected. The Birkett test should also allow better inferences as to the properties of the Cohassett interior than option (b).

Option (d) is a low risk option because values of many of the hydraulic properties of the Grande Ronde Basalt in the vicinity of the ESF would be obtained before shaft construction. It would provide information about disqualifying conditions near the RRL-2 location and useful design information on the expected behavior of the Cohassett dense interior. This option would yield a data base from which to evaluate the results of post-ES tests.

Option (e) has a very low risk because it would give a three-dimensional perspective on a substantial portion of the site before the start of other site characterization activities. Testing from several pumping centers should establish, with a high degree of confidence, the ability of the Cohassett dense interior to host a repository. Any subsequent geohydrologic testing would be largely confirmatory.

Given these considerations, including the many past criticisms leveled by NRC and others, it is recommended that the prudent, low-risk approach represented by <u>option (d)</u> be adopted. This option would give the best opportunity for satisfying pre-ES geohydrologic testing program objectives without major delays in other components of site characterization.

The basis for the logic of the program and activities required to implement the program, including construction of new facilities, are explained in Appendix C.

F. APPROVALS

The recommended option is approved and the activities required to implement the option may proceed as proposed.

Approve: [illegible]
Disapprove: ____________
Comments: ____________

Date: 3/16/87

Ralph Stein
Director
Engineering and
Geotechnology Division

Approve: [illegible]
Disapprove: ____________
Comments: ____________

Date: [illegible]

John Anttonnen
Assistant Manager for Commercial
Nuclear Waste
Richland Operations Office

Approve: A. H. Kale

Disapprove: ________________

Comments: ________________

____

____

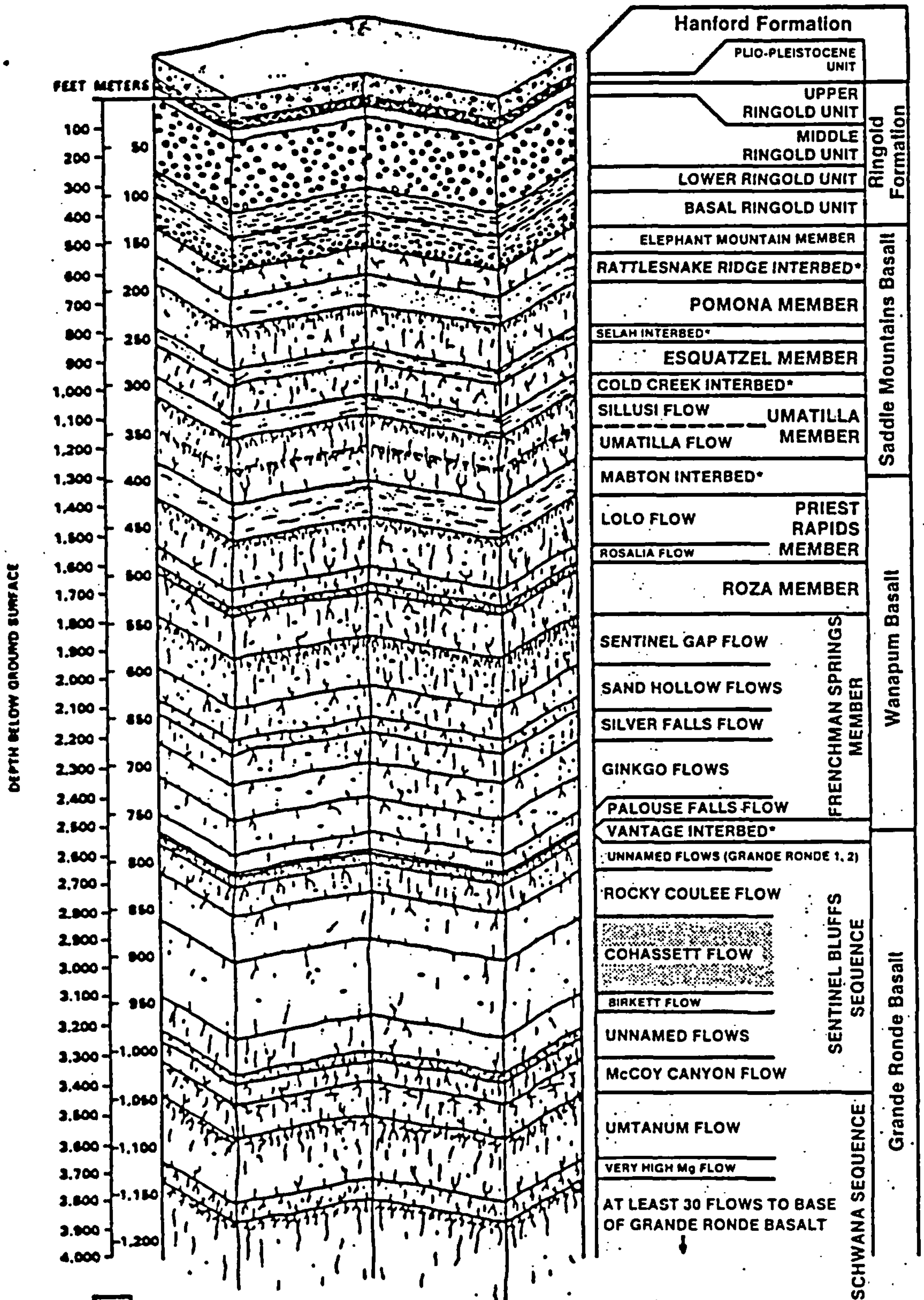
Date: 3/16/87

Stephen Kale
Associate Director
Office of Geologic Repositories

G. NEXT STEPS

Subsequent activities related to the implementation of the recommended approach are presented in a diagram (Exhibit VII) and include the development of: (a) a strategy for the total geohydrology program; (b) a revised issue resolution strategy; (c) Section 8.3.1.3 of the Site Characterization Plan (SCP); (d) geohydrology-related study plans; (e) approved drilling plans for wells DC-24, -25, -32, and -33; (f) numerical analyses required to support planning decisions; and (g) responses to NRC concerns. The goal is to conduct an NRC workshop on the pre-ES geohydrology program in April, 1987 and to start drilling of DC-24 and DC-25 by September, 1987.

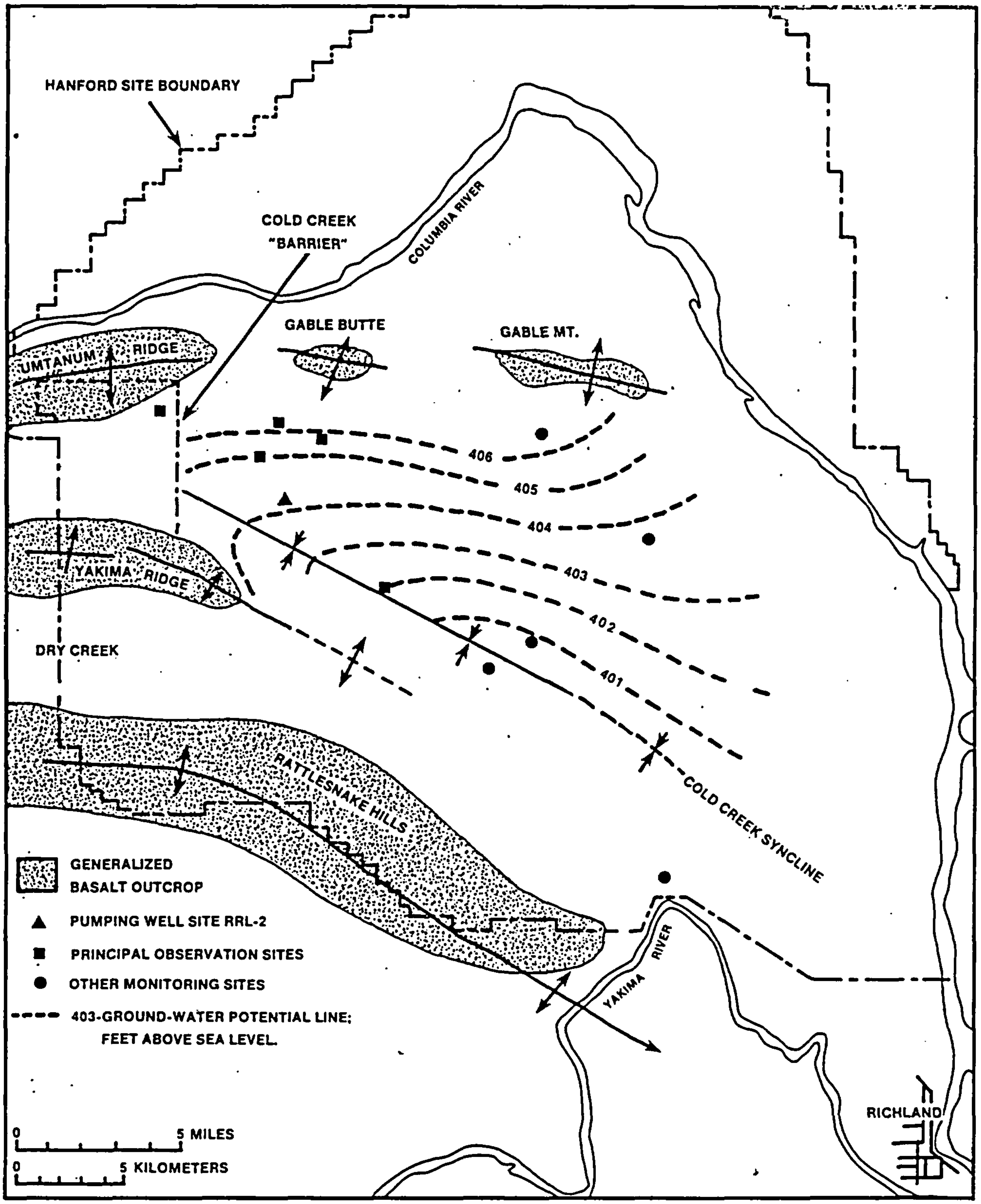
At least two workshops with the NRC staff, States and affected Indian Tribes will be necessary before the start of testing. The objective of the first workshop will be to obtain closure on the pre-ES geohydrologic testing program and the resolution of earlier NRC comments. Preparation for this workshop will require the completion of the pre-ES geohydrology testing strategy and a comment-response document. Materials needed for a second workshop include the issue resolution strategy, Section 8.3.1.3 of the SCP, the hydrology-related study plans and documentation supporting the first test, such as test plans with specifications, QA plans and procedures, baseline acceptance and test-decision criteria, and numerical analyses supporting planning decisions. The second workshop would occur soon after issuance of the SCP.



CANDIDATE REPOSITORY HORIZON

*INTERBEDS ARE STRATIGRAPHICALLY CONTAINED IN THE ELLENSBURG FORMATION

Stratigraphy of the Columbia River Basalt Group, from within the Grande Ronde to the surface, and sediments within the RRL.



CONCEPTUALIZED POTENTIOMETRIC SURFACE NEAR TOP OF GRANDE RONDE BASALT, COLD CREEK SYNCLINE, FALL 1986 WATER LEVELS

SUMMARY OF HYDROLOGIC TESTS TO RESOLVE ISSUES HAVING GROUND WATER INFORMATION NEEDS

Issue	Information Needs	Parameters	Tests	Timing Need	Comments
1.1 Release to accessible environment	Diffusion in dead-end pore (matrix diffusion)	Diffusion coefficients	Multiple well tracer tests; Lab tests on rock samples	Post ES, should be incidental with other tracer tests	
	Flow & mass transport through fractures versus continuum	Kh (horizontal hydraulic conductivity) of flow tops or T(transmissivities); Kv (vertical hydraulic conductivities) and Kh of flow interiors; response shapes of hydrographs	LHS tests; borehole cluster tests in ESF	Pre ES at RRL2 Post ES for others	Pre ES for: perishable conditions; identify disqualifying conditions
		Effective thickness of flow tops; Dispersivities; Storativity of flow tops and specific storage of flow interiors	Multiple well tracer tests; borehole cluster tracer tests in ESF; core analyses	Pre ES at RRL-2; Post ES, coordinate with other tracer tests	Pre ES for: same as above for 1.1
	Hydraulic properties and thickness of damaged rock	K(hydraulic conductivity) effective porosity	Borehole tests in ESF	Post ES	
	Spatial distribution of hydraulic properties including directionality of hydraulic conductivity or T of flow tops and interiors, Umtanum to Ringold	3-D head distribution; K_v flow interiors; T and Kh of flow tops; effective thickness; dispersivity effective pososity	Baseline monitoring;	Pre ES;	
			LHS tests and tracer test (for T, Kv effective thickness, effective porosity, Kh, dispersivities);	At least RRL2 Pre ES	Results of RRL-2 tests would determine need to do others pre ES
			single-well tests for T	Post ES	Pre ES for: same as above for 1.1
			Dual well test (T, effective thickness, dispersivity)	Post ES	
			Drill & test piezometers, T	Concurrent with ES	
	Hydraulic boundary conditions	3-D distribution of hydraulic head	Baseline head monitoring	Pre ES	Pre ES for: Same as 1.1
		Spatial distribution of Kh or T of flow tops and K_v of flow interior	LHS tests at RRL2 Other LHS tests	Pre ES Some may be Pre ES, Others Post ES	Depends on results of RRL-2 Pre ES for: same as above for 1.1.

Symbols: CASZ - Controlled Area Study Zone
ES - Exploratory Shaft
ESF - Exploratory Shaft Facility
Kh - Horizontal Hydraulic Conductivity
Kv - Vertical Hydraulic Conductivity
LHS - Large-Scale Hydraulic Stress
T - Transmissivity

EXHIBIT III

Issue	Information Needs	Parameters	Tests	Timing Need	Comments
1.2 Individual Protection	Ground-water travel time	Same as 1.6	Same as 1.6	Same as 1.6	Pre ES for: same as above for 1.1
	Ground-water flux rates past waste package and at accessible environment	Same as 1.1, 1.4, 1.6	Same as 1.1, 1.4, 1.6	Same as 1.1, 1.4, 1.6	
1.4 Waste Package Life	Ground-water flux past waste package	Hydraulic head in Cohassett and Birkett flow tops	Baseline monitoring	Pre ES	Pre ES for: perishable condition
		K_v Cohassett flow interior Kh Cohassett flow interior	LHS tests, borehole cluster tests in ES, ESF tests (borehole and/or chamber)	Pre ES RRL-2 Post ES for others Post ES	Decision to run other LHS tests pre- or post-ES will be made after evaluating results of RRL-2 tests
1.5 Release Rates	Ground-water flux	Same as 1.4	Same as 1.4	Same as 1.4	Pre ES for: same as 1.4
1.6 Groundwater Travel Time	Disturbed zone outer boundary	K_v, Kh Cohassett interior	LHS tests Borehole tests in ESF	RRL-2 Pre ES Others Post ES Post ES test results	Need for other LHS tests pre ES would be decided after RRL-2 Pre ES for: same as 1.1
		Effective porosity and Kh, Birkett, Rocky Coulee, Cohassett flow tops	Porthole tests in ES LHS tests Tracer tests	Post ES RRL-2 Pre ES, others Post ES	
		K_v Birkett, Rocky Coulee flow interiors	Porthole tests in ES LHS tests	Post ES RRL-2, Pre ES	
	Accessible environment boundary	3-D distribution of hydraulic properties over CASZ and surrounding area • Hydraulic head in flow tops	Baseline head monitoring		
		• T of flow tops • Effective thickness, porosity of flow tops	LHS tests Tracer tests	RRL-2 Pre ES, others after ES	Pre ES for: same as 1.1
		• K_v flow interiors of Birkett, Cohassett, Rocky Coulee	K_v Cohassett flow interior will also be measured in ESF tests	Post ES	

Issue	Information Needs	Parameters	Tests	Timing Need	Comments
	Hydraulic parameters and boundary conditions within and surrounding CASZ	Same as previous information need plus hydraulic properties or other evidence of hydraulic boundaries and leakance in hydrographs of LHS tests and as indicated by regional flow system modeling	Same as previous	Same as previous	
	Hydrochemistry of upper Grande Ronde water in vicinity of CASZ	Concentration of carbon isotopes (C-12, C-13, C-14), Cl-36, H-3, I-129, deuterium, O-18, major dissolved and suspended solids and gases, pH, temp., in flow tops of Birkett, Cohassett, Rocky Coulee, Umtanum, and perhaps others	Samples from drill and test wells	Pre ES for some Post ES for others	Pre ES for: identifying disqualifying condition
			LHS tests: RRL-2 Others	 Pre ES Post ES	 Depends on results of RRL-2 tests
			Samples from other available wells	As many pre ES as possible from available wells	Pre ES for: identifying disqualifying condition
1.7 Performance Confirmation	Hydraulic properties of Cohassett interior and flow top and Birkett flow top immediately adjacent to repository excavation	Same as 1.6	Various in situ tests in repository excavation during and after construction (to be designed later)	Post ES (during and after repository construction)	
1.8 Favorable and Adverse Conditions	Ground-water flow rates to ESF and repository during construction and operation	Specific storage and K_V of Cohassett flow interior and K_H and storativity of Birkett and Cohassett flow tops	Same as 1.4	Same as 1.4	Pre ES for: identifying disqualifying condition; engineering design data
	Combustible gas inflow to ESF and repository during construction and operation	Concentration of major dissolved gases in Birkett, Cohassett and Rocky Coulee flow tops	Same as 1.6 plus hydrochemistry tests	Same as 1.6 plus hydrochemistry tests	

Issue	Information Needs	Parameters	Tests	Timing Need	Comments
1.9 Postclosure Guidelines	Boundary Conditions and distribution of hydraulic properties of flow tops-Umtanum, McCoy Canyon, Birkett, Cohassett to Ginko	Same as 1.6	Same as 1.6 and 1.4	Same as 1.6 and 1.4	Pre ES for: Perishable condition, identify disqualifying condition
	Hydraulic properties of flow interiors-Birkett, Cohassett, Rocky Coulee	Same as 1.6	Same as 1.6 and 1.4	Same as 1.6 and 1.4	
	Hydrochemistry of groundwater in flow tops	Same as 1.6	Same as 1.6 and 1.4	Same as 1.6 and 1.4	
1.11 Repository Design	Inflow rates of water and combustible or toxic gases to repository	Same as related information need in 1.8 and 4.1.4	Same as 1.8 and 4.1.4	Same as 1.8 and 4.1.4	Pre ES for: same as 1.8
	Hydraulic properties of Cohassett flow interior and adjacent flow tops surrounding the repository	Same as 1.6, 1.7, and 1.8	Same as 1.6 and 1.7	Same as 1.6 and 1.7	
1.12 Seals Postclosure	Hydraulic conductivities of seals and zone between seals and rock or casing	Same as information need	Hydraulic and tracer tests in borehole and shafts plus lab tests	Post ES	
2.6 Waste Package Design Preclosure	Ground-water flux past package	Same as 1.4	Same as 1.4	Same as 1.4	
2.7 Repository Design Preclosure	Same as 1.1, 1.2, 1.6, 1.8, 1.9	Same as 1.1, 1.2, 1.4, 1.6	Same as 1.1, 1.2, 1.4, 1.6	Same as 1.1, 1.2, 1.4 1.6	Pre ES for: same as 1.8
4.1.1 Ease and Cost of Construction	Water and gas inflow to repository	Same as 1.8	Same as 1.8	Same as 1.8	
4.1.3 Rock Characteristics	Distribution of hydraulic properties of Cohassett flow interior and adjacent flow tops	Same as 1.1, 1.2, 1.6	Same as 1.1, 1.2, 1.6	Same as 1.1, 1.2, 1.6	
4.1.4 Preclosure Hydrology	Ground water and gas inflow to ESF and repository	Same as 1.8	Same as 1.8	Same as 1.8	Pre ES for: same as 1.8

EXHIBIT III (Cont'd)

Issue	Information Needs	Parameters	Tests	Timing Need	Comments
4.2 Repository design: nonradiological worker safety	Same as 1.8 and 1.11	Same as 1.8	Same as 1.8	Same as 1.8	Pre ES for: same as 1.8
4.4 Repository design; adequate technology for repository construction, operation, closure, decommissioning	Same as 1.8 and 1.11	Same as 1.8	Same as 1.8	Same as 1.8	Pre ES for: same as 1.8
4.5 Repository design: cost of waste packages and repository	Same as 1.11	Same as 1.8	Same as 1.8	Same as 1.8	Pre ES for: engineering design data

EXHIBIT III (Cont'd)

APPENDIX A

Geohydrology of the Hanford Site

Within the northern half of the Columbia Plateau, composite potentiometric surfaces have been mapped and data limitations described. One surface is drawn for each hydrostratigraphic unit: Saddle Mountains, Wanapum, and Grande Ronde Basalts. These data suggest that the Pasco Basin is an area of regional ground-water flow convergence. This is expected since the basin occupies the lowest topographic point in the plateau. Knowledge of vertical hydraulic head distributions across the plateau (outside of the Hanford site) is limited to about 12 piezometers established by the Washington Department of Ecology and numerous composite wells (within a single formation) developed for agricultural use. Generally, these data show a trend of decreasing head with increasing depth. This means ground-water recharge is taking place at the monitored locations. Comparison of the above-mentioned potentiometric surfaces also suggests recharge is taking place across large portions of the plateau.

Hydraulic heads are monitored in 35 wells on the Hanford site in support of the basalt studies. Most head measurements are within single basalt flow tops or interbeds rather than composite measurements of several hydrostratigraphic units. Within the central part of the controlled area study zone, the observed horizontal head gradients in the basalts appear to range between 10^{-5} and 10^{-4}. Vertically, head gradients are directed downward across the Saddle Mountains Basalt and upward across the lower Wanapum and Grande Ronde Basalts, convergency in the upper Wanapum.

Within the area bounded by multilevel piezometer wells DC-19, 20, and 22, ground-water movement in the Wanapum and Grande Ronde Basalts appears to be south to southwest. The local hydraulic influence of geologic structures (Umtanum Ridge-Gable Mountain anticline, Yakima Ridge anticline, and the Cold Creek flow impediment) bordering the proposed repository site requires further investigation.

Horizontal hydraulic conductivities estimated from field tests within flow interiors range between 10^{-15} and 10^{-9} m/s. No definitive estimates of vertical hydraulic conductivity within flow interiors presently exist. The ratio of vertical to horizontal hydraulic conductivity for flow interiors is estimated to be approximately three to one.

More than 200 single-hole, small-scale hydraulic tests have been completed in flow tops and interbeds in some 35 boreholes across the Hanford site. These data have identified the stratigraphic locations of several significant sources of ground water and have provided information about the spatial variability of conductivities within individual flow tops and interbeds. Values as large as 10^{-2} m/s or as small as 10^{-12} m/s are reported. The geometric mean for the flow tops and interbeds of the Saddle Mountains and Wanapum Basalts is 10^{-5} to 10^{-4} m/s. The geometric mean for Grande Ronde Basalt flow tops is between 10^{-8} and 10^{-7} m/s.

Some hydraulic testing of tectonic features has occurred. This includes the few faults or shear zones penetrated in boreholes or the large-scale testing of major geologic structures. The tectonic features tested have equivalent hydraulic conductivities that are either high (10^{-3} to 10^{-4} m/s) or low (less than 10^{-11} m/s).

Two small-scale tracer tests have been conducted in the flow tops of the McCoy Canyon flow of the Grande Ronde Basalt. Longitudinal dispersivity values reported were 0.46 and 0.84 m and effective thickness estimates were 2×10^{-3} and 3×10^{-3} m. Estimates of large-scale transverse dispersivities for Wanapum and Grande Ronde Basalts were also calculated by modeling changes in chloride concentrations. Transverse dispersivities ranging from 20 to 370 m were reported. Values of about 45 m are interpreted as most reliable.

Specific storage values reported from field tests of basalt flow tops range between 10^{-4} and 10^{-5} 1/m. By assuming reasonable ranges for compressibility of fractured and solid rocks, specific storage values for basalt flow interiors are estimated to be about 10^{-6} to 10^{-7} 1/m.

Ground waters in basalt aquifers across the Columbia Plateau are relatively dilute, bicarbonate waters with cation ratios (Na+K)/(Na+K+Ca+Mg) varying between 12 and 99 percent. Low values correspond to recently recharged waters and high values exist in older, more evolved waters. Ground-water ages vary from approximately 5,000 to over 30,000 years, as estimated from the percentage of modern carbon-14 present in water samples. Chlorine-36 analyses indicate that ground-water ages in the Grande Ronde Basalts at the controlled area study zone are greater than 100,000 years. Data on ground-water ages are sparsely distributed in the Columbia Plateau; therefore, it is not possible to rigorously evaluate ground-water travel times from expected recharge to discharge areas using age-dating techniques.

Beneath the Hanford site, shallow basalt water is of a sodium-bicarbonate chemical type; deep basalt water is of a sodium-chloride chemical type. On a location-by-location basis, chemical and isotopic shifts can be pronounced and are believed to delineate flow system boundaries, chemical evolution taking place along flow paths, and ground-water mixing. Most ground waters sampled from across the Columbia Plateau appear to be compositionally similar to shallow ground water from the Hanford site as represented by water samples from springs, the unconfined aquifer, and the Saddle Mountains Basalt. These similarities exist for major cations, anions, pH, and the stable isotopes of hydrogen, carbon, and oxygen. There are no reported ground-water analyses from the regional data base that manifest the same degree of enrichment in sodium, chloride, and fluoride as do most Wanapum and Grande Ronde ground waters underlying the Hanford site.

An analysis of hydrochemical data suggests that a geochemical evolutionary trend exists that developed as a result of rock and water interaction. It appears that dissolution-precipitation reactions involving volcanic glass, plagioclase feldspar, calcite, clays, and zeolites are important components in this process. Evidence also suggests that the deep Grande Ronde Basalt waters form an evolutionary trend distinct from shallower waters. This deep ground water is thought to move upward in the stratigraphic section and mix with shallower ground water. The best evidence for such mixing exists in the Wanapum Basalt beneath the central portion of the controlled area study zone. Several preliminary conceptual flow models have been developed and data needs have been identified. On a regional basis, the Pasco Basin appears to be an area of regional ground-water flow convergence. Although specifics are sometimes unavailable, it is proposed that the shallow basalts are locally recharged and discharged within sub-basins of the Columbia Plateau, while deeper basalts are part of a larger, regional flow system. The topographic and hydraulic effects of major anticlines trending generally east-west across the plateau likely contribute to the development of local flow systems and complicate (i.e., impede, redirect, or vertically mix) interbasin ground-water movement.

The layered geology at the controlled area study zone consists of alternating basalt flows containing high to low-conductivity intraflow units. Such heterogeneity causes rectilinear, three-dimensional ground-water movement to occur with lateral movement in flow tops and interbeds and vertical movement across flow interiors. Hydrochemical data suggest two possible conceptual models for ground-water movement within the controlled area study zone. One model proposes that upward ground-water movement is largely restricted in the central portion of the controlled area study zone. Subsequent lateral flow to the east within the Wanapum Basalt creates a plume of mineralized waters that traces the direction of ground-water movement. In the second model, a stagnant or near-stagnant flow system is proposed in the upper Cold Creek syncline. This condition is created by the presence of the Cold Creek flow impediment, Umtanum Ridge-Gable Mountain anticline, and the Yakima Ridge anticline. In this model, the degree of lateral flushing increases to the east and southeast where the syncline opens and the anticlines die out.

APPENDIX B

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

APR 10 1986

Mr. O. L. Olson
Director
Basalt Waste Isolation Division
U. S. Department of Energy
Richland Operations Office
P. O. Box 550
Richland, WA 99352

Dear Mr. Olson:

By this letter, the U. S. Nuclear Regulatory Commission (NRC) is transmitting the staff's review of the document entitled "Test Plan for Multiple-Well Hydraulic Testing of Selected Hydrogeologic Units at the RRL-2 Site, Basalt Waste Isolation Project (BWIP), Reference Repository Location" (SD-BWI-TP-040). The staff's observations resulting from the December 9-10, 1985 meeting have been integrated into these comments.

Based on the staff's review of the document prior to the December 1985 meeting, it was initially determined that the proposed testing strategy was consistent with that presented in the NRC's BWIP Site Technical Position (STP) 1.1. The test plan indicated that testing would begin with a repository scale, multiple-well pump test of the Rocky Coulee flow top. Additionally, testing would occur only after baseline hydraulic heads had been established and would continue until sufficient data were collected to allow identification and evaluation of hydrologic boundaries and hydraulic continuity of the hydrogeologic units surrounding the RRL.

Discussions during the meeting, however, indicated that the BWIP's present strategy deviates significantly from the strategy presented in STP 1.1 in two key areas. First, initial testing will not be on a repository scale, and thus, will not adequately evaluate the hydrologic and hydraulic properties of the Columbia River Basalts within the Cold Creek Syncline. This reduced scale of testing will not support development and calibration of repository performance models. Although the test plan indicated that repository scale testing would be performed, the BWIP refused, during the December meeting, to commit to performing such a test. Second, BWIP indicated during the meeting that baseline hydraulic heads, with respect to characterization of the pre-emplacement ground water flow system, will not be established prior to initiating the testing. Stage 1 of the strategy presented in STP 1.1 calls for a technical consensus that piezometric baseline, which is adequate for use in developing defensible assessments with respect to 10 CFR 60, has been established prior to initiating testing. The primary NRC concern is that perturbations on the system may be of such a magnitude that baseline determination may be delayed for a long period of time or be impossible to obtain within DOE's schedule for repository development. As the BWIP has stated in the past, other site activities, such as exploratory shaft construction and testing, may also significantly perturb hydraulic heads around the RRL further delaying establishment of baseline. This premise is substantiated by the hydraulic head perturbations evidenced in wells DC-19, 20, and 22 caused by removal of bridge plugs from RRL-14 and the drilling of DC-23, thus delaying the establishment of an LHS test baseline by several months. If such small-scale activities can create significant perturbations, it is conceivable that perturbations caused by exploratory shaft construction could delay the establishment of hydrologic baseline, with respect to characterization of the pre-emplacement groundwater flow system, for a period of several years. Such perturbations, should they occur while LHS testing is being performed, could also limit the DOE's ability to interpret LHS test data. The DOE's hydrologic testing strategy should allow for sequencing of site activities so that effects of one activity will not compromise the ability to perform others. Hydrologic baseline should be established to the extent possible with existing wells prior to performing any hydrologic testing. The DOE should be conservative with respect to baseline establishment, as this may be the only opportunity to collect necessary information in this area. Should the DOE determine that a testing program that significantly deviates from the agreed to strategy in STP 1.1 is more appropriate for characterizing the hydrologic regime at the BWIP, the DOE should provide to the NRC their rationale for deviating from STP 1.1 and explain how the proposed plan will provide a better hydrologic characterization of the site.

It became apparent during the December 1985 meeting that the BWIP's proposed plans for hydrologic site characterization were not sufficiently developed to allow commencement of testing in February 1986, as proposed. A sound technical rationale for the purpose and timing of the proposed testing was not presented nor was documentation provided to the NRC at the meeting. In addition, testing procedures and quality assurance plans had not yet been finalized, and the BWIP could not satisfactorily demonstrate how the testing strategy was being integrated with other site characterization activities.

It is our understanding, based on several telephone conversations between our staffs, that the BWIP is currently reevaluating their strategy and plan for hydrologic testing. In accordance with NRC/DOE agreements on pre-licensing consultations, it is requested that NRC/DOE consultations take place during the development of any new testing strategy so that the NRC can provide timely guidance that can be considered during your planning stages and thereby avoid unnecessary schedule delays. Additionally, the staff also requests early involvement in the readiness review process to provide the DOE guidance in this area prior to issuance of the Draft Readiness Review Plan.

Prior to initiating any hydrologic test work, the DOE should also develop a comprehensive quality assurance plan that is consistent with the criteria of Appendix B of 10 CFR 50. Backfitting of QA procedures after the fact is not acceptable.

Although most of the attached comments were discussed during the December 1985 meeting, few were resolved to the satisfaction of the NRC staff. Many of our comments required analyses that the BWIP had either not performed or was not prepared to present at the meeting. When revising the test plan document, the DOE should reincorporate the consultation review steps as agreed at the May 1985 Hydrology meeting. Additionally, the attached detailed comments together with the observations and agreements in the signed meeting minutes resulting from the December 1985 meeting should be addressed. The NRC considers resolution of these comments necessary prior to initiating hydrologic testing or exploratory shaft construction. The next appropriate forum for resolving these comments is the NRC/DOE workshop tentatively planned for July or August of this year.

Should you have any questions, please contact Paul Hildenbrand of my staff at FTS 427-4672 or Michael Weber at FTS 427-4746.

Sincerely,

John J. Linehan, Section Leader
Repository Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure:
NRC Review Comments

cc: R. Stein, DOE-HQ

NRC'S DETAILED COMMENTS ON
"TEST PLAN FOR MULTIPLE-WELL HYDRAULIC TESTING OF
SELECTED HYDROGEOLOGIC UNITS AT THE RRL-2 SITE,
BWIP, RRL" SD-BWI-TP-040

The following comments have been classified into several categories as they pertain to BWIP's proposed large-scale hydraulic stress (LHS) testing at RRL-2.

Monitoring Facilities

1. Monitoring Locations and Frequencies

Because of the uneven distribution of monitoring facilities around the pumping well (RRL-2B), BWIP's ability to characterize and interpret hydraulic responses to pumping stress in three dimensions is limited. As planned, water levels will not be monitored between radial distances of 152 m (RRL-2A) and 2250 m (RRL-14). Without water level information at intermediate scales between RRL-2A and RRL-14, results from LHS testing of the Grande Ronde Basalts at RRL-2 may yield considerable uncertainty in interpretations drawn from the test results. For example, deviations from expected drawdown responses may be caused by distributed leakage through flow interiors or discrete features, or by interference by hydrogeologic boundaries. It appears that current monitoring facilities at the Hanford Site are inadequate to achieve the objectives of LHS testing because of their locations and limited number.

The inadequacy of present monitoring facilities is especially acute for the third planned LHS test, which will stress the Grande Ronde 5 flow top. Of the three proposed tests, the LHS test of the Grande Ronde 5 flow top has the greatest potential to be a repository-scale test because of the unit's apparent high transmissivity in the vicinity of the RRL-2 cluster. However, only two facilities presently monitor the Grande Ronde 5 flow top: RRL-2C at 76 m from RRL-2B and RRL-14 at 2250 m. The limited number and locations of these facilities appear to be inadequate to characterize hydrologic boundaries and hydraulic continuity, and the spatial distribution of hydraulic properties. BWIP should install additional monitoring facilities or substantially modify existing facilties prior to conducting the proposed LHS test in the Grande Ronde Number 5 flow top.

Prior to conducting LHS testing, BWIP needs to demonstrate how proposed monitoring facilities will provide necessary hydraulic head and response data for site characterization. BWIP should assess the limitations of the present monitoring network at the Hanford Site and improve the network to accomplish the objectives of LHS testing and site characterization. Potential improvements to the network range from increasing the frequency and location of head measurements at existing facilities to installing new monitoring facilities. A more comprehensive piezometer network (both in frequency of measurement and location) would support characterization of the groundwater flow system in the Pasco Basin and provide a potentiometric baseline against which BWIP could compare effects of drilling, well development, testing, and other activities (e.g., exploratory shaft construction, off-site perturbations, wastewater disposal activities).

2. Cement Effects

During the drilling of RRL-2A and -6, the Rocky Coulee flow top was cemented to reduce mud loss. This cementing may adversely complicate the interpretation of water level responses and tracer breakthrough during the first LHS test. Such complications in RRL-2A could be especially important because of the sensitivity of test interpretations to water level responses at this location and because cement may inhibit tracer injection into the Rocky Coulee flow top.

During the meeting, BWIP asserted that cement does not significantly interfere with hydraulic communication between RRL-2A and the Rocky Coulee flow top. This position was based on evaluation of dynamic temperature logs and comparisons of hydraulic test data. Dynamic temperature logging indicated that the Rocky Coulee flow top still contributes flow to the well. BWIP also compared the transmissivity value determined from a hydraulic test of the combined Grande Ronde 2 flow and the Rocky Coulee flow top in RRL-2A with the transmissivity value determined from a pulse test in RRL-2B. BWIP concluded that the two transmissivity values compared favorably, thus indicating that cement does not inhibit hydraulic communication between the borehole and the Rocky Coulee flow top.

Although BWIP provided a verbal basis for its assertion that cement in RRL-2A and -6 does not signficantly inhibit hydraulic communication with the Rocky Coulee flow top, BWIP did not provide any documentation of the conclusions nor supporting assessments. BWIP should document the basis for its assertion and then provide it to NRC for review and comment.

3. Borehole Interflow

Subsequent to the first LHS test in the Rocky Coulee flow top and removal of bridgeplugs, interformational flow via open boreholes between flow tops and other producing zones may occur within observation wells RRL-2A, DC-4, RRL-6, and the McGee Well. The bridgeplugs were originally installed to minimize borehole interflow, which could interfere with interpretations of LHS test results by perturbing water levels. BWIP indicated during the meeting that borehole interflow would not significantly perturb water levels, yet did not provide any rationale for this conclusion. BWIP should carefully analyze whether borehole interflow subsequent to bridgeplug removal will significantly affect interpretations of LHS test results. This analysis should then be presented to NRC for review.

4. Monitoring Facilities for the Ratio Test

BWIP proposes to analyze LHS test results using the Neuman-Witherspoon ratio method to derive estimates of vertical hydraulic conductivity of the flow interiors near RRL-2B. The utility of the first ratio test in the Rocky Coulee flow top is limited, however, because limitations of present monitoring facilities preclude determination of diffusivity for the flow interior above the Rocky Coulee flow. In addition, ratio testing could result in low, non-conservative estimates of hydraulic diffusivity for the Rocky Coulee flow interior because of piezometer compliance, which is the non-ideal response of piezometers caused by small-scale deformation of piezometer components.

The Neuman-Witherspoon (1972) ratio method requires head response data from within confining beds adjacent to the pumped aquifer (e.g., Rocky Coulee flow top in the first planned LHS test). These data are interpreted along with response data from within the pumped aquifer to estimate the hydraulic diffusivity of the confining units, where diffusivity equals the ratio of the confining unit's vertical hydraulic conductivity and its specific storage. Although response data can be collected from the piezometer completed within the Rocky Coulee flow interior at RRL-2C, response data cannot be collected within the flow interior above the Rocky Coulee flow top because BWIP has not completed a piezometer within the interior of Grande Ronde flow number 2. Thus, the first LHS test will not estimate the diffusivity of the flow interior above the Rocky Coulee flow top. Because of this limitation, the first LHS test will not serve as a good example of applying the ratio test to characterize vertical hydraulic conductivities of the Columbia River Basalts. In comparison, testing the Cohassett flow top may provide a better demonstration of ratio testing since flow interiors above and below the flow top will be monitored.

In addition, the utility of the first ratio test may also be limited because piezometer compliance could delay head responses in piezometers completed in the flow interiors. This delay could bias analyses of test results by underestimating the hydraulic diffusivity of the interiors, thus underestimating values of vertical hydraulic conductivity which would be nonconservative with respect to repository performance. BWIP should assess the significance of time-lag due to compliance of piezometers in the RRL-2C cluster that will be used for the ratio test. For example, BWIP could measure piezometer compliance prior to LHS testing by conducting pulse tests in appropriate piezometers. After the LHS test is completed and the results needed for the ratio test have been collected, BWIP could then compare the lag time determined in pulse tests with the time difference between the start of the test and initial response detected in the piezometers completed in the flow interiors. If the piezometer lag time is comparable with the initial response time, then BWIP may need to correct the response data to characterize hydraulic diffusivities.

5. Grout Permeabilities

During the meeting, BWIP indicated that the permeabilities of grouts used in the clustered piezometer installations (i.e. DC-19/20/22) had recently been estimated using permeameter testing. The contrast between the grout permeability in the cluster installations and that of the basalts is important to reliable performance of the piezometers. In addition, the effectiveness of the bond between the grout and basalt also affects the reliability of piezometer responses. Isolation of monitoring intervals using grout is especially important to reliable performance of piezometers completed within flow interiors because of the similarity of hydraulic conductivities between the grout and basalt. BWIP should present its analyses of grout permeability and integrity to NRC to demonstrate reliable performance of the piezometers.

6. Westbay Installation

Based on discussions during the meeting and the subsequent site visit by NRC consultants (12/11/85), the trial installation of a Westbay device in RRL-14 appears to be providing useful information about the device's utility within the Hanford site monitoring network. BWIP indicated during the meeting that the travelling pressure probe in the Westbay device will be used to monitor several horizons at RRL-14 during the LHS test. This does not appear feasible, however, because approximately 8 hours are required to complete a profile of all ports. The probe cannot be moved back and forth from one portal to another, thus it may not be useful to monitor several horizons during the LHS test because of the time consumed in moving the probe. BWIP should evaluate whether the configuration of the Westbay device can be effectively modified to monitor several flow horizons during LHS testing.

Despite their apparent limitations for near-field multi-level monitoring of LHS tests, Westbay devices may satisfy the need for additional far-field monitoring facilities at the Hanford Site (cf. USGS letter from Rollo to Olson, October 21, 1985). Additional facilities are needed to characterize the regional groundwater flow system in terms of both horizontal and vertical hydraulic gradients. For example, monitoring of such facilities outside of the Cold Creek Syncline may provide DOE with the ability to characterize vertical pressure profiles in areas where site activities are not expected to cause significant transient hydrologic responses. This type of additional information could significantly contribute to BWIP's understanding of the groundwater flow system at the Hanford Site. Based on experience gained with the Westbay device at RRL-14, BWIP should consider installing similar types of devices in boreholes distant from the RRL to characterize the regional groundwater flow system.

Testing Procedures

7. LHS Testing Focus

The test plan states on page 41 that the "real focus of large-scale hydraulic testing in the Grande Ronde Basalt at the RRL-2 site is the Cohassett flow interior." This statement appears to be inconsistent with both the objectives of LHS testing stated earlier in the plan and BWIP's approach to repository performance assessment. As described in other sections of the test plan and NRC's BWIP Site Technical Position 1.1, the primary objective of LHS testing at BWIP is to provide repository-scale hydraulic data to support licensing assessments of repository performance. This includes characterization of hydraulic parameters, identification of hydrologic boundaries, evaluation of far-field hydraulic continuity, and formulation of defensible conceptual models of the groundwater flow system. To accomplish these objectives, LHS testing should develop a far-field perturbation in response to controlled stress, which can best be done in the units with the highest transmissivities. Of the three units identified in the test plan for LHS testing, the Cohassett flow appears to have the lowest transmissivities. Therefore, BWIP's focus on the Cohassett flow may decrease the potential for fulfilling the primary objective of LHS testing.

The focus on the Cohassett flow interior also appears inconsistent with BWIP's current approach to repository performance assessment. As stated on page 2-9 of the Exploratory Shaft Test Plan [SD-BWI-TP-007], "BWIP is following a logic which does not take credit for [groundwater] travel time [in] the preferred horizon dense interior." Since the goal of LHS testing is to develop information necessary for demonstrating compliance with licensing requirements, it would appear that BWIP should focus testing on hydrogeologic units that it plans to take credit for in the compliance demonstration.

In addition, if BWIP's proposed testing plan focuses on the Cohassett flow interior, the plan should be modified to include a long-term pumping test of the Cohassett flow top. The test plan implies that LHS testing will not be considered in the Cohassett flow top because of its assumed low transmissivity relative to other flow tops. However, long-term testing of the flow top may yield valuable information about the vertical hydraulic conductivity of the Cohassett and Rocky Coulee flow interiors. Uncertainty in estimates of vertical leakage can be reduced by pumping a lower transmissivity unit such as the Cohassett flow top because uncertainty in leaky aquifer analyses is reduced in LHS tests where aquifer response deviates substantially from the theoretical Theis response, and this deviation increases as the ratio in conductivities between the aquifer and confining units decreases. Thus, LHS testing of low transmissivity flow tops may provide more information about vertical hydraulic conductivity than tests in higher transmissivity units.

BWIP should determine the appropriate focus of LHS testing at RRL-2 with respect to its approach for performance assessment and the objectives for LHS testing. As discussed during the meeting, BWIP should also evaluate LHS testing of the Cohassett flow top based on preliminary estimates of the unit's transmissivity at RRL-2B that will be determined through pulse tests and well development.

8. Pump Selection

The test plan states that the first LHS test in the Rocky Coulee flow top will use a positive displacement (sucker rod) pump. Positive displacement pumps, however, do not produce a continuous and constant rate of discharge. Fluctuations in pressure at the pumping well caused by pump cycling may complicate interpretation of early-time drawdown data if the fluctuations cause oscillations in water levels at observation wells RRL-2C and -2A. In addition, changes in pumping rate may be difficult to accomplish during the early part of the test because of the operation of the pump. It appears BWIP would have to turn the pump off to alter the pump discharge rate, which may unnecessarily complicate interpretation of the LHS test results. If the production capability of RRL-2B in the Rocky Coulee flow top is greater than anticipated, the sucker rod pump may not be able to pump at sufficiently high rates to optimize the performance of the LHS test.

When the selection of the sucker rod pump was discussed during the meeting, BWIP indicated the selection was based on the need to minimize the effects of wellbore storage. Although this is an advantage of using the sucker rod pump, other pumping schemes such as submersible pumping may also acheive this advantage while providing relatively constant discharge rates.

BWIP should attempt to keep the discharge rate relatively constant, as appropriate, during the pumping test to minimize complications in interpreting the test results. In addition, BWIP should document its rationale for selecting the sucker rod pump and evaluate potential adverse effects of sucker rod pumping on interpretation of water level data from the pumping well and RRL-2C and -2A.

9. Criteria for LHS Testing

The LHS test plan describes a nominal 30-day period of pumping during the first test from the Rocky Coulee flow top. The plan recognizes satisfactory tracer recovery and indications of hydraulic boundary conditions as criteria to determine when pumping should be terminated. Premature termination of the pumping, however, may limit the ability of the test to fulfill its objectives.

During the meeting, BWIP elaborated on the termination criteria which included accomplishment of test objectives and jeopardization of synchronous head measurements. In their present form, however, both of these criteria are subjective and need to be defined in greater detail to develop objective criteria for determining when pumping should be terminated. BWIP should also develop criteria for determining when transient responses caused by LHS testing have sufficiently subsided to allow subsequent LHS tests to begin.

Similar criteria should be developed to determine when pressure trends have been reestablished after the first tracer has been injected during the first LHS test, but before the transducer is pulled out of the second piezometer prior to tracer injection. During the meeting, BWIP indicated that both transducers in RRL-2A and -2C in the Rocky Coulee flow top could be out of the piezometers at the same time, which would eliminate BWIP's capability of monitoring drawdown if measurable perturbations from the first test do not reach more distant monitoring facilities beyond 2250 m. Thus, BWIP would not be able to detect hydrogeologic boundaries. Further, the removal of the tracer injection apparatus may also perturb pressures in the flow top, which could not be characterized unless at least one transducer remained in a piezometer in the flow top. Once developed, these criteria should be incorporated into LHS and tracer testing procedures.

10. Development of RRL-2B

The LHS test plan does not discuss how the the pumping well, RRL-2B, has been or will be developed prior to the first LHS test in the Rocky Coulee flow top, or how the well will be developed prior to subsequent tests. Drill cuttings and drilling fluids remaining in the Rocky Coulee flow top may inhibit flow to the well, thus decreasing well efficiency and potential pumping rates. The purpose of well development is to remove cuttings and drilling fluids from the formation. The drilling and completion specifications document for RRL-2B and -2C [SD-BWI-TC-023] mentions that RRL-2C will be developed prior to installation of the piezometers, but does not discuss well development activities for RRL-2B. In addition to improving well efficiency, controlled development of RRL-2B using air-lift pumping or other suitable techniques may provide valuable pre-LHS testing transmissivity estimates allowing selection of optimal pumping rates from the Rocky Coulee flow top. Use of well development as a pre-test would require that BWIP monitor water levels and/or pressures, discharge rates, and hydraulic responses to the development stress. Controlled well development of RRL-2B may provide more accurate estimates of aquifer transmissivity and a more defensible basis for selection of optimal pumping rates than the proposed pulse testing, particularly in higher transmissivity units. Hydrochemical sampling during well development could also be used to evaluate whether the bulk of drilling fluids injected during drilling have been removed. BWIP should carefully document the development procedures used in RRL-2B. If the well has not been developed, BWIP should evaluate alternative development techniques and develop RRL-2B, as appropriate, prior to initiation of LHS testing.

11. Mechanical Effects

Based on pre-test analyses described in the test plan, BWIP expects that pumping from RRL-2B will develop significant drawdowns (e.g., 263 meters) in the vicinity of the pumping well during the first LHS test. Such large drawdowns may stimulate discontinuous deformation of the basalt flows by decreasing pore pressures and changing fracture apertures. Although stresses caused by changes in pore pressure may be insignificant compared with in-situ stresses, BWIP should recognize that changes in fracture apertures in close proximity to the pumping well may cause anomalous head responses during LHS testing.

12. Vesicular Zone Testing

As agreed in the meeting, BWIP needs to consider performing LHS tests of the vesicular zone in the Cohasset flow interior. BWIP's decision to conduct testing of the vesicular zone should be consistent with the test plan and be based on preliminary testing of the vesicular zone after the pumping well has been drilled through the zone.

13. Convergent Tracer Test

The test plan proposes integration of convergent well tracer testing with LHS testing of the Rocky Coulee flow top. The NRC is concerned that the tracer test may complicate the interpretation of LHS testing results. Injection of tracer solution and chase water under 250 m of head into RRL-2A and -2C, may result in pressure perturbations that could interfere with aquifer responses to pumping stress, especially within the flow interiors. Although such perturbations may not last long within flow tops (e.g., several hours to days), the pressure pulses in flow interiors may be on the order of meters and persist for periods up to tens of days. As discussed in comment number 9, conduct of the tracer test may also prevent continuous collection of pressure data at RRL-2A and -2C because the pressure transducers will be removed to inject the tracers.

In addition, the test plan does not provide a detailed rationale for how information derived from the convergent well tracer test will be utilized in evaluations of site performance. For example, the two-well recirculating tracer test conducted previously at the BWIP was not designed to provide repository-scale estimates of dispersivity (Leonhart et al., 1984). This same limitation also applies to the dispersivity values determined in the convergent well tests at RRL-2. The test plan's description of proposed tests does not evaluate whether lateral dispersion will be significant with respect to

STRATEGIES TO INVESTIGATE DISQUALIFTYING CONDITIONS

	ISSUE	DISQUALIFYING CONDITION	PARAMETERS	EVALUATION CRITERIA*	TESTS
1.9.1	Post-Closure Geohydrology	Groundwater travel time less than 1000 years	a. Hydraulic properties of flow tops	$\frac{Ti}{nb} > 5$m/yr	
			• Hydraulic gradient (i)		Spatial and temporal distribution of hydraulic head
			• Transmissivity (T)		LHS tests in flow tops
			• Effective thickness (nb)		Multiwell tracer tests
			• Storativity		LHS tests in flow tops
			b. Hydraulic properties of flow interior	K'v 10^{-9} m/s	
			• Vertical hydraulic conductivity (K'v) of dense interior		LHS tests in flow tops
			• horizontal hydraulic conductivity (Kh) of flow		LHS Tests in flow tops
			• Specific storage		Estimated from tests of core samples
			• Effective porosity		Estimated from tests of core samples
			c. Presence or absence of discrete, highly transmissive features which cross-cut flows	Unexpected vertical response to LHS, such as responses across several intervening flow interiors	
			• Leakance	Recharge boundary within 5km	LHS tests in flow tops
			• Hydraulic boundaries		LHS tests in flow tops
			d. Radioisotope content of ground water	Presence of recent meteoric water:	Sampling and analysis
			• Radioisotope concentrations	H-3 0.2TU C-14 80% modern I-129 10^{-8} pCi/L	

EXHIBIT IV

STRATEGIES TO INVESTIGATE DISQUALIFTYING CONDITIONS (Cont'd)

	ISSUE	DISQUALIFYING CONDITION	PARAMETERS	EVALUATION CRITERIA*	TESTS
4.1.4	Pre-closure Hydrology	Engineering conditions beyond reasonably available technology	a. Hydraulic properties of Cohassett dense interior	$K'v \geq 10^{-9}$ m/s	
			• Vertical hydraulic conductivity		LHS test in Birkett flow top
			• Specific storage		Estimated from tests core samples
			b. Hydraulic properties of adjacent flow tops	N.A.	
			• Transmissivity		LHS test in flow tops
			• Storativity		LHS test in flow tops
			• Head distribution		Spatial and temporal distribution of hydraulic head
			c. Gas content of groundwater	$CH_4 \geq 1200$mg/L	
			• Gas concentration		Sampling and analysis

*Conditions that are so severe as to be indicative of potential disqualification. Futher evaluations and/or investigations to resolve the conditions will be necessary.

EXHIBIT IV (cont'd)

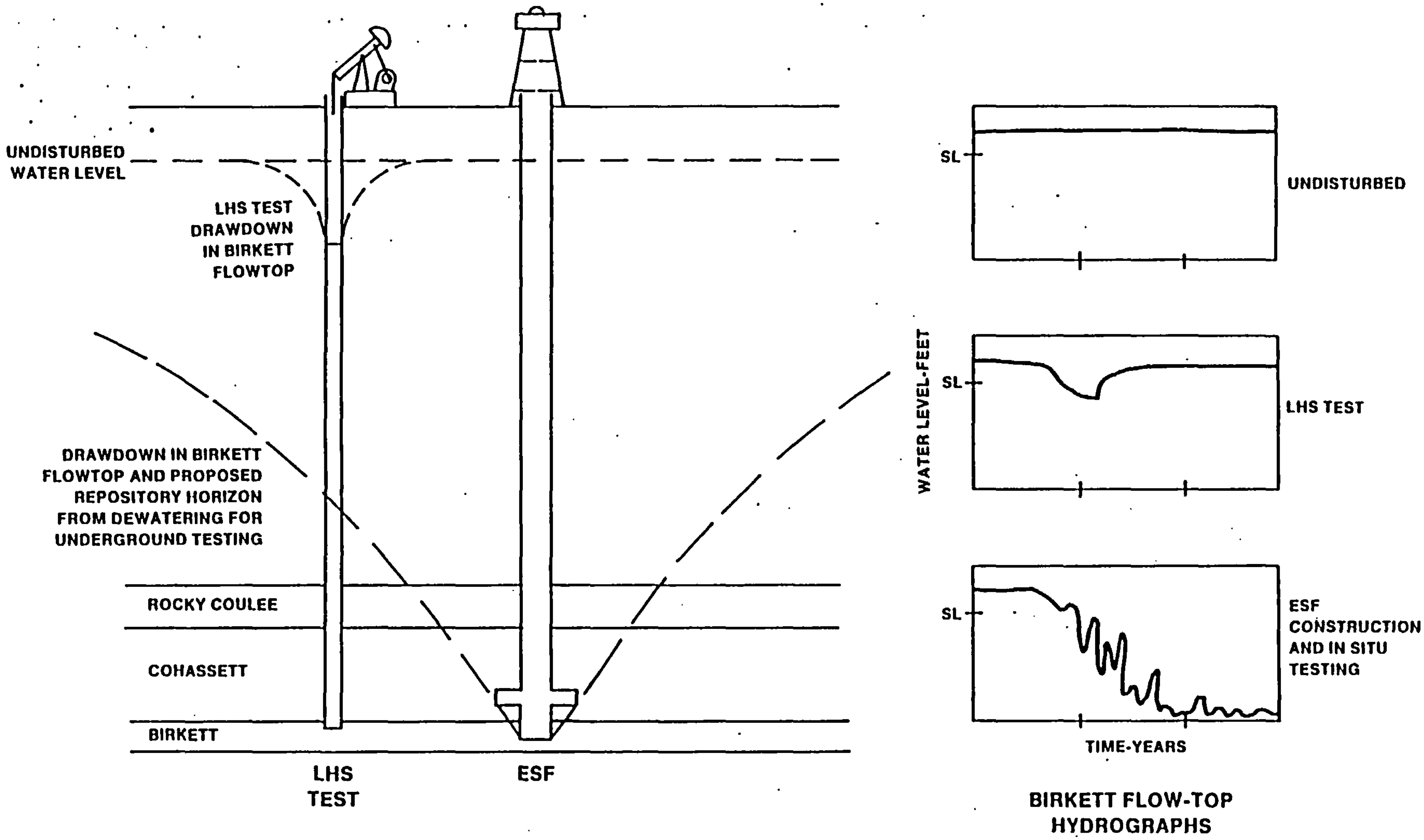


EXHIBIT V

SCHEMATIC OF RELATIVE EFFECTS OF SITE CHARACTERIZATION ACTIVITIES ON GROUND-WATER LEVELS IN PUMPED INTERVALS

0216-0024DS 3/16/87

OPTIONS FOR PRE-ES HYDROLOGY TESTING PROGRAM

	OPTION	PRO	CON
A.	Establish baseline only - drill and equilibrate DC-24, 25	• Minimal schedule disruption on start of ES • Least cost impact • Yields data on perishable head conditions	• Provides insufficient information about disqualifying conditions Provides no information to support engineering design • Potential compromise of interpreting future test results • Probably not credible with technical community • Subject to severe programmatic criticism • Gains no experience with testing procedures and equipment • Potential change of hydraulic parameters in vicinity of ES not detectable
B.	Establish baseline; Test Rocky Coulee only - drill and equilibrate DC-24,25,32,&33 - pump RRL-2B - take samples from Rocky Coulee - run tracer test	• No reprogramming necessary; conform to current test plan and facilities • Yields data on perishable conditions and hydraulic parameters of Rocky Coulee • Provides some information on disqualifying conditions • Expedites start of ES construction	• Provides little information to support engineering design • Provides little information on impact of ESF on future tests • May not be credible with technical community • Limited experience with testing procedures and equipment
C.	Establish baseline; Test Birkett only - drill and equilibrate DC-24,25,32,&33 - deepen and pump well RRL-2B - take samples from Birkett - run tracer test	• Provides some information for engineering design • Yields data on perishable hydraulic properties and conditions of Birkett flow top and Cohassett interior • Provides some information on disqualifying conditions • Provides some information on impacts of ESF on future tests	• Limited credibility with technical community • Limited experience with testing procedures and equipment • May delay ES construction schedule • Requires modification to pumping well and additional monitoring facilities • Some reprogramming required
D.	Establish baseline; test multiple flow tops (Rocky Coulee, Cohassett, and Birkett) and Cohassett vesicular zone - drill and equilibrate DC-24,25,32,&33 - deepen and pump well RRL-2B - take smaples from flow tops - run tracer tests -	• Yields data on perishable conditions in Grande Ronde • Provides substantial information for engineering design at RRL-2 site • Provides information on disqualifying conditions at RRL-2 site • Enhances credibility with technical community • Provides information to predict impacts of ES on future geohydrologic tests	• Delays ES construction schedule • Near-term site costs increase • Requires additional monitoring facilities • Reprogramming required
E.	Establish baseline; test multiple flow tops (Rocky Coulee, Cohassett, and Birkett) and Cohassett vesicular zone at several (3-4) additional pumping centers - drill and equilibrate DC-24,25,32&33. - deepen and pump well RRL-2B drill and pump other centers - take smaples from flow tops - run tracer tests	• Yields definitive data on perishable conditions in Grande Ronde • Provides definitive design information over wide area of Cohassett flow • Provides definitive information on disqualifying conditions over much of CASZ • Provides some information on flow system boundaries • Avoids interference from ESF activities and attendant interpretation problems • High credibility with technical community	• Major delays in ES construction schedule • Near-term site costs increase substantially • Major reprogramming required • Requires considerable monitoring and pumping facilities

EXHIBIT VI

ACTIVITIES FOR THE IMPLEMENTATION OF OPTION D

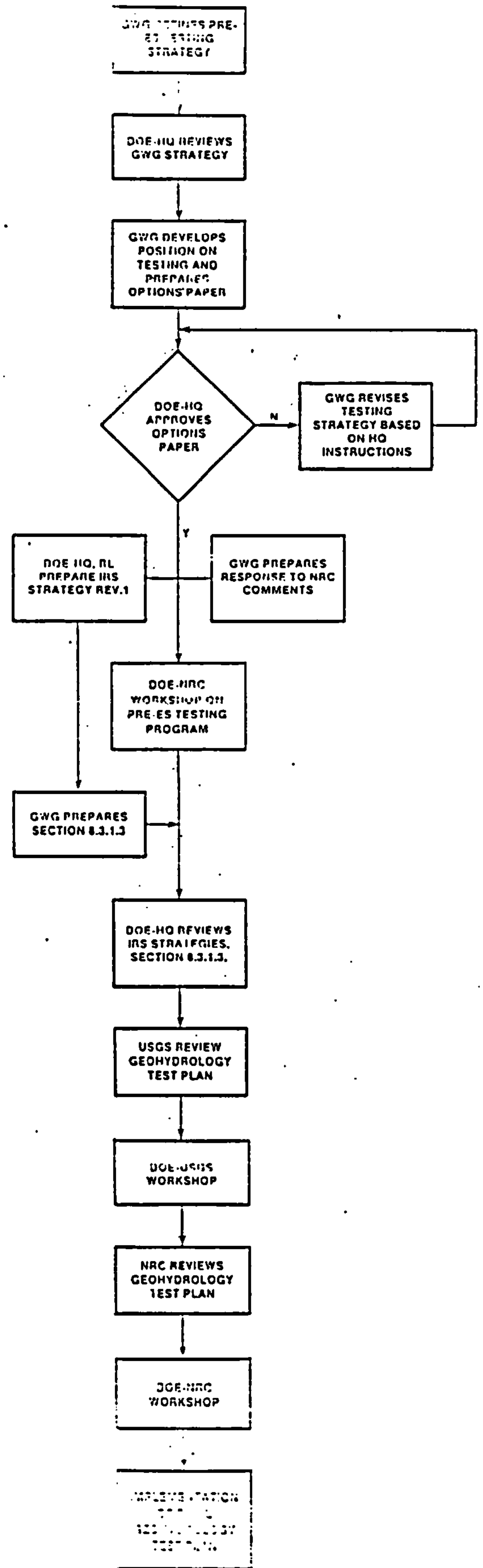


EXHIBIT VII

longitudinal dispersion, or whether the hydraulic gradients imposed during the test will result in tracer behavior that is fundamentally different from tracer behavior under ambient conditions. This difference may be especially significant if flow through fractured basalt is assumed to represent an equivalent porous medium. Further, the plan does not discuss uncertainties about the representativeness of effective porosity and dispersivity values for portions of the Rocky Coulee flow top distant from RRL-2 and other basalt flow tops.

The NRC agrees that the DOE needs to characterize effective porosity and dispersivity at the BWIP site, but this information should be collected in a manner that does not compromise the primary objective of the LHS testing, i.e. to characterize the groundwater flow system including hydrologic boundaries, hydraulic continuity, and hydraulic parameters. BWIP should assess potential complications of conducting the convergent tracer tests in conjunction with the LHS test and concurrent ratio test, particularly with respect to monitoring water level responses within the flow interiors. This assessment should also document the rationale for the tracer tests including a discussion of the limitations and uncertainties that will be associated with the tracer test results.

REFERENCE: Leonhart, L. R., R. Jackson, D. Graham, L. Gelhar, G. Thompson, B. Kauchoro, and C. Wilson, 1984, "Analysis and Interpretation of a Recirculating Tracer Experiment Performed in a Deep Basalt Flow Top," RHO-BW-SA-300 P, Rockwell Hanford Operations.

<u>Hydrologic Baseline</u>

14. Perturbations to Hydrologic Baseline

Based on reviews of recent water level data submitted by BWIP, NRC observes that trends in hydraulic heads appeared to have been sufficiently established for LHS testing in the Rocky Coulee flow top in May and June of 1985. Since that time, concurrent site preparation activities (e.g., drilling bridgeplugs at RRL-14 and drilling DC-23) have perturbed the groundwater system causing significant deviations to pre-test trends. During the meeting, BWIP acknowledged that more time is now required to reestablish pre-test trends before LHS testing can begin. These recent perturbations demonstrated that hydraulic stresses can be propagated across the Reference Repository Location, thus adding credence to the feasibility of conducting repository-scale LHS testing. The perturbations also indicate that future combinations of drilling, construction, and testing may perturb hydraulic heads to the extent that characterization of the pre-emplacement groundwater flow system and LHS testing would be delayed for a significant amount of time.

In developing strategies and schedules for site activities, BWIP should consider potential complications and delays of site activities caused by perturbations to the hydrologic system. For example, BWIP indicated that a multi-year period of reduced site activity might be required to establish hydrologic baseline if it cannot be established prior to LHS testing and Exploratory Shaft construction. BWIP's strategy for site characterization should consider the practicality of these contingencies in light of the ambitious project schedules.

15. Hydrochemical Sampling

The test plan lists constituents that will be analyzed in groundwater samples collected during pumping (cf. Table 13). Although the list appears comprehensive, the test plan does not discuss the objectives for collecting the hydrochemical data or provide a rationale supporting the list. Based on NRC's understanding of BWIP's current strategy for site characterization, these data will be used to characterize baseline hydrochemistry of the Hanford Site to confirm conceptual groundwater flow models and to support predictions of post-emplacement hydrochemical environments along potential radionuclide pathways. BWIP should amend the test plan to discuss the objectives and rationale for the hydrochemical sampling.

In addition, BWIP has omitted carbonate and bicarbonate species from the list of constituents that will be analyzed. Bicarbonate and carbonate species may significantly affect radionuclide transport by a variety of processes, such as complexing, pH buffering, and precipitation. In addition, concentrations of these two species are essential for calculating ion balances. The NRC recognizes that the concentrations of these two species may be calculated based on pH, alkalinity, and concentrations of other constituents (Stumm and Morgan, 1970). However, it would be prudent for BWIP to analyze for carbonate and bicarbonate as a more direct and precise method of determining their concentrations than through calculations. BWIP should include carbonate and bicarbonate in the list of constituents to be analyzed or amend the test plan to describe how their concentrations will be determined in lieu of analysis.

REFERENCE: Stumm, W. and J. J. Morgan, 1970, "Aquatic Chemistry: An Introduction Emphasizing Chemical Equalibria in Natural Waters," (New York, New York: Wiley-Interscience).

16. Data Release

Until several days before the meeting, the most recent water level information available to the NRC staff and contractors had been collected six months earlier (May/June 1985). NRC has not received pressure data from the BWIP site for the last 10 months. If NRC is to provide constructive comments to DOE on the adequacy of hydrologic data and interpretations, BWIP needs to release essential information such as the water level data on a more-timely basis. The meeting may have been postponed if the NRC had been informed about the perturbations caused by drilling activities prior to the meeting. BWIP should release tabulated and time profile data including down-hole pressures, water levels, and environmental heads in accordance with the Site Specific Agreement, which specifies a 45-day release time frame from the time of data acquisition to the time the data are provided to the NRC.

APPENDIX C

PROPOSED PRE-ES GEOHYDROLOGIC TESTING PROGRAM

After the establishment of a hydraulic-head baseline and before the start of construction of the exploratory shafts (ES), DOE will conduct hydraulic tests in the Rocky Coulee flow top, Cohassett flow top and vesicular zone, and Birkett flow top within the upper Grande Ronde Basalt sequence. The logical basis for the proposed testing program is presented in Figure 1.

The hydraulic-head baseline will be established, for the most part, from a network of about 36 monitoring sites within the Hanford site (Figure 2). These monitoring sites consist of single boreholes that monitor single basalt horizons and several nested piezometer wells that monitor multiple horizons (i.e., RRL-2C, DC-19, DC-20, and DC-22). Two additional nested piezometer wells (DC-24 and DC-25) will be completed and equilibrated as part of the hydraulic-head baseline network before the first LHS test takes place. These new facilities will be used for water-level monitoring of multiple hydrostratigraphic units; they will neither be hydraulically tested nor hydrochemically sampled while under construction.

The chemistry of the ground waters is not perceived to be a "perishable" condition in the pre-ES timeframe. However, if ground-water sampling is not on the critical path, provisions will be made to collect hydrochemical samples at DC-24 and DC-25 as drilling progresses.

For the LHS tests, several existing boreholes will be modified (fitted with piezometers) in order to add monitoring points in the Birkett flow top. Those boreholes requiring modification include the McGee well, RRL-2A, RRL-6, RRL-14, RRL-17, DC 4/5, and DC-16. In addition, new nested piezometers, DC-32 and DC-33, will be placed at locations about 1000 meters southwest and southeast of RRL-2, respectively, in order to provide additional monitoring locations in appropriate proximity to the RRL-2B pumping center. The distribution of primary monitoring facilities during LHS tests of key horizons of the Grande Ronde Basalt is presented in Figure 3. The total time required for drilling and modifying all boreholes and reestablishing a hydrologic baseline is estimated at approximately 10 months.

After the reestablishment of the hydraulic-head baseline in the controlled-area study zone (CASZ), a series of LHS tests will be initiated. The tests would be conducted in the following order: the Rocky Coulee flow top, the Cohassett flow top, the Cohassett vesicular zone, and the Birkett flow top. Testing the Rocky Coulee flow top offers the opportunity for exerting appreciable stress on the system by pumping RRL-2B. This borehole will be successively deepened after each test. The Cohassett flow top and vesicular zone are assumed to be not transmissive enough for an LHS test; therefore, small-scale injection tests in RRL-2B are planned for these units. In the event either of these zones proves sufficiently transmissive, then a full LHS test will be performed. The Birkett flow top is expected to yield sufficient water to perform an LHS test.

Convergent tracer tests will be conducted in conjunction with LHS tests either by injecting tracers prior to the start of pumping or late in the pumping portion of the tests. Different, nonradioactive tracers will be injected into two nearby observation wells (RRL-2A and RRL-2C); tracer arrival will be observed at the pumping well (RRL-2B). The time required to complete the four tests is estimated to be approximately 12 months.

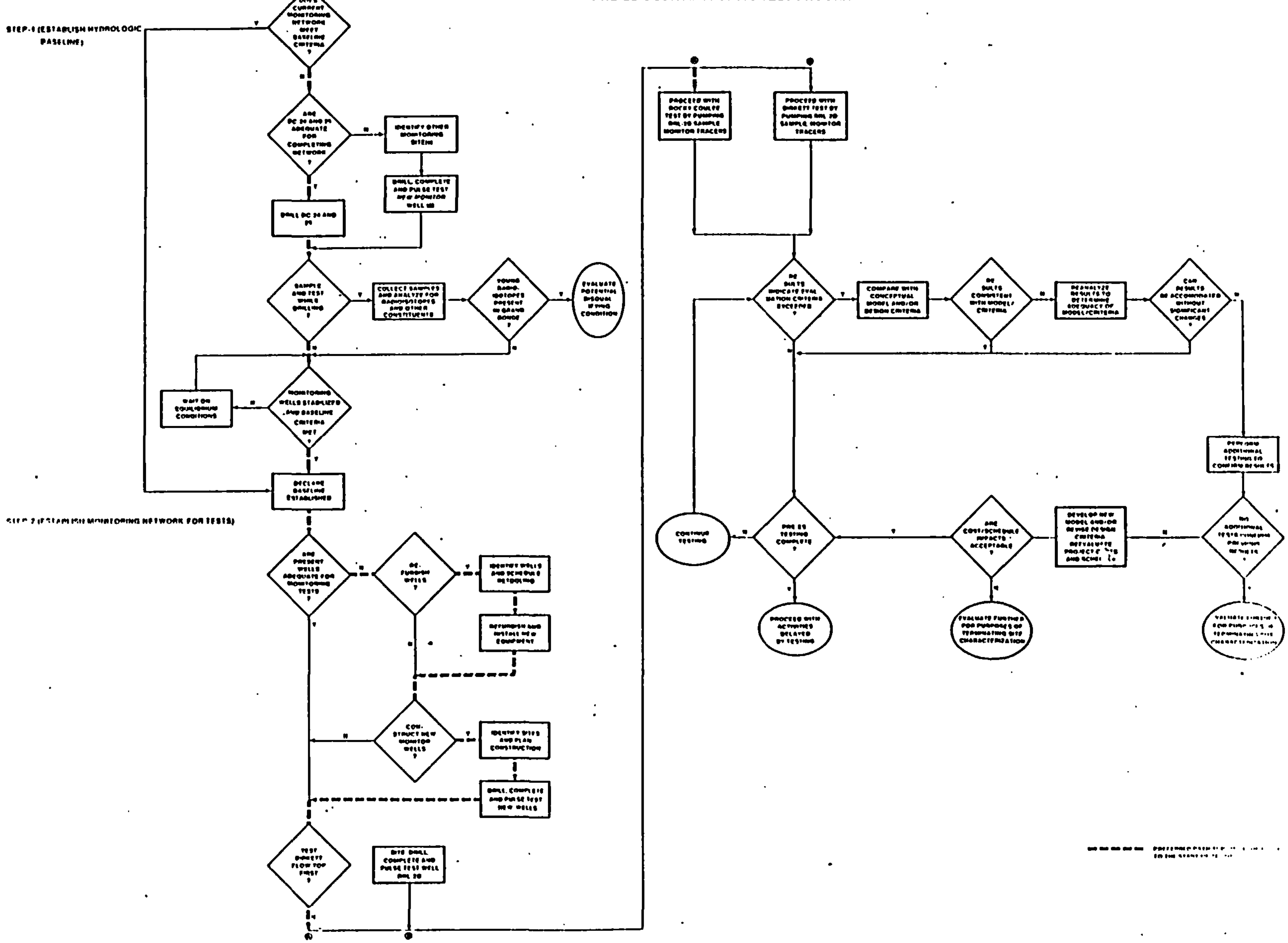
The Birkett and the Rocky Coulee LHS tests will allow the testing of a large volume of rock, probably to repository scale (i.e., a volume comparable to that of the proposed repository). Since it is expected that the Birkett flow top can be pumped at a greater rate than the Rocky Coulee flow top, the Birkett test could yield more data about the geohydrologic system in the vicinity of the ESF. The tests in the Cohassett flow top and vesicular zone will probably be of shorter duration and would interrogate a lesser volume of rock because of the lower hydraulic conductivities of these units relative to other units to be tested.

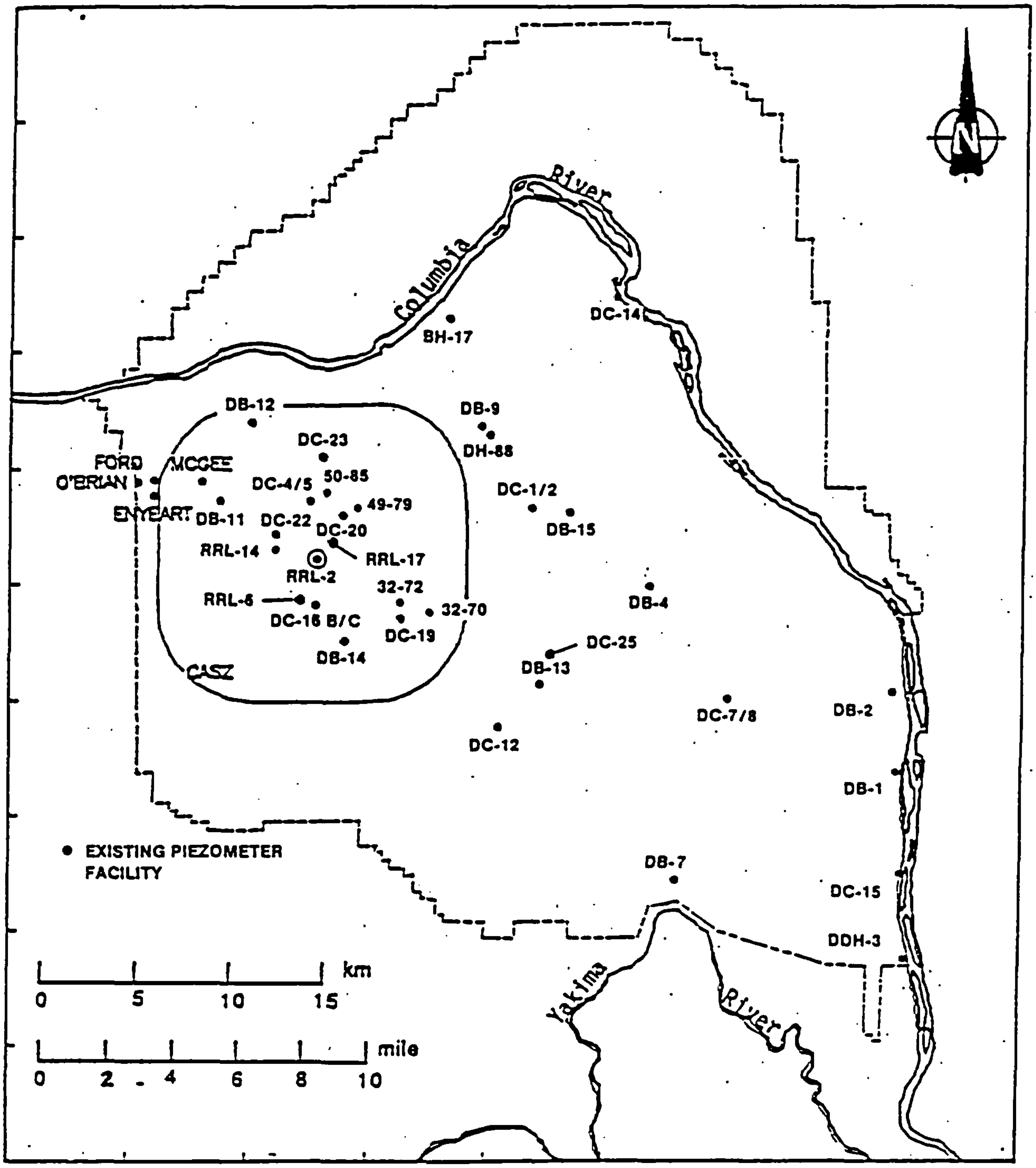
Results from these four tests will be evaluated for, among other things, hydraulic parameters that would be used to determine the presence of disqualifying conditions and any changes necessary to current ESF and repository designs (see Figure 1). The results of these evaluations will be used to determine whether and where further tests should be run before ES construction.

Pumping during the tests will provide an opportunity to collect representative ground-water samples from the Rocky Coulee and Birkett flow tops for chemical analysis. Water samples will be analyzed, at a minimum, for ^{14}C, ^{36}Cl, ^{129}I, tritium, major dissolved and suspended solids and gases, temperature, and pH. The results of these analyses, particularly for the short-lived radioactive isotopes, could yield an indication of the presence of a disqualifying condition. The collection and analysis of ground-water samples during LHS testing should not affect the ES schedule.

The combined schedule to carry out the recommended pre-ES geohydrologic testing program is presented in Figure 4. The total duration of the program is estimated at 22 months after the start of drilling.

LOGIC PROCESS FOR PRE-ES GEOHYDROLOGIC TEST PROGRAM





HYDRAULIC-HEAD BASELINE MONITORING LOCATIONS AT THE HANFORD SITE

PRIMARY LHS TEST MONITORING FACILITIES IN THE GINKGO FLOW TOP

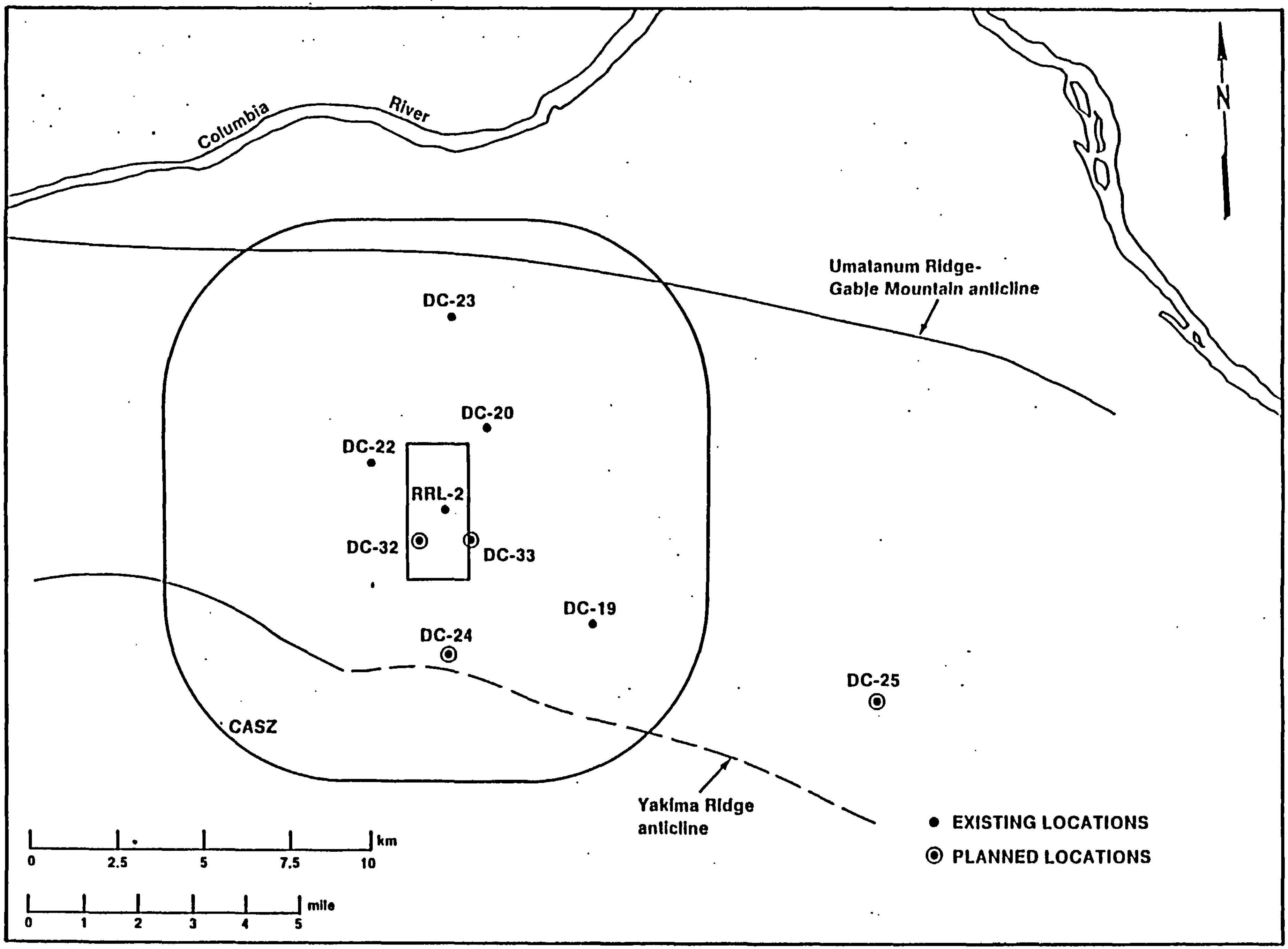


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FIGURE 3

PRIMARY LHS TEST MONITORING FACILITIES IN THE ROCKY COULEE FLOW TOP

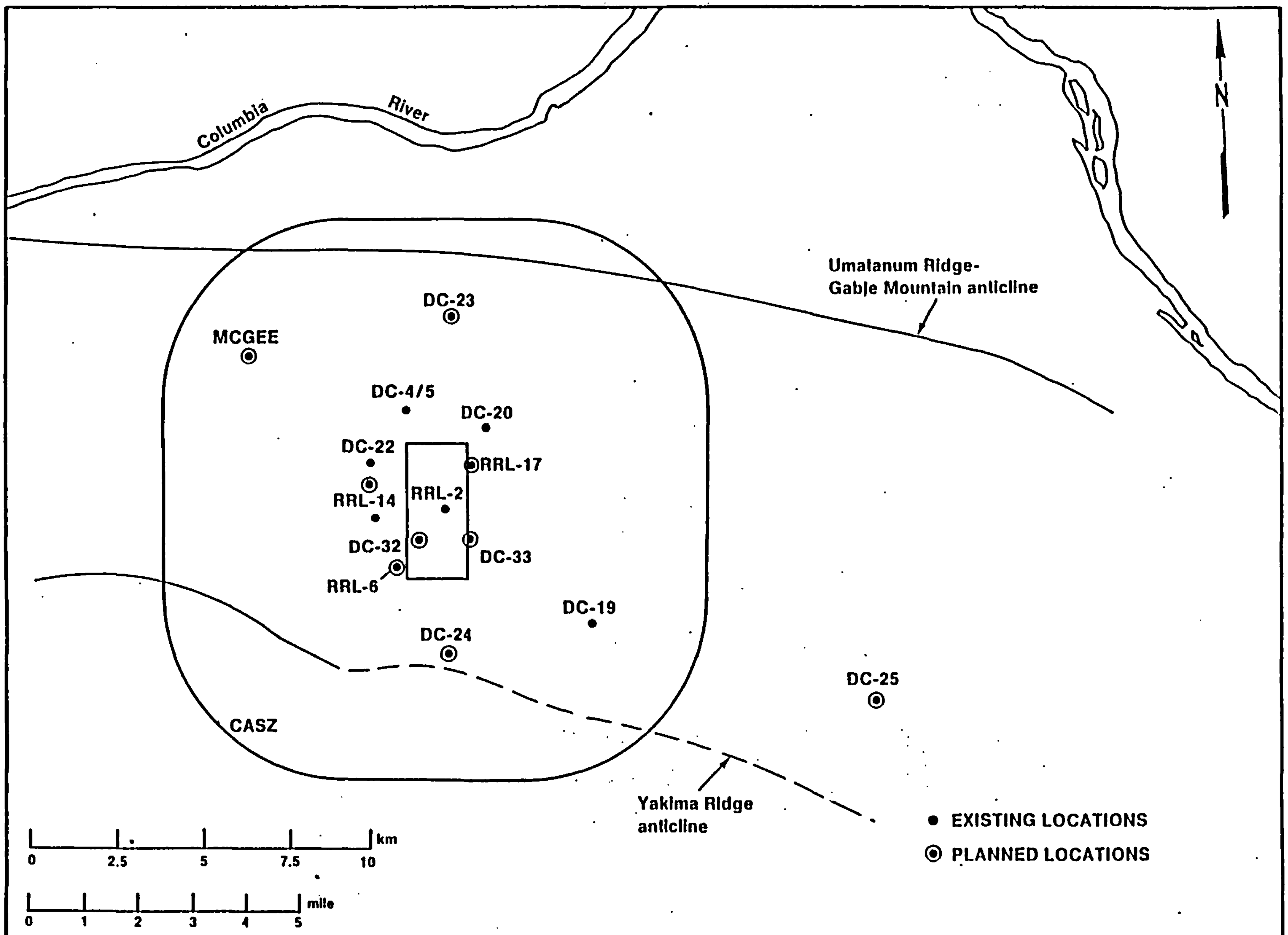

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FIGURE 3 (cont'd)

PRIMARY LHS TEST MONITORING FACILITIES IN THE COHASSETT FLOW TOP

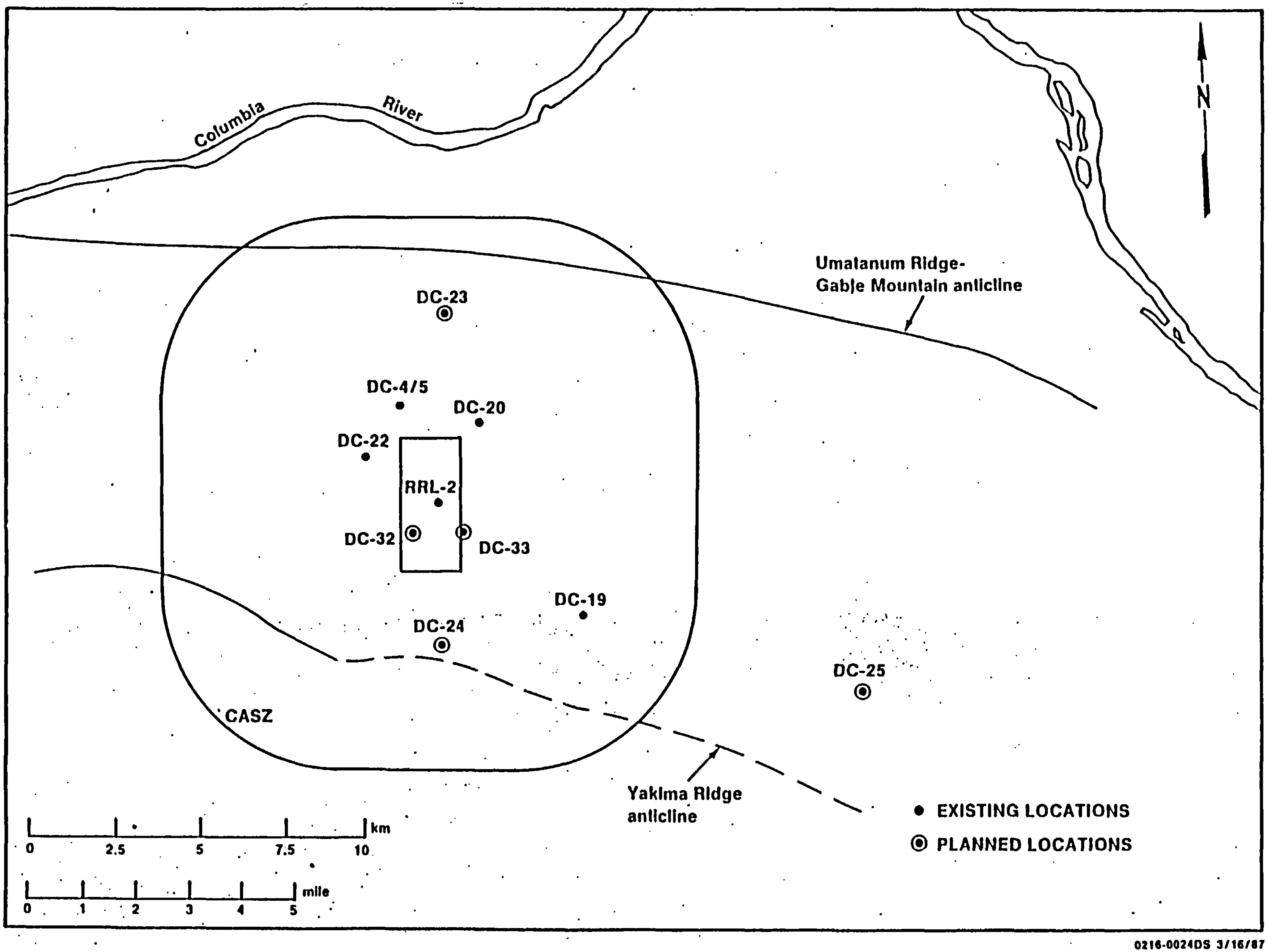

FIGURE 3 (cont'd)

PRIMARY LHS TEST MONITORING FACILITIES IN THE BIRKETT FLOW TOP

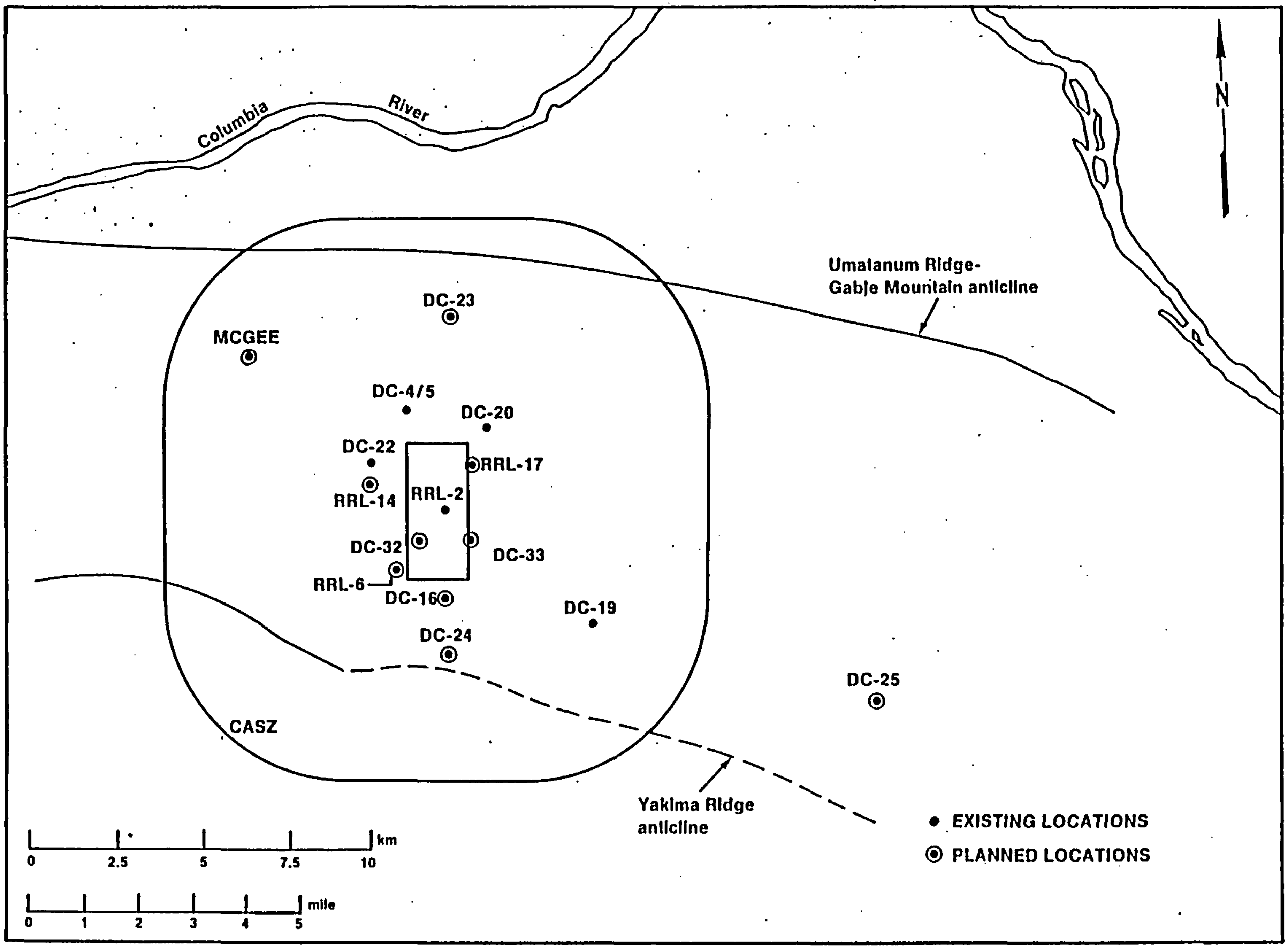

FIGURE 3 (cont'd).

PRIMARY LHS TEST MONITORING FACILITIES IN THE UMTANUM FLOW TOP

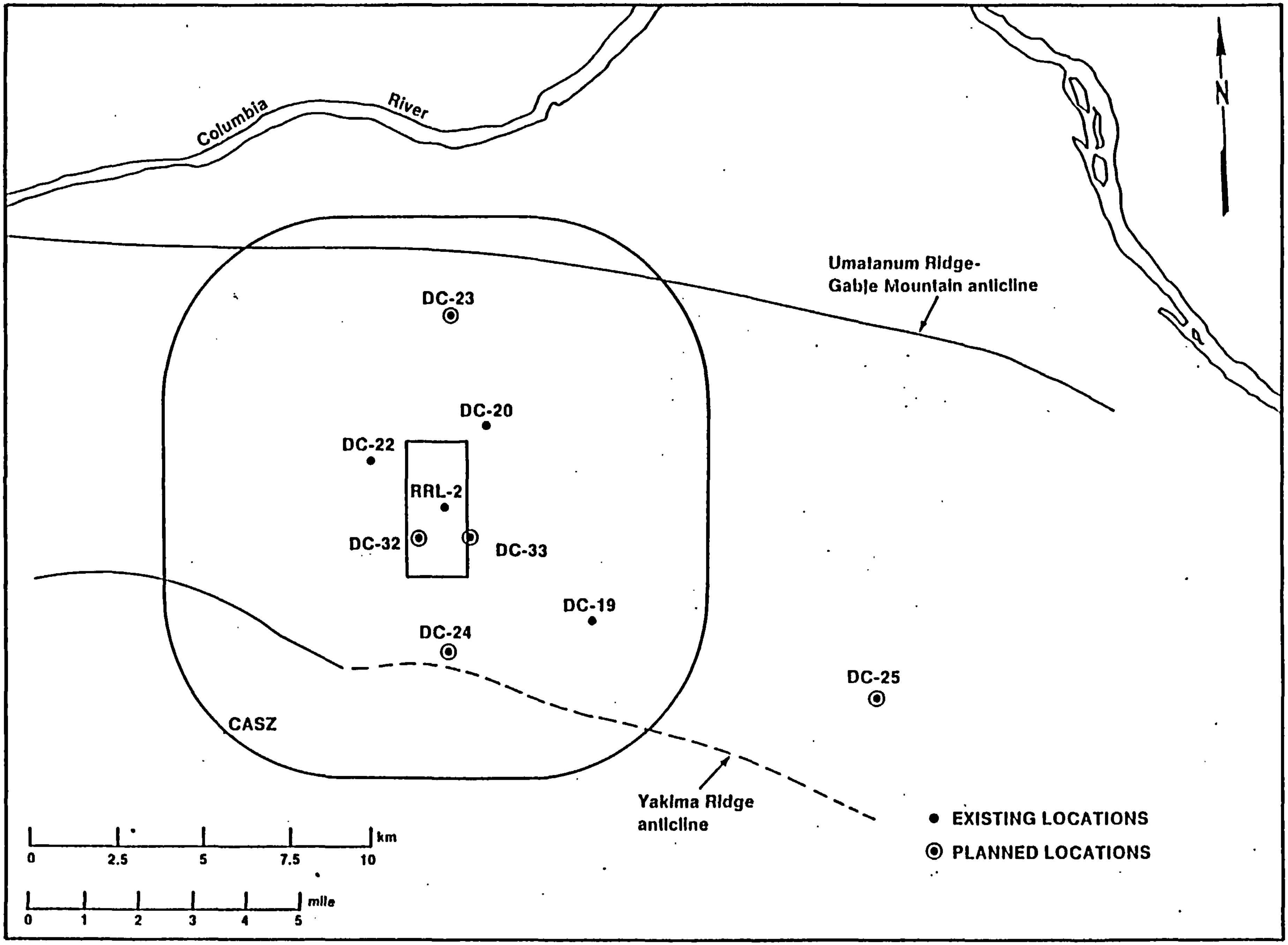

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FIGURE 3 (cont'd)

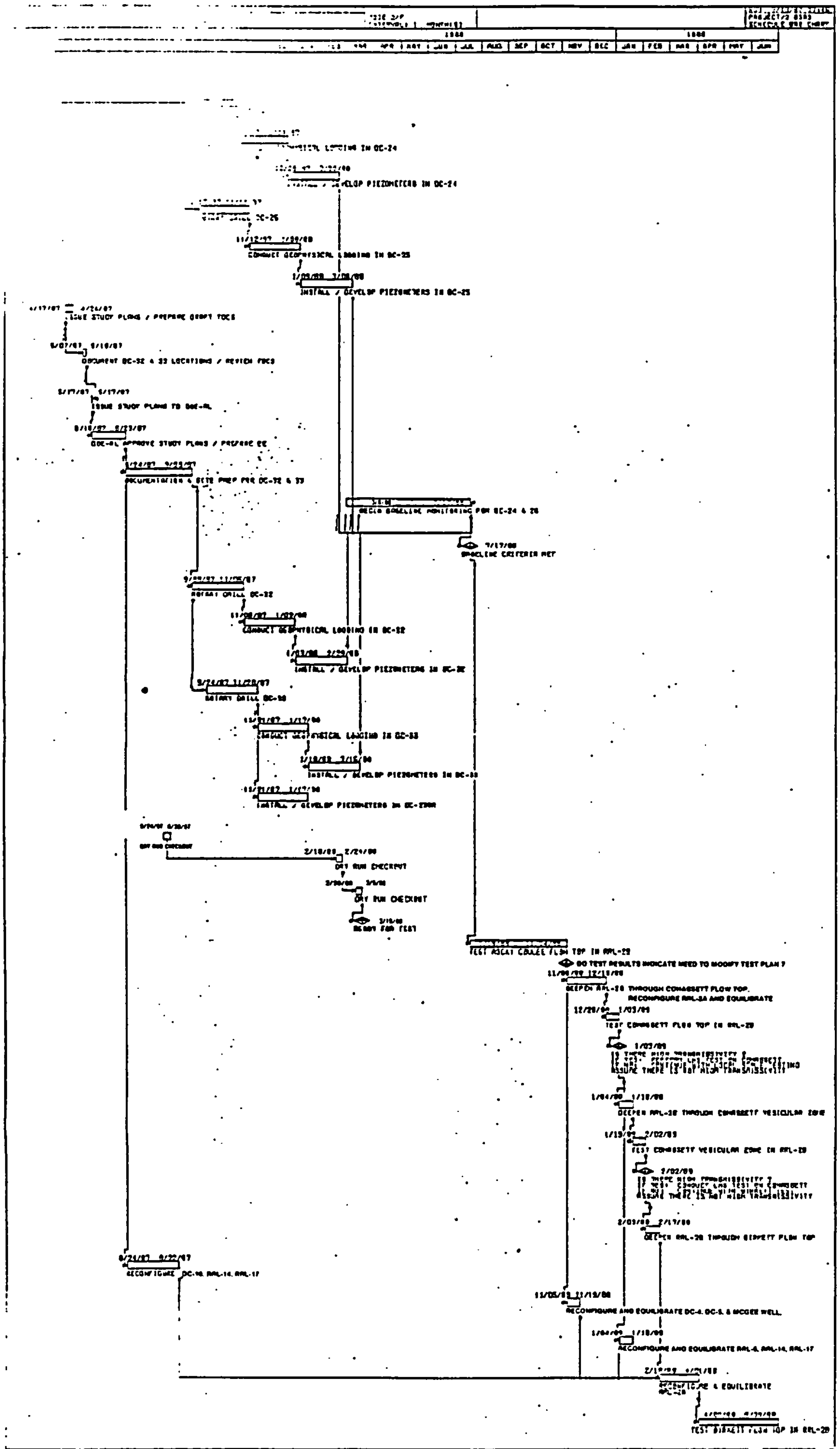

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FIGURE 4

ENCLOSURE C

RESPONSE TO LETTER FROM NRC STAFF ABOUT THE GEOHYDROLOGY TESTING PROGRAM AT HANFORD

The letter, dated April 10, 1986, from J. Linehan to O. Olson, made two major observations with regard to the geohydrology program presented at the December 1985 hydrology workshop. First, there was concern that the initial testing will not be on a repository scale. The NRC staff considered this to differ from the strategy defined by the NRC's Site Technical Position (STP) 1.1. Second, the staff felt that the ability to establish the hydraulic-head baseline may be in jeopardy from perturbations such as those caused by the Exploratory Shaft Facility (ESF). In the absence of a baseline, the evaluations of the pre-waste emplacement ground-water system and the results of future Large-scale Hydraulic Stress (LHS) tests could be compromised.

On the basis of an analysis of information needs to resolve licensing issues for the Hanford site, we have revised the geohydrologic program for the pre-ES time period. That program is structured around four objectives:

- To collect data on geohydrologic conditions that will be changed by site characterization activities.
- To collect data having the potential for providing an early indication of the presence of disqualifying conditions.
- To collect data on geohydrologic conditions in order to identify the effects of the ESF on the flow system and subsequent geohydrologic tests.
- To collect data on geohydrologic conditions that may affect the design of the ESF and/or the repository.

In order to meet the aforementioned objectives, the initial testing is planned to be of repository scale in areal extent. Therefore, we intend to stress four separate horizons: Rocky Coulee flow top, Cohassett flow top, Cohassett vesicular zone, and Birkett flow top. As a minimum, the tests of the Rocky Coulee flow top and Birkett flow top at the RRL-2B pumping well will be LHS tests and should reach to the boundaries of the proposed repository and beyond. In addition, we anticipate small-scale injection tests of the Cohassett flow top and vesicular zone. LHS tests of these units will be performed in the event they prove sufficiently transmissive. The tests identified above will be done in the absence of any external disturbances from other site characterization activities, especially ES construction. Further, descriptive information about the pre-ES testing program may be found in Section 8.3.1.3. of the Site Characterization Plan (in preparation), and the Department's option paper on pre-ES geohydrologic testing which gives a general overview of the program.

As for the hydraulic-head baseline, the program contains ongoing hydraulic-head monitoring which we believe provides the baseline needed to understand the ground-water flow regime and to evaluate subsequent hydraulic tests. As part of its pre-ES geohyrologic testing program, the Department of will supplement the monitoring network for hydraulic head. In particular, two multi-piezometer wells, DC-24 and DC-25, will be constructed. These facilities will be located to augment our understanding of the ground-water flow system and refine the preferred conceptual model. During the post-ES time period, additional monitoring wells will be installed and LHS tests will be performed to investigate the boundaries of the system.

Hydraulic head is monitored at 36 sites scattered over the Hanford site. Data from these sites, plus new multi-piezometer wells will, in our view, constitute a suitable baseline to characterize the pre-waste emplacement ground-water system at the site. We expect that the hydraulic-head data will be sufficient to meet our criteria for establishing the hydraulic-head baseline before the start of LHS testing. We expect these steps will adequately serve our testing objectives.

The NRC staff noted that the Department had not performed the analyses required to address their concerns. The results of the analyses will be available before start of the LHS test series at RRL-2B.

The NRC staff also requested early involvement in the readiness review process for the testing program. The Department agrees to keep the staff informed of progress with the readiness review. NRC's Onsite Representative and other interested staff will be invited to attend formal review meetings. Documentation related to the readiness review, including QA plans and procedures, will be provided as soon as internal management checks are completed. Whenever individual tests are performed, the NRC staff will be invited to attend as observers.

2. Responses to Detailed Comments

Monitoring Facilities

1. Monitoring Locations and Frequencies

NRC Comment -

Because of the uneven distribution of monitoring facilities around the pumping well (RRL-2B), BWIP's ability to characterize and interpret hydraulic responses to pumping stress in three dimensions is limited. As planned, water levels will not be monitored between radial distances of 152 m (RRL-2A) and 2250 m (RRL-14). Without water level information at intermediate scales between RRL-2A and RRL-14, results from LHS testing of the Grande Rhonde Basalts at RRL-2 may yield considerable uncertainty in interpretations drawn from the test results. For example, deviations from expected drawdown responses may be caused by distributed leakage through flow interiors or discrete features, or by interference by hydrogeologic boundaries. It appears that current monitoring facilities at the Hanford Site are inadequate to achieve the objectives of LHS testing because of their locations and limited number.

The inadequacy of present monitoring facilities is especially acute for the third planned LHS test, which will stress the Grande Ronde 5 flow top. Of the three proposed tests, the LHS test of the Grande Ronde 5 flow top has the greatest potential to be a repository-scale test because of the unit's apparent high transmissivity in the vicinity of the RRL-2 cluster. However, only two facilities presently monitor the Grande Ronde 5 flow top: RRL-2C at 76 m from RRL-2B and RRL-14 at 2250 m. The limited number and locations of these facilities appear to be inadequate to characterize hydrologic boundaries and hydraulic continuity, and the spatial distribution of hydraulic properties. BWIP should install additional monitoring facilities or substantially modify existing facilities prior to conducting the proposed LHS test in the Grande Ronde Number 5 flow top.

Prior to conducting LHS testing, BWIP needs to demonstrate how proposed monitoring facilities will provide necessary hydraulic head and response data for site characterization. BWIP should assess the limitations of the present monitoring network at the Hanford Site and improve the network to accomplish the objectives of LHS testing and site characterization. Potential improvements to the network range from increasing the frequency and location of head measurements at existing facilities to installing new monitoring facilities. A more comprehensive piezometer network (both in frequency of measurement and location) would support characterization of the groundwater flow system in the Pasco Basin and provide a potentiometric baseline against which BWIP could compare effects of drilling, well development, testing, and other activities (e.g., exploratory shaft construction, off-site perturbations, wastewater disposal activities).

DOE RESPONSE -

Current plans include the construction of additional multiple-level piezometer facilities at five sites; DC-23, DC-24, DC-25, DC-32, and DC-33 (figure 1) prior to initiating pre-ES LHS tests. At each site monitoring points will be provided in the Priest Rapids interflow, the Sentinel Gap flow top, the Ginkgo flow top, the Rocky Coulee flow top, the Cohassett flow top, the Birkett flow top, and the Umtanum flow top.

Eight existing boreholes will be modified for use as test observation points (figure 2). A permanent piezometer will be installed in DC-16 to monitor the Birkett flow top. The Birkett flow top was selected to be monitored in DC-16 based on comparison of the distribution of monitoring points available for each of the four pre-ES tests. Straddle packers and bridge plugs will be used to isolate test horizons in boreholes RRL-2A, RRL-6, RRL-14, RRL-17, DC-4, DC-5, and McGee well.

Borehole RRL-2A is currently configured to monitor the Rocky Coulee flow top and the Grande Ronde No. 2 flow above the Rocky Coulee flow. RRL-2A will be reconfigured for each of the three tests that follow the Rocky Coulee test such that the stressed (e.g., pumped or pulsed) horizon will be monitored. Monitoring of the stressed horizons at RRL-2A is important because of the near proximity of RRL-2A to the test well, RRL-2B. The remaining six boreholes, RRL-6, RRL-14, RRL-17, DC-4, DC-5, and McGee well will be configured to monitor the Rocky Coulee flow top during the Rocky Coulee flow top LHS test and then reconfigured to monitor the Birkett flow top during the Birkett flow top LHS test. Hydraulic response is not expected at RRL-6, RRL-14, RRL-17, DC-4, DC-5, and McGee well for the stress tests of the Cohassett flow top and Cohassett vesicular zone because of the distance the boreholes are from the test well and the expected low transmissivity of these horizons. However, if after deepening the test well, RRL-2B, it is found the Cohassett flow top and/or the Cohassett vesicular zone have sufficient transmissivity to support LHS tests, then the six facilities would be reconfigured to monitor the pumped horizon(s).

As reflected in the test plan for hydraulic testing at RRL-2B (Stone, et al., 1985), the frequency of measurement of hydraulic head or pressure at facilities in the Hanford Site Monitoring Network (figure 2) will be increased during hydraulic testing. Current monitoring frequencies are adequate for determining the hydraulic head baseline in the absence of any large perturbations.

2. Cement Effects

NRC COMMENT -

During the drilling of RRL-2A and -6, the Rocky Coulee flow top was cemented to reduce mud loss. This cementing may adversely complicate the interpretation of water level responses and tracer breakthrough during the first LHS test. Such complications in RRL-2A could be especially important because of the sensitivity of test interpretations to water level responses at this location and because cement may inhibit tracer injection into the Rocky Coulee flow top.

During the meeting, BWIP asserted that cement does not significantly interfere with hydraulic communication between RRL-2A and the Rocky Coulee flow top. This position was based on evaluation of dynamic temperature logs and comparisons of hydraulic test data. Dynamic temperature logging indicated that the Rocky Coulee flow top still contributes flow to the well. BWIP also compared the transmissivity value determined from a hydraulic test of the combined Grande Ronde 2 flow and the Rocky Coulee flow top in RRL-2A with the transmissivity value determined from a pulse test in RRL-2B. BWIP concluded that the two transmissivity values compared favorably, thus indicating that cement does not inhibit hydraulic communication between the borehole and the Rocky Coulee flow top.

Although BWIP provided a verbal basis for its assertion that cement in RRL-2A and -6 does not significantly inhibit hydraulic communication with the Rocky Coulee flow top, BWIP did not provide any documentation of the conclusions nor supporting assessments. BWIP should document the basis for its assertion and then provide it to NRC for review and comment.

DOE RESPONSE -

Available information indicates that spot cementing of the Rocky Coulee flow top during drilling of borehole RRL-2A had minimal effect on the hydraulic properties of this flow. Evidence suggesting that the cement did not significantly inhibit hydraulic communication between the borehole and the flow top includes:

- o Single borehole tests performed on the composite Rocky Coulee and Grande Ronde No.2 flow tops at RRL-2A <u>prior to cementing</u> resulted in an estimated transmissivity ranging between 1 and 10 ft^2/d (Strait and Mercer, 1986). Pulse testing of the Rocky Coulee flow top was conducted at RRL-2B while monitoring hydraulic responses in the same horizon at RRL-2A and RRL-2C. Estimated transmissivity of the Rocky Coulee flow top at RRL-2A, following cementing of the Rocky Coulee flow top, was 6.5ft2/d (Jackson et al., 1986). The post-cementing test results are consistent with estimates of transmissivity obtained from the pre-cement test.

- o Dynamic fluid-temperature logs (copies on file with Basalt Records Management System) run subsequent to cementing indicate water production (about two gallons per minute) from the Rocky

Coulee flow top at RRL-2A. This suggests a significant hydraulic connection between the Rocky Coulee flow top and the open interval in RRL-2A.

- o Hydraulic responses were observed in the Rocky Coulee flow top at RRL-2A and RRL-2C while drilling RRL-2B in June, 1985 (Jackson et al. 1986, p. 23-24), indicating hydraulic connection.

The effects of cementing of the Rocky Coulee flow top at RRL-6 are not as well understood. Dynamic temperature logs of RRL-6 did not indicate a hydraulic connection between the Rocky Coulee flow top and the borehole. However, water-level data from subsequent monitoring of the Rocky Coulee flow top at RRL-6 are consistent with data from other Rocky Coulee flow top piezometers on the site.

3. Borehole Interflow

NRC COMMENT -

Subsequent to the first LHS test in the Rocky Coulee flow top and removal of bridgeplugs, interformational flow via open boreholes between flow tops and other producing zones may occur within observation wells RRL-2A, DC-4, RRL-6, and the McGee Well. The bridgeplugs were originally installed to minimize borehole interflow, which could interfere with interpretations of LHS test results by perturbing water levels. BWIP indicated during the meeting that borehole interflow, would not significantly perturb water levels, yet did not provide any rationale for this conclusion. BWIP should carefully analyze whether borehole interflow subsequent to bridgeplug removal will significantly affect interpretations of LHS test results. This analysis should then be presented to NRC for review.

DOE RESPONSE -

Preliminary, unpublished analyses (Internal letter 10130-85-034, S. M. Baker to W. H. Price) have been performed to determine the approximate effect of borehole interflow at DC-16. It was concluded from these analyses that borehole interflow at DC-16 would not affect water-level measurements at other observation points (e.g., DC-19, DC-20, DC-22, and RRL-2) for the Rocky Coulee flow top test.

We believe the results of the above described modelling can be used to qualitatively estimate the effect of borehole interflow at observation wells RRL-2A, DC-4, RRL-6, and McGee well. That is, effect on observed water levels at other observation points (e.g., DC-19, DC-20, and RRL-2C) is expected to be negligible due to borehole interflow at RRL-2A, DC-4, RRL-6, and McGee well. However, the water levels observed in the interval in which interflow occurs will not be accurate at the borehole (i.e., RRL-2A, DC-4, RRL-6, and McGee well). As recommended in internal letter 10130-85-034, additional modelling will be performed to estimate the effects of borehole interflow, subsequent to bridge plug removal to reposition the straddle packer in RRL-2A, DC-4, RRL-6, and the McGee Well. The approach taken to estimate the effects of borehole interflow will be described in the Site Groundwater Study Plan (SD-BWI-SP-047) which is expected to be released by July 1987. The results of the modelling will be used to chose the appropriate monitoring option.

4. Monitoring Facilities for the Ratio Test

NRC COMMENT -

BWIP proposes to analyze LHS test results using the Neuman-Witherspoon ratio method to derive estimates of vertical hydraulic conductivity of the flow interiors near RRL-2B. The utility of the first ratio test in the Rocky Coulee flow top is limited, however, because limitations of present monitoring facilities preclude determination of diffusivity for the flow interior above the Rocky Coulee flow. In addition, ratio testing could result in low, nonconservative estimates of hydraulic diffusivity for the Rocky Coulee flow interior because of piezometer compliance, which is the non-ideal response of piezometers caused by small-scale deformation of piezometer components. The Neuman-Witherspoon (1972) ratio method requires head response data from within confining beds adjacent to the pumped aquifer (e.g., Rocky Coulee flow top in the first planned LHS test). These data are interpreted along with response data from within the pumped aquifer to estimate the hydraulic diffusivity of the confining units, where diffusivity equals the ratio of the confining unit's vertical hydraulic conductivity and its specific storage. Although response

data can be collected from the piezometer completed within the Rocky Coulee flow interior at RRL-2C, response data cannot be collected within the flow interior above the Rocky Coulee flow top because BWIP has not completed a piezometer within the interior of Grande Ronde flow number 2. Thus, the first LHS test will not estimate the diffusivity of the flow interior above the Rocky Coulee flow top. Because of this limitation, the first LHS test will not serve as a good example of applying the ratio test to characterize vertical hydraulic conductivities of the Columbia River Basalts. In comparison, testing the Cohassett flow top may provide a better demonstration of ratio testing since flow interiors above and below the flow top will be monitored.

In addition, the utility of the first ratio test may also be limited because piezometer compliance could delay head responses in piezometers completed in the flow interiors. This delay could bias analyses of test results by underestimating the hydraulic diffusivity of the interiors, thus underestimating values of vertical hydraulic conductivity which would be nonconservative with respect to repository performance. BWIP should assess the significance of time-lag due to compliance of piezometers in the RRL-2C cluster that will be used for the ratio test. For example, BWIP could measure piezometer compliance prior to LHS testing by conducting pulse tests in appropriate piezometers. After the LHS test is completed and the results needed for the ratio test have been collected, BWIP could then compare the lag time determined in pulse tests with the time *difference between the start of the test and initial response detected in the piezometers completed in the flow interiors. If the piezometer lag time is comparable with the initial response time, then BWIP may need to correct the response data to characterize hydraulic diffusivities.*

DOE RESPONSE -

A single multiple-piezometer nest, RRL-2C, was designed and constructed to serve as a nearby monitoring facility for the test at RRL-2B. One of the purposes RRL-2C is to serve is that of a facility for ratio tests to calculate vertical hydraulic diffusivity of several flow interiors. Piezometers are completed in flow tops (interflow zones) and flow interiors of the Rocky Coulee, Cohassett, and Birkett (Grande Ronde No. 5) flows. These piezometers will provide for ratio tests of the Rocky Coulee flow interior when the Rocky Coulee flow top is pumped, and of the Cohassett and Birkett flow interiors when the Birkett flow top is pumped. The practical limit to the number of piezometer tubes in a multiple-level installation was six at the time of construction of RRL-2C. Therefore, the interior of the Grande Ronde No. 2 was not fitted with a piezometer.

The ratio method is yet to be successfully applied in testing deep basalt flows. Therefore, the use of the ratio method to calculate vertical hydraulic diffusivity from the results of the first LHS test should be viewed as an evaluation of the methodology as well as an

attempt to estimate this parameter. Even if successful, the ratio test at RRL-2 may yield results of limited applicability because the vertical hydraulic diffusivity estimates derived from the test will apply to only a small region within the flow interior. Using the ratio method to evaluate results of the first LHS test will be valuable in developing plans for subsequent tests designed to determine vertical hydraulic properties.

Other approaches will be used to estimate flow interior vertical diffusivity. These approaches include analysis of the drawdown data in the pumped flow top with the Hantush-Jacob method (Hantush and Jacob, 1955) and Hantush Modified method (Hantush, 1960) and numerical analysis using the observed responses in the pumped flow top and adjacent flow tops. Estimating vertical diffusivity of confining units based solely on response of the pumped aquifer does have a disadvantage that should be noted here. That is, in a layered system it is generally not possible to discriminate the source of leakage into an aquifer if it is confined above and below such as the basalt flow tops are confined above and below by flow dense interiors.

The numerical analysis approach would use a quasi-three dimensional or fully three-dimensional numerical groundwater flow model of the site which would be "calibrated" to the observed water-level responses. The major disadvantage of the numerical approach is that solutions are not unique. However, with ever increasing data base, the number of solutions possible should be reduced.

Both the analytical and numerical approaches have the advantage of providing estimates of flow dense interior vertical diffusivity integrated over a large area. The application and limitations of all anticipated techniques will be discussed in the Site Groundwater Study Plan (SD-BWI-TP-047) which is expected to be released by July 1987.

The significance of time lag resulting from piezometer compliance in the RRL-2C piezometer cluster is an important consideration and will be assessed. Piezometer compliance due to compressibility of the fluid within the piezometer tube will be minimized by using a packer set at depth in the piezometer tube to isolate the lower part of the piezometer. Lag time due to compressibility of the remaining fluid in the piezometer tube and sand pack can be calculated. A detailed discussion of the plans for performing sensitivity studies and field tests of piezometer compliance and lag time are to be discussed in the Site Groundwater Study Plan (SD-BWI-SP-047).

As noted in response to comment 7, the Birkett flow top will be pumped prior to ES construction. When the Birkett flow top is pumped data from piezometers completed in the overlying Cohassett interior and the underlying Birkett interior and in the Birkett flow top will provide for ratio tests of both the Cohassett and the Birkett flow interiors.

5. Grout Permeability

NRC COMMENT -

During the meeting, BWIP indicated that the permeabilities of grouts used in the clustered piezometer installations (i.e. DC-19/20/22) had recently been estimated using permeameter testing. The contrast between the grout permeability in the cluster installations and that of the basalts is important to reliable performance of the piezometers. In addition, the effectiveness of the bond between the grout and basalt also affects the reliability of piezometer responses. Isolation of monitoring intervals using grout is especially important to reliable performance of piezometers completed within flow interiors because of the similarity of hydraulic conductivities between the grout and basalt. BWIP should present its analyses of grout permeability and integrity to NRC to demonstrate reliable performance of the piezometers.

DOE RESPONSE -

Formal documentation of the cement permeability is provided by Jackson et al. 1986, pp. 44-45. This document contains test results obtained by Rockwell and their cementing subcontractor. Details on the laboratory tests are found in the subcontractor's laboratory reports or in controlled notebooks, both of which are on file with the Site Characterization Field Investigation Department. The same document (pp. 49-65) shows the observed responses in RRL-2C piezometers during development pumping of each of the piezometer tubes. This information was provided to the NRC in December, 1986 at Richland, Washington.

In an effort to determine the sufficiency of piezometer seals a preliminary evaluation of historic hydraulic perturbations and monitored responses to drilling activities has been performed (Wilson, 1987, 29p.) The conclusion from the preliminary evaluation is that the piezometer seals are probably good and the observed vertical response to drilling activities is probably due to naturally occurring connections.

Additional activities to assess the integrity of piezometer seals and estimate the effect of a finite seal leakage on characterization activities will include numerical modelling of observed responses and sensitivity studies to estimate the effect of piezometer seal leakage on large-scale hydraulic test interpretation. Integrity tests similar to those done at DC-19, DC-20, and DC-22 will be performed at all new piezometer installations (e.g., DC-24, DC-25, DC-32, and DC-33) and evaluation of data from both new and existing piezometers will be ongoing for evidence of seal degradation or inadequacy.

6. Westbay Installation

NRC COMMENT -

Based on discussions during the meeting and the subsequent site visit by NRC consultants (12/11/85), the trial installation of a Westbay device in RRL-14 appears to be providing useful information about the device's utility within the Hanford Site monitoring network. BWIP indicated during the meeting that the travelling pressure probe in the Westbay device will be used to mintor several horizons at RRL-14 during the LHS test. This does not appear feasible, however, because approximately 8 hours are required to complete a profile of all ports. The probe cannot be moved back and forth from one portal to another, thus it may not be useful to monitor several horizons during the LHS test because of the time consumed in moving the probe. BWIP should evaluate whether the configuration of the Westbay device can be effectively modified to monitor several flow horizons during LHS testing.

Despite their apparent limitations for near-field multi-level monitoring of LHS tests, Westbay devices may satisfy the need for additional far-field monitoring facilities at the Hanford Site (cf. USGS letter from Rollo to Olson, October 21, 1985). Additional facilities are needed to characterize the regional groundwater flow system in terms of both horizontal and vertical hydraulic gradients. For example, monitoring of such facilities outside of the Cold Creek Syncline may provide DOE with the ability to characterize vertical pressure profiles in areas where site activities are not expected to cause significant transient hydrologic responses. This type of additional information could significantly contribute to BWIP's understanding of the groundwater flow system at the Hanford Site. Based on experience gained with the Westbay device at RRL-14, BWIP should consider installing similar types of devices in boreholes distant from the RRL to characterize the regional groundwater flow system.

DOE RESPONSE -

The BWIP agrees that the usefulness of the Westbay system at RRL-14 for near-field monitoring of several horizons during an LHS test is limited by the time required to complete a profile of all ports. However, this limitation is not so important at a large distance from the pumping well during a long-term test. The proximity of the DC-22 piezometer site to RRL-14 will also provide a backup monitoring point and a comparison for evaluating the usefulness of the Westbay system.

The Westbay system has been removed from RRL-14 because of an unanticipated problem with the packer material. The system will be reinstalled with new packers prior to LHS testing. Following evaluation of the renovated Westbay system, BWIP will develop a plan for its appropriate employment.

Testing Procedures

7. LHS Testing Focus

NRC COMMENT -

The test plan states on page 41 that the "real focus of large-scale hydraulic testing in the Grande Ronde Basalt at the RRL-2 site is the Cohassett flow interior". This statement appears to be inconsistent with both the objectives of LHS testing stated earlier in the plan and BWIP's approach to repository performance assessment. As described in other sections of the test plan and NRC's BWIP Site Technical Position 1.1, the primary objective of LHS testing at BWIP is to provide repository-scale hydraulic data to support licensing assesssments of repository performance. This includes characterization of hydraulic parameters, identification of hydrologic boundaries, evaluation of far-field hydraulic continuity, and formulation of defensible conceptual models of the groundwater flow system. To accomplish these objectives, LHS testing should develop a far-field perturbation in response to controlled stress, which can best be done in the units with the highest transmissivities. Of the three units identified in the test plan for LHS testing, the Cohassett flow appears to have the lowest transmissivities. Therefore, BWIP's focus on the Cohassett flow may decrease the potential for fulfilling the primary objective of LHS testing.

The focus on the Cohassett flow also appears inconsistent with BWIP's current approach to repository performance assessment. As stated on page 2-9 of the Exploratory Shaft Test Plan [SD-BWI-TP-007], "BWIP is following a logic which does not take credit for [groundwater] travel time [in] the perferred horizon dense interior". Since the goal of LHS testing is to develop information necessary for demonstrating compliance with licensing requirements, it would appear that BWIP should focus testing on hydrogeologic units that it plans to take credit for in the compliance demonstration.

In addition, if BWIP's proposed testing plan focuses on the Cohassett flow interior, the plan should be modified to include a long-term pumping test of the Cohassett flow top. The test plan implies that LHS testing will not be considered in the Cohassett flow top because of its assumed low transmissivity relative to other flow tops. However, long-term testing of the flow top may yield valuable information about the vertical hydraulic conductivity of the Cohassett and Rocky Coulee flow interiors. Uncertainty in estimates of vertical leakage can be reduced by pumping a lower transmissivity unit such as the Cohassett flow top because uncertainty in leaky aquifer analyses is reduced in LHS tests where aquifer response deviates substantially from the theoretical Theis response, and this deviation increases as the ratio in conductivities between the aquifer and confining units decreases. Thus, LHS testing of low transmissivity flow tops may provide more information about vertical hydraulic conductivity than tests in higher transmissivity units.

BWIP should determine the appropriate focus of LHS testing at RRL-2 with respect to its approach for performance assessment and the objectives for LHS testing. As discussed during the meeting, BWIP should also evaluate LHS testing of the Cohassett flow top based on preliminary estimates of the unit's transmissivity at RRL-2B that will be determined through pulse tests and well development.

DOE RESPONSE -

The BWIP hydrology testing strategy has evolved significantly since the DOE/NRC workshop of December 1985. BWIP will establish a groundwater level baseline before the potential disturbance of LHS testing and ES construction occur. Hydraulic tests on four hydrostratigraphic units (Three flow tops and the Cohassett vesicular zone) will be performed at the RRL-2 site prior to ES construction. Two of the flow tops, the Rocky Coulee and Birkett flow top, are expected to have transmissivity sufficient to support LHS tests based on estimates of flow top hydraulic conductivity from the nearby corehole RRL-2A. The Cohassett flow top and vesicular zone are expected to not have sufficient transmissivity to support LHS tests thus, local-scale tests of the Cohassett flow top and Cohassett vesicular zone are expected.

8. Pump Selection

NRC COMMENT -

The test plan states that the first LHS test in the Rocky Coulee flow will use a positive displacement (sucker rod) pump. Positive displacement pumps, however, do not produce a continuous and constant rate of discharge. Fluctuations in pressure at the pumping well caused by pump cycling may complicate interpretation of early-time drawdown data if the fluctuations cause oscillations in water levels at observation wells RRL-2C and -2A. In addition, changes in pumping rate may be difficult to accomplish during the early part of the test because of the operation of the pump. It appears BWIP would have to *turn the pump off to alter the pump discharge rate, which may unnecessarily complicate interpretation of the LHS test results. If the production capability of RRL-2B in the Rocky Coulee flow top is greater than anticipated, the sucker rod pump may not be able to pump at sufficiently high rates to optimize the performance of the LHS test.*

When the selection of the sucker rod pump was discussed during the meeting, BWIP indicated the selection was based on the need to minimize the effects of wellbore storage. Although this is an advantage of using the sucker rod pump, other pumping schemes such as submersible pumping may also acheive this advantage while providing relatively constant discharge rates.

BWIP should attempt to keep the discharge rate relatively constant, as appropriate, during the pumping test to minimize complications in interpreting the test results. In addition, BWIP should document its rationale for selecting the sucker rod pump and evaluate potential adverse effects of sucker rod pumping on interpretation of water level data from the pumping well and RRL-2C and -2A.

DOE RESPONSE -

The pumping system selected to remove water from the Rocky Coulee flow top in RRL-2B is powered by an electric motor, operated by 60 cycle alternating current. The system embodies a reciprocal positive displacement pump and a geared reduction system for translating the rotary motion of the motor to the linear, reciprocal motion of the pump plunger. A multiple belt drive is used to transmit power from the motor to the geared reduction system. Short of belt slippage, which can be prevented by proper adjustment, the system must produce a constant rate of discharge from minute to minute, provided the current frequency does not vary substantially.

The pump will lift about 8 gpm at about 10 strokes per minute. The estimated hydraulic head fluctuation 250 ft from the pumping well caused by removal of 0.8 gallon (i. e., one stroke of the pump) is so small its estimation with the Theis equation is out of range of the W(u) tables. This fluctuation is not expected to have an adverse effect on the interpretation of data from the observation wells and is expected to be attenuated in travel to the nearest observation well, 250 feet away.

Changes in pumping rate are not difficult to accomplish with the sucker rod pump system, but they do require stopping the pump. If changes in discharge rate are needed in the early part of the test, it would be advisable to stop, equilibrate, and start the test over. The lack of ability to adjust pumping rate continuously is not viewed as a disadvantage.

If the Rocky Coulee flow top yields more than about 15 gpm, a different pumping system may be needed. Yield of more than 15 gpm is viewed as unlikely, but if it is the case, the test design will be reevaluated in light of the apparent differing hydraulic conditions. If all test objectives would not likely be accomplished using the above pump operating at the maximum discharge rate (i.e., 15 gpm) then, a different pumping system would be required. The pump that is presently installed at RRL-2B is adequate to produce the greatest flow that can be reasonably expected from the Rocky Coulee flow top with approximately 800 feet of drawdown.

A submersible pump has the advantage of producing a continuous flow. However, the groundwater must be degassed before it enters the pump to avoid gas lock and wellbore storage must be minimized. Minimizing wellbore storage in combination with the degasser is difficult. A packer has to be set above the pump to reduce borehole storage which requires an elaborate system for venting gas to the surface plus providing electric power to the submersible motor and monitoring groundwater pressure change below the packer. Without the gas separation and venting capability, the submersible pump would be likely to fail due to gas lock.

Pressure measurements only will be made in RRL-2B, the pumping well. The measurements during pumping are not regarded as particularly useful in estimating hydraulic parameter values because of the frictional losses in flow near the well bore and on entry into the well bore. This commonly recognized fact negates the supposed adverse effect of "sucker rod pumping on interpretation of water level data from the pumping well." Pressure measured after pumping ceases in RRL-2B will be useful information for recovery analysis to estimate hydraulic property values, etc.

9. Criteria for LHS Testing

NRC COMMENT -

The LHS test plan describes a nominal 30-day period of pumping during the first test from the Rocky Coulee flow top. The plan recognizes satisfactory tracer recovery and indications of hydraulic boundary conditions as criteria to determine when pumping should be terminated. Premature termination of the pumping, however, may limit the ability of the test to fulfill its objectives. During the meeting, BWIP elaborated on the termination criteria which included accomplishment of test objectives and jeopardization of synchronous head measurements. In their present form, however, both of these criteria are subjective and need to be defined in greater detail to develop objective criteria for determining when pumping should be terminated. BWIP should also develop criteria for determining when transient responses caused by LHS testing have sufficiently subsided to allow subsequent LHS tests to begin.

Similar criteria should be developed to determine when pressure trends have been reestablished after the first tracer has been injected during the first LHS test, but before the transducer is pulled out of the second piezometer prior to tracer injection. During the meeting, BWIP indicated that both transducers in RRL-2A and -2C in the Rocky Coulee flow top could be out of the piezometers at the same time, which would eliminate BWIP's capability of monitoring drawdown if measurable perturbations from the first test do not reach more distant monitoring facilities beyond 2250 m. Thus, *BWIP would not be able to detect hydrogeologic boundaries. Further, the removal of the tracer injection apparatus may also perturb pressures in the flow top, which could not be characterized unless at least one transducer remained in a piezometer in the flow top. Once developed, these criteria should be incorporated into LHS and tracer testing procedures.*

DOE RESPONSE-

Hydraulic testing will not begin until synchronous hydraulic head baseline criteria have been reached. Criteria will be developed to determine when pumping should be terminated and when transient responses caused by earlier testing have subsided sufficiently to allow subsequent tests to begin. The criteria will be included in the Site Groundwater Study Plan (SD-BWI-SP-047) and are expected to be released by July 1987.

Tracer injection can precede pumping and/or be delayed until all other hydraulic test objectives have been met in order to minimize the effect on hydraulic testing (see response to comment 13). The installation of additional monitoring points (i.e., DC-32 and DC-33) at an intermediate distance will also help in determining when hydraulic testing objectives have been met. Criteria for starting and stopping the tracer test will be developed and will also be included in the Site Groundwater Study Plan (SD-BWI-SP-047).

10. Development of RRL-2B

NRC COMMENT -

The LHS test plan does not discuss how the pumping well, RRL-2B, has been or will be developed prior to the first LHS test in the Rocky Coulee flow top, or how the well will be developed prior to subsequent tests. Drill cuttings and drilling fluids remaining in the Rocky Coulee flow top may inhibit flow to the well, thus decreasing well efficiency and potential pumping rates. The purpose of well development is to remove cuttings and drilling fluids from the formation. The drilling and completion specifications document for RRL-2B and -2C [SD-BWI-TC-023] mentions that RRL-2C will be developed prior to installation of the piezometers, but does not discuss well development activities for RRL-2B. In addition to improving well efficiency, controlled development of RRL-2B using air-lift pumping or other suitable techniques may provide valuable pre-LHS testing transmissivity estimates allowing selection of optimal pumping rates from the Rocky Coulee flow top. Use of well development as a pre-test would require that BWIP monitor water levels and/or pressures, discharge rates, and hydraulic responses to the development stress. Controlled well development of RRL-2B may provide more accurate estimates of aquifer transmissivity and a more defensible basis for selection of optimal pumping rates than the proposed pulse testing, particularly in higher transmissivity units. Hydrochemical sampling during well development could also be used to evaluate whether the bulk of drilling fluids injected during drilling *have been removed. BWIP should carefully document the development procedures used in RRL-2B. If the well has not been developed, BWIP should evaluate alternative development techniques and develop RRL-2B, as appropriate, prior to initiation of LHS testing.*

DOE RESPONSE -

The test plan will be revised to discuss well development which was conducted at RRL-2B prior to pump installation and any further development planned prior to subsequent tests. Hydrochemical sampling will be conducted during any future development pumping to determine the degree of drilling fluid removal. Well RRL-2B was developed, as described by Jackson et al., 1986 (p. 39), prior to installation of the sucker rod pumping system. The borehole clean-up involved circulating Hanford system water in the open-hole part of the borehole immediately after reaching the interim depth of 2,858 ft. This was done to remove drill cuttings that may have accumulated in the borehole during the drilling operation (note: the drilling fluid was water with no additives). In addition to this work, limited borehole development was performed by air-lift pumping in September, 1985. An estimated 1,000 gal of fluid was removed from the borehole. Further flushing of the borehole was accomplished in October, 1985. The total volume of Hanford system water used to flush the borehole was about 48,000 gal. A video survey indicated that only minor amounts of particulate matter remained suspended in the water after circulation.

Air-lift pumping was not used as the principal technique to develop the borehole because of the low transmissivity of the Rocky Coulee flow top. Preliminary estimates of transmissivity of the Rocky Coulee flow top range from about 2 to 6 ft_2/d in the vicinity of RRL-2B.

11. Mechanical Effects

NRC COMMENT -

Based on pre-test analyses described in the test plan, BWIP expects that pumping from RRL-2B will develop significant drawdowns (e.g., 263 meters) in the vicinity of the pumping well during the first LHS test. Such large drawdowns may stimulate discontinuous deformation of the basalt flows by decreasing pore pressures and changing fracture apertures. Although stresses caused by changes in pore pressure may be insignificant compared with in-situ stresses, BWIP should recognize that changes in fracture apertures in close proximity to the pumping well may cause anomalous head responses during LHS testing.

DOE RESPONSE -

The BWIP agrees with NRC that "changes in fracture apertures in close proximity to the pumping well may cause anomalous headresponses during...testing." BWIP also agrees with the NRC that changes in pore pressure should be insignificant and the changes in fracture aperture would occur only very near the pumping well where the maximum change in groundwater pressure will occur. The nearby piezometer, RRL-2C and RRL-2A, would not be affected by either mechanical effects or wellbore inefficiency. For these reasons, and for reasons stated in response to comment 8, the pumping well is not relied on for data during drawdown.

12. Vesicular Zone Testing

NRC COMMENT -

As agreed in the meeting, BWIP needs to consider performing LHS tests of the vesicular zone in the Cohasset flow interior. BWIP's decision to conduct testing of the vesicular zone should be consistent with the test plan and be based on preliminary testing of the vesicular zone after the pumping well has been drilled through the zone.

DOE RESPONSE -

Preliminary results from testing the Cohassett vesicular zone at RRL-2A during drilling indicates that the vesicular zone possesses a transmissivity of 10^{-4} ft^2/d (Strait and Mercer, 1986). Because the Cohassett vesicular zone is believed to be of such low transmissivity, BWIP is anticipating performing a pressurized pulse test or constant head injection test. If conditions are identified at RRL-2B that indicate sufficient water is available to pump, a constant discharge pumping test will be performed at that well site.

13. Convergent Tracer Test

NRC COMMENT -

The test plan proposes integration of convergent well tracer testing with LHS testing of the Rocky Coulee flow top. The NRC is concerned that the tracer test may complicate the interpretation of LHS testing results. Injection of tracer solution and chase water under 250 m of head into RRL-2A and -2C, may result in pressure perturbations that could interfere with aquifer responses to pumping stress, especially within the flow interiors. Although such perturbations may not last long within flow tops (e.g., several hours to days), the pressure pulses in flow interiors may be on the order of meters and persist for periods up to tens of days. As discussed in comment number 9, conduct of the tracer test may also prevent continuous collection of pressure data at RRL-2A and -2C because the pressure transducers will be removed to inject the tracers.

In addition, the test plan does not provide a detailed rationale for how information derived from the convergent well tracer test will be utilized in evaluations of site performance. For example, the two-well recirculating tracer test conducted previously at the BWIP was not designed to provide repository-scale estimates of dispersivity (Leonhart et al., 1984). This same limitation also applies to the dispersivity values determined in the covergent well tests at RRL-2. The test plan's description of proposed tests does not evaluate whether lateral dispersion will be significant with respect to longitudinal dispersion, or whether the hydraulic gradients imposed during the test will result in tracer behavior that *is fundamentally different from tracer behavior under ambient conditions. This difference may be especially significant if flow through fractured basalt is assumed to represent an equivalent porous medium. Further, the plan does not discuss uncertainties about the representativeness of effective porosity and dispersivity values for portions of the Rocky Coulee flow top distant from RRL-2 and other basalt flow tops.*

The NRC agrees that the DOE needs to characterize effective porosity and dispersivity at the BWIP site, but this information should be collected in a manner that does not compromise the primary objective of the LHS testing, i.e., to characterize the groundwater flow system including hydrologic boundaries, hydraulic continuity, and hydraulic parameters. BWIP should assess potential complications of conducting the covergent tracer tests in conjunction with the LHS test and concurrent ratio test, particularly with respect to monitoring water level responses within the flow interiors. This assessment should also document the rationale for the tracer tests including a discussion of the limitations and uncertainties that will be associated with the tracer test results.

REFERENCE: Leonhart, L. R., R. Jackson, D. Graham, L. Gelhar, G. Thompson, B. Kauchoro, and C. Wilson, 1984, "Analysis and Interpretation of a Recirculating Tracer Experiment Performed in a Deep Basalt Flow Top," RHO-BW-SA-300 P, Rockwell Hanford Operations.

DOE RESPONSE -

As discussed under comment 9, the tracer test should not be conducted until specific criteria have been met to insure that objectives of the hydraulic portion of the test have been met. These criteria will be developed prior to the LHS test.

The detailed rationale for how information derived from the convergent well tracer test will be utilized in evaluation of site performance will be contained in the site groundwater study plan and performance assessment plans, issue resolution strategies, and other higher-order documents. These documents drive the test plan.

The BWIP does recognize the need to understand the degree of scale-dependency of dispersivity parameters. The strategy being developed within the site groundwater study plan therefore proposes to conduct several tracer tests at different scales up to about 1 km. This will allow the BWIP to determine if functional relationships with distance can be defined. The tests at RRL-2 will provide input to this data base but are not intended to fulfill the entire data need.

The NRC is correct in noting that the proposed convergent tracer tests will not yield a direct estimate of lateral (transverse) dispersivity. The assumption of zero lateral dispersivity is conservative, and performance measures will be insensitive to the parameter, thereby precluding the need for actual field measurement.

The hydraulic gradients imposed during the test will obviously be much greater than under ambient conditions. The flow, however, is expected to be laminar under test conditions except very near to the pumping well. In order to investigate the effect of scale with respect to gradient, tracer tests will be carried out in other flow tops and locations in the CASZ at several selected gradients. Information on these tracer tests is provided in the Site Groundwater Study Plan (SD-BWI-SP-047) to be released by July 1987.

The NRC expressed other concerns implying that underlying assumptions traditionally made in the analysis of convergent tracer tests may not be maintained by the test conditions. The basis of these concerns focused on a consideration that the hydraulic gradient imposed by the pumping test may be so steep (as compared to ambient conditions) as to affect the dispersivity and effective porosity measurement. This effect will be examined theoretically and/or (if necessary) experimentally to demonstrate the sensitivity. Conceptually, this concern would arise if (1) groundwater flow conditions exceeded threshold values for Reynold's Number, thereby invalidating the assumption of Darcian flow conditions; (2) porous medium assumptions were invalid, or (3) there were a change in hydraulic properties resulting from changes in elastic or inelastic properties of the aquifer due to the high stress conditions. It is not clear that any of these conditions would exist in the case of the proposed testing of RRL-2.

Past discussions with the NRC have also revealed concerns over the role of diffusive versus dispersive properties of the porous medium. It is recognized that gradients of magnitudes imposed by the assumed pumping test conditions would not permit discrimination between the relative contributions of diffusion and dispersion in flow tops with regard to the transport of a conservative solute. Under planned test conditions the diffusive component is insignificant compared to the dispersive component.

The comment reads in paragraph 3: "NRC agrees that the DOE needs to characterize effective porosity and dispersivity at the BWIP site, but this information should be collected in a manner that does not compromise the primary objective..., i.e., to characterize the groundwater flow system..." Performing radial convergent tracer tests as adjunct to the LHS test is one means from which effective porosity and dispersivity data can be obtained without compromising the hydraulic objectives of the test. Modifications to the test plan that will assure both data from tracer tests and pumping tests are not compromised are being considered and developed.

For the purpose of developing a methodology that assures neither test is compromised the following is being considered. Two discrete suites of tracers are required. One suite of tracers is injected prior to pumping. Tracer arrival observations would then be analyzed on a real time basis to define the mass and dilution of the second suite of tracers. The second suite of tracers would be injected after all pumping test objectives are accomplished. The expectation is that nearly identical results can be demonstrated from analysis of the two tracer tests. If so, then future radial convergent tracer tests performed as adjunct to LHS test will use the "pre-pumping" injection methodology which would minimize test duration and interference between test objectives (i.e. perturbations associated with removal of transducers, injection of tracers, and reinstallation of transducers). Other concerns associated with tracer tests include the effects of scale of separation and scale of test gradient. Plans to address these concerns and other limitations and uncertainties are provided in the Site Groundwater Study Plan (SD-BWI-SP-047).

The need and rationale for tracer tests are discussed in detail in issue resolution strategies and study plans, respectively. The rationale underlying our initial proposal to conduct convergent tracer tests as adjunct to pumping tests at RRL-2 involved recognition of the need to build a representative data base on effective porosity of basalt flow tops. This need arises in support of groundwater travel time and radionuclide transport estimations. If it is possible to obtain effective porosity data in such a manner, the opportunity exists to obtain a more substantial assemblage of field-measured effective porosity at an earlier time in the site characterization schedule than would be possible through independent tests.

<u>Hydrologic Baseline</u>

14. Perturbations to Hydrologic Baseline

NRC COMMENT -

Based on reviews of recent water level data submitted by BWIP, NRC observes that trends in hydraulic heads appeared to have been sufficiently established for LHS testing in the Rocky Coulee flow top in May and June of 1985. Since that time, concurrent site preparation activities (e.g., drilling bridgeplugs at RRL-14 and drilling DC-23) have perturbed the groundwater system causing significant deviations to pre-test trends. During the meeting, BWIP acknowledged that more time is now required to reestablish pre-test trends before LHS testing can begin. These recent perturbations demonstrated that hydraulic stresses can be propagated across the Reference Repository Location, thus adding credence to the feasibility of conducting repository-scale LHS testing. The perturbations also indicate that future combinations of drilling, construction, and testing may perturb hydraulic heads to the extent that characterization of the pre-emplacement groundwater flow system and LHS testing would be delayed for a significant amount of time.

In developing strategies and schedules for site activities, BWIP should consider potential complications and delays of site activities caused by perturbations to the hydrologic system. For example, BWIP indicated that a mult-year period of reduced site activity might be required to establish hydrologic baseline if it cannot be established *prior to LHS testing and Exploratory Shaft construction. BWIP's strategy for site characterization should consider the practicality of these contingencies in light of the ambitious project schedules.*

DOE RESPONSE -

The BWIP agrees that the installation of monitoring facilities will perturb the baseline, however, we will reestablish the baseline prior to initiation of LHS testing.

15. Hydrochemical Sampling

NRC COMMENT -

The test plan lists constituents that will be analysed in groundwater samples collected during pumping (cf. Table 13). Although the list appears comprehensive, the test plan does not discuss the objectives for collecting the hydrochemical data or provide a rationale supporting the list. Based on NRC's understanding of BWIP's current strategy for site characterization, these data will be used to characterize baseline hydrochemistry of the Hanford Site to confirm conceptual groundwater flow models and to support predictions of post-emplacement hydrochemical environment along potential radionuclide pathways. BWIP should amend that test plan to discuss the objectives and rationale for the hydrochemical sampling.

In addition, BWIP has omitted carbonate and bicarbonate species from the list of constituents that will be analyzed. Bicarbonate and carbonate species may significantly affect radionuclide transport by a variety of processes, such as complexing, pH buffering, and precipitation. In addition, concentrations of these two species are essential for calculating ion balances. The NRC recognizes that the concentrations of these two species may be calculated based on pH, alkalinity, and concentrations of other constituents (Stumm and Morgan, 1970). However, it would be prudent for BWIP to analyze for carbonate and bicarbonate as a more direct and precise method of determining their concentrations than through calculations. BWIP should include carbonate and bicarbonate in the list of constituents to be analyzed or amend the test plan to describe how their concentrations will be determined in lieu of analysis.

REFERENCE: Stumm, W. and J. J. Morgan, 1970, "Aquatic Chemistry: An Introduction Emphasizing Chemical Equalibria in Natural Waters," (New York, New York: Wiley-Interscience).

DOE RESPONSE -

As the NRC staff notes, two objectives of the hydrochemistry program are to: test groundwater flow concepts, and identify the geochemical environment that radionuclides released from a repository would encounter. Other objectives are to: establish a baseline of radionuclide concentrations in groundwater, and contribute to quantification of groundwater flow rate using age dating techniques.

The SCP and appropriate study plans will reflect these objectives. BWIP agrees with the NRC staff that carbonate and bicarbonate concentrations can be calculated using pH and alkalinity (obtained by titration) (Greenburg et al, 1985). To our knowledge reliable techniques to directly measure the concentrations of carbonate and bicarbonate are not available.

16. Data Release

NRC COMMENT -

Until several days before the meeting, the most recent water level information available to the NRC staff and contractor had been collected six months earlier (May/June 1985). NRC has not received pressure data from the BWIP site for the last 10 months. If NRC is to provide constructive comments to DOE on the adequacy of hydrologic data and interpretations, BWIP needs to release essential information such as the water level data on a more-timely basis. The meeting may have been postponed if the NRC had been informed about the perturbations caused by drilling activities prior to the meeting. BWIP should release tabulated and time profile data including down-hole pressures, water levels, and enviromental heads in accordance with the Site Specific Agreement, which specifies a 45-day release time frame from the time of data acquisition to the time the data are provided to the NRC.

DOE RESPONSE -

DOE's policy on data release is to provide data in accordance with the Site Specific Agreement. DOE Will comply with this policy to the best of its ability.

REFERENCES

Basalt Records Management Center, Basalt Waste Isolation Project, Rockwell Hanford Operations, P.O. Box 800, Richland, Washington 99352, Telephone (509) 376-7114.

Early, Spice, and Mitchell (1986), "A Hydrochemical Data Base for the Hanford Site, Washington," Rockwell Hanford Operations, RIchland, Washington, SD-BWI-DP-061).

Greenburg, Trussell, and Clesceri, Eds., (1985). "Standard Methods for the Examination of Water and Wastewater," 16th edition, AWWA and WPCF.

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Jackson, R. L., L. C. Swanson, L. D. Diediker, R. L. Jones, and R. K. Ledgerwood, 1986, Design, Drilling, and Construction of Well RRL-2B, and iezometer Nest RRL-2C, SD-BWI-TI-329, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

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Stone, R., A. H. Lu, P. M. Rogers, R. W. Bryce, 1985, Plans for Multiple-well Hydraulic Testing of Selected Hydrogeologic Units at the RRL-2 Site, Basalt Waste Isolation Projection, Reference Repository Location, SD-BWI-TP-040 (Draft 11/85), Rockwell Hanford Operations, Richland, Washington.

Strait, S. R. and R. B. Mercer, 1986, Hydraulic Property Data From Selected Test Zones on the Hanford Site, SD-BWI-DP-051, Rev. 2 (in preparation), Rockwell Hanford Operations, Richland, Washington.

Internal Letter

Rockwell International

Date March 18, 1985

No. 10130-85-034

TO (Name Organization Internal Address)
W. H. Price
Drilling & Testing
MO/029/600 Area

FROM (Name Organization Internal Address Phone)
S. M. Baker
Site Analysis Group
PBB/1100 Area
6-4764

Subject Modeling Analysis of Effects of Open Intervals in Boreholes DC-16A and DC-16C

Attached is a report of study entitled "Effects on Open Intervals in Boreholes DC-16A and DC-16C". The study is done under your request addressed in your letter (10120-84-372). The report summarizes a modeling analysis of the effects of the present borehole configuration on flow in the Cohassett Flow Bottom during Large Scale Hydraulic Stress Tests.

The study concludes a negligible effect on predicted water levels at the various observation wells due to present bridge plug placement in boreholes DC-16A and DC-16C. It should be noted that neither DC-16A or DC-16C will be used as monitoring wells. The calculated heads at DC-16 presented in this report would not be accurate because the leakance through the well has spread to the entire cell where the well is located. Further study should be conducted if boreholes DC-16A and DC-16C would be used as monitoring wells in Grande Ronde flow tops.

If you have any question, please contact A. H. Lu of my staff on 3-5381.

S. M. Baker, Manager
Site Analysis Group

SMB/AHL/abj

Att.

cc: R. C. Arnett w/o att.
W. R. Brown w/o att.
C. R. Comstock
R. E. Gephart w/o att.
R. L. Jackson
J. M. Jimenez
A. H. Lu
D. J. Moak w/o att.
P. M. Rogers w/o att.
R. M. Smith
F. A. Spane w/o att.
R. Stone
S. R. Strait
M. D. Veatch

LOCATION OF MULTIPLE-LEVEL PIEZOMETER FACILITIES

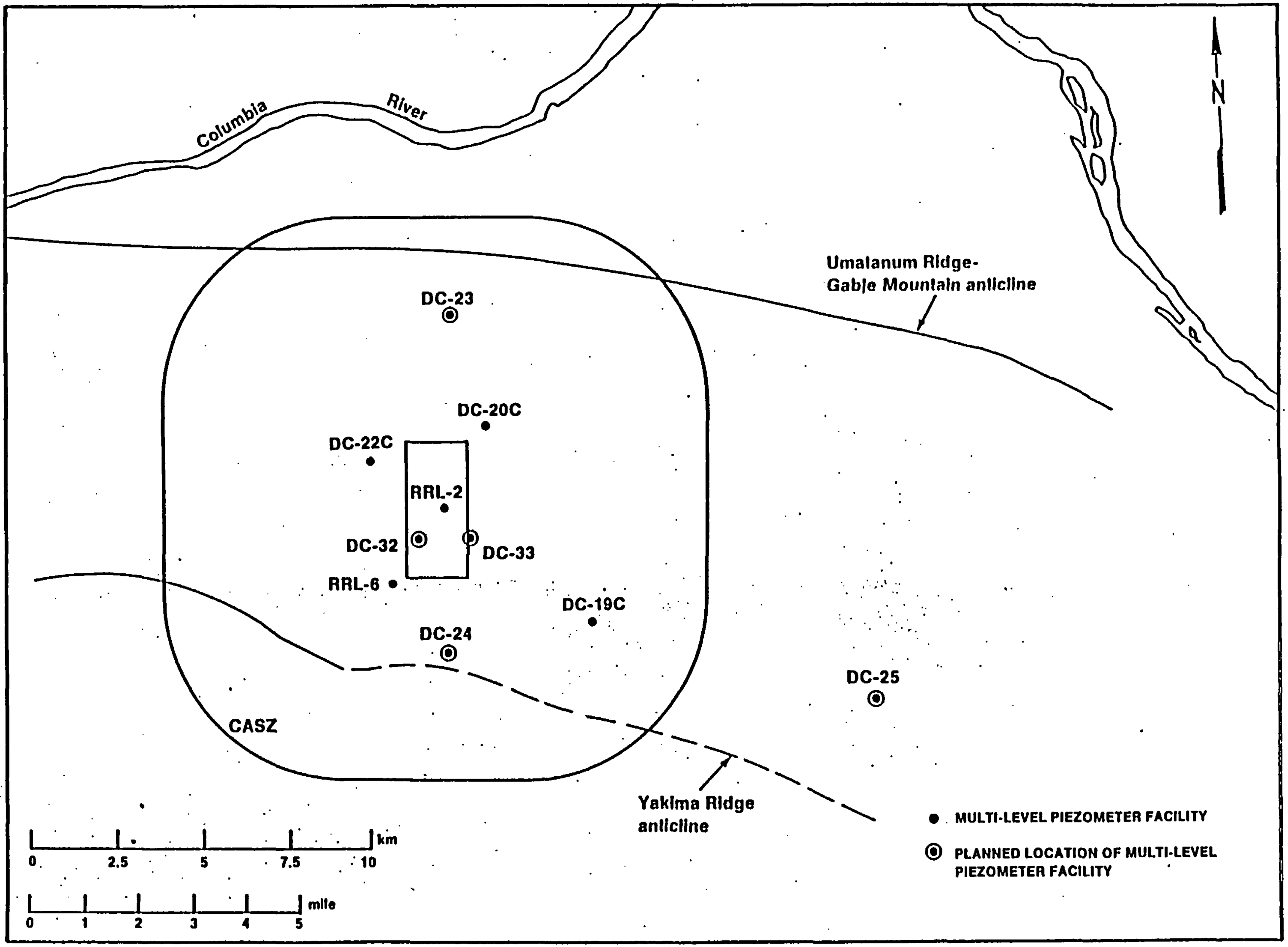
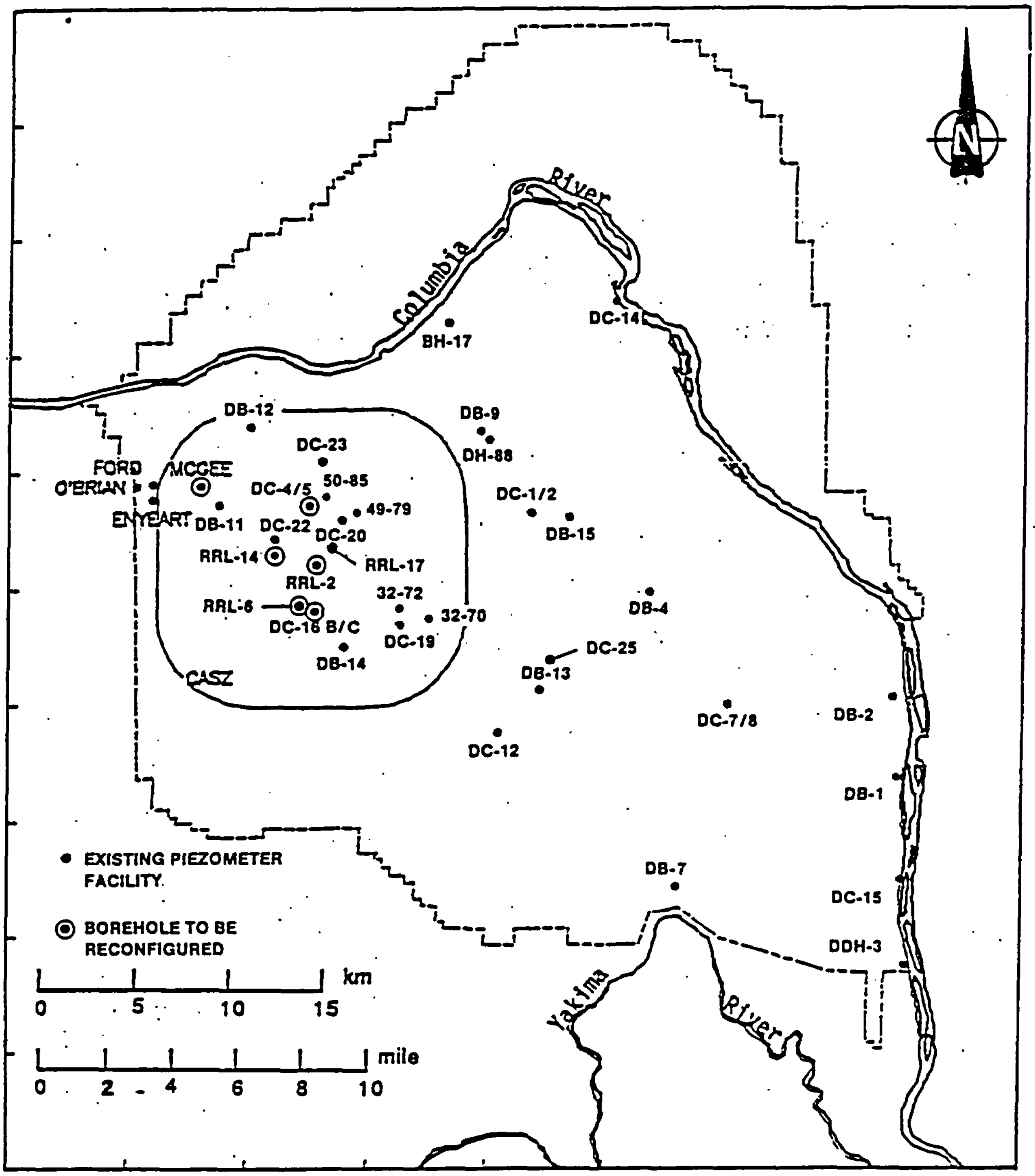


FIGURE 1

0216-0024DS 3/16/87

FIGURE 2



MONITORING LOCATIONS AT THE HANFORD SITE

0216-0024DS 3/16/87

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

RECEIVED
FEB 13 1987
BWIP CORRESPONDENCE CONTROL
CA-988

February 6, 1987

Our ref: 863-1049.005
RSC/094

Rockwell Hanford Operations
P.O. Box 800
Richland, WA 99352

ATTENTION: Mr. P.M. Rogers

RE: CA-988 PRELIMINARY EVALUATION OF THE ADEQUACY OF PIEZOMETER SEALS

Dear Mr. Rogers:

I am pleased to transmit our draft report "Preliminary Evaluation of the Adequacy of Piezometer Seals." This report documents the results of a brief overview of the available piezometric data in the RRL area to provide a preliminary evaluation of the apparent adequacy of the piezometer seals. Also included are recommendations for future analyses, field tests, and a discussion of alternative piezometer designs.

If the potential exists for using information contained in this report in support of licensing, I recommend that it be returned with your comments and formalized as a final Golder report in accordance with our QA procedures.

The concepts presented were developed by Larry Rollins, David South, Dick Bielefeld and myself. Please contact me if you have any questions or would like further elaboration on the ideas presented.

Sincerely,

GOLDER ASSOCIATES

Charles R. Wilson

Charles R. Wilson

CRW/ah
Enclosure

cc: J. Cheshire, Rockwell

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

REPORT TO
ROCKWELL HANFORD OPERATIONS

PRELIMINARY EVALUATION OF THE ADEQUACY OF PIEZOMETER SEALS

Distribution:

5 copies - Rockwell Hanford Operations
Richland, Washington

5 copies - Golder Associates
Redmond, Washington

February 1987 863-1049.005

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

This report presents the results of a preliminary evaluation of the adequacy of piezometer seals in four multilevel standpipe piezometers located in the RRL area of the Cold Creek Syncline on the BWIP Site. This evaluation was based upon a review of water level responses to drilling and testing in boreholes DC-23W and DC-23GR. Available hydrographs from piezometers DC-19C, DC-20C, DC-22C, and DC-23W were studied to help assess the adequacy of the seals in those installations. The results of these studies are summarized in Section 2. Alternatives for future analyses, field tests, and alternative piezometer designs are presented in Sections 3 through 5, respectively. Conclusions and recommendations are presented in Section 6.

Our conclusions are based upon information on historic hydraulic perturbations and monitored responses presented in the following BWIP documents: (1) SD-BWI-TI-313 "Preliminary Evaluation of Piezometer Responses at DC-19, DC-20 and DC-22 During Construction of DC-23W;" (2) Internal Letter 75220-86-114 from F.A. Spane to S.M. Baker; (3) "Cross-Formational Responses at RRL Nested Piezometer Sites DC-19C, DC-20C, and DC-22C" by F.A. Spane; and (4) the data package provided to us by Mary Hartman in support of the DC-23W piezometer response modeling effort.

2. EVALUATION OF WATER LEVEL RESPONSES

Hydrographs of key horizons in the Wanapum and Grande Ronde were taken from document (1) above and are shown in Figures 1 through 3 for DC-19C, DC-20C, and DC-22C, respectively. The perturbation of interest occurred from September 12 to October 3, 1985, during DC-23W drilling, and from October 21 to 25, 1985, during DC-23W development pumping. Weak perturbations are seen through September 28, during the period of mud rotary drilling in the upper Wanapum. It is interesting to note that during this period a perturbation was monitored in the Sentinel Gap flowtop before drilling reached that flowtop. Much stronger perturbations are seen beginning September 29, when drilling resumed with water instead of mud, and beginning October 21, when the composite Wanapum was developed by air-lift pumping. An earlier perturbation occurred in the Grande Ronde in late May and early June, 1985, during removal of a bridge plug in RRL-14. A lack of detailed information on this earlier perturbation prevented it from being studied in the same degree of detail as that from the DC-23W drilling.

Hydrographs from DC-23W presented in Figure 4 show the response of the Rosalia and Sentinel Gap flow tops to pump testing in the Rosalia flow top in nearby DC-23GR. Again, water pressures in the Rosalia and Sentinel Gap are seen to be synchronous before and after the test, and an attenuated perturbation from the pump test is clearly seen in the underlying Sentinel Gap flow top.

The synchronous behavior of water pressures in the Rosalia (Priest Rapids Interflow Zone) and Sentinel Gap flow tops in the upper Wanapum is clearly evident in all piezometers in the forementioned figures, and is strong evidence for efficient hydraulic communication between these horizons. The independent behavior of the Ginkgo and nearly all Grande Ronde flow tops is strong evidence for a lack of efficient hydraulic communication among these deeper horizons. The only exception to this latter statement is the evidence, provided by synchronous behavior, of efficient communication between the Rocky Coulee and Cohassett flow tops

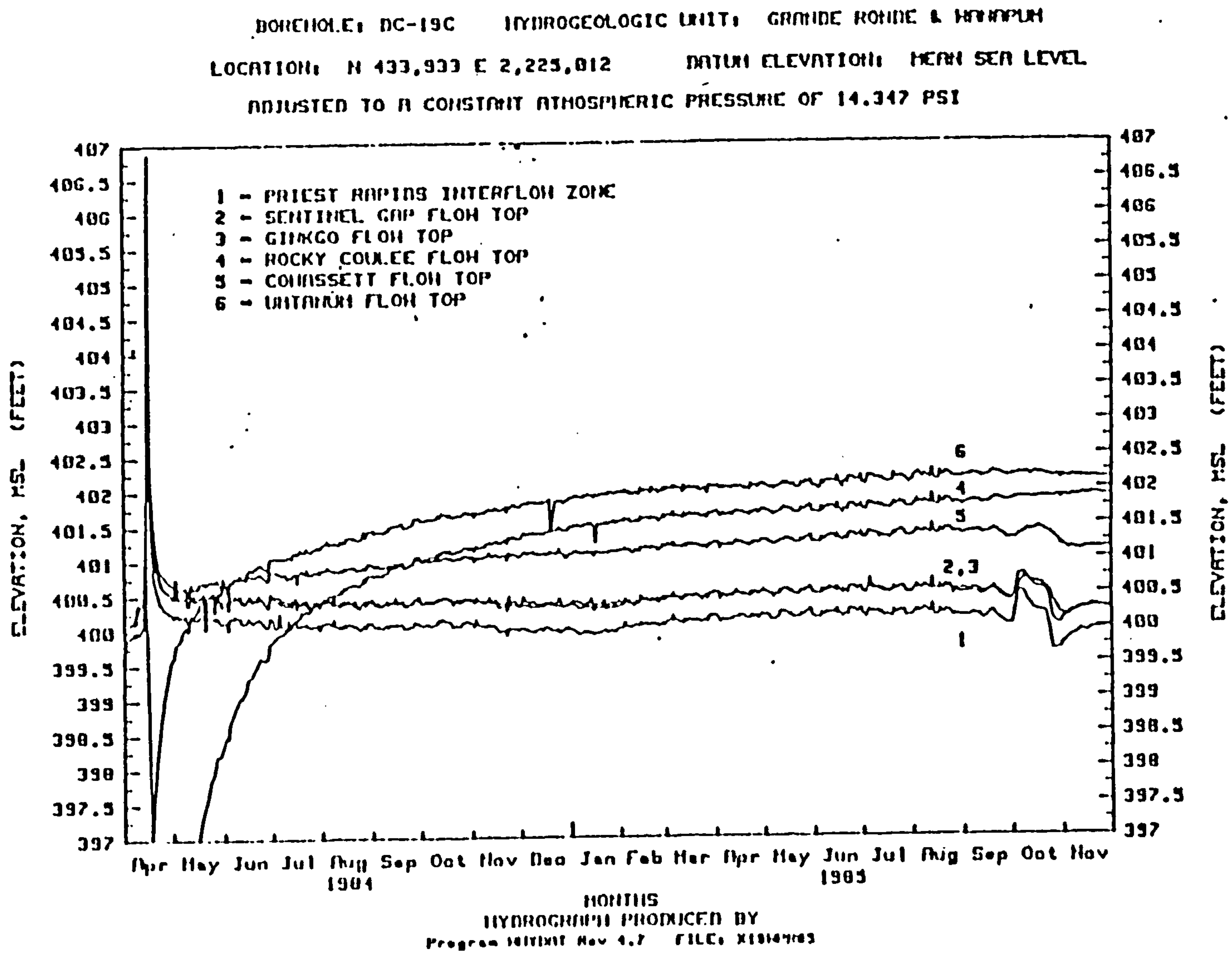


FIGURE 1
HYDROGRAPHS OF WANAPUM AND GRANDE RONDE HORIZONS IN DC-19C
PIEZOMETER SEALS

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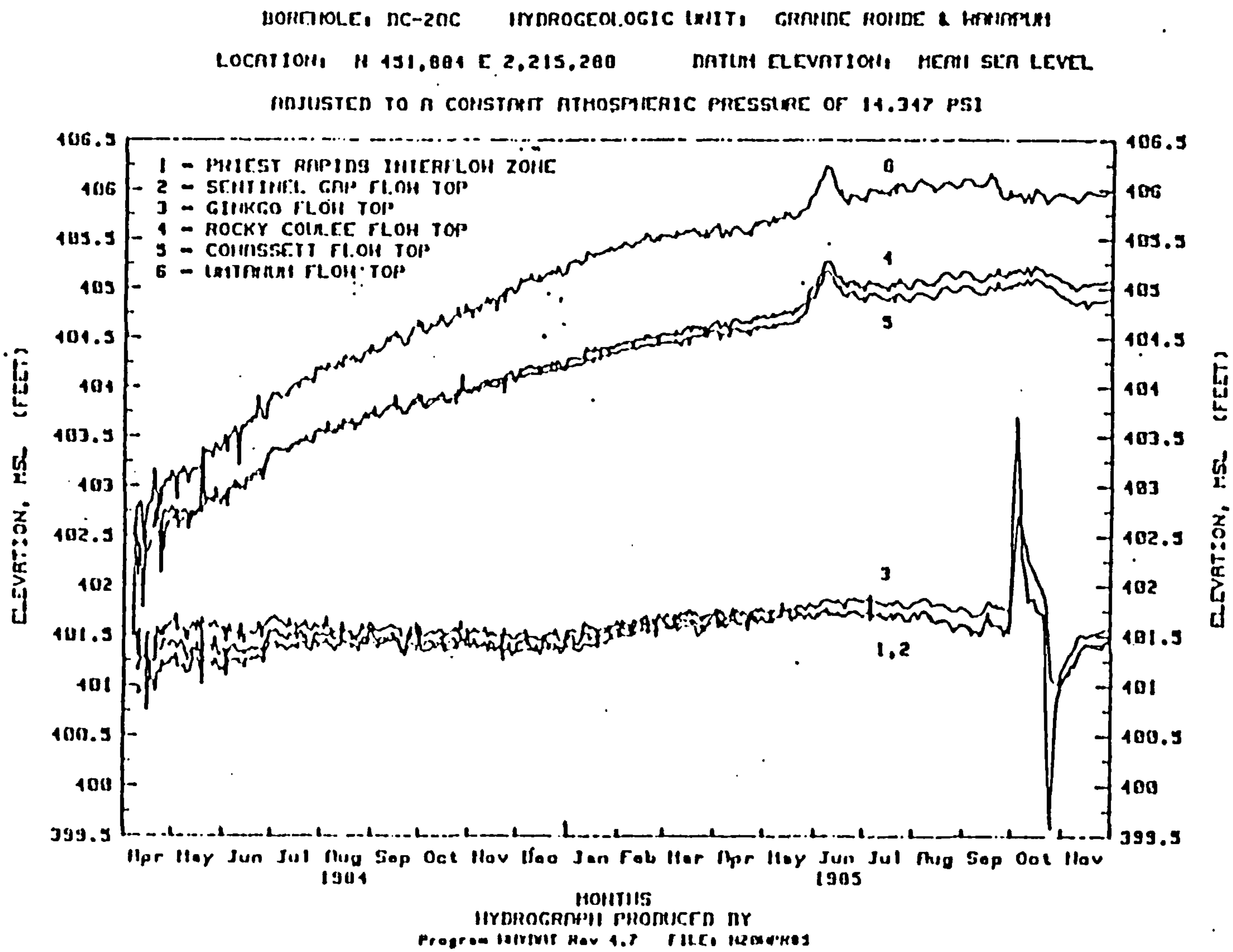

FIGURE 2
HYDROGRAPHS OF WANAPUM AND GRANDE RONDE HORIZONS IN DC-20C
PIEZOMETER SEALS

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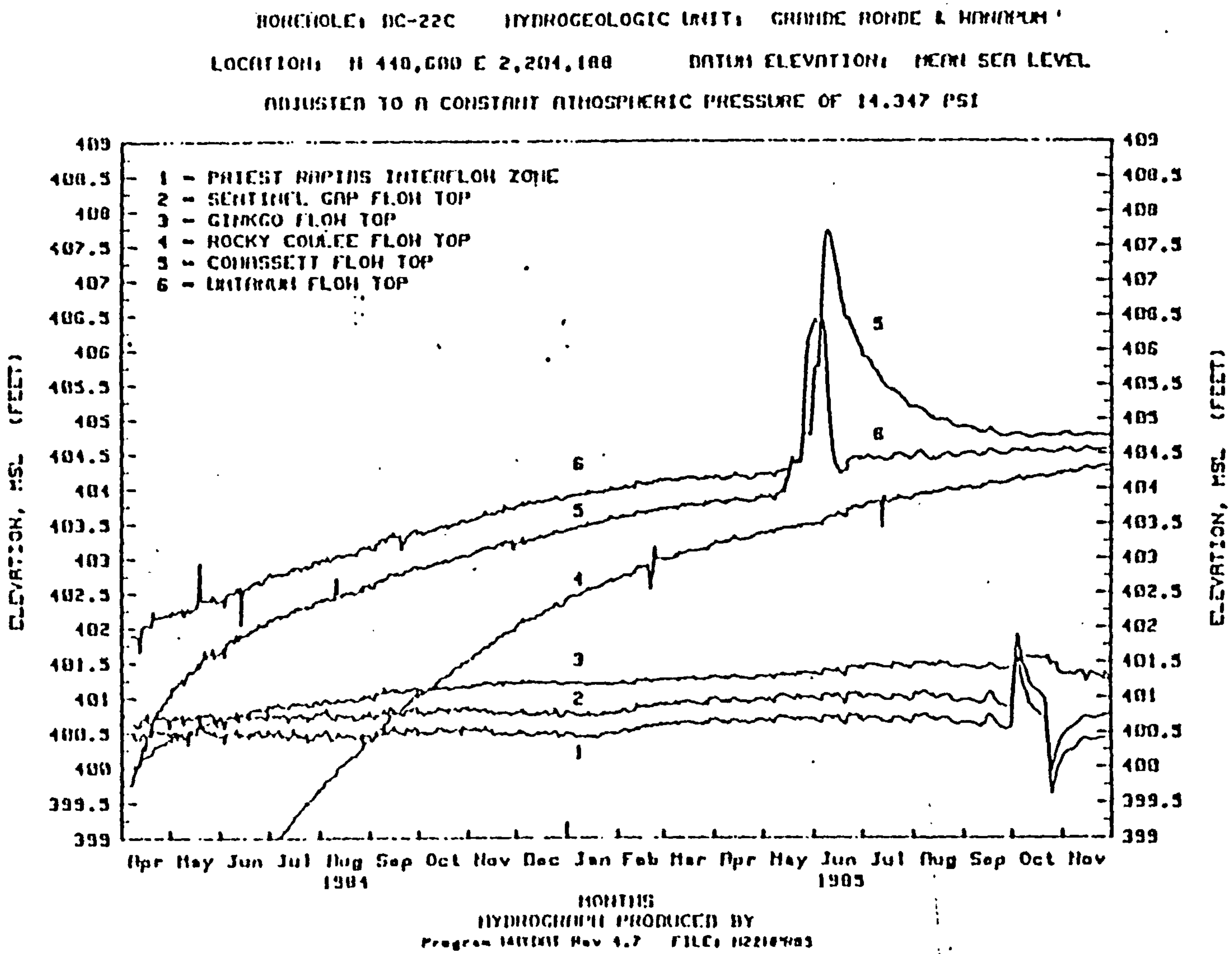


FIGURE 3

HYDROGRAPHS OF WANAPUM AND GRANDE RONDE HORIZONS IN DC-22C

PIEZOMETER SEALS

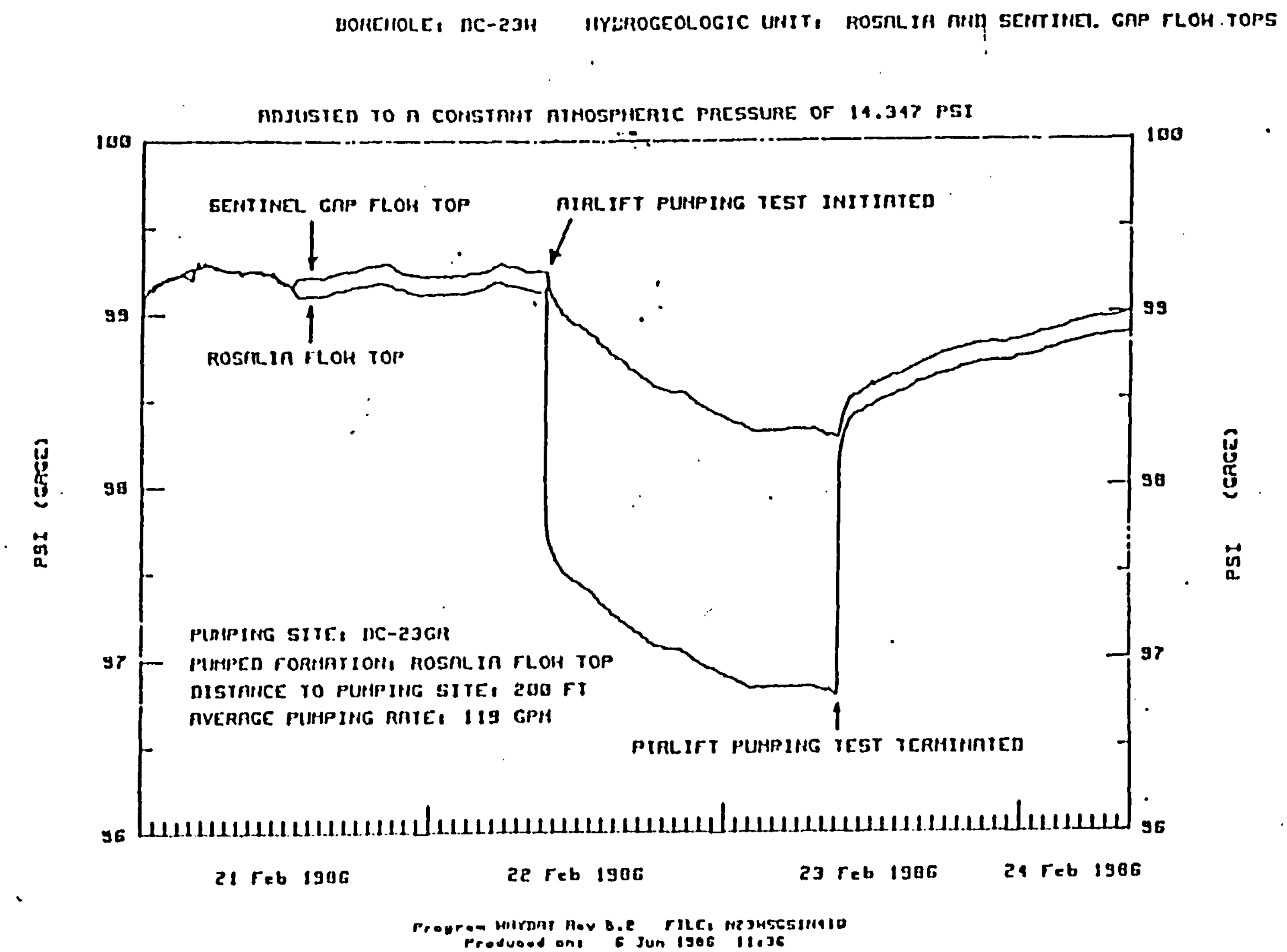


FIGURE 4
PRESSURE HYDROGRAPH FOR THE ROSALIA AND SENTINEL GAP FLOW TOPS AT DC-23W
PIEZOMETER SEALS

at DC-20C. While some degree of hydraulic communication may exist among all monitored Wanapum and Grande Ronde horizons, highly efficient communication is evident only between the Rosalia and Sentinel Gap flow tops and between the Rocky Coulee and Cohassett flow tops in the vicinity of DC-22C.

Highly efficient communication between two flowtops suggests the presence of relatively high permeability vertical flow paths. The available information is insufficient to confidently determine whether these flow paths are naturally present or result from flaws in the piezometer seals.

Assuming that the piezometer seals were carefully placed, with appropriate use made of tubing spacers, high density neat grout, and emplacement by pressure injection beneath a rising grout surface, then good seals would be expected. Further, if proper grout emplacement and tubing spacing techniques were used, one would expect flaws to occur randomly and to be relatively independent of the competence of the surrounding rock and the number of tubes in the hole. There is a total of 20 seals between monitored Wanapum and Grande Ronde zones in the four wells. Assuming proper placement techniques, it is not likely that significant flaws would randomly occur in every seal in the four piezometers between the Rosalia and Sentinel Gap, and in none of the seals between virtually every other set of flowtops.

The one questionable seal in the Grande Ronde, between the Rocky Coulee and Cohassett flowtops in DC-20C, is understood to be at a location where the Rocky Coulee dense interior is thin and the rock is of poor quality. This evidence suggests enhanced hydraulic communication through a geologic anomaly rather than a faulty seal.

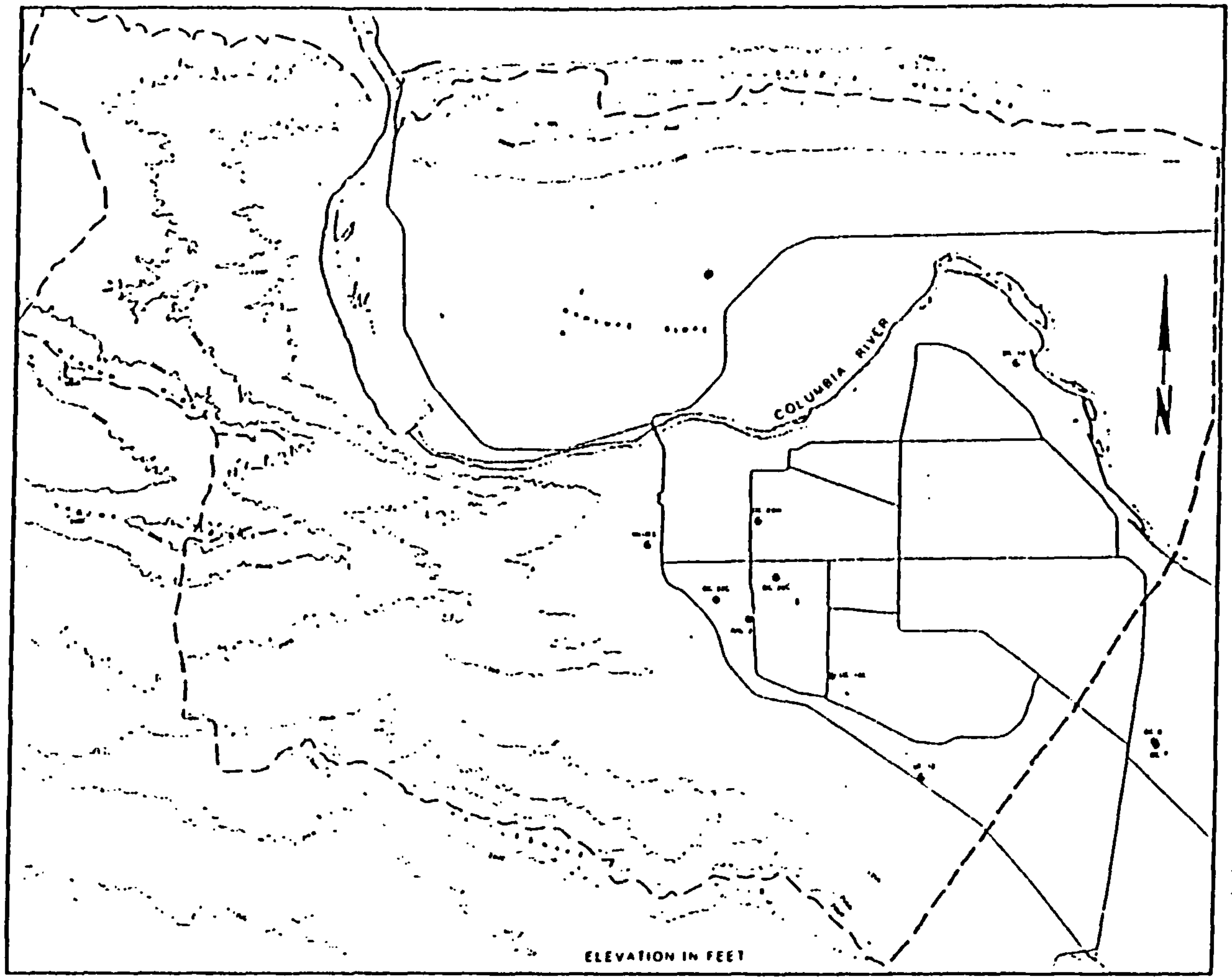
Although the foregoing reasoning suggests that the seals are probably good and that the observed vertical communication is probably a natural phenomenon, it does not provide complete assurance that this conclusion is correct. Additional information regarding the adequacy of the seals can be obtained from more detailed numerical analysis of existing data, and from the results of specifically designed in-situ tests.

3. NUMERICAL ANALYSIS OF AVAILABLE DATA

Hydrologic modeling of the Wanapum basalts would be expected to provide additional information on the possible mechanisms responsible for the observed hydraulic communication between the Rosalia and Sentinel Gap flow tops. This would be accomplished by developing a model with defensible boundary conditions that is calibrated to available head data. This model would then be run in a transient state reproducing the known hydraulic perturbations from drilling and testing, and evaluating the sensitivity of the results to alternative vertical leakage scenarios. The principal scenarios to be considered would include localized vertical leakage at or near the piezometers, uniform vertical leakage through the dense flow interiors, and treatment of the upper Wanapum as a single, homogeneous hydrostratigraphic unit. Variations of these scenarios, such as the locations and sizes of discrete leakage features, could be readily evaluated with the model.

Development of such a model is currently in progress by Golder, in support of BWIP's Site Characterization Plan. The 3-dimensional finite element code FE3DGW is being used. The area covered by the model is shown in Figure 5. The boundaries of the model extend laterally to no-flow boundaries at the edge of the Pasco Basin on the north, west and south, and to known constant head boundaries on the east. The eight deep wells shown on the figure within the model area coincide with model nodes, and any can be modeled as pumping centers. A plan view of the model mesh is shown in Figure 6. The more refined discretization in the RRL will support more detailed analyses in that area. Also, the results of this model are expected to provide supportable local boundary conditions for future highly detailed models of the RRL.

In vertical section, the model divides the Wanapum into seven material layers, consisting of the Rosalia, Sentinel Gap, and Ginkgo flow tops and the four adjacent composite horizons. The Mabton interbed and Rocky Coulee flow top form the upper and lower model boundaries, respectively, and are held at constant head.



Note: Dashed line indicates model boundary.

0 5000 10000
Meters

FIGURE 5

LOCATION MAP OF PASCO BASIN SHOWING WANAPUM MODEL BOUNDARY

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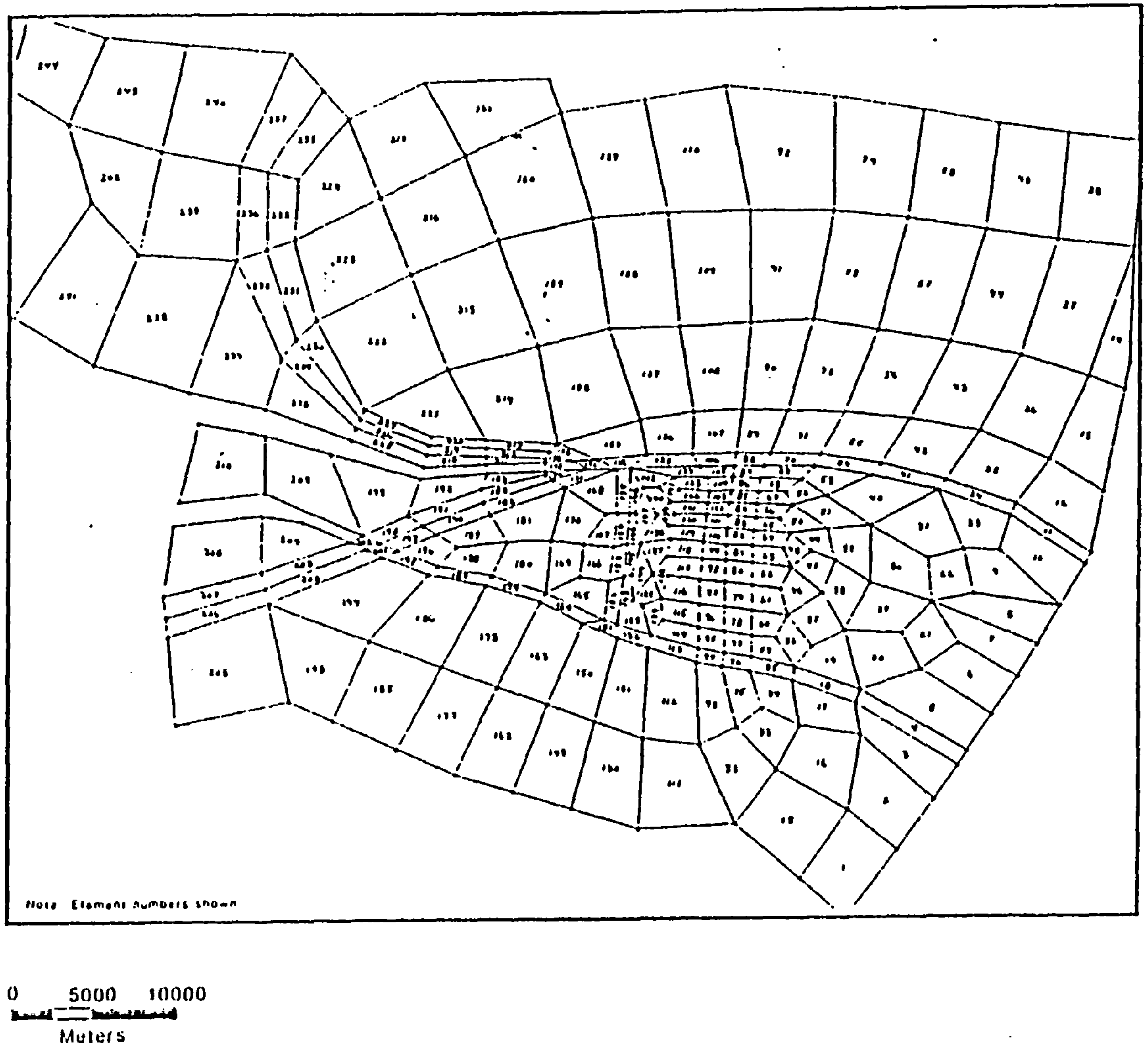

FIGURE 6
WANAPUM MODEL MESH
PIEZOMETER SEALS

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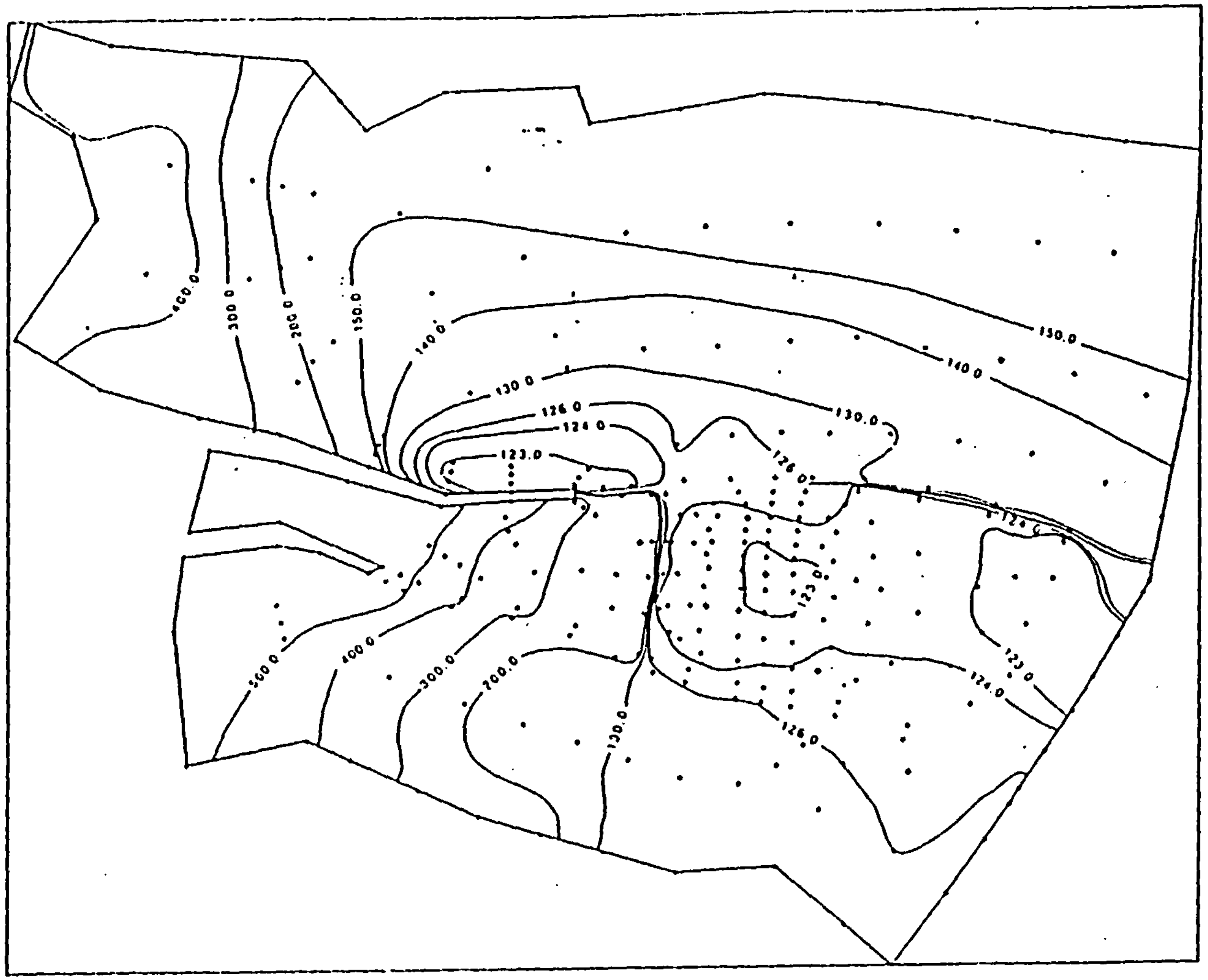
Results from a recent steady state run are shown in Figure 7, where equipotential contours are plotted for the Ginkgo flow top. The predicted heads on this run matched measured heads to within about +/- 2 m., which was slightly improved in our final steady state calibration run. Preparations are now underway to continue into transient simulations of the hydraulic perturbations during DC-23W drilling and development pumping.



Note: Heads are shown in meters above msl.

0 5000 10000

Meters

FIGURE 7

HEADS IN GINKGO FLOW TOP FROM MODEL CALIBRATION RUN

PIEZOMETER SEALS

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4. FIELD TESTS

A variety of field tests have been conceptualized that may provide additional information regarding the integrity of the questionable piezometer seals. If significant leaks are present, certain of these tests can potentially provide positive evidence for those leaks; however, if the leaks are slight, the degree of confidence that can be placed in the results of most of the tests will rapidly decline. None of these tests can be considered standard, all will require pretest technique development and analysis, and any of these tests may yield inconclusive results.

As will be seen, the list of tests was developed in an unconstrained, "blue-sky" discussion. While each test has certain merit, they have been addressed in a preliminary order of priority because not all are believed to have the same probability of success. The tests are described below in terms of an "upper" monitored flowtop, such as the Rosalia, that directly overlies the questionable seal, and a "lower" monitored flowtop, such as the Sentinel Gap, that directly underlies the questionable seal.

4.1 Radioactive Tracer Test

A steady-state, vertically downward hydraulic gradient would be established by pumping in the lower flowtop, and a short-lived, poorly sorbed gamma emitting radioactive tracer such as $NH_4 Br^{82}$ would be released in the upper flowtop as shown in Figure 8. Gamma detectors would be placed inside the tubing of the other piezometers at locations within the lower flowtop and between the upper and lower flowtops where the seal is questionable. The tracer would be expected to migrate toward the lower flowtop. If it migrated through a flowpath within the seal, a strong response would be expected to be measured through the

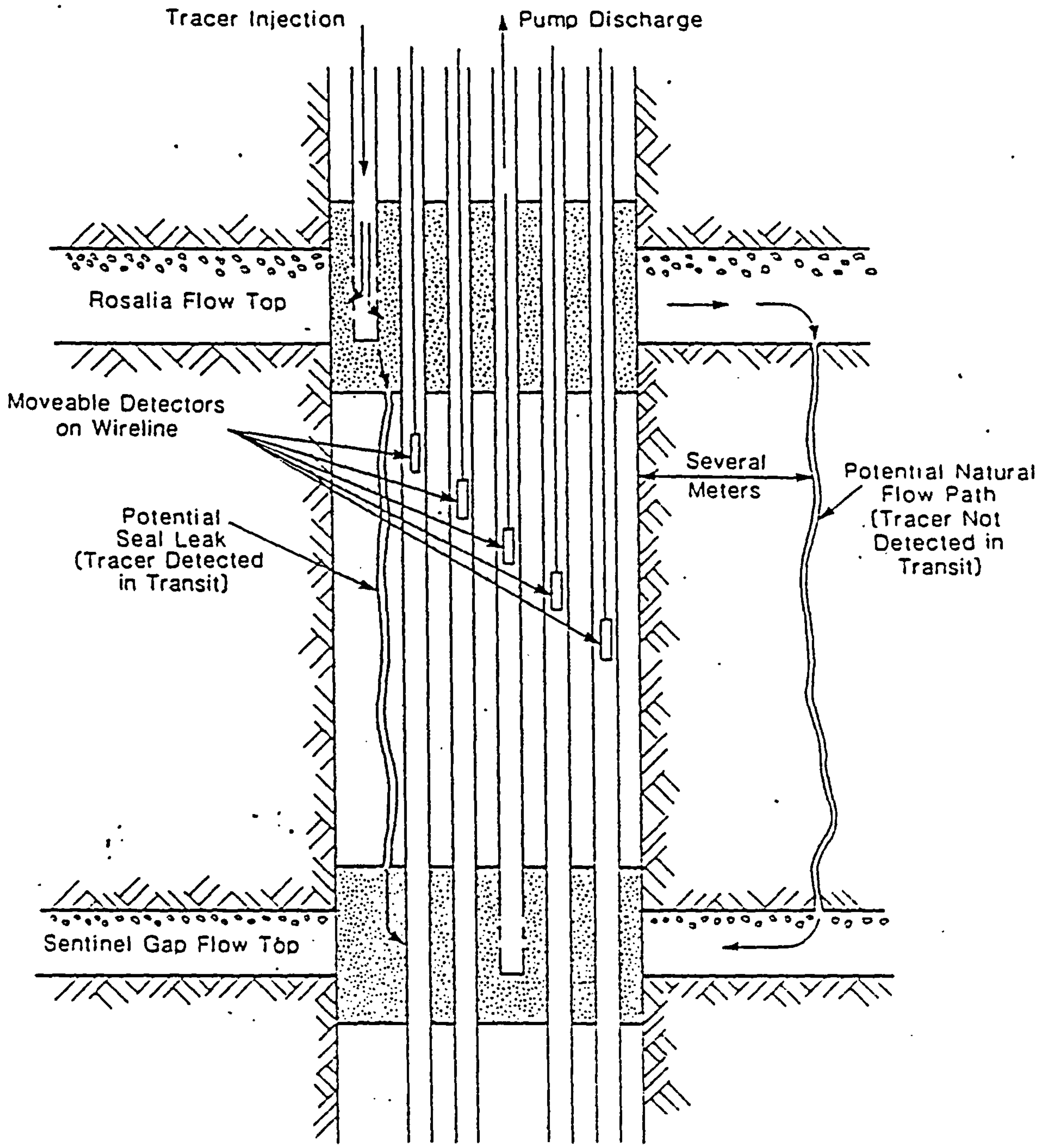

FIGURE 8

SCHEMATIC OF RADIOACTIVE TRACER TEST

PIEZOMETER SEALS

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metal tubing. The gamma energy would be rapidly attenuated by the rock, and if the tracer followed a natural flowpath through the rock even a few meters away from the hole, little or no response would be expected to be seen.

The likelihood of success is considered to be higher for this test than for most of the other tests considered. This test may be capable of detecting relatively small seal leaks. Pretest analysis and evaluation of gamma ray attenuation in the basalt, grout and tubing wall would be required. Also, care would be required in handling the radioactive materials, and approval to release such a tracer may be difficult to obtain.

4.2 Trace Constituent Test

A steady-state, vertically downward hydraulic gradient would be established by pumping in the lower flowtop, and a nonsorbing tracer would be released in the upper flowtop as shown in Figure 9. The tracer-laden water would be expected to migrate toward the lower flowtop. Samples would be regularly taken of water issuing from the lower flowtop and subjected to hydrochemical trace analysis. Detection of the tracer would indicate that vertical fluid movement was occurring. If the tracer-laden water had migrated through a flowpath largely within the seal, it may acquire dissolved trace minerals that would be different than if the water had migrated largely along a natural flowpath within the rock.

The likelihood of success for this test is potentially good, but will depend upon the ability of the moving tracer-laden water to dissolve exotic trace minerals from the grout, the ability to detect those minerals, and the ability to distinguish trace minerals dissolved at the grout-sand pack interface from those dissolved along a leakage flowpath.

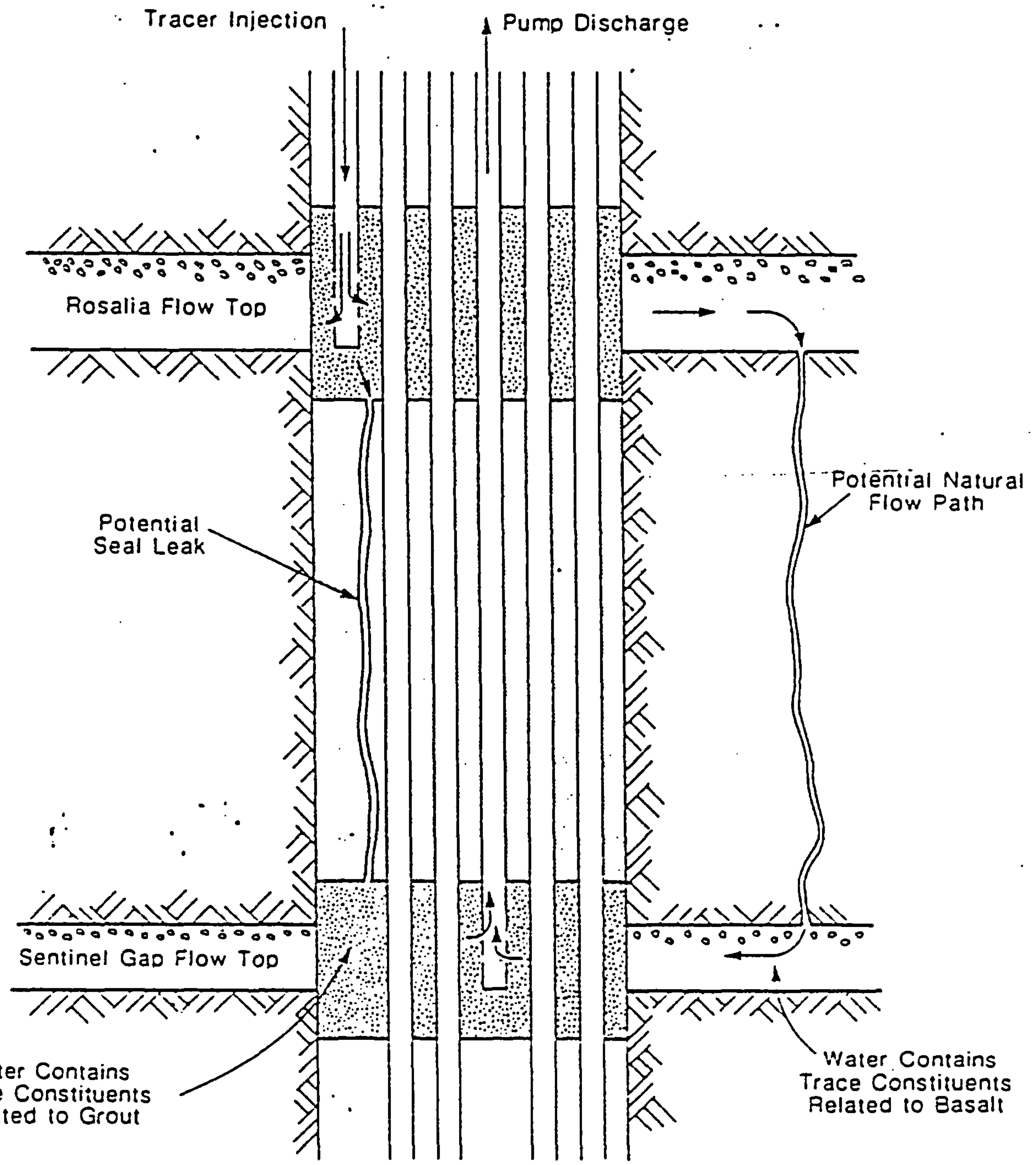

FIGURE 9

SCHEMATIC OF TRACE CONSTITUENT TEST

PIEZOMETER SEALS

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Even if this test provides an indication of a leak, it may not be able to distinguish whether the leak is in the seal above or below the lower flowtop without further refinement. The uncertainties of this test are greater than those of the foregoing tests, and pretest analysis and evaluation of the dynamics of trace mineral pickup from the basalt, grout and tubing walls would be required. The environmental effects of this test are expected to be relatively small.

4.3 Thermal Perturbation Test

A steady-state, vertically downward hydraulic gradient would be established by pumping in the lower flowtop, and heated water would be injected into the upper flowtop as shown in Figure 10. Temperature detectors would be placed inside the tubing of the other piezometers at locations within the lower flowtop and between the upper and lower flowtops where the seal is questionable. The heated water would be expected to migrate toward the lower flowtop. If it migrated through a high conductivity flowpath within the seal, a strong temperature response would be expected to be measured through the metal tubing. The heat would be rapidly attenuated by the rock, and if the heated water followed a natural flowpath through the rock even a few meters away from the hole, a significantly weaker response would be expected to be seen.

If a relatively large leak is present, the likelihood of success for this test is considered to be relatively high. Smaller leaks may not be as easily detected because the rate of heat transfer by conduction may be as rapid as by advection along the flowpath. Under either case the rate of heat loss to the formation is expected to be significant and it may not be possible to track water movement by this approach along the entire distance between the two flow tops. Pretest analysis and evaluation of thermal conduction and heat capacity in the basalt, grout and tubing wall would be required. This test would be fairly easily implemented and its environmental effects are expected to be small.

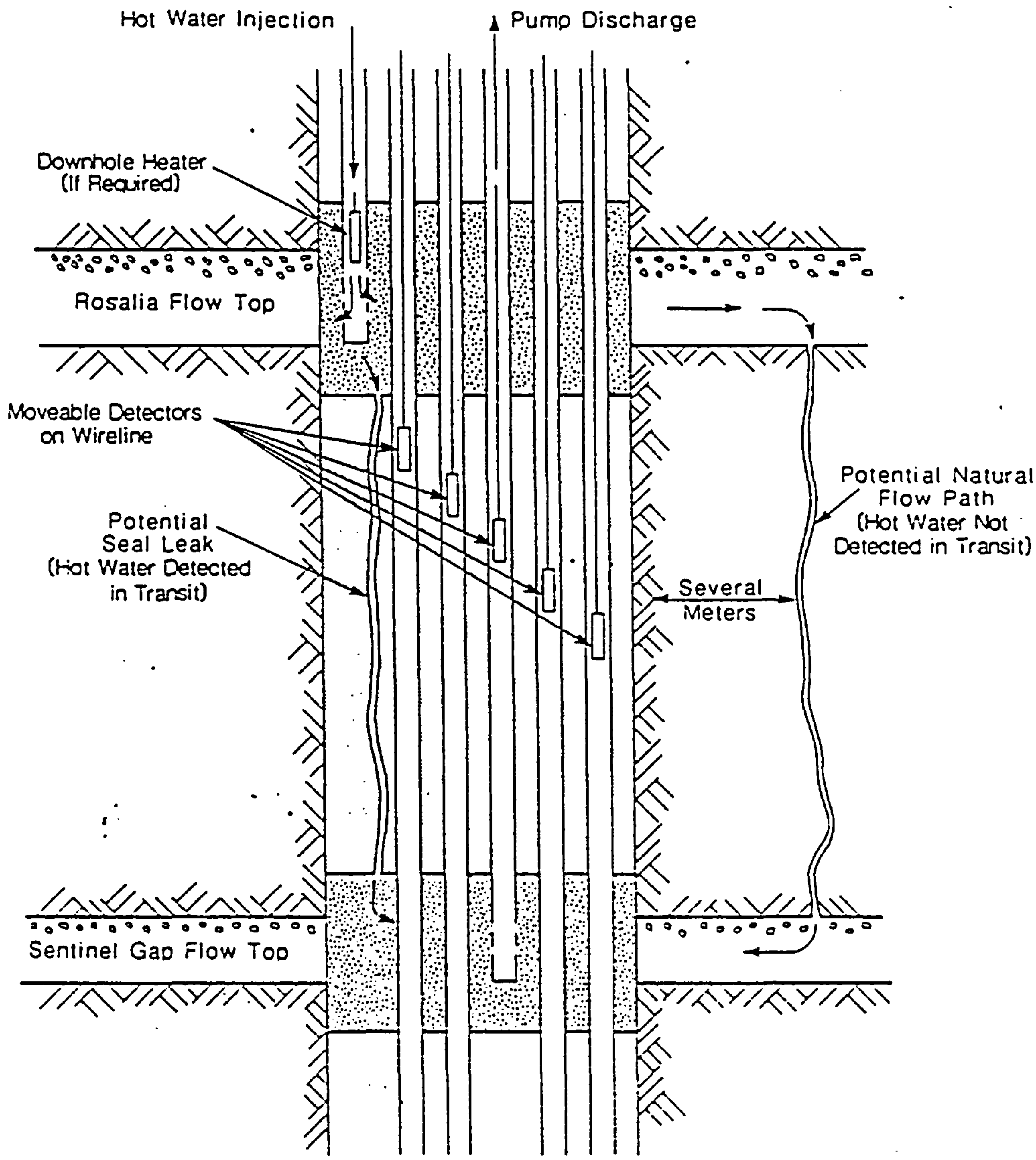

FIGURE 10
SCHEMATIC OF THERMAL PERTURBATION TEST
PIEZOMETER SEALS

4.4 Borehole Geophysical Tests

A number of standard borehole geophysical tests are available which might provide information on the potential for seal leaks. These include density, sonic and resistivity logs. As discussed below, each of these logs has potential benefits but may also have problems related to the presence of multiple piezometers in the same hole.

Standard omnidirectional density logging would not be expected to work because the high density of the multiple steel pipes would be expected to dominate the response such that minor variations resulting from voids in the grout would not be distinguishable. Directional density scanning with a neutron emitting tool could be potentially useful, but could only be directed radially outward away from the center of the hole. This constraint may be significant if flaws from grout emplacement are preferentially related to interference among tubes rather than interference between the tubes and the borehole wall.

Sonic waves can be used to check bonding between the piezometers and grout by testing for reflective fracture surfaces. While they may be useful very near the piezometer tube, multiple reflections would be expected at greater distances from the other standpipes in the hole. Sonic bonding logs may have already been performed in these holes, and should be checked for an initial evaluation of the adequacy of this [illegible].

Electrical methods were given a [illegible] likelihood of success because of the shielding provided by the metal piezometer pipes. Detection of the weak electric current induced by the magnetic field established by moving polar water molecules outside a piezometer tube was considered and may provide some results, but should first be tested under controlled conditions. Detection of variations in resistivity of the fluid outside the piezometers was considered in association with injection of an electrolytic tracer solution, but would also be expected to be shielded by the tubing.

4.5 Tracer Sorption Test

A steady-state, vertically downward hydraulic gradient would be established by pumping in the lower flowtop, and a nonsorbing and sorbing tracer pair would be released in the upper flowtop as shown in Figure 11. The tracer-laden water would be expected to migrate toward the lower flowtop. Samples would be regularly taken of water issuing from the lower flowtop piezometer and subjected to hydrochemical analysis to determine breakthrough characteristics. Retardation of the sorbing tracer would be expected to be greatly enhanced if the tracers traveled uniformly through a quasiporous medium rather than through a discrete fracture flowpath.

While support for such an interpretation of differences in sorptive characteristics may be obtained from the results of the tracer tests performed in DC-7/8, the lack of experience in performing and interpreting such tests at the BWIP Site would necessarily attach considerable uncertainty in assessing their results. Additionally, this test would only be capable of distinguishing high surface area flow paths from low surface area flow paths, and would not be able to distinguish among them. For example, flow through a seal leak and flow through a nearby natural fracture are both low surface area flow paths and could not be distinguished from each other.

The greatest strength of this test may lie in the ease of coupling with the forementioned trace constituent test, to provide additional information on the nature of the flow path. The environmental effects of this test are expected to be relatively small.

4.6 Multiple Well Interference Test

A transient pressure perturbation would be induced by pumping in the upper flowtop, and arrival times of that perturbation would be precisely monitored in the lower flowtop of the pumping well and in the upper and lower flowtops in at least one other well. If the flowtops were hydraulically homogeneous and isotropic, a pressure perturbation

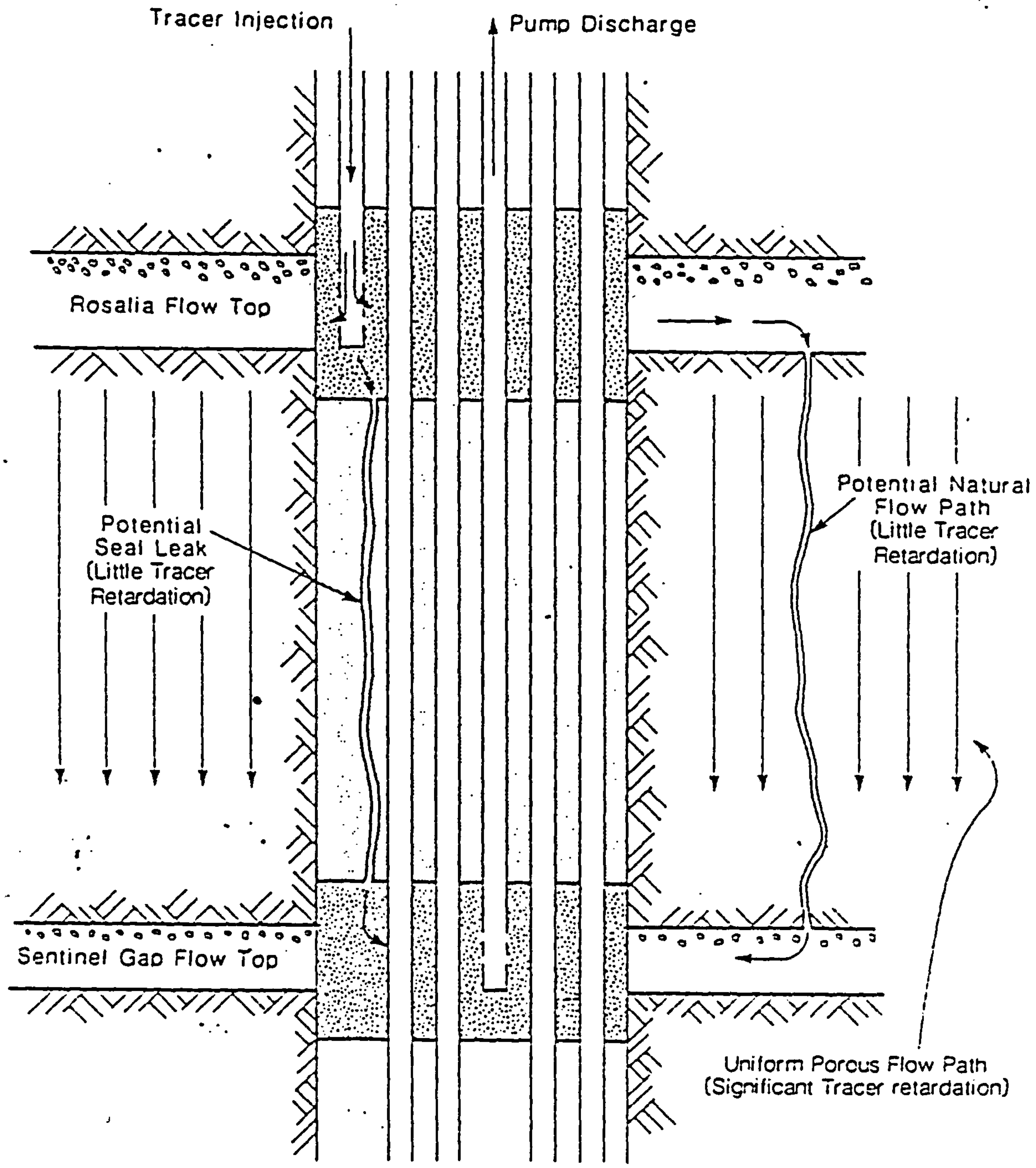

FIGURE 11

SCHEMATIC OF TRACER SORPTION TEST

PIEZOMETER SEALS

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traveling uniformly downward would be expected to arrive at the nearest observation point sooner than at a more distant observation point. However, if that perturbation traveled through a discrete, permeable pathway such as an isolated tectonic fracture or a leaky seal, the perturbation would be expected to first appear in the piezometer nearest that pathway. If such a pathway exists, its general proximity might be inferred from sequential pump testing at each of the wells.

The likelihood of success for this test is considered to be poor. Successful analysis of the results will depend strongly upon the extent to which the assumptions of flow top homogeneity and isotropy are valid. Although the need to assume isotropy could be mitigated through direct analysis of tests in three or more wells for this parameter, the presence of significant heterogeneities in the flow tops could in themselves cause results that could not be distinguished from those of discrete leakage features. The effects of flow top heterogeneities will be particularly significant if the contrast between horizontal permeability in the flow tops and vertical permeability in the dense interiors is large.

The test is also inherently weak because it cannot distinguish between leakage within a seal and leakage through a natural feature in the vicinity of a piezometer. Further, this test will work only if significant leaks are present at or near only one of the two wells. If high permeability seal leaks are actually present in all Rosalia-Sentinel Gap seals, then this test will not be capable of distinguishing between uniform vertical flow and vertical flow through those leaks.

The uncertainties of this test are significant, and pretest analysis will be required. The environmental effects of this test are expected to be relatively small.

5. ALTERNATIVE PIEZOMETER DESIGNS

Alternative piezometer designs may be considered if substantive evidence of seal failure becomes available. Several conceptual alternatives are described below. Each of the major alternative designs has a significant technical or cost problem and further analysis should be performed before pursuing any one of them.

5.1 Single Casing Design

The single casing design would eliminate many of the grout-pipe surface interfaces in the current design that may lead to seal failure, yet retain the simplicity of individual open standpipes. A schematic drawing of this alternative is shown in Figure 12. The concept of the design is to cement one string of casing in the hole, gun-perforate next to monitoring zones, install the piezometer tubes, and isolate the zones within the casing using manufactured seal blocks.

The advantage of this concept is that grouting would be performed in a single operation on a single outer casing, thereby reducing the likelihood of bond failure. A cement bond log could be run prior to installation of the seal blocks to evaluate the quality of the grout bond. The individual piezometer tubes could then be sealed after casing perforation under more readily controlled conditions inside this outer casing. The design of leak-proof inner seal blocks then becomes the focal point of this conceptual approach. Several options exist, including mechanical packers, resin grouting, and plumbed piezometers, which should be evaluated in further studies.

This approach has the disadvantage of being developmental, and the equipment used would have to be specially designed, fabricated and tested. In addition, grout emplacement would necessarily be under considerable pressure which could drive excessive grout into the horizons to be monitored. Although this design is used successfully in the oil industry, its use at the BWIP site is not expected to be

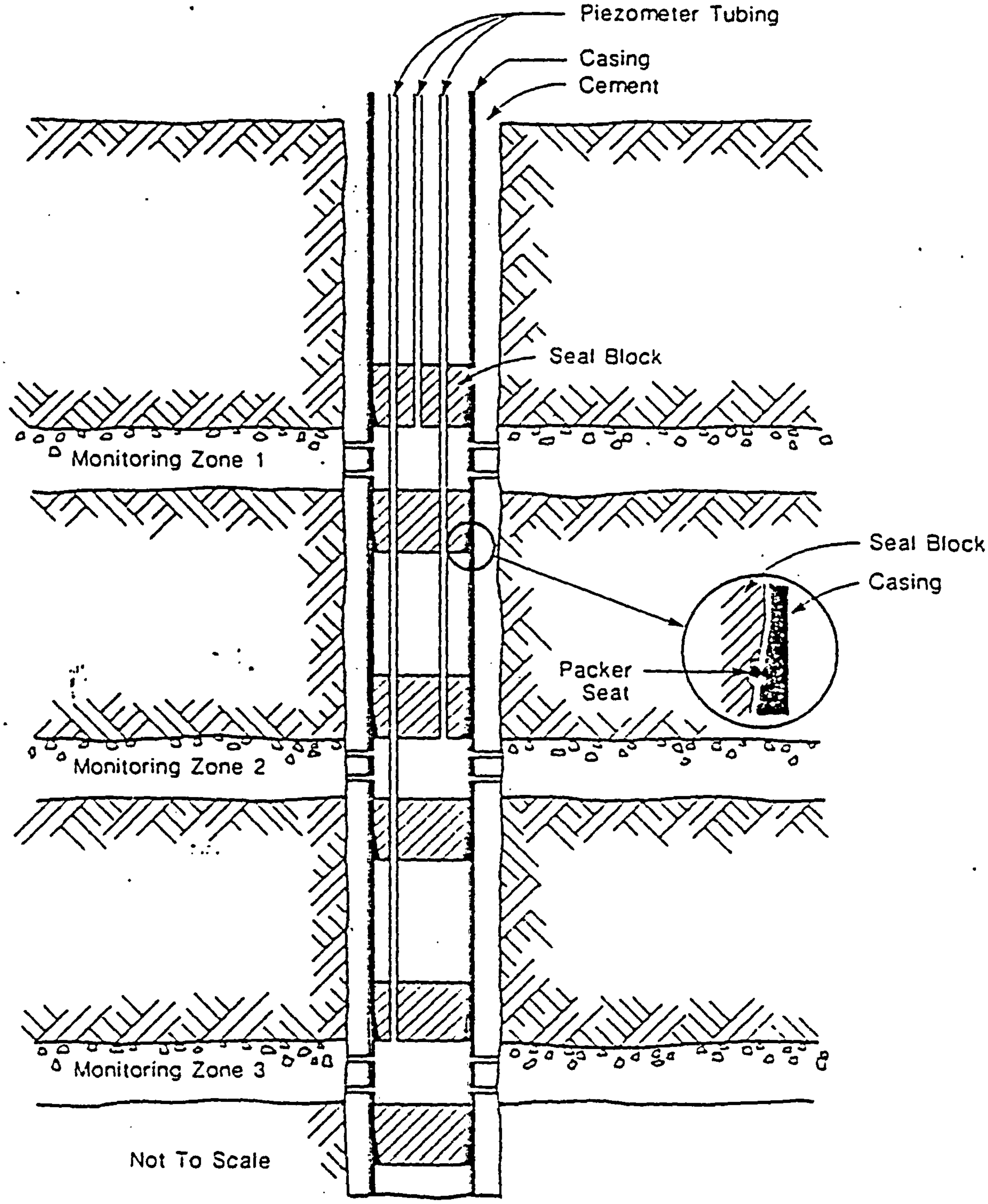

FIGURE 12

SCHEMATIC OF ALTERNATIVE SINGLE CASING DESIGN

PIEZOMETER SEALS

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acceptable because of potential damage to the monitored horizons. Techniques should be investigated for alternative staged grouting through perforations in the outer casing that would limit grout emplacement to predetermined locations.

5.2 Single Piezometer Installation

The single piezometer installation design also eliminates many of the grout-pipe surface interfaces in the current design that may lead to seal failure, yet retains the simplicity of individual open standpipes. This relatively obvious solution would place only one piezometer in each borehole, and would use the technology developed for the existing piezometers. The disadvantage of this approach is the high cost of drilling a separate hole for each individual installation.

5.3 Multiport Piezometer Installation

The multiport piezometer monitors a number of separate horizons using a traveling probe within a single tube. An example of this type of piezometer is the Westbay System which was installed in RRL-2. We understand that this system failed because of packer leaks. The approach has the advantage of permitting many individual horizons to be monitored from a single relatively small diameter borehole, but the disadvantage of being mechanically more complex and more developmental than the standard grouting process presently being used. Additional development work appears to be required to successfully implement this alternative.

5.4 Downhole Remote Nonretrievable Sensing

This conceptual alternative would involve permanent emplacement of downhole pressure sensors which could be read remotely at a surface location. It is considered highly developmental because (1) the sensor would have to be capable of functioning remotely for the life of the facility (some 10 to 20 years), and (2) the readout system from the sensor (for example, an electric wire or optical fiber) would have to be more amenable to sealing than the piezometer tubes now being used. Meeting the first criterion is expected to be very difficult to achieve and would require significant development work.

5.5 Refinement of Present Techniques

Several aspects of the present piezometer installation and grout emplacement techniques may be amenable to improvement. These would include potential modification of the grout mix, hole cleaning and development practices, piezometer spacing techniques, and grout emplacement practices. An independent evaluation of existing techniques would be required before recommendations for refinements could be prepared.

6. CONCLUSIONS AND RECOMMENDATIONS

The synchronous behavior of water pressures between several monitored flowtops is strong evidence for efficient vertical hydraulic communication, and the pattern of such behavior suggests that this communication is through naturally occurring flowpaths. However, the available information is not sufficient to assure that this conclusion is correct. The present uncertainty associated with the integrity of piezometer seals is not considered to be of overriding significance to the site characterization effort to date because all but one of the questionable seals is in the upper Wanapum far from the reference repository horizon, and the one remaining seal that is near the repository horizon is in a zone of poor rock thought to be relatively permeable. However, the issue is significant to future installations because of the importance of avoiding seal failures in the Grande Ronde.

Because the available information suggests that the seals are not likely to be the cause of the observed synchronous behavior, it would not be prudent to embark on an ambitious field testing program to evaluate leakage paths without further information. It is recommended that a stepwise investigation be adopted, as follows:

(1) Perform short term analytical and numerical modeling studies to develop additional insight into the nature and hydrologic implications of the observed field responses. Such studies are already underway and can provide additional information within one to two months. These studies should include a comprehensive review of present piezometer installation and grout emplacement practices at BWIP.

(2) Develop conceptual designs for the most promising field tests and evaluate their likelihood of success. Such studies could be performed concurrent with the foregoing modeling studies, and their early initiation would recognize the likelihood that some field testing will ultimately be required before the issue of leakage can be finally put to rest. Such testing capability will ultimately also be required to demonstrate the adequacy of final borehole sealing techniques at the time of repository closure.

(3) If the additional information provided by the modeling suggests that seal failure is a reasonable possibility and if the conceptual design studies suggest that the piezometer seals can be successfully tested insitu, then proceed to develop final designs and implement field testing.

(4) If seal failure is found to be likely based on the results of the foregoing, proceed to develop alternative piezometer designs.

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Abstract

This data package contains a revision of the Site Hydrochemical Data Base for water samples associated with the Basalt Waste Isolation Project (BWIP). In addition to the detailed chemical analyses the following information is included:

o A summary description of the data base format

o Detailed descriptions of verification procedures used to check data entries

o Detailed descriptions of validation procedures used to evaluate data quality.

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BWIP SUMMARY OF REVISION	Number SD-BWI-DP-061	Page 2.1 of 415

Rev/Chg. No.	Date	Description Of Changes
1	5/15/86	SD-BWI-DP-061, Rev 1, is a complete update of the 1985 data package (SD-BWI-DP-061, Rev 0). The changes made reflect the addition of new data since the release of SD-BWI-DP-061, Rev 0. All tables and figures found in the new version include these new data.

A HYDROCHEMICAL DATA BASE FOR THE HANFORD SITE, WASHINGTON

1.0 INTRODUCTION

This data package contains a listing of the Site Hydrochemical Data Base for the Hanford Site and a summary of data verification and validation procedures applied to the analyses. The data base originally reported by Early et al. (1986) utilized the INFO data base software package (Henco Software, Inc., Copyright 1983). In March 1985, all hydrochemistry data were transferred to the NOMAD2 data base (Dun and Bradstreet Corp.) This document represents a revision of the original data package and the included data base (reported from NOMAD2) is current to April 15, 1986.

The hydrochemistry data tables present the following types of information:

- Sample Event
  - Sample Identification
  - Location
  - Date
  - Collection Techniques Used
  - Source of data
- Results of Field Measurements
  - Sample Temperatures
  - Conductivity
  - Alkalinity
  - Turbidity
  - pH
  - Redox potential
- Results of Laboratory Measurements
  - Alkalinity
  - Conductivity
  - pH
  - Major, minor and trace inorganic components
  - Total carbon and total organic carbon
  - Dissolved gases
  - Stable isotopic constituents
  - Radioactive constituents

Nearly all of the hydrochemical samples reported in this data base were collected from within the Hanford Site and represent all components of the hydrologic cycle. Personnel from the Basalt Waste Isolation Project (BWIP) collected most of the samples as part of a hydrochemical characterization program although this report includes numerous data from other sources. The following sections of this document identify the location of sample sites and specific sources of non-BWIP data as well as verification and validation procedures applied to the data.

In addition to incorporating data from many new analyses, during the past year the data base has been improved through an aggressive verification program that has resulted in increased confidence in the accuracy of hydrochemical data published in the current data package. Consequently, some minor differences will be noted for a few analyses presented in this document as compared to those reported in Early et al. (1985). The changes are based on discovery of transcription and data entry errors or incorrect conversion of data from one set of units to another. In addition, some older analyses have been removed from the data base because of the lack of adequate documentation and traceability. Many of these changes are described in the following sections of this report.

Every attempt has been made to eliminate errors in data transcription and transfer. However, the potential exists for some errors to occur inadvertantly in a data base of this size. It is anticipated that future updates of this document gradually will reduce the probability of errors.

2.0 LOCATION OF SAMPLING SITES

The data base includes hydrochemical samples of the following types:

- Precipitation
- Surface Water
- Springs
- Groundwater (confined and unconfined)

Figures 1 through 5 identify the location of all sampling sites.

3.0 DATA SOURCES

Most of the analyses listed in the Site Hydrochemical Data Base were determined by several Rockwell Hanford Operations (Rockwell) laboratories on samples collected by Rockwell personnel. During 1976-1980, there was a sampling activity known as the confined aquifer sampling program (CASP) with two Rockwell laboratories jointly providing the analyses. The BWIP began sample collection in 1980 and in 1982 one of the Rockwell analytical laboratories (Research and Engineering) was transferred into the BWIP. Since 1982 the BWIP has operated its own laboratory and performed all field and most laboratory analyses. Subcontractors of the BWIP analyze selected constituents requiring specialized equipment.

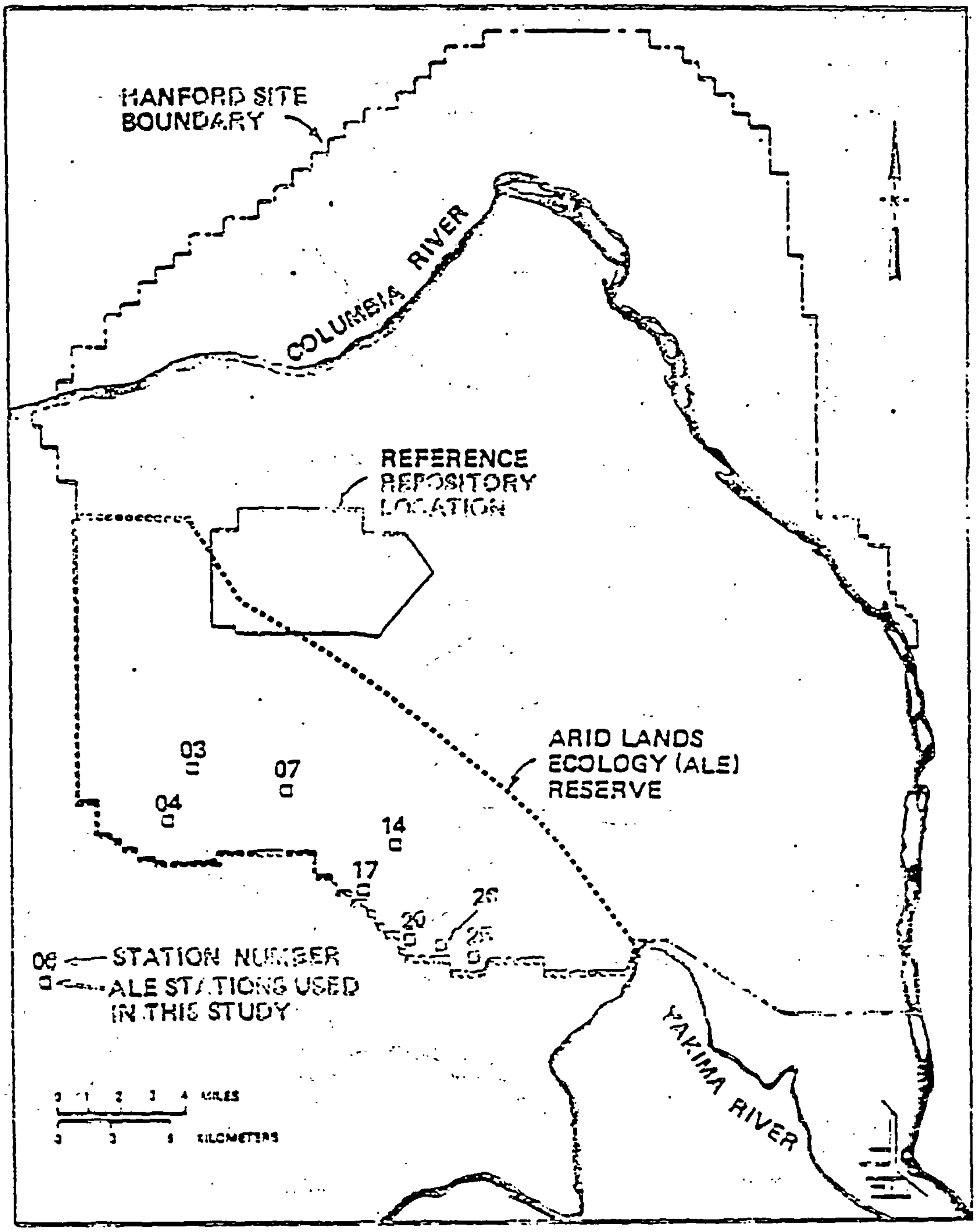

FIGURE 1. Location of Precipitation Stations.

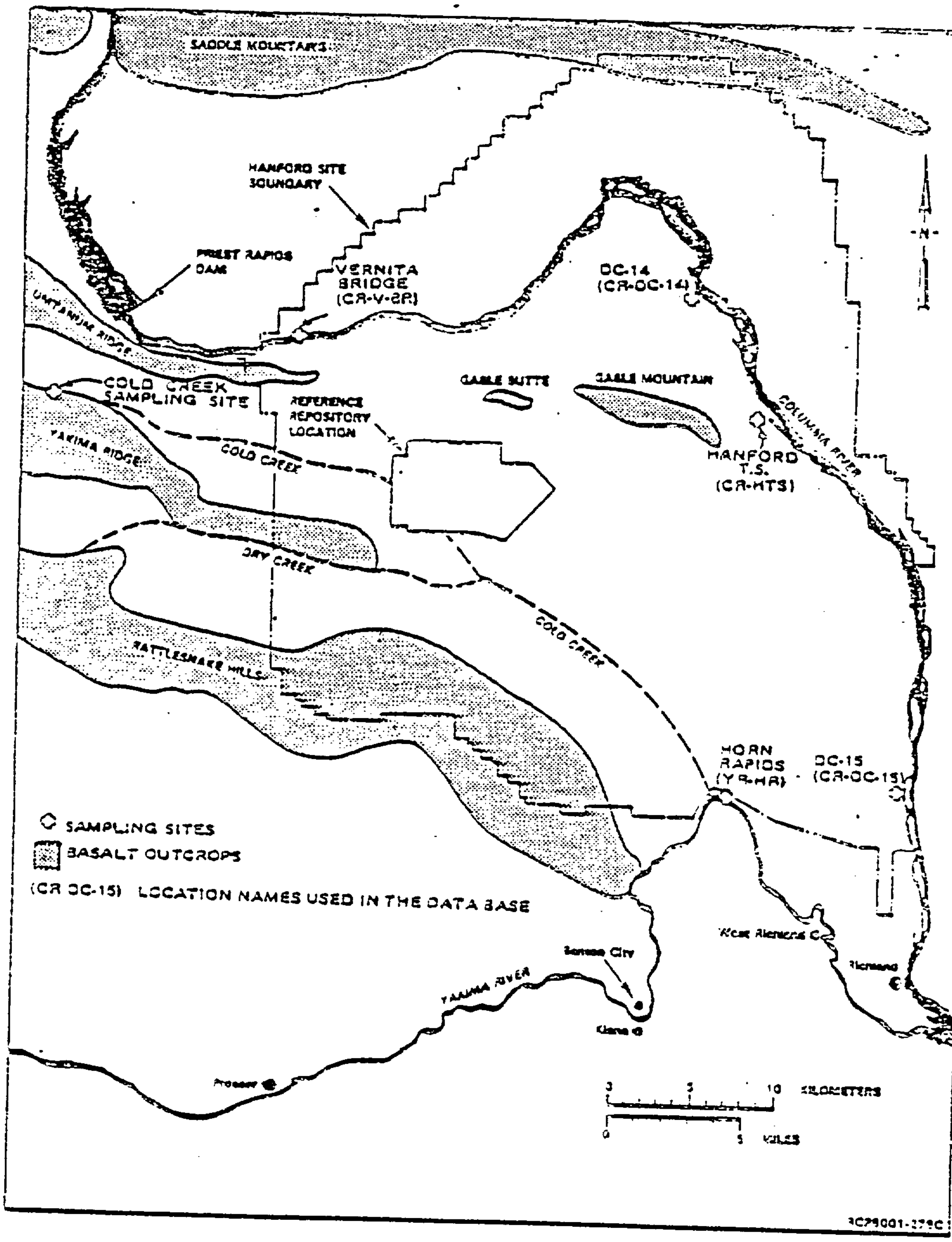

FIGURE 2. Location of Surface Water Sampling Sites.

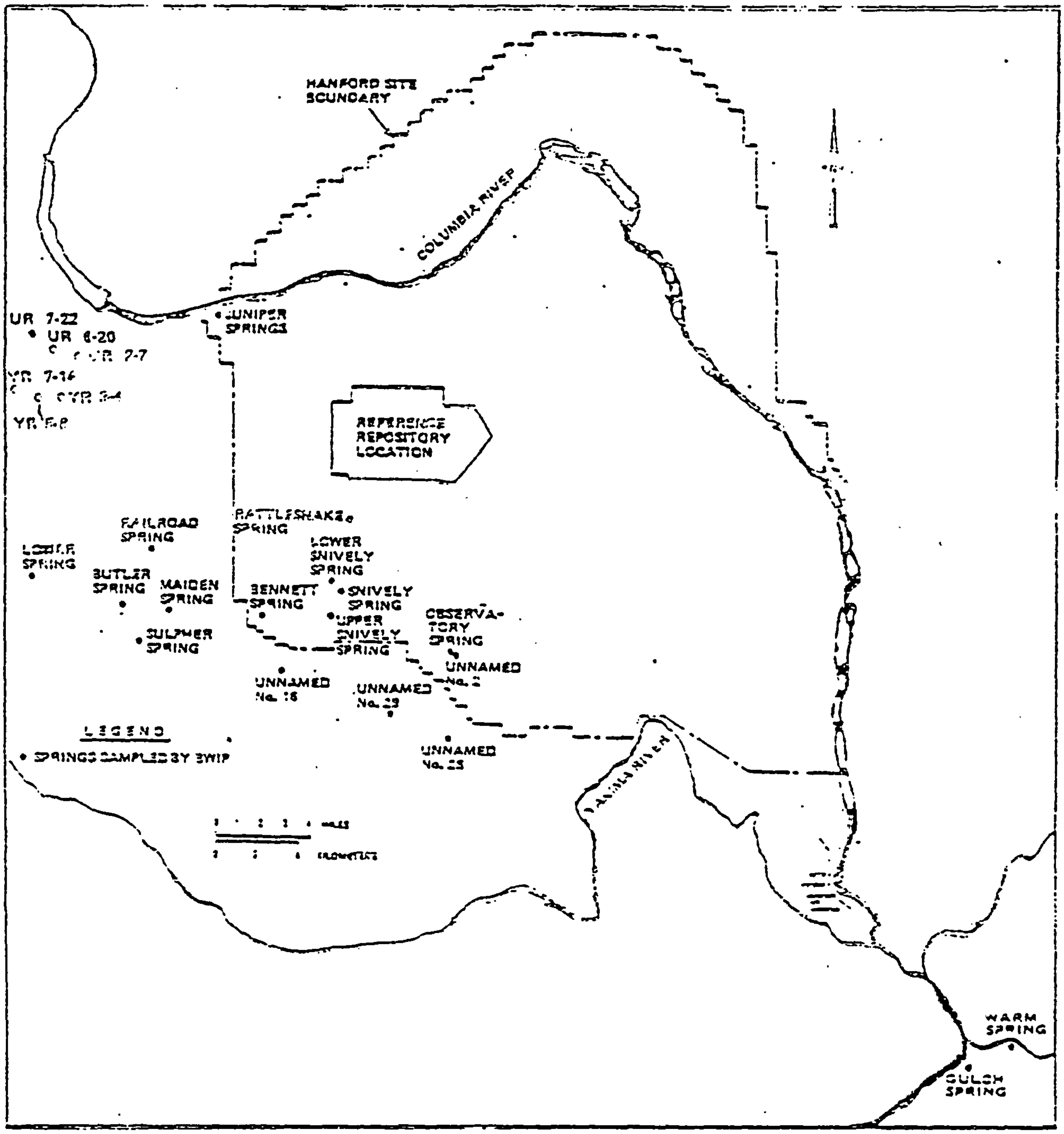

FIGURE 3. Location of Springs.

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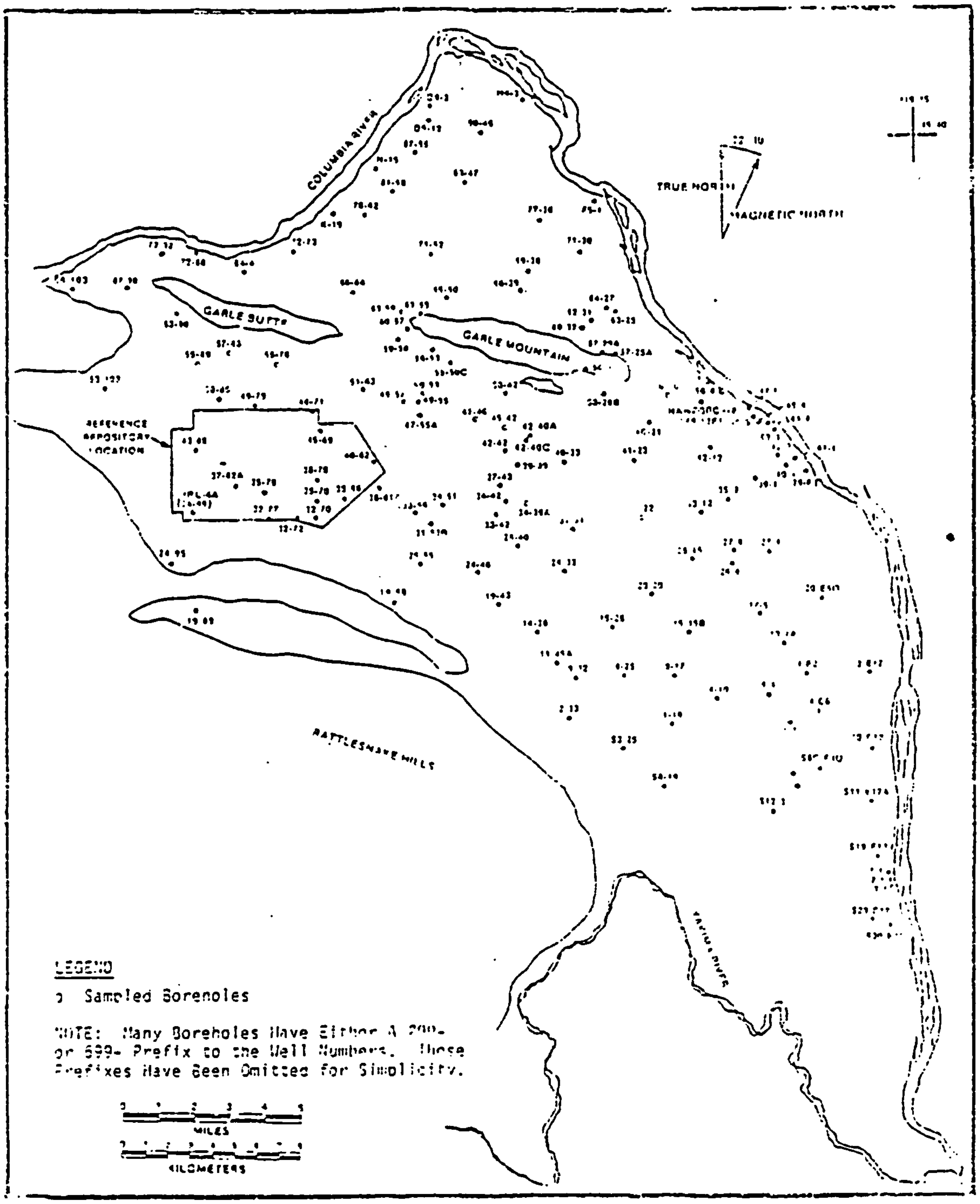

FIGURE 4. Location of Sampling Wells for the Unconfined Aquifer.

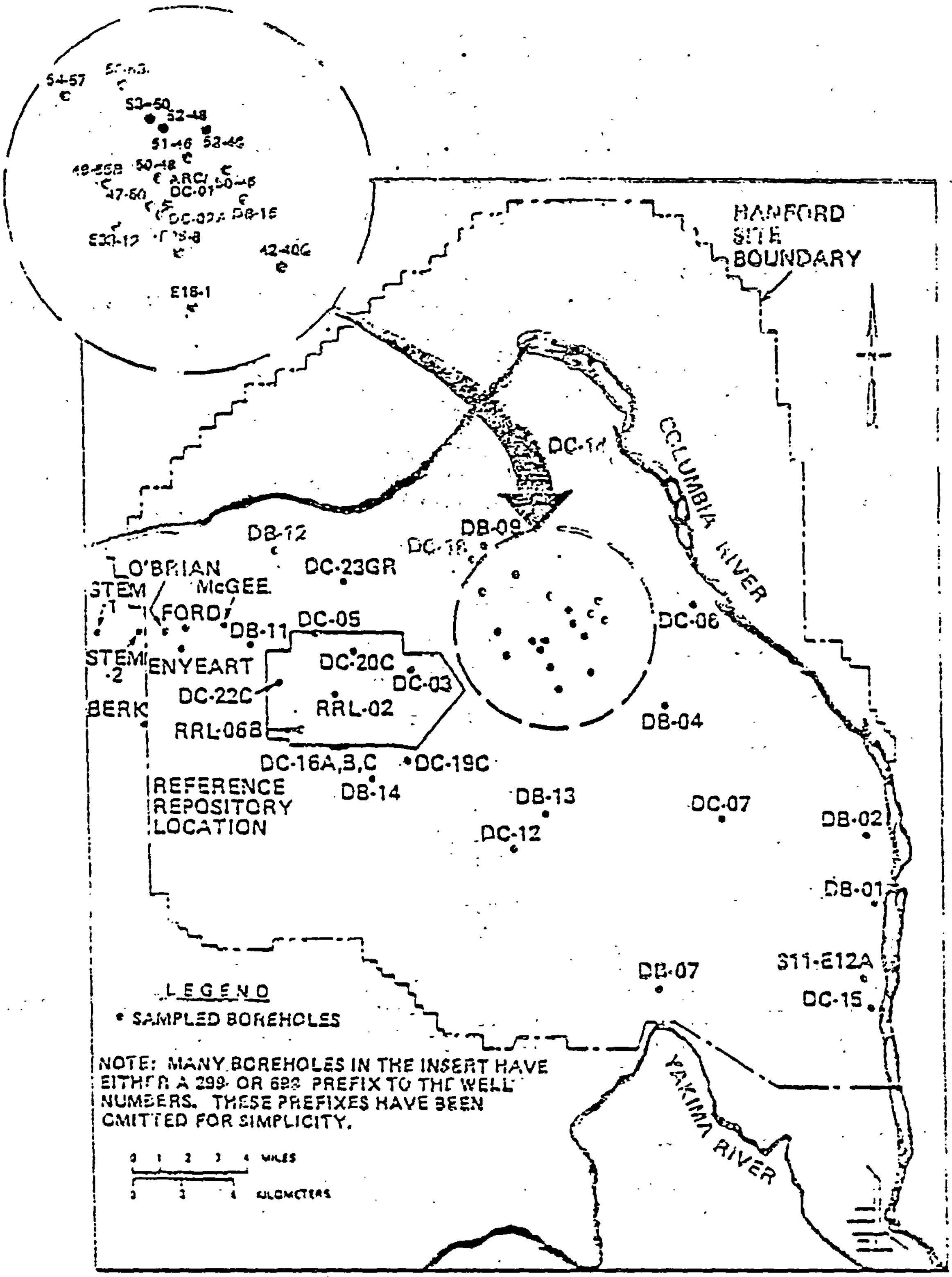

FIGURE 5. Location of Sampled Boreholes for the Confined Aquifers.

Hydrochemical data also are available from a variety of additional documented sources and are included in the Site Hydrochemical Data Base for the sake of completeness. Most data for the unconfined aquifer are contained within a collection of Pacific Northwest Laboratory (PNL) reports (Raymond, et al. 1976; Myers et al. 1976, 1977; Myers, 1978; Eddy, 1979; Eddy and Wilbur, 1980, 1981; Eddy et al. 1982, 1983; Prater et al. 1984; Cline et al. 1985). Several additional analyses are found in Graham et al. (1984).[1] Analyses for a variety of springs and/or boreholes are found in Strait and Moore (1982); LaSala et al. (1973), Apps et al. (1979), and Summers and Weber (1978) and are also included.

Samples analyzed by non-BWIP laboratories and documented in the sources cited above frequently contain some data that are not reported in the Site Hydrochemical Data Base due to the specific format used in reporting data. For example, HCO_3^- and $CO_3^=$ concentrations are reported by some authors but this data base currently does not explicitly include these components. Interested readers are referred to those publications for a more complete listing of available data.

A number of partial chemical analyses for springs of the Rattlesnake Hills are available in Schwab et al. (1979). However, questions exist as to the quality of these analyses. Consequently, they have not been incorporated into the data base.

4.0 STRUCTURE OF DATA BASE PRINTOUT

The printout of the Site Hydrochemical Data Base is found in Appendix A and is arranged into the following series of reports:

- Sampling Events - pages 66 to 88
- Major Inorganics (4 reports) - pages 90 to 187
- Trace Elements - pages 189 to 264
- Dissolved gases - pages 266 to 269
- Radioactive Isotopes - pages 271 to 313
- Stable Isotopes - pages 315 to 328

Each report contains specific information as described below. Where specified data or information is unknown or not available a blank field occurs. For some species where a specific analysis is below the instrumental detection limit a blank data field also exists. However, the BWIP solution chemistry laboratory recently began to identify anion analyses that are below detection and they are reported in the data base as "ND" (not detected). The confusion that this may cause data base users will be eliminated in a future update of this data package where all species that were not detected will be so indicated.

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1 - Many groundwater samples from the unconfined aquifer at Hanford are affected by waste management activities. The listed references discuss the areal extent of disposal effects.

The printout of data is constrained to the format of the NOMAD data base software package. As such, numerical values for specific parameters cannot be truncated to the proper number of significant figures for output. In general, one or more zeroes may be added to some printout values to satisfy formating requirements. The user should be aware of this limitation and refer to the analytical uncertainties that are discussed elsewhere in this document, or may be included in the data tables, to ascertain the significance of trailing zeroes for data entries.

4.1 Sampling Events (pages 66-88)

Figure 6 is a copy of a page of the sampling event report and contains information that is common to all samples associated with a sampling event. For example:

- Location - This is a site name referenced to the maps in Figures 1 to 5
- Sample Event Code - Each sampling event may have as many as three samples associated with it. The first sample number is arbitrarily chosen as the sample event code (SEC) number for the event. Non-BWIP data are assigned a unique SEC number for bookkeeping purposes[2]
- Producing Zone - This information applies only to groundwater samples and represents the major stratigraphic zone(s) from which the sample came. Some inconsistencies in level of stratigraphic detail exist but all producing zone information is referenced to the representative geologic log in Figure 7.
- Packer Top/Bottom - For boreholes these data fields report the depth interval below surface (in feet) that was isolated by packers (or a packer and the bottom of the hole or slotted pipe) during sampling. Where a blank field exists packer depth information is not available. For spring and precipitation samples for which packer information is not appropriate blank fields are also listed.

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2 - Samples collected by the BWIP are assigned a two-part numerical code. The first two digits (e.g., 83-) refer to the fiscal year (FY) in which they were collected. Some samples reported in the data base were collected as part of the CASP and analyzed by the Analytical Laboratories of Rockwell. These samples are identified by sample numbers with a CP-prefix. During FY 1979 some samples analyzed under the auspices of CASP were taken from borehole DB-15 which was partially funded by the BWIP. As a consequence, water samples were assigned both CP- and 79- sample numbers. The latter are used in the data base while the equivalent CP-numbers are maintained in BWIP records. All remaining non-BWIP samples are arbitrarily assigned a sample number of the form SITE-xxx.

SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
BLRK.	85-255	PRIEST RAPIDS TO ROZA	884	1239	PUMP	06/13/85	1
DB-01	81-19	MABTON	976	990	AIRLIFT IG	02/02/81	1
	81-65	PRIEST RAPIDS	1080	1139	AIRLIFT IG	05/01/81	1
	82-27	PRIEST RAPIDS	1080	1139	PUMP	11/10/81	1
	85-32	PRIEST RAPIDS	1080	1139	SIPHONED	10/27/84	1
DB-02	79-65	MABTON	846	924	AIRLIFT IG	07/13/79	1
	81-13	PRIEST RAPIDS	1028	1190	AIRLIFT IG	12/08/80	1
	81-10	ROZA	1166	1190	AIRLIFT IG	12/23/80	1
DB-04	79-77	MABTON	1360	1403	AIRLIFT IG	08/07/79	1
DB-07	79-89	MABTON	587	812	AIRLIFT IG	07/13/79	1
	83-413	MABTON	587	812	AIRLIFT	06/29/83	1
	85-216	MABTON	587	812	WINDMILL	04/25/85	1
DB-09	79-28	MABTON	461	589	AIRLIFT IG	07/12/79	1
	83-472	MABTON	461	589	PUMP	07/15/83	1
DB-11	85-4	MABTON	709	1020	FLOWING	10/10/84	1
	85-15	MABTON	709	1020	FLOWING	10/15/84	1
	85-18	PRIEST RAPIDS	1020	1210	FLOWING	10/15/84	1
	86-52	PRIEST RAPIDS	1020	1210	FLOWING	10/28/85	1
	86-103	PRIEST RAPIDS	1020	1210	PUMP	11/21/85	1
	81-57	PRIEST RAPIDS	1037	1046	FLOWING	01/15/81	1
DB-12	63-95	SELAH	171	189	SWAB	04/20/78	1
	81-25	PRIEST RAPIDS	524	602	AIRLIFT IG	10/31/80	1
DB-13	80-159	MABTON	1195	1202		04/18/80	1
	83-404	MABTON	1195	1292	PUMP	07/07/83	1
DB-14	81-162	PRIEST RAPIDS	1181	1213	AIRLIFT	05/25/81	1
DB-15	79-17	RATTLESNAKE RIDGE	150	222	PUMP	04/26/79	1
	79-35	SELAH	370	422	PUMP	05/10/79	1
	79-33	COLD CREEK	510	613	PUMP	05/24/79	1
	79-15	ASOTIN/UMATILLA	640	682	PUMP	06/04/79	1
	79-39	UMATILLA INTRAFLOW	680	754	PUMP	06/14/79	1
	79-31	MABTON	680	844	PUMP	07/03/79	1
	79-25	MABTON	680	844		07/24/79	1
	79-51	PRIEST RAPIDS	858	969	PUMP	08/13/79	1
	79-85	PRIEST RAPIDS	909	969	SWAB	08/16/79	1
	79-80	PRIEST RAPIDS/ROZA	1045	1105	SWAB	08/27/79	1
	79-62	FRENCHMAN SPRINGS	1300	1343	PUMP	09/27/79	1
	79-90	FRENCHMAN SPRINGS	1300	1343	SWAB	09/27/79	1
	80-35	FRENCHMAN SPRINGS	1353	1373	SWAB	10/04/79	1
	80-24	FRENCHMAN SPRINGS	1383	1443	SWAB	10/13/79	1
	80-77	FRENCHMAN SPRINGS	1450	1530	SWAB	10/15/79	1

FIGURE 6. Sampling Events Report.

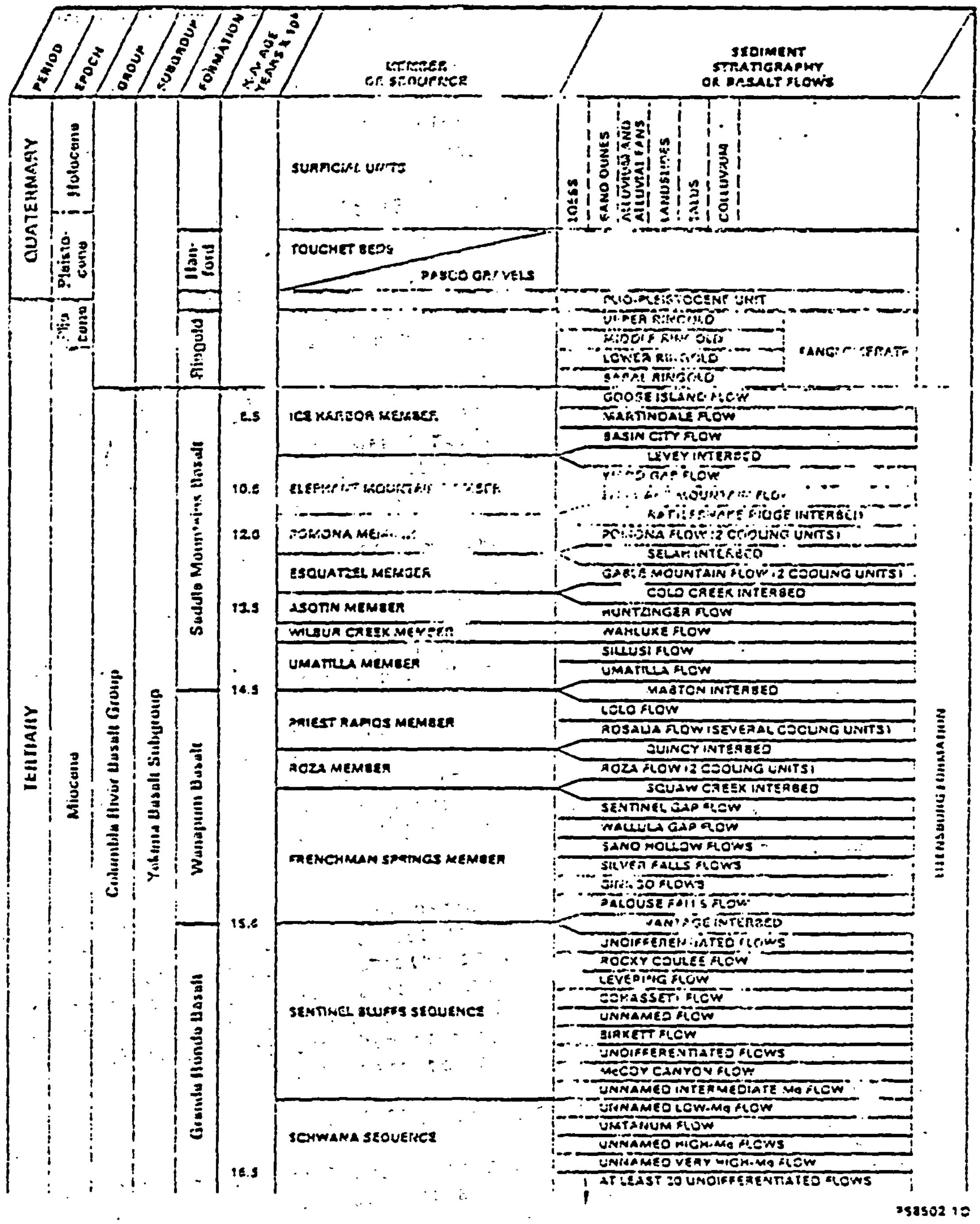

FIGURE 7. Stratigraphic Units Present in the Pasco Basin.

- Sampling Method - A brief description of the sampling technique is reported. The sample method and its identifier in the data base are as follows:

  Airlift - Airlift pumping using compressed air

  Airlift IG - Airlift pumping using compressed inert gas

  Dip - Sample bottle was submerged below water surface

  Flowing - Sampled zone was flowing under artesian pressure. For springs, water was pumped through submerged plastic tubing using a peristaltic pump

  Precipitation Collector - A sampling device consisting of a large funnel emptying into a plastic sample bottle. Snow samples frequently were collected from the ground near the precipitation collector.

  Swab - Swab cups and rods

  Pump - A submersible or turbine pump

  Windmill - A windmill-type pump actuated by a compressed air cylinder

- Date - The date that sampling occurred (Month/Day/Year). The data base requires a date even if one is unknown. Many unconfined aquifer samples fall into this category and are dealt with by recording the date as 1/1/xx, where xx is the calendar year of collection

- Source - A number which is keyed to specific data source references appearing at the end of the sampling event report. In addition to identifying data sources, this code number also contains information relative to the traceability of analyses. The reader is referred to Section 5.1.1 for a more detailed discussion of data traceability.

4.2 Major Inorganics - Report 1 (pages 90-106)

Figure 8 presents a copy of a portion of the first major inorganic report. This information is common to all samples collected during the sampling event.

- Location - Same as above

- Sample Event Code - Same as above

SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
BLRK	85-255	7.85	7.80	268.00			-180.00	22.7
DB-01	81-19	8.55	8.24	438.00		0.16	-110.00	18.1
	81-65	8.95	8.90	491.00		1.00	-190.00	23.9
	82-27		8.67	473.00		0.31	-260.00	19.9
	85-32	8.95	9.05	482.00		0.40	-245.00	20.6
DB-02	79-65							24.0
	81-13	8.66	8.43	463.00		2.00		18.5
	81-10		8.67	496.00		1.90		20.9
DB-04	79-77							[illegible].5
DB 07	79-89							22.0
	83-413	9.45	9.35	528.00		0.14	-380.00	24.5
	85-216	9.05	9.15	530.00		19.00	-220.00	20.0
DB-09	79-28							22.0
	83-472	8.50	8.50	311.00		0.15	-240.00	22.4
DB-11	85-4		8.10	274.00		0.32		26.5
	85-15		8.10	259.00		0.17		27.[illegible]
	85-18	8.10	8.10	262.00			-230.00	27.1
	86-52	8.11	7.95	277.00		1.60	-250.00	26.5
	66-103							
	81:57		8.1[illegible]	277.00				[illegible].4
DB-12	63-95		8.05		320.00			15.8
	81-25		8.46	301.00		1.60	140.00	17.1
DB-13	80-159							
	83-404	8.35	8.35	301.00		0.23	-300.00	2[illegible].5
DB-14	81-162	9.31		714.00		0.73		25.0
DB-15	79-17		7.00		317.80			27.4
	79-35	7.80			327.00			19.6
	79-33		8.10		342.00			[illegible].2
	79-15		8.20		352.00			[illegible]
	79-30		9.70		427.30			22.1
	79-31		8.70		450.30			22.9
	79-25							22.8
	79-51		8.50					24.0
	79-85		9.67		79[illegible].49			24.[illegible]
	79-80		9.83		79[illegible].30			[illegible]
	79-62		[illegible].28		7[illegible].60			[illegible]
	79-90		9.21		738.80			22.4
	80-35		9.41		74[illegible]			2[illegible]
	80-24		9.5[illegible]		75[illegible]			[illegible]
	80-77		[illegible].36		737.[illegible]			22.1
	80-1		9.44		764.[illegible]	0.[illegible]		25.[illegible]
[illegible]-01	SIIE-230	8.10			314.[illegible]			
	SIIE-226	8.50			351.00			
	SIIE-227	8.20	9.62		5[illegible].00			
	SIIE-228	8.40	8.5[illegible]		65[illegible]			
	SIIE-229	9.50	8.61		70[illegible]			
	SIIE-231	8.90			353.[illegible]			
	SIIE-232	8.60	8.60		3[illegible]			
	SIIE-233	8.90			402.[illegible]			
	SIIE-234	9.30			552.20			

FIGURE 8. Major Inorganics Report

- **Lab pH -** The pH value (in pH units) measured in the laboratory at room temperature. It is determined on only one of the samples in a sampling event but is recorded for all common samples

- **Field pH -** The pH value (in pH units) measured in the field at the time of sample collection and at the collection temperature. It is determined on only one of the samples in a sampling event but is recorded for all common samples.

- **Lab Specific Conductance - (Lab Cond.)** It is reported in units of microsiemens/cm at 25°C and is determined on only one of the samples in a sampling event but is recorded for all common samples. For samples collected by Rockwell personnel prior to approximately October 1, 1980, specific conductance usually (but not always) was measured in the field. Comparison of conductivity measurements made in the field and laboratory during this time period indicated essentially no difference within the precision of the measurements. Therefore, following that approximate date all conductivity measurements made by Rockwell personnel have been performed in the laboratory. Complete documentation as to the details of specific conductance measurements made prior to October 1, 1980 is lacking but it is assumed that they were performed in the field. Since February 1986, personnel of the Hydrochemistry Unit of the Site Department (BWIP) have made routine field measurements of specific conductance that will be incorporated into the data base.

- **Field Specific Conductance - (Field Cond.)** It is reported in units of microsiemens/cm at 25°C and is determined on only one of the samples in a sampling event but is recorded for all common samples.

- **Turbidity -** It is measured in the field on an unfiltered sample in nephelometric turbidity units (NTU) and is determined on only one of the samples in a sampling event but is recorded for all common samples.

- **ORP -** The oxidation reduction potential (ORP) is measured in units of millivolts with a platinum electrode relative to an Orion reference electrode that has the potential characteristics of a saturated calomel electrode. Measurements are reported for the collection temperature listed and are determined on only one of the samples in a sampling event.

Data are recorded for all common samples. These data can be converted by the following equation to a standard hydrogen reference electrode at 25°C yielding a value of Eh:

$$Eh\ (MV) = E_{pt,T} + 257.1 - 0.64\ T(°C)$$

This equation results from linear regression of data found in Orion (1980).

- Sample Temperature - The temperature (in °C) of the sample at the time of collection. The in situ temperature of sampled zones in boreholes at Hanford can be adequately estimated by use of the following equation:

$$T\ (°C) = 15.0 + 0.038\ [Depth\ (m)] \quad \text{(Early, et al., 1983)}$$

This equation is based on a linear regression of temperature-depth results from five Hanford boreholes. As more borehole temperature data are documented this equation will be revised.

4.3 Major Inorganics - Report 2 (pages 108-133)

Figure 9 is a continuation of the major inorganic data. The location and sample event code are interpreted as described previously. Where the concentration of a species is below the quantification limit of the instrument a "<" will precede the numerical estimate of quantification limit.

Associated with each species listed is an analysis code, "(A)", which defines the analytical technique used to obtain the data. The key for these analysis codes is given at the end of this report.

- Sample Number - The specific sample number associated with the sampling event for which data exist.
- NA - Sodium concentration in mg/L.
- K - Potassium concentration in mg/L.
- CA - Calcium concentration in mg/L.
- MG - Magnesium concentration in mg/L.

SAMPLE TYPE. CONFINED
ANALYSIS GROUP. MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
BERK	85-255	85-255	27.000	(1)	6.840	(1)	15.300	(1)	9.140	(1)
		85-256	28.400	(1)	6.900	(1)	15.500	(1)	9.230	(1)
DB-01	81-19	81-15	97.200	(1)	13.100	(1)	1.700	(1)	0.479	(1)
		81-19	101.000	(1)	13.200	(1)	1.780	(1)	0.490	(1)
	81-65	81-65	101.000	(1)	16.000	(1)	0.490	(1)	0.150	(1)
		81-70	100.000	(1)	15.900	(1)	0.500	(1)	0.150	(1)
	82-27	82-27	99.700	(1)	15.300	(1)	0.430	(1)	0.100	(1)
		82-87	100.000	(1)	15.300	(1)	0.490	(1)	< 0.100	(1)
	85-32	85-32	101.000	(1)	15.800	(1)	0.420	(1)	0.084	(1)
		85-33	100.000	(1)	15.700	(1)	0.430	(1)	0.095	(1)
DB-02	79-65	CP123	107.700	(1)	13.500	(1)	1.500	(1)	0.450	(1)
	81-13	81-11	98.700	(1)	17.000	(1)	0.740	(1)	0.290	(1)
		81-13	99.400	(1)	17.300	(1)	0.750	(1)	0.360	(1)
	81-10	81-10	103.000	(1)	16.300	(1)	0.590	(1)	0.080	(1)
		81-7	104.000	(1)	16.500	(1)	0.600	(1)	0.090	(1)
DB 04	79-77	CP116	77.800	(1)	10.600	(1)	0.560	(1)	0.160	(1)
DB-07	79-89	CP121	118.400	(1)	14.200	(1)	1.500	(1)	0.090	(1)
	83-413	83-413	117.000	(1)	12.600	(1)	1.460	(1)	< 0.100	(1)
		83-448	114.000	(1)	12.300	(1)	1.430	(1)	< 0.100	(1)
	85-216	85-216	113.100	(1)	12.300	(1)	1.390	(1)	< 0.100	(1)
		85-217	112.800	(1)	12.300	(1)	1.360	(1)	< 0.100	(1)
DB-09	79-28	CP115	75.100	(1)	12.200	(1)	0.560	(1)	0.130	(1)
	83-472	83-410	70.800	(1)	10.520	(1)	0.450	(1)	< 0.100	(1)
		83-472	71.000	(1)	10.500	(1)	0.450	(1)	< 0.100	(1)
DB-11	85-18	85-18	31.400	(1)	9.720	(1)	14.700	(1)	7.020	(1)
		85-19	31.100	(1)	9.610	(1)	14.600	(1)	6.960	(1)
	86-52	86-52	32.300	(1)	9.450	(1)	14.900	(1)	7.180	(1)
		86-53	32.700	(1)	9.640	(1)	15.000	(1)	7.240	(1)
	81-57	81-57	33.300	(1)	9.920	(1)	15.300	(1)	7.500	(1)
DB-12	63-95	63-95	16.800	(1)	7.100	(1)	25.300	(1)	13.500	(1)
	81-25	81-25	31.400	(1)	8.240	(1)	18.800	(1)	10.300	(1)
		81-42	31.500	(1)	8.310	(1)	18.800	(1)	10.300	(1)
DB-13	83-404	83-404	54.200	(1)	10.100	(1)	8.000	(1)	2.030	(1)
		83-455	55.000	(1)	10.300	(1)	9.080	(1)	2.020	(1)
DB-14	81-162	81-139	137.000	(1)	17.600	(1)	2.030	(1)	< 0.020	(1)
		81-162	130.900	(1)	16.370	(1)	1.910	(1)	< 0.020	(1)
DB-15	79-17	79-17	44.400	(1)	10.400	(1)	18.900	(1)	4.900	(1)
		79-4	42.000	(1)	11.600	(1)	19.600	(1)	5.100	(1)

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FIGURE 9. Major Inorganics Report 2.

4.4 Major Inorganics - Report 3 (pages 135-160)

Figure 10 is a continuation of the major inorganic data. The location, sample event code, and sample number are interpreted as described previously. Where the concentration of a species is below the quantification limit of the instrument a "<" will precede the numerical estimate of quantification limit. The analysis code key is given at the end of this report.

o Lab Alkalinity -	A laboratory measurement of alkalinity usually is made in duplicate for each sampling event. The mean of the two analyses is recorded in the data base for all associated samples. It is reported in units of mg/L as $CaCO_3$.
o Field Alkalinity -	A measurement of alkalinity made in the field at the time of sample collection. See under lab alkalinity for additional information.
o SI -	Silicon concentration in mg/L.
o TOC -	Total organic carbon in mg/L.
o Total Carbon (TC)	The sum of all organic and inorganic forms of carbon in mg/L.

4.5 Major Inorganics - Report 4 (pages 161-187)

Figure 11 is a continuation of the major inorganic data. The location, sample event code, and sample number are interpreted as described previously. Where the concentration of a species is below the quantification limit of the instrument a "<" will precede the numerical estimate of quantification limit. The analysis code key is given at the end of this report.

o CL -	Chloride concentration in mg/L.
o F -	Fluoride concentration in mg/L.
o BR -	Bromide concentration in mg/L. Bromide measurements made by the high performance liquid chromatography (HPLC) technique were performed on samples archived by the solution chemistry laboratory for up to three years. Sample integrity relative to bromide has not been established over this period of time.
o SO4 -	Sulfate concentration in mg/L.
o NO3 -	Nitrate concentration in mg/L.
o PO4 -	Phosphate concentration in mg/L.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
BERK	85-255	85-255	132.000	135.000	27.500	(1)	0.600	(1)	32.500	(1)
		85-256	132.000	135.000	27.800	(1)				
DB-01	81-19	81-15	193.000	191.000	27.500	(1)				
		81-19	193.000	191.000	27.900	(1)				
	81-65	81-65	132.000	134.000	35.500	(1)				
		81-70	132.000	134.000	35.500	(1)				
	82-27	82-27		136.000	35.400	(1)	0.660	(1)		
		82-87		136.000	35.300	(1)				
	85-32	85-32	138.000	137.000	33.600	(1)	0.400	(1)	28.860	(1)
		85-33	138.000	137.000	33.600	(1)				
DB-02	79-65	CP123			33.000	(1)				
	81-13	81-11	140.000	134.200	29.600	(1)				
		81-13	140.000	134.200	29.700	(1)				
	81-10	81-10		134.200	34.200	(1)				
		81-7		134.200	34.300	(1)				
DB-04	79-77	CP116			48.600	(1)				
DB-07	79-89	CP121			41.500	(1)				
	83-413	83-413	170.000	170.000	38.370	(1)	0.740	(1)	34.880	(1)
		83-448	170.000	170.000	37.400	(1)				
	85-216	85-216	163.000	164.000	36.800	(1)	1.180	(1)	32.200	(1)
		85-217	163.000	164.000	36.600	(1)				
DB-09	79-23	CP115			31.400	(1)				
	83-472	83-410	138.000	139.000	27.400	(1)				
		83-472	138.000	139.000	27.400	(1)	0.440	(1)	32.410	(1)
DB-11	85-18	85-18	140.000	141.000	28.000	(1)	0.240	(1)	32.990	(1)
		85-19	140.000	141.000	28.700	(1)	0.240	(1)	32.990	(1)
	86-52	86-52	141.000	140.000	30.400	(1)	0.260	(1)	32.900	(1)
		85-53	141.000	140.000	30.400	(1)				
	81-57	81-57		141.000	32.170	(1)				
DB-12	63-85	63-85		145.000	14.300	(1)				
	81-25	81-25		171.900	26.100	(1)				
		81-42		171.900	26.000	(1)				
DB-13	83-404	83-404	154.000	153.000	29.800	(1)	0.640	(1)	33.650	(1)
		83-455	154.000	153.000	30.000	(1)				
DB-14	81-162	81-139	128.400		36.220	(1)				
		81-162	128.400		36.560	(1)				
DB-15	79-17	79-17		98.400	24.000	(1)				
		79-4		98.400	26.000	(1)				

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FIGURE 10. Major Inorganics Report 3.

SAMPLE TYPE. CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
BERK	85-255	85-255	4.600	(1)	0.560	(1)									
		85-256	4.500	(1)	0.490	(1)									
DB-01	81-19	81-15	16.000	(1)	3.490	(1)			0.270	(1)					[illegible].478
		81-19	16.700	(1)	3.660	(1)			0.210	(1)					3.979
	81-65	81-65	47.500	(1)	7.210	(1)			15.300	(1)					1.050
		81-70	47.400	(1)	7.200	(1)			16.200	(1)					0.634
	82-27	82-27	46.600	(1)	7.080	(1)			16.300	(1)					0.119
		82-87	47.500	(1)	7.140	(1)			16.600	(1)					-0.079
	85-32	85-32	48.000	(1)	7.200	(1)			17.000	(1)					-0.017
		85-33	48.000	(1)	7.200	(1)			17.000	(1)					-0.482
DB-02	79-65	CP123	14.600	(1)	5.500	(1)			< 1.200	(1)	< 0.500	(1)	< 0.500	(1)	
	81-13	81-11	29.700	(1)	5.080	(1)			35.600	(1)					2.774
		81-13	29.900	(1)	5.140	(1)			35.700	(1)					3.115
	81-10	81-10	31.900	(1)	5.760	(1)			38.200	(1)					2.617
		81-7	31.900	(1)	5.760	(1)			38.500	(1)					3.046
DB-04	79-77	CP116	6.400	(1)	1.100	(1)			1.100	(1)					
DB-07	79-89	CP121	55.530	(1)	7.300	(1)			[illegible]	(1)					
	83-413	83-413	56.500	(1)	7.680	(1)			0.900	(1)					0.696
		83-448	57.100	(1)	7.950	(1)			0.990	(1)					-0.877
	85-216	85-216	52.700	(1)	8.300	(1)			0.850	(1)					0.859
		85-217	53.000	(1)	8.400	(1)			0.950	(1)					0.631
DB-09	79-28	CP115	9.800	(1)	0.100	(1)			< 1.200	(1)					
	83-472	83-410	10.200	(1)	0.840	(1)			14.500	(1)					-1.442
		83-472	10.100	(1)	0.840	(1)			14.400	(1)					-0.313
DB-11	85-18	85-18	4.900	(1)	0.800	(1)									
		85-19	5.000	(1)	0.700	(1)									
	86-52	86-52	4.180	(1)	0.770	(1)			ND	(1)	ND	(1)			
		86-53	4.160	(1)	0.770	(1)			ND	(1)	ND	(1)			
	81-57	81-57	4.600	(1)	0.720	(1)									
DB-12	83-95	83-95	4.600	(1)	0.030	(1)			19.300	(1)					[illegible].140
	81-25	81-25	5.300	(1)	0.710	(1)			3.810	(1)					-3.528
		81-42	5.300	(1)	0.710	(1)			3.790	(1)					-3.447
DB-13	83-404	83-404	[illegible]	(1)	0.490	(1)			[illegible]	(1)					0.213
		83-455	4.620	(1)	0.490	(1)			0.180	(1)					0.857
DB-14	81-162	81-139	129.000	(1)	9.490	(1)			< [illegible]	(1)					[illegible].545
		81-162	129.000	(1)	9.440	(1)			< 0.500	(1)					-3.905
DB-15	79-17	79-17	7.700	(1)	< 0.300	(1)			[illegible]	(1)	7.000	(1)	< 1.200	(1)	[illegible].395
		79-4	7.800	(1)	< 0.300	(1)			38.700	(1)	6.400	(1)	< 1.200	(1)	5.824

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FIGURE 11. Major Inorganics Report 5.

o Charge Balance – The calculated percent deviation between the observed total cations and anions (each measured in milliequivalents/L) determined according to the following equation:

$$\text{Charge Balance} = \left[\frac{\text{Total Cations} - \text{Total Anions}}{\text{Total Cations} + \text{Total Anions}}\right] \times 100\%$$

where:

$$\text{Total Cations (Meq/L)} = \frac{[Na^{+}]}{22.9898} + \frac{[K^{+}]}{39.102} + \frac{[Ca^{2+}]}{20.04} + \frac{[Mg^{2+}]}{12.156}$$

$$\text{Total Anions (Meq/L)} = \frac{\text{Alkalinity}}{50.} + \frac{[Cl^{-}]}{35.453} + \frac{[F^{-}]}{18.9984} + \frac{[NO_3^{-}]}{62.0049} \quad \frac{[SO_4^{2-}]}{48.0308}$$

The concentrations are in units of mg/L and divisors in these equations are the equivalent weights of the respective species.

A charge balance will be computed as long as data for all of the key species are present. Key species include sodium, potassium, calcium, magnesium, alkalinity, chloride, fluoride, and sulfate. If available, nitrate is included in the calculation, but does not appear to be quantitatively important except for the unconfined aquifer. Therefore, a charge balance will be determined whether or not nitrate analyses are provided.

4.6 Trace Elements (pages 189-264)

Figure 12 is an example of the printout for trace element data. The report is an alphabetical listing of 18 trace constituents that covers three printed pages. The location, sample event code, and sample number are interpreted as described previously. All elements are reported by their conventional chemical symbols and concentrations are reported in units of mg/L. Measurements below quantification are noted by use of "<". The analysis code key is given at the end of this report.

Since October 1985, determination of several trace elements was stopped by the BWIP solution chemistry laboratory because these elements were rarely, if ever, above the quantification limit of the instrument. Chromium, cobalt, nickle, cadmium, and lead are affected by this change.

Because of their low concentrations in groundwaters, trace elements are more likely than major constituents to suffer the effects of contamination prior to analysis. While the BWIP has not systematically evaluated the impact of contamination on trace element concentrations, several cautionary comments are warranted. First, unusually high concentrations of molybdenum in a few groundwater samples are suspected of resulting from contamination by joint compound used on drill pipe. Second, anomalously high concentrations of iron and other transition metals occassionally are reported and are believed to be caused by contamination from the borehole casing pipe and pump tubing. Finally, the elevated zinc concentrations observed in precipitation samples probably are due to the use of galvanized iron funnels in the sample collectors.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
BERK	85-255	85-255	< 0.06[illegible]	(1)			< 0.015	(1)	0.024	(1)			< 0.017	[illegible]
		85-256	< 0.050	(1)			< 0.015	(1)	0.033	(1)			< 0.017	[illegible]
DB-01	81-19	81-15	0.020	(1)			[illegible]	[illegible]	[illegible]	(1)			< 0.01[illegible]	(1)
		81-19	< 0.010	(1)			0.130	[illegible]	0.014	(1)			< 0.010	(1)
	81-65	81-65	< 0.01[illegible]	(1)			0.210	(1)	0.005	(1)			< 0.004	(1)
		81-70	< [illegible]	(1)			0.210	(1)	0.005	(1)			< 0.004	[illegible]
	82-27	82-27	< 0.075	(1)			0.210	[illegible]	0.011	(1)			< 0.015	[illegible]
		82-87	< 0.075	(1)			0.200	[illegible]	0.021	(1)			< 0.015	(1)
	85-32	85-32	< 0.010	(1)			0.19[illegible]		0.00[illegible]	(1)			< 0.00[illegible]	(1)
		85-33	< 0.013	(1)			0.190	[illegible]	0.009	(1)			< 0.003	(1)
DB-02	79-65	CP123	0.050	(1)			0.2[illegible]	[illegible]					< 0.010	(1)
	81-13	81-11	0.200	(1)			0.15[illegible]	[illegible]	0.1[illegible]	(1)			< 0.010	(1)
		81-13	0.2[illegible]	(1)			0.150	[illegible]	0.200	(1)			< 0.010	(1)
	81-10	81-10	[illegible]	(1)			0.140	[illegible]	0.2[illegible]	(1)			< 0.010	[illegible]
		81-7	0.900	(1)			0.150	[illegible]	0.190	(1)			< 0.010	[illegible]
DB-04	79-77	CP116	0.100	(1)			[illegible]	[illegible]	[illegible]	(1)			< 0.010	(1)
DB-07	79-89	CP12[illegible]	0.170	(1)			0.650	(1)	0.010	(1)			< 0.010	(1)
	83-413	83-413	< 0.080	(1)			0.490	[illegible]	0.011	(1)			< 0.010	(1)
		83-448	< 0.080	(1)			0.480		0.021	(1)			< 0.010	(1)
	85-216	85-216	< 0.050	(1)			0.630	(1)	0.009	(1)			< 0.017	(1)
		85-217	< 0.060	(1)			0.620	(1)	0.062	(1)			< 0.017	(1)
DB-09	79-28	CP115	[illegible]	(1)			[illegible]	[illegible]	0.012	(1)			< 0.010	[illegible]
	83-472	83-410	< 0.080	(1)			< 0.020	[illegible]	0.010	(1)			< 0.010	[illegible]
		83-472	< [illegible]	(1)			< 0.02[illegible]	[illegible]	0.013	(1)			< 0.010	
DB-11	85-18	85-18	< 0.013	(1)			0.007	[illegible]	[illegible]	(1)			< 0.003	[illegible]
		85-19	< 0.013	(1)			[illegible]	[illegible]	0.041	(1)			< 0.003	[illegible]
	86-52	86-52	< 0.200	(1)			< [illegible]		0.052	[illegible]				
		86-53	< 0.200	(1)			< [illegible]		0.053	(1)				
	81-57	81-57	[illegible]	(1)			0.025		[illegible]	(1)			< 0.005	[illegible]
DB-12	83-95	83-95	< [illegible]	(1)			0.2[illegible]	[illegible]	[illegible]	[illegible]			0.020	[illegible]
	81-25	81-25	0.070	(1)			[illegible]	[illegible]	0.170	[illegible]			< 0.005	[illegible]
		81-42	0.070	(1)			0.030	(1)	[illegible]	(1)			< 0.005	[illegible]
DB-13	83-404	83-404	< 0.080	(1)			< 0.020	(1)	0.01[illegible]	(1)			< 0.010	[illegible]
		83-455	< 0.080	(1)			< 0.020	[illegible]	0.014	(1)			< 0.010	(1)
DB-14	81-162	81-139	0.030	(1)			0.5[illegible]	[illegible]	[illegible]	(1)			< 0.004	[illegible]
		81-162	0.004	(1)			0.530		0.004	(1)			< 0.00[illegible]	[illegible]
DB-15	79-17	79-17	< 0.020	(1)			< 0.005	[illegible]	[illegible]	(1)			< 0.010	(1)
		79-4	0.040	(1)			< 0.019	(1)	[illegible]	(1)	< 0.010	(1)	< 0.010	(1)

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FIGURE 12. Trace Elements Report.

SAMPLE TYPE CONFINED
ANALYSIS GROUP TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
BERK	85-255	85-255	< 0.032	(1)	< 0.006	(1)	0.052	(1)	< 0.008	(1)	0.053	(1)	< 0.034	(1)
		85-256	< 0.032	(1)	< 0.006	(1)	0.072	(1)	< 0.008	(1)	0.049	(1)	< 0.034	(1)
DB-01	81-19	81-15	0.004	(1)	< 0.002	(1)	0.038	(1)	0.087	(1)	0.201	(1)	0.151	(1)
		81-19	< 0.003	(1)	< 0.002	(1)	0.050	(1)	0.048	(1)	< 0.100	(1)	< 0.030	(1)
	81-65	81-65	< 0.006	(1)	< 0.003	(1)	0.360	(1)	0.015	(1)	0.006	(1)	0.110	(1)
		81-70	< 0.006	(1)	< 0.003	(1)	0.370	(1)	0.015	(1)	0.005	(1)	0.110	(1)
	82-27	82-27	< 0.036	(1)	< 0.006	(1)	0.120	(1)	0.015	(1)	< 0.003	(1)	0.100	(1)
		82-87	< 0.036	(1)	< 0.006	(1)	0.130	(1)	0.014	(1)	< 0.003	(1)	0.100	(1)
	85-32	85-32	< 0.007	(1)	0.002	(1)	0.049	(1)	0.015	(1)	0.003	(1)	0.099	(1)
		85-33	< 0.007	(1)	0.002	(1)	0.046	(1)	0.015	(1)	0.003	(1)	0.102	(1)
DB-02	79-65	CP123	< 0.003	(1)	0.010	(1)	0.030	(1)			< 0.020	(1)	< 0.030	(1)
	81-13	81-11	0.010	(1)	0.009	(1)	0.680	(1)			0.374	(1)	0.270	(1)
		81-13	0.005	(1)	< 0.005	(1)	0.690	(1)	< 0.005	(1)	0.399	(1)	0.280	(1)
	81-10	81-10	0.004	(1)	< 0.005	(1)	0.130	(1)	< 0.005	(1)	0.335	(1)	0.250	(1)
		81-7	0.005	(1)	0.005	(1)	0.130	(1)	< 0.005	(1)	0.374	(1)	0.240	(1)
DB-04	79-77	CP116	< 0.003	(1)	0.024	(1)	1.980	(1)			< 0.024	(1)	< 0.030	(1)
DB-07	79-89	CP121	< 0.003	(1)	0.020	(1)	0.500	(1)			< 0.020	(1)	< 0.030	(1)
	83-413	83-413	< 0.040	(1)	< 0.010	(1)	0.030	(1)	0.007	(1)	0.005	(1)	0.050	(1)
		83-448	< 0.040	(1)	< 0.010	(1)	0.030	(1)	0.008	(1)	0.006	(1)	0.050	(1)
	85-216	85-216	< 0.032	(1)	0.006	(1)	0.187	(1)	< 0.008	(1)	< 0.005	(1)	0.049	(1)
		85-217	< 0.032	(1)	0.008	(1)	0.202	(1)	< 0.008	(1)	0.005	(1)	0.040	(1)
DB-09	79-28	CP115	< 0.003	(1)	0.016	(1)	0.220	(1)			< 0.020	(1)	< 0.030	(1)
	83 472	83-410	< 0.040	(1)	< 0.010	(1)	0.030	(1)	0.006	(1)	0.006	(1)	< 0.020	(1)
		83-472	< 0.040	(1)	< 0.010	(1)	0.040	(1)	0.007	(1)	0.005	(1)	< 0.020	(1)
DB-11	85-18	85-18	< 0.007	(1)	< 0.001	(1)	0.092	(1)	0.016	(1)	0.053	(1)	< [illegible]	(1)
		85-19	< 0.007	(1)	< 0.001	(1)	0.090	(1)	0.017	(1)	0.052	(1)	< 0.008	(1)
	86-52	86-52			< 0.012	(1)	0.087	(1)	0.021	(1)	0.047	(1)	< 0.600	(1)
		86-53			< 0.012	(1)	0.089	(1)	0.020	(1)	0.043	(1)	< 0.500	(1)
	81-57	81-57	0.004	(1)	< 0.005	(1)	0.103	(1)			0.339	(1)	0.131	(1)
DB-12	63-95	63-95	< 0.005	(1)	< 0.005	(1)	< 0.025	(1)					< 0.020	(1)
	81-25	81-25	0.007	(1)	0.010	(1)	0.069	(1)			[illegible]	(1)	0.230	(1)
		81-42	0.010	(1)	0.010	(1)	0.050	(1)			0.304	(1)	0.210	(1)
DB-13	83-404	83-404	< 0.040	(1)	< 0.010	(1)	[illegible]	(1)	0.020	(1)	0.030	(1)	< [illegible]	(1)
		83-455	< 0.040	(1)	< 0.010	(1)	0.070	(1)	0.020	(1)	0.020	(1)	< 0.020	(1)
DB-14	81-162	81-139	< 0.008	(1)	< 0.003	(1)	0.150	(1)	0.002	(1)	[illegible]	(1)	[illegible]	(1)
		81-162	< 0.006	(1)	< 0.003	(1)	0.170	(1)	0.003	(1)	0.007	(1)	0.110	(1)
DB-15	79-17	79-17	< 0.003	(1)	< 0.002	(1)	0.020	(1)	< 0.020	(1)	< 0.020	(1)	< [illegible]	(1)
		79-4	< 0.010	(1)	< 0.010	(1)	0.020	(1)			< 0.020	(1)	< 0.010	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

FIGURE 12. Continued

SAMPLE TYPE, CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
BERK	85-255	85-255	< 0.030	(1)			< 0.180	(1)	0.054	(1)	< 0.020	(1)
		85-256	< 0.030	(1)			< 0.180	(1)	0.055	(1)	< 0.020	(1)
DB-01	81-19	81-15	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.010	(1)	< 0.002	(1)
		81-19	< 0.020	(1)	< 0.200	(1)	< 0.010	(1)	0.010	(1)	< 0.002	(1)
	81-65	81-65	< 0.008	(1)	0.080	(1)	< 0.043	(1)	0.002	(1)	< 0.004	(1)
		81-70	< 0.008	(1)	0.080	(1)	< 0.043	(1)	0.002	(1)	< 0.004	(1)
	82-27	82-27	< 0.026	(1)	< 0.340	(1)	< 0.160	(1)	0.002	(1)	< 0.150	(1)
		82-87	< 0.026	(1)	< 0.340	(1)	< [illegible]	(1)	0.002	(1)	< 0.015	(1)
	85-32	85-32	< 0.003	(1)			< [illegible]	(1)	< 0.000	(1)	< 0.004	(1)
		85-33	< 0.003	(1)			< 0.040	(1)	< 0.000	(1)	< 0.004	(1)
DB-02	79-65	CP123									0.020	(1)
	81-13	81-11	< 0.010	(1)	< 0.200	(1)	< [illegible]	(1)	0.004	(1)	0.030	(1)
		81-13	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	0.030	(1)
	81-10	81-10	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.002	(1)	0.020	(1)
		81-7	< 0.010	(1)	0.300	(1)	< 0.100	(1)	0.003	(1)	0.020	(1)
DB-04	79-77	CP116									0.100	(1)
DB-07	79-80	CP121									0.020	(1)
	83-413	83-413	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.009	(1)	< 0.010	(1)
		83-448	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.009	(1)	< 0.010	(1)
	85-216	85-216	< 0.030	(1)			< 0.180	(1)	0.008	(1)	< 0.020	(1)
		85-217	< 0.030	(1)			< 0.180	(1)	0.008	(1)	< 0.020	(1)
DB-09	79-28	CP115									0.050	(1)
	83-472	83-410	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-472	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< [illegible]	(1)
DB-11	85-18	85-18	< 0.003	(1)			< 0.040	(1)	0.049	(1)	< 0.004	(1)
		85-19	< 0.003	(1)			< 0.040	(1)	0.049	(1)	< 0.004	(1)
	86-52	86-52							0.055	(1)	< 0.040	(1)
		86-53							0.056	(1)	< 0.040	(1)
	81-57	81-57	< 0.010	(1)	< 0.020	(1)	< 0.100	(1)	0.080	(1)	[illegible]	(1)
DB-12	63-95	63-95									< 0.005	(1)
	81-25	81-25	< 0.010	(1)	< 0.200	(1)	< [illegible]	(1)	[illegible]	(1)	0.060	(1)
		81-42	< 0.010	(1)	< 0.200	(1)	< [illegible]	(1)	0.030	(1)	0.080	(1)
DB-13	83-404	83-404	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.050	(1)	< 0.010	(1)
		83-455	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.050	(1)	< 0.010	(1)
DB-14	81-162	81-139	< 0.008	(1)	0.110	(1)	< 0.040	(1)	0.007	(1)	[illegible]	(1)
		81-162	< 0.008	(1)	0.130	(1)	< 0.040	(1)	0.007	(1)	0.005	(1)
DB-15	79-17	79-17	< 0.020	(1)	< 0.200	(1)	[illegible]	(1)	[illegible]	(1)	[illegible]	(1)
		79-4	< 0.010	(1)	< 0.100	(1)	< [illegible]	(1)	0.160	(1)	0.100	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

FIGURE 12. Continued

A large number of phosphorous results determined by inductively coupled atomic emission spectrometry (ICP-AES) are presented in the trace elements report. It is known that the detection of trace amounts of phosphorous by this technique is subject to significant error and all of these analyses must be considered suspect.

4.7 Dissolved Gases (pages 256-269)

Figure 13 presents a portion of the dissolved gas report. The location, sample event code, and sample number are interpreted as described previously. The gas data are reported in units of mole percent for each constituent. The BWIP provided its vendor with samples either in the form of gas (exsolved from groundwater under atmospheric pressure at the well head) or as gas dissolved in groundwater. In the latter case (which accounts for most samples), the vendor who supplied the analyses extracted dissolved gases, under vacuum, from groundwater samples in stainless steel containers. The extraction time was insufficient to remove all of the dissolved gases. Therefore, because of the different solubilities and exsolution rates of individual gas components the relative amounts (mole %) reported in this table must be regarded only as estimates.[3] Similarly, the vendor reported the volume of gas extracted from each sample but, for the reason cited above, these results are known to be significantly in error and are not reported. Changes in procedures for sample collection and analysis of dissolved gases in groundwaters have been implemented.

Absolute gas concentrations are not available except for a few non-BWIP samples (Apps et al. 1979) and they are not reported in the data base. New sample collection techniques recently implemented by the BWIP permit reliable determination of absolute dissolved gas concentrations in groundwater. These results will be reported in a future update of this document.

All analyte species are reported by their conventional chemical symbols except carbon monoxide which is referred to as "C MON". A "<" denotes analyses below the detection limit of the mass spectrometer. The analysis method is listed at the bottom of each page.

Cross-referencing sample numbers between dissolved gas samples and the appropriate sampling method (Sampling Events Report) illustrates a source of uncertainty in this report that must be acknowledged. There is an indication that some gas samples were collected by airlift techniques. This implication is incorrect as gas samples are never collected in that manner. Future updates of this data package will seek to correct these errors.

3 - Currently, the only use made of these data by the BWIP is with the relative amounts of the two major gaseous components, nitrogen and methane.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: GAS

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AR MOLE%(REL)	C MON MOLE%(REL)	CH4 MOLE%(REL)	CO2 MOLE%(REL)	HE MOLE%(REL)	H2 MOLE%(REL)	N2 MOLE%(REL)	O2 MOLE%(REL)
DB-13	83-404	83-404	0.870	< 0.100	15.600	0.070	0.010	< 0.010	83.300	0.020
DB-15	79-17	79-17	< 0.010	< 0.100	< 0.010	0.200	< 0.010	0.130	0.650	0.0[illegible]
	79-35	79-35	< 0.010	< 0.010	< 0.010	0.010	< 0.010	0.100	0.270	0.020
	79-33	79-33	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.010	0.020	0.010
	79-15	79-15	0.350	14.400	29.200	0.060	< 0.010	0.330	7.570	0.180
	79-39	79-39	0.050	< 0.100	4.400	0.070	< 0.010	0.100	2.500	0.030
	79-51	79-51	0.090	< 0.100	96.300	0.030	< 0.010	< 0.010	3.580	< 0.010
		79-61	0.080	< 0.100	96.000	0.[illegible]0	< 0.010	< 0.010	3.870	< 0.010
		79-92	0.080	< 0.100	96.100	0.020	< 0.010	< 0.010	3.800	< 0.010
	79-85	79-74	0.930	2.820	3.980	0.040	< 0.010	0.060	74.100	18.100
		79-85	0.880	3.100	7.070	0.040	< 0.010	0.040	70.300	18.600
	79-80	79-80	0.080	< 0.100	94.870	< 0.010	< 0.010	0.820	4.210	0.020
		79-99	0.070	< 0.100	85.070	< 0.010	< 0.001	0.850	4.000	< 0.010
	79-62	79-62	< 0.010	< 0.100	83.060	1.330	< 0.010	4.350	10.880	0.380
		79-84	0.190	< 0.100	91.980	0.100	< 0.010	< 0.010	7.620	0.110
	80-35	80-35	0.220	< 0.100	86.900	0.200	< 0.010	1.070	10.800	0.710
		80-41	0.180	< 0.100	89.800	0.220	< 0.010	1.280	8.340	0.180
	80-24	80-24	0.110	< 0.100	94.400	0.010	0.010	0.090	5.400	< 0.0[illegible]
		80-74	0.110	< 0.100	94.300	0.020	< 0.010	0.050	5.500	< 0.010
	80-77	80-42	0.160	< 0.100	91.100	< 0.010	< 0.010	0.950	7.770	< 0.010
		80-77	0.160	< 0.100	90.500	< 0.010	0.020	0.940	8.380	< 0.010
	80-1	80-1	0.090	< 0.100	94.300	< 0.010	< 0.010	< 0.010	5.600	< 0.010
		80-51	0.150	< 0.100	93.800	< 0.010	< 0.010	< 0.010	6.060	< 0.010
DC-05	79-30	79-30	0.150	4.720	93.400	[illegible]	[illegible]	< 0.010	1.700	< 0.010
DC-06	80-238	80-238	1.120	< 0.100	0.570	< [illegible]	0.230	< 0.010	98.000	< [illegible]
	80-15	80-15	1.350	< 0.100	< 0.010	[illegible]	0.290	< 0.010	97.600	0.420
	80-29	80-29	1.360	< 0.100	0.480	[illegible]	0.310	0.170	97.800	< 0.010
		80-37	1.500	< 0.100	0.900	< [illegible]	0.350	0.200	96.800	0.120
	79-58	79-57	1.140	< 0.100	0.770	< [illegible]	0.300	0.240	97.500	< 0.020
		79-58	1.170	< 0.100	0.750	< 0.010	0.260	0.180	97.600	0.050
	80-75	80-45	1.230	< 0.100	1.580	< 0.010	0.420	0.230	96.000	< 0.010
		80-75	1.540	< 0.100	1.050	< 0.010	0.320	0.290	95.000	0.190
DC-07	82-23	82-23	1.190	2.300	4.320	< 0.020	0.210	0.080	91.300	0.590
		82-56	1.130	1.800	4.390	< 0.010	0.210	0.090	92.000	0.270
	82-10	82-10A	1.010	< 0.100	4.140	0.020	0.200	< 0.010	94.300	< [illegible]
		82-10B	1.100	2.000	5.160	0.010	0.220	0.030	91.000	0.340
		82-33	1.100	3.200	5.180	< 0.010	0.220	0.030	89.700	0.540
DC-12	80-80	80-80	0.140	< 0.100	95.900	[illegible]	< [illegible]	< 0.010	3.420	< 0.010
	80-100	80-100	0.110	< 0.100	92.100	< 0.010	< 0.010	< 0.010	7.780	< 0.010
		80-40	0.130	< 0.100	94.100	< [illegible]	< 0.010	< 0.010	5.790	0.010
	80-97	80-97	0.120	1.800	92.700	0.060	< 0.010	< 0.010	5.200	0.110
	80-32	80-32	0.120	< 0.100	91.900	0.030	< 0.010	< 0.010	7.860	< 0.010
	80-124	80-124	0.140	< 0.100	91.500	0.040	< 0.010	< 0.010	3.300	< 0.0[illegible]

ANALYSIS METHOD= MASS SPECTROMETRY

FIGURE 13. Dissolved Gases Report.

Several dissolved gas analyses for borehole DB-15 (sample numbers 79-15, 79-17, 79-33, 79-35, and 79-39) were analyzed under conditions where compensation for water vapor present in the gas was not done. While these few analyses are of questionable value they are included for completeness.

4.3 Radioactive Isotopes (pages 271-313)

Figure 14 is an example of the printout for radioactive species. The report is an alphabetical listing of all analytical data for radioactive constituents currently in the data base and it covers three pages. The location, sample event code, and sample number are interpreted as described previously. Measurements below detection are noted by use of a "<". The analysis code key is given at the end of this report.

- Cl-36 - Cl-36 concentration in atoms/L. The vendor who supplied the BWIP with Cl-36/Cl analyses also determined total chloride (Cl) on the same sample. The value of Cl-36 provided by the vendor was based on these analyses. However, the Cl-36 values reported in this data package have been computed from the vendor-supplied Cl-36/Cl value and the appropriate BWIP chloride data reported in Major Inorganics Report 4 (see Section 4.5).
  The +/- uncertainty in the Cl-36 concentration is that reported by the vendor.

- Cl-36/Cl - The atomic ratio of Cl-36 to total Cl.
  The +/- uncertainty in Cl-36/Cl value is that reported by the vendor.

- C-14 PMC - The activity of carbon-14 relative to the total amount of carbon in the sample is normalized to the analogous ratio in a modern carbon standard (oxalic acid - corrected to 1950) and is reported as Percent Modern Carbon (PMC). The reported values of PMC for all BWIP samples (source code = 1) have not been corrected for fractionation by use of the measured $\delta^{13}C$ of the samples.

  Many of the carbon-14 analyses for BWIP samples reported in Early et al. (1985) were corrected for isotopic fractionation effects. As this correction is based upon assumptions that may not be valid for Hanford groundwaters, this practice has been discontinued. Carbon-14 results from non-BWIP sources (source code = 2 to 13) may have been corrected for isotopic fractionation. Generally, information relative to these corrections is not available in the referenced documents. However, the magnitude of this correction on PMC values is small.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE	(A)	CL36/CL ATOM RATIO	+/- RANGE	(A)	C14PMC %	+/- RANGE	(A)
BERK	85-255	85-255							7.300E+00	1.20000E+00	(1)
DB-01	81-19	81-19							2.700E+00	8.00000E-01	(1)
	81-65	81-65							3.100E+00	8.00000E-01	(1)
	82-27	82-27	8.500E+07	2.00000E+06	(1)	1.060E-13	2.00000E-15	(1)	6.300E+00	1.10000E+00	(1)
		82-87							2.500E+00	8.00000E-01	(1)
	85-32	85-32							1.700E+00	1.20000E+00	(1)
DB-02	81-13	81-13							1.100E+01	1.50000E+00	(1)
	81-10	81-10							2.200E+00	6.00000E-01	(1)
DB-07	83-413	83-413							4.300E+00	1.50000E+00	(1)
	85-216	85-216							3.000E+00	1.40000E+00	(1)
DB-09	83-472	83-472							2.210E+01	2.10000E+00	(1)
DB-11	85-4	85-4							2.600E+00	1.20000E+00	(1)
	85-15	85-15							1.800E+00	9.00000E-01	(1)
	85-13	85-18							2.400E+00	1.50000E+00	(1)
		85-19									
	86-52	86-52							3.400E+00	1.10000E+00	(1)
		86-53							4.800E+00	1.50000E+00	(1)
DB-12	81-25	81-25							8.200E+00	8.00000E-0[illegible]	(1)
DB-13	80-159	80-159							9.200E+00	1.20000E+00	(1)
	83-404	83-404							1.100E+01	1.60000E+00	(1)
DB-14	81-162	81-139							< 3.100E+00		(1)
		81-162							3.500E+00	1.00000E+00	(1)
DB-15	79-17	79-17									
		79-22									
	79-35	79-20									
		79-35									
	79-33	79-27									
		79-33									
	79-15	79-15									
		79-38									
	79-39	79-39							3.900E+00	1.10000E+00	(1)
		79-8									
	79-31	79-31									
		79-5									
	79-51	79-51									
	79-85	79-66									
		79-85									
	79-80	79-80							5.700E+00	1.60000E+00	(1)
	79-62	79-62							4.000E+00	1.70000E+00	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

FIGURE 34. Radioactive Isotopes Report.

SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
BERK	85-255	85-255	5.000E-02	6.00000E-02	(1)						
DB-01	81-19	81-19	1.470E+00	1.00000E-01	(1)						
	81-65	81-65	2.680E+00	9.00000E-02	(1)						
	82-27	82-27	5.400E-01	6.00000E-02	(1)	7.000E-03		(1)			
		82-87									
	85-32	85-32	2.000E-02	8.00000E-02	(1)						
DB-02	81-13	81-13	7.810E+00	2.70000E-01	(1)						
	81-10	81-10	2.900E-01	5.00000E-02	(1)	4.200E-02		(1)			
DB-07	83-413	83-413	5.000E-02	8.00000E-02	(1)						
	85-216	85-216	8.000E-02	1.00000E-01	(1)						
DB-09	83-472	83-472	6.800E-01	1.10000E-01	(1)						
DB-11	85-4	85-4	1.600E-01	9.00000E-02	(1)						
	85-15	85-15	1.300E-01	9.00000E-02	(1)						
	85-18	85-18									
		85-19	8.000E-02	1.00000E-01	(1)						
	86-52	86-52	3.000E-02	8.00000E-02	(1)						
		86-53									
DB-12	81-25	81-25	1.130E+00	7.00000E-02	(1)	4.000E-03		(1)			
DB-13	80-159	80-159									
	83-404	83-404	6.000E-02	7.00000E-02	(1)						
DB-14	81-162	81-139									
		81-162	2.590E+00	1.30000E-01	(1)						
DB-15	79-17	79-17	1.080E+01	2.00000E-01	(1)	4.600E+00	4.00000E-01	(1)	4.400E+00	4.00000E-01	(1)
		79-22	1.060E+01	2.00000E-01	(1)						
	79-35	79-20	2.600E-01	4.00000E-02	(1)						
		79-35	9.000E-01	7.00000E-02	(1)	1.900E-02	2.00000E-03	(1)	2.700E-02	2.00000E-03	(1)
	79-33	79-27				3.300E-02	3.80000E-02	(1)	2.700E-02	2.40000E-02	(1)
		79-33	1.100E-01	4.00000E-02	(1)	4.200E-02	7.00000E-03	(1)	4.400E-02	7.00000E-03	(1)
	79-15	79-15	1.200E-01	5.00000E-02	(1)	6.900E-02	3.20000E-02	(1)	7.800E-02	2.30000E-02	(1)
		79-38	1.100E-01	6.00000E-02	(1)						
	79-39	79-39	1.000E-01	5.00000E-02	(1)	4.700E-01	3.00000E-02	(1)	5.300E-01	3.00000E-02	(1)
		79-8				5.500E-01	6.00000E-02	(1)	5.700E-01	5.00000E-02	(1)
	79-31	79-31				2.000E-01	1.00000E-02	(1)	2.000E-01	1.00000E-02	(1)
		79-5	2.300E-01	5.00000E-02	(1)						
	79-51	79-51	2.500E-01	5.00000E-02	(1)	1.800E-01	1.00000E-02	(1)	1.800E-01	1.00000E-02	(1)
	79-85	79-66	1.200E-01	6.00000E-02	(1)						
		79-85	1.900E-01	5.00000E-02	(1)	6.900E-01	3.00000E-02	(1)	5.500E-01	3.00000E-02	(1)
	79-80	79-80	1.500E-01	6.00000E-02	(1)	3.600E-01	2.00000E-02	(1)	2.700E-02	1.00000E-02	(1)
	79-62	79-62									

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

FIGURE 14. Continued

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE	(A)	U234/U238 ATOM RATIO	+/- RANGE	(A)	U235/U238 ATOM RATIO	+/- RANGE	(A)
HERK	85-255	85-255									
DB-01	81-19	81-19									
	81-65	81-65									
	82-27	82-27				1.03[illegible]E-04		(1)	7.300E-03		(1)
		82-87									
	85-32	85-32									
DB-02	81-13	81-13									
	81-10	81-10				[illegible]E-04	7.00000E-06	(1)	7.2[illegible]E-03	7.00000E-05	(1)
DB-07	83-413	83-413									
	85-216	85-216									
DB-09	83-472	83-472									
DB-11	85-4	85-4									
	85-15	85-15									
	85-18	85-18									
		85-19									
	86-52	86-52									
		86-53									
DB-12	81-25	81-25				8.800E-05	7.00000E-06	(1)	7.100E-03	2.00000E-04	(1)
DB-13	80-159	80-159									
	83-404	83-404									
DB-14	81-162	81-139									
		81-162									
DB-15	79-17	79-17	3.3[illegible]E+00	2.70000E-01	(1)	7.0[illegible]E-05	8.00000E-06	(1)			
		79-22									
	79-35	79-20									
		79-35	[illegible]E-02	1.00000E-03	(1)	1.0[illegible]	[illegible]E-05	(1)			
	79-33	79-27	2.40[illegible]E-02	2.70000E-02	(1)	6.00[illegible]E-05	6.70000E-05	(1)			
		79-33	[illegible].100E-02	5.00000E-03	(1)	7.800E-05	1.70000E-05	(1)			
	79-15	79-15	5.100E-02	2.30000E-02	(1)	8.3[illegible]E-05	4.50000E-05	(1)			
		79-38									
	79-39	79-39	3.5[illegible]E-01	2.00000E-02	(1)	8.30[illegible]E-05	6.00000E-05	(1)			
		79-8	4.000E-01	4.00000E-02	(1)	7.70[illegible]E-05	1.0[illegible]E-05	(1)			
	79-31	79-31	1.400E-01	1.00000E-02	(1)	7.50[illegible]	8.00[illegible]E-05	(1)			
		79-5									
	79-51	79-51	[illegible].400E-01	1.00000E-02	(1)	7.[illegible]E-05	5.[illegible]E-05	(1)			
	79-85	79-66									
		79-85	[illegible]E-01	3.00000E-02	(1)	5.[illegible]E-05	3.0[illegible]E-05	(1)			
	79-80	79-80	2.700E-01	1.00000E-02	(1)	5.500E-05	4.00000E-05	(1)			
	79-62	79-62									

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

FIGURE 14. Continued

Early et al. (1985) reported values for the carbon-14 "age" of groundwaters based upon measurements of PMC. Because of the ambiguity associated with such age estimates they have been eliminated from this update of the data base.

Where reported, the +/- range is the uncertainty (in percent) for PMC given by the vendor.

- o H-3 - Tritium concentration reported in tritium units where:

  1 Tu = 3.23 pCi/L

  Where reported, the +/- range is the uncertainty (in tritium units) of the tritium concentration as reported by the vendor.

- o Total Uranium - Uranium concentration in ug/L. Where reported, the +/- range is the uncertainty in the total uranium concentration reported by the vendor.

- o Uranium 234 - U-234 concentration in DPM/L. Where reported, the +/- range is the uncertainty in the U-234 concentration reported by the vendor.

- o Uranium 238 - U-238 concentration in DPM/L. Where reported, the +/- range is the uncertainty in the U-238 concentration reported by the vendor.

- o Uranium 234/238 - The atomic ratio of U-234 to that of U-238 (no units). Where reported, the +/- range is the uncertainty in the U-234/U-238 ratio reported by the vendor.

- o Uranium 235/238 - The atomic ratio of U-235 to that of U-238 (no units). Where reported, the +/- range is the uncertainty in the U-235/U-238 ratio reported by the vendor.

4.9 <u>Stable Isotopes</u> (pages 315-323)

Figure 15 presents a portion of the stable isotope report. The analysis method is listed at the bottom of each page.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
BERK	85-255	85-255			-11.200	-1[illegible]8.000	-17.600	
DB-01	81-19	81-19			3.400	-147.000	-17.500	
	81-65	81-65			-18.300	-138.000	-17.300	20.500
	82-27	82-27			-18.400	-141.000	-17.400	17.000
		82-87			-18.200			21.500
	85-32	85-32			-18.100	-1[illegible]2.000	-17.400	16.000
DB-02	79-65	79-65				-1[illegible].000	-17.000	
	81-13	81-13			-16.100	-1[illegible].000	-15.800	2.[illegible]
	81-10	81-10			-15.400	-140.000	-17.000	8.000
DB-04	79-77	79-77				-155.000	-17.000	
DB-07	79-89	79-89				-1[illegible]5.000	-13.400	
	83-413	83-413			6.600	[illegible].000	-15.700	
	85-216	85-216			7.100	[illegible].000	-17.300	
DB-09	79-28	79-28				-152.000	-17.500	
	83-472	83-472			-12.400	-145.000	-17.700	
DB-11	85-4	85-4			-10.000	-152.000	-18.500	8.400
	85-15	85-15			-9.900	-150.000	-1[illegible].500	7.400
	85-18	85-18			-9.400	-154.000		15.800
	86-52	86-52			-10.000	-1[illegible]9.000	-18.800	
		86-53			-10.200			
DS-12	81-25	81-25			-13.600	-1[illegible]3.000	-18.800	
DB-13	80-159	80-159			-13.400			
	83-404	83-404			-13.100	[illegible].000	[illegible] 500	
DB-14	81-162	81-139			11.300			
		81-162			11.400	-134.000	-[illegible].400	11.000
DB-15	79-17	79-17			-13.100	-1[illegible]2.000	-1[illegible].200	-10.300
		79-22				-145.000	-17.100	
		79-4				-15[illegible].000	-17.100	
	79-35	79-20				-1[illegible]9.000	-17.600	
		79-35			-23.800	-150.000	-17.900	
	79-33	79-27				-152.000	-17.800	
		79-33			-15.500	-155.000	-17.900	
	79-15	79-15			-8.400	-1[illegible].000	[illegible]7.200	23.700
		79-38					-17.500	
	79-39	79-39			-6.500	-153.000	-17.300	
		79-8			-6.500	-147.000	-17.100	0.6[illegible]
	79-31	79-31			-3.900	-151.000	-17.200	3.500
	79-25	79-25				149.000	-17.500	

ANALYSIS METHOD: MASS SPECTROMETRY

FIGURE 15. Stable Isotopes Report.

- C-13 (CH_4) - The $\delta^{13}C$ (in units of permil) for methane in gas separated from the sample. Delta-^{13}C values are referenced to the Pee Dee Belemnite (PDB).[4]

- D(CH_4) - The δD (in units of permil) for methane gas separated from the sample. Delta-D values are referenced to standard mean ocean water (SMOW).

- C-13 - The $\delta^{13}C$ for inorganic carbon in aqueous samples (concentrated by precipitation of $BaCO_3$ from a basified aliquot). It is reported in units of permil and referenced to PDB. The analytical uncertainty for $\delta^{13}C$ for inorganic carbon is +/- 0.5 per mil.

- D - The δD for water samples. It is reported in units of permil and referenced to SMOW. The analytical uncertainty for δD for water is +/- 2.0 per mil.

- O-18 - The $\delta^{18}O$ for water samples. It is reported in units of permil and referenced to SMOW. The analytical uncertainty for $\delta^{18}O$ for water is +/- 0.2 per mil.

- S-34 - The $\delta^{34}S$ for sulfate-sulfur in aqueous samples (concentrated by precipitation of $BaSO_4$). It is reported in units of permil and referenced to the Canyon Diablo troilite. The analytical uncertainty for $\delta^{34}S$ for sulfate sulfur is +/- 0.5 per mil.

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4 - The delta terminology is defined as follows:

$$\delta(‰) = [(R_{sample} - R_{std})/R_{std}] \times 1000 \text{ permil}$$

where:

R = D/H

= $^{13}C/^{12}C$

= $^{18}O/^{16}O$

= $^{34}S/^{32}S$

5.0 EVALUATION OF DATA QUALITY

There are three techniques used by the BWIP for assessing the quality of hydrochemical data reported in the Site Hydrochemical Data Base. These are:

- Verification of data transferred into the data base.
- Evaluation of the chemical analyses.
- Evaluation of sample representativeness.

For the purpose of this document the term "verification" refers to all of those techniques by which the accurate recording and transfer (electronically or by hand) of data is confirmed. "Validation" refers to those techniques by which the ability to represent the chemical composition of water from a specific site or stratigraphic zone by a collected sample can be assessed.

5.1 Data Traceability and Verification

All data presented in the Site Hydrochemical Data Base have been evaluated with respect to traceability to original sources. Furthermore, the accuracy of data transfer (verification) has been addressed. A discussion of these topics follows.

5.1.1 Traceability. All data collected by the BWIP solution chemistry laboratory (or its predecessor - Research and Engineering laboratory of Rockwell) and subcontractors to the BWIP are traceable through sample numbers to the appropriate controlled notebooks, numbered internal letters and data sheets (provided by the vendors). Data conforming to these criteria are denoted by a source code of 1 (see Section 4.1) and are considered to be fully traceable. All other hydrochemical data come from sources external to the BWIP and are traceable only to the reports or documents from which they were extracted (source code = 2 to 18). The BWIP does not assume responsibility for any further level of traceability for these samples.

Early et al. (1985) reported chemical analyses for groundwaters collected from Hanford boreholes for the CASP program between 1976 and 1980 (see Section 3.0). These samples were analyzed by several Hanford laboratories for major constituents and by off-site vendors for tritium, carbon-14, and stable isotopes. Significant questions as to the traceability and quality of the major constituent analyses currently exist and the BWIP has adopted the position that, at present, it is most prudent to remove the entire analysis for all of these samples from the Site Hydrochemistry Data Base. Consequently, this revision of the data package contains none of these data. Before the next update of this document the BWIP will thoroughly examine available hydrochemical data for these samples to see if traceability and analytical quality can be confirmed. Analyses will be reinstated to the data base on a case-by-case basis. It is anticipated that most of these analyses will be permanently removed.

The confirmation of traceability for sample analyses presented in the hydrochemical data base is an ongoing process. Future updates of this data package will continue to address this concern.

5.1.2 Verification. All data reported in the Site Hydrochemical Data Base have been entered and verified by two clerks. In addition, data from the BWIP solution chemistry laboratory have been checked for correctness by laboratory personnel. Furthermore, special verification checks have been made by a clerk on an ad hoc basis.

Information relative to the sampling event has been supplied by personnel of the Drilling and Testing Group of the Site Department and verified by a clerk. The sampling method information currently is under review and likely contains some errors (i.e., wrong method reported for a sampling event). Furthermore, attempts are being made to provide missing packer depths, and sample dates where possible. These changes will be incorporated in updates to this data package.

Since the Site Hydrochemistry Data Base was first published (Early et al. 1985) significant progress in verification and data security has been accomplished. For example, substantial upgrading of reported results for carbon-14, uranium isotopes, and $\delta^{13}C$ (CH_4) has occurred as a result of careful reevaluation of data reported by vendor laboratories. In addition, the verification process for sample analyses now calls for a sequence of checks to insure accuracy and includes a provision for "locking" the data entry/update capabilities of the data base such that the ability to make changes are restricted to authorized individuals.

5.2 Evaluation of the Chemical Analyses

There are a variety of test strategies that can be applied to the hydrochemical analyses to check them for internal consistency. These include the following:

- Examination of the charge balance for each sample
- Examination of total cations vs. specific conductance
- Examination of total anions vs. specific conductance
- Comparison of duplicate analyses
- Analysis of lab control samples
- Participation in interlaboratory analysis programs

5.2.1 Charge Balance: The charge balance, as defined in section 4.5 is a measure of how closely the analyzed water sample achieves electrical neutrality. Because it must be neutral, any deviation is a reflection of uncertainties in major ionic species of the analyses and, possibly, may indicate that one or more species of importance either is in error or was not determined. Canceling errors and large analytical errors for trace elements will not be detected by this type of evaluation.

Figure 16 is a presentation of charge balance results, in histogram form for all samples from the data base with appropriate analytical information. Of the approximately 700 analyses presented in Figure 18 nearly 60 percent are within +/- 2 percent of a perfect charge balance and approximately 85 percent are within +/- 5 percent of neutrality. Many sources of information on the analytical aspects of water quality address the question of charge balance and suggest appropriate limits of acceptability for analyses (Skougstad et al., Freeze and Cherry, 1979; APHA, 1978; ASTM, 1980; Anderson, 1975; Hem, 1970). Most of these discussions recognize the need for a sliding scale with more restrictive criteria for samples with large concentrations of dissolved ionic species. However, the specific criteria chosen differ among the sources.

The BWIP tentatively has adopted a maximum allowable deviation of +/- 5 percent as a criterion to screen all analyses. This standard is consistent with that cited in Freeze and Cherry (1979) and acknowledges the way in which the BWIP uses charge balance as only one of many indicators of sample quality. Table 1 identifies those samples which exceed this criterion. In addition, Table 1 reports the results of other data quality evaluations as discussed below.

5.2.2 Total Cations and Total Anions vs. Specific Conductance: While the observed charge balance deviation for a sample may be small, a chemical analysis may be seriously in error due to contamination occurring in the field and laboratory. In addition, for those samples with poor charge balances it may not be obvious what component(s) is in error. In both cases, an analysis of total cations and total anions relative to specific conductance may be helpful discriminators.

APHA (1978) recognizes that a close functional relationship exists between specific conductance and total dissolved solids. Summers et al. (1978) applied this technique for evaluating groundwaters from the Pasco Basin. By separating the total dissolved solids into total cations and total anions, examining the covariance of each with respect to specific conductance, and comparing these results to those samples with poor charge balance identified above, it should be possible to identify if the poor balance results from an error in the anion or cation analyses. Alternatively, badly contaminated samples with an acceptable charge balance may standout from the overall population of water samples and be identified as anomolous. Finally, poor determinations of specific conductance may be recognized by this type of evaluation.

Figure 17 presents graphs of specific conductance vs. total cations and total anions for all waters from the Hanford Site with appropriate analytical data. The central line results from linear regression of data with a charge balance within +/- 5 percent of neutrality and a specific conductance less than 2000 microsiemens/cm (to avoid inclusion of outliers) and the two boundary lines represent a 95 percent confidence limit uncertainty band.

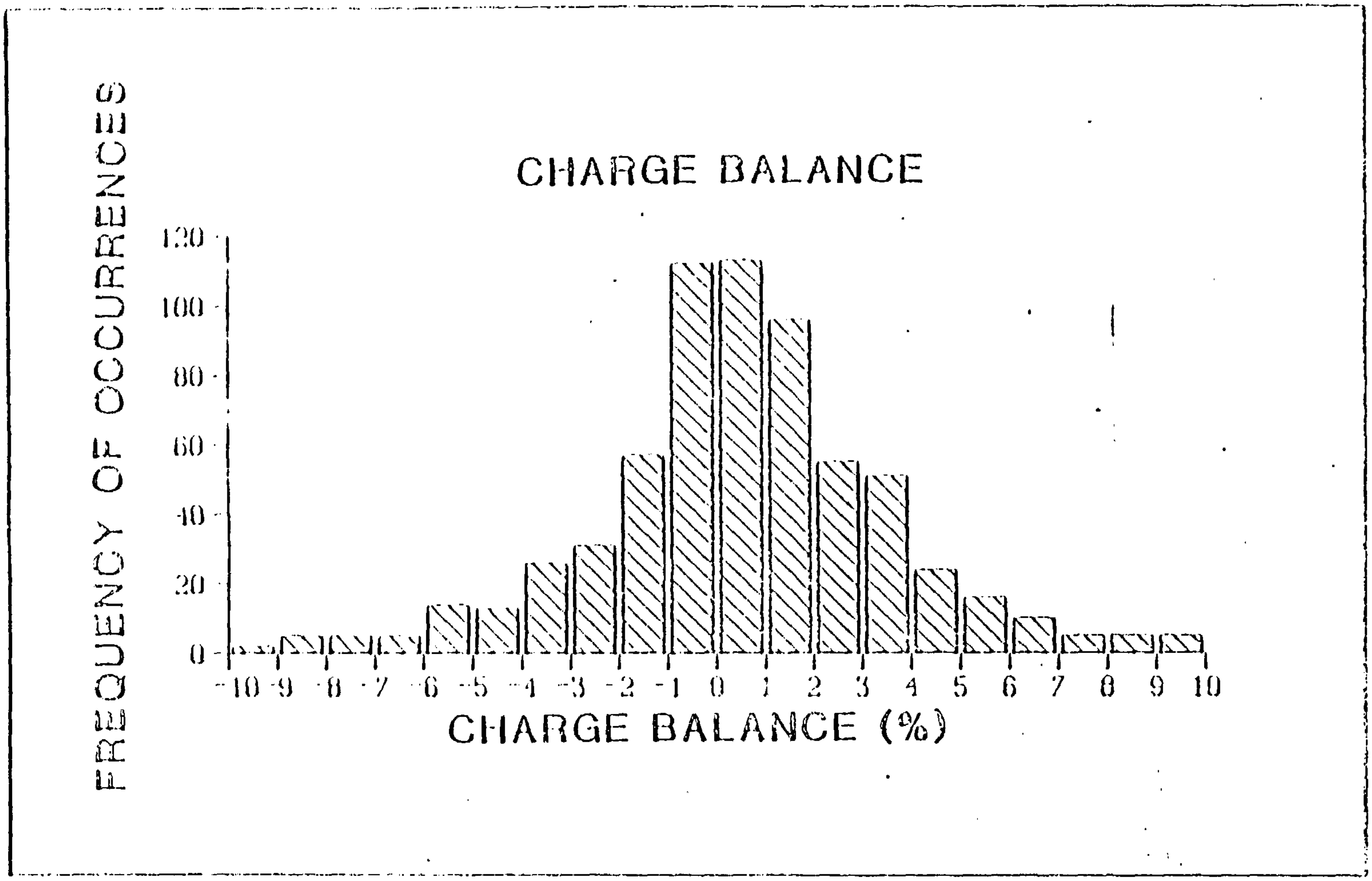

FIGURE 16. Histogram of Charge Balance Data for Hydrochemical Samples from Springs, Surface Waters, and Groundwaters on the Hanford Site. Twenty-Six Analyses Lie Outside the Limits of the Figure.

TABLE 1. Summary Listing of Potentially Anomalous Analyses for Hydrochemical Samples

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	NA	K	CA	MG	CL	F	SO4	NA	K	CA	MG	SI	CL	F	SO4	FA	T	TOC	[illegible]
			|--DUPLICATE COMPARISONS--|											|---SAME ZONE/SITE COMPARISONS----|											
DB-02	81-13	81-13																					X		
DB-09	79-28	CP115																			X				
DB-14	81-162	81-139						X																	
		81-162						X																	
DB-15	79-15	79-15									X														
		79-46									X														
	79-62	79-62						X																	
		79-84						X																	
	79-90	79-90						X																	
		79-95						X																	
	80-35	80-35									X														
		80-41	X								X														
	79-51	79-51									X	X	X												
		79-61									X	X	X												
	79-85	79-74	X										X												
		79-85	X										X												X
	79-80	79-80	X					X																	
		79-99	X					X																	
	79-17	79-17	X				X	X					X										X		
		79-22																					X		
		79-4	X				X	X					X												
DC-01	SITE-238	SITE-238																					X		
	SITE-242	SITE-242																					X		
	SITE-236	SITE-236				X																			
	SITE-237	SITE-237																					X		
	SITE-230	SITE-230																					X		
	SITE-231	SITE-231																					X		
	SITE-235	SITE-235																					X		
DC-02-A2	SITE-213	SITE-213																					X		
	80-4	80-25	X				X	X	X	X		X													
		80-4	X				X	X	X	X		X													
DC-03	80-27	80-27	X						X		X	X	X												
		80-81							X		X	X	X												
DC-05	79-30	79-30	X		X							X													
		79-32	X		X							X													
DC-06	80-13	80-13	X																						
		80-58	X																						
	80-191	80-186				X																			
		80-191				X																			
	80-29	80-29										X													
		80-37										X													
	79-58	79-57				X																			

CB= CHARGE BALANCE C= CATIONS A= ANIONS SC= SPECIFIC CONDUCTIVITY FA= FIELD ALKALINITY T= TRITIUM TOC= TOTAL ORGANIC CARBON

TABLE 1 (continued)

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	I--DUPLICATE COMPARISONS--I							I---SAME ZONE/SITE COMPARISONS----I									T	TOC	..2
							NA	K	CA	MG	CL	F	SO4	NA	K	CA	MG	SI	CL	F	SO4	FA			
DC-06	79-58	79-58				X																			
	80-118	80-118				X					X	X													
		80-133				X					X	X													
	79-59	79-59					X																		
		79-97					X																		
	SITE-214	SITE-214	X	X													X								
	80-2?8	80-201	X	X													X								
	80-15	80-15	X		X						X	X													
		80-70	X		X						X	X							X	X					
DC-07	80-103	80-103						X	X		X	X											X		
		80-163	X					X	X		X	X													
	80-183	80-178						X								X						X			
		80-188						X								X						X			
	80-196	80-177				X			X		X	X	X			X						X			
		80-196				X			X		X	X	X			X						X			
	80-11	80-11																	X	X	X				
		80-19																	X	X	X				
	80-39	80-39										X	X						X	X	X				
		80-98										X	X						X	X	X				
	82-10	82-10																					X	X	
	82-23	82-23																					X	X	
DC-12	80-209	80-209									X	X													
		80-242									X	X													
	80-233	80-233						X																	
		80-243						X																	
	80-32	80-68	X	X																					
	80-82	80-23										X													
		80-82										X													
	80-234	80-208											X												
		80-234											X										X		
	80-100	80-100						X																	
		80-83						X																	
	80-174	80-143									X	X													
		80-174									X	X						X							
DC-14	80-69	80-69									X		X												
		80-83									X		X												
	80-99	80-55									X														
		80-99									X														
	80-89	80-36						X			X		X												
		80-89						X			X		X												
	81-20	81-20	X																						
		81-22	X																						
	80-3	80-3							X																
		80-34							X																
	80-155	80-155						X																	
		80-185						X																	
	80-104	80-104					X	X																	

CB= CHARGE BALANCE C= CATIONS A= ANIONS SC= SPECIFIC CONDUCTIVITY FA= FIELD ALKALINITY T= TRITIUM TOC= TOTAL ORGANIC CARBON

TABLE I (continued)

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	I--DUPLICATE COMPARISONS--I NA	K	CA	MG	CL	F	SO4	I---SAME ZONE/SITE COMPARISONS----I NA	K	CA	MG	SI	CL	F	SO4	FA	T	TOC	[illegible]
DC-14	80-104	80-125					X	X																	
	80-129	80-115											X												
		80-129											X												
	80-117	80-117	X																						
		80-151	X																						
	83-150	83-150																							X
	83-261	83-261																							X
	80-213	80-213	X																						
		80-236	X																						
	81-30	81-18																					X		
	80-189	80-127						X																	
		80-189						X																	
	80-47	80-47						X	X																
		80-65						X	X																
	80-157	80-157									X														
		80-183									X														
DC-15	80-57	80-57					X	X			X														
		80-65					X	X			X														
	80-135	80-135				X		X																	
		80-149						X																	
	80-120	80-139																					X		
	80-131	80-108					X																		
		80-131					X																		
	80-193	80-114						X																	
		80-193	X					X																	
	81-33	81-22	X				X	X																	
		81-33					X	X																	
		81-37																					X		
	81-69	81-54				X																			
	81-96	81-88									X														
		81-95									X														
	82-94	82-94																						X	
	81-41	81-24	X	X																					
		81-41				X																			
	81-2	81-2	X																						
		81-36	X																						
	80-176	80-130									X	X													
		80-176									X	X													
		80-199									X	X													
	81-64	81-64				X																		X	
		81-80				X																			
DC-15A	82-124	82-135																							X
		82-139																							X
	82-202	82-202				X																		X	
		82-228				X																			
	82-231	82-214A																							
		82-279A																							
		82-279B																							

CB= CHARGE BALANCE C= CATIONS A= ANIONS SC= SPECIFIC CONDUCTIVITY FA= FIELD ALKALINITY T= TRITIUM TOC= TOTAL ORGANIC CARBON

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TABLE 1 (continued)

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	I--DUPLICATE COMPARISONS--I							I---SAME ZONE/SITE COMPARISONS----I											
							NA	K	CA	MG	CL	F	SO4	NA	K	CA	MG	SI	CL	F	SO4	FA	T	TOC	O2
DC 16A	82-332	82-332	X																						
	82-188	82-140																							X
		82-188A																							X
	82-19	82-198																							X
	81-109	81-109					X		X															X	
		81-167					X		X																
	83-29	83-20																							X
		83-29																						X	
	82-430	82-430																						X	
DC-19C	84-53	84-53																							X
DC-23GR	86-141	86-141											X												
		86-142											X												
ENYEART	84-166	84-166																							X
FORD	SITE-219	SITE-219	X														X								
	85-303	85-303						X	X																
		85-304						X	X																
MCGEE	83-513	83-513																					X		
	SITE-225	SITE-225												X		X		X							
	80-64	80-64						X																	
		80-88						X																	
	81-54	81-54								X															
		81-56								X															
KRL-02	82-401	82-401																						X	
		82-414																							X
	82-170	82-170																					X	X	
	82-65	82-65										X													
		82-75										X													
	82-309	82-309																						X	
SP-BENNETT	SITE-218	SITE-218																	X		X				
	79-13	79-13	X																						
SP-BENSON	SITE-217	SITE-217	X																						
SP-BUTLER	79-1	79-1									X														
		79-50									X														
SP-JUNIPER	SITE-215	SITE-215	X														X				X				
	79-2	79-2								X															
		79-43								X															
	81-115	81-115																			X				
		81-161	X																		X				
	83-372	83-305							X																
		83-372							X																

CB- CHARGE BALANCE C- CATIONS A- ANIONS SC- SPECIFIC CONDUCTIVITY FA- FIELD ALKALINITY T- TRITIUM TOC- TOTAL ORGANIC CARBON

TABLE 1 (continued)

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	I--DUPLICATE COMPARISONS--I NA	K	CA	MG	CL	F	SO4	I---SAME ZONE/SITE COMPARISONS----I NA	K	CA	MG	SI	CL	F	SO4	FA	T	TOC	O2
SP-LO-SNIVELY	79-34	79-19	X				X		X	X	X										X				
		79-34					X		X	X	X			X							X				
SP-LOZIER	79-6	79-44											X								X				
		79-6											X								X				
	83-316	83-316																			X				
		83-343																			X				
SP-MAIDEN	79-100	79-67											X												
		79-96											X												
SP-OBSERVATORY	81-119	81-119					X																		
		81-157					X																		
	84-392	84-310					X																		
		84-392					X																		
SP-RAILROAD	79-76	79-76	X		X		X		X																
		79-81					X		X																
SP-RATTLESNAKE	SITE-216	SITE-216	X											X		X	X					X			
	79-88	79-87							X				X												
		79-88							X				X												
SP-SNIVELY	79-49	79-37											X												
		79-49											X												
SP-SULFUR	79-29	79-29	X																		X				
		79-38	X																		X				
	83-409	83-409																			X				
		83-442																			X				
SP-UNNAMED-02	79-75	79-75	X																						
SP-UNNAMED-16	79-73	79-73											X												
		79-82											X												
SP-UNNAMED-26	79-98	79-54						X																	
		79-98						X																	
SP-UNNAMED-29	79-16	79-16									X		X												
		79-24									X		X												
SP-YRS-08	85-336	85-336															X		X		X				
		85-337															X		X		X				
	86-147	86-147															X		X		X				
		86-148															X		X		X				
STEM-1	85-297	85-297						X	X																
		85-298						X	X																

CB= CHARGE BALANCE C= CATIONS A= ANIONS SC= SPECIFIC CONDUCTIVITY FA= FIELD ALKALINITY T= TRITIUM TOC= TOTAL ORGANIC CARBON

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TABLE 1 (continued)

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	I--DUPLICATE COMPARISONS--I NA	K	CA	MG	CL	F	SO4	I---SAME ZONE/SITE COMPARISONS----I NA	K	CA	MG	SI	CL	F	SO4	FA	T	TOC	O2
199-D08-03	SITE-72	SITE-72	X																						
199-H04-03	SITE-81	SITE-81				X																			
199-K-19	SITE-83	SITE-83	X																						
199-N-15	SITE-42	SITE-42	X																						
299-E16-01	SITE-161	SITE-161	X													X						X	X		
299-E26-08	SITE-167	SITE-167				X															X				
	SITE-168	SITE-168	X																						
	SITE-165	SITE-165	X		X																				
299-E33-12	SITE-170	SITE-170	X		X																		X		
	SITE-171	SITE-171	X		X																		X		
	SITE-172	SITE-172	X		X																	X	X		
	SITE-169	SITE-169	X		X																				
699-S06-E04D	SITE-11	SITE-11	X																X						
699-S11-E12A	80-61	80-61																	X						
699-14-38	SITE-86	SITE-86	X																						
699-17-05	SITE-151	SITE-151																X							
	SITE-18	SITE-18																X							
699-19-88	85-278	85-278											X												
		85-279											X												
699-27-08	SITE-50	SITE-50	X																						
	SITE-76	SITE-76	X																						
	SITE-87	SITE-87	X																						
699-31-31	SITE-69	SITE-69	X																						
699-32-22	SITE-51	SITE-51																	X						
	SITE-65	SITE-65	X																						
	SITE-89	SITE-89	X																						
699-32-70B	SITE-70	SITE-70	X																						
699-33-42	SITE-12	SITE-12	X		X														X		X				
	SITE-67	SITE-67	X																						
	SITE-91	SITE-91																	X						
699-35-09	SITE-104	SITE-104												X											
699-35-66	SITE-77	SITE-77	X																						

CB= CHARGE BALANCE C- CATIONS A- ANIONS SC- SPECIFIC CONDUCTIVITY FA= FIELD ALKALINITY T= TRITIUM TOC= TOTAL ORGANIC CARBON

TABLE 1 (continued)

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	DUPLICATE COMPARISONS NA	K	CA	MG	CL	F	SO4	SAME ZONE/SITE COMPARISONS NA	K	CA	MG	SI	CL	F	SO4	FA	T	TOC	O2
699-37-43	SITE-173	SITE-173				X										X	X	X	X		X				
	SITE-34	SITE-34														X	X	X	X		X				
699-37-82A	SITE-105	SITE-105	X																						
699-40-01	SITE-10	SITE-10																	X						
	SITE-106	SITE-106												X											
699-42-40C	SITE-176	SITE-176	X		X																		X		
	SITE-177	SITE-177	X																		X		X		
	SITE-178	SITE-178	X																				X		
	SITE-180	SITE-180														X									
699-45-42	SITE-57	SITE-57	X																						
699-46-05	SITE-156	SITE-156	X														X								
	SITE-256	SITE-256															X								
699-46-21A	SITE-75	SITE-75	X																						
699-47-50	SITE-181	SITE-181																					X		
	SITE-205	SITE-205																					X		
699-48-71	SITE-59	SITE-59	X																						
699-49-55	SITE-126	SITE-126															X	X				X			
	SITE-157	SITE-157																X			X				
	SITE-39	SITE-39															X								
	SITE-58	SITE-58															X								
	SITE-78	SITE-78																				X			
	SITE-9	SITE-9													X		X								
699-49-55A	SITE-182	SITE-182				X																			
699-49-55B	SITE-183	SITE-183																	X						
	SITE-184	SITE-184	X																						
	SITE-185	SITE-185	X																						
699-50-42	SITE-115	SITE-115														X	X	X				X			
	SITE-14	SITE-14															X	X				X			
	SITE-271	SITE-271																	X						
699-50-45	SITE-186	SITE-186	X	X												X									
	SITE-203	SITE-203														X									
699-50-48	SITE-187	SITE-187	X	X																	X				
	SITE-204	SITE-204																			X		X		
699-51-46	SITE-188	SITE-188	X																						

CB= CHARGE BALANCE C= CATIONS A= ANIONS SC= SPECIFIC CONDUCTIVITY FA= FIELD ALKALINITY T= TRITIUM TOC= TOTAL ORGANIC CARBON

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TABLE 1 (continued)

LOCATION	SAMPLE EVENT NUMBER	SAMPLE NUMBER	CB	C	A	SC	I--DUPLICATE COMPARISONS--I							I---SAME ZONE/SITE COMPARISONS----I										T	TOC	O2
							NA	K	CA	MG	CL	F	SO4	NA	K	CA	MG	SI	CL	F	SO4	FA			
699-52-46A	SITE-189	SITE-189	X																						
699-52-48	SITE-190	SITE-190	X	X												X									
	SITE-199	SITE-198														X									
699-54-57	SITE-192	SITE-192	X																						
699-55-50C	SITE-128	SITE-128	X																			X			
	SITE-193	SITE-193	X													X		X							
699-55-76	SITE-117	SITE-117																				X			
	SITE-129	SITE-129																			X				
	SITE-71	SITE-71												X											
699-56-53	SITE-196	SITE-196	X																						
	SITE-197	SITE-197	X																						
699-59-58	SITE-107	SITE-107	X																						
699-63-90	SITE-133	SITE-133	X																	X					
	SITE-74	SITE-74																		X					
699-72-73	SITE-109	SITE-109	X																						

CB- CHARGE BALANCE C- CATIONS A- ANIONS SC- SPECIFIC CONDUCTIVITY FA= FIELD ALKALINITY T= TRITIUM TOC= TOTAL ORGANIC CARBON

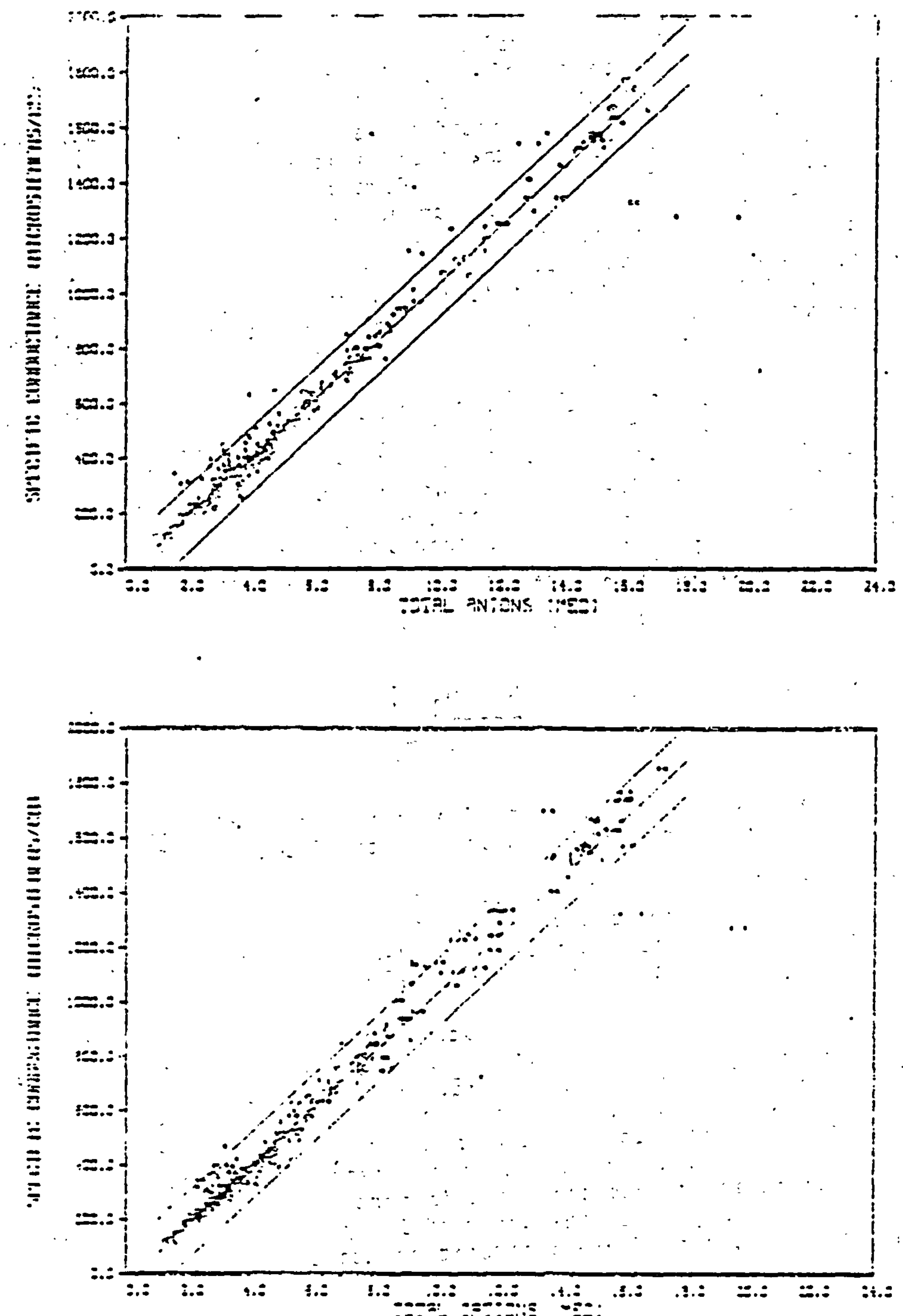

FIGURE 17. Total Cations and Total Anions vs. Specific Conductance for Hydrochemical Samples from Springs, Surface Waters, and Groundwaters on the Hanford Site. Samples 80-135 and Site-81 Lie Outside the Limits of the Figures.

Table 1 identifies those samples that lie significantly off the trends (i.e., outside of the 95 percent confidence limit uncertainty band). When coupled with charge balance information it becomes clear that for some samples the source of a poor charge balance can be identified as resulting from either inaccurate cation or anion analyses while the others are suggestive of contamination, erroneous conductivity measurement, or both. Furthermore, when the analyses are viewed within the context of their nearest neighbors in a borehole (see section 5.3.2) it may be possible to identify the specific cation or anion that is anomalous. Early et al. (1985) attempted to make this type of evaluation. However, in Table 1 of this document such specific information has been excluded pending implementation of procedures for objectively evaluating the anomalies. Future updates to this data package will address this question further.

5.2.3 Comparison of Duplicate Analyses: Nearly all analyses for a specific sampling event performed by the BWIP solution chemistry laboratory since 1980 have been done as duplicates. Figure 18 presents histogram comparisons of these duplicates for the major cations and anions. Only ICP-AES data for cations and ion chromatography data for anions are used for these comparisons. Where triplicate analyses exist, the comparison is based on the maximum and minimum concentration values reported for the sampling event.

The deviations are computed as follows:

$$\text{Deviation (percent)} = \left[\frac{M_1 - M_2}{(M_1+M_2)/2}\right] \times 100\%$$

where: M_1 = concentration of M in the 1st duplicate
M_2 = concentration of M in the 2nd duplicate

This equation is a slight modification of that used in Early et al. (1985) but is preferred because the absolute value of the calculated deviation does not depend upon which analysis is taken as M_1 or M_2. It is the absolute value of the deviations that are presented in Figure 18.

The analytical uncertainties of instruments used in an analysis are closely related to the observed deviations for duplicates. West et al. (1983) report that for cations (analyzed by ICP-AES) a relative precision of 1-3 percent is observed. For anions (analyzed by ion chromatography) the relative precision is less than 1 percent. In general, these results are based upon repetitive analysis of samples under optimum instrument and laboratory conditions. An estimate of relative precision that is more applicable to routine analytical conditions probably is on the order of 3-5 percent. For the purpose of this document a criterion of +/- 5 percent is adopted.

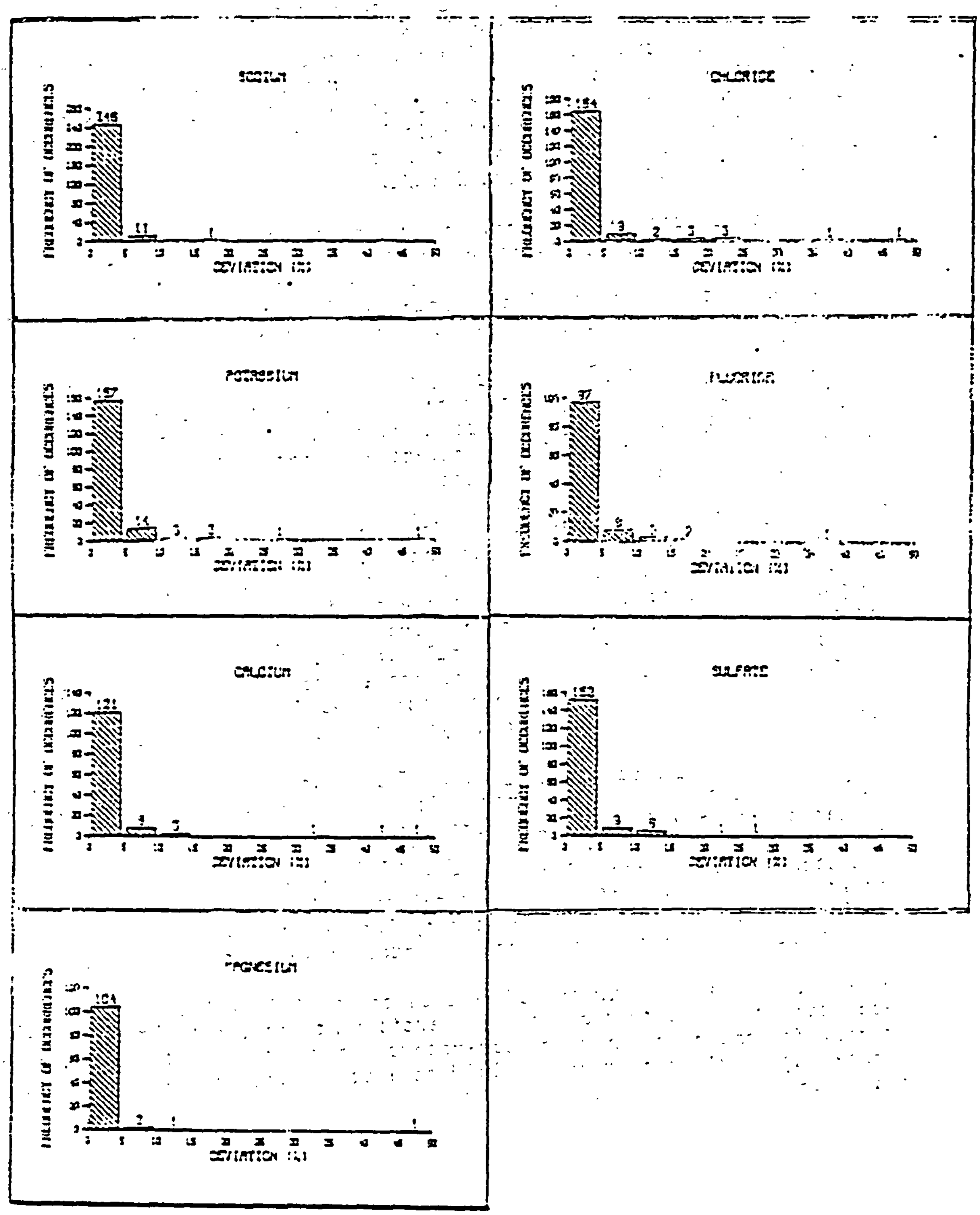

FIGURE 18. Histograms Showing Comparison of Duplicate Analyses for Major Cations and Anions in Hydrochemical Samples from Springs, Surface Waters, and Confined Aquifers for the Hanford Site. Several Analyses Lie Outside the Limits of the Figure. Figures Above Bars Represent the Number of Occurrences Within the Concentration Ranges Shown.

Table 1 presents results of these comparisons for those samples with a deviation greater than +/- 5 percent for the major cations and anions. Alkalinity, a major, possible source of error is omitted from this evaluation. While it is measured on both duplicate samples only a mean value is reported by the BWIP solution chemistry laboratory. However, errors in alkalinity may be detected in the total anion vs. specific conductance analysis described above. In recognition of the fact that analytical uncertainties increase with decreasing concentrations, the comparison of duplicate analyses described above is performed only when concentrations exceed 5 mg/L.

In addition to the major inorganic components, a comparison of duplicates for all analytical data is possible in principle. While few duplicate analyses exist for dissolved gases and stable and radioactive isotopes, trace elements could be evaluated in this manner. Future updates of this data package will extend the evaluation of duplicate analyses to these additional components.

5.2.4 Laboratory Control Samples. In general, inclusion of one or more laboratory control samples with a batch of water samples sent to a vendor for analysis represents an appropriate check on the laboratory. While this procedure could be applied to most of the analytical needs of the BWIP it has been used only with the δD and $\delta^{18}O$ analyses.

Table 2 is a listing of the δD and $\delta^{18}O$ analyses of a laboratory control sample sent to the vendor and reported on the dates noted. The results suggest a gradual trend toward enrichment of the samples in the heavy isotopes of both hydrogen and oxygen from 1981 to 1985. Based upon extensive review of analytical procedures and the results obtained on internationally recognized isotopic standards during this time period the vendor has concluded (and the BWIP concurs) that observed fractionation effects probably represent a problem in long-term storage of the laboratory control samples. Since October 1985 new laboratory control samples have been prepared on a six-month cycle to avoid this problem.

5.2.5 Interlaboratory Analyses. The solution chemistry laboratory of the BWIP has participated in the United States Geological Survey Analytical Evaluation Program for Standard Reference Water Samples (USGS-AEPSRWS) since 1982. Reference water samples are analyzed semi-annually by nearly one hundred laboratories nationwide. This program is a valuable aid to a laboratory in assessing the quality of its analytical capabilities. A discussion of the results for the BWIP solution chemistry laboratory covering the early stages of participation in this program is presented in West et al. (1983).

Table 3 presents a comparison of results of the BWIP solution chemistry laboratory relative to those of all participants in the interlaboratory analysis program for the major chemical parameters important in Hanford groundwaters. Approximately 80 percent of the BWIP results lie within +/- 1σ of the mean and nearly 95 percent are within +/- 2σ.

TABLE 2. LAB CONTROL SAMPLE ANALYSES FOR δD AND $\delta^{18}O$

DATE REPORTED	SAMPLE NUMBER	LAB CONTROL[a] SERIES	δD (permil)	$\delta^{18}O$ (permil)
12/23/81	82-59	1	-124	-17.4
03/23/82	82-18	1	-137	-17.6
05/14/82	82-82	1	-13[illegible]	-17.5
05/28/82	82-128	1	-137	-17.5
06/22/82	82-171	1	-138	-17.2
12/30/82	83-192	1	-138	-18.2
02/24/83	83-186	1	-133	-17.7
06/15/83	83-346	1	-135/-134	-17.7
12/28/83	84-66	1	-136	-16.9
04/06/84	84-155	1	-130	-16.7
06/26/84	84-248	1	-131	-16.8
09/20/84	84-321	1	-128	-16.9
05/10/85	85-209	1	-130/-128	-17.0
07/31/85	85-259	1	-126	-17.1
10/17/85	85-332	1	-129/-127	-17.1
10/17/85	85-342	2	-128	-17.2
10/17/85	85-355	2	-130	-17.0
12/04/85	86-76	2	-132/-132[b]	-17.5

a Lab control series 1 corresponds to a set of sample bottles containing Columbia River water prepared in 1981. Series 2 represents a new set of sample bottles containing Columbia River water prepared in October 1985.

b δD values from a rerun analysis of sample 86-76 reported on 3/18/86.

TABLE 3. COMPARISON OF BWIP SOLUTION CHEMISTRY LABORATORY RESULTS WITH THOSE OF OTHER LABORATORIES: USGS ANALYTICAL EVALUATION PROGRAM

Fall 1982

Constituent	Mean	±1σ[b]	BWIP
Alkalinity (mg/L)[c]	32.3	±2.5	33
Ca (mg/L)	13.87	±1.35	14.0
Cl (mg/L)	2.77	±0.33	2.4
F (mg/L)	0.57	±0.08	0.5
K (mg/L)	1.37	±0.37	1.9
Mg (mg/L)	3.57	±0.29	3.6
Na (mg/L)	6.20	±0.77	6.5
SiO_2 (mg/L)	7.36	±0.50	7.9
SO_4 (mg/L)	27.51	±3.12	26.0
pH	6.39	±0.42	6.3
Sp. Cond. (µS)	138.9	±9.0	137

Spring 1983

Constituent	Mean	±1σ[b]	BWIP
Alkalinity (mg/L)[c]	160.9	±5.2	156
Ca (mg/L)	86.9	±6.0	90
Cl (mg/L)	49.7	±2.1	50
F (mg/L)	1.01	±0.10	0.9
K (mg/L)	4.86	±0.80	4.4
Mg (mg/L)	51.7	±3.2	55
Na (mg/L)	78.9	±3.8	79
SiO_2 (mg/L)	7.59	±1.00	7.7
SO_4 (mg/L)	346.1	±22.1	320
pH	8.09	±0.17	7.8
Sp. Cond. (µS)	1098	±69	1110

Fall 1983

Constituent	Mean	±1σ[b]	BWIP
Alkalinity (mg/L)[c]	150.7	±5.4	152
Ca (mg/L)	70.6	±6.3	73
Cl (mg/L)			a
F (mg/L)			a
K (mg/L)	4.72	±0.59	4.6
Mg (mg/L)	28.0	±1.5	30
Na (mg/L)	77	±3.3	79
SiO_2 (mg/L)	12.62	±2.37	13.2
SO_4 (mg/L)			a
pH	8.13	±0.20	8.2
Sp. Cond. (µS)	859	±47.3	875

Spring 1984

Constituent	Mean	±1σ[b]	BWIP
Alkalinity (mg/L)[c]	200.6	±6.4	199
Ca (mg/L)	143.4	±8.5	139
Cl (mg/L)	37.6	±2.93	39.5
F (mg/L)	3.00	±0.21	2.8
K (mg/L)	5.26	±0.54	5.1
Mg (mg/L)	53.6	±3.4	53
Na (mg/L)	113.5	±7.6	125
SiO_2 (mg/L)	17.33	±1.55	13.4
SO_4 (mg/L)	543.6	±31.7	521
pH	8.48	±0.14	8.6
Sp. Cond. (µS)	1399	±91	1440

Fall 1984

Constituent	Mean	±1σ[b]	BWIP
Alkalinity (mg/L)[c]	3.2	±3.0	1
Ca (mg/L)	25.3	±2.4	28
Cl (mg/L)	4.24	±0.39	3.8
F (mg/L)	0.44	±0.09	0.5
K (mg/L)	2.16	±0.34	2.4
Mg (mg/L)	10.36	±0.89	11.0
Na (mg/L)	5.33	±0.50	5.5
SiO_2 (mg/L)	13.2	±2.0	14
SO_4 (mg/L)	119	±10	120
pH	5.53	±0.23	5.5

Spring 1985

Constituent	Mean	±1σ[b]	BWIP
Alkalinity (mg/L)[c]	142.5	±4.3	133
Ca (mg/L)	62.5	±2.6	68
Cl (mg/L)			a
F (mg/L)			a
K (mg/L)	3.72	±0.59	3.3
Mg (mg/L)	27.9	±1.6	30
Na (mg/L)	65.2	±3.3	70
SiO_2 (mg/L)	8.81	±1.42	9.3
SO_4 (mg/L)	210.3	±8.9	200
pH	8.32	±0.15	8.2

Fall 1985

Constituent	Mean	±1σ[b]	BWIP
Alkalinity (mg/L)[c]	27.16	±4.65	25.0
Ca (mg/L)	11.42	±0.90	11.0
Cl (mg/L)	2.39	±0.70	2.7
F (mg/L)	0.469	±0.063	0.48
K (mg/L)	1.14	±0.13	1.2
Mg (mg/L)	2.98	±0.37	3.1
Na (mg/L)	4.64	±0.47	4.8
SiO_2 (mg/L)	7.13	±1.24	7.5
SO_4 (mg/L)	19.5	±0.9	19
pH	[illegible]	±0.074	[illegible]
Sp. Cond. (µS)	111.2	±6.6	100

a. No data provided by BWIP Solution Chemistry Laboratory
b. Mean values are the average of reported results from participating laboratories. The ±1σ values are based on these analyses.
c. Alkalinity is in units of mg/L as $CaCO_3$

5.3 Evaluation of Sample Representativeness

Although the checks on the quality of the chemical analyses described above are important, evaluation of the representativeness for each sample is crucial before interpretations based upon the data are considered reliable. For precipitation and stream samples seasonal variability is a virtual certainty and must be addressed accordingly. Likewise, the composition of spring samples may be seasonally dependent. In order to address this possibility, the BWIP implemented a quarterly spring sampling program for selected springs approximately one year ago.

For groundwater samples there are special problems related to drilling and sampling that complicate attempts at obtaining representative samples. For example, most Hanford boreholes have been drilled with bentonite-based fluids frequently containing additives such as soda ash, causticized lignite and organic polymers (Halko, 1985). Estimates of the amount of fluid lost to each zone and the amount of water recovered prior to sampling are made during drilling and testing. These estimates are included in the borehole completion reports (e.g., see Diediker, 1983; and Wintczak, 1984). However, a record of fluid composition rarely is available.

While detailed reconstruction of potential contamination effects occurring in most Hanford boreholes is not possible, Graham et al. (1985) report results for a well-documented test in borehole DC-14 that illustrates the chemical effects of drilling fluid and borehole development on water chemistry. In addition, the current hydrochemistry borehole sampling program now includes detailed evaluation of drilling fluid composition and the time-dependent chemistry of groundwater recovered during the development phase of a sampled zone. Future updates to this data package will include groundwater samples that have been collected by this more rigorous program and it should be easier to assess their representativeness.

A further question of sample representativeness is related to changes in the sample (resulting from chemical reactions) that occur during decompression as groundwater is brought to the surface prior to collection. For example, field collection personnel report that degassing sometimes occurs and unstable (i.e., gradually rising) pH values are observed when field measurements are made on groundwaters from the Saddle Mountains Formation.

All perspectives of the question of sample representativeness cannot be addressed in this document. However, there are a number of tests that, when applied to the analyses, may provide an estimate of the overall consistency of the hydrochemical data. These are:

- o comparison of multiple analyses from the same borehole and producing zone or spring.
- o comparison of all analyses from a single borehole as a function of depth.
- o evaluation of tritium contamination in groundwater.
- o evaluation of organic carbon contamination in groundwater.
- o evaluation of contamination of dissolved gases.

5.3.1 Analyses from Same Sampling Site: In many instances more than one sample has been taken over a period of years from the same producing zone of a borehole. Occasionally, these samples have been analyzed by different laboratories. Appendix B presents a comparison of all multiple sample analyses from boreholes in the Site Hydrochemical Data Base. Several significant deviations of major chemical constituents result from the intercomparisons. There are no clear guidelines for identifying anomalous analyses by this technique. For the present, elemental analyses for one sample differing by more than approximately 25 percent (arbitrarily chosen) from the median value of the analyses are highlighted unless the concentrations are below 10 mg/L. These anomalies are recorded in Table 1. While one cannot dismiss the possibility of temporal changes in groundwater chemistry, to a first approximation it is assumed that these effects are small. However, this problem is potentially serious for groundwaters from a large part of the unconfined aquifer at Hanford where changes in water chemistry may reflect changes in waste disposal over the past 40 years. This possible problem has not been addressed in the current evaluation.

Spring sample analyses might be anticipated to be more variable than groundwater analyses due to the potential for evaporation effects and contamination of spring pools by surficial processes. Appendix B presents comparisons of multiple sampling events for springs. The internal consistency of most analyses suggests that the comparison is valid. Anomalous analyses are noted in Table 1.

The current comparison is limited to the major chemical parameters although it could be extended to all constituents (trace elements, dissolved gases and stable and radioactive isotopes). Future revisions to this data package may consider these additional components.

Analyses by atomic adsorption spectrophotometry (Al, Mg, Mn) and high performance liquid chromatography (Br) have not been included in this evaluation.

5.3.2 Continuity of Compositional Depth Profiles. Another test that may apply as a validation tool for borehole data is useful for those sites where a sufficient quantity of data as a function of depth exists. This test is based on the observation that compositional depth profiles for Hanford boreholes (from data presented in this data package) do not appear to exhibit random variation of major chemical parameters. While compositional discontinuities may exist, the overall pattern is quite regular. This observation suggests that random compositional fluctuations, potentially indicating non-representative analyses, can be identified by statistical means.

The potential value of this technique is that it encompasses the following factors associated with a sampling event:

- borehole development (i.e., drilling fluid contamination).
- sampling techniques.
- uncertainties in chemical analyses.

In addition, however, any inherent depth-related compositional variability is addressed by this analysis.

In principle this technique can be applied to 10-15 boreholes on the Hanford Site and used to evaluate most major and trace inorganic and isotopic species. However, this type of analysis has not yet been attempted systematically.

5.3.3 Tritium Contamination. Tritium (H-3) is formed in the earth's upper atmosphere, incorporated into the water molecule, precipitated and becomes associated with the groundwater system through infiltration. Because of its short half-life (12.3 years) groundwater that has been isolated from the atmosphere for greater than approximately 100 years should be free of tritium. However, Davis (1981) acknowledges that a small amount of tritium (0.1 to 1.0 Tu) can be produced in situ in groundwater due to nuclear reactions involving the decay of natural uranium and thorium.

During the drilling of most boreholes at Hanford, drilling fluid made up with Columbia River water has been used. The current natural tritium content of the river water is approximately 25 to 30 Tu (see analyses in the Site Hydrochemical Data Base). LaSala and Doty (1971) report that in 1969 the tritium content of the Columbia River was from 300 to 600 Tu and that the drilling fluid used in borehole ARC-DC-1 contained 418 Tu. Therefore, tritium from the Columbia River is a useful tracer for identifying borehole contamination associated with drilling.

The results of several studies conducted by the BWIP suggest that the tritium content of Hanford groundwaters can be used as an indicator of contamination by drilling fluid. However, the specific, quantitative criterion used for identifying contamination must be matched to the type of data evaluation being done (Graham, 1984 and Graham et al., 1985). For example, Gifford et al. (1985) excluded groundwater samples with more than 0.5 Tu from a chlorine-36 study out of concern for the effect of contamination on this sensitive parameter. Graham (1984) and Graham et al. (1985) suggest that groundwaters with less than 1 Tu are sufficiently free of contamination to yield representative hydrochemical data for major inorganic constituents and stable isotopes.

Based on the measured tritium concentrations of drilling fluid make-up water from the Columbia River (300-600 Tu, 1969; 25-30 Tu, 1986) five percent contamination of groundwater (similar to the overall analytical uncertainty for major cations and anions) leads to expected tritium levels of 15-30 Tu (1969) and approximately 1.5 Tu (1986) in collected samples. Early et al. (1985) chose a bounding tritium content of 5 Tu such that groundwaters exceeding this value might be expected to show the effects of drilling fluid contamination and use of that value is continued in this revision of the data base. The intent of this criterion is to alert Site Hydrochemical Data Base users of the potential problem of contamination. However, it is the user's responsibility to determine whether this limit is appropriate for the evaluation being made.

Figure 19 is a histogram of tritium analyses for groundwaters from confined aquifers at Hanford. Based on the discussion above, many of the samples represented in the data base exhibit some tritium contamination. Table 1 identifies the affected samples.

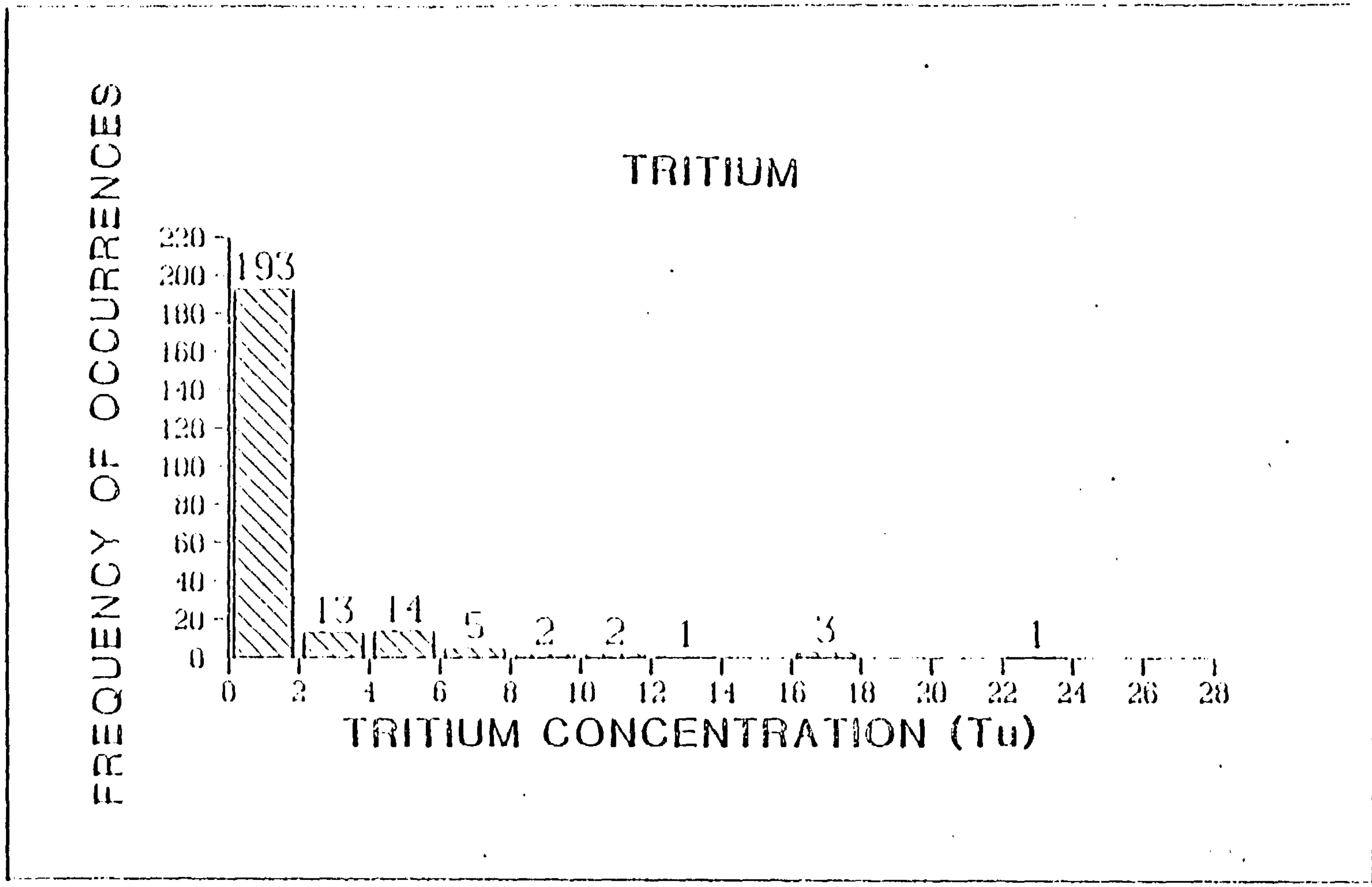

FIGURE 19. Histogram of Tritium Concentrations in Groundwaters from Confined Aquifers. Figures Above Bars Represent the Number of Occurrences Within the Concentration Ranges Shown.

5.3.4 Organic Carbon Contamination. As in the case of tritium, the organic carbon content of Hanford groundwaters can be a measure of contamination with drilling fluid. Halko (1984) describes the organic components that frequently are included in drilling fluids and Graham et al. (1985) assess the affects of these fluids on the total organic carbon (TOC) level of recovered water in the test at DC-14. They found that, for this specific test, TOC values of approximately 5 to 10 mg/L may be indicative of contamination for some major inorganic constituents.

Figure 20 is a histogram of observed TOC values (including dissolved methane) for groundwaters taken from confined aquifers at Hanford. Because the organic composition of drilling fluids can be so variable no definitive criterion for TOC to identify such contamination is available. Table 1 notes those samples with TOC in excess of 10 mg/L which is tentatively suggested as an indicator of contamination that may affect the major chemistry of the water samples.

5.3.5 Dissolved Gases. One simple test of the representativeness of dissolved gas analyses is to note those samples containing significant amounts of oxygen. The great majority of gas analyses reported in the Site Hydrochemical Data Base contain very little if any oxygen. Furthermore, the discussions in DOE/RL 82-3 (1982; pg. 5.1-132) suggest that this observation is compatible with the reducing conditions thought to prevail in basalt groundwaters. Jointly, these findings point to the low probability of significant dissolved oxygen associated with Hanford groundwaters. Generally it can be assumed that air contamination during sample collection is responsible for elevated oxygen levels. Using the normal composition of air it is possible to correct these analyses for contamination. Table 1 identifies these gas analyses that have apparent air contamination (i.e., >1% oxygen) and the five samples from borehole DB-15 that were identified in Section 4.7 as being of questionable value. Also identified in Table 1 is one gas sample apparently grossly contaminated with argon.

6.0 SUMMARY AND CONCLUSIONS

This data package presents the Site Hydrochemical Data Base (Appendix A). A variety of verification and validation procedures have been applied to the data and those are summarized in Figure 21. The goal of these procedures is to insure that hydrochemical data quality is high and to identify those specific analyses that appear to be questionable. The results of this evaluation is summarized in Table 1.

Identification of potentially anomalous samples or analyses in Table 1 must be approached with caution. The great majority of analyses in the Site Hydrochemical Data Base appear to be excellent. Many of those samples flagged in Table 1 probably are of equally high quality. The purpose of Table 1 is only to serve as a guide for data users and to alert them to potential uncertainties.

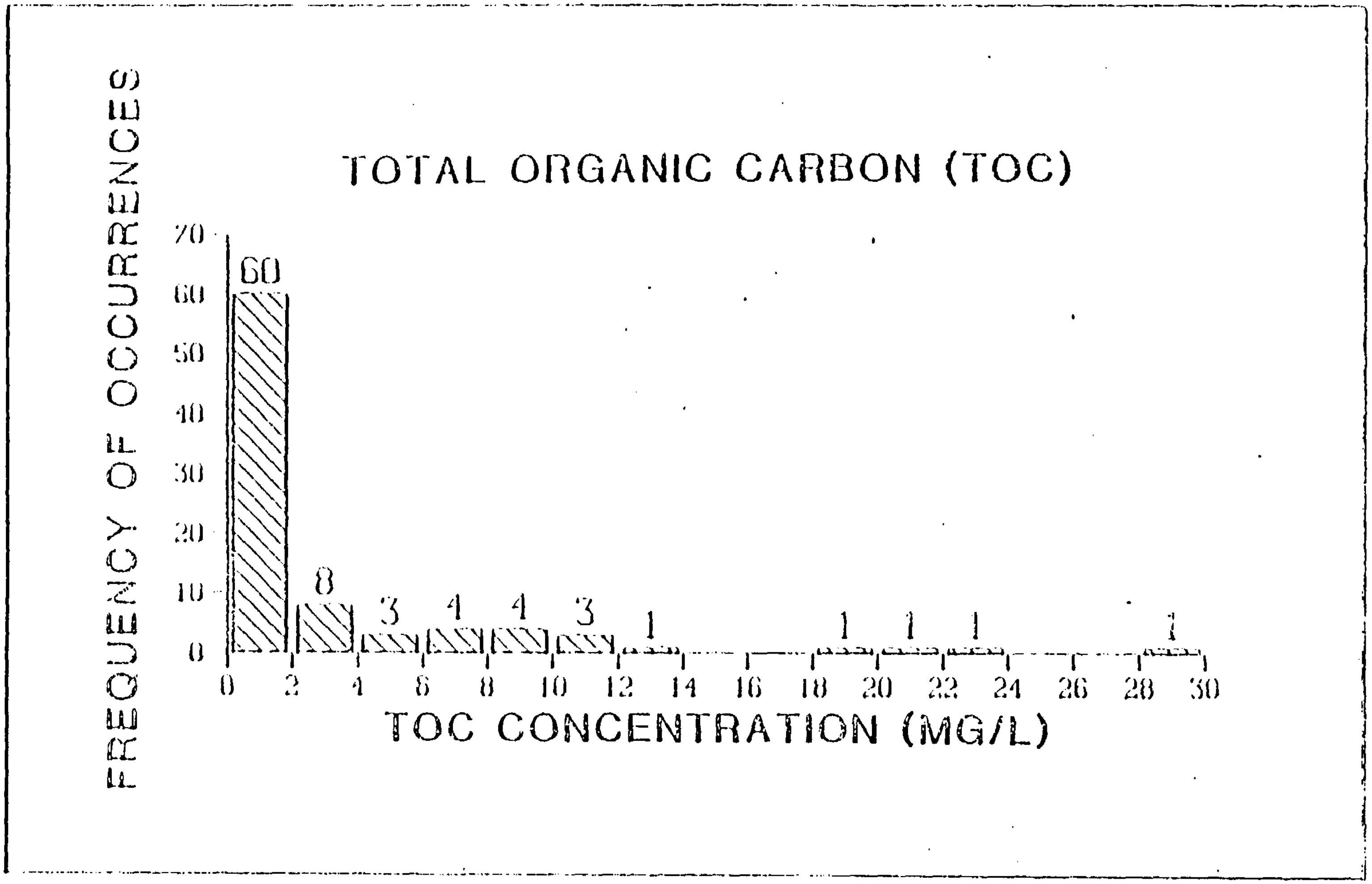

FIGURE 20. Histogram of Total Organic Carbon Concentrations in Groundwaters from Confined Aquifers. Figures Above Bars Represent the Number of Occurrences Within the Concentration Ranges Shown.

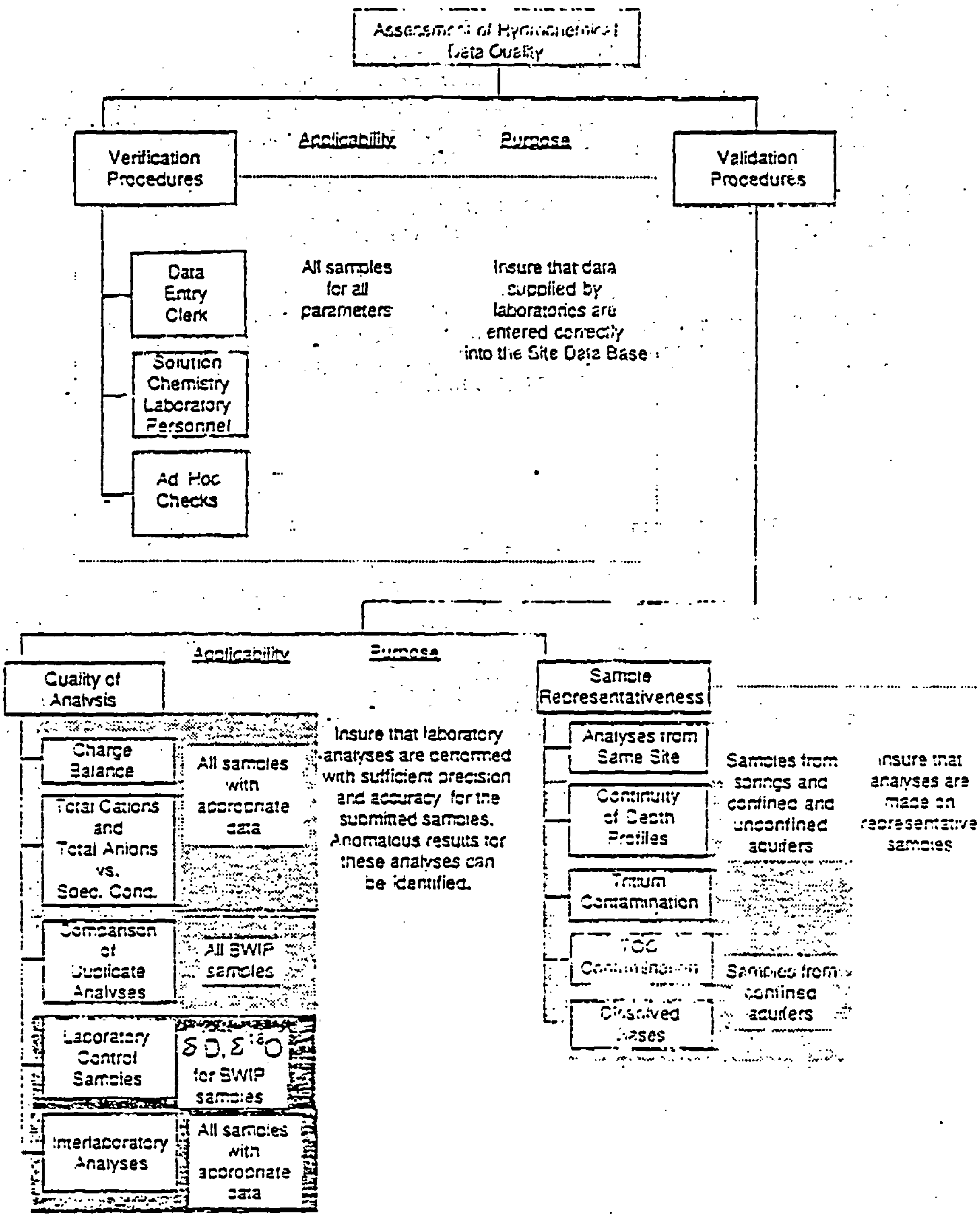

FIGURE 21. Summary Logic Diagram for Verification and Validation Procedures Applied to Hydrochemical Analyses.

Currently, the verification and validation procedures are incomplete. For example, certain information (e.g., sampling method, in situ temperature, date) has not been fully verified. Furthermore, in future updates to this data package it will be possible to compare the total inorganic carbon (TIC) content of samples determined by a carbon analyzer to analogous information extracted from alkalinity values. Many of the validation checks can be extended to parameters beyond the major inorganics (e.g., trace elements) and this will be addressed also. Finally, it is anticipated that greater use will be made of laboratory control samples in the future to evaluate the quality of analyses from subcontractors.

A further concern that must be considered is the fact that some types of data can be checked more thoroughly than others. For example, validation of precipitation and surface water analyses is more limited in scope than for groundwater samples. Fortunately, the BWIP is not as dependent on these data for its characterization and flow modeling studies.

7.0 ACKNOWLEDGEMENTS

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APPENDIX A

SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
BERK	85-255	PRIEST RAPIDS TO ROZA	884	1239	PUMP	06/13/85	1
DB 01	81-19	MABTON	976	990	AIRLIFT IG	02/02/81	1
	81-65	PRIEST RAPIDS	1080	1139	AIRLIFT IG	05/01/81	1
	82 27	PRIEST RAPIDS	1080	1139	PUMP	11/10/81	1
	85 32	PRIEST RAPIDS	1080	1139	SIPHONED	10/27/84	1
DB-02	79-65	MABTON	846	924	AIRLIFT IG	07/13/79	1
	81-13	PRIEST RAPIDS	1028	1190	AIRLIFT IG	12/08/80	1
	81-10	ROZA	1166	1190	AIRLIFT IG	12/23/80	1
DB 04	79-77	MABTON	1360	1403	AIRLIFT IG	06/07/79	1
DB-07	79-89	MABTON	597	812	AIRLIFT IG	07/13/79	1
	83-413	MABTON	597	812	AIRLIFT	06/29/83	1
	85-216	MABTON	507	812	WINDMILL	04/25/85	1
DB-09	79-28	MABTON	461	539	AIRLIFT IG	07/12/79	1
	83 472	MABTON	461	539	PUMP	07/15/83	1
DB 11	85-4	MABTON	709	1020	FLOWING	10/10/84	1
	85 15	MABTON	709	1020	FLOWING	10/15/84	1
	85-18	PRIEST RAPIDS	1020	1210	FLOWING	10/15/84	1
	86 52	PRIEST RAPIDS	1020	1210	FLOWING	10/28/85	1
	86-103	PRIEST RAPIDS	1020	1210	PUMP	11/21/85	1
	81-57	PRIEST RAPIDS	1037	1046	FLOWING	01/15/81	1
DB-12	63-95	SELAH	171	180	SWAB	04/20/78	1
	81-25	PRIEST RAPIDS	524	592	AIRLIFT IG	10/31/80	1
DB-13	80-159	MABTON	1195	1292		04/18/80	1
	83-404	MABTON	1195	1292	PUMP	07/07/83	1
DB-14	81-162	PRIEST RAPIDS	1181	1218	AIRLIFT	05/25/81	1
DB-15	79-17	RATTLESNAKE RIDGE	150	222	PUMP	04/25/79	1
	79 35	SELAH	370	422	PUMP	05/10/79	1
	79-33	COLD CREEK	510	515	PUMP	05/24/79	1
	79-15	ASOTIN/UMATILLA	640	632	PUMP	06/04/79	1
	79 39	UMATILLA INTRAFLOW	680	754	PUMP	05/14/79	1
	79 31	MABTON	680	844	PUMP	07/03/79	1
	79 25	MABTON	680	844		07/24/79	1
	79-51	PRIEST RAPIDS	858	959	PUMP	08/13/79	1
	79-85	PRIEST RAPIDS	909	959	SWAB	08/16/79	1
	79-80	PRIEST RAPIDS/ROZA	1045	1105	SWAB	08/27/79	1
	79 62	FRENCHMAN SPRINGS	1300	1343	PUMP	09/27/79	1
	79-90	FRENCHMAN SPRINGS	1300	1343	SWAB	09/27/79	1
	80 35	FRENCHMAN SPRINGS	1353	1373	SWAB	10/04/79	1
	80 24	FRENCHMAN SPRINGS	1393	1443	SWAB	10/13/79	1
	80-77	FRENCHMAN SPRINGS	1450	1530	SWAB	10/15/79	1

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SAMPLING EVENTS
SAMPLE TYPE. CONFINED

location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
DB-15	80-1	FRENCHMAN SPRINGS	1570	1683	SWAB	11/09/70	1
DC-01	SITE-230	POMONA	362	416	SWAB	05/08/69	4
	SITE-226	POMONA TO UMATILLA	362	712	PUMP	05/10/69	4
	SITE-227	POMONA TO MABTON	362	890	PUMP	05/20/69	4
	SITE-228	POMONA TO U. ROZA	362	1190	PUMP	05/26/69	4
	SITE-229	POMONA TO ROCKY COULEE FT	362	2242	PUMP	06/12/69	4
	SITE-231	POMONA TO ESQUATZEL FT	450	530	SWAB	05/08/69	4
	SITE-232	ESQUATZEL TO COLD CREEK	540	620	SWAB	05/08/69	4
	SITE-233	COLD CREEK TO UMATILLA	638	726	SWAB	05/19/69	4
	SITE-234	UMATILLA INTRAFLOW CONTACT	720	810	SWAB	05/[illegible]/69	4
	SITE-235	PRIEST RAPIDS	980	1120	SWAB	[illegible]/27/69	4
	SITE-236	L. PRIEST RAPIDS AND ROZA	1090	1280	SWAB	[illegible]	4
	SITE-237	L. ROZA AND FRENCHMAN SPRINGS	1330	1520	SWAB	06/10/69	4
	SITE-238	COHASSETT FB AND BELOW	2600	2770	SWAB	06/22/69	4
	SITE-239	UMTANUM FB AND BELOW	3146	3235	SWAB	06/29/69	4
	SITE-240	UMTANUM FB AND BELOW	3168	3196	SWAB	06/29/69	4
	SITE-241	GRANDE RONDE	3206	3246	SWAB	05/29/69	4
	SITE-242	GRANDE RONDE	3320	3431	SWAB	07/02/69	4
	SITE-243	GRANDE RONDE	4080	4283	SWAB	07/14/69	4
DC-02-A2	80-4	ROCKY COULEE FB TO BELOW UMTANUM	2253	3303	SWAB	10/15/79	1
	SITE-213	GRANDE RONDE	3243	3273	SWAB	06/01/85	5
DC-03	80-27	UMTANUM FB	3575	3335	SWAB	03/10/80	1
DC-05	79-30	VANTAGE			PUMP	07/19/79	1
DC-06	80-161	ROCKY COULEE	2156	[illegible]	FLOWING	[illegible]/14/80	1
	80-72	VANTAGE TO ROCKY COULEE FT	2258	2289	FLOWING	10/19/79	1
	SITE-214	ROCKY COULEE FT TO TO BELOW UMTANUM	2260	4333	FLOWING	[illegible]/21/79	5
	80-238	ROCKY COULEE FT TO ID BELOW UMTANUM	2250	4333	FLOWING	02/11/80	1
	80-191	COHASSETT TO ROCKY COULEE FB	2396	2697	FLOWING	08/14/80	1
	80-13	COHASSETT FT	2447	2477	FLOWING	10/05/79	1
	79-59	MCCOY CANYON FT	2887	2917	FLOWING	09/27/79	1
	81-45	MCCOY CANYON	2892	3078	FLOWING	10/31/80	1
	80-118	MCCOY CANYON FB AND UMTANUM FT	2992	3078	FLOWING	05/27/80	1
	80-15	UMTANUM FB AND BELOW	3242	3529	FLOWING	[illegible]	1
	81-82	UMTANUM FB AND BELOW	3242	3529	FLOWING	02/24/81	1
	80-29	GRANDE RONDE	3530	[illegible]	FLOWING	02/08/[illegible]	1
	79-58	GRANDE RONDE	3591	[illegible]	FLOWING	09/02/[illegible]	1
	80-75	GRANDE RONDE	4169	[illegible]	FLOWING	01/02/80	1
DC-07	82-20	ROCKY COULEE THRU UMTANUM	2730	[illegible]	PUMP	[illegible]	1
	82-10	ROCKY COULEE THRU UMTANUM	2780	3943	PUMP	[illegible]	1
	80-39	ROCKY COULEE FB AND COHASSETT	2852	3052	AIRLIFT IQ	10/12/79	1
	80-11	ROCKY COULEE FB AND COHASSETT	2952	3052	AIRLIFT IG	[illegible]/79	1
	79-52	UMTANUM FT	3555	[illegible]	AIRLIFT	09/[illegible]/79	1
	80-103	GRANDE RONDE	4112	[illegible]	AIRLIFT IQ	07/24/80	1
	80-188	GRANDE RONDE	4830	5063	AIRLIFT	08/14/80	1

SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
DC-07	80-196	GRANDE RONDE	4830	5008	SWAB	08/15/80	1
DC-12	80-60	PRIEST RAPIDS	1217	1254	PUMP	01/23/80	1
	80-100	PRIEST RAPIDS/ROZA	1328	1364	PUMP	02/07/80	1
	80-97	ROZA/FRENCHMAN SPRINGS	1508	1534	PUMP	02/25/80	1
	80-32	FRENCHMAN SPRINGS	1688	1710	PUMP	03/11/80	1
	80-82	FRENCHMAN SPRINGS	1910	1984	PUMP	04/08/80	1
	80-124	FRENCHMAN SPRINGS	2050	2079	AIRLIFT IG	05/09/80	1
	80-101	ROCKY COULEE FT	2408	2446	SWAB	07/14/80	1
	80-174	ROCKY COULEE FT	2408	2446	AIRLIFT IG	07/14/80	1
	80-209	COHASSETT FB	2818	2843	AIRLIFT IG	09/02/80	1
	80-233	COHASSETT FB	2818	2845	AIRLIFT IG	09/10/80	1
	80-234	GRANDE RONDE	2838	2864	AIRLIFT IG	09/24/80	1
	81-61	GRANDE RONDE	4022	4071	AIRLIFT IG	04/20/81	1
	82-85	GRANDE RONDE	4419	4455	AIRLIFT IG	11/04/81	1
DC-14	80-3	ELEPHANT MOUNTAIN	368	475	PUMP	01/22/80	1
	80-53	RATTLESNAKE RIDGE	475	538	PUMP	01/18/80	1
	80-47	SELAH	675	788	FLOWING	02/05/80	1
	80-69	ASOTIN	880	907	FLOWING	03/14/80	1
	80-99	ASOTIN	910	925	FLOWING	03/26/80	1
	80-89	ASOTIN	925	969	FLOWING	03/26/80	1
	80-71	MABTON	969	1083	FLOWING	04/07/80	1
	80-144	PRIEST RAPIDS	1180	1192	FLOWING	05/20/80	1
	80-189	PRIEST RAPIDS	1196	1217	FLOWING	05/20/80	1
	80-112	ROZA	1285	1346	FLOWING	06/11/80	1
	80-157	SQUAW CREEK	1480	1516	FLOWING	06/23/80	1
	80-155	FRENCHMAN SPRINGS	1575	1632	FLOWING	07/07/80	1
	80-104	FRENCHMAN SPRINGS	1640	1709	FLOWING	07/14/80	1
	80-129	FRENCHMAN SPRINGS	1720	1820	FLOWING	07/29/80	1
	80-170	FRENCHMAN SPRINGS	1820	1875	FLOWING	08/12/80	1
	80-117	FRENCHMAN SPRINGS	1888	1903	FLOWING	08/22/80	1
	80-213	L. FRENCHMAN SPRINGS TO ROCKY COULEE	2120	2235	FLOWING	09/09/80	1
	81-20	COHASSETT FT	2410	2513	FLOWING	10/14/80	1
	81-30	MCCOY CANYON FB AND UMTANUM FT	3060	3144	FLOWING	12/23/80	1
	81-44	UMTANUM FB	3180	3225	FLOWING	01/19/81	1
	81-141	UMTANUM FB	3192	3228	FLOWING	07/15/81	1
	82-8	GRANDE RONDE	3260	3335	FLOWING	01/11/82	1
	82-315	GRANDE RONDE	3260	3335	FLOWING	08/[illegible]/82	1
	83-156	GRANDE RONDE	3260	3335	FLOWING	02/15/83	1
	83-152	GRANDE RONDE	3260	3335	FLOWING	02/18/83	1
	83-157	GRANDE RONDE	3260	3335	FLOWING	02/22/83	1
	83-178	GRANDE RONDE	3260	3335	FLOWING	02/25/83	1
	83-183	GRANDE RONDE	3260	3335	FLOWING	03/01/83	1
	83-154	GRANDE RONDE	3260	3335	FLOWING	03/04/83	1
	83-150	GRANDE RONDE	3260	3335	FLOWING	03/08/83	1
	83-266	GRANDE RONDE	3260	3335	FLOWING	03/11/83	1
	83-261	GRANDE RONDE	3260	3335	FLOWING	03/15/83	1
DC-15	80-56	LEVEY	275	343	PUMP	01/04/80	1

SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
DC-15	80-54	RATTLESNAKE RIDGE	417	406	PUMP	01/23/80	1
	80-57	COLD CREEK	713	787	PUMP	03/25/80	1
	80-87	MABTON	1003	1072	PUMP	04/14/80	1
	80-137	PRIEST RAPIDS/ROZA	1210	1293	PUMP	05/05/80	1
	80-176	ROZA	1357	1390	AIRLIFT IG	06/12/80	1
	80-135	FRENCHMAN SPRINGS	1481	1506	AIRLIFT IG	06/30/80	1
	80-120	FRENCHMAN SPRINGS	1540	1593	AIRLIFT IG	07/15/80	1
	80-131	FRENCHMAN SPRINGS	1735	[illegible]	AIRLIFT IG	08/04/80	1
	80-193	FRENCHMAN SPRINGS	1834	1887	AIRLIFT IG	09/12/80	1
	81-41	L. FRENCHMAN SPRINGS TO U. GRANDE RONDE	2099	2198	AIRLIFT IG	10/[illegible]/80	1
	81-2	ROCKY COULEE FT	2227	[illegible]	AIRLIFT IG	12/23/80	1
	81-46	COHASSETT FB	2651	[illegible]	AIRLIFT IG	12/[illegible]/80	1
	81-33	GRANDE RONDE	2692	2733	AIRLIFT IG	01/[illegible]/81	1
	81-27	MCCOY CANYON FB AND UMTANUM FT	2961	3113	AIRLIFT IG	02/[illegible]/81	1
	81-64	UMTANUM FB	3245	3288	AIRLIFT IG	[illegible]/23/81	1
	81-96	GRANDE RONDE	3301	3412	AIRLIFT IG	[illegible]/10/81	1
	81-69	GRANDE RONDE	3301	3412	AIRLIFT IG	04/13/81	1
	82-94	GRANDE RONDE	4138	4263	SIPHONED	11/05/81	1
DC-16A	81-109	RATTLESNAKE RIDGE	668	835	PUMP	09/23/81	1
	82-17	SELAH	928	1021	PUMP	10/21/81	1
	82-93	MABTON	1395	1568	PUMP	01/28/82	1
	82-19	PRIEST RAPIDS/ROZA	1760	1828	PUMP	03/[illegible]/82	1
	82-188	L. ROZA AND U. FRENCHMAN SPRINGS	1892	2000	WINDMILL	04/[illegible]/82	1
	82-124	FRENCHMAN SPRINGS	2105	2156	WINDMILL	05/12/82	1
	82-143	FRENCHMAN SPRINGS	2201	[illegible]	WINDMILL	06/03/82	1
	82-231	FRENCHMAN SPRINGS	2266	[illegible]	WINDMILL	06/24/82	1
	82-202	FRENCHMAN SPRINGS	2266	[illegible]	AIRLIFT IG	06/25/82	1
	82-322	FRENCHMAN SPRINGS	2476	2559	PUMP	0[illegible]/02/82	1
	82-339	FRENCHMAN SPRINGS	2585	[illegible]	PUMP	08/19/82	1
	82-332	FRENCHMAN SPRINGS	2585	[illegible]	PUMP	08/20/82	1
	82-419	VANTAGE AND U. GRANDE RONDE	2670	[illegible]	PUMP	09/14/82	1
	82-430	VANTAGE AND U. GRANDE RONDE	2671	2730	WINDMILL	09/[illegible]/82	1
	83-29	ROCKY COULEE	2838	2946	WINDMILL	11/15/82	1
DC-16B	83-147	MABTON	1368	1500	PUMP	02/23/83	1
DC-16C	83-100	ROCKY COULEE FT	2823	2943	AIRLIFT	11/19/82	1
	83-259	MCCOY CANYON FT	3499	3551	AIRLIFT	03/15/83	1
DC-18	86-166	PRIEST RAPIDS	398	730	PUMP	03/31/85	1
DC-19C	84-53	FRENCHMAN SPRINGS	[illegible]26	[illegible]	PUMP	[illegible]	1
	84-40	FRENCHMAN SPRINGS	2421	2488	PUMP	12/[illegible]/83	1
	84-75	COHASSETT FT	3008	3105	PUMP	11/[illegible]/83	1
	84-86	UMTANUM FT	3567	[illegible]	PUMP	11/[illegible]/83	1
DC-20C	84-9	WANAPUM/GRANDE RONDE	1581	[illegible]	PUMP	11/30/83	1
DC-22C	84-105	WANAPUM/GRANDE RONDE	1709	3630	PUMP	02/11/84	1

SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
DC-23GR	86-133	PRIEST RAPIDS	1345	1425	PUMP	02/26/86	1
	86-141	SENTINEL GAP	1575	1635	PUMP	03/05/86	1
	86-181	GINKGO	2155	2216	PUMP	04/02/86	1
ENYEART	SITE-209	PRIEST RAPIDS	935	1092	PUMP	11/29/51	6
	SITE-210	PRIEST RAPIDS	935	1092	PUMP	05/14/69	6
	84-166	PRIEST RAPIDS	935	1092	FLOWING	02/29/84	1
	85-1	PRIEST RAPIDS	960	1088	FLOWING	10/09/84	1
	85-180	PRIEST RAPIDS	960	1092	FLOWING	03/01/85	1
FORD	SITE-206	PRIEST RAPIDS	620	777	PUMP	11/30/51	6
	SITE-207	PRIEST RAPIDS	620	777	PUMP	08/27/70	6
	SITE-219	PRIEST RAPIDS	620	777	FLOWING	08/11/78	5
	85-168	PRIEST RAPIDS	620	777	PUMP	03/22/85	1
	85-303	PRIEST RAPIDS	620	777	PUMP	08/22/85	1
MCGEE	SITE-224	PRIEST RAPIDS	691	978	FLOWING	05/14/69	8
	SITE-222	PRIEST RAPIDS	691	978	FLOWING	08/27/70	7
	SITE-223	PRIEST RAPIDS	691	978	FLOWING	09/08/70	7
	SITE-225	PRIEST RAPIDS	691	978	FLOWING	01/01/77	6
	SITE-220	PRIEST RAPIDS	691	978	FLOWING	08/13/78	5
	82-7	PRIEST RAPIDS	691	978	FLOWING	04/02/82	1
	85-175	PRIEST RAPIDS	691	938	FLOWING	02/19/85	1
	85-300	PRIEST RAPIDS	691	978	PUMP	08/22/85	1
	86-34	PRIEST RAPIDS	691	978	FLOWING	10/18/85	1
	80-64	PRIEST RAPIDS	692	925	FLOWING	04/17/80	1
	81-79	PRIEST RAPIDS	692	925	FLOWING	03/10/81	1
	81-54	ROZA	925	968	FLOWING	03/10/81	1
	82-64	ROZA	925	968	FLOWING	04/05/82	1
	82-263	ROZA INTRAFLOW	1028	1006	FLOWING	08/28/82	1
	82-397	ROZA/FRENCHMAN SPRINGS	1099	1167	FLOWING	08/05/82	1
	82-424	FRENCHMAN SPRINGS	1320	1378	FLOWING	09/13/82	1
	82-436	FRENCHMAN SPRINGS	1404	1440	FLOWING	09/24/82	1
	83-32	FRENCHMAN SPRINGS	1443	1483	FLOWING	10/18/82	1
	83-83	FRENCHMAN SPRINGS	1581	1580	FLOWING	[illegible]/17/82	1
	83-186	FRENCHMAN SPRINGS	1674	1750	FLOWING	12/06/82	1
	83-373	GRANDE RONDE INTERFLOW	1844	1992	WINDMILL	05/24/83	1
	83-331	ROCKY COULEE FT	1991	2092	WINDMILL	06/07/83	1
	83-460	ROCKY COULEE FB	2128	2199	WINDMILL	06/21/83	1
	83-476	COHASSETT FT	2188	2337	WINDMILL	07/14/83	1
	83-513	COHASSETT FB	2393	2524	WINDMILL	08/03/83	1
	84-24	UMTANUM FB	2854	3123	WINDMILL	10/05/83	1
OBRIAN	85-194	PRIEST RAPIDS	600	730	FLOWING	03/27/85	1
RRL-02	82-68	PRIEST RAPIDS	1574	1714	AIRLIFT IG	02/12/82	1
	82-65	ROZA	1735	1773	AIRLIFT IG	02/24/82	1
	82-170	FRENCHMAN SPRINGS	2244	2644	AIRLIFT IG	04/14/82	1
	82-122	U. GRANDE RONDE AND ROCKY COULEE	2719	2910	AIRLIFT IG	05/17/82	1
	82-401	COHASSETT FB	3247	3344	WINDMILL	09/17/82	1

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SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
RRL-02	84-7	COHASSETT FB	3247	3344	WINDMILL	10/24/83	1
	82-364	UMTANUM FT	3568	3781	WINDMILL	07/21/82	1
	82-309	UMTANUM	3781	3827	WINDMILL	08/16/82	1
	82-456	VERY HIGH MG ZONE	3837	3889	WINDMILL	09/29/82	1
RRL-06B	83-25	UMTANUM	3708	3823	PUMP	10/06/82	1
RRL-14	82-403	COHASSETT	3017	3147	WINDMILL	09/20/82	1
	84-11	COHASSETT	3077	3140	WINDMILL	10/27/83	1
	83-151	COHASSETT FB	3294	3403	PUMP	12/02/82	1
	83-49	UMTANUM FT	3715	3814	WINDMILL	11/08/82	1
STEM-1	85-252	PRIEST RAPIDS TO UPPER FRENCHMAN SPRINGS	469	970	PUMP	03/13/85	1
	85-297	PRIEST RAPIDS TO UPPER FRENCHMAN SPRINGS	469	970	PUMP	08/22/85	1
	86-31	PRIEST RAPIDS TO UPPER FRENCHMAN SPRINGS	469	970	PUMP	10/18/85	1
STEM-2	86-19	PRIEST RAPIDS TO UPPER FRENCHMAN SPRINGS	565	1002	PUMP	10/07/85	1
299-E16-01	SITE-161	ELEPHANT MOUNTAIN	468	510	PUMP	05/15/82	2
	SITE-162	ELEPHANT MOUNTAIN	468	510	PUMP	07/13/82	2
	SITE-163	ELEPHANT MOUNTAIN	468	510	PUMP	07/13/82	2
	SITE-164	ELEPHANT MOUNTAIN	468	510	PUMP	07/14/82	2
299-E26-08	SITE-166	RATTLESNAKE RIDGE	326	396	PUMP	05/18/82	2
	SITE-167	RATTLESNAKE RIDGE	326	395	PUMP	05/19/82	2
	SITE-168	RATTLESNAKE RIDGE	328	396	PUMP	05/19/82	2
299-E33-12	SITE-170	RATTLESNAKE RIDGE	305	330	PUMP	05/21/82	2
	SITE-171	RATTLESNAKE RIDGE	305	330	PUMP	05/22/82	2
	SITE-172	RATTLESNAKE RIDGE	305	380	PUMP	05/22/82	2
699-S11-E12A	80-61	LEVEY INTERBED	225	232	FLOWING	[illegible]/19/80	1
	80-180	LEVEY INTERBED	225	232	AIRLIFT IG	07/24/80	1
699-42-40C	SITE-176	ELEPHANT MOUNTAIN	245	245	PUMP	04/16/82	2
	SITE-177	RATTLESNAKE RIDGE	306	390	PUMP	05/20/82	2
	SITE-178	RATTLESNAKE RIDGE	306	390	PUMP	05/21/82	2
	SITE-179	RATTLESNAKE RIDGE	306	390	PUMP	05/21/82	2
	SITE-180	RATTLESNAKE RIDGE	306	390	PUMP	11/19/82	2
699-47-50	SITE-205	RATTLESNAKE RIDGE	260	225	PUMP	08/25/82	2
	SITE-181	RATTLESNAKE RIDGE	260	225	PUMP	07/15/82	2
699-49-55B	SITE-183	RATTLESNAKE RIDGE	170	226	PUMP	05/27/82	2
	SITE-184	RATTLESNAKE RIDGE	170	226	PUMP	05/27/82	2
	SITE-185	RATTLESNAKE RIDGE	170	226	PUMP	05/28/82	2
699-50-45	SITE-203	RATTLESNAKE RIDGE	133	178	PUMP	07/22/82	2
	SITE-186	RATTLESNAKE RIDGE	133	178	PUMP	06/23/82	2

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SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
699-50-48	SITE-204	RATTLESNAKE RIDGE	213	250	PUMP	06/10/80	3
	SITE-187	RATTLESNAKE RIDGE	213	250	PUMP	08/07/82	2
699-51-46	SITE-188	RATTLESNAKE RIDGE	120	163	PUMP	08/04/82	2
	SITE-201	RATTLESNAKE RIDGE	120	165	PUMP	05/06/80	3
699-52-46A	SITE-202	RATTLESNAKE RIDGE	165	225	PUMP	05/13/80	3
	SITE-189	RATTLESNAKE RIDGE	170	225	PUMP	08/07/82	2
699-52-48	SITE-199	RATTLESNAKE RIDGE	145	195	PUMP	04/08/80	3
	SITE-190	RATTLESNAKE RIDGE	145	185	PUMP	08/10/82	2
699-53-50	SITE-191	RATTLESNAKE RIDGE	145	194	PUMP	07/14/82	2
	SITE-200	RATTLESNAKE RIDGE	146	193	PUMP	04/17/80	3
699-54-57	SITE-192	RATTLESNAKE RIDGE	236	321	PUMP	05/17/82	2
699-56-53	SITE-196	RATTLESNAKE RIDGE	190	270	PUMP	06/03/82	2
	SITE-197	RATTLESNAKE RIDGE	190	270	PUMP	06/03/82	2

SAMPLING EVENTS
SAMPLE TYPE: PRECIPITATION

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
STATION-03	82-89				PRECIP COL	12/14/81	1
	82-51				PRECIP COL	03/02/82	1
	82-81				PRECIP COL	03/15/82	1
	82-78				PRECIP COL	03/29/82	1
	82-179				PRECIP COL	04/14/82	1
	82-138				PRECIP COL	05/10/82	1
	83-80				PRECIP COL	10/26/82	1
	83-46				PRECIP COL	11/01/82	1
	83-118				PRECIP COL	[illegible]/82	1
	83-189				PRECIP COL	01/07/83	1
	83-114				PRECIP COL	02/02/83	1
	83-143				PRECIP COL	02/11/83	1
	83-277				PRECIP COL	03/09/83	1
STATION-04	82-15				PRECIP COL	12/14/81	1
	82-61				PRECIP COL	03/02/82	1
	82-60				PRECIP COL	03/15/82	1
	82-90				PRECIP COL	03/29/82	1
	82-120				PRECIP COL	04/14/82	1
	82-117				PRECIP COL	05/10/82	1
	83-36				PRECIP COL	10/26/82	1
	83-84				PRECIP COL	11/01/82	1
	83-141				PRECIP COL	11/19/82	1
	83-116				PRECIP COL	[illegible]02/82	1
	83-110				PRECIP COL	[illegible]	1
	83-155				PRECIP COL	12/2[illegible]/82	1
	83-102				PRECIP COL	01/0[illegible]/83	1
	83-165				PRECIP COL	02/0[illegible]/83	1
	83-180				PRECIP COL	02/1[illegible]/83	1
	83-250				PRECIP COL	03/0[illegible]/83	1
STATION-07	82-45				PRECIP COL	12/14/81	1
	82-92				PRECIP COL	03/02/82	1
	82-57				PRECIP COL	03/15/82	1
	82-44				PRECIP COL	03/29/82	1
	82-136				PRECIP COL	04/14/82	1
	82-185				PRECIP COL	05/10/82	1
	83-43				PRECIP COL	10/26/82	1
	83-23				PRECIP COL	11/01/82	1
	83-187				PRECIP COL	11/19/82	1
	83-148				PRECIP COL	12/02/82	1
	83-169				PRECIP COL	01/07/83	1
	83-181				PRECIP COL	02/02/83	1
	83-124				PRECIP COL	[illegible]/11/83	1
	83-208				PRECIP COL	03/09/83	1
STATION-14	82-38				PRECIP COL	12/14/81	1
	82-20				PRECIP COL	03/02/82	1
	82-63				PRECIP COL	03/15/82	1
	82-86				PRECIP COL	03/29/82	1

SAMPLING EVENTS
SAMPLE TYPE: PRECIPITATION

Location	Sample Event Code	Producing Zone	Packer Top	Packer Bottom	Sampling Method	Date	Source
STATION 14	82-178				PRECIP COL	04/14/82	1
	82-147				PRECIP COL	05/10/82	1
	83-71				PRECIP COL	10/26/82	1
	83-55				PRECIP COL	11/01/82	1
	83-132				PRECIP COL	11/19/82	1
	83-184				PRECIP COL	12/02/82	1
	83-160				PRECIP COL	12/27/82	1
	83-174				PRECIP COL	01/07/83	1
	83-128				PRECIP COL	02/02/83	1
	83-149				PRECIP COL	02/11/83	1
	83-295				PRECIP COL	03/09/83	1
	86-106				PRECIP COL	11/21/85	1
STATION-17	82-99				PRECIP COL	12/14/81	1
	82-53				PRECIP COL	01/19/82	1
	82-95				PRECIP COL	01/10/82	1
	82-70				PRECIP COL	02/26/82	1
	82-80				PRECIP COL	03/15/82	1
	82-100				PRECIP COL	03/29/82	1
	82-118				PRECIP COL	04/14/82	1
	82-134				PRECIP COL	05/10/82	1
	83-11				PRECIP COL	10/26/82	1
	83-86				PRECIP COL	11/01/82	1
	83-159				PRECIP COL	11/19/82	1
	83-120				PRECIP COL	12/02/82	1
	83-199				PRECIP COL	12/27/82	1
	83-182				PRECIP COL	12/29/82	1
	83-126				PRECIP COL	01/07/83	1
	83-152				PRECIP COL	02/02/83	1
	83-256				PRECIP COL	03/09/83	1
	86-107				PRECIP COL	11/21/85	1
STATION 20	82-50				PRECIP COL	12/14/81	1
	82-16				PRECIP COL	01/19/82	1
	82-26				PRECIP COL	01/19/82	1
	82-58				PRECIP COL	02/26/82	1
	82-74				PRECIP COL	03/02/82	1
	82-54				PRECIP COL	03/05/82	1
	82-1				PRECIP COL	03/15/82	1
	82-96				PRECIP COL	03/29/82	1
	82-196				PRECIP COL	04/14/82	1
	82-197				PRECIP COL	05/10/82	1
	83-37				PRECIP COL	10/26/82	1
	83-34				PRECIP COL	11/01/82	1
	83-170				PRECIP COL	11/19/82	1
	83-130				PRECIP COL	12/27/82	1
	83-119				PRECIP COL	12/29/82	1
	83-158				PRECIP COL	01/07/83	1
STATION-25	82-9				PRECIP COL	12/14/81	1

SAMPLING EVENTS
SAMPLE TYPE: PRECIPITATION

LOCATION	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
STATION-25	82-76				PRECIP COL	12/17/81	1
	82-24				PRECIP COL	01/19/82	1
	82-83				PRECIP COL	02/26/82	1
	82-66				PRECIP COL	03/02/82	1
	82-79				PRECIP COL	03/05/82	1
	82-25				PRECIP COL	03/15/82	1
	82-67				PRECIP COL	03/29/82	1
	82-153				PRECIP COL	04/14/82	1
	82-152				PRECIP COL	05/10/82	1
	83-89				PRECIP COL	10/26/82	1
	83-53				PRECIP COL	[illegible]/01/82	1
	83-134				PRECIP COL	11/19/82	1
	83-139				PRECIP COL	12/02/82	1
	83-142				PRECIP COL	12/27/82	1
	83-190				PRECIP COL	01/07/83	1
	83-198				PRECIP COL	02/02/83	1
	83-135				PRECIP COL	02/11/83	1
	83-217				PRECIP COL	03/09/83	1
STATION-26	82-29				PRECIP COL	[illegible]	1
	82-32				PRECIP COL	[illegible]/19/82	1
	82-48				PRECIP COL	01/19/82	1
	82-91				PRECIP COL	02/26/82	1
	82-08				PRECIP COL	03/02/82	1
	82-30				PRECIP COL	03/05/82	1
	82-71				PRECIP COL	03/15/82	1
	82-39				PRECIP COL	03/29/82	1
	82-116				PRECIP COL	[illegible]/14/82	1
	82-108				PRECIP COL	05/10/82	1
	83-3				PRECIP COL	[illegible]/26/82	1
	83-70				PRECIP COL	[illegible]/82	1
	83-163				PRECIP COL	[illegible]/19/82	1
	83-177				PRECIP COL	[illegible]/02/82	1
	83-171				PRECIP COL	[illegible]/82	1
	83-167				PRECIP COL	[illegible]/29/82	1
	83-131				PRECIP COL	[illegible]/83	1
	83-101				PRECIP COL	[illegible]	1
	83-104				PRECIP COL	02/[illegible]/83	1
	83-284				PRECIP COL	03/09/83	1
	86-108				PRECIP COL	[illegible]	1

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SAMPLING EVENTS
SAMPLE TYPE, SPRING

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
SP-BENNETT	SITE-218				FLOWING	08/03/78	5
	79-13				FLOWING	05/25/79	1
	85-362				FLOWING	09/20/85	1
	86-190				FLOWING	04/04/86	1
SP-BENSON	SITE-217				FLOWING	08/01/78	5
SP-BUTLER	79-1				FLOWING	06/07/79	1
SP-GULCH	84-359				FLOWING	07/19/84	1
SP-JUNIPER	SITE-215				FLOWING	07/29/78	5
	79-2				FLOWING	05/31/79	1
	81-115				FLOWING	06/26/81	1
	83-372				FLOWING	05/26/83	1
SP-ED-SNIVELY	79-34				FLOWING	05/18/79	1
	82-362				FLOWING	08/12/82	1
	83-396				FLOWING	05/19/83	1
SP-LOZIER	79-6				FLOWING	08/29/79	1
	81-186				FLOWING	06/30/81	1
	83-316				FLOWING	05/15/83	1
SP-MAIDEN	79-100				FLOWING	08/24/79	1
	83-420				FLOWING	07/21/83	1
SP-OBSERVATORY	81-119				FLOWING	07/02/81	1
	83-433				FLOWING	06/30/83	1
	84-392				FLOWING	05/25/84	1
	84-329				FLOWING	08/02/84	1
	85-359				FLOWING	09/18/85	1
	86-178				FLOWING	04/01/86	1
SP-RAILROAD	79-76				FLOWING	08/20/79	1
SP-RATTLESNAKE	SITE-216				FLOWING	07/31/78	5
	79-88				FLOWING	08/07/79	1
	83-412				FLOWING	07/28/83	1
SP-SNIVELY	79-49				FLOWING	06/23/79	1
SP-SULFUR	79-29				FLOWING	05/08/79	1
	83-409				FLOWING	07/21/83	1
SP-UNNAMED-02	79-75				FLOWING	07/26/78	1
SP-UNNAMED-16	79-73				FLOWING	08/04/79	1
SP-UNNAMED-26	79-98				FLOWING	08/13/79	1

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SAMPLING EVENTS
SAMPLE TYPE. SPRING

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
SP-UNNAMED-29	79-16				FLOWING	07/24/70	1
SP-UP-SNIVELY	79-71				FLOWING	03/[illegible]/79	1
	81-125				FLOWING	07/31/81	1
	83-503				FLOWING	09/08/83	1
	86-193				FLOWING	04/08/86	1
SP-UR2-07	85-343				FLOWING	08/29/85	1
	86-159				FLOWING	03/17/86	1
SP-UR6-20	85-346				FLOWING	08/29/85	1
	86-162				FLOWING	03/17/86	1
SP-UR7-22	85-349				FLOWING	08/29/85	1
	86-153				FLOWING	03/13/86	1
SP-WARM	84-358				FLOWING	07/13/84	1
SP-YR3-04	85-333				FLOWING	08/27/85	1
	86-150				FLOWING	03/13/86	1
SP-YR5-08	85-336				FLOWING	08/27/85	1
	86-147				FLOWING	03/19/86	1
SP-YR7-14	85-339				FLOWING	08/27/85	1
	86-156				FLOWING	[illegible]	1

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SAMPLING EVENTS
SAMPLE TYPE: SURFACE

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
COLD CREEK	84-317				DIP	08/01/84	1
	84-302				DIP	08/09/84	1
	85-223				DIP	05/01/85	1
CR-DC-14	83-258				DIP	03/16/83	1
CR-DC-15	81-68				DIP	03/23/81	1
	81-1				DIP	12/10/81	1
CR-HTS	SITE 221				DIP	07/25/78	5
CR-V-BR	84-330				DIP	08/01/84	1
	84-311				DIP	08/07/84	1
	85-206				DIP	04/11/85	1
	85-266				DIP	07/26/85	1
	86-70				DIP	11/06/85	1
	86-109				DIP	01/27/86	1
YR-BR	85-210				DIP	04/15/85	1
	85-260				DIP	07/26/85	1
	86-67				DIP	11/04/85	1
	86-113				DIP	01/29/86	1

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
RRL-06A	82-40	MIDDLE RINGOLD			PUMP	10/21/81	1
199-D04-04	SITE-41	UNCONFINED			PUMP	01/01/77	11
199-D05-12	SITE-80	UNCONFINED			PUMP	01/01/79	13
199-D08-03	SITE-72	UNCONFINED			PUMP	04/18/78	12
199-F05-01	SITE-82	UNCONFINED			PUMP	01/01/79	13
199-H04-03	SITE-81	UNCONFINED			PUMP	01/01/79	13
199-K-19	SITE-83	UNCONFINED			PUMP	01/01/79	13
199-N-15	SITE-42	UNCONFINED			PUMP	01/01/77	11
299-E26-08	SITE-165	UNCONFINED			PUMP	03/23/82	2
299-E33-12	SITE-169	UNCONFINED			PUMP	05/11/82	2
399-01-01	SITE-244	UNCONFINED			PUMP	07/01/83	17
399-01-03	SITE-43	UNCONFINED			PUMP	01/01/77	11
399-02-01	SITE-245	UNCONFINED			PUMP	07/01/83	17
399-03-01	SITE-246	UNCONFINED			PUMP	07/01/83	17
399-04-10	SITE-44	UNCONFINED			PUMP	01/01/77	11
399-08-04	SITE-140	UNCONFINED			PUMP	01/01/82	16
599-HAN-19	SITE-3	UNCONFINED			PUMP	01/01/74	8
699-S03-E12	SITE-22	UNCONFINED			PUMP	01/01/76	10
	SITE-141	UNCONFINED			PUMP	01/01/82	16
699-S03-25	SITE-7	UNCONFINED			PUMP	01/01/74	8
	SITE-142	UNCONFINED			PUMP	01/01/82	16
	86-55	UNCONFINED			PUMP	10/31/85	1
	86-130	UNCONFINED			PUMP	02/13/86	1
699-S06-E04D	SITE-11	UNCONFINED			PUMP	05/01/75	9
699-S08-19	SITE-46	UNCONFINED			PUMP	01/01/77	11
	SITE-84	UNCONFINED			PUMP	01/01/79	13
699-S11-E12A	SITE-4	UNCONFINED			PUMP	01/01/74	8
699-S12-03	SITE-45	UNCONFINED			PUMP	01/01/77	11

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SAMPLING EVENTS
SAMPLE TYPE UNCONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
699-S12-03	SITE-143	UNCONFINED			PUMP	01/01/82	16
699-S19-E13	SITE-120	UNCONFINED			PUMP	01/01/81	15
699-S24-19	85-213	UNCONFINED			PUMP	04/18/85	1
	85-291	UNCONFINED	60	82	PUMP	03/14/85	1
699-S29-E12	SITE-21	UNCONFINED			PUMP	01/01/76	10
699-S30-E15A	SITE-144	UNCONFINED			PUMP	01/01/82	16
699-01-18	SITE-145	UNCONFINED			PUMP	01/01/82	16
699-02-03	SITE-1	UNCONFINED			PUMP	01/01/74	8
699-02-33	SITE-85	UNCONFINED			PUMP	01/01/79	13
	SITE-146	UNCONFINED			PUMP	01/01/82	16
699-04-E06	SITE-47	UNCONFINED			PUMP	01/01/77	11
699-08-17	SITE-23	UNCONFINED			PUMP	01/01/76	10
699-08-25	SITE-32	UNCONFINED			PUMP	01/01/76	10
699-08-32	SITE-19	UNCONFINED			PUMP	06/01/75	9
699-09-E02	SITE-16	UNCONFINED			PUMP	06/01/75	9
699-10-E12	SITE-147	UNCONFINED			PUMP	01/01/82	16
	SITE-247	UNCONFINED			PUMP	07/01/83	17
699-11-45A	SITE-148	UNCONFINED			PUMP	01/01/82	16
	85-263	UNCONFINED			PUMP	07/25/85	1
	86-43	UNCONFINED			PUMP	10/24/85	1
	86-124	UNCONFINED			PUMP	02/07/86	1
699-13-01A	SITE-60	UNCONFINED			PUMP	04/19/78	12
699-14-38	SITE-61	UNCONFINED			PUMP	03/20/78	12
	SITE-86	UNCONFINED			PUMP	01/01/79	13
699-15-15B	SITE-13	UNCONFINED			PUMP	05/01/75	9
	SITE-149	UNCONFINED			PUMP	01/01/82	16
699-15-26	SITE-24	UNCONFINED			PUMP	[illegible]/01/76	10
	SITE-150	UNCONFINED			PUMP	01/01/82	16
699-17-05	SITE-18	UNCONFINED			PUMP	[illegible]/01/75	9
	SITE-151	UNCONFINED			PUMP	01/01/82	16

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
699-18-43	SITE-48	UNCONFINED			PUMP	01/01/77	11
	SITE-121	UNCONFINED			PUMP	01/01/81	15
699-19-58	85-220	UNCONFINED			PUMP	05/06/85	1
	85-260	UNCONFINED			PUMP	07/24/85	1
	86-40	UNCONFINED			PUMP	10/30/85	1
	86-121	UNCONFINED			PUMP	02/07/86	1
699-19-88	85-278	UNCONFINED			PUMP	08/01/85	1
	86-54	UNCONFINED			PUMP	11/01/85	1
	86-127	UNCONFINED			PUMP	02/12/86	1
699-20-E05-0	SITE-49	UNCONFINED			PUMP	01/01/77	11
699-20-20	SITE-25	UNCONFINED			PUMP	01/01/76	10
699-24-33	SITE-28	UNCONFINED			PUMP	01/01/78	10
699-24-46	SITE-122	UNCONFINED			PUMP	01/01/81	15
699-24-95	85-288	UNCONFINED			PUMP	08/[illegible]/85	1
	86-61	UNCONFINED			PUMP	11/0[illegible]/85	1
	86-115	UNCONFINED			PUMP	01/29/86	1
699-25-55	SITE-100	UNCONFINED			PUMP	[illegible]/01/80	14
699-26-15	SITE-26	UNCONFINED			PUMP	01/01/76	10
699-26-15A	SITE-263	UNCONFINED			PUMP	05/06/84	15
699-27-04	SITE-101	UNCONFINED			PUMP	01/01/[illegible]	[illegible]
699-27-08	SITE-5	UNCONFINED			PUMP	01/01/74	8
	SITE-30	UNCONFINED			PUMP	01/01/76	10
	SITE-50	UNCONFINED			PUMP	01/01/77	11
	SITE-76	UNCONFINED			PUMP	04/17/78	12
	SITE-87	UNCONFINED			PUMP	01/01/79	13
699-28-40	SITE-68	UNCONFINED			PUMP	04/19/78	12
699-31-31	SITE-69	UNCONFINED			PUMP	[illegible]/17/78	[illegible]
	SITE-102	UNCONFINED			PUMP	01/01/80	14
699-31-53B	SITE-88	UNCONFINED			PUMP	01/01/79	13
699-32-22	SITE-17	UNCONFINED			PUMP	[illegible]5/01/75	9
	SITE-27	UNCONFINED			PUMP	[illegible]/01/76	10
	SITE-51	UNCONFINED			PUMP	01/01/77	11
	SITE-65	UNCONFINED			PUMP	01/01/78	12
	SITE-89	UNCONFINED			PUMP	01/01/79	13

SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	Sample Event Code	Producing Zone	Packer Top	Packer Bottom	Sampling Method	Date	Source
699-32-70B	SITE-70	UNCONFINED			PUMP	01/01/78	12
	SITE-90	UNCONFINED			PUMP	01/01/79	13
	SITE-152	UNCONFINED			PUMP	01/01/82	16
699-32-72	SITE-35	UNCONFINED			PUMP	01/01/76	10
699-32-77	SITE-103	UNCONFINED			PUMP	01/01/80	14
699-33-42	SITE-12	UNCONFINED			PUMP	05/01/75	9
	SITE-29	UNCONFINED			PUMP	01/01/76	10
	SITE-52	UNCONFINED			PUMP	01/01/77	11
	SITE-67	UNCONFINED			PUMP	04/20/78	12
	SITE-91	UNCONFINED			PUMP	01/01/79	13
699-33-56	SITE-8	UNCONFINED			PUMP	01/01/74	8
	SITE-40	UNCONFINED			PUMP	01/01/76	10
	SITE-53	UNCONFINED			PUMP	01/01/77	11
	SITE-62	UNCONFINED			PUMP	04/20/78	12
	SITE-92	UNCONFINED			PUMP	01/01/79	13
699-34-39A	SITE-93	UNCONFINED			PUMP	01/01/79	13
699-34-42	SITE-33	UNCONFINED			PUMP	01/01/76	10
	SITE-153	UNCONFINED			PUMP	01/01/82	16
699-34-51	SITE-66	UNCONFINED			PUMP	04/20/78	12
699-35-09	SITE-31	UNCONFINED			PUMP	01/01/76	10
	SITE-104	UNCONFINED			PUMP	01/01/80	14
	SITE-264	UNCONFINED			PUMP	05/04/84	18
699-35-66	SITE-77	UNCONFINED			PUMP	04/18/78	12
	SITE-94	UNCONFINED			PUMP	01/01/79	13
699-35-70	SITE-36	UNCONFINED			PUMP	01/01/76	10
699-35-78	SITE-54	UNCONFINED			PUMP	01/01/77	11
699-36-61A	SITE-95	UNCONFINED			PUMP	01/01/79	13
699-37-43	SITE-34	UNCONFINED			PUMP	01/01/76	10
	SITE-173	UNCONFINED			PUMP	08/13/82	2
699-37-82A	SITE-105	UNCONFINED			PUMP	01/01/80	14
699-38-70	SITE-37	UNCONFINED			PUMP	01/01/76	10
699-39-13	SITE-248	UNCONFINED			PUMP	07/01/83	17
699-39-01	SITE-249	UNCONFINED			PUMP	07/01/83	17

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
699-39-39	SITE-266	UNCONFINED			PUMP	06/04/84	18
699-40-01	SITE-10	UNCONFINED			PUMP	06/01/75	9
	SITE-106	UNCONFINED			PUMP	01/01/80	14
	SITE-250	UNCONFINED			PUMP	07/01/83	17
	SITE-265	UNCONFINED			PUMP	06/04/84	18
699-40-33	SITE-55	UNCONFINED			PUMP	01/01/77	11
	SITE-251	UNCONFINED			PUMP	07/01/83	17
699-40-62	SITE-56	UNCONFINED			PUMP	01/01/77	11
699-41-01	SITE-252	UNCONFINED			PUMP	07/01/83	17
699-41-23	SITE-15	UNCONFINED			PUMP	06/01/75	9
	SITE-113	UNCONFINED			PUMP	01/01/80	14
699-42-02	SITE-154	UNCONFINED			PUMP	01/01/82	16
699-42-12	SITE-2	UNCONFINED			PUMP	01/01/74	8
	SITE-155	UNCONFINED			PUMP	01/01/82	15
	SITE-267	UNCONFINED			PUMP	08/04/84	18
699-42-40A	SITE-174	UNCONFINED			PUMP	[illegible]/82	[illegible]
699-42-40C	SITE-175	UNCONFINED			PUMP	01/19/82	2
699-42-42	SITE-114	UNCONFINED			PUMP	01/01/80	14
699-43-03	SITE-253	UNCONFINED			PUMP	07/01/83	17
699-43-88	SITE-123	UNCONFINED			PUMP	01/01/81	15
699-44-04	SITE-254	UNCONFINED			PUMP	07/01/83	17
699-45-04	SITE-255	UNCONFINED			PUMP	07/01/83	17
699-45-42	SITE-57	UNCONFINED			PUMP	01/01/77	11
	SITE-268	UNCONFINED			PUMP	08/04/84	18
699-45-69	SITE-96	UNCONFINED			PUMP	01/01/79	13
699-46-05	SITE-156	UNCONFINED			PUMP	01/01/82	16
	SITE-256	UNCONFINED			PUMP	07/01/83	17
699-46-21A	SITE-75	UNCONFINED			PUMP	04/[illegible]/78	12
	SITE-124	UNCONFINED			PUMP	01/01/81	15
699-47-06	SITE-257	UNCONFINED			PUMP	07/01/83	17

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
699-47-46	SITE-269	UNCONFINED			PUMP	06/04/84	18
699-48-07	SITE-258	UNCONFINED			PUMP	07/01/83	17
699-48-18	SITE-125	UNCONFINED			PUMP	01/01/81	15
699-48-71	SITE-59	UNCONFINED			PUMP	01/01/77	11
699-49-13	SITE-259	UNCONFINED			PUMP	07/01/83	17
699-49-55	SITE-9	UNCONFINED			PUMP	01/01/74	8
	SITE-39	UNCONFINED			PUMP	01/01/76	10
	SITE-58	UNCONFINED			PUMP	01/01/77	11
	SITE-78	UNCONFINED			PUMP	04/17/78	12
	SITE-97	UNCONFINED			PUMP	01/01/79	13
	SITE-126	UNCONFINED			PUMP	01/01/81	15
	SITE-157	UNCONFINED			PUMP	01/01/82	16
699-49-55A	SITE-182	UNCONFINED			PUMP	03/11/82	2
699-49-57	SITE-38	UNCONFINED			PUMP	01/01/76	10
699-49-79	SITE-20	UNCONFINED			PUMP	06/01/75	9
699-50-08	SITE-64	UNCONFINED			PUMP	04/19/78	12
699-50-28B	SITE-63	UNCONFINED			PUMP	04/19/78	12
699-50-42	SITE-14	UNCONFINED			PUMP	06/01/75	9
	SITE-115	UNCONFINED			PUMP	01/01/80	14
	SITE-271	UNCONFINED			PUMP	06/04/84	18
699-50-53	SITE-270	UNCONFINED			PUMP	06/04/84	18
699-50-85	SITE-127	UNCONFINED			PUMP	01/01/81	15
699-51-63	SITE-118	UNCONFINED			PUMP	01/01/80	14
699-53-103	SITE-160	UNCONFINED			PUMP	01/01/77	11
699-53-47B	SITE-272	UNCONFINED			PUMP	06/04/84	18
699-54-34	SITE-273	UNCONFINED			PUMP	06/04/84	18
699-55-50C	SITE-79	UNCONFINED			PUMP	04/17/78	12
	SITE-128	UNCONFINED			PUMP	01/01/81	15
	SITE-193	UNCONFINED			PUMP	03/09/82	2
	SITE-274	UNCONFINED			PUMP	06/04/84	18
699-55-76	SITE-71	UNCONFINED			PUMP	04/18/78	12

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SAMPLING EVENTS
SAMPLE TYPE. UNCONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
699-55-76	SITE-117	UNCONFINED			PUMP	01/01/80	14
	SITE-120	UNCONFINED			PUMP	01/01/81	15
699-55-89	SITE-118	UNCONFINED			PUMP	01/01/80	14
699-56-53	SITE-194	UNCONFINED			PUMP	01/11/82	2
	SITE-195	UNCONFINED			PUMP	01/11/82	2
699-57-25A	SITE-119	UNCONFINED			PUMP	01/01/80	14
	SITE-275	UNCONFINED			PUMP	08/04/84	18
699-57-29A	SITE-276	UNCONFINED			PUMP	08/04/84	18
699-57-83	SITE-130	UNCONFINED			PUMP	01/01/81	15
699-59-58	SITE-107	UNCONFINED			PUMP	01/01/80	14
	SITE-277	UNCONFINED			PUMP	06/04/84	18
699-60-32	SITE-278	UNCONFINED			PUMP	08/04/84	18
699-60-57	SITE-198	UNCONFINED			PUMP	02/10/82	2
699-62-31	SITE-131	UNCONFINED			PUMP	01/01/81	15
	SITE-279	UNCONFINED			PUMP	08/04/84	18
699-63-25A	SITE-132	UNCONFINED			PUMP	01/01/81	15
699-63-55	SITE-280	UNCONFINED			PUMP	06/04/84	18
699-63-58	SITE-281	UNCONFINED			PUMP	08/04/84	18
699-63-90	SITE-74	UNCONFINED			PUMP	04/18/78	12
	SITE-133	UNCONFINED			PUMP	01/01/81	15
699-64-27	SITE-158	UNCONFINED			PUMP	01/21/82	16
699-65-50	SITE-73	UNCONFINED			PUMP	04/18/78	12
	SITE-134	UNCONFINED			PUMP	01/01/81	15
	SITE-282	UNCONFINED			PUMP	08/04/84	18
699-66-103	85-203	UNCONFINED			PUMP	04/11/85	1
	86-73	UNCONFINED			PUMP	11/08/85	1
	86-112	UNCONFINED			PUMP	[illegible]/86	1
	85-294	UNCONFINED		124	PUMP	05/15/85	1
699-66-39	SITE-135	UNCONFINED			PUMP	01/01/81	15
699-66-58	SITE-136	UNCONFINED			PUMP	01/01/81	15
699-66-64	SITE-137	UNCONFINED			PUMP	01/01/81	15

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	PRODUCING ZONE	PACKER TOP	PACKER BOTTOM	SAMPLING METHOD	DATE	SOURCE
699-67-98	SITE-260	UNCONFINED			PUMP	07/01/83	17
699-69-38	SITE-6	UNCONFINED			PUMP	01/01/74	8
699-71-30	SITE-108	UNCONFINED			PUMP	01/01/80	14
699-71-52	SITE-138	UNCONFINED			PUMP	01/01/81	15
699-72-73	SITE-109	UNCONFINED			PUMP	01/01/80	14
699-72-88	SITE-98	UNCONFINED			PUMP	01/01/79	13
	SITE-261	UNCONFINED			PUMP	07/01/83	17
699-72-92	SITE-262	UNCONFINED			PUMP	07/01/83	17
699-77-36	SITE-110	UNCONFINED			PUMP	01/01/80	14
699-78-62	SITE-111	UNCONFINED			PUMP	01/01/80	14
699-81-58	SITE-159	UNCONFINED			PUMP	01/01/82	16
699-83-47	SITE-112	UNCONFINED			PUMP	01/01/80	14
699-87-55	SITE-99	UNCONFINED			PUMP	01/01/79	13
699-90-45	SITE-139	UNCONFINED			PUMP	01/01/81	15

LIST OF REFERENCE DOCUMENTS BY SOURCE NUMBER

SOURCE NUMBER	REFERENCE DOCUMENT
1	SAMPLES COLLECTED BY THE BASALT WASTE ISOLATION PROJECT (BWIP). ANALYSES OF MOST MAJOR AND TRACE SPECIES DONE BY THE BWIP SOLUTION CHEMISTRY LABORATORY OR ITS PREDECESSOR (RESEARCH AND ENGINEERING LABORATORY-ROCKWELL). ANALYSES OF OTHER SPECIES DONE BY VENDOR LABORATORIES. ORIGINAL RECORDS FOR ANALYSES PERFORMED BY THE BWIP SOLUTION CHEMISTRY LABORATORY PRIOR TO APPROXIMATELY SEPTEMBER 1, 1985 ARE FOUND IN LABORATORY NOTEBOOKS STORED WITHIN THE SOLUTION AND SOLIDS CHARACTERIZATION GROUP. PERMANENT RECORDS GENERATED AFTER THAT DATE ARE KEPT IN THE BASALT RECORDS MANAGEMENT CENTER (BRMC). ORIGINAL RECORDS FOR ALL VENDOR SUPPLIED ANALYSES ARE ON FILE WITHIN THE HYDROCHEMISTRY UNIT. IN THE FUTURE, THE PERMANENT RECORDS FOR ALL HYDROCHEMICAL DATA WILL BE ON FILE WITH THE BRMC.
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3	STRAIT, S. R. AND MOORE, B. A., 1982, GEOHYDROLOGY OF THE RATTLESNAKE RIDGE INTERBED IN THE GABLE MOUNTAIN POND AREA, RHO-ST-38, ROCKWELL HANFORD OPERATIONS, RICHLAND, WASHINGTON.
4	LASALA, A. M., JR. AND DOTY, G. C., 1971, PRELIMINARY EVALUATION OF HYDROLOGIC FACTORS RELATED TO RADIOACTIVE WASTE STORAGE IN BASALTIC ROCKS AT THE HANFORD RESERVATION, WASHINGTON, OPEN-FILE REPORT, U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C.
5	APPS, J., DOE, T., DOTY, B., DOTY, S., GALBRAITH, R., KEARNS, [illegible], KORBT, B., LONS, J., MONROE, A., NARASIMHAN, T. N., NELSON, P., WILSON, C. R., AND WITHERSPOON, P. A., 1979, GEOHYDROLOGIC STUDIES FOR NUCLEAR WASTE ISOLATION AT THE HANFORD RESERVATION, LBL-8764, VOL. 2, LAWRENCE BERKELEY LABORATORY, BERKELEY, CALIFORNIA.
6	DATA FROM U. S. GEOLOGICAL SURVEY DATA FILE, 1978, AS REPORTED IN: SUMMERS, W. K. AND WEBER, P. A., 1978, DATA FOR WELLS PENETRATING BASALT IN THE PASCO BASIN AREA, WASHINGTON, RHO-BWI-C-19, 6 VOL., ROCKWELL HANFORD OPERATIONS, RICHLAND, WASHINGTON.
7	LASALA, A. M., JR., DOTY, G. C., AND PEARSON, F. J., JR., [illegible] A PRELIMINARY EVALUATION OF REGIONAL GROUNDWATER FLOW IN SOUTH-CENTRAL WASHINGTON, OPEN-FILE REPORT, U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C.
8	RAYMOND, J. R., MYERS, D. A., FIX, J. J., MCGHAN, V. L., AND SCHMIDT, P. M., 1976, ENVIRONMENTAL MONITORING REPORT ON THE RADIOLOGICAL STATUS OF GROUNDWATER BENEATH THE HANFORD SITE, JANUARY-DECEMBER, [illegible] BNWL-1970, BATTELLE, PACIFIC NORTHWEST LABORATORIES, RICHLAND, WASHINGTON.

LIST OF REFERENCE DOCUMENTS BY SOURCE NUMBER

SOURCE NUMBER	REFERENCE DOCUMENT
9	MYERS, D. A., FIX, J. J., PLUMMER, P. J., RAYMOND, J. R., MCGHAN, V. L. AND HILTY, E. L., 1976, ENVIRONMENTAL MONITORING REPORT OF GROUNDWATER BENEATH THE HANFORD SITE, JANUARY-DECEMBER 1975, BNWL-2034, BATTELLE, PACIFIC NORTHWEST LABORATORIES, RICHLAND, WASHINGTON.
10	MYERS, D. A., FIX, J. J., AND RAYMOND, J. R. 1977, ENVIRONMENTAL MONITORING REPORT OF GROUNDWATER BENEATH THE HANFORD SITE, JANUARY-DECEMBER 1976, BNWL-2199, BATTELLE PACIFIC NORTHWEST LABORATORIES, RICHLAND, WASHINGTON.
11	MYERS, D. A., 1978, ENVIRONMENTAL MONITORING REPORT ON THE STATUS OF GROUNDWATER BENEATH THE HANFORD SITE, JANUARY-DECEMBER 1977, PNL-2624, PACIFIC NORTHWEST LABORATORIES, RICHLAND, WASHINGTON.
12	EDDY, P. A., 1979, RADIOLOGICAL STATUS OF THE GROUNDWATER BENEATH THE HANFORD PROJECT, JANUARY DECEMBER 1978, PNL-2899, PACIFIC NORTHWEST LABORATORY, RICHLAND, WASHINGTON.
13	EDDY, P. A. AND WILBUR, J. S., 1980, RADIOLOGICAL STATUS OF THE GROUNDWATER BENEATH THE HANFORD SITE, JANUARY-DECEMBER 1979, PNL-3346, PACIFIC NORTHWEST LABORATORY, RICHLAND, WASHINGTON.
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15	EDDY, P. A., CLINE, C. S., PRATER, L. A., 1982, RADIOLOGICAL STATUS OF THE GROUNDWATER BENEATH THE HANFORD SITE, JANUARY-DECEMBER 1981, PNL-4237, PACIFIC NORTHWEST LABORATORY, RICHLAND, WASHINGTON.
16	EDDY, P. A., PRATER, L. S., RIEGER, J. T., 1983, GROUNDWATER SURVEILLANCE OF THE HANFORD SITE FOR CY1982, PNL-4659, PACIFIC NORTHWEST LABORATORY, RICHLAND, WASHINGTON.
17	PRATER, L.S., J.T. RIEGER, C.S.CLINE, E.J. JENSEN, T.L. LIIKALA, AND K.R. OSTER, 1984, GROUND-WATER SURVEILLANCE AT THE HANFORD SITE FOR CY 1983, PNL-5041 PACIFIC NORTHWEST LABORATORY, RICHLAND, WASHINGTON.
18	CLINE, C.S., J.T. RIEGER, AND J.R. RAYMOND, 1985, GROUND-WATER MONITORING AT THE HANFORD SITE, JANUARY DECEMBER 1984, PNL-5408 PACIFIC NORTHWEST LABORATORY, RICHLAND, WASHINGTON.

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SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
BLRK	85-255	7.85	7.80	268.00			-180.00	22.7
DB-01	81-19	8.55	8.24	438.00		0.18	-110.00	19.1
	81-65	8.95	8.90	491.00		1.00	-190.00	23.9
	82-27		8.67	473.00		0.31	-260.00	19.9
	85-32	8.95	9.05	482.00		0.40	-245.00	20.6
DB-02	79-65							24.0
	81-13	8.66	8.43	463.00		2.00		16.5
	81-10		8.67	496.00		1.90		20.9
DB-04	79-77							23.5
DB-07	79-89							22.0
	83-413	9.45	9.35	528.00		0.14	-380.00	24.6
	85-216	9.05	9.15	530.00		19.00	-220.00	20.0
DB-09	79-28							22.0
	83-472	8.50	8.50	311.00		0.18	-240.00	22.4
DB-11	85-4		8.10	274.00		0.32	·	26.5
	85-15		8.10	259.00		0.17		27.7
	85-18	8.10	8.10	262.00			-230.00	27.1
	86-52	8.11	7.95	277.00		1.60	-250.00	26.5
	86-103							
	81-57		8.19	277.00				26.4
DB-12	83-95		8.05		320.00			15.8
	81-25		8.46	301.00		1.60	140.00	17.1
DB-13	80-159							
	83-404	8.35	8.35	301.00		0.28	-300.00	27.5
DB-14	81-162	9.31		714.00		0.73		25.0
DB-15	79-17		7.00		317.80			17.4
	79-35	7.80			327.00			19.6
	79-33		8.10		342.00			21.2
	79-15		8.20		382.00			22.0
	79-39		8.70		427.50			22.1
	79-31		8.70		450.30			22.8
	79-25							22.8
	79-51		9.50					23.0
	79-85		9.67		798.20			24.0
	79-80		9.63		790.30			23.9
	79-62		9.33		741.60			20.6
	79-90		9.31		738.60			22.4
	80-35		9.41		747.10			24.2
	80-24		9.53		758.90			25.4
	80-77		9.38		737.30			23.1
	80-1		9.44		764.40	0.28		25.1
DC-01	STIE-210	8.10			314.00			
	STIE-226	8.50			351.00			
	STIE-227	9.20	9.62		580.00			
	STIE-228	9.40	9.58		664.00			
	STIE-229	9.50	9.61		707.00			
	STIE-231	8.90			353.00			
	STIE-232	8.60	8.60		344.00			
	STIE-233	8.90			402.00			
	STIE-234	9.30			552.00			

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SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
DC-01	SITE-235	9.50	9.70		773.00			
	SITE-236	10.20	10.43		804.00			
	SITE-237	9.70	9.94		839.00			
	SITE-238	8.90	8.10		403.00			
	SITE-239	9.60	10.12		867.00			
	SITE-240	9.90	9.79		860.00			
	SITE-241	9.9[illegible]	[illegible]		85[illegible]			
	SITE-242	9.70	9.70		8[illegible]			
	SITE-243	8.90	9.10		630.00			
DC-02-A2	80-[illegible]		[illegible].80					22.9
	SITE-213	9.80	9.90		84[illegible]			33.4
DC-03	80-27		10.80					
DC-05	79-30	9.00			1790.00			
DC-06	80-161	9.90						21.0
	80-72							
	SITE-214	10.10	10.10		1060.[illegible]			3[illegible]
	80-238		10.20		1128.[illegible]	0.27	-330.00	41.0
	80-191		9.62		1326.00	0.36	-380.00	21.0
	80-13		8.55					24.9
	79-59							
	81-45		10.05	1291.70		0.27	-360.00	18.8
	80-118		9.71		1539.[illegible]	2.10		18.5
	80-15		9.75		1576.00	0.13		22.3
	81-82	9.70	9.40	1666.00		0.08	-450.00	37.5
	80-29		10.44		988.70	0.21		44.7
	79-58		10.00		1[illegible]			[illegible].4
	80-75		10.50		1062.00	[illegible]		43.2
DC-07	82-23	9.15	9.89	1110.00		4.90	-420.00	25.3
	82-10	9.26	9.57	1126.00		15.00	-440.00	25.0
	80-39		8.40					19.4
	80-11		8.50					23.0
	79-52		9.10					
	80-103		9.83		1527.[illegible]	[illegible].18		19.0
	80-188		8.95					25.5
	80-196		9.48		1276.00		-60.00	25.4
DC-12	80-80		9.21		672.[illegible]	4.00		22.0
	80-100		9.40		653.20	0.13		23.0
	80-97		9.45		653.[illegible]	0.20		22.6
	80-32		9.5[illegible]		72[illegible]	0.25		23.9
	80-82		9.4[illegible]		70[illegible]	55.00		21.6
	80-124		9.38		661.50	0.18		24.1
	80-101							20.9
	80-174		9.5[illegible]		70[illegible]	1.70	-210.00	20.8
	80-209		9.14		746.40		-165.00	24.7
	80-233		9.46				-250.00	25.1
	80-234		10.1[illegible]		90[illegible]	2.30	-300.00	26.1
	81-61	9.44	9.52	776.00		0.20		41.7
	82-85		9.52	744.00		0.51	-255.00	2[illegible].0
DC-14	80-3		8.35			[illegible]		[illegible].9
	80-53		8.10		253.0[illegible]	0.27		25.7

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SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
DC-14	80-47		7.65		281.88	0.19		20.0
	80-69		9.41		353.60	0.16		19.3
	80-99		9.66		390.00	0.12		19.6
	80-89		9.22		351.70	0.18		23.8
	80-71		9.44		396.00	0.18		17.7
	80-144		8.84		315.80	0.15		24.1
	80-189		8.80		325.90	0.20		23.5
	80-112		8.75		323.00	0.10	-120.00	28.3
	80-157		9.45		357.50	0.02	45.00	20.1
	80-155		9.41		361.00	0.11	-215.00	30.7
	80-104		9.57		359.15	0.24	-120.00	24.7
	80-129		9.44		358.80	0.19	-210.00	30.3
	80-170		9.38		351.40	0.34	-225.00	34.5
	80-117		9.65		421.40	0.16	-300.00	36.2
	80-213		9.69		757.40	0.45	-270.00	27.9
	81-20		9.61	1340.00		0.54	-350.00	32.0
	81-30	9.50	9.59	1458.00		0.39	-280.00	19.8
	81-44	9.70	9.72	1543.00		0.10	-295.00	14.2
	81-141	9.74		1523.00				
	82-8		9.64	1510.00		0.41	-418.00	28.5
	82-315							
	83-156	9.21	9.53	1550.00		0.50	-290.00	31.2
	83-152	9.15		1559.00		0.35	-310.00	29.4
	83-157	9.19	9.20	1553.00		0.25	-320.00	30.0
	83-178	9.20	9.60	1559.00		0.34		29.7
	83-183	9.14	9.30	1576.00		0.35	-320.00	30.2
	83-154	9.10	9.33	1572.00		0.35		30.2
	83-150	9.20		1573.00		0.37	-300.00	30.5
	83-266	9.10	9.30	1570.00		0.35	-300.00	30.5
	83-261	9.20	9.60	1584.00		0.50	-325.00	35.1
DC-15	80-56		7.80		364.10	0.48		17.0
	80-54		8.25		301.90	1.00		13.1
	80-57		8.06		179.50	0.17		20.6
	80-87		8.27		477.00	15.00		19.7
	80-137		9.42		419.50	0.30		22.7
	80-176		9.31		450.00	0.26	-240.00	25.6
	80-135		9.43		65900.00	0.21	-300.00	27.2
	80-120		9.36		515.70	0.31	-140.00	[illegible]
	80-131		9.54		583.60	0.12	-380.00	27.7
	80-193		9.63		627.60	0.35	-420.00	29.0
	81-41		9.13	1070.00		0.10	-90.00	28.5
	81-2		9.34	1148.00		1.30	70.00	23.2
	81-46		9.27	1119.00		0.62		2[illegible]
	81-33		9.13	1248.00		0.12	-300.00	29.5
	81-27	9.70	9.46	1246.00		[illegible]	-420.00	27.5
	81-64	9.16	9.20	1771.00		17.00		23.3
	81-96	9.23	8.80	1340.00		4.10		32.8
	81-69	9.16	9.02	1334.00		1.20	[illegible]	27.[illegible]
	82-94	9.30	9.81	1192.00			-330.00	18.6
DC-16A	81-109	8.69	8.32	494.00		0.23	-330.00	21.0

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SAMPLING EVENTS
SAMPLE TYPE: CONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
DC-16A	82-17	8.04	7.25	293.00		0.18	-245.00	24.1
	82-93		8.86	340.00		0.36	-310.00	25.4
	82-19	9.38	9.14	795.00		1.00	-450.00	29.7
	82-188	9.09	9.43	878.00		0.52	-405.00	21.5
	82-124	9.05	9.39	607.00		0.40	-335.00	23.8
	82-143	9.11	9.44	1236.00		5.40	-425.00	22.4
	82-231		9.07					
	82-202		9.07	1230.00		0.50	-170.00	31.6
	82-322	8.95	9.11	1673.00		0.14		34.2
	82-339							28.1
	82-332	9.00	9.30	1663.00		0.24	-375.00	36.0
	82-419							23.4
	82-430	9.32	9.45	1738.00		0.35	-390.00	23.4
	83-29	9.18	9.51	1746.00		0.51	-350.00	25.0
DC-16B	83-147	7.20	7.28	288.00		0.30	-205.00	29.4
DC-16C	83-100	8.76	9.20					29.7
	83-259	8.40	8.80	920.00		0.13		30.5
DC-18	86-166	9.28	9.18	388.00		5.00	-215.00	21.5
DC-19C	84-53	8.50	8.60	941.00		0.35	-370.00	28.7
	84-40	9.00		942.00		0.57	-100.00	24.0
	84-75	8.75	8.85	1009.00		2.20	-250.00	24.4
	84-86	9.05	8.95	888.00		[illegible]	-330.00	23.3
DC-20C	84-9	9.05	9.05	844.00		0.33	60.00	32.3
DC-22C	84-105	9.00	9.15	639.00		[illegible]	-310.00	30.5
DC-23GR	86-133	9.41	9.30	705.00		[illegible]	-255.00	29.0
	86-141	9.42	9.25	632.00		6.30	-355.00	[illegible]
	86-181	9.94	9.92	602.00		4.60	-410.00	29.5
ENYEART	SITE-209		7.70		277.00			23.0
	SITE-210		8.50		290.00			
	84-166	8.13	8.05	280.00		0.11	-210.00	22.0
	85-1		[illegible]	280.00		[illegible]		[illegible]
	85-180	8.05	7.95	270.00		0.32	-140.00	20.2
FORD	SITE-206		7.80		291.00			23.9
	SITE-207		8.00		295.00			24.2
	SITE-219		8.00		300.00			[illegible]
	85-188	8.00	8.05	283.00		0.28	-210.00	[illegible]
	85-303	8.02	7.75	289.00		0.45	-225.00	24.3
[illegible]	SITE-224		8.10		[illegible]			
	SITE-222		8.10		[illegible]			[illegible]
	SITE-223		8.10		[illegible]			[illegible]
	SITE-225		8.20		[illegible]			
	SITE-220		[illegible]		[illegible]			[illegible]
	82-7	6.88	7.68	283.00		0.18	-300.00	[illegible]
	85-175	8.05	8.05	262.00		0.23	-155.00	[illegible]
	85-300	7.95	7.90	278.00		0.20	-245.00	[illegible]
	86-34	8.00	7.95	278.00		0.37	-250.00	24.9
	80-64		[illegible]		278.00	0.29		29.3
	81-79	8.11	7.85	280.00		0.23	-250.00	24.3
	81-54	8.09	7.69	281.00		[illegible]	-205.00	25.0
	82-64	6.60	7.68	280.00		0.15	-365.00	25.3

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SAMPLING EVENTS
SAMPLE TYPE. CONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
MCGEE	82-263	7.37	7.70	271.00		0.15	-250.00	26.7
	82-397	7.10	8.11	283.00		0.19	-200.00	28.2
	82-424	7.40	7.45	284.00		0.25	-170.00	30.5
	82-436	8.11	7.80	288.00		0.10	-100.00	31.7
	83-32	7.65	7.56	281.00		0.25	-150.00	20.4
	83-83	7.60	8.16	288.00		0.27	-230.00	31.8
	83-188	7.98	8.00	282.00		0.25	-210.00	31.8
	83-373	9.40	9.40	388.00		0.20	-350.00	27.3
	83-331	8.90	9.05	380.00		0.72	-350.00	27.8
	83-460	9.25	9.45	395.00		0.39	-350.00	26.3
	83-476	9.40	9.40	389.00		0.23	-300.00	26.6
	83-513	9.55	9.50	524.00		0.54	-340.00	27.9
	84-24	9.31	9.45	582.00		1.10	-410.00	25.8
DURIAN	85-194	7.95	7.85	284.00		0.42	-205.00	19.0
RRL-02	82-68	9.09	9.14	810.00		0.32	-160.00	5.5
	82-65	8.94	9.32	683.00		0.15	-385.00	21.8
	82-170	8.60	8.30	1408.00		11.00		29.1
	82-122	8.60	8.76	1856.00		0.28	-405.00	26.9
	82-401	9.60	9.71	1616.00		0.57	-290.00	23.4
	84-7	9.60	9.60	1632.00		10.00	-365.00	19.5
	82-364	9.38	9.41	1740.00		0.25	-220.00	29.4
	82-309	9.30	9.34					25.9
	82-456	9.75	9.78	1747.00		42.00	-300.00	22.3
RRL-06B	83-25							
RRL-14	82-403	9.40	9.48	1634.00		0.53	-50.00	22.9
	84-11							
	83-151							
	83-49							
STEM 1	85-252	7.75	7.95	295.00		0.22	-170.00	19.5
	85-297	8.01	8.05	302.00		1.60	-140.00	19.9
	86-31	8.12	7.80	302.00		0.50	-150.00	19.5
STEM 2	86-19	8.20	8.05	293.00		0.30	-25.00	19.5
299-E16-01	STIE-161	8.60	9.05		325.00			23.3
	STIE-162	8.30	8.45		380.00			22.9
	STIE-163	8.80	8.35		370.00			22.8
	STIE-164	8.60	8.30		340.00			23.2
299-E26-08	STIE-166	8.40	8.50		360.00			21.3
	STIE-167	8.30	8.35		370.00			19.5
	STIE-168	8.30			375.00			20.6
299-E33-12	STIE-170	9.10	9.75		345.00			20.3
	STIE-171	9.00	9.45		305.00			19.7
	STIE-172	8.90	9.25		315.00			19.9
699-S11-E12A	80-61		8.15		247.80	0.12		15.5
	80-180		8.04		356.00	0.14	-190.00	17.1
699-42-40C	STIE-176	7.80	7.70		425.00			18.0
	STIE-177	9.00	8.75		365.00			18.4
	STIE-178	8.30			260.00			19.8
	STIE-179	8.20	8.45		330.00			19.5
	STIE-180							
699-47-50	STIE-205		7.50		521.60			13.3

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SAMPLING EVENTS
SAMPLE TYPE. CONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
699-47-50	SITE-181	7.80	7.80		550.00			10.4
699-49-55B	SITE-183	7.60	7.80		375.00			18.1
	SITE-184	7.60	7.80		365.00			18.4
	SITE-185	7.50						19.0
699-50-45	SITE-203		7.40		301.10			16.8
	SITE-186	8.20	7.60		410.00			17.6
699-50-48	SITE-204		7.50		320.30			18.4
	SITE-187	8.20	7.60		470.00			19.8
699-51-46	SITE-188	8.80	8.50		320.00			17.3
	SITE-201		8.90		254.80			16.5
699-52-46A	SITE-202		7.40		313.40			17.8
	SITE-189	8.00	7.65		[illegible]			18.4
699-52-48	SITE-199		7.40		[illegible]			16.8
	SITE-190	8.00	8.05		400.00			17.9
699-53-50	SITE-191	7.60	7.65		365.00			17.[illegible]
	SITE-200		7.20		308.30			18.8
699-54-57	SITE-192	7.60	7.80		350.00			17.7
699-56-53	SITE-196	7.50	7.75					17.4
	SITE-197	7.60	7.85					18.4

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SAMPLING EVENTS
SAMPLE TYPE: PRECIPITATION

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
STATION-03	82-89							2.0
	82-51							
	82-81							7.6
	82-78							10.0
	82-179							9.0
	82-138							20.0
	83-90							14.0
	83-46							17.0
	83-118							10.0
	83-189							10.5
	83-114							8.5
	83-143							14.0
	83-277							17.0
STATION-04	82-15							0.7
	82-61							
	82-60							7.2
	82-90							9.0
	82-120							8.0
	82-117							18.0
	83-36							12.0
	83-84							21.0
	83-141							7.0
	83-116							3.0
	83-110							1.0
	83-155							
	83-102							9.5
	83-165							5.0
	83-180							13.0
	83-250							16.0
STATION-07	82-46							2.2
	82-92							
	82-57							9.5
	82-44							11.0
	82-136							10.0
	82-185							20.0
	83-43							12.0
	83-23							19.0
	83-187							8.0
	83-148							2.0
	83-169							13.0
	83-181							7.0
	83-124							13.0
	83-208							18.0
STATION-14	82-38							0.1
	82-20							
	82-63							9.5
	82-86							10.0
	82-178							12.0
	82-147							17.0
	83-71							10.0

SAMPLING EVENTS
SAMPLE TYPE: PRECIPITATION

location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
STATION-14	83-55							19.0
	83-132							7.0
	83-184							4.0
	83-160							1.0
	83-174							13.0
	83-128							5.0
	83-149							11.0
	83-295							17.0
	86-106							
STATION-17	82-99							2.4
	82-53							1.0
	82-95							1.0
	82-70							
	82-80							0.6
	82-100							
	82-113							3.0
	82-134							8.0
	83-11							4.0
	83-86							7.5
	83-159							
	83-120							
	83-199							3.0
	83-182							
	83-126							5.5
	83-162							1.0
	83-256							8.0
	86-107							
STATION-20	82-50							3.8
	82-16							
	82-26							
	82-58							
	82-74							
	82-54							6.0
	82-1							3.3
	82-96							4.0
	82-196							2.0
	82-197							12.0
	83-37							5.6
	83-34							8.5
	83-170							2.0
	83-130							4.0
	83-119							
	83-158							5.5
STATION-25	82-9							2.4
	82-76							2.0
	82-24							2.0
	82-83							
	82-66							
	82-79							8.0
	82-25							6.6

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SAMPLING EVENTS
SAMPLE TYPE: PRECIPITATION

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
STATION-25	82-67							10.0
	82-153							8.5
	82-152							14.5
	83-89							10.0
	83-53							13.0
	83-134							5.5
	83-139							4.0
	83-142							5.0
	83-190							10.0
	83-198							2.0
	83-135							11.5
	83-217							17.0
STATION-26	82-29							2.0
	82-32							1.0
	82-48							1.0
	82-91							
	82-98							
	82-30							5.0
	82-71							3.2
	82-39							5.5
	82-116							3.0
	82-108							12.0
	83-3							8.0
	83-76							11.0
	83-163							3.0
	83-177							
	83-171							4.0
	83-187							
	83-131							[illegible].5
	83-101							1.0
	83-104							13.0
	83-284							12.0
	86-108							

SAMPLING EVENTS
SAMPLE TYPE. SPRING

location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
SP-BENNETT	SITE-218		7.50		230.00			13.0
	79-13		7.15		220.30			11.2
	85-362	7.63	7.50	263.00		0.30	180.00	12.2
	86-190	7.79	7.63	260.00		0.30	90.00	12.2
SP-BENSON	SITE-217	7.30	7.30		200.00			13.5
SP-BUTLER	79-1		8.60		201.10			12.0
SP GULCH	84-359	7.55	7.65	431.00				15.2
SP-JUNIPER	SITE-215	8.30	8.30		260.00			20.0
	79-2		7.30		330.00			17.3
	81-115	7.93		334.00		0.18		
	83-372	7.90	7.75	353.00		0.12	150.00	17.3
SP-LO-SNIVELY	79-34		7.60		220.00			14.2
	82-362	7.09	7.34	221.00		0.36	140.00	14.9
	83-396	7.85	7.75	231.00		0.21	170.00	14.7
SP-LOZIER	79-6		7.35		212.84			12.5
	81-186	7.50		215.00		0.39		
	83-316	7.20	7.55	221.00		0.75	125.00	12.4
SP-MAIDEN	79-100							14.7
	83-420	7.85	7.45	179.00		0.23	130.00	12.8
SP-OBSERVATORY	81-119	7.86		219.00		0.21		
	83-433	7.85	7.35	211.00		0.13	-30.00	12.4
	84-392	7.40	7.55	220.00		0.33	140.00	10.0
	84-329							
	85-359	7.57	7.55	217.00		0.32	195.00	10.1
	86-178	7.97	7.81	219.00		0.20	120.00	8.9
SP-RAILROAD	79-76		[illegible]		248.08			13.2
SP-RATTLESNAKE	SITE-216	7.70	7.70		275.00			[illegible]
	79-88		[illegible]		410.20			[illegible]
	83-412	7.55	7.55	395.00		0.34	130.00	21.0
SP-SNIVELY	79-49		8.75		193.50			13.4
SP-SULFUR	79-29		8.00		214.[illegible]			[illegible]
	83-409	7.50	7.65	235.00		0.34	100.00	16.0
SP-UNNAMED-02	79-75		7.85		206.00			12.0
SP-UNNAMED-16	79-73		7.00		197.30			13.2
SP-UNNAMED-26	79-98		8.75		[illegible]			[illegible]
SP-UNNAMED-29	79-16	7.39	7.00		249.[illegible]			14.9
SP-UP-SNIVELY	79-71		7.65		186.[illegible]			14.1
	81-126	7.77		195.00		0.26		
	83-503	7.95	[illegible]	188.00		0.30	-20.00	13.0
	86-193	7.88	7.72	205.00		0.27	110.00	12.8
SP-UR2-07	85-343	6.72	6.70	238.00		0.30	195.00	13.0
	86-159	6.97	6.39	252.00		0.27	135.00	
SP-UR6-20	85-346	6.86	6.70	232.00		0.30	180.00	17.5
	86-152	7.0[illegible]	6.9[illegible]	239.00		0.22	140.00	7.8
SP-UR7-22	85-349	7.19	7.25	229.00		0.30	185.00	14.5
	86-153	7.31	7.19	258.00			175.00	9.3
SP-WARM	84-358	7.60	7.55	308.00			355.00	22.5
SP-YR3-04	85-333	6.80	8.30	236.00		0.1[illegible]	360.00	12.5
	85-330	7.03	8.04	262.00		0.38	162.00	8.0
SP-YR5-08	85-336	6.62	8.65	218.00		0.30	250.00	13.5

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SAMPLING EVENTS
SAMPLE TYPE. SPRING

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
SP YR5 08	86-147	6.90	6.83	352.00		0.85	190.00	5.5
SP YR7-14	85-339	6.65	6.65	177.00		0.40	245.00	11.8
	86-156	6.89	6.87	153.00		0.73	165.00	7.6

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SAMPLING EVENTS
SAMPLE TYPE: SURFACE

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
COLD CREEK	84-317							
	84-302	8.50	8.10	308.00		1.80	165.00	19.0
	85-223	8.40	8.50	278.00		1.80	112.00	14.0
CR-DC-14	83-258	7.50	8.80	150.00		0.30		6.8
CR-DC-15	81-68							
	81-1							
CR-HTS	SITE-221	8.70	8.70		115.00			22.2
CR-V-BR	84-330							
	84-311	8.29	8.00	117.00		1.50	160.00	20.7
	85-206	8.40	8.50	152.00		1.30	25.00	11.0
	85-266	8.35	8.15	123.00		1.60	87.00	20.2
	86-70	8.04	7.50	128.00		1.60	125.00	11.9
	86-109	7.93	7.94	143.00		1.10	150.00	11.8
YR-BR	85-210	7.35	7.25	122.00		29.50	135.00	11.0
	85-269	8.47	8.40	291.00		22.00	173.00	25.7
	86-67	7.87	7.55	218.00			205.00	10.2
	86-118	8.09	8.06	260.00		16.30	162.00	9.7

SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
RRI-06A	82-40	7.13						17.9
199-B04-04	SITE-41		7.60		310.00	0.00		39.1
199-D05-12	SITE-80	8.00	7.70	338.00	335.00	4.20		24.2
199-D08-03	SITE-72	7.80	7.80	314.00	320.00	2.00		32.5
199-F05-01	SITE-82	7.90	7.80	232.00	228.00	0.80		20.6
199-H04-03	SITE-81	8.00	7.90	3500.00	3500.00	3.90		22.4
199-K-19	SITE-83	8.00	8.10	240.00	235.00	0.70		22.2
199-N-15	SITE-42		7.90		194.00			20.7
299-E26-08	SITE-165	8.20	7.70		395.00			
299-E33-12	SITE-169	7.60	7.10		630.00			
399-01-01	SITE-244		7.40		212.00	0.20		17.1
399-01-03	SITE-43		8.00		330.00			15.9
399-02-01	SITE-245		6.90		183.00	0.50		17.1
399-03-01	SITE-246		6.30		200.00	0.20		16.4
399-04-10	SITE-44		7.50		302.00	1.00		17.5
399-08-04	SITE-140	8.00	7.60	310.00	310.00	2.00		16.6
699-HAN-19	SITE-3	7.90		321.00		1.00		17.5
699-S03-E12	SITE-22		9.40		223.00	4.00		16.8
	SITE-141	8.40	8.30	256.00	255.00	1.60		
699-S03-25	SITE-7		7.90	513.00		3.00		18.5
	SITE-142	8.20	7.80	535.00	540.00	1.20		18.9
	86-55	7.82	7.75	530.00		0.50	-142.00	19.5
	86-130	7.80	7.49	521.00		34.00	-175.00	18.6
699-S06-E04D	SITE-11		7.50	416.00		5.00		
699-S08-19	SITE-46		7.80		420.00			18.0
	SITE-84	8.10	8.00	423.00	412.00	0.80		18.2
699-S11-E12A	SITE-4		8.00	352.00		1.00		17.5
699-S12-03	SITE-45		7.90		395.00	2.00		17.3
	SITE-143	8.30	7.90	395.00	394.00	3.50		17.7
699-S19-E13	SITE-120	7.90	7.90	398.00	395.00	1.60		17.1
699-S24-19	85-213	7.10	7.10	281.00		0.55	55.00	14.0
	85-291	7.27	7.00	309.00		0.24	172.00	16.3
699-S29-E12	SITE-21		7.80		395.00			16.7
699-S30-E15A	SITE-144	7.90	7.50	455.00	450.00	0.50		18.6
699-01-18	SITE-145	8.40	8.20	422.00	422.00	1.40		19.1
699-02-03	SITE-1		7.90	418.00		1.00		
699-02-33	SITE-85	7.80	7.30	352.00	325.00	44.00		19.2
	SITE-146	8.20	7.70	310.00	335.00	4.50		19.3
699-04-E06	SITE-47	8.00			352.00			17.0
699-08-17	SITE-23		8.00		436.00	10.00		18.4
699-08-25	SITE-32		8.00		430.00	1.00		13.5
699-08-32	SITE-19		7.80	361.00		3.00		
699-09-E02	SITE-16		7.80	322.00		2.00		17.9
699-10-E12	SITE-147	8.20	7.80	403.00	408.00	2.80		19.3
	SITE-247		7.80		424.00	0.20		17.8
699-11-45A	SITE-148	8.00	7.70	293.00	290.00	1.20		19.3
	85-263	7.80	7.65	288.00		1.30	-127.00	19.4
	86-43	7.82	7.70	287.00		6.20	-65.00	19.4
	86-124	7.86	7.82	291.00		6.30	-60.00	19.6
699-13-01A	SITE-60	7.80	7.80	352.00	348.00			17.4

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SAMPLING EVENTS
SAMPLE TYPE. UNCONFINED

location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
699-14-38	SITE-61	7.80	7.80	315.00	300.00	2.00		19.0
	SITE-86	7.90	7.80	322.00	310.00	3.60		19.1
699-15-15B	SITE-13		7.70	408.00		4.00		
	SITE-149	8.20	7.80	446.00	445.00	14.00		19.4
699-15-26	SITE-24		7.90		445.00			18.5
	SITE-150	8.20	7.80	447.00	445.00	0.30		18.8
699-17-05	SITE-18		7.80	457.00		31.00		16.2
	SITE-151	8.20	7.80	494.00	505.00	7.40		19.0
699-19-43	SITE-48		7.80		380.00			18.1
	SITE-121	7.90	7.60	402.00	400.00	0.30		17.5
699-19-58	85-229	7.30	7.15	315.00		0.50	-150.00	21.5
	85-260	7.50	7.50	316.00		0.50	-167.00	20.4
	86-40	7.65	7.25	317.00		1.20	-120.00	19.7
	86-121	7.64	7.67	311.00		1.10	-170.00	20.0
699-19-88	85-278	7.70	7.30	264.00		0.35	225.00	17.6
	86-64	7.74	7.35	239.00		0.70	120.00	17.2
	86-127	7.77	7.49	260.00		0.60	-12.00	17.4
699-20-E05-0	SITE-40		8.00		298.00	1.00		19.3
699-20-20	SITE-25		7.90		460.00			17.5
699-24-33	SITE-28		7.90		455.00			19.4
699-24-46	SITE-122	7.90	7.90	323.00	325.00	23.00		20.5
699-24-95	85-288	7.54	7.35	418.00		19.00	-70.00	19.7
	86-61	7.47	7.00	351.00		2.30	-115.00	13.3
	86-115	7.46	7.45	415.00		1.35	-125.00	12.9
699-25-55	SITE-100	8.00	8.00	392.00		3.00		18.1
699-26-15	SITE-26		8.00		46[illegible].00			17.2
699-26-15A	SITE-263		7.90		442.00	0.50		17.5
699-27-04	SITE-101	8.00	8.00	354.00	349.00	24.00		17.5
699-27-08	SITE-5		8.00	486.00		1.30		[illegible]
	SITE-30		8.00		468.00	1.00		[illegible]
	SITE-50		7.80		485.00			[illegible]
	SITE-76	7.90	7.90	473.00	450.[illegible]			[illegible]
	SITE-87	7.90	7.90	488.00	462.[illegible]	0.40		16.8
699-28-40	SITE-68	7.90	7.90	416.00	418.[illegible]	1.00		19.2
699-31-31	SITE-69	7.90	7.90	454.00	454.[illegible]	1.00		20.5
	SITE-102	8.10	8.00	435.00		[illegible]		19.4
699-31-53B	SITE-88	7.80	8.00	394.00	382.00	[illegible]		21.1
699-32-22	SITE-17		[illegible]	533.00		8.80		[illegible]
	SITE-27		8.00		[illegible]	1.00		[illegible]
	SITE-51		7.90		522.[illegible]	1.00		18.4
	SITE-65	7.80	7.90	512.00	52[illegible]	2.[illegible]		18.[illegible]
	SITE-89	7.90	8.00	528.00	50[illegible]	[illegible]		18.[illegible]
699-32-70B	SITE-70	7.80	7.70	351.00	34[illegible]	3.00		20.3
	SITE-90	7.30	7.80	353.00	340.00	[illegible]		[illegible]
	SITE-152	8.10	7.[illegible]	342.00	34[illegible]	3.[illegible]		[illegible]
699-32-72	SITE-35		7.80		297.[illegible]	[illegible]		20.5
699-32-77	SITE-103	8.20	8.00	285.00	280.00	0.50		16.6
699-33-42	SITE-12		7.70	448.00		[illegible]		
	SITE-29		7.90		425.[illegible]	3.00		19.8
	SITE-52		7.80		420.00	4.00		19.8

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
699-33-42	SIIE-67	7.60	7.90	429.00	415.00	2.00		19.7
	SIIE-91	7.90	7.90	436.00	410.00	0.80		20.0
699-33-56	SIIE-8		7.70	429.00		9.00		
	SIIE-40		7.80		416.00	4.00		21.7
	SIIE-53		7.70		420.00	1.00		21.5
	SIIE-62	7.90	7.90	427.00	430.00	4.00		21.2
	SIIE-92	7.50	7.80	436.00	420.00	1.60		21.5
699-34-39A	SIIE-93	7.90	7.90	412.00	405.00	1.30		21.5
699-34-42	SIIE-33		7.90		433.00	1.00		20.6
	SIIE-153	8.20	7.90	387.00	375.00	0.80		20.3
699-34-51	SIIE-66	7.70	7.80	434.00	424.00			21.1
699-35-00	SIIE-31		8.00		382.00	1.00		17.3
	SIIE-104	8.10	7.90	394.00	380.00	1.30		17.5
	SIIE-264		8.00		407.00	0.80		17.5
699-35-66	SIIE-77	7.90	7.90	404.00	400.00	25.00		21.2
	SIIE-94	8.00	7.90	412.00	404.00	0.90		21.2
699-35-70	SIIE-36		7.70		489.00	10.00		20.4
699-35-78	SIIE-54		8.00		241.00	1.00		15.0
699-36-61A	SIIE-95	8.00	7.80	400.00	395.00	0.90		22.2
699-37-43	SIIE-34		8.00		367.00	2.00		21.0
	SIIE-173	7.80	7.75		1150.00			21.0
699-37-82A	SIIE-105	10.40	10.70	387.00	382.00	7.40		18.0
699-38-70	SIIE-37		7.60		850.00	1.00		20.7
699-39-E3	SIIE-248		7.90		310.00	2.80		17.0
699-39-01	SIIE-249		7.80		390.00	0.40		18.4
699-39-39	SIIE-266		8.20		278.00	1.60		19.5
699-40-01	SIIE-10		7.70	357.00		4.00		
	SIIE-106	8.10	8.10	389.00	390.00	1.00		17.3
	SIIE-250		7.90		393.00	0.20		17.8
	SIIE-265		8.00		410.00	0.70		17.5
699-40-33	SIIE-55		8.00		324.00	2.00		18.1
	SIIE-251		8.00		320.00	0.50		18.1
699-40-62	SIIE-56		7.70		405.00			21.4
699-41-01	SIIE-252		8.00		390.00	0.30		17.7
699-41-23	SIIE-15		7.70	507.00		2.00		17.7
	SIIE-113	8.20	8.00	454.00	460.00	8.10		18.0
699-42-02	SIIE-154	8.20	7.90	393.00	395.00	1.00		17.9
699-42-12	SIIE-2		8.00	440.00		1.00		17.5
	SIIE-155	8.20	7.90	447.00	450.00	1.90		17.6
	SIIE-267		7.90		426.00	0.50		18.0
699-42-40A	SIIE-174	7.90	7.95		395.00			18.1
699-42-40C	SIIE-175	7.80						
699-42-42	SIIE-114	8.00	8.00	457.00	447.00	0.70		17.2
699-43-03	SIIE-253		7.80		390.00	3.90		18.0
699-43-88	SIIE-123	7.80	7.70	366.00	365.00	170.00		18.0
699-44-04	SIIE-254		7.80		385.00	0.30		17.8
699-45-04	SIIE-255		7.70		379.00	0.70		17.1
699-45-42	SIIE-57		8.00		285.00	2.00		18.8
	SIIE-268		8.10		261.00	1.60		18.5
699-45-69	SIIE-96	8.00	8.00	430.00	420.00	3.40		20.0

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
699-46-05	SITE-156	8.20	7.80	402.00	410.00	1.00		17.7
	SITE-256		7.30		410.00	35.00		17.5
699-46-21A	SITE-75	7.90	8.00	398.00	388.00	1.00		17.2
	SITE-124	8.10	7.80	425.00	425.00	1.60		16.8
699-47-06	SITE-257		7.70		320.00	0.20		17.1
699-47-46	SITE-269		7.80		443.00	0.30		17.5
699-48-07	SITE-258		7.30		165.00	0.20		11.3
699-48-18	SITE-125	8.00	7.90	371.00	370.00	7.50		17.2
699-48-71	SITE-59		7.90		317.00	3.00		19.3
699-49-13	SITE-259		7.70		321.00	0.40		15.8
699-49-55	SITE-9		8.10	601.00		10.00		
	SITE-39		8.20		580.00	4.00		17.0
	SITE-58		8.20		635.00	2.00		17.4
	SITE-78	8.70	9.40	588.00	612.00	20.00		17.6
	SITE-97	8.40	8.20	604.00	600.00	3.80		13.2
	SITE-126	9.50	10.00	601.00	590.00	14.00		17.0
	SITE-157	8.80	8.80	637.00	632.00	16.00		18.3
699-49-55A	SITE-182	8.20	8.15		850.00			18.8
699-49-57	SITE-38		7.60		927.00			16.4
699-49-79	SITE-20		7.60	388.00		2.00		
699-50-08	SITE-64	7.60	8.00	397.00	350.[illegible]			18.2
699-50-28B	SITE-63	7.80	7.80	327.00	290.00	1.00		19.2
699-50-42	SITE-14		7.80	330.00		13.00		
	SITE-115	7.80	7.70	215.00	232.00	32.00		16.7
	SITE-271		7.70		304.00	5.90		19.0
699-50-53	SITE-270		7.80		610.00	0.70		18.0
699-50-85	SITE-127	8.10	8.00	338.00	333.00	2.80		20.0
699-51-63	SITE-116	8.00	8.00	308.00	294.00	0.50		17.8
699-53-103	SITE-160		8.00	285.00				26.8
699-53-47B	SITE-272		7.80		281.00	1.20		15.5
699-54-34	SITE-273		7.30		326.00	3.00		21.0
699-55-50C	SITE-79	8.00	7.90	236.00	230.00	1.00		16.4
	SITE-128	8.00	7.80	233.00	235.00	1.00		16.8
	SITE-193	8.00	7.65		220.[illegible]			16.5
	SITE-274		8.00		242.00	0.50		15.5
699-55-76	SITE-71	8.00	8.50	352.00	350.00	250.00		17.7
	SITE-117	9.00	9.10	298.00	294.00	3.80		17.2
	SITE-129	7.80	7.70	254.00	255.00	5.10		17.0
699-55-89	SITE-118	8.10	8.10	308.00	304.00	1.70		17.7
699-56-53	SITE-194	8.40	7.06		260.00			14.6
	SITE-195	8.40	7.25					14.4
699-57-25A	SITE-119	8.10	8.10	321.00	312.00	[illegible]		19.3
	SITE-275		8.10		316.00	[illegible].60		22.0
699-57-29A	SITE-276		8.80		295.00	1.30		18.5
699-57-83	SITE-130	7.90	7.70	285.00	285.00	2.80		17.3
699-59-58	SITE-107	8.20	8.20	266.00	243.00	0.90		17.5
	SITE-277		8.10		269.00	0.50		17.5
699-60-32	SITE-278		8.10		300.00	0.50		18.0
699-60-57	SITE-198	8.10	7.95		375.00			18.5
699-62-31	SITE-131	7.60	7.30	339.00	338.00	16.00		17.5

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SAMPLING EVENTS
SAMPLE TYPE: UNCONFINED

Location	SAMPLE EVENT CODE	LAB PH PH UNITS	FIELD PH PH UNITS	LAB COND MICROSIEMENS/CM	FIELD COND MICROSIEMENS/CM	TURBIDITY TURBID UNITS	ORP MV	SAMPLE TEMP(C)
699-62-31	SIIE-279		7.80		333.00	2.40		17.5
699-63-25A	SIIE-132	8.00	7.80	518.00	515.00	1.10		16.8
699-63-55	SIIE-280		8.10		281.00	0.60		17.0
699-63-58	SIIE-281		8.10		310.00	0.40		17.0
699-63-90	SIIE-74	7.90	7.80	323.00	320.00	1.00		17.4
	SIIE-133	8.00	7.80	318.00	325.00	1.50		17.0
699-64-27	SIIE-158	8.10	7.80	759.00	775.00	2.40		17.7
699-65-50	SIIE-73	8.10	8.00	276.00	272.00	1.00		17.7
	SIIE-134	8.10	8.00	280.00	280.00	1.10		19.0
	SIIE-282		8.20		274.00	0.50		12.5
699-66-103	85-203	7.95	7.95	219.00		0.23	20.00	14.5
	86-73	8.03	7.65	206.00		0.90	114.00	13.4
	86-112	7.89	8.16	228.00		0.22	185.00	12.3
	85-204	8.03	7.80	228.00		0.19	175.00	16.4
699-66-39	SIIE-135	9.20	9.60	378.00	375.00	1.40		17.5
699-66-58	SIIE-136	8.10	7.90	277.00	286.00	1.40		16.9
699-66-64	SIIE-137	7.80	7.90	282.00	283.00	2.00		17.4
699-67-98	SIIE-260		7.70		290.00	0.20		16.7
699-69-38	SIIE-6		7.50	704.00		1.00		14.5
699-71-30	SIIE-108	8.10	7.80	569.00	571.00	2.60		16.7
699-71-52	SIIE-138	7.80	7.90	332.00	328.00	100.00		17.5
699-72-73	SIIE-109	8.00	7.90	287.00	285.00	14.00		18.7
699-72-88	SIIE-98	7.80	7.50	294.00	280.00	0.40		21.2
	SIIE-261		7.50		282.00	0.30		20.9
699-72-92	SIIE-262		7.70		282.00	0.90		17.8
699-77-36	SIIE-110	7.90	7.80	862.00	830.00	0.70		16.6
699-78-62	SIIE-111	8.10	8.10	342.00	322.00	0.90		16.5
699-81-58	SIIE-159	8.20	8.00	213.00	214.00	5.30		16.6
699-83-47	SIIE-112	8.10	8.10	344.00	326.00	9.10		17.1
699-87-55	SIIE-99	8.20	8.00	272.00	265.00	0.30		16.9
699-90-45	SIIE-139	7.60	7.40	345.00	345.00	12.00		16.5

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
BERK	85-255	85-255	27.900	(1)	6.840	(1)	15.300	(1)	9.140	(1)
		85-256	28.400	(1)	6.900	(1)	15.500	(1)	9.230	(1)
DB-01	81-19	81-15	97.200	(1)	13.100	(1)	1.700	(1)	0.479	(1)
		81-19	101.000	(1)	13.200	(1)	1.780	(1)	0.490	(1)
	81-65	81-65	101.000	(1)	16.000	(1)	0.490	(1)	0.150	(1)
		81-70	100.000	(1)	15.900	(1)	0.500	(1)	0.150	(1)
	82-27	82-27	90.700	(1)	15.300	(1)	0.430	(1)	0.100	(1)
		82-87	100.000	(1)	15.300	(1)	0.490	(1)	< 0.100	(1)
	85-32	85-32	101.000	(1)	15.800	(1)	0.420	(1)	0.084	(1)
		85-33	100.000	(1)	15.700	(1)	0.430	(1)	0.095	(1)
DB-02	79-65	CP123	107.700	(1)	13.500	(1)	1.500	(1)	0.450	(1)
	81-13	81-11	98.700	(1)	17.000	(1)	0.740	(1)	0.290	(1)
		81-13	99.400	(1)	17.300	(1)	0.750	(1)	0.360	(1)
	81-10	81-10	103.000	(1)	16.300	(1)	0.590	(1)	0.090	(1)
		81-7	104.000	(1)	16.500	(1)	0.600	(1)	0.090	(1)
DB-04	79-77	CP116	77.800	(1)	10.600	(1)	0.560	(1)	0.160	(1)
DB-07	79-89	CP121	118.400	(1)	14.200	(1)	1.600	(1)	0.090	(1)
	83-413	83-413	117.000	(1)	12.600	(1)	1.460	(1)	< 0.100	(1)
		83-448	114.000	(1)	12.300	(1)	1.430	(1)	< 0.100	(1)
	85-216	85-216	113.100	(1)	12.300	(1)	1.390	(1)	< 0.100	(1)
		85-217	112.800	(1)	12.300	(1)	1.360	(1)	< 0.100	(1)
DB-09	79-28	CP115	75.100	(1)	12.200	(1)	0.560	(1)	0.130	(1)
	83-472	83-410	70.900	(1)	10.520	(1)	0.450	(1)	< 0.100	(1)
		83-472	71.000	(1)	10.500	(1)	0.450	(1)	< 0.100	(1)
DB-11	85-18	85-18	31.400	(1)	9.720	(1)	14.700	(1)	7.020	(1)
		85-19	31.100	(1)	9.610	(1)	14.600	(1)	6.960	(1)
	86-52	86-52	32.300	(1)	9.450	(1)	14.900	(1)	7.180	(1)
		86-53	32.700	(1)	9.640	(1)	15.000	(1)	7.240	(1)
	81-57	81-57	33.300	(1)	9.920	(1)	15.300	(1)	7.500	(1)
DB-12	83-95	83-95	16.800	(1)	7.100	(1)	25.300	(1)	13.500	(1)
	81-25	81-25	31.400	(1)	9.240	(1)	18.800	(1)	10.300	(1)
		81-42	31.500	(1)	9.310	(1)	18.900	(1)	10.300	(1)
DB-13	83-404	83-404	54.200	(1)	10.100	(1)	9.000	(1)	2.030	(1)
		83-455	55.000	(1)	10.300	(1)	9.080	(1)	2.020	(1)
DB-14	81-162	81-139	137.000	(1)	17.600	(1)	2.030	(1)	< 0.020	(1)
		81-162	130.900	(1)	16.370	(1)	1.910	(1)	< 0.020	(1)
DB-15	79-17	79-17	44.400	(1)	10.400	(1)	18.900	(1)	4.900	(1)
		79-4	42.000	(1)	11.600	(1)	19.600	(1)	5.100	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
DB-15	79-35	79-20	73.400	(1)	7.120	(1)	2.360	(1)	0.390	(1)
		79-35	80.700	(1)	7.050	(1)	2.290	(1)	0.300	(1)
	79-33	79-27	83.000	(1)	8.170	(1)	2.040	(1)	0.390	(1)
		79-33	82.100	(1)	8.160	(1)	2.000	(1)	0.400	(1)
	79-15	79-15	89.900	(1)	10.600	(1)	1.620	(1)	0.460	(1)
		79-46	90.700	(1)	10.600	(1)	[illegible]	(1)	0.470	(1)
	79-39	79-39	97.100	(1)	10.600	(1)	[illegible]	(1)	0.460	(1)
		79-8	97.600	(1)	10.800	(1)	1.900	(1)	0.470	(1)
	79-31	79-31	91.800	(1)	11.000	(1)	1.900	(1)	0.420	(1)
		79-5	93.900	(1)	11.100	(1)	1.930	(1)	0.430	(1)
	79-51	79-51	171.000	(1)	14.800	(1)	2.030	(1)	0.060	(1)
		79-61	170.000	(1)	14.300	(1)	1.970	(1)	0.070	(1)
	79-85	79-74	179.000	(1)	15.400	(1)	2.[illegible]	(1)	0.820	(1)
		79-85	176.000	(1)	15.600	(1)	3.040	(1)	0.550	(1)
	79-80	79-80	171.000	(1)	15.800	(1)	1.500	(1)	0.340	(1)
		79-99	170.000	(1)	14.700	(1)	1.300	(1)	0.300	(1)
	79-62	79-62	135.000	(1)	14.500	(1)	2.200	(1)	0.240	(1)
		79-84	160.000	(1)	17.000	(1)	2.400	(1)	0.300	(1)
	79-90	79-90	168.000	(1)	14.700	(1)	1.[illegible]	(1)	0.230	(1)
		79-95	164.000	(1)	16.600	(1)	2.700	(1)	0.400	(1)
	80-35	80-35	170.000	(1)	18.600	(1)	4.300	(1)	2.200	(1)
		80-41	159.000	(1)	18.100	(1)	3.900	(1)	2.000	(1)
	80-24	80-24	163.000	(1)	19.300	(1)	1.300	(1)	0.080	(1)
		80-74	153.000	(1)	19.200	(1)	1.300	(1)	0.050	(1)
	80-77	80-42	162.000	(1)	19.200	(1)	1.400	(1)	0.190	(1)
		80-77	161.000	(1)	18.300	(1)	1.400	(1)	0.100	(1)
	80-1	80-1	164.000	(1)	17.700	(1)	1.300	(1)	0.110	(1)
		80-51	164.000	(1)	17.600	(1)	1.200	(1)	0.100	(1)
DC-01	SITE-230	SITE-230	60.000	(0)	8.800	(0)	4.700	(0)	1.200	(0)
	SITE-226	SITE-226	79.000	(0)	8.000	(0)	2.200	(0)	0.300	(0)
	SITE-227	SITE-227	124.000	(0)	9.600	(0)	2.000	(0)	0.400	(0)
	SITE-228	SITE-228	102.000	(0)	10.000	(0)	2.400	(0)	0.100	(0)
	SITE-229	SITE-229	141.000	(0)	11.000	(0)	2.500	(0)	0.100	(0)
	SITE-231	SITE-231	77.000	(0)	8.400	(0)	2.200	(0)	0.300	(0)
	SITE-232	SITE-232	79.000	(0)	7.800	(0)	2.100	(0)	0.300	(0)
	SITE-233	SITE-233	90.000	(0)	9.900	(0)	1.700	(0)	0.400	(0)
	SITE-234	SITE-234	114.000	(0)	14.000	(0)	1.7[illegible]	(0)	0.400	(0)
	SITE-235	SITE-235	164.000	(0)	10.000	(0)	0.9[illegible]	(0)	0.400	(0)
	SITE-236	SITE-236	177.000	(0)	12.000	(0)	5.800	(0)	0.100	(0)
	SITE-237	SITE-237	163.000	(0)	15.000	(0)	5.000	(0)	0.100	(0)
	SITE-238	SITE-238	87.000	(0)	8.000	(0)	1.200	(0)	0.200	(0)
	SITE-239	SITE-239	182.000	(0)	3.300	(0)	0.900	(0)		
	SITE-240	SITE-240	181.000	(0)	3.900	(0)	0.700	(0)	0.100	(0)
	SITE-241	SITE-241	175.000	(0)	5.900	(0)	0.600	(0)	0.100	(0)
	SITE-242	SITE-242	165.000	(0)	4.700	(0)	0.200	(0)	0.100	(0)
	SITE-243	SITE-243	134.000	(0)	3.000	(0)	0.200	(0)		

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
DC-02-A2	80-4	80-25	287.000	(1)	19.900	(1)	55.700	(1)	11.700	(1)
		80-4	263.000	(1)	17.100	(1)	35.300	(1)	7.400	(1)
	SITE-213	SITE-213	181.000	(0)	3 200	(0)	0.260	(0)	< 42.000	(0)
DC-03	80-27	80-27	4410.000	(1)	739 000	(1)	383.000	(1)	1.310	(1)
		80-81	4330.000	(1)	734.000	(1)	337.000	(1)	0.150	(1)
DC-05	79-30	79-30	278.000	(1)	23.900	(1)	13.000	(1)	0.110	(1)
		79-32	286.000	(1)	23.100	(1)	12.600	(1)	0.090	(1)
DC-06	80-161	80-147	229 000	(1)	3.780	(1)	1.320	(1)	0.050	(1)
		80-161	229.000	(1)	3.900	(1)	1.330	(1)	0.060	(1)
	80-72	80-22	233.000	(1)	13.300	(1)	3.700	(1)	1 140	(1)
		80-72	233.000	(1)	13.700	(1)	4.500	(1)	1.150	(1)
	SITE-214	SITE-214	233.000	(0)	3 200	(0)	1.300	(0)	< 470.000	(0)
	80-238	80-201	217.000	(1)	3 260	(1)	1.170	(1)	< 0.010	(1)
		80-238	214.000	(1)	3.560	(1)	1 270	(1)	0.020	(1)
	80-191	80-186	350 000	(1)	15.900	(1)	4.510	(1)	0.170	(1)
		80-191	365.000	(1)	16.300	(1)	4.320	(1)	0.170	(1)
	80-13	80-13	432.000	(1)	22.100	(1)	6.500	(1)	0.120	(1)
		80-58	445.000	(1)	22 600	(1)	6 300	(1)	0.140	(1)
	79-59	79-59	300.000	(1)	7 300	(1)	2.000	(1)	0.170	(1)
		79-97	281.000	(1)	7 400	(1)	1.900	(1)	0.170	(1)
	81-45	81-45	270 000	(1)	6.180	(1)	1.600	(1)	0.030	(1)
		81-8	269.000	(1)	6.200	(1)	1.670	(1)	0.030	(1)
	80-118	80-118	310.000	(1)	6 720	(1)	1 660	(1)	0.010	(1)
		80-133	310.000	(1)	6 500	(1)	1.490	(1)	0.010	(1)
	80-15	80-15	361.000	(1)	4.060	(1)	2.140	(1)	0.025	(1)
		80-70	368.000	(1)	4.200	(1)	2.240	(1)	0.025	(1)
	81-82	81-76	359.000	(1)	3.350	(1)	2.640	(1)	< 0.001	(1)
		81-82	360.000	(1)	3 380	(1)	2.700	(1)	< 0.010	(1)
	80-29	80-29	209 100	(1)	1 650	(1)	0.950	(1)	0.006	(1)
		80-37	218.000	(1)	0.340	(1)	0 970	(1)	0.006	(1)
	79-58	79-57	212.000	(1)	1.490	(1)	1.120	(1)	0.008	(1)
		79-58	208.000	(1)	2.400	(1)	1.200	(1)	0.010	(1)
	80-75	80-45	242.000	(1)	1.900	(1)	0.950	(1)	< 0.005	(1)
		80-75	241.000	(1)	1.900	(1)	0.930	(1)	< 0.005	(1)
DC-07	82-23	82-23	235.000	(1)	3.060	(1)	3.730	(1)	< 0.100	(1)
		82-56	226 000	(1)	2.810	(1)	3.920	(1)	< 0.100	(1)
	82-10	82-10	259.000	(1)	3 330	(1)	3.460	(1)	< 0.100	(1)
		82-33	258.000	(1)	3.310	(1)	3.470	(1)	< 0 100	(1)
									0.030	(2)
	80-39	80-39	123.000	(1)	5 200	(1)	2.900	(1)	0.220	(1)
		80-98	134.000	(1)	5 000	(1)	2.800	(1)	0.210	(1)
	80-11	80-11	199.000	(1)	5 000	(1)	2.400	(1)	0.050	(1)
		80-19	198.000	(1)	5 100	(1)	2.400	(1)	0.050	(1)
	79-52	79-52	264.000	(1)	3.700	(1)	2.900	(1)	0.220	(1)

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
DC-07	79-52	79-55	263.000	(1)	3.600	(1)	2.800	(1)	0.220	(1)
	80-103	80-103	312.000	(1)	8.650	(1)	7.280	(1)	1.200	(1)
		80-163	303.000	(1)	4.820	(1)	5.250	(1)	1.240	(1)
	80-188	80-178	416.000	(1)	5.800	(1)	4.540	(1)	0.019	(1)
		80-188	433.000	(1)	5.500	(1)	4.600	(1)	0.020	(1)
	80-196	80-177	438.000	(1)	6.080	(1)	11.000	(1)	0.910	(1)
		80-196	420.000	(1)	6.250	(1)	17.700	(1)	1.200	(1)
DC-12	80-80	80-62	142.000	(1)	15.200	(1)	1.030	(1)	0.090	(1)
		80-80	145.000	(1)	15.100	(1)	1.090	(1)	0.200	(1)
	80-100	80-100	123.000	(1)	13.800	(1)	1.310	(1)	0.045	(1)
		80-63	123.000	(1)	16.300	(1)	1.380	(1)	0.052	(1)
	80-97	80-73	126.000	(1)	13.800	(1)	1.600	(1)	0.098	(1)
		80-97	123.000	(1)	13.700	(1)	1.560	(1)	0.094	(1)
	80-32	80-32	244.000	(1)	26.500	(1)	3.890	(1)	0.180	(1)
		80-68	242.000	(1)	26.100	(1)	3.780	(1)	0.180	(1)
	80-82	80-23	135.000	(1)	17.100	(1)	1.540	(1)	0.120	(1)
		80-82	135.000	(1)	17.400	(1)	1.520	(1)	0.120	(1)
	80-124	80-102	135.000	(1)	16.300	(1)	1.150	(1)	0.075	(1)
		80-124	131.000	(1)	16.300	(1)	1.120	(1)	0.070	(1)
	80-101	80-101	143.000	(1)	15.700	(1)	2.280	(1)	0.250	(1)
		80-169	148.000	(1)	16.100	(1)	2.060	(1)	0.210	(1)
	80-174	80-174	145.000	(1)	15.000	(1)	1.170	(1)	0.051	(1)
	80-209	80-209	155.000	(1)	13.000	(1)	1.400	(1)	0.050	(1)
		80-242	159.000	(1)	12.500	(1)	1.400	(1)	0.050	(1)
	80-233	80-233	138.000	(1)	13.000	(1)	1.640	(1)	0.160	(1)
		80-243	139.000	(1)	13.700	(1)	1.770	(1)	0.170	(1)
	80-234	80-208	159.000	(1)	16.000	(1)	5.000	(1)	0.051	(1)
		80-234	157.000	(1)	15.700	(1)	4.860	(1)	0.051	(1)
	81-61	81-61	161.000	(1)	7.620	(1)	1.070	(1)	< 0.020	(1)
		81-72	153.000	(1)	7.580	(1)	1.050	(1)	0.010	(1)
	82-85	82-47	155.000	(1)	7.530	(1)	1.280	(1)	< 0.100	(1)
									0.028	(2)
		82-85	157.000	(1)	7.610	(1)	1.280	(1)	< 0.100	(1)
DC-14	80-3	80-3	55.500	(1)	9.950	(1)	8.580	(1)	1.870	(1)
		80-34	58.300	(1)	9.050	(1)	9.000	(1)	1.730	(1)
	80-53	80-16	49.200	(1)	13.400	(1)	6.700	(1)	1.470	(1)
		80-53	48.800	(1)	13.100	(1)	6.500	(1)	1.440	(1)
	80-47	80-47	30.500	(1)	12.000	(1)	15.100	(1)	2.470	(1)
		80-85	31.900	(1)	13.000	(1)	16.000	(1)	2.500	(1)
	80-69	80-69	78.000	(1)	13.100	(1)	1.450	(1)	0.077	(1)
		80-83	79.300	(1)	12.800	(1)	1.460	(1)	0.077	(1)
	80-99	80-55	83.200	(1)	13.100	(1)	4.670	(1)	0.140	(1)
		80-99	83.300	(1)	13.300	(1)	4.600	(1)	0.140	(1)
	80-89	80-36	81.800	(1)	12.200	(1)	0.950	(1)	0.281	(1)
		80-89	83.500	(1)	13.100	(1)	0.960	(1)	0.031	(1)
	80-71	80-2	79.400	(1)	12.800	(1)	7.000	(1)	0.290	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
DC-14	80-71	80-71	79.600	(1)	12.700	(1)	7.030	(1)	0.260	(1)
	80-144	80-136	64.000	(1)	20.000	(1)	2.440	(1)	0.250	(1)
		80-144	65.600	(1)	20.400	(1)	2.740	(1)	0.280	(1)
	80-189	80-127	65.500	(1)	22.100	(1)	3.530	(1)	0.300	(1)
		80-189	64.500	(1)	20.600	(1)	3.420	(1)	0.290	(1)
	80-112	80-112	62.700	(1)	21.300	(1)	3.190	(1)	0.210	(1)
		80-168	61.300	(1)	20.400	(1)	3.150	(1)	0.200	(1)
	80-157	80-157	72.500	(1)	13.100	(1)	3.990	(1)	0.380	(1)
		80-183	71.900	(1)	13.200	(1)	4.100	(1)	0.400	(1)
	80-155	80-155	76.100	(1)	11.900	(1)	1.170	(1)	0.053	(1)
		80-185	79.200	(1)	12.700	(1)	1.230	(1)	0.054	(1)
	80-104	80-104	79.400	(1)	12.200	(1)	1.600	(1)	0.080	(1)
		80-125	85.300	(1)	13.100	(1)	2.300	(1)	0.011	(1)
	80-129	80-115	73.200	(1)	11.300	(1)	0.950	(1)	0.020	(1)
		80-129	74.700	(1)	11.800	(1)	1.010	(1)	0.020	(1)
	80-170	80-156	79.300	(1)	13.600	(1)	0.880	(1)	0.010	(1)
		80-170	78.200	(1)	14.100	(1)	0.860	(1)	0.020	(1)
	80-117	80-117	114.000	(1)	11.700	(1)	0.710	(1)	0.020	(1)
		80-151	116.000	(1)	11.500	(1)	0.720	(1)	0.020	(1)
	80-213	80-213	148.000	(1)	9.600	(1)	1.250	(1)	0.050	(1)
		80-236	151.000	(1)	9.620	(1)	1.320	(1)	0.050	(1)
	81-20	81-20	264.000	(1)	18.000	(1)	3.820	(1)	0.100	(1)
		81-22	270.000	(1)	18.400	(1)	3.890	(1)	0.100	(1)
	81-30	81-16	316.000	(1)	8.260	(1)	4.250	(1)	0.040	(1)
		81-30	315.000	(1)	8.080	(1)	4.140	(1)	0.040	(1)
									0.039	(2)
	81-44	81-44	325.000	(1)	8.100	(1)	4.520	(1)	0.090	(1)
									0.076	(2)
		81-47	317.000	(1)	8.340	(1)	4.590	(1)	0.087	(1)
	81-141	81-141	344.000	(1)	7.320	(1)	1.820	(1)	< 0.087	(1)
	82-8	82-42	323.000	(1)	5.770	(1)	1.300	(1)	< 0.100	(1)
		82-8	316.000	(1)	5.560	(1)	1.270	(1)	< 0.100	(1)
	83-156	83-156	337.000	(1)	5.810	(1)	1.290	(1)	< 0.103	(1)
									0.009	(2)
		83-197	336.000	(1)	5.780	(1)	1.270	(1)	< 0.100	(1)
	83-152	83-152	336.000	(1)	5.730	(1)	1.560	(1)	< 0.103	(1)
									0.010	(2)
		83-193	332.000	(1)	5.810	(1)	1.540	(1)	< 0.100	(1)
	83-157	83-157	338.000	(1)	5.900	(1)	1.320	(1)	< 0.103	(1)
									0.009	(2)
		83-179	337.000	(1)	5.880	(1)	2.070	(1)	< 0.100	(1)
	83-178	83-103	327.000	(1)	5.690	(1)	1.280	(1)	< 0.100	(1)
		83-178	328.000	(1)	5.710	(1)	1.280	(1)	< 0.103	(1)
									0.009	(2)
	83-183	83-123	331.000	(1)	5.850	(1)	1.290	(1)	< 0.100	(1)
		83-183	330.000	(1)	5.880	(1)	1.290	(1)	< 0.103	(1)
									0.008	(2)
	83-154	83-154	336.000	(1)	5.730	(1)	1.320	(1)	< 0.103	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
DC-14	83-154	83-154							0.011	(2)
		83-191	335.000	(1)	5.760	(1)	1.300	(1)	< 0.100	(1)
	83-150	83-108	334.000	(1)	5.680	(1)	1.290	(1)	< 0.100	(1)
		83-150	335.000	(1)	5.770	(1)	1.41[illegible]	[illegible]	< 0.100	(1)
									0.010	(2)
	83-266	83-233	335.000	(1)	5.820	(1)	1.300	(1)	< 0.100	(1)
		83-266	32[illegible].000	(1)	5.660	(1)	1.300	[illegible]	< [illegible]	(1)
									0.004	(2)
	83-261	83-203	332.000	(1)	5.870	(1)	1.330	[illegible]	< 0.100	(1)
		83-261	333.000	(1)	5.880	(1)	1.350	[illegible]	< 0.100	(1)
									0.009	(2)
DC-15	80-56	80-31	5[illegible].300	(1)	12.600	(1)	10.500	[illegible]	3.300	(1)
		80-56	51.300	(1)	12.400	(1)	10.700	[illegible]	3.340	(1)
	80-54	80-54	58.200	(1)	12.600	(1)	8.870	(1)	2.450	(1)
		80-76	59.000	(1)	12.600	(1)	9.170	(1)	2.500	(1)
	80-57	80-57	11[illegible].300	(1)	12.100	(1)	[illegible]	[illegible]	0.510	(1)
		80-65	123.000	(1)	12.900	(1)	3.440	[illegible]	0.350	(1)
	80-87	80-87	109.300	(1)	13.600	(1)	2.580	[illegible]	0.850	(1)
		80-94	110.300	(1)	13.800	(1)	2.590	(1)	0.950	(1)
	80-137	80-137	89.100	(1)	11.100	(1)	1.080	[illegible]	0.032	(1)
		80-197	91.300	(1)	11.000	(1)	1.0[illegible]		0.03[illegible]	(1)
	80-176	80-176	9[illegible].500	(1)	14.200	(1)	[illegible]		[illegible]	(1)
		80-999	9[illegible]	(1)	14.200	(1)	1.[illegible]	[illegible]	0.024	(1)
	80-135	80-135	98.100	(1)	14.500	(1)	1.540	(1)	0.040	(1)
		80-149	97.900	(1)	13.300	(1)	1.6[illegible]	[illegible]	0.04[illegible]	(1)
	80-120	80-120	102.000	(1)	15.900	(1)	1.32[illegible]	[illegible]	0.053	(1)
		80-139	100.000	(1)	15.400	(1)	1.33[illegible]	[illegible]	0.054	(1)
	80-131	80-108	[illegible].000	(1)	14.000	(1)	0.950	[illegible]	0.03[illegible]	(1)
		80-131	[illegible].000	(1)	13.600	(1)	0.960	[illegible]	0.03[illegible]	(1)
	80-193	80-114	[illegible].000	(1)	14.700	(1)	1.4[illegible]	[illegible]	0.0[illegible]	(1)
		80-193	11[illegible].000	(1)	13.300	(1)	1.4[illegible]	[illegible]	0.0[illegible]	(1)
	81-41	81-24	[illegible]	[illegible]	10.600	(1)	3.49[illegible]	[illegible]	0.2[illegible]	(1)
		81-41	2[illegible].000	(1)	10.800	(1)	3.490	[illegible]	0.[illegible]	(1)
	81-2	81-2	2[illegible].000	(1)	14.600	(1)	5.890	[illegible]	[illegible]	(1)
		81-36	2[illegible]	(1)	14.900	(1)	6.05[illegible]	[illegible]	[illegible]	[illegible]
	81-46	81-46	228.[illegible]	(1)	11.900	(1)	10.400	[illegible]	[illegible]	(1)
		81-50	230.000	(1)	11.700	(1)	10.300	[illegible]	[illegible]	(1)
									[illegible]	(2)
	81-33	81-32	255.[illegible]	(1)	14.800	(1)	7.[illegible]	[illegible]	[illegible]	(2)
									0.029	(2)
		81-33	252.[illegible]	(1)	23.600	(1)	7.770	[illegible]	0.030	[illegible]
	81-27	81-27	254.[illegible]	(1)	5.720	(1)	2.120	[illegible]	< [illegible]	(1)
		81-74	262.000	(1)	5.640	(1)	2.110	(1)	< 0.02[illegible]	(1)
									[illegible]	(2)
	81-64	81-64	362.000	(1)	8.140	(1)	4.300	[illegible]	0.0[illegible]	(1)
		81-80	355.000	(1)	8.010	(1)	4.130	[illegible]	0.0[illegible]	(1)
									0.056	(2)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
DC-15	81-96	81-85	267.000	(1)	3.860	(1)	2.030	(1)	0.040	(1)
		81-96	277.000	(1)	4.010	(1)	2.210	(1)	0.150	(1)
									0.120	(2)
	81-69	81-69	271.000	(1)	3.940	(1)	2.220	(1)	0.030	(1)
		81-84	263.000	(1)	3.690	(1)	2.110	(1)	0.030	(1)
									0.014	(2)
	82-94	82-41	265.000	(1)	2.740	(1)	1.790	(1)	< 0.100	(1)
		82-94	271.000	(1)	2.880	(1)	1.840	(1)	< 0.100	(1)
									0.040	(2)
DC-16A	81-109	81-109	104.000	(1)	4.200	(1)	10.800	(1)	4.900	(1)
		81-167	98.200	(1)	3.870	(1)	10.100	(1)	4.570	(1)
	82-17	82-17	46.600	(1)	6.440	(1)	14.000	(1)	3.510	(1)
		82-55	46.800	(1)	6.420	(1)	15.000	(1)	3.500	(1)
	82-93	82-45	68.600	(1)	11.600	(1)	5.970	(1)	1.470	(1)
		82-93	68.700	(1)	11.600	(1)	5.970	(1)	1.490	(1)
									1.130	(2)
	82-19	82-19	165.000	(1)	17.000	(1)	2.020	(1)	< 0.100	(1)
		82-88	166.000	(1)	16.900	(1)	2.000	(1)	< 0.100	(1)
									0.064	(2)
	82-188	82-140	180.000	(1)	18.200	(1)	1.670	(1)	< 0.100	(1)
									0.034	(2)
		82-188	180.000	(1)	18.300	(1)	1.870	(1)	< 0.100	(1)
	82-124	82-124	142.000	(1)	20.300	(1)	1.670	(1)	< 0.100	(1)
									0.036	(2)
		82-172	140.000	(1)	20.100	(1)	1.670	(1)	< 0.100	(1)
	82-143	82-126	232.000	(1)	34.400	(1)	4.830	(1)	< 0.100	(1)
									0.042	(2)
		82-143	232.000	(1)	34.600	(1)	4.900	(1)	< 0.100	(1)
	82-202	82-202	217.000	(1)	30.200	(1)	3.870	(1)	< 0.100	(1)
									0.057	(2)
		82-228	227.000	(1)	31.500	(1)	4.050	(1)	< 0.100	(1)
	82-322	82-322	324.000	(1)	32.000	(1)	3.890	(1)	< 0.100	(1)
									0.034	(2)
		82-361	320.000	(1)	31.600	(1)	3.820	(1)	< 0.100	(1)
	82-332	82-332	323.000	(1)	29.400	(1)	4.360	(1)	< 0.100	(1)
		82-358	325.000	(1)	29.500	(1)	4.310	(1)	< 0.100	(1)
									0.034	(2)
	82-430	82-430	346.000	(1)	20.000	(1)	2.740	(1)	< 0.100	(1)
									0.034	(2)
		82-473	355.000	(1)	20.400	(1)	2.810	(1)	< 0.100	(1)
	83-29	83-29	355.000	(1)	24.300	(1)	2.630	(1)	< 0.100	(1)
		83-41	353.000	(1)	23.800	(1)	2.620	(1)	< 0.100	(1)
DC-16B	83-147	83-147	56.300	(1)	11.400	(1)	4.800	(1)	1.450	(1)
		83-185	56.600	(1)	11.500	(1)	4.820	(1)	1.460	(1)
DC-16C	83-100	83-100	300.000	(1)	9.050	(1)	1.530	(1)	< 0.100	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
DC-15C	83-100	83-30	297.000	(1)	8.900	(1)	1.800	(1)	< 0.100	(1)
	83-259	83-215	180.000	(1)	17.300	(1)	1.630	(1)	< 0.100	(1)
		83-259	180.000	(1)	17.300	(1)	1.740	(1)	< 0.100	(1)
DC-18	86-166	86-166	84.300	(1)	12.400	(1)	0.653	(1)	< 0.200	(1)
		86-167	84.600	(1)	12.400	(1)	0.619	(1)	< 0.200	(1)
DC-19C	84-53	84-53	188.000	(1)	19.400	(1)	1.720	(1)	0.180	(1)
		84-84	190.000	(1)	19.700	(1)	1.760	(1)	0.180	(1)
	84-40	84-40	191.000	(1)	20.700	(1)	2.040	(1)	0.130	(1)
		84-77	193.000	(1)	20.800	(1)	2.050	(1)	0.130	(1)
	84-75	84-29	194.000	(1)	12.000	(1)	1.890	(1)	0.210	(1)
		84-75	190.000	(1)	11.600	(1)	1.870	(1)	0.190	(1)
	84-86	84-18	177.000	(1)	6.340	(1)	2.000	(1)	0.310	(1)
		84-86	177.000	(1)	6.200	(1)	1.990	(1)	0.270	(1)
DC-20C	84-9	84-49	171.000	(1)	17.400	(1)	1.550	(1)	< 0.100	(1)
		84-9	171.000	(1)	17.400	(1)	1.560	(1)	< 0.100	(1)
DC-22C	84-105	84-105	126.000	(1)	17.000	(1)	1.850	(1)	< 0.100	(1)
		84-153	125.000	(1)	16.800	(1)	1.830	(1)	< 0.100	(1)
DC-23GR	86-133	86-133	134.800	(1)	20.200	(1)	4.070	(1)	< 0.230	(1)
		86-134	133.300	(1)	19.900	(1)	4.030	(1)	< 0.200	(1)
	86-141	86-141	120.200	(1)	19.300	(1)	3.830	(1)	< 0.230	(1)
		86-142	120.300	(1)	19.300	(1)	3.960	(1)	< 0.200	(1)
	86-181	86-181	127.300	(1)	12.200	(1)	2.490	(1)	< 0.230	(1)
		86-182	129.000	(1)	12.300	(1)	2.470	(1)	< 0.200	(1)
ENYEART	SITE-209	SITE-209	29.000	(0)	6.700	(0)	19.000	(0)	11.000	(0)
	SITE-210	SITE-210	27.000	(0)	6.400	(0)	18.000	(0)	11.000	(0)
	84-166	84-166	26.300	(1)	6.410	(1)	18.100	(1)	11.200	(1)
		84-184	25.000	(1)	6.300	(1)	18.000	(1)	11.200	(1)
	85-180	85-180	25.000	(1)	6.220	(1)	18.200	(1)	10.900	(1)
		85-181	25.100	(1)	6.240	(1)	18.100	(1)	10.800	(1)
FORD	SITE-206	SITE-206	27.000	(0)	8.500	(0)	19.000	(0)	12.300	(0)
	SITE-207	SITE-207	26.000	(0)	7.300	(0)	18.000	(0)	11.900	(0)
	SITE-219	SITE-219	26.000	(0)	5.600	(0)	17.900	(0)	6.300	(0)
	85-188	85-188	26.700	(1)	7.240	(1)	18.300	(1)	10.600	(1)
		85-189	26.500	(1)	7.260	(1)	18.600	(1)	10.600	(1)
	85-303	85-303	26.200	(1)	6.910	(1)	18.400	(1)	10.400	(1)
		85-304	27.400	(1)	7.390	(1)	19.300	(1)	10.900	(1)
MCGEE	SITE-224	SITE-224	30.000	(0)	7.900	(0)	17.[illegible]	(0)	[illegible]	(0)
	SITE-222	SITE-222	30.000	(0)	8.600	(0)	16.[illegible]	(0)	3.900	(0)
	SITE-223	SITE-223	30.000	(0)	8.300	(0)	16.000	(0)	3.800	(0)
	SITE-225	SITE-225	38.000	(0)	8.000	(0)	24.0[illegible]	(0)	[illegible]	(0)

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SAMPLE TYPE. CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
MCGEE	SITE-220	SITE-220	29.500	(0)	7.500	(0)	16 500	(0)	8 500	(0)
	82-7	82-52	28.300	(1)	7.560	(1)	15.900	(1)	8.400	(1)
		82-7	27.700	(1)	7.310	(1)	15.600	(1)	8.280	(1)
	85-175	85-175	28.700	(1)	7.800	(1)	18.700	(1)	8 660	(1)
		85-176	29.400	(1)	7.900	(1)	16.800	(1)	8.750	(1)
	85-300	85-300	29.200	(1)	7.910	(1)	16.800	(1)	8.590	(1)
		85-301	29.300	(1)	7.940	(1)	16.600	(1)	8.500	(1)
	86-34	86-34	29.300	(1)	7.910	(1)	16.500	(1)	8.630	(1)
		86-35	28.900	(1)	7.750	(1)	18.300	(1)	8.550	(1)
	80-64	80-64	29.700	(1)	8.850	(1)	16.600	(1)	9.280	(1)
		80-88	29.400	(1)	8.310	(1)	16.600	(1)	9.260	(1)
	81-79	81-73	30.800	(1)	8.440	(1)	16.400	(1)	8.770	(1)
		81-79	31.500	(1)	8.550	(1)	16.000	(1)	9.050	(1)
	81-54	81-54	31.200	(1)	8.310	(1)	17.100	(1)	9.500	(1)
		81-56	31.400	(1)	8.420	(1)	16.720	(1)	9 000	(1)
	82-64	82-11	29.900	(1)	8 100	(1)	16.800	(1)	8.810	(1)
		82-64	29.700	(1)	8.040	(1)	16.600	(1)	8.710	(1)
	82-263	82-263	27.000	(1)	7.010	(1)	16 400	(1)	8.600	(1)
		82-283	27.400	(1)	7.090	(1)	16.700	(1)	8.700	(1)
	82-397	82-325	28.300	(1)	7.430	(1)	16.400	(1)	8.900	(1)
		82-397	28.600	(1)	7.530	(1)	16.500	(1)	9.000	(1)
	82-424	82-424	28.100	(1)	7.660	(1)	17 300	(1)	9.500	(1)
		82-474	28.100	(1)	7.690	(1)	17.600	(1)	9.600	(1)
	82-436	82-436	28.200	(1)	7.770	(1)	17.200	(1)	9.200	(1)
		82-498	28.300	(1)	7 790	(1)	17.400	(1)	9.300	(1)
	83-32	83-32	27.400	(1)	7.770	(1)	17.700	(1)	8.500	(1)
		83-63	27.700	(1)	7.800.	(1)	17.900	(1)	8.500	(1)
	83-83	83-27	28.500	(1)	7 680	(1)	17.600	(1)	9.160	(1)
		83-83	28.700	(1)	7.800	(1)	18.000	(1)	9.300	(1)
	83-188	83-113	31 700	(1)	9 110	(1)	17 700	(1)	5.800	(1)
		83-188	31.800	(1)	9.200	(1)	17.800	(1)	5.800	(1)
	83-373	83-323	85.600	(1)	8.150	(1)	2.670	(1)	0 250	(1)
									0.260	(2)
		83-373	85.400	(1)	8.120	(1)	2.660	(1)	0.260	(1)
									0.250	(2)
	83-331	83-331	87.100	(1)	8.060	(1)	1.060	(1)	< 0.100	(1)
									0.070	(2)
		83-344	88.600	(1)	8.140	(1)	1.040	(1)	< 0.100	(1)
									0.080	(2)
	83-460	83-460	89.100	(1)	8.170	(1)	0.820	(1)	< 0.100	(1)
		83-474	90.700	(1)	8.270	(1)	0.810	(1)	< 0.100	(1)
	83-476	83-417	90.500	(1)	8.320	(1)	0.870	(1)	< 0.100	(1)
		83-476	90.900	(1)	8 360	(1)	0.870	(1)	< 0.100	(1)
	83-513	83-513	120.000	(1)	9 710	(1)	1.170	(1)	< 0 100	(1)
		83-545	120.000	(1)	9.820	(1)	1 180	(1)	< 0.100	(1)
	84-24	84-24	130.000	(1)	10.170	(1)	1 930	(1)	< 0.100	(1)
		84-38	126.000	(1)	9.870	(1)	1.000	(1)	< 0 100	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)		MG MG/L	(A)
DURIAN	85-194	85-194	24.800	(1)	6.330	(1)	19.800	(1)		11.700	(1)
		85-195	24.800	(1)	6.340	(1)	19.700	(1)		11.500	(1)
KRL 02	82-68	82-28	162.000	(1)	20.000	(1)	1.880	(1)		0.200	(1)
		82-68	162.000	(1)	20.000	(1)	2.020	(1)		0.190	(1)
										0.180	(2)
	82-65	82-65	141.000	(1)	15.500	(1)	1.960	(1)	<	0.100	(1)
		82-75	139.000	(1)	15.400	(1)	1.990	(1)	<	0.100	(1)
										0.054	(2)
	82-170	82-163	236.000	(1)	35.600	(1)	9.500	(1)		0.230	(1)
										0.220	(2)
		82-170	252.000	(1)	35.100	(1)	8.400	(1)		0.230	(1)
	82-122	82-122	374.000	(1)	25.300	(1)	2.880	(1)	<	0.100	(1)
										0.042	(2)
		82-192	379.000	(1)	25.600	(1)	2.390	(1)	<	0.100	(1)
	82-401	82-401	337.000	(1)	13.800	(1)	2.220	(1)	<	0.100	(1)
										0.057	(2)
		82-479	337.000	(1)	13.000	(1)	2.190	(1)	<	0.100	(1)
	84-7	84-43	351.000	(1)	13.400	(1)	2.360	(1)	<	0.100	(1)
		84-7	353.000	(1)	13.500	(1)	2.350	(1)	<	0.100	(1)
	82-364	82-364	355.000	(1)	9.390	(1)	1.630	(1)	<	0.100	(1)
										0.019	(2)
		82-381	361.000	(1)	8.610	(1)	[illegible]	(1)	<	0.100	(1)
	82-309	82-309	336.000	(1)	8.460	(1)	2.800	(1)		0.150	(1)
										0.150	(2)
		82-351	328.000	(1)	8.360	(1)	2.800	(1)		0.150	(1)
	82-456	82-413	358.000	(1)	5.770	(1)	1.850	(1)	<	0.100	(1)
		82-456	364.000	(1)	5.870	(1)	1.830	(1)	<	0.100	(1)
XRL-14	82-403	82-403	338.000	(1)	24.700	(1)	2.300	(1)	<	0.100	(1)
										0.036	(2)
		82-489	335.000	(1)	24.500	(1)	2.100	(1)	<	0.100	(1)
STEM-1	85-252	85-252	25.500	(1)	5.610	(1)	20.400	(1)		12.100	(1)
		85-253	25.300	(1)	5.510	(1)	[illegible]	(1)		12.000	(1)
	85-297	85-297	25.300	(1)	6.120	(1)	21.200	(1)		12.300	(1)
		85-298	25.100	(1)	5.670	(1)	20.100	(1)		12.300	(1)
	86-31	86-31	25.200	(1)	5.720	(1)	20.300	(1)		12.500	(1)
		86-32	25.400	(1)	5.710	(1)	20.400	(1)		12.500	(1)
STEM-2	86-19	86-19	25.100	(1)	5.830	(1)	[illegible]	(1)		12.100	(1)
		86-20	24.800	(1)	5.840	(1)	19.300	(1)		11.900	(1)
299-E16-01	SITE-161	SITE-161	28.000	(0)	10.900	(0)	15.000	(0)		[illegible]	(0)
	SITE-162	SITE-162	30.000	(0)	10.200	(0)	28.000	(0)		9.200	(0)
	SITE-163	SITE-163	31.000	(0)	10.200	(0)	28.000	(0)		9.600	(0)
	SITE-164	SITE-164	31.000	(0)	10.200	(0)	26.000	(0)		9.900	(0)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
299-E26-08	SITE-166	SITE-166	20.000	(0)	10.400	(0)	19.000	(0)	8.200	(0)
	SITE-167	SITE-167	18.000	(0)	9.800	(0)	21.000	(0)	9.200	(0)
	SITE-168	SITE-168	19.000	(0)	9.800	(0)	19.000	(0)	9.200	(0)
299-E33-12	SITE-170	SITE-170	17.000	(0)	8.600	(0)	14.000	(0)	7.200	(0)
	SITE-171	SITE-171	17.000	(0)	8.300	(0)	18.000	(0)	7.700	(0)
	SITE-172	SITE-172	17.000	(0)	8.000	(0)	19.000	(0)	8.500	(0)
699-S11-E12A	80-61	80-61	50.300	(1)	8.700	(1)	22.400	(1)	6.050	(1)
		80-7	51.300	(1)	8.860	(1)	22.800	(1)	6.170	(1)
	80-180	80-138	47.200	(1)	7.500	(1)	21.100	(1)	5.800	(1)
		80-180	48.200	(1)	7.800	(1)	21.600	(1)	5.900	(1)
699-42-40C	SITE-175	SITE-176	24.600	(0)	6.400	(0)	26.600	(0)	11.800	(0)
	SITE-177	SITE-177	35.000	(0)	14.400	(0)	10.000	(0)	3.700	(0)
	SITE-178	SITE-178	33.000	(0)	13.700	(0)	7.500	(0)	4.500	(0)
	SITE-179	SITE-179	35.000	(0)	13.600	(0)	10.000	(0)	4.600	(0)
	SITE-180	SITE-180	36.000	(0)	12.700	(0)	18.700	(0)	4.500	(0)
699-47-50	SITE-205	SITE-205	20.390	(0)	7.390	(0)	55.310	(0)	14.660	(0)
	SITE-181	SITE-181	22.000	(0)	7.200	(0)	46.000	(0)	18.500	(0)
699-49-55B	SITE-183	SITE-183	11.000	(0)	6.900	(0)	38.000	(0)	11.900	(0)
	SITE-184	SITE-184	12.000	(0)	6.800	(0)	39.000	(0)	12.200	(0)
	SITE-185	SITE-185	12.000	(0)	6.800	(0)	38.000	(0)	12.400	(0)
699-50-45	SITE-203	SITE-203	16.390	(0)	5.710	(0)	30.020	(0)	10.210	(0)
	SITE-186	SITE-186	17.000	(0)	6.000	(0)	92.000	(0)	15.700	(0)
699-50-48	SITE-204	SITE-204	30.390	(0)	10.990	(0)	22.080	(0)	4.230	(0)
	SITE-187	SITE-187	33.000	(0)	11.000	(0)	18.000	(0)	6.200	(0)
699-51-46	SITE-188	SITE-188	21.000	(0)	9.200	(0)	19.000	(0)	2.200	(0)
	SITE-201	SITE-201	20.000	(0)	9.310	(0)	32.020	(0)	4.230	(0)
699-52-46A	SITE-202	SITE-202	16.510	(0)	4.230	(0)	33.630	(0)	9.190	(0)
	SITE-189	SITE-189	16.000	(0)	7.300	(0)	24.000	(0)	10.500	(0)
699-52-48	SITE-199	SITE-199	51.700	(0)	6.690	(0)	14.430	(0)	3.050	(0)
	SITE-190	SITE-190	50.000	(0)	6.400	(0)	6.200	(0)	1.900	(0)
699-53-50	SITE-191	SITE-191	21.000	(0)	7.300	(0)	30.000	(0)	10.900	(0)
	SITE-200	SITE-200	20.390	(0)	7.120	(0)	28.980	(0)	8.630	(0)
699-54-57	SITE-192	SITE-192	2.300	(0)	7.200	(0)	25.000	(0)	11.600	(0)
699-56-53	SITE-196	SITE-196	21.000	(0)	6.800	(0)	38.000	(0)	13.200	(0)
	SITE-197	SITE-197	21.000	(0)	6.600	(0)	38.000	(0)	13.500	(0)

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SAMPLE TYPE. PRECIPITATION
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
STATION-03	82-51	82-51	0.184	(1)	< 0.277	(1)	0.268	(1)	< 0.103	(1)
STATION-04	82-61	82-61	0.174	(1)	< 0.277	(1)	0.516	(1)	< 0.103	(1)
STATION-07	82-92	82-92	0.112	(1)	< 0.277	(1)	0.205	(1)	< 0.103	(1)
STATION-14	82-20	82-20	0.180	(1)	0.501	(1)	0.219	(1)	< 0.103	(1)
STATION-17	82-70	82-70	0.270	(1)	< 0.277	(1)	0.281	(1)	< 0.103	(1)
STATION-20	82-58	82-58	< 0.067	(1)	< 0.277	(1)	0.088	(1)	< 0.103	(1)
	82-74	82-74	0.110	(1)	< 0.277	(1)	0.101	(1)	< 0.103	(1)
STATION-25	82-83	82-83	< 0.067	(1)	< 0.277	(1)	0.142	(1)	< 0.103	(1)
	82-66	82-66	0.107	(1)	< 0.277	(1)	0.129	(1)	< 0.103	(1)
STATION-26	82-91	82-91	0.069	(1)	< 0.277	(1)	0.222	(1)	< 0.075	(1)
	82-98	82-98	0.259	(1)	< 0.277	(1)	0.224	(1)	< 0.103	(1)

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SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
SP-BENNETT	SITE-218	SITE-218	7.100	(0)	1.600	(0)	22.800	(0)	8.200	(0)
	79-13	79-13	8.900	(1)	2.600	(1)	25.600	(1)	9.800	(1)
	85-362	85-362	9.130	(1)	2.740	(1)	29.000	(1)	10.100	(1)
		85-363	9.170	(1)	2.760	(1)	29.100	(1)	10.100	(1)
	86-190	86-190	9.080	(1)	2.380	(1)	28.700	(1)	9.890	(1)
		86-191	8.240	(1)	2.360	(1)	28.500	(1)	9.850	(1)
SP-BENSON	SITE-217	SITE-217	6.090	(0)	1.500	(0)	22.830	(0)	4.300	(0)
SP-BUTLER	79-1	79-1	8.800	(1)	2.300	(1)	21.700	(1)	9.700	(1)
		79-50	8.800	(1)	2.400	(1)	21.900	(1)	9.680	(1)
SP-GULCH	84-359	84-359	18.200	(1)	4.780	(1)	43.800	(1)	19.500	(1)
		84-383	19.300	(1)	4.700	(1)	43.100	(1)	19.200	(1)
SP-JUNIPER	SITE-215	SITE-215	19.600	(0)	5.200	(0)	23.600	(0)	10.300	(0)
	79-2	79-2	30.000	(1)	6.906	(1)	24.700	(1)	17.800	(1)
		79-43	28.800	(1)	6.600	(1)	23.500	(1)	16.900	(1)
	81-115	81-115	24.190	(1)	5.850	(1)	23.950	(1)	15.240	(1)
		81-161	24.640	(1)	5.950	(1)	24.160	(1)	15.380	(1)
	83-372	83-305	24.570	(1)	5.910	(1)	27.810	(1)	17.000	(1)
		83-372	24.500	(1)	5.800	(1)	25.350	(1)	16.570	(1)
SP-LD SNIVELY	79-34	79-19	9.500	(1)	2.500	(1)	19.900	(1)	9.800	(1)
		79-34	11.200	(1)	2.900	(1)	22.600	(1)	11.200	(1)
	82-362	82-362	8.700	(1)	2.400	(1)	22.200	(1)	10.200	(1)
		82-377	8.400	(1)	2.300	(1)	22.100	(1)	10.100	(1)
	83-396	83-311	8.560	(1)	2.660	(1)	22.860	(1)	10.370	(1)
		83-396	8.590	(1)	2.430	(1)	22.500	(1)	10.230	(1)
SP-LOZIER	79-6	79-44	7.700	(1)	2.000	(1)	23.400	(1)	9.300	(1)
		79-6	7.600	(1)	1.800	(1)	23.000	(1)	9.100	(1)
	81-186	81-116	7.850	(1)	1.260	(1)	24.080	(1)	8.940	(1)
		81-186	7.770	(1)	1.260	(1)	24.010	(1)	8.880	(1)
	83-316	83-316	7.810	(1)	1.410	(1)	24.580	(1)	8.870	(1)
		83-343	7.720	(1)	1.480	(1)	24.590	(1)	8.860	(1)
SP-MAIDEN	79-100	79-67	7.810	(1)	2.570	(1)	19.350	(1)	8.890	(1)
		79-96	7.620	(1)	2.530	(1)	18.440	(1)	8.800	(1)
	83-420	83-420	7.130	(1)	1.660	(1)	19.320	(1)	7.370	(1)
		83-435	7.270	(1)	1.700	(1)	19.660	(1)	7.510	(1)
SP-OBSERVATORY	81-119	81-119	7.540	(1)	1.740	(1)	21.990	(1)	10.670	(1)
		81-157	8.100	(1)	1.990	(1)	22.080	(1)	10.710	(1)
	83-433	83-433	7.400	(1)	1.820	(1)	22.690	(1)	10.930	(1)
		83-461	7.420	(1)	1.900	(1)	23.110	(1)	11.070	(1)
	84-392	84-310	7.430	(1)	1.810	(1)	22.600	(1)	11.000	(1)
		84-392	7.830	(1)	2.000	(1)	23.000	(1)	11.200	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJORS

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
SP-OBSERVATORY	84-329	84-329	7.380	(1)	1.830	(1)	22.5[illegible]	[illegible]	[illegible]	(1)
		84-366	7.330	(1)	1.790	(1)	22.200	(1)	10.800	(1)
	85-359	85-359	7.100	(1)	1.580	(1)	21.100	(1)	10.400	(1)
		85-360	7.200	(1)	1.480	(1)	21.500	[illegible]	10.600	(1)
	86-178	86-178	7.420	(1)	1.700	(1)	22.700	[illegible]	10.900	(1)
		86-179	7.360	(1)	1.600	(1)	22.500	(1)	10.800	(1)
SP-RAILROAD	79-76	79-76	7.200	(1)	3.200	(1)	18.700	(1)	14.900	(1)
		79-81	6.600	(1)	2.900	(1)	16.900	(1)	14.200	(1)
SP-RATTLESNAKE	SITE-216	SITE-216	12.000	(0)	3.000	(0)	28.500	(0)	[illegible]	(0)
	79-88	79-87	16.600	(1)	8.300	(1)	48.500	(1)	17.200	(1)
		79-88	16.300	(1)	8.300	(1)	45.800	(1)	17.250	(1)
	83-412	83-412	19.250	(1)	4.990	(1)	53.980	(1)	15.630	(1)
		83-466	17.990	(1)	4.990	(1)	53.840	(1)	15.600	(1)
SP-SNIVELY	79-49	79-37	[illegible].000	(1)	2.500	(1)	21.600	(1)	9.400	(1)
		79-49	[illegible].000	(1)	2.500	(1)	21.500	(1)	9.300	(1)
SP-SULFUR	79-29	79-29	[illegible].900	(1)	3.600	(1)	23.900	[illegible]	[illegible].100	(1)
		79-36	9.800	(1)	3.600	(1)	23.500	(1)	[illegible].100	(1)
	83-409	83-409	9.370	(1)	2.970	(1)	25.820	(1)	9.330	(1)
		83-442	9.780	(1)	2.890	(1)	25.500	(1)	9.200	(1)
SP-UNNAMED-02	79-75	79-75	[illegible].800	(1)	2.930	(1)	19.700	(1)	10.000	(1)
SP-UNNAMED-16	79-73	79-73	8.300	(1)	2.100	(1)	20.6[illegible]	(1)	6.750	(1)
		79-82	8.400	(1)	2.080	(1)	20.25[illegible]	(1)	8.860	(1)
SP-UNNAMED-26	79-98	79-54	[illegible].000	(1)	6.800	(1)	27.[illegible]	[illegible]	[illegible].300	(1)
		79-98	11.300	(1)	5.200	(1)	26.800	[illegible]	10.800	(1)
SP-UNNAMED-29	79-16	79-16	[illegible].700	(1)	2.560	(1)	27.5[illegible]	[illegible]	[illegible].400	(1)
		79-24	11.700	(1)	2.100	(1)	28.500	[illegible]	10.400	(1)
SP-UP-SNIVELY	79-71	79-60	[illegible].870	(1)	2.360	(1)	16.980	(1)	7.590	(1)
		79-71	[illegible].830	(1)	2.220	(1)	16.620	(1)	7.520	(1)
	81-126	81-126	7.900	(1)	1.900	(1)	13.500	[illegible]	7.400	(1)
		81-200	7.700	(1)	1.820	(1)	18.900	[illegible]	7.290	(1)
	83-503	83-503	[illegible].230	(1)	2.090	(1)	19.490	[illegible]	[illegible].370	(1)
		83-547	8.000	(1)	2.050	(1)	19.410	(1)	7.370	(1)
	86-193	86-193	5.080	(1)	2.180	(1)	21.500	[illegible]	8.030	(1)
		86-194	5.050	(1)	2.120	(1)	21.300	[illegible]	[illegible].030	(1)
SP-OR2-07	85-343	85-343	8.890	(1)	1.700	(1)	27.100	[illegible]	7.570	(1)
		85-344	8.930	(1)	1.690	(1)	26.8[illegible]	[illegible]	[illegible].520	(1)
	86-159	86-159	8.920	(1)	1.530	(1)	28.700	[illegible]	[illegible].500	(1)
		86-160	8.990	(1)	1.530	(1)	28.800	[illegible]	9.880	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS

SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
SP-UR6-20	85-346	85-346	9.860	(1)	1.110	(1)	24.100	(1)	9.850	(1)
		85-347	9.920	(1)	1.090	(1)	24.200	(1)	9.890	(1)
	86-162	86-162	10.000	(1)	1.280	(1)	24.900	(1)	9.840	(1)
		86-163	10.000	(1)	1.270	(1)	24.900	(1)	9.820	(1)
SP-UR7-22	85-349	85-349	11.200	(1)	2.370	(1)	17.300	(1)	12.300	(1)
		85-350	11.100	(1)	2.320	(1)	17.300	(1)	12.300	(1)
	86-153	86-153	14.600	(1)	1.830	(1)	19.800	(1)	12.100	(1)
		86-154	14.500	(1)	1.840	(1)	19.900	(1)	12.200	(1)
SP-WARM	84-358	84-358	22.900	(1)	6.200	(1)	25.600	(1)	11.200	(1)
		84-371	22.900	(1)	6.200	(1)	25.700	(1)	11.300	(1)
SP-YR3-04	85-333	85-333	8.440	(1)	2.580	(1)	20.400	(1)	12.700	(1)
		85-334	8.420	(1)	2.550	(1)	20.300	(1)	12.700	(1)
	86-150	86-150	8.530	(1)	2.360	(1)	23.000	(1)	14.200	(1)
		86-151	8.530	(1)	2.290	(1)	23.100	(1)	14.200	(1)
SP-YR5-08	85-336	85-336	10.800	(1)	2.580	(1)	20.200	(1)	9.150	(1)
		85-337	10.700	(1)	2.550	(1)	20.300	(1)	9.200	(1)
	86-147	86-147	12.600	(1)	2.690	(1)	33.500	(1)	15.400	(1)
		86-148	12.400	(1)	2.720	(1)	33.600	(1)	15.400	(1)
SP-YR7-14	85-339	85-339	7.900	(1)	2.260	(1)	18.900	(1)	6.900	(1)
		85-340	7.860	(1)	2.200	(1)	16.700	(1)	6.360	(1)
	86-156	86-156	7.180	(1)	1.770	(1)	14.500	(1)	6.050	(1)
		86-157	7.280	(1)	1.780	(1)	14.600	(1)	6.090	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SURFACE
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
COLD CREEK	84-317	84-317	15.400	(1)	3.030	(1)	30.900	(1)	12.500	(1)
		84-336	15.500	(1)	3.060	(1)	31.400	(1)	12.800	(1)
	84-302	84-302	15.600	(1)	2.870	(1)	31.800	(1)	13.[illegible]	(1)
		84-345	15.500	(1)	2.900	(1)	31.500	(1)	12.800	(1)
	85-223	85-223	13.800	(1)	2.630	(1)	28.100	(1)	12.000	(1)
		85-224	13.300	(1)	2.550	(1)	27.700	(1)	11.600	(1)
CR-DC-14	83-258	83-211	2.400	(1)	0.900	(1)	20.300	(1)	4.820	(1)
		83-258	2.470	(1)	0.960	(1)	20.700	(1)	4.950	(1)
CR-HIS	SITE-221	SITE-221	1.250	(0)	0.300	(0)	15.000	(0)	< 8.300	(0)
CR-V-DR	84-330	84-330	2.470	(1)	0.720	(1)	15.9[illegible]	(1)	[illegible]	(1)
		84-361	2.430	(1)	0.750	(1)	15.900	(1)	3.[illegible]	(1)
	84-311	84-311	2.560	(1)	0.720	(1)	15.900	(1)	3.[illegible]	(1)
		84-356	2.540	(1)	0.690	(1)	16.000	(1)	[illegible]	(1)
	85-206	85-206	2.430	(1)	0.910	(1)	22.200	(1)	5.[illegible]	(1)
		85-207	2.430	(1)	0.830	(1)	22.200	(1)	5.[illegible]	(1)
	85-266	85-266	2.260	(1)	0.420	(1)	17.30[illegible]	(1)	3.980	(1)
		85-267	2.220	(1)	0.410	(1)	15.00[illegible]	(1)	3.870	(1)
	86-70	86-70	2.190	(1)	< 0.590	(1)	18.200	(1)	4.380	(1)
		86-71	2.070	(1)	< 0.590	(1)	18.800	(1)	4.[illegible]	(1)
	86-109	86-109	2.250	(1)	0.742	(1)	18.70[illegible]	(1)	4.[illegible]	(1)
		86-110	2.250	(1)	0.740	(1)	18.700	(1)	4.590	(1)
YR-DR	85-210	85-210	6.180	(1)	1.300	(1)	12.700	(1)	4.[illegible]	(1)
		85-211	6.140	(1)	1.410	(1)	12.800	(1)	4.320	(1)
	85-269	85-269	16.300	(1)	2.980	(1)	30.300	(1)	10.[illegible]	(1)
		85-270	16.300	(1)	2.890	(1)	29.800	(1)	10.[illegible]	(1)
	86-67	86-67	13.400	(1)	2.310	(1)	22.800	(1)	8.[illegible]	(1)
		86-68	13.500	(1)	2.270	(1)	22.800	(1)	8.330	(1)
	86-118	86-118	15.700	(1)	2.670	(1)	24.100	(1)	9.540	(1)
		86-119	15.500	(1)	2.660	(1)	24.000	(1)	9.[illegible]	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS [illegible] CODES.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
RRL-06A	82-40	82-35	20.100	(1)	4.400	(1)	41.200	(1)	14.500	(1)
		82-40	20.200	(1)	4.400	(1)	41.400	(1)	14.500	(1)
199-B04-04	SITE-41	SITE-41	10.000	(0)	4.900	(0)	43.000	(0)	5.900	(0)
199-D05-12	SITE-80	SITE-80	12.000	(0)	4.100	(0)	39.000	(0)	8.400	(0)
199-D08-03	SITE-72	SITE-72	5.200	(0)	5.000	(0)	46.000	(0)	6.900	(0)
199-F05-01	SITE-82	SITE-82	4.400	(0)	2.700	(0)	34.000	(0)	4.500	(0)
199-H04-03	SITE-81	SITE-81	700.000	(0)	10.000	(0)	50.000	(0)	7.500	(0)
199-K-19	SITE-83	SITE-83	3.400	(0)	1.900	(0)	34.000	(0)	4.300	(0)
199-N-15	SITE-42	SITE-42	2.900	(0)	2.400	(0)	27.000	(0)	4.600	(0)
299-E26-08	SITE-165	SITE-165	15.600	(0)	5.600	(0)	25.800	(0)	10.700	(0)
299-E33-12	SITE-160	SITE-169	74.000	(0)	7.000	(0)	34.000	(0)	13.100	(0)
399-01-01	SITE-244	SITE-244	9.700	(0)	2.200	(0)	26.000	(0)	4.700	(0)
399-01-03	SITE-43	SITE-43	21.000	(0)	3.100	(0)	33.000	(0)	5.500	(0)
399-02-01	SITE-245	SITE-245	11.000	(0)	2.600	(0)	19.000	(0)	4.100	(0)
399-03-01	SITE-246	SITE-246	12.000	(0)	2.900	(0)	22.000	(0)	4.500	(0)
399-04-10	SITE-44	SITE-44	22.000	(0)	3.800	(0)	20.000	(0)	5.800	(0)
399-08-04	SITE-140	SITE-140	17.000	(0)	4.600	(0)	35.000	(0)	7.200	(0)
699-HAN-19	SITE-3	SITE-3	25.000	(0)	5.400	(0)	31.000	(0)	7.100	(0)
699-S03-E12	SITE-22	SITE-22	17.000	(0)	7.000	(0)	26.000	(0)	3.100	(0)
	SITE-141	SITE-141	13.000	(0)	4.700	(0)	24.000	(0)	8.100	(0)
699-S03-25	SITE-7	SITE-7	26.000	(0)	7.300	(0)	51.000	(0)	14.000	(0)
	SITE-142	SITE-142	26.000	(0)	7.700	(0)	62.000	(0)	15.000	(0)
	86-55	86-55	26.000	(1)	7.490	(1)	61.000	(1)	14.900	(1)
		86-56	25.700	(1)	7.460	(1)	60.800	(1)	14.900	(1)
	86-130	86-130	25.600	(1)	7.610	(1)	62.500	(1)	14.600	(1)
		86-131	25.200	(1)	7.380	(1)	61.000	(1)	14.300	(1)
699-S06-E04D	SITE-11	SITE-11	22.000	(0)	6.600	(0)	45.000	(0)	12.000	(0)
699-S08-19	SITE-48	SITE-46	32.000	(0)	7.600	(0)	41.000	(0)	8.800	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE. UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-S08-19	SITE-84	SITE-84	36.000	(0)	7.800	(0)	38.000	(0)	8.000	(0)
699-S11-E12A	SITE-4	SITE-4	16.000	(0)	4.600	(0)	39.000	(0)	11.000	(0)
699-S12-03	SITE-45	SITE-45	23.000	(0)	5.600	(0)	43.000	(0)	9.300	(0)
	SITE-143	SITE-143	24.000	(0)	5.800	(0)	42.000	(0)	9.600	(0)
699-S19-E13	SITE-120	SITE-120	22.000	(0)	6.000	(0)	40.000	(0)	11.000	(0)
699-S24-19	85-213	85-213	16.400	(1)	3.180	(1)	29.5[illegible]	[illegible]	10.700	(1)
		85-214	16.300	(1)	3.220	(1)	29.400	[illegible]	10.200	(1)
	85-291	85-291	18.900	(1)	2.820	(1)	31.400	[illegible]	11.800	(1)
		85-292	17.000	(1)	2.940	(1)	31.900	[illegible]	11.300	(1)
699-S29-E12	SITE-21	SITE-21	23.000	(0)	8.500	(0)	44.000	[illegible]	[illegible]	(0)
699-S30-E15A	SITE-144	SITE-144	17.000	(0)	6.000	(0)	60.0[illegible]	[illegible]	12.[illegible]	(0)
699-01-18	SITE-145	SITE-145	23.000	(0)	6.600	(0)	48.000	[illegible]	11.200	(0)
699-02-03	SITE-1	SITE-1	19.000	(0)	6.300	(0)	44.000	(0)	11.000	(0)
699-02-33	SITE-85	SITE-85	13.000	(0)	4.400	(0)	38.000	(0)	11.300	(0)
	SITE-146	SITE-146	12.000	(0)	4.400	(0)	42.000	[illegible]	11.000	(0)
699-04-E06	SITE-47	SITE-47	17.000	(0)	6.000	(0)	38.000	(0)	11.000	(0)
699-08-17	SITE-23	SITE-23	22.000	(0)	7.300	(0)	46.000	(0)	11.000	(0)
699-08-25	SITE-32	SITE-32	22.000	(0)	7.300	(0)	46.000	(0)	12.000	(0)
699-08-32	SITE-19	SITE-19	13.000	(0)	5.900	(0)	40.000	[illegible]	10.000	(0)
699-09-E02	SITE-16	SITE-16	30.000	(0)	6.900	(0)	24.000	(0)	8.700	(0)
699-10-E12	SITE-147	SITE-147	[illegible]	(0)	5.500	(0)	45.000	[illegible]	[illegible]	(0)
	SITE-247	SITE-247	19.000	(0)	5.900	(0)	48.000	[illegible]	15.[illegible]	(0)
699-11-45A	SITE-148	SITE-148	[illegible]	(0)	4.600	(0)	[illegible]	[illegible]	[illegible]	(0)
	85-263	85-263	11.200	(1)	5.220	(1)	34.4[illegible]	[illegible]	9.320	(1)
		85-264	11.200	(1)	5.190	(1)	34.5[illegible]	[illegible]	9.390	(1)
	86-43	86-43	[illegible]	(1)	4.750	(1)	32.[illegible]	[illegible]	[illegible]	(1)
		86-44	10.200	(1)	4.800	(1)	33.200	[illegible]	9.[illegible]	(1)
	86-124	86-124	9.940	(1)	4.750	(1)	33.200	[illegible]	9.350	(1)
		86-125	9.330	(1)	4.740	(1)	33.900	[illegible]	9.600	(1)
699-13-01A	SITE-60	SITE-60	22.000	(0)	6.500	(0)	33.000	[illegible]	13.[illegible]	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-14-38	SITE-61	SITE-61	17.000	(0)	6.000	(0)	34.000	(0)	11.000	(0)
	SITE-86	SITE-86	17.000	(0)	5.700	(0)	30.000	(0)	9.400	(0)
699-15-15B	SITE-13	SITE-13	20.000	(0)	7.200	(0)	47.000	(0)	9.300	(0)
	SITE-149	SITE-149	20.000	(0)	6.400	(0)	54.000	(0)	11.000	(0)
699-15-26	SITE-24	SITE-24	22.000	(0)	7.300	(0)	46.000	(0)	12.000	(0)
	SITE-150	SITE-150	23.000	(0)	6.300	(0)	48.000	(0)	12.000	(0)
699-17-05	SITE-18	SITE-18	12.000	(0)	6.400	(0)	61.000	(0)	11.000	(0)
	SITE-151	SITE-151	10.000	(0)			70.000	(0)	10.000	(0)
699-19-43	SITE-48	SITE-48	18.000	(0)	5.700	(0)	43.000	(0)	11.000	(0)
	SITE-121	SITE-121	19.000	(0)	5.600	(0)	44.000	(0)	10.000	(0)
699-19-58	85-229	85-229	12.900	(1)	4.810	(1)	34.300	(1)	12.300	(1)
		85-230	12.800	(1)	4.850	(1)	34.900	(1)	12.500	(1)
	85-260	85-260	13.800	(1)	5.500	(1)	34.300	(1)	12.400	(1)
		85-261	13.800	(1)	5.500	(1)	34.700	(1)	12.500	(1)
	86-40	86-40	12.800	(1)	5.020	(1)	34.000	(1)	12.200	(1)
		86-41	12.600	(1)	4.830	(1)	33.700	(1)	12.100	(1)
	86-121	86-121	12.400	(1)	5.040	(1)	33.800	(1)	12.200	(1)
		86-122	12.400	(1)	4.920	(1)	33.100	(1)	12.000	(1)
699-19-88	85-278	85-278	12.200	(1)	3.250	(1)	27.000	(1)	10.900	(1)
		85-279	12.100	(1)	3.210	(1)	27.000	(1)	10.800	(1)
	86-64	86-64	11.600	(1)	3.330	(1)	26.600	(1)	10.400	(1)
		86-65	11.700	(1)	3.300	(1)	26.800	(1)	10.500	(1)
	86-127	86-127	11.500	(1)	3.480	(1)	27.000	(1)	10.600	(1)
		86-128	11.700	(1)	3.690	(1)	27.300	(1)	10.700	(1)
699-20-E05-0	SITE-49	SITE-49	13.000	(0)	5.900	(0)	35.000	(0)	9.500	(0)
699-20-20	SITE-25	SITE-25	20.000	(0)	8.000	(0)	53.000	(0)	11.000	(0)
699-24-33	SITE-28	SITE-28	25.000	(0)	7.600	(0)	47.000	(0)	13.000	(0)
699-24-46	SITE-122	SITE-122	16.000	(0)	6.000	(0)	32.000	(0)	12.000	(0)
699-24-05	85-288	85-288	14.800	(1)	4.220	(1)	51.300	(1)	16.500	(1)
		85-289	14.800	(1)	4.220	(1)	51.800	(1)	16.500	(1)
	86-61	86-61	13.800	(1)	4.120	(1)	47.300	(1)	14.000	(1)
		86-62	13.800	(1)	4.140	(1)	47.700	(1)	14.100	(1)
	86-115	86-115	14.000	(1)	4.390	(1)	52.600	(1)	16.500	(1)
		86-116	14.200	(1)	4.340	(1)	52.300	(1)	16.000	(1)
699-25-55	SITE-100	SITE-100	10.000	(0)	5.100	(0)	50.000	(0)	12.000	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-26-15	SITE-26	SITE-26	23.000	(0)	7.100	(0)	48.000	(0)	11.000	(0)
699-26-15A	SITE-263	SITE-263	24.000	(0)	6.000	(0)	49.000	(0)	11.000	(0)
699-27-04	SITE-101	SITE-101	10.000	(0)	5.700	(0)	50.000	(0)	10.000	(0)
699-27-08	SITE-5	SITE-5	19.000	(0)	8.400	(0)	58.000	(0)	12.000	(0)
	SITE-30	SITE-30	19.000	(0)	6.900	(0)	54.000	(0)	11.000	(0)
	SITE-50	SITE-50	20.000	(0)	6.300	(0)	55.000	(0)	12.000	(0)
	SITE-76	SITE-76	20.000	(0)	6.700	(0)	54.000	(0)	13.000	(0)
	SITE-87	SITE-87	21.000	(0)	6.400	(0)	48.000	(0)	12.000	(0)
699-28-40	SITE-68	SITE-68	23.000	(0)	6.700	(0)	46.000	(0)	12.000	(0)
699-31-31	SITE-69	SITE-69	30.000	(0)	7.200	(0)	43.000	(0)	13.000	(0)
	SITE-102	SITE-102	30.000	(0)	6.800	(0)	37.000	(0)	11.000	(0)
699-31-53B	SITE-88	SITE-88	21.000	(0)	4.900	(0)	38.000	(0)	12.000	(0)
699-32-22	SITE-17	SITE-17	31.000	(0)	7.000	(0)	53.000	(0)	14.000	(0)
	SITE-27	SITE-27	29.000	(0)	7.200	(0)	53.000	(0)	13.000	(0)
	SITE-51	SITE-51	29.000	(0)	6.500	(0)	51.000	(0)	13.000	(0)
	SITE-65	SITE-65	30.000	(0)	6.900	(0)	50.000	(0)	14.000	(0)
	SITE-89	SITE-89	29.000	(0)	6.600	(0)	46.000	(0)	13.000	(0)
699-32-70B	SITE-70	SITE-70	18.000	(0)	4.500	(0)	37.000	(0)	12.000	(0)
	SITE-90	SITE-90	19.000	(0)	4.300	(0)	32.000	(0)	9.800	(0)
	SITE-152	SITE-152	18.000	(0)	4.100	(0)	34.000	(0)	11.000	(0)
699-32-72	SITE-35	SITE-35	16.000	(0)	4.300	(0)	28.000	(0)	12.000	(0)
699-32-77	SITE-103	SITE-103	25.000	(0)	3.200	(0)	30.000	(0)	7.000	(0)
699-33-42	SITE-12	SITE-12	31.000	(0)	8.800	(0)	41.000	(0)	13.000	(0)
	SITE-29	SITE-29	29.000	(0)	7.000	(0)	38.000	(0)	12.000	(0)
	SITE-52	SITE-52	29.000	(0)	5.300	(0)	37.000	(0)	12.000	(0)
	SITE-67	SITE-67	29.000	(0)	6.400	(0)	38.000	(0)	13.000	(0)
	SITE-91	SITE-91	31.000	(0)	6.200	(0)	35.000	(0)	12.000	(0)
699-33-56	SITE-8	SITE-8	27.000	(0)	5.800	(0)	42.000	(0)	13.000	(0)
	SITE-40	SITE-40	25.000	(0)	6.100	(0)	41.000	(0)	12.000	(0)
	SITE-53	SITE-53	24.900	(0)	5.700	(0)	46.000	(0)	[illegible]	(0)
	SITE-62	SITE-62	24.000	(0)	6.000	(0)	47.000	(0)	14.000	(0)
	SITE-92	SITE-92	25.000	(0)	5.700	(0)	41.000	(0)	12.000	(0)
699-34-39A	SITE-93	SITE-93	31.000	(0)	6.800	(0)	32.000	(0)	11.000	(0)
699-34-42	SITE-33	SITE-33	32.000	(0)	7.300	(0)	37.000	(0)	11.000	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-34-42	SITE-153	SITE-153	28.000	(0)	6.100	(0)	32.000	(0)	9.900	(0)
699-34-51	SITE-66	SITE-66	21.000	(0)	5.900	(0)	50.000	(0)	15.000	(0)
699-35-09	SITE-31	SITE-31	19.000	(0)	5.500	(0)	40.000	(0)	9.500	(0)
	SITE-104	SITE-104	10.000	(0)	5.500	(0)	50.000	(0)	10.000	(0)
	SITE-264	SITE-264	20.000	(0)	5.200	(0)	46.000	(0)	12.000	(0)
699-35-66	SITE-77	SITE-77	20.000	(0)	5.900	(0)	43.000	(0)	13.000	(0)
	SITE-94	SITE-94	23.000	(0)	5.600	(0)	40.000	(0)	11.000	(0)
699-35-70	SITE-36	SITE-36	28.000	(0)	6.600	(0)	51.000	(0)	16.000	(0)
699-35-78	SITE-54	SITE-54	23.000	(0)	3.200	(0)	19.000	(0)	6.400	(0)
699-36-61A	SITE-95	SITE-95	21.000	(0)	5.600	(0)	40.000	(0)	13.000	(0)
699-37-43	SITE-34	SITE-34	41.000	(0)	8.400	(0)	25.000	(0)	7.900	(0)
	SITE-173	SITE-173	57.000	(0)	8.700	(0)	82.000	(0)	29.000	(0)
699-37-82A	SITE-105	SITE-105	22.000	(0)	8.000	(0)	50.000	(0)	0.400	(0)
699-38-70	SITE-37	SITE-37	21.000	(0)	7.300	(0)	92.000	(0)	29.000	(0)
699-39-E3	SITE-248	SITE-248	15.000	(0)	5.000	(0)	31.000	(0)	11.000	(0)
699-39-01	SITE-249	SITE-249	18.000	(0)	5.700	(0)	43.000	(0)	12.000	(0)
699-39-39	SITE-266	SITE-266	28.000	(0)	4.600	(0)	23.000	(0)	4.900	(0)
699-40-01	SITE-10	SITE-10	17.000	(0)	6.000	(0)	40.000	(0)	11.000	(0)
	SITE-106	SITE-106	10.000	(0)	5.800	(0)	50.000	(0)	11.000	(0)
	SITE-250	SITE-250	18.000	(0)	5.700	(0)	44.000	(0)	12.000	(0)
	SITE-265	SITE-265	18.000	(0)	4.800	(0)	44.000	(0)	12.000	(0)
699-40-33	SITE-55	SITE-55	52.000	(0)	7.500	(0)	14.000	(0)	3.900	(0)
	SITE-251	SITE-251	56.000	(0)	7.100	(0)	16.000	(0)	4.000	(0)
699-40-62	SITE-56	SITE-56	17.000	(0)	5.300	(0)	43.000	(0)	15.000	(0)
699-41-01	SITE-252	SITE-252	19.000	(0)	5.600	(0)	42.000	(0)	12.000	(0)
699-41-23	SITE-15	SITE-15	30.000	(0)	7.300	(0)	48.000	(0)	15.000	(0)
	SITE-113	SITE-113	29.000	(0)	6.700	(0)	42.000	(0)	12.000	(0)
699-42-02	SITE-154	SITE-154	19.000	(0)	5.300	(0)	41.000	(0)	12.000	(0)
699-42-12	SITE-2	SITE-2	24.000	(0)	5.400	(0)	41.000	(0)	14.000	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-42-12	SITE-155	SITE-155	28.000	(0)	5.400	(0)	43.000	(0)	15.000	(0)
	SITE-267	SITE-267	25.000	(0)	4.700	(0)	43.000	(0)	15.000	(0)
699-42-40A	SITE-174	SITE-174	28.000	(0)	3.800	(0)	19.000	(0)	14.000	(0)
699-42-40C	SITE-175	SITE-175	25.000	(0)	4.300	(0)	22.000	(0)	12.400	(0)
699-42-42	SITE-114	SITE-114	24.000	(0)	5.800	(0)	50.000	(0)	[illegible]	(0)
699-43-03	SITE-253	SITE-253	20.000	(0)	5.100	(0)	41.000	(0)	12.000	(0)
699-43-88	SITE-123	SITE-123	14.000	(0)	4.600	(0)	42.000	[illegible]	[illegible]	(0)
699-44-04	SITE-254	SITE-254	19.000	(0)	5.400	(0)	44.000	[illegible]	12.000	(0)
699-45-04	SITE-255	SITE-255	13.000	(0)	5.200	(0)	40.000	[illegible]	11.000	(0)
699-45-42	SITE-57	SITE-57	16.000	(0)	4.500	(0)	25.000	(0)	11.000	(0)
	SITE-268	SITE-268	13.000	(0)	3.700	(0)	22.000	[illegible]	9.000	(0)
699-45-69	SITE-96	SITE-96	14.000	(0)	3.800	(0)	41.000	[illegible]	17.000	(0)
699-46-05	SITE-156	SITE-156	22.000	(0)	4.700	(0)	43.000	[illegible]	[illegible]	(0)
	SITE-256	SITE-256	22.000	(0)	5.200	(0)	42.000	[illegible]	13.000	(0)
699-46-21A	SITE-75	SITE-75	21.000	(0)	4.900	(0)	40.000	[illegible]	15.000	(0)
	SITE-124	SITE-124	21.000	(0)	4.700	(0)	42.000	[illegible]	14.000	(0)
699-47-06	SITE-257	SITE-257	21.000	(0)	4.400	(0)	37.000	(0)	3.000	(0)
699-47-46	SITE-269	SITE-269	23.000	(0)	7.300	(0)	43.000	[illegible]	16.000	(0)
699-48-07	SITE-258	SITE-258	6.600	(0)	1.400	(0)	22.000	(0)	5.200	(0)
699-48-18	SITE-125	SITE-125	13.000	(0)	5.700	(0)	[illegible]	[illegible]	[illegible]	(0)
699-48-71	SITE-59	SITE-59	10.000	(0)	3.600	(0)	32.000	[illegible]	13.000	(0)
699-49-13	SITE-259	SITE-259	27.000	(0)	5.500	(0)	34.000	[illegible]	[illegible]	(0)
699-49-55	SITE-8	SITE-8	[illegible]	(0)	7.700	(0)	[illegible]	[illegible]	[illegible]	(0)
	SITE-39	SITE-39	39.000	(0)	10.000	(0)	[illegible]	[illegible]	12.000	(0)
	SITE-58	SITE-58	43.000	(0)	11.000	(0)	[illegible]	[illegible]	15.000	(0)
	SITE-78	SITE-78	42.000	(0)	12.000	(0)	[illegible]	[illegible]	[illegible]	(0)
	SITE-97	SITE-97	45.000	(0)	13.000	(0)	58.000	[illegible]	7.700	(0)
	SITE-126	SITE-126	41.000	(0)	12.000	(0)	64.000	[illegible]	[illegible]	(0)
	SITE-157	SITE-157	45.000	(0)	13.000	(0)	67.000	[illegible]	3.300	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-49-55A	SITE-182	SITE-182	35.000	(0)	10.300	(0)	70.000	(0)	20.000	(0)
699-49-57	SITE-38	SITE-38	53.000	(0)	8.700	(0)	85.000	(0)	25.000	(0)
699-49-79	SITE-20	SITE-20	8.700	(0)	4.200	(0)	44.000	(0)	15.000	(0)
699-50-08	SITE-64	SITE-64	22.000	(0)	6.900	(0)	42.000	(0)	12.000	(0)
699-50-28B	SITE-63	SITE-63	22.000	(0)	4.200	(0)	31.000	(0)	11.000	(0)
699-50-42	SITE-14	SITE-14	18.000	(0)	5.900	(0)	31.000	(0)	12.000	(0)
	SITE-115	SITE-115	16.000	(0)	4.600	(0)	17.000	(0)	5.000	(0)
	SITE-271	SITE-271	18.000	(0)	5.200	(0)	28.000	(0)	9.200	(0)
699-50-53	SITE-270	SITE-270	28.000	(0)	7.200	(0)	62.000	(0)	18.000	(0)
699-50-85	SITE-127	SITE-127	10.000	(0)	3.900	(0)	38.000	(0)	12.000	(0)
699-51-63	SITE-116	SITE-116	12.000	(0)	4.100	(0)	32.000	(0)	12.000	(0)
699-53-103	SITE-160	SITE-160	29.000	(0)	7.800	(0)	17.000	(0)	9.200	(0)
699-53-47B	SITE-272	SITE-272	5.900	(0)	3.200	(0)	33.000	(0)	9.400	(0)
699-54-34	SITE-273	SITE-273	19.000	(0)	4.400	(0)	27.000	(0)	12.000	(0)
699-55-50C	SITE-79	SITE-79	6.000	(0)	4.700	(0)	29.000	(0)	8.900	(0)
	SITE-128	SITE-128	5.000	(0)	4.300	(0)	29.000	(0)	7.900	(0)
	SITE-193	SITE-193	4.700	(0)	4.100	(0)	19.000	(0)	9.200	(0)
	SITE-274	SITE-274	4.700	(0)	4.000	(0)	31.000	(0)	8.700	(0)
699-55-76	SITE-71	SITE-71	14.000	(0)	5.900	(0)	41.000	(0)	8.100	(0)
	SITE-117	SITE-117	10.000	(0)	5.500	(0)	34.000	(0)	5.200	(0)
	SITE-129	SITE-129	9.600	(0)	4.800	(0)	28.000	(0)	4.900	(0)
699-55-89	SITE-118	SITE-118	10.000	(0)	4.400	(0)	33.000	(0)	12.000	(0)
699-56-53	SITE-194	SITE-194	8.400	(0)	5.300	(0)	25.000	(0)	10.500	(0)
	SITE-195	SITE-195	8.500	(0)	5.400	(0)	25.000	(0)	10.500	(0)
699-57-25A	SITE-119	SITE-119	31.000	(0)	6.600	(0)	30.000	(0)	[illegible]	(0)
	SITE-275	SITE-275	31.000	(0)	5.600	(0)	24.000	(0)	7.300	(0)
699-57-29A	SITE-276	SITE-276	29.000	(0)	6.900	(0)	23.000	(0)	6.700	(0)
699-57-83	SITE-130	SITE-130	7.600	(0)	3.500	(0)	30.000	(0)	12.000	(0)
699-59-58	SITE-107	SITE-107	27.000	(0)	5.400	(0)	30.000	(0)	7.000	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-59-58	SITE-277	SITE-277	27.000	(0)	5.100	(0)	21.000	(0)	5.800	(0)
699-60-32	SITE-278	SITE-278	23.000	(0)	4.300	(0)	28.000	(0)	8.200	(0)
699-60-57	SITE-198	SITE-198	38.000	(0)	7.800	(0)	16.000	(0)	8.500	(0)
699-62-31	SITE-131	SITE-131	20.000	(0)	5.200	(0)	36.000	(0)	8.100	(0)
	SITE-279	SITE-279	21.000	(0)	5.000	(0)	35.000	(0)	8.700	(0)
699-63-25A	SITE-132	SITE-132	24.000	(0)	5.200	(0)	64.000	(0)	13.000	(0)
699-63-55	SITE-280	SITE-280	29.000	(0)	5.400	(0)	21.000	(0)	7.200	(0)
699-63-58	SITE-281	SITE-281	29.000	(0)	5.000	(0)	23.000	(0)	7.600	(0)
699-63-90	SITE-74	SITE-74	11.000	(0)	4.700	(0)	36.000	(0)	13.000	(0)
	SITE-133	SITE-133	11.000	(0)	4.400	(0)	34.000	(0)	12.000	(0)
699-64-27	SITE-158	SITE-158	48.000	(0)	7.100	(0)	91.000	(0)	21.000	(0)
699-65-50	SITE-73	SITE-73	19.000	(0)	5.400	(0)	26.000	(0)	9.200	(0)
	SITE-134	SITE-134	19.000	(0)	5.000	(0)	24.000	(0)	8.200	(0)
	SITE-282	SITE-282	21.000	(0)	4.800	(0)	24.000	(0)	8.200	(0)
699-66-103	85-203	85-203	6.840	(1)	3.530	(1)	29.000	(1)	7.890	(1)
		85-204	6.830	(1)	3.280	(1)	28.000	(1)	7.730	(1)
	86-73	86-73	6.540	(1)	2.260	(1)	27.100	(1)	7.400	(1)
		86-74	6.390	(1)	2.170	(1)	26.500	(1)	7.250	(1)
	86-112	86-112	6.660	(1)	3.060	(1)	28.300	(1)	7.810	(1)
		86-113	6.540	(1)	3.050	(1)	28.200	(1)	7.780	(1)
	85-294	85-294	6.880	(1)	2.920	(1)	28.300	(1)	7.880	(1)
		85-295	6.830	(1)	2.890	(1)	28.100	(1)	7.840	(1)
699-66-39	SITE-135	SITE-135	61.000	(0)	1.300	(0)	10.300	(0)	3.300	(0)
699-66-58	SITE-136	SITE-136	14.000	(0)	5.400	(0)	27.000	(0)	5.400	(0)
699-66-64	SITE-137	SITE-137	16.000	(0)	5.500	(0)	27.000	(0)	3.300	(0)
699-67-98	SITE-260	SITE-260	13.000	(0)	4.500	(0)	38.000	(0)	10.000	(0)
699-69-38	SITE-6	SITE-6	34.000	(0)	13.000	(0)	72.000	(0)	5.800	(0)
699-71-30	SITE-108	SITE-108	39.000	(0)	6.200	(0)	56.000	(0)	14.000	(0)
699-71-52	SITE-138	SITE-138	22.000	(0)	5.500	(0)	30.000	(0)	10.000	(0)
699-72-73	SITE-109	SITE-109	10.000	(0)	5.500	(0)	32.000	(0)	10.000	(0)

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NA MG/L	(A)	K MG/L	(A)	CA MG/L	(A)	MG MG/L	(A)
699-72-88	SITE-98	SITE-98	9.300	(0)	4.500	(0)	33.000	(0)	7.500	(0)
	SITE-261	SITE-261	9.700	(0)	4.300	(0)	38.000	(0)	7.600	(0)
699-72-92	SITE-262	SITE-262	8.600	(0)	4.100	(0)	36.000	(0)	9.100	(0)
699-77-36	SITE-110	SITE-110	69.000	(0)	7.100	(0)	70.000	(0)	30.000	(0)
699-78-62	SITE-111	SITE-111	15.000	(0)	5.100	(0)	35.000	(0)	10.000	(0)
699-81-58	SITE-159	SITE-159	4.000	(0)	2.600	(0)	20.000	(0)	7.400	(0)
699-83-47	SITE-112	SITE-112	18.000	(0)	4.400	(0)	31.000	(0)	11.000	(0)
699-87-55	SITE-99	SITE-99	16.000	(0)	3.500	(0)	26.000	(0)	9.600	(0)
699-90-45	SITE-139	SITE-139	16.000	(0)	5.700	(0)	35.000	(0)	11.000	(0)

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LIST OF ANALYSIS METHODS FOR MAJOR CATIONS

SPECIE	(A)	ANALYSIS METHOD
CA	0	Unclassified
	1	ICP
K	0	Unclassified
	1	ICP
MG	0	Unclassified
	1	ICP
	2	AA
NA	0	Unclassified
	1	ICP

AA: Graphite Furnace Atomic Absorption Spectrophotometry
ICP: Inductively Coupled Plasma Atomic Emission Spectrometry
Unclassified: Analysis comes from a non-BWIP documented source and the method is not specified in this data package.

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SAMPLE TYPE: CONFINED •
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
BERK	85-255	85-255	132.000	135.000	27.500	(1)	0.600	(1)	32 500	(1)
		85-256	132.000	135.000	27.800	(1)				
DB-01	81-19	81-15	193.000	191.000	27.500	(1)				
		81-19	193.000	191.000	27.900	(1)				
	81-65	81-65	132.000	134.000	35.500	(1)				
		81-70	132.000	134.000	35.500	(1)				
	82-27	82-27		136.000	35.400	(1)	0.660	(1)		
		82-87		136.000	35.300	(1)				
	85-32	85-32	131.000	137.000	33.800	(1)	0.400	(1)	28.860	(1)
		85-33	139.000	137.000	33.600	(1)				
DB-02	79-65	CP123			33.000	(1)				
	81-13	81-11	140.000	134.200	29.600	(1)				
		81-13	140.000	134.200	29.700	(1)				
	81-10	81-10		134.200	34.200	(1)				
		81-7		134.200	34.300	(1)				
DB-04	79-77	CP116			48.600	(1)				
DB-07	79-89	CP121			41.500	(1)				
	83-413	83-413	170.000	170 000	38.370	(1)	0.740	(1)	34.880	(1)
		83-448	170 000	170.000	37.400	(1)				
	85-216	85-216	163.000	164.000	36.800	(1)	1.180	(1)	32.200	(1)
		85-217	163.000	164.000	36.600	(1)				
DB-09	79-28	CP115			31 400	(1)				
	83-472	83-410	139.000	139.000	27.400	(1)				
		83-472	134.000	139.000	27.400	(1)	0.440	(1)	32.410	(1)
DB-11	85-18	85-18	140 000	141.000	28.900	(1)	0.240	(1)	32.990	(1)
		85-19	140.000	141.000	28.700	(1)	0.240	(1)	32.990	(1)
	86-52	86-52	141 000	140 000	30.400	(1)	0.260	(1)	32.900	(1)
		86-53	141 000	140.000	30.400	(1)				
	81-57	81-57		141.000	32.170	(1)				
DB-12	83-95	83-95		145.000	14.000	(1)				
	81-25	81-25		171.900	26.100	(1)				
		81-42		171.000	26.000	(1)				
DB-13	83-404	83-404	154.000	153.000	29.800	(1)	0.640	(1)	33.650	(1)
		83-455	154.000	153.000	30.000	(1)				
DB-14	81-162	81-139	128.400		36.230	(1)				
		81-162	128.400		36.560	(1)				
DB-15	79-17	79-17		98 400	24.000	(1)				
		79-4		88.400	26.000	(1)				

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SAMPLE TYPE. CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
DB-15	79-35	79-20		171.500	20.700	(1)				
		79-35		171.500	20.500	(1)				
	79-33	79-27		174.000	25.600	(1)				
		79-33		174.000	25.200	(1)				
	79-15	79-15		191.300	29.400	(1)				
		79-46		191.300	29.700	(1)				
	79-39	79-39		207.700	28.700	(1)				
		79-8		207.700	28.800	(1)				
	79-31	79-31		194.700	28.000	(1)				
		79-5		194.700	28.600	(1)				
	79-51	79-51		154.200	53.200	(1)				
		79-61		154.200	54.000	(1)				
	79-85	79-74		156.650	57.900	(1)				
		79-85		156.650	50.000	(1)				
	79-80	79-80		149.600	62.500	(1)				
		79-99		149.600	57.200	(1)				
	79-62	79-62		146.800	41.000	(1)				
		79-84		146.800	40.300	(1)				
	79-90	79-90		161.200	39.500	(1)				
		79-95		161.200	43.500	(1)				
	80-35	80-35		158.600	94.500	(1)				
		80-41		158.600	85.400	(1)				
	80-24	80-24		154.200	46.600	(1)				
		80-74		154.200	47.500	(1)				
	80-77	80-42		168.600	45.000	(1)				
		80-77		168.600	44.300	(1)				
	80-1	80-1		148.200	45.600	(1)				
		80-51		148.200	46.000	(1)				
DC-01	SITE-230	SITE-230		122.000	11.000	(0)				
	SITE-226	SITE-226		180.000	25.000	(0)				
	SITE-227	SITE-227		168.000	34.000	(0)				
	SITE-228	SITE-228		171.000	37.000	(0)				
	SITE-229	SITE-229		171.000	38.000	(0)				
	SITE-231	SITE-231		161.000	17.000	(0)				
	SITE-232	SITE-232		180.000	21.000	(0)				
	SITE-233	SITE-233		192.000	26.000	(0)				
	SITE-234	SITE-234		182.000	27.000	(0)				
	SITE-235	SITE-235		157.000	42.000	(0)				
	SITE-236	SITE-236		153.000	42.000	(0)				
	SITE-237	SITE-237		168.000	38.000	(0)				
	SITE-238	SITE-238		179.000	22.000	(0)				
	SITE-239	SITE-239		208.000	54.000	(0)				
	SITE-240	SITE-240		208.000	56.000	(0)				
	SITE-241	SITE-241		202.000	49.000	(0)				
	SITE-242	SITE-242		180.000	29.000	(0)				
	SITE-243	SITE-243		161.000	31.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE. CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
DC-02-A2	80-4	80-25		390.200	124.000	(1)				
		80-4		390.200	93.600	(1)				
	SITE-213	SITE-213			71.400	(0)				
DC-03	80-27	80-27		143.000	2.790	(1)				
		80-81		143.000	2.060	(1)				
DC-05	79-30	79-30	121.000		34.800	(1)				
		79-32	121.000		33.600	(1)				
DC-06	80-181	80-147			52.300	(1)				
		80-161			53.400	(1)				
	80-72	80-22			22.100	(1)				
		80-72			22.500	(1)				
	SITE-214	SITE-214		183.100	53.700	(1)				
	80-238	80-201		166.600	61.800	(1)				
		80-238		166.600	64.700	(1)				
	80-191	80-186		137.000	63.100	(1)				
		80-191		137.000	58.500	(1)				
	80-13	80-13		137.000	54.900	(1)				
		80-58		137.000	53.400	(1)				
	79-59	79-59			50.500	(1)				
		79-87			48.700	(1)				
	81-45	81-45		183.700	49.400	(1)				
		81-8		183.700	49.400	(1)				
	80-118	80-118		114.400	50.000	(1)				
		80-133		114.400	46.100	(1)				
	80-15	80-15		93.200	34.500	(1)				
		80-70		93.200	35.000	(1)				
	81-82	81-76	83.000	84.000	38.500	(1)				
		81-82	83.000	84.000	38.500	(1)				
	80-29	80-29		151.800	54.100	(1)				
		80-37		151.800	51.900	(1)				
	79-58	79-57		155.500	61.200	(1)				
		79-58		155.500	51.800	(1)				
	80-75	80-45		173.400	51.600	(1)				
		80-75		173.400	50.200	(1)				
DC-07	82-23	82-23	158.000	180.000	45.900	(1)	[illegible].340	(1)		
		82-56	158.000	180.000	46.600	(1)				
	82-10	82-10	141.000	160.000	45.000	(1)	[illegible].610	(1)		
		82-33	141.000	160.000	45.000	(1)				
	80-39	80-39		177.400	35.300	(1)				
		80-98		177.400	35.200	(1)				
	80-11	80-11		141.200	43.200	(1)				
		80-19		141.200	43.600	(1)				
	79-52	79-52			46.000	(1)				
		79-55			47.200	(1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
DC-07	80-103	80-103		158.400	47.200	(1)				
		80-163		158.400	47.700	(1)				
	80-188	80-178		108.000	57.400	(1)				
		80-188		108.000	57.700	(1)				
	80-195	80-177		107.600	75.200	(1)				
		80-196		197.600	77.500	(1)				
DC-12	80-80	80-62		137.100	32.600	(1)				
		80-80		137.100	32.600	(1)				
	80-100	80-100		139.700	34.100	(1)				
		80-63		139.700	37.600	(1)				
	80-97	80-73		143.400	31.300	(1)				
		80-97		143.400	31.200	(1)				
	80-32	80-32		173.250	86.300	(1)				
		80-68		173.250	86.100	(1)				
	80-82	80-23		147.400	33.000	(1)				
		80-82		147.400	32.400	(1)				
	80-124	80-102		139.700	35.300	(1)				
		80-124		139.700	35.000	(1)				
	80-101	80-101			51.800	(1)				
		80-169			50.800	(1)				
	80-174	80-174		144.650	28.900	(1)				
	80-209	80-209		163.000	52.800	(1)				
		80-242		163.000	51.800	(1)				
	80-233	80-233		157.400	46.300	(1)				
		80-243		157.400	50.000	(1)				
	80-234	80-208		210.600	54.500	(1)				
		80-234		210.600	53.800	(1)				
	81-61	81-61	146.000	150.000	54.900	(1)				
		81-72	146.000	150.000	56.000	(1)				
	82-85	82-47		151.800	63.200	(1)				
		82-85		151.800	63.000	(1)	2.560	(1)		
DC-14	80-3	80-3		132.400	27.700	(1)				
		80-34		132.400	27.800	(1)				
	80-53	80-16		109.300	32.400	(1)				
		80-53		109.300	31.800	(1)				
	80-47	80-47		107.800	32.400	(1)				
		80-85		107.800	33.900	(1)				
	80-69	80-69		144.600	25.100	(1)				
		80-83		144.600	25.000	(1)				
	80-99	80-55		166.700	24.300	(1)				
		80-99		166.700	24.000	(1)				
	80-89	80-36		149.600	25.600	(1)				
		80-89		149.600	26.000	(1)				
	80-71	80-2		151.800	26.200	(1)				
		80-71		151.800	26.100	(1)				
	80-144	80-136		134.200	27.800	(1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
DC-14	80-144	80-144		134.200	26.800	(1)				
	80-189	80-127		140.800	27.400	(1)				
		80-189		140.800	27.000	(1)				
	80-112	80-112		134.200	30.800	(1)				
		80-168		134.200	29.800	(1)				
	80-157	80-157		145.200	19.800	(1)				
		80-183		145.200	20.000	(1)				
	80-155	80-155		145.750	42.400	(1)				
		80-185		145.750	42.100	(1)				
	80-104	80-104		148.500	38.700	(1)				
		80-125		148.500	38.500	(1)				
	80-120	80-115		146.300	58.800	(1)				
		80-120		146.300	60.400	(1)				
	80-170	80-156		160.000	60.800	(1)				
		80-170		160.000	61.200	(1)				
	80-117	80-117		187.600	68.900	(1)				
		80-151		187.600	68.800	(1)				
	80-213	80-213		206.600	72.500	(1)				
		80-236		206.600	75.600	(1)				
	81-20	81-20		150.900	48.400	(1)				
		81-22		150.900	49.200	(1)				
	81-30	81-16	112.000	109.000	57.300	(1)				
		81-30	112.000	109.000	56.000	(1)				
	81-44	81-44	124.000	131.000	48.500	(1)				
		81-47	124.000	131.000	50.600	(1)				
	81-141	81-141	106.030		54.200	(1)				
	82-8	82-42		109.000	51.600	(1)				
		82-8		109.000	51.800	(1)	0.980	(1)		
	83-156	83-156	103.000	110.000	53.700	(1)	0.840	(1)	11.500	(1)
		83-197	103.000	110.000	53.300	(1)				
	83-152	83-152	110.000		53.200	(1)	0.770	(1)	10.740	(1)
		83-103	110.000		53.100	(1)				
	83-157	83-157	114.000	123.000	54.300	(1)	0.740	(1)	11.100	(1)
		83-179	114.000	123.000	54.500	(1)				
	83-178	83-103	114.000	109.000	53.400	(1)				
		83-178	114.000	109.000	53.400	(1)	0.640	(1)	11.100	(1)
	83-183	83-123	107.000	118.000	53.400	(1)				
		83-183	107.000	118.000	53.100	(1)	0.510	(1)	11.000	(1)
	83-154	83-154	110.000	120.000	54.000	(1)	0.620	(1)	11.000	(1)
		83-101	110.000	120.000	54.800	(1)				
	83-150	83-108	109.000		54.300	(1)				
		83-150	108.000		54.700	(1)	0.810	(1)	10.800	(1)
	83-266	83-233	110.000	117.000	55.300	(1)				
		83-266	110.000	117.000	54.500	(1)	0.110	[illegible]	11.300	(1)
	83-261	83-203	109.000	118.000	53.700	(1)				
		83-261	109.000	118.000	53.800	(1)	0.540	(1)	12.800	(1)
DC-15	80-58	80-31		167.500	23.100	(1)				

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
DC-15	80-56	80-56		167.500	25.500	(1)				
	80-54	80-54		157.900	25.500	(1)				
		80-76		157.900	26.000	(1)				
	80-57	80-57		248.600	32.800	(1)				
		80-65		248.600	33.700	(1)				
	80-87	80-87		232.600	28.500	(1)				
		80-94		232.600	28.600	(1)				
	80-137	80-137		130.100	32.600	(1)				
		80-197		130.100	32.800	(1)				
	80-176	80-176		138.600	32.100	(1)				
		80-999		138.600	32.500	(1)				
	80-135	80-135		148.500	37.800	(1)				
		80-149		148.500	36.300	(1)				
	80-120	80-120		162.250	37.700	(1)				
		80-139		162.250	37.700	(1)				
	80-131	80-108		151.800	55.700	(1)				
		80-131		151.800	56.100	(1)				
	80-193	80-114		173.000	58.000	(1)				
		80-193		173.000	59.200	(1)				
	81-41	81-24		94.400	40.800	(1)				
		81-41		94.400	41.200	(1)				
	81-2	81-2		86.240	43.400	(1)				
		81-36		86.240	44.500	(1)				
	81-46	81-46		78.300	38.300	(1)				
		81-50		78.300	38.000	(1)				
	81-33	81-32		52.300	43.900	(1)				
		81-33		52.300	42.500	(1)				
	81-27	81-27	108.000	104.000	54.900	(1)				
		81-74	108.000	104.000	54.800	(1)				
	81-64	81-64	66.000	75.170	40.600	(1)	23.000	(1)		
		81-80	66.000	75.170	39.900	(1)				
	81-96	81-85	88.000	85.000	38.100	(1)				
		81-96	88.000	85.000	39.300	(1)				
	81-69	81-69	83.000	86.000	37.700	(1)				
		81-84	83.000	86.000	36.800	(1)				
	82-94	82-41	146.300		54.700	(1)				
		82-94	146.300		54.000	(1)	11.370	(1)		
DC-16A	81-109	81-109	226.000	224.000	22.200	(1)	28.480	(1)		
		81-167	229.000	224.000	22.200	(1)				
	82-17	82-17	141.000	148.000	9.870	(1)	3.410	(1)		
		82-55	141.000	148.000	9.870	(1)				
	82-93	82-45		184.000	33.900	(1)				
		82-93		184.000	34.200	(1)	9.740	(1)		
	82-19	82-19	146.000	150.000	38.300	(1)	8.440	(1)		
		82-88	146.000	150.000	39.400	(1)				
	82-188	82-140	145.000	151.000	36.100	(1)				
		82-188	145.000	151.000	36.100	(1)	3.550	(1)		

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SAMPLE TYPE. CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
DC-16A	82-124	82-124	142.000	144.000	40.800	(1)	4.910	(1)		
		82-172	142.000	144.000	40.600	(1)				
	82-143	82-126	86.000	103.000	37.700	(1)				
		82-143	86.000	103.000	38.000	(1)	[illegible].610	(1)		
	82-202	82-202		107.600	33.700	(1)	[illegible].180	(1)	30.230	(1)
		82-228		107.600	34.200	(1)				
	82-322	82-322	91.000	90.000	37.900	(1)	6.800	(1)	24.950	(1)
		82-361	91.000	90.000	37.500	(1)				
	82-332	82-332	121.000	126.000	34.000	(1)	5.800	(1)		
		82-358	121.000	126.000	34.400	(1)				
	82-430	82-430	138.000	150.000	28.600	(1)	20.000	(1)	46.210	(1)
		82-473	138.000	150.000	29.200	(1)				
	83-29	83-29	141.000		45.900	(1)	[illegible].320	(1)	36.180	(1)
		83-41	141.000		46.400	(1)				
DC-16B	83-147	83-147	135.000	148.000	33.400	(1)	1.740	(1)	35.700	(1)
		83-185	135.000	148.000	33.500	(1)				
DC-16C	83-100	83-100	118.000	124.000	42.700	(1)	1.870	(1)	23.120	(1)
		83-30	118.000	124.000	42.400	(1)				
	83-259	83-215	126.000	130.000	38.000	(1)				
		83-259	126.000	130.000	37.800	(1)	1.190	(1)	28.400	(1)
DC-18	86-166	86-166	155.000	154.000	26.600	(1)	0.500	(1)	30.600	(1)
		86-167	155.000	154.000	26.600	(1)				
DC-19C	84-53	84-53	127.000	125.000	31.400	(1)	[illegible].210	(1)	30.180	(1)
		84-84	127.000	125.000	31.500	(1)				
	84-40	84-40	144.000		31.600	(1)	1.620	(1)	31.430	(1)
		84-77	144.000		31.700	(1)				
	84-75	84-29	215.000	217.000	37.900	(1)				
		84-75	216.000	217.000	37.900	(1)	1.750	(1)	25.780	(1)
	84-86	84-18	121.000	113.000	41.300	(1)				
		84-86	121.000	113.000	40.600	(1)	1.850	(1)	25.060	(1)
DC-20C	84-9	84-49	132.500	132.000	35.800	(1)				
		84-9	132.500	132.000	35.800	(1)	[illegible].950	(1)	29.270	(1)
DC-22C	84-105	84-105	125.000	114.000	35.600	(1)	1.080	(1)	27.230	(1)
		84-153	125.000	114.000	35.700	(1)				
DC-23GR	86-133	86-133	124.000	124.000	27.300	(1)	[illegible].160	(1)	26.600	(1)
		86-134	124.000	124.000	27.200	(1)				
	86-141	86-141	112.000	110.000	28.300	(1)	0.950	(1)	21.300	(1)
		86-142	112.000	110.000	28.400	(1)				
	86-181	86-181	166.000	167.000	50.300	(1)	[illegible].460	(1)	18.500	(1)
		86-182	166.000	167.000	50.600	(1)				

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
ENYEART	SITE-209	SITE-209		151.000	30.000	(0)				
	SITE-210	SITE-210		150.000	28.000	(0)				
	84-166	84-166	146.000	147.000	28.000	(1)	0.270	(1)	34.340	(1)
		84-184	146.000	147.000	27.900	(1)				
	85-180	85-180	145.000	145.000	27.900	(1)	0.620	(1)	38.200	(1)
		85-181	145.000	145.000	28.000	(1)	0.330	(1)	35.940	(1)
FORD	SITE-206	SITE-206		155.000	30.000	(0)				
	SITE-207	SITE-207		148.000	26.000	(0)				
	SITE-219	SITE-219		154.100	24.700	(0)				
	85-188	85-188	148.000	145.000	27.600	(1)	0.860	(1)	33.970	(1)
		85-189	148.000	145.000	27.600	(1)	0.440	(1)	34.570	(1)
	85-303	85-303	148.000	150.000	31.300	(1)	0.860	(1)	35.000	(1)
		85-304	148.000	150.000	31.100	(1)				
MCGEE	SITE-224	SITE-224			27.100	(0)				
	SITE-222	SITE-222			26.000	(0)				
	SITE-225	SITE-225			0.110	(0)				
	SITE-220	SITE-220		146.700	26.100	(0)				
	82-7	82-52	140.000	145.000	29.300	(1)				
		82-7	140.000	145.000	29.800	(1)	0.760	(1)		
	85-175	85-175	142.000	143.000	27.900	(1)	0.430	(1)	34.700	(1)
		85-176	142.000	143.000	28.000	(1)	0.300	(1)	35.110	(1)
	85-300	85-300	142.000	142.000	30.600	(1)	0.280	(1)	34.500	(1)
		85-301	142.000	142.000	30.500	(1)				
	86-34	86-34	143.000	143.000	28.700	(1)	0.280	(1)	33.400	(1)
		86-35	143.000	143.000	28.700	(1)				
	80-64	80-64		142.400	26.600	(1)				
		80-88		142.400	26.300	(1)				
	81-79	81-73	139.000	136.000	27.300	(1)				
		81-79	139.000	136.000	28.200	(1)				
	81-54	81-54	138.000	133.000	28.000	(1)	0.660	(1)		
		81-56	138.000	133.000	27.800	(1)				
	82-64	82-11	134.000	139.000	29.600	(1)				
		82-64	134.000	139.000	29.300	(1)				
	82-263	82-263	143.000	139.000	28.500	(1)	0.440	(1)	39.700	(1)
		82-283	143.000	139.000	28.800	(1)				
	82-397	82-325	148.000	142.000	28.900	(1)				
		82-397	148.000	142.000	29.100	(1)	0.350	(1)	40.490	(1)
	82-424	82-424	139.000	146.000	29.200	(1)	0.290	(1)	37.910	(1)
		82-474	139.000	146.000	29.600	(1)				
	82-436	82-436	143.000	148.000	29.200	(1)	0.540	(1)	36.600	(1)
		82-498	143.000	148.000	29.600	(1)				
	83-32	83-32	144.000	148.000	29.800	(1)	0.420	(1)	36.600	(1)
		83-63	144.000	148.000	30.000	(1)				
	83-83	83-27	151.000	151.000	29.900	(1)				
		83-83	151.000	151.000	30.000	(1)	0.500	(1)	38.600	(1)
	83-188	83-113	148.000	150.000	30.800	(1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: COMBINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	[illegible] MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
MCGEE	83-188	83-188	148.000	150.000	31.000	(1)	0.430	(1)	40.500	(1)
	83-373	83-323	189.000	193.000	41.100	(1)				
		83-373	189.000	193.000	40.900	(1)	[illegible].120	(1)	36.180	(1)
	83-331	83-331	177.000	185.000	43.500	(1)	8.770	(1)	43.450	(1)
		83-344	177.000	185.000	43.500	(1)				
	83-460	83-460	194.000	191.000	45.900	(1)	1.840	(1)	41.390	(1)
		83-474	194.000	191.000	47.500	(1)				
	83-476	83-417	188.000	181.000	44.800	(1)				
		83-476	188.000	181.000	45.000	(1)	3.350	(1)	38.890	(1)
	83-513	83-513	175.000	176.000	48.400	(1)	3.690	(1)	31.600	(1)
		83-545	175.000	176.000	48.700	(1)				
	84-24	84-24	185.000	208.000	56.600	(1)	3.980	(1)	38.420	(1)
		84-38	185.000	208.000	57.200	(1)				
OBRIAN	85-194	85-194	147.000	148.000	27.100	(1)	0.670	(1)	34.720	(1)
		85-195	147.000	148.000	27.000	(1)	0.460	(1)	35.010	(1)
KRL-02	82-68	82-28	156.000	190.000	29.800	(1)				
		82-68	155.000	190.000	29.300	(1)	5.490	(1)		
	82-65	82-65	144.000	155.000	34.000	(1)	6.080	(1)		
		82-75	144.000	155.000	33.400	(1)				
	82-170	82-163	88.000	93.000	27.000	(1)				
		82-170	88.000	93.000	26.500		37.090	(1)		
	82-122	82-122	81.000	86.000	34.500	(1)	2.650	(1)		
		82-192	81.000	86.000	35.300					
	82-401	82-401	159.000	165.000	44.700		[illegible].700	(1)	29.800	(1)
		82-479	159.000	165.000	44.500	(1)				
	84-7	84-43	145.000	149.000	49.200	(1)				
		84-7	145.000	149.000	49.500	(1)	2.810	(1)	23.550	(1)
	82-364	82-364	131.000	136.000	47.700	(1)	5.140	(1)	26.740	(1)
		82-381	131.000	136.000	48.800	(1)				
	82-309	82-309	134.000	132.000	36.100		9.800	(1)	45.080	(1)
		82-351	134.000	132.000	35.400	(1)				
	82-456	82-413	135.000	135.000	37.100	(1)				
		82-456	135.000	135.000	37.300	(1)	4.680	(1)	24.430	(1)
KRL-14	82-403	82-403	132.000	195.000	43.600	(1)				
		82-480	182.000	195.000	44.000	(1)				
SIEM-1	85-252	85-252	151.000	151.000	27.400	(1)	0.830	(1)	34.900	(1)
		85-253	151.000	151.000	27.400	(1)				
	85-297	85-297	156.000	156.000	29.700	(1)	0.370	(1)	35.900	(1)
		85-298	156.000	156.000	29.600	(1)				
	86-31	86-31	157.000	157.000	27.300	(1)	0.200	(1)	35.400	(1)
		86-32	157.000	157.000	27.400	(1)				
SIEM-2	86-19	86-19	153.000	152.000	27.700	(1)	0.340	(1)	35.400	(1)
		86-20	153.000	152.000	27.900	(1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
299-E16-01	SITE-161	SITE-161		80.000	68.000	(0)				
	SITE-162	SITE-162		143.000	68.000	(0)				
	SITE-163	SITE-163		144.000	66.000	(0)				
	SITE-164	SITE-164		145.000	68.000	(0)				
299-E26-08	SITE-166	SITE-166		99.000	79.000	(0)				
	SITE-167	SITE-167		103.000	79.000	(0)				
	SITE-168	SITE-168		104.000	79.000	(0)				
299-E33-12	SITE-170	SITE-170		39.000	60.000	(0)				
	SITE-171	SITE-171		50.000	67.000	(0)				
	SITE-172	SITE-172		64.000	72.000	(0)				
699-S11-E12A	80-61	80-61		170.500	21.200	(1)				
		80-7		170.500	21.500	(1)				
	80-180	80-138		172.700	27.200	(1)				
		80-180		172.700	27.800	(1)				
699-42-40C	SITE-176	SITE-176		128.000	49.000	(0)				
	SITE-177	SITE-177		122.000	72.000	(0)				
	SITE-178	SITE-178		123.000	72.000	(0)				
	SITE-179	SITE-179		125.000	72.000	(0)				
699-47-50	SITE-181	SITE-181		95.000	51.000	(0)				
699-49-55B	SITE-183	SITE-183		120.000	73.000	(0)				
	SITE-184	SITE-184		122.000	73.000	(0)				
	SITE-185	SITE-185		117.000	71.000	(0)				
699-50-45	SITE-186	SITE-186		114.000	58.000	(0)				
699-50-48	SITE-187	SITE-187		114.000	66.000	(0)				
699-51-46	SITE-188	SITE-188		86.000	69.000	(0)				
699-52-46A	SITE-189	SITE-189		117.000	79.000	(0)				
699-52-48	SITE-190	SITE-190		147.000	59.000	(0)				
699-53-50	SITE-191	SITE-191		114.000	70.000	(0)				
699-54-57	SITE-192	SITE-192		117.000	70.000	(0)				
699-56-53	SITE-196	SITE-196		130.000	43.000	(0)				
	SITE-197	SITE-197		129.000	41.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
STATION-03	82-51	82-51			< 0.045	(1)				
STATION-04	82-61	82-61			0.608	(1)				
STATION-07	82-92	82-92			< 0.045	(1)				
STATION-14	82-20	82-20			0.057	(1)				
STATION-17	82-70	82-70			< 0.045	(1)				
STATION-20	82-58	82-58			0.133	(1)				
	82-74	82-74			< 0.045	(1)				
STATION-25	82-83	82-83			0.126	(1)				
	82-66	82-66			< 0.045	(1)				
STATION-26	82-91	82-91			< 0.045	(1)				
	82-98	82-98			< 0.045	(1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
SP-BENNETT	SITE-218	SITE-218		88.500	21.500	(0)				
	79-13	79-13		85.600	22.900	(1)				
	85-362	85-362	92.000	91.000	23.600	(1)	0.630	(1)	22.300	(1)
		85-363	92.000	91.000	23.600	(1)				
	86-190	86-190	91.000	90.000	22.600	(1)	0.690	(1)	21.400	(1)
		86-191	91.000	90.000	22.600	(1)				
SP-BENSON	SITE-217	SITE-217		90.980	18.200	(0)				
SP-BUTLER	79-1	79-1		93.000	19.400	(1)				
		79-50		93.000	19.400	(1)				
SP-GULCH	84-359	84-359	147.000	147.000	21.900	(1)	13.040	(1)	46.810	(1)
		84-383	147.000	147.000	21.500	(1)				
SP-JUNIPER	SITE-215	SITE-215		156.600	23.300	(0)				
	79-2	79-2		152.800	26.100	(1)				
		79-43		152.800	24.900	(1)				
	81-115	81-115	146.000	145.000	27.130	(1)				
		81-161	146.000	145.000	27.270	(1)				
	83-372	83-305	153.000	154.000	26.890	(1)				
		83-372	153.000	154.000	26.450	(1)	0.600	(1)	37.120	(1)
SP-LO-SNIVELY	79-34	79-19		91.900	19.100	(1)				
		79-34		91.900	21.300	(1)				
	82-362	82-362	91.000	96.000	23.700	(1)	0.480	(1)	26.500	(1)
		82-377	91.000	96.000	23.600	(1)				
	83-396	83-311	94.300	92.900	23.680	(1)	0.450	(1)	23.920	(1)
		83-396	94.300	92.900	23.500	(1)				
SP-LOZIER	79-6	79-44		98.700	20.900	(1)				
		79-6		98.700	20.700	(1)				
	81-186	81-116	91.420		23.340	(1)				
		81-186	91.420		23.220	(1)				
	83-316	83-316	89.000	93.000	22.760	(1)	0.670	(1)	23.530	(1)
		83-343	89.000	93.000	22.450	(1)				
SP-MAIDEN	79-100	79-67			23.900	(1)				
		79-96			23.700	(1)				
	83-420	83-420	71.000	71.000	18.640	(1)	0.380	(1)	18.980	(1)
		83-435	71.000	71.000	18.960	(1)				
SP-OBSERVATORY	81-119	81-119	91.970		18.230	(1)				
		81-157	91.970		18.290	(1)				
	83-433	83-433	91.000	96.000	17.540	(1)	0.680	(1)	23.710	(1)
		83-461	91.000	96.000	17.730	(1)				
	84-392	84-310	94.000	96.000	17.400	(1)				
		84-392	94.000	96.000	17.600	(1)	0.790	(1)	22.260	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
SP-OBSERVATORY	84-329	84-329			18.100	(1)				
		84-366			18.000	(1)				
	85-359	85-359	93.000	91.000	17.900	(1)	0.890	(1)	22.800	(1)
		85-360	93.000	91.000	17.900	(1)				
	86-178	86-178	94.000	93.000	17.000	(1)	1.630	(1)	22.300	(1)
		86-179	94.000	93.000	16.900	(1)				
SP-RAILROAD	79-76	79-76		118.130	25.500	(1)				
		79-81		118.130	25.800	(1)				
SP-RATTLESNAKE	SITE-216	SITE-216		136.100	21.000	(0)				
	79-88	79-87		20[illegible].600	25.000	[illegible]				
		79-88		202.600	25.500	(1)				
	83-412	83-412	200.000	203.000	23.180	(1)	1.750	(1)	51.380	(1)
		83-466	200.000	203.000	23.210	(1)				
SP-SNIVELY	79-40	79-37		79.800	20.700	(1)				
		79-40		79.800	20.500	(1)				
SP-SULFUR	79-29	79-29		97.000	24.100	(1)				
		79-36		97.000	24.000	(1)				
	83-409	83-409	102.000	99.000	25.640	(1)	0.580	(1)	27.950	(1)
		83-442	102.000	99.000	25.390	(1)				
SP-UNNAMED-02	79-75	79-75		91.350	16.300	(1)	2.600	(1)		
SP-UNNAMED-16	79-73	79-73		89.800	25.500	(1)				
		79-82		89.800	25.600	(1)				
SP-UNNAMED-26	79-98	79-54		124.220	26.100	(1)				
		79-98		124.220	26.100	(1)				
SP-UNNAMED-29	79-16	79-16		112.400	20.230	(1)				
		79-24		112.400	20.230	(1)				
SP-UP-SNIVELY	79-71	79-69		71.920	21.170	(1)				
		79-71		71.920	21.090	(1)				
	81-126	81-126		74.000	20.500	(1)				
		81-200		74.000	20.000	(1)				
	83-503	83-503	75.000	77.000	21.710	(1)	0.350	(1)	18.880	(1)
		83-547	75.000	77.000	21.650	(1)				
	86-193	86-193	75.000	77.000	20.300	(1)	0.560	(1)	18.100	(1)
		86-194	75.000	77.000	20.100	(1)				
SP-UR2-07	85-343	85-343	[illegible]	111.000	24.200	(1)	[illegible].270	(1)	[illegible]	(1)
		85-344	11[illegible].000	111.000	24.200	(1)				
	86-159	86-159	108.000	109.000	19.300	(1)	[illegible].840	[illegible]	31.900	(1)
		86-160	108.000	109.000	19.400	(1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SD-BWI-DP-061 Rev 1

SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
SP-UR6-20	85-346	85-346	100.000	104.000	27.300	(1)	0.980	(1)	30.200	(1)
		85-347	100.000	104.000	27.400	(1)				
	86-162	86-162	95.000	97.000	21.100	(1)	2.370	(1)	28.800	(1)
		86-163	95.000	97.000	21.000	(1)				
SP-UR7-22	85-349	85-349	90.000	92.000	23.000	(1)	1.050	(1)	23.800	(1)
		85-350	90.000	92.000	23.100	(1)				
	86-153	86-153	92.000	93.000	20.900	(1)	2.300	(1)	25.200	(1)
		86-154	92.000	93.000	21.300	(1)				
SP-WARM	84-358	84-358	133.000	134.000	28.300	(1)	0.780	(1)	31.580	(1)
		84-371	133.000	134.000	28.400	(1)				
SP-YR3-04	85-333	85-333	102.000	103.000	20.700	(1)	0.660	(1)	31.000	(1)
		85-334	102.000	103.000	20.500	(1)				
	86-150	86-150	109.000	109.000	18.900	(1)	1.330	(1)	31.400	(1)
		86-151	109.000	109.000	18.900	(1)				
SP-YR5-08	85-336	85-336	94.000	95.000	23.100	(1)	1.150	(1)	27.000	(1)
		85-337	94.000	95.000	23.500	(1)				
	86-147	86-147	97.000	96.000	20.000	(1)	4.380	(1)	32.300	(1)
		86-148	97.000	96.000	19.800	(1)				
SP-YR7-14	85-339	85-339	63.000	66.000	18.000	(1)	1.090	(1)	22.000	(1)
		85-340	63.000	66.000	18.000	(1)				
	86-156	86-156	53.000	54.000	15.400	(1)	1.940	(1)	17.600	(1)
		86-157	53.000	54.000	15.600	(1)				

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SAMPLE TYPE: SURFACE
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
COLD CREEK	84-317	84-317			24.000	(1)				
		84-336			24.000	(1)				
	84-302	84-302	142.000	139.000	21.000	(1)	1.390	(1)	33.000	(1)
		84-345	142.000	139.000	20.800	(1)				
	85-223	85-223	122.000	122.000	21.100	(1)	1.440	(1)	30.030	(1)
		85-224	122.000	122.000	21.200	(1)				
CR-DC-14	83-258	83-211	81.000	65.000	3.100	(1)				
		83-258	61.000	65.000	3.200	(1)	1.510	(1)	16.420	(1)
CR-HTS	SITE-221	SITE-221		54.900	0.930	(0)				
CR-V-BR	84-330	84-330			2.640	(1)				
		84-361			2.620	(1)				
	84-311	84-311	[illegible]	48.000	2.750	(1)	[illegible]	(1)	14.190	(1)
		84-356	49.000	48.000	2.740	(1)				
	85-206	85-206	[illegible]	61.500	2.000	(1)	1.550	(1)	16.310	(1)
		85-207	63.000	61.500	1.980	(1)				
	85-266	85-266	53.000	53.000	1.890	(1)	1.770	(1)	13.940	(1)
		85-267	53.000	53.000	1.880	(1)				
	86-70	86-70	59.000	54.000	1.960	(1)	1.560	(1)	15.000	(1)
		86-71	59.000	54.000	1.960	(1)				
	86-109	86-109	61.600	58.200	2.090	(1)	1.150	(1)	15.100	(1)
		86-110	61.600	58.200	2.080	(1)				
YR-BR	85-210	85-210	49.000	51.000	9.000	(1)	3.340	(1)	14.940	(1)
		85-211	49.000	51.000	9.030	(1)				
	85-269	85-269	[illegible]	121.000	10.700	(1)	[illegible]	(1)	29.510	(1)
		85-270	123.000	121.000	10.600	(1)				
	86-67	86-67	98.000	97.000	9.910	(1)	1.720	(1)	24.700	(1)
		86-68	98.000	97.000	9.920	(1)				
	86-118	86-118	107.000	107.000	10.600	(1)	1.970	(1)	26.300	(1)
		86-119	[illegible]	107.000	10.500	[illegible]				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
RRL-06A	82-40	82-35		116.000	21.900	(1)				
		82-40		116.000	21.800	(1)				
199-B04-04	SITE-41	SITE-41		98.000	21.000	(0)				
199-D05-12	SITE-80	SITE-80		90.000	19.000	(0)				
199-D08-03	SITE-72	SITE-72		70.000	18.000	(0)				
199-F05-01	SITE-82	SITE-82		98.000	12.000	(0)				
199-H04-03	SITE-81	SITE-81		196.000	14.000	(0)				
199-K-19	SITE-83	SITE-83		72.000	6.800	(0)				
199-N-15	SITE-42	SITE-42		62.000	8.000	(0)				
299-E26-08	SITE-165	SITE-165		89.000	21.000	(0)				
299-E33-12	SITE-169	SITE-169		109.000	46.000	(0)				
399-01-01	SITE-244	SITE-244	62.000		6.100	(0)				
399-01-03	SITE-43	SITE-43		77.000	6.000	(0)				
399-02-01	SITE-245	SITE-245	55.000		6.100	(0)				
399-03-01	SITE-246	SITE-246	59.000		7.000	(0)				
399-04-10	SITE-44	SITE-44		90.000	9.000	(0)				
399-08-04	SITE-140	SITE-140	120.000		16.000	(0)				
699-HAN-19	SITE-3	SITE-3		138.000	17.000	(0)				
699-S03-E12	SITE-22	SITE-22		82.000	15.000	(0)				
	SITE-141	SITE-141	98.000		15.000	(0)				
699-S03-25	SITE-7	SITE-7		125.000	13.000	(0)				
	SITE-142	SITE-142	140.000		15.000	(0)				
	86-55	86-55	148.000	147.000	15.500	(1)	0.280	(1)	34.270	(1)
		86-56	148.000	147.000	15.500	(1)				
	86-130	86-130	152.000	149.000	15.000	(1)	0.450	(1)	34.800	(1)
		86-131	152.000	149.000	15.000	(1)				
699-S06-E04D	SITE-11	SITE-11		147.000	15.000	(0)				
699-S08-19	SITE-46	SITE-46		160.000	18.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-S08-19	SITE-84	SITE-84		172.000	18.000	(0)				
699-S11-E12A	SITE-4	SITE-4		126.000	18.000	(0)				
699-S12-03	SITE-45	SITE-45		120.000	15.000	(0)				
	SITE-143	SITE-143	130.000		15.000	(0)				
699-S19-E13	SITE-120	SITE-120		131.000	17.000	(0)				
699-S24-19	85-213	85-213	127.000	127.000	12.800	(1)	0.660	(1)	32.570	(1)
		85-214	127.000	127.000	12.800	(1)				
	85-291	85-291	140.000	136.000	13.100	(1)	1.490	(1)	35.700	(1)
		85-292	140.000	136.000	13.200	(1)				
699-S29-E12	SITE-21	SITE-21		157.000	16.000	(0)				
699-S30-E15A	SITE-144	SITE-144	200.000		15.000	(0)				
699-01-18	SITE-145	SITE-145	120.000		18.000	(0)				
699-02-03	SITE-1	SITE-1		126.000	16.000	(0)				
699-02-33	SITE-85	SITE-85		140.000	17.000	(0)				
	SITE-146	SITE-146	130.000		17.000	(0)				
699-04-E06	SITE-47	SITE-47		120.000	16.000	(0)				
699-08-17	SITE-23	SITE-23		121.000	16.000	(0)				
699-05-25	SITE-32	SITE-32		126.000	16.000	(0)				
699-06-32	SITE-19	SITE-19		123.000	13.000	(0)				
699-09-E02	SITE-16	SITE-16		131.000	17.000	(0)				
699-10-E12	SITE-147	SITE-147	[illegible]		20.000	(0)				
	SITE-247	SITE-247	178.000		19.600	(0)				
699-11-45A	SITE-148	SITE-148	129.000		12.000	(0)				
	85-263	85-263	121.000	121.000	13.000	[illegible]	0.340	[illegible]	27.600	(1)
		85-264	121.000	121.000	13.100	(1)				
	86-43	86-43	123.000	121.000	12.400	[illegible]	[illegible]280	(A)	28.000	(1)
		86-44	[illegible].000	121.000	12.800	[illegible]				
	86-124	86-124	121.000	123.000	12.600	[illegible]	[illegible].320	[illegible]	27.600	(1)
		86-125	121.000	123.000	12.700	(1)				
699-13-01A	SITE-60	SITE-60		130.000	17.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-14-38	SITE-61	SITE-61		140.000	22.000	(0)				
	SITE-86	SITE-86		148.000	23.000	(0)				
699-15-15B	SITE-13	SITE-13		123.000	14.000	(0)				
	SITE-149	SITE-149	120.000		15.000	(0)				
699-15-26	SITE-24	SITE-24		124.000	17.000	(0)				
	SITE-150	SITE-150	130.000		17.000	(0)				
699-17-05	SITE-18	SITE-18		106.000	13.000	(0)				
	SITE-151	SITE-151	100.000		23.000	(0)				
699-19-43	SITE-48	SITE-48		110.000	13.000	(0)				
	SITE-121	SITE-121		115.000	14.000	(0)				
699-19-58	85-229	85-229	134.000	137.000	25.400	(1)	0.430	(1)	33.030	(1)
		85-230	134.000	137.000	25.600	(1)				
	85-260	85-260	139.000	139.000	26.500	(1)	0.510	(1)	32.300	(1)
		85-261	139.000	139.000	26.500	(1)				
	86-40	86-40	139.000	139.000	25.300	(1)	0.260	(1)	32.900	(1)
		86-41	139.000	139.000	25.300	(1)				
	86-121	86-121	138.000	141.000	24.200	(1)	0.270	(1)	32.100	(1)
		86-122	138.000	141.000	24.300	(1)				
699-19-88	85-278	85-278	116.000	113.000	22.800	(1)	0.290	(1)	27.560	(1)
		85-279	116.000	113.000	22.800	(1)				
	86-64	86-64	116.000	114.000	22.200	(1)	0.310	(1)	28.000	(1)
		86-65	116.000	114.000	22.200	(1)				
	86-127	86-127	118.000	117.000	21.100	(1)	0.300	(1)	28.100	(1)
		86-128	118.000	117.000	21.300	(1)				
699-20-E05-0	SITE-49	SITE-49		110.000	15.000	(0)				
699-20-20	SITE-25	SITE-25		116.000	17.000	(0)				
699-24-33	SITE-28	SITE-28		135.000	20.000	(0)				
699-24-46	SITE-122	SITE-122		156.000	29.000	(0)				
699-24-95	85-288	85-288	206.000	199.000	20.200	(1)	1.610	(1)	48.600	(1)
		85-289	206.000	199.000	20.200	(1)				
	86-61	86-61	189.000	189.000	21.000	(1)	0.700	(1)	45.100	(1)
		86-62	189.000	189.000	21.000	(1)				
	86-115	86-115	209.000	211.000	20.000	(1)	0.630	(1)	50.100	(1)
		86-116	209.000	211.000	20.000	(1)				
699-25-55	SITE-100	SITE-100		146.000	23.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-26-15	SITE-26	SITE-26		120.000	17.000	(0)				
699-26-15A	SITE-263	SITE-263	116.000		17.000	(0)				
699-27-04	SITE-101	SITE-101		131.000	14.000	(0)				
699-27-08	SITE-5	SITE-5		119.000	17.000	(0)				
	SITE-30	SITE-30		122.000	16.000	(0)				
	SITE-50	SITE-50		110.000	17.000	(0)				
	SITE-76	SITE-76		120.000	16.000	(0)				
	SITE-87	SITE-87		123.000	17.000	(0)				
699-28-40	SITE-68	SITE-68		140.000	16.000	(0)				
699-31-31	SITE-69	SITE-69		110.000	20.000	(0)				
	SITE-102	SITE-102		109.000	23.000	(0)				
699-31-53B	SITE-88	SITE-88		164.000	21.000	(0)				
699-32-22	SITE-17	SITE-17		105.000	14.000	(0)				
	SITE-27	SITE-27		113.000	15.000	(0)				
	SITE-51	SITE-51		110.000	14.000	(0)				
	SITE-65	SITE-65		110.000	14.000	(0)				
	SITE-89	SITE-89		115.000	16.000	(0)				
699-32-70B	SITE-70	SITE-70		110.000	20.000	(0)				
	SITE-90	SITE-90		123.000	21.000	(0)				
	SITE-152	SITE-152	120.000		20.000	(0)				
699-32-72	SITE-35	SITE-35		115.000	14.000	(0)				
699-32-77	SITE-103	SITE-103		106.000	23.000	(0)				
699-33-42	SITE-12	SITE-12		107.000	18.000	(0)				
	SITE-29	SITE-29		117.000	19.000	(0)				
	SITE-52	SITE-52		110.000	18.000	(0)				
	SITE-67	SITE-67		110.000	18.000	(0)				
	SITE-91	SITE-91		115.000	20.000	(0)				
699-33-56	SITE-8	SITE-8		167.000	18.000	(0)				
	SITE-40	SITE-40		171.000	19.000	(0)				
	SITE-53	SITE-53		170.000	21.000	(0)				
	SITE-62	SITE-62		170.000	20.000	(0)				
	SITE-92	SITE-92		180.000	22.000	(0)				
699-34-39A	SITE-93	SITE-93		115.000	21.000	(0)				
699-34-42	SITE-33	SITE-33		113.000	20.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE. UNCONFINED
ANALYSIS GROUP. MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-34-42	SITE-153	SITE-153	110.000		20.000	(0)				
699-34-51	SITE-66	SITE-66		160.000	19.000	(0)				
699-35-09	SITE-31	SITE-31		131.000	15.000	(0)				
	SITE-104	SITE-104		131.000	15.000	(0)				
	SITE-264	SITE-264	125.000		15.000	(0)				
699-35-66	SITE-77	SITE-77		140.000	18.000	(0)				
	SITE-94	SITE-94		148.000	20.000	(0)				
699-35-70	SITE-36	SITE-36		184.000	18.000	(0)				
699-35-78	SITE-54	SITE-54		98.000	17.000	(0)				
699-36-61A	SITE-95	SITE-95		148.000	22.000	(0)				
699-37-43	SITE-34	SITE-34		151.000	23.000	(0)				
	SITE-173	SITE-173		106.000	44.000	(0)				
699-37-82A	SITE-105	SITE-105		50.000	14.000	(0)				
699-38-70	SITE-37	SITE-37		126.000	22.000	(0)				
699-39-E3	SITE-248	SITE-248	120.000		16.800	(0)				
699-39-01	SITE-249	SITE-249	124.000		17.800	(0)				
699-39-30	SITE-266	SITE-266	100.000		14.000	(0)				
699-40-01	SITE-10	SITE-10		120.000	17.000	(0)				
	SITE-106	SITE-106		123.000	14.000	(0)				
	SITE-250	SITE-250	129.000		17.800	(0)				
	SITE-265	SITE-265	120.000		18.000	(0)				
699-40-33	SITE-55	SITE-55		160.000	21.000	(0)				
	SITE-251	SITE-251	172.000		20.600	(0)				
699-40-62	SITE-56	SITE-56		140.000	24.000	(0)				
699-41-01	SITE-252	SITE-252	128.000		17.800	(0)				
699-41-23	SITE-15	SITE-15		108.000	17.000	(0)				
	SITE-113	SITE-113		114.000	14.000	(0)				
699-42-02	SITE-154	SITE-154	120.000		18.000	(0)				
699-42-12	SITE-2	SITE-2		118.000	18.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-42-12	SITE-155	SITE-155	120.000		19.000	(0)				
	SITE-267	SITE-267	114.000		18.000	(0)				
699-42-40A	SITE-174	SITE-174		114.000	44.000	(0)				
699-42-42	SITE-114	SITE-114		114.000	18.000	(0)				
699-43-03	SITE-253	SITE-253	130.000		17.800	(0)				
699-43-88	SITE-123	SITE-123		60.000	7.000	(0)				
699-44-04	SITE-254	SITE-254	128.000		17.800	(0)				
699-45-04	SITE-255	SITE-255	122.000		16 800	(0)				
699-45-42	SITE-57	SITE-57		98.000	22.000	(0)				
	SITE-268	SITE-268	103.000		21.000	(0)				
699-45-69	SITE-96	SITE-96		98.000	20.000	(0)				
699-46-05	SITE-156	SITE-156	120.000		19.000	(0)				
	SITE-256	SITE-256	123.000		17.300	(0)				
699-46-21A	SITE-75	SITE-75		120.000	16.000	(0)				
	SITE-124	SITE-124		123.000	17.000	(0)				
699-47-06	SITE-257	SITE-257	124.000		15.000	(0)				
699-47-46	SITE-269	SITE-269	[illegible]		22 000	(0)	[illegible].800	(0)		
699-48-07	SITE-258	SITE-258	[illegible]3.000		7 000	(0)				
699-48-18	SITE-125	SITE-125		119.000	0.000	(0)				
699-48-71	SITE-59	SITE-59		98.000	18.000	(0)				
699-49-13	SITE-259	SITE-259	133.000		16.400	(0)				
699-49-55	SITE-9	SITE-9		94.000	17.000	(0)				
	SITE-39	SITE-39		93.000	15.000	(0)				
	SITE-58	SITE-58		32 000	15.000	(0)				
	SITE-78	SITE-78		57.000	14.000	(0)				
	SITE-97	SITE-97		72.000	16.000	(0)				
	SITE-126	SITE-126		26.000	8.000	(0)				
	SITE-157	SITE-157	48.000		11.000	(0)				
699-49-55A	SITE-182	SITE-182		104.000	39.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-49-57	SITE-38	SITE-38		113.000	18.000	(0)				
699-49-79	SITE-20	SITE-20		94.000	17.000	(0)				
699-50-08	SITE-64	SITE-64		130.000	17.000	(0)				
699-50-28B	SITE-63	SITE-63		130.000	17.000	(0)				
699-50-42	SITE-14	SITE-14		106.000	21.000	(0)				
	SITE-115	SITE-115		42.000	5.000	(0)				
	SITE-271	SITE-271	89.000		14.000	(0)				
699-50-53	SITE-270	SITE-270	93.000		18.000	(0)				
699-50-85	SITE-127	SITE-127		123.000	20.000	(0)				
699-51-63	SITE-116	SITE-116		114.000	14.000	(0)				
699-53-103	SITE-160	SITE-160		140.000	26.000	(0)				
699-53-47B	SITE-272	SITE-272	120.000		12.000	(0)				
699-54-34	SITE-273	SITE-273	92.000		28.000	(0)				
699-55-50C	SITE-79	SITE-79		110.000	11.000	(0)				
	SITE-128	SITE-128		79.000	11.000	(0)				
	SITE-193	SITE-193		109.000	26.000	(0)				
	SITE-274	SITE-274	104.000		11.000	(0)				
699-55-76	SITE-71	SITE-71		46.000	4.100	(0)				
	SITE-117	SITE-117		29.000	5.000	(0)				
	SITE-129	SITE-129		43.000	6.000	(0)				
699-55-89	SITE-118	SITE-118		131.000	23.000	(0)				
699-57-25A	SITE-119	SITE-119		131.000	23.000	(0)				
	SITE-275	SITE-275	126.000		19.000	(0)				
699-57-29A	SITE-276	SITE-276	119.000		21.000	(0)				
699-57-83	SITE-130	SITE-130		115.000	16.000	(0)				
699-59-58	SITE-107	SITE-107		114.000	23.000	(0)				
	SITE-277	SITE-277	113.000		19.000	(0)				
699-60-32	SITE-278	SITE-278	117.000		19.000	(0)				
699-60-57	SITE-198	SITE-198		155.000	44.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-62-31	SITE-131	SITE-131		139.000	17.000	(0)				
	SITE-279	SITE-279	125.000		18.000	(0)				
699-63-25A	SITE-132	SITE-132		155.000	17.000	(0)				
699-63-55	SITE-280	SITE-280	120.000		19.000	(0)				
699-63-58	SITE-281	SITE-281	109.000		18.000	(0)				
699-63-90	SITE-74	SITE-74		120.000	20.000	(0)				
	SITE-133	SITE-133		123.000	20.000	(0)				
699-64-27	SITE-158	SITE-158	150.000		17.000	(0)				
699-65-50	SITE-73	SITE-73		110.000	17.000	(0)				
	SITE-134	SITE-134		115.000	18.000	(0)				
	SITE-282	SITE-282	115.000		18.000	(0)				
699-66-103	85-203	85-203	90.000	93.000	13.200	(1)	0.390	(1)	22.380	(1)
		85-204	90.000	93.000	12.900	(1)				
	86-73	86-73	96.000	91.000	12.300	(1)	0.370	(1)	22.600	(1)
		86-74	96.000	91.000	12.300	(1)				
	86-112	86-112	96.700	96.500	12.000	(1)	0.430	(1)	22.700	(1)
		86-113	96.700	96.500	12.000	(1)				
	85-294	85-294	98.000	95.000	12.800	(1)	0.550	(1)	22.300	(1)
		85-295	98.000	95.000	12.800	(1)				
699-66-39	SITE-135	SITE-135		31.000	4.000	(0)				
699-66-58	SITE-136	SITE-136		107.000	17.000	(0)				
699-66-64	SITE-137	SITE-137		123.000	17.000	(0)				
699-67-98	SITE-260	SITE-260	129.000		16.400	(0)				
699-69-38	SITE-6	SITE-6		258.000	11.000	(0)				
699-71-30	SITE-108	SITE-108		196.000	15.000	(0)				
699-71-52	SITE-138	SITE-138		107.000	13.000	(0)				
699-72-73	SITE-109	SITE-109		119.000	14.000	(0)				
699-72-88	SITE-98	SITE-98		98.000	17.000	(0)				
	SITE-261	SITE-261	101.000		15.900	(0)				
699-72-92	SITE-262	SITE-262	111.000		15.000	(0)				

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	LAB ALK MG/L AS CACO3	FIELD ALK MG/L AS CACO3	SI MG/L	(A)	TOC MG/L	(A)	TC MG/L	(A)
699-77-36	SITE-110	SITE-110		230.000	16.000	(0)				
699-78-62	SITE-111	SITE-111		114.000	14.000	(0)				
699-81-58	SITE-159	SITE-159	86.000		7.000	(0)				
699-83-47	SITE-112	SITE-112		114.000	15.000	(0)				
699-87-55	SITE-99	SITE-99		98.000	18.000	(0)				
699-90-45	SITE-139	SITE-139		156.000	17.000	(0)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

LIST OF ANALYSIS METHODS FOR OTHER MAJOR CONSTITUENTS

SPECIE	(A)	ANALYSIS METHOD
FIELD ALK	1	Titration
LAB ALK	1	Titration
SI	0	Unclassified
	1	ICP
TC	0	Unclassified
	1	IR Detector
TOC	0	Unclassified
	1	Persulfate Oxidation

ICP: Inductively Coupled Plasma Atomic Emission Spectrometry
Unclassified: Analysis comes from a non-BWIP documented source and the method is not specified in this data package.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	Cl MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
BERK	85-255	85-255	4.600	(1)	0.560	(1)									
		85-256	4.500	(1)	0.490	(1)									
DB-01	81-19	81-15	15.000	(1)	3.490	(1)			0.270	(1)					[illegible].473
		81-19	15.700	(1)	3.660	(1)			0.210	(1)					3.079
	81-65	81-65	47.500	(1)	7.210	(1)			18.300	(1)					[illegible].050
		81-70	47.400	(1)	7.200	(1)			18.200	(1)					0.634
	82-27	82-27	46.600	(1)	7.080	(1)			16.300	(1)					0.118
		82-87	47.500	(1)	7.140	(1)			16.600	(1)					-0.079
	85-32	85-32	48.000	(1)	7.200	(1)			17.000	(1)					-0.017
		85-33	48.000	(1)	7.200	(1)			17.000	(1)					-0.482
DB-02	79-65	CP123	14.600	(1)	5.500	(1)			< 1.200	(1)	< 0.500	(1)	< 0.500	(1)	
	81-13	81-11	29.700	(1)	5.080	(1)			35.600	(1)					2.774
		81-13	29.900	(1)	5.140	(1)			35.700	(1)					3.115
	81-10	81-10	31.900	(1)	5.760	(1)			38.200	(1)					2.617
		81-7	31.900	(1)	5.760	(1)			38.500	(1)					3.046
DB-04	79-77	CP116	6.400	(1)	1.100	(1)			[illegible]	(1)					
DB-07	79-89	CP121	55.500	(1)	7.300	(1)			[illegible]	(1)					
	83-413	83-413	53.500	(1)	7.680	(1)			0.900	(1)					[illegible].305
		83-448	57.100	(1)	7.950	(1)			0.890	(1)					-0.377
	85-216	85-216	52.700	(1)	8.300	(1)			0.860	(1)					0.859
		85-217	53.000	(1)	8.400	(1)			0.880	(1)					0.531
DB-09	79-28	CP115	9.800	(1)	0.100	(1)			< 1.200	(1)					
	83-472	83-410	10.200	(1)	0.840	(1)			14.500	(1)					-0.442
		83-472	10.100	(1)	0.840	(1)			14.000	(1)					-0.313
DB-11	85-18	85-18	4.900	(1)	0.800	(1)									
		85-19	5.000	(1)	0.700	(1)									
	86-52	86-52	4.130	(1)	0.770	(1)			ND	(1)	ND	(1)			
		86-53	4.130	(1)	0.770	(1)			ND	(1)	ND	(1)			
	81-57	81-57	4.800	(1)	0.720	(1)									
DB-12	63-95	63-95	4.800	(1)	0.030	(1)			19.100	(1)					-2.340
	81-25	81-25	5.300	(1)	0.710	(1)			0.810	(1)					-3.616
		81-42	5.300	(1)	0.710	(1)			0.790	(1)					-3.447
DB-13	83-404	83-404	4.530	(1)	0.490	(1)			[illegible]	(1)					[illegible].215
		83-455	4.620	(1)	0.490	(1)			0.160	(1)					0.857
DB-14	81-162	81-139	129.000	(1)	9.490	(1)			< [illegible]	(1)					[illegible].546
		81-162	129.000	(1)	9.440	(1)			< 0.500	(1)					-3.905
DB-15	79-17	79-17	7.700	(1)	< 0.300	(1)			37.300	(1)	7.000	(1)	< 1.200	(1)	[illegible].896
		79-4	7.800	(1)	< 0.300	(1)			39.700	(1)	6.400	(1)	< 1.200	(1)	5.824

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
DB-15	79-35	79-20	3.500	(1)	0.900	(1)			< 1.200	(1)	< 0.600	(1)	0.900	(1)	1.789
		79-35	3.400	(1)	0.800	(1)			< 1.200	(1)	< 0.600	(1)	0.900	(1)	3.150
	79-33	79-27	7.400	(1)	3.000	(1)			< 1.200	(1)	< 0.600	(1)	7.400	(1)	0.918
		79-33	7.200	(1)	3.000	(1)			< 1.200	(1)	< 0.600	(1)	0.900	(1)	0.475
	79-15	79-15	8.800	(1)	3.000	(1)			< 1.200	(1)	< 0.600	(1)			0.391
		79-46	9.400	(1)	2.900	(1)			< 1.200	(1)	< 0.600	(1)	5.200	(1)	0.673
	79-31	79-31	6.900	(1)	0.900	(1)			2.900	(1)	< 0.500	(1)			2.317
		79-5	6.900	(1)	1.000	(1)			2.800	(1)	< 0.500	(1)	0.900	(1)	3.359
	79-51	79-51	117.000	(1)	21.800	(1)			10.900	(1)	< 0.500	(1)	< 1.000	(1)	1.010
		79-61	107.000	(1)	19.300	(1)			9.400	(1)	< 0.500	(1)	< 1.000	(1)	3.572
	79-85	79-74	105.000	(1)	19.000	(1)			9.600	(1)	< 0.500	(1)	< 1.000	(1)	6.964
		79-85	105.000	(1)	19.100	(1)			10.200	(1)	< 0.500	(1)	< 1.000	(1)	5.978
	79-80	79-80	104.000	(1)	19.000	(1)			6.800	(1)	< 0.500	(1)	< 1.000	(1)	5.790
		79-99	104.000	(1)	19.000	(1)			6.800	(1)	< 0.500	(1)	< 1.000	(1)	5.444
	79-62	79-62	97.800	(1)	16.900	(1)			20.100	(1)	2.900	(1)	< 0.500	(1)	1.350
		79-84	98.000	(1)	17.000	(1)			20.100	(1)	< 0.500	(1)	< 0.500	(1)	3.551
	79-90	79-90	94.600	(1)	16.800	(1)			19.800	(1)	< 0.500	(1)	< 0.500	(1)	3.750
		79-95	96.800	(1)	17.000	(1)			19.800	(1)	< 0.500	(1)	< 0.500	(1)	3.042
	80-35	80-35	109.000	(1)	18.400	(1)			16.300	(1)					4.496
		80-41	103.000	(1)	18.000	(1)			16.500	(1)					5.178
	80-24	80-24	111.000	(1)	19.500	(1)			17.800	(1)					0.271
		80-74	108.000	(1)	19.300	(1)			17.500	(1)					-0.517
	80-77	80-42	102.000	(1)	17.400	(1)			18.400	(1)					0.494
		80-77	101.000	(1)	17.600	(1)			18.700	(1)					0.126
	80-1	80-1	105.000	(1)	19.800	(1)			9.400	(1)	< 0.500	(1)	< 0.500	(1)	3.293
		80-51	105.000	(1)	19.500	(1)			9.400	(1)	< 0.500	(1)	< 0.500	(1)	3.348
DC-01	SITE-230	SITE-230	11.000	(0)	0.500	(0)			19.000	(0)	0.500	(0)	0.010	(0)	-0.189
	SITE-226	SITE-226	3.900	(0)	1.000	(0)			0.400	(0)	0.200	(0)	0.250	(0)	0.017
	SITE-227	SITE-227	68.000	(0)	10.000	(0)					0.200	(0)	0.140	(0)	
	SITE-228	SITE-228	85.000	(0)	13.000	(0)			1.800	(0)			0.070	(0)	0.161
	SITE-229	SITE-229	83.000	(0)	15.000	(0)			5.600	(0)	0.100	(0)	0.080	(0)	-0.919
	SITE-231	SITE-231	7.700	(0)	0.800	(0)			12.000	(0)	0.200	(0)	0.080	(0)	-0.453
	SITE-232	SITE-232	4.200	(0)	1.000	(0)					0.100	(0)	0.110	(0)	
	SITE-233	SITE-233	13.000	(0)	1.700	(0)					0.200	(0)	0.160	(0)	
	SITE-234	SITE-234	49.000	(0)	7.500	(0)			1.600	(0)	0.300	(0)	0.210	(0)	-0.188
	SITE-235	SITE-235	120.000	(0)	16.000	(0)			2.000	(0)	0.100	(0)	0.080	(0)	0.382
	SITE-236	SITE-236	120.000	(0)	20.000	(0)			10.000	(0)	0.200	(0)	0.010	(0)	3.713
	SITE-237	SITE-237	110.000	(0)	20.000	(0)			12.000	(0)	0.300	(0)	0.050	(0)	-0.250
	SITE-238	SITE-238	13.000	(0)	2.000	(0)			3.600	(0)	0.300	(0)	0.000	(0)	-0.810
	SITE-239	SITE-239	98.000	(0)	21.000	(0)			13.000	(0)	0.200	(0)	0.040	(0)	
	SITE-240	SITE-240	94.000	(0)	20.000	(0)			12.000	(0)	0.200	(0)	0.040	(0)	-0.627
	SITE-241	SITE-241	98.000	(0)	20.000	(0)			10.000	(0)	0.200	(0)	0.010	(0)	-1.406
	SITE-242	SITE-242	90.000	(0)	18.100	(0)			14.000	(0)	0.300	(0)	0.010	(0)	-0.194
	SITE-243	SITE-243	68.000	(0)	11.000	(0)			21.000	(0)	0.400	(0)	0.030	(0)	
DC-02-A2	80-4	80-25	75.500	(1)	17.700	(1)			44.200	(1)					[illegible].353
		80-4	74.600	(1)	20.800	(1)			45.300	(1)					8.786

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SAMPLE TYPE. CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
DC-02-A2	SITE-213	SITE-213	95.000	(0)	21.000	(0)			26.000	(0)					
DC-03	80-27	80-27	6230.000	(1)	40.800	(1)			720.[illegible]	(1)					[illegible].035
		80-81	7392.000	(1)	13.700	(1)			162.000	(1)					1.927
DC-05	79-30	79-30	[illegible].600	(1)	14.000	(1)			< 0.300	(1)	< 0.500	(1)	< 0.500	(1)	[illegible].101
		79-32	36.400	(1)	13.300	(1)			< 0.500	(1)	< 0.500	(1)	< 0.500	(1)	53.285
DC-06	80-161	80-147	110.000	(1)	34.700	(1)			74.100	(1)					
		80-161	112.000	(1)	35.100	(1)			75.900	(1)					
	80-72	80-22	[illegible]30.000	(1)	30.600	(1)			113.900	(1)					
		80-72	130.000	(1)	31.100	(1)			11[illegible]	(1)					
	SITE-214	SITE-214	125.000	(0)	41.000	(0)			95.000	(0)					63.449
	80-238	80-201	129.000	(1)	39.900	(1)			85.200	(1)					-7.131
	80-191	80-186	295.000	(1)	22.400	(1)			197.000	(1)					-[illegible].552
		80-191	290.000	(1)	22.200	(1)			190.000	(1)					[illegible].211
	80-13	80-13	258.000	(1)	21.400	(1)			11[illegible].000	(1)					[illegible].312
		80-58	259.000	(1)	21.500	(1)			111.000	(1)					[illegible].065
	81-45	81-45	145.000	(1)	35.600	(1)			163.000	(1)					-4.184
		81-8	146.000	(1)	35.000	(1)			161.000	(1)					-1.358
	80-118	80-118	166.000	(1)	42.200	(1)			19[illegible]	(1)					[illegible]203
		80-133	[illegible]52.000	(1)	36.600	(1)			18[illegible]	(1)					[illegible].593
	80-15	80-15	21[illegible].000	(1)	35.400	(1)			189.000	(1)	1.300	(1)			8.451
		80-70	[illegible]34.100	(1)	24.100	(1)			18[illegible]	(1)	6.200	(1)			[illegible].936
	81-82	81-76	289.000	(1)	35.600	(1)			17[illegible]	(1)					[illegible].413
		81-82	289.000	(1)	35.600	(1)			17[illegible].000	(1)					[illegible].567
	80-29	80-29	96.300	(1)	34.000	(1)			[illegible]9.500	(1)					-[illegible].063
		80-37	[illegible]	(1)	39.000	(1)			[illegible]9.000	(1)					[illegible].475
	79-58	79-57	109.000	(1)	30.600	(1)			81.600	(1)					[illegible].775
		79-58	105.000	(1)	31.200	(1)			81.[illegible]	(1)					-[illegible].444
	80-75	80-45	[illegible].900	(1)	40.400	(1)			15[illegible]	(1)					-[illegible].890
		80-75	[illegible]9.000	(1)	41.100	(1)			15[illegible].000	(1)					-2.533
DC-07	82-23	82-23	[illegible].000	(1)	37.000	(1)			[illegible]	(1)					-[illegible]
		82-56	[illegible].000	(1)	36.800	(1)			[illegible]	(1)					-[illegible].805
	82-10	82-10	[illegible].000	(1)	39.000	(1)			8[illegible]	(1)					[illegible].059
		82-33	13[illegible].000	(1)	39.000	(1)			[illegible]	(1)					[illegible]
							0.27[illegible]	([illegible])							[illegible]
	80-39	80-39	40.900	(1)	10.000	(1)			2[illegible]	(1)					[illegible].102
		80-98	39.600	(1)	10.800	(1)			2[illegible]	(1)					[illegible]
	80-11	80-11	97.500	(1)	24.500	(1)			7[illegible]	(1)					[illegible].334
		80-19	95.800	(1)	24.400	(1)			77.500	(1)					[illegible].393
	80-103	80-103	171.000	(1)	34.900	(1)			225.000	(1)					-[illegible].898
		80-163	180.000	(1)	41.400	(1)			232.000	(1)					-[illegible].468
	80-188	80-178	4[illegible].000	(1)	22.000	(1)			173.000	(1)					-[illegible].544
		80-188	420.000	(1)	22.200	(1)			175.000	(1)					[illegible].019
	80-196	80-177	385.000	(1)	22.100	(1)			172.000	(1)					[illegible].528
		80-196	332.000	(1)	20.800	(1)			153.000	(1)					[illegible].900

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
DC-12	80-80	80-62	103.000	(1)	10.300	(1)			3.300	(1)					2.859
		80-80	104.000	(1)	10.100	(1)			2.800	(1)					0.766
	80-100	80-100	96.500	(1)	8.900	(1)									
		80-63	95.600	(1)	8.900	(1)									
	80-97	80-73	105.000	(1)	8.200	(1)			1.400	(1)					-3.022
		80-97	103.000	(1)	8.200	(1)			1.200	(1)					-3.604
	80-32	80-68	109.000	(1)	9.500	(1)			5.900	(1)			1.800	(1)	22.817
	80-82	80-23	89.500	(1)	6.000	(1)									
		80-82	89.600	(1)	6.600	(1)									
	80-124	80-102	102.000	(1)	10.300	(1)									
		80-124	103.000	(1)	9.800	(1)									
	80-101	80-101	107.000	(1)	13.000	(1)									
		80-169	107.000	(1)	13.100	(1)									
	80-174	80-143	103.000	(1)	12.600	(1)									
		80-174	127.000	(1)	13.600	(1)			1.700	(1)					-2.430
	80-209	80-209	110.000	(1)	13.200	(1)			2.200	(1)					3.269
		80-242	101.000	(1)	12.300	(1)									
	80-233	80-233	116.200	(1)	13.400	(1)									
		80-243	113.300	(1)	13.800	(1)			1.300	(1)					-4.439
	80-234	80-208	104.000	(1)	12.300	(1)			15.400	(1)					-3.407
		80-234	103.000	(1)	12.600	(1)			13.500	(1)					-3.727
	81-61	81-61	130.000	(1)	12.900	(1)			4.200	(1)					-1.228
		81-72	130.000	(1)	12.900	(1)			4.200	(1)					-0.652
	82-85	82-34					0.220	(2)							
		82-47	127.000	(1)	13.700	(1)			2.930	(1)					0.565
		82-85	132.000	(1)	13.700	(1)			3.250	(1)					-0.115
DC-14	80-3	80-3	5.900	(1)	1.100	(1)			28.100	(1)					-0.375
		80-34	5.700	(1)	1.000	(1)			28.100	(1)					-0.885
	80-53	80-16	6.700	(1)	0.800	(1)			24.000	(1)					0.806
		80-53	6.500	(1)	0.800	(1)			23.500	(1)					-0.003
	80-47	80-47	4.900	(1)	0.600	(1)			17.600	(1)	2.700	(1)			-2.732
		80-85	5.000	(1)	0.600	(1)			18.100	(1)	2.700	(1)			-0.305
	80-69	80-69	5.900	(1)	1.500	(1)			17.600	(1)					4.142
		80-83	7.400	(1)	2.900	(1)			18.800	(1)					2.646
	80-99	80-55	7.000	(1)	2.900	(1)			19.600	(1)					1.285
		80-99	5.900	(1)	2.300	(1)			19.600	(1)					2.127
	80-89	80-36	7.000	(1)	2.900	(1)			14.300	(1)					3.761
		80-89	5.500	(1)	2.100	(1)			19.300	(1)	0.700	(1)			4.562
	80-71	80-2	11.000	(1)	1.600	(1)			29.100	(1)			4.100	(1)	1.097
		80-71	11.800	(1)	1.500	(1)			29.100	(1)			4.100	(1)	1.288
	80-144	80-136	6.200	(1)	0.900	(1)			21.800	(1)					1.141
		80-144	6.300	(1)	1.000	(1)			21.200	(1)					2.613
		80-199					< 0.050	(2)							
	80-189	80-105					< 0.050	(2)							
		80-127	6.200	(1)	1.000	(1)			24.200	(1)					0.946
		80-189	6.300	(1)	1.000	(1)			24.200	(1)					-0.328
	80-112	80-112	6.600	(1)	0.800	(1)			16.500	(1)					2.343

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
DC-14	80-112	80-168	5.800	(1)	0.900	(1)			16.600	(1)					1.359
							< 0.050	(2)							1.359
	80-157	80-157	7.800	(1)	2.200	(1)									
							< 0.050	(2)							
		80-183	?.000	(1)	2.200	(1)									
	80-155	80-155	6.900	(1)	2.200	(1)			20.500	(1)					?.343
		80-185	6.900	(1)	2.100	(1)			20.500	(1)					2.523
							< 0.050	(2)							?.523
	80-104	80-104	5.100	(1)	1.800	(1)							0.800	(1)	
		80-125	5.100	(1)	1.800	(1)							1.700	(1)	
		80-148					< 0.050	(2)							
	80-129	80-115			2.300	(1)			?3.500	(1)					
							< 0.050	(2)							
		80-129			2.300	(1)			17.?00	(1)					
	80-170	80-156	5.100	(1)	2.200	(1)			18.600	(1)					-0.084
		80-170	5.100	(1)	2.200	(1)			18.600	(1)					-0.524
		80-195					< 0.050	(2)							
	80-117	80-109					< 0.050	(2)							
		80-117	7.000	(1)	3.600	(1)			24.300	(1)					5.431
		80-151	7.200	(1)	3.600	(1)			24.700	(1)					?.161
	80-213	80-213	70.200	(1)	24.300	(1)			18.700	(1)					-?.093
		80-225	70.400	(1)											
							0.210	(2)							
		80-236	?0.600	(1)	24.400	(1)			13.700	(1)					-6.218
	81-20	81-20	222.000	(1)	22.000	(1)			169.000	(1)					-6.951
		81-22	217.000	(1)	21.600	(1)			166.000	(1)					-5.028
		81-40					0.340	(2)							
	81-30	81-16	221.000	(1)	40.700	(1)			145.000	(1)					1.123
							0.420	(2)							1.123
		81-30	231.000	(1)	40.600	(1)			144.0??	(1)					?.181
	81-44	81-44	2??.000	(1)	47.100	(1)			135.???	(1)					-?.063
		81-47	237.000	(1)	46.300	(1)			135.0?0	(1)					-?.093
							0.450	(2)							-?.093
	81-141	81-141	255.000	(1)	50.000	(1)			112.000	(1)					?.968
							0.440	(2)							2.968
	82-8	82-31	247.000	(1)	44.000	(1)			134.000	(1)					
							0.400	(?)							
		82-42	24?.000	(1)	44.000	(1)			130.000	(1)					-?.137
	83-156	83-156	253.000	(1)	48.400	(1)			141.000	(1)					?.203
		83-197	253.000	(1)	48.400	(1)			147.000	(1)					-? 370
	83-152	83-152	254.000	(1)	48.700	(1)			141.000	(1)					-? 053
		83-193	254.000	(1)	48.900	(1)			141.000	(1)					-?.?75
	83-157	83-157	254.000	(1)	50.700	(1)			140.000	(1)					-?.?32
		83-179	254.000	(1)	49.900	(1)			140.000	(1)					-?.?16
	83-178	83-103	254.000	(1)	48.500	(1)			140.000	(1)					-?.268
		83-178	253.000	(1)	48.300	(1)			140.000	(1)					-?.935
	83-183	83-123	254.000	(1)	49.800	(1)			141.000	(1)					-?.355
		83-183	254.000	(1)	49.800	(1)			141.000	(1)					-?.700

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
DC-14	83-154	83-154	254.000	(1)	50.100	(1)			141.000	(1)					-1.005
		83-191	254.000	(1)	50.800	(1)			140.000	(1)					-1.207
	83-150	83-108	253.000	(1)	49.000	(1)			140.000	(1)					-0.151
		83-150	253.000	(1)	49.000	(1)			140.000	(1)					0.026
	83-266	83-233	252.000	(1)	50.100	(1)			140.000	(1)					-0.547
		83-266	251.000	(1)	50.100	(1)			140.000	(1)					-1.954
	83-261	83-203	251.000	(1)	48.900	(1)			138.000	(1)					-0.749
		83-261	251.000	(1)	48.800	(1)			138.000	(1)					-0.596
DC-15	80-56	80-31	11.200	(1)	1.200	(1)									
		80-56	11.300	(1)	1.200	(1)									
	80-54	80-54	8.100	(1)	1.000	(1)									
		80-76	7.800	(1)	1.000	(1)									
	80-57	80-57	15.500	(1)	1.100	(1)									
		80-65	9.800	(1)	0.700	(1)									
	80-87	80-87	17.900	(1)	2.000	(1)									
		80-94	17.800	(1)	2.000	(1)									
	80-137	80-137	46.800	(1)	11.500	(1)			2.000	(1)					-4.018
		80-197	46.900	(1)	11.400	(1)			2.400	(1)					-2.997
	80-176	80-130	35.200	(1)	8.900	(1)									
							0.130	(2)							
		80-176	38.600	(1)	9.500	(1)									
		80-999	35.900	(1)	0.000	(1)									
	80-135	80-135	40.100	(1)	9.100	(1)			2.700	(1)	< 0.500	(1)	< 0.500	(1)	0.787
		80-149	39.700	(1)	9.300	(1)									
							0.130	(2)							
	80-120	80-120	44.500	(1)	10.900	(1)			1.300	(1)					-1.864
		80-139	44.500	(1)	10.900	(1)			1.300	(1)					-2.890
	80-131	80-108	66.000	(1)	12.100	(1)			7.500	(1)					-4.160
		80-131	64.700	(1)	11.800	(1)			7.500	(1)					-1.356
	80-193	80-114	70.700	(1)	8.600	(1)			4.800	(1)					-3.553
		80-193	72.200	(1)	8.600	(1)			4.800	(1)					-5.339
	81-41	81-24	170.000	(1)	11.500	(1)			140.000	(1)					-5.506
		81-31					0.270	(2)							
		81-41	165.000	(1)	11.500	(1)			141.000	(1)					-6.754
	81-2	81-2	224.000	(1)	18.400	(1)			119.000	(1)					-7.238
		81-36	224.000	(1)	18.300	(1)			119.000	(1)					-5.990
							0.330	(2)							-5.990
	81-46	81-46	183.000	(1)	17.500	(1)			139.000	(1)					1.161
							0.340	(2)							1.161
		81-50	182.000	(1)	17.400	(1)			139.000	(1)					1.475
	81-33	81-17					0.400	(2)							
		81-32	206.000	(1)	22.900	(1)			198.000	(1)					-5.122
		81-33	205.000	(1)	22.800	(1)			198.000	(1)					-0.813
	81-27	81-27	189.000	(1)	32.600	(1)			131.000	(1)					-0.498
		81-74	190.000	(1)	32.800	(1)			133.000	(1)					-1.217
		81-77					0.340	(2)							
	81-64	81-64	308.000	(1)	23.500	(1)			214.000	(1)					0.912

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
DG-15	81-64	81-80	303.000	(1)	23.500	(1)			214.000	(1)					- .070
	81-96	81-66	210.000	(1)	22.700	(1)			171.000	(1)					
		81-85	222.000	(1)	21.800	(1)			175.000	(1)					- .909
							0.360	(2)							-3.909
	81-69	81-69	224.000	(1)	21.700	(1)			175.000	(1)					-3.312
		81-84	224.000	(1)	21.700	(1)			175.000	(1)					- .832
							0.330	(2)							-4.832
	82-94	82-41	138.000	(1)	46.900	(1)			105.000	(1)					0.955
		82-94	137.000	(1)	46.300	(1)			107.200	(1)					.144
DG-16A	81-109	81-109	3.520	(1)	0.480	(1)			22.100	(1)					4.754
		81-134					< 0.050	(2)							
		81-167	3.570	(1)	0.480	(1)			21.903	(1)					.353
	82-17	82-17	3.590	(1)	0.470	(1)			4.430	(1)					0.719
		82-22					< 0.050	(2)							
		82-55	3.570	(1)	0.470	(1)			4.470	(1)					.902
	82-93	82-45	5.100	(1)	0.700	(1)			4.600	(1)					-3.356
		82-6					< 0.050	(2)							
		82-93	4.900	(1)	0.620	(1)			4.602	(1)					.151
	82-19	82-19	148.000	(1)	9.500	(1)			2.000	(1)					.395
		82-72					0.240	(2)							
		82-88	147.000	(1)	9.900	(1)			2.000	(1)					.333
	82-168	82-110					0.270	(2)							
		82-140	170.000	(1)	9.900	(1)			1.200	(1)					.150
		82-188	[illegible]	(1)	10.000	(1)			1.200	(1)					- .202
	82-124	82-124	110.000	(1)	13.000	(1)			1.900	(1)					.593
		82-145					0.200	(2)							
		82-172	109.000	(1)	13.000	(1)			1.900	(1)					.125
	82-143	82-126	308.000	(1)	10.900	(1)			3.700	(1)					- .363
		82-143	309.000	(1)	10.800	(1)			5.510	(1)					-1.107
		82-175					0.460	(2)							
	82-202	82-202	253.000	(1)	12.300	(1)			5.100	(1)					.024
		82-228	255.000	(1)	12.400	(1)			5.050	(1)					.289
							0.440	(2)							2.280
	82-322	82-322	442.000	(1)	24.100	(1)			[illegible]	(1)					- .531
		82-361	423.000	(1)	24.000	(1)			[illegible]	(1)					- .775
		82-376					0.600	(2)							
	82-332	82-332	451.000	(1)	26.100	(1)			2.520	(1)					- .132
		82-358	451.000	(1)	25.900	(1)			2.520	(1)					- .355
							0.620	(2)							- .358
	82-430	82-430	414.000	(1)	27.600	(1)			5.420	(1)					- .373
		82-473	411.000	(1)	27.300	(1)			8.420	(1)					- .291
							0.540	(2)							- .291
	83-29	83-29	427.000	(1)	26.600	(1)			5.500	(1)					- .111
							0.590	(2)							- .111
		83-41	427.000	(1)	26.900	(1)			5.300	(1)					- .908
							0.600	(2)							-0.908

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SAMPLE TYPE. CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
DC-16B	83-147	83-147	7.360	(1)	0.740	(1)									
		83-185	7.360	(1)	0.770	(1)									
DC-16C	83-100	83-100	367.000	(1)	23.900	(1)			3.980	(1)					-2.934
							0.460	(2)							-2.934
		83-30	354.000	(1)	23.600	(1)			4.000	(1)					-3.072
							0.500	(2)							-3.072
	83-259	83-215	188.000	(1)	11.200	(1)			1.550	(1)					-0.871
		83-259	188.000	(1)	11.200	(1)			1.580	(1)					-0.938
DC-18	86-166	86-166	26.400	(1)	3.540	(1)			0.220	(1)					0.217
		86-167	26.400	(1)	3.550	(1)			0.220	(1)					0.351
DC-19C	84-53	84-53	180.000	(1)	15.100	(1)			21.900	(1)					-0.316
		84-84	175.000	(1)	14.900	(1)			21.400	(1)					1.167
	84-40	84-40	181.000	(1)	14.600	(1)			9.890	(1)					-0.057
		84-77	180.000	(1)	14.500	(1)			9.750	(1)					0.647
	84-75	84-29	202.000	(1)	15.700	(1)			14.800	(1)					-1.750
		84-75	202.000	(1)	15.800	(1)			14.800	(1)					-2.845
	84-86	84-18	185.000	(1)	14.600	(1)			4.630	(1)					-2.185
		84-86	185.000	(1)	14.600	(1)			4.550	(1)					-2.225
DC-20C	84-9	84-49	164.000	(1)	10.600	(1)			7.790	(1)					-0.107
		84-9	164.000	(1)	10.600	(1)			7.790	(1)					-0.107
DC-22C	84-105	84-105	103.000	(1)	7.630	(1)			2.160	(1)					3.286
		84-153	107.000	(1)	7.610	(1)			2.200	(1)					1.885
DC-23GR	86-133	86-133	133.500	(1)	6.990	(1)			2.530	(1)					-0.504
		86-134	132.800	(1)	6.990	(1)			1.820	(1)					-0.815
	86-141	86-141	117.000	(1)	6.280	(1)			4.490	(1)					0.043
		86-142	119.300	(1)	6.430	(1)			5.000	(1)					-0.573
	86-181	86-181	64.600	(1)	16.900	(1)			1.420	(1)					-0.580
		86-182	64.500	(1)	16.900	(1)			1.450	(1)					-0.112
ENYEART	SITE-209	SITE-209	5.400	(0)	0.600	(0)			1.800	(0)	0.100	(0)			-0.110
	SITE-210	SITE-210	4.800	(0)	0.400	(0)					0.200	(0)			
	84-166	84-166	4.670	(1)	1.000	(1)									
		84-184	4.650	(1)	0.780	(1)									
	85-180	85-180	4.500	(1)	0.600	(1)									
		85-181	4.500	(1)	0.600	(1)									
FORD	SITE-206	SITE-206	5.800	(0)	0.500	(0)			1.800	(0)	0.100	(0)			-0.029
	SITE-207	SITE-207	4.400	(0)	0.700	(0)			0.200	(0)					-0.071
	SITE-219	SITE-219	4.870	(0)	0.620	(0)			< 2.000	(0)					-10.445
	85-188	85-188	4.800	(1)	0.790	(1)									
		85-189	4.700	(1)	0.700	(1)									
	85-303	85-303	4.640	(1)	0.650	(1)									

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
FORD	85-303	85-304	4.840	(1)	0.640	(1)									
MCGEE	SITE-224	SITE-224	5.200	(0)	0.500	(0)					0.200	(0)	0.020	(0)	
	SITE-222	SITE-222	4.400	(0)					< 2.000	(0)			0.030	(0)	
	SITE-223	SITE-223	4.500	(0)	0.700	(0)							0.030	(0)	
	SITE-225	SITE-225	4.000	(0)	0.800	(0)			< 0.500	(0)	< 0.250	(0)			
	SITE-220	SITE-220	4.820	(0)	0.800	(0)			< 2.000	(0)					-2.538
	82-7	82-52	4.400	(1)	0.600	(1)									
		82-7	4.500	(1)	0.700	(1)									
	85-175	85-175	4.500	(1)	0.650	(1)									
		85-176	4.500	(1)	0.650	(1)									
	85-300	85-300	4.030	(1)	0.710	(1)									
		85-301	4.310	(1)	0.700	(1)									
	86-34	86-34	4.340	(1)	0.690	(1)			ND	(1)	ND	(1)			
		86-35	4.330	(1)	0.680	(1)			ND	(1)	ND	(1)			
	80-64	80-64	5.000	(1)	0.700	(1)			7.200	(1)					-1.034
		80-88	4.800	(1)	0.700	(1)									
	81-79	81-73	4.100	(1)	0.670	(1)									
		81-79	4.150	(1)	0.700	(1)									
	81-54	81-54	4.100	(1)	0.650	(1)									
		81-56	4.150	(1)	0.650	(1)									
	82-64	82-11	4.800	(1)	0.700	(1)									
		82-64	4.700	(1)	0.700	(1)									
	82-263	82-263	4.120	(1)	0.610	(1)									
		82-283	4.120	(1)	0.610	(1)									
	82-397	82-325	4.820	(1)	0.580	(1)									
		82-397	4.940	(1)	0.580	(1)									
	82-424	82-424	5.070	(1)	0.650	(1)									
		82-474	4.390	(1)	0.640	(1)									
	82-436	82-436	4.200	(1)	0.650	(1)			0.200	(1)					-1.241
		82-498	4.300	(1)	0.650	(1)			0.200	(1)					-0.905
	83-32	83-32	4.600	(1)	0.640	(1)			0.090	(1)					-2.498
							< 0.050	(2)							-2.498
		83-63	4.600	(1)	0.640	(1)			0.090	(1)					-2.099
							< 0.050	(2)							-2.099
	83-83	83-27	5.000	(1)	0.640	(1)			0.050	(1)					-2.042
							< 0.050	(2)							-2.042
		83-58					< 0.050	(2)							
		83-83	5.000	(1)	0.640	(1)			0.050	(1)					-..342
	83-188	83-113	4.800	(1)	0.630	(1)									
							< 0.050	(2)							
		83-188	4.900	(1)	0.630	(1)									
							< 0.050	(2)							
	83-373	83-323	6.820	(1)	3.660	(1)			1.660	(1)					-..317
		83-373	6.820	(1)	3.660	(1)			1.660	(1)					-.429
	83-331	83-331	7.490	(1)	3.410	(1)			1.620	(1)					-0.837
		83-344	7.600	(1)	3.480	(1)			1.630	(1)					-.211
	83-460	83-460	7.060	(1)	3.520	(1)			1.250	(1)					-.910

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
MCGEE	83-460	83-474	7.060	(1)	3.520	(1)			0.240	(1)					-0.046
	83-476	83-417	7.600	(1)	3.500	(1)	0.170	(1)	0.450	(1)					2.104
		83-476	7.570	(1)	3.510	(1)	0.170	(1)	0.450	(1)					2.326
	83-513	83-513	48.400	(1)	11.000	(1)			1.110	(1)					0.430
		83-545	48.400	(1)	10.700	(1)			1.140	(1)					0.593
	84-24	84-24	48.400	(1)	9.300	(1)			6.230	(1)					-1.402
		84-38	48.800	(1)	9.300	(1)			6.250	(1)					-3.053
OBRIAN	85-194	85-194	4.800	(1)	0.710	(1)									
		85-195	4.800	(1)	0.780	(1)									
RRL-02	82-68	82-28	133.000	(1)	8.500	(1)			1.600	(1)					-2.136
							0.230	(2)							-2.136
		82-68	133.000	(1)	8.500	(1)			1.600	(1)					-2.129
	82-65	82-65	122.000	(1)	8.600	(1)			2.000	(1)					-2.934
		82-75	123.000	(1)	9.400	(1)			2.000	(1)					-4.132
							0.220	(2)							-4.132
	82-170	82-163	347.000	(1)	15.000	(1)			21.000	(1)	2.300	(1)			3.499
							0.480	(2)							3.409
		82-170	344.000	(1)	15.000	(1)			21.000	(1)	2.300	(1)			3.113
	82-122	82-122	507.000	(1)	21.700	(1)			1.400	(1)					-0.368
		82-192	508.000	(1)	21.400	(1)			1.500	(1)					0.245
							0.700	(2)							0.245
	82-401	82-401	403.000	(1)	20.000	(1)			4.200	(1)					-2.180
		82-416					0.530	(2)							
		82-479	406.000	(1)	20.000	(1)			4.200	(1)					-2.453
	84-7	84-43	420.000	(1)	14.000	(1)	0.560	(1)	0.870	(1)					0.485
		84-7	416.000	(1)	14.000	(1)	0.690	(1)	0.950	(1)					1.131
	82-364	82-364	451.000	(1)	18.200	(1)			1.700	(1)					-2.062
		82-381	448.000	(1)	18.000	(1)			1.700	(1)					-0.919
							0.680	(2)							-0.919
	82-309	82-309	384.000	(1)	17.200	(1)			3.560	(1)					1.815
		82-351	383.000	(1)	17.100	(1)			3.680	(1)					0.880
		82-386					0.560	(2)							
	82-456	82-413	454.000	(1)	20.100	(1)			2.400	(1)					-2.449
							0.620	(2)							-2.449
		82-456	455.000	(1)	20.100	(1)			2.400	(1)					-1.711
RRL-14	82-403	82-403	357.000	(1)	24.300	(1)			16.800	(1)					-0.646
							0.500	(2)							-0.646
		82-489	356.000	(1)	23.700	(1)			16.600	(1)					-0.583
SILM-1	85-252	85-252	5.100	(1)	0.400	(1)									
		85-253	5.100	(1)	0.410	(1)									
	85-297	85-297	4.930	(1)	0.590	(1)			0.190	(1)					1.749
		85-298	4.930	(1)	0.590	(1)			0.180	(1)					-0.646
	86-31	86-31	4.870	(1)	0.570	(1)			0.190	(1)	ND	(1)			-0.294
		86-32	4.830	(1)	0.570	(1)			0.180	(1)	ND	(1)			-0.074

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	Cl MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
STEM-2	86-19	86-19	4.820	(1)	0.580	(1)			ND	(1)	ND	(1)			
		86-20	4.830	(1)	0.580	(1)			ND	(1)	ND	(1)			
299-E16-01	SITE-161	SITE-161	2.600	(0)	0.620	(0)			28.000	(0)					0.771
	SITE-162	SITE-162	1.400	(0)	0.610	(0)			38.000	(0)					0.523
	SITE-163	SITE-163	1.200	(0)	0.570	(0)			31.000	(0)					[illegible].802
	SITE-164	SITE-164	< 1.000	(0)	0.590	(0)			35.000	(0)					0.447
299-E25-08	SITE-166	SITE-166	7.900	(0)	0.510	(0)			35.000	(0)					[illegible].496
	SITE-167	SITE-167	7.[illegible]00	(0)	0.580	(0)			18.000	(0)					2.919
	SITE-168	SITE-168	8.100	(0)	0.530	(0)			37.000	(0)					-[illegible].469
299-E33-12	SITE-170	SITE-170	6.600	(0)	0.230	(0)			28.000	(0)					[illegible].077
	SITE-171	SITE-171	7.300	(0)	0.200	(0)			28.000	(0)					[illegible].103
	SITE-172	SITE-172	6.100	(0)	0.170	(0)			25.000	(0)					13.336
699-S11-E12A	80-61	80-61	13.800	(1)	0.700	(1)									
	80-180	80-138	[illegible]3.000	(1)	7.700	(1)									
		80-180	143.000	(1)	7.700	(1)									
699-42-40C	SITE-176	SITE-176	5.100	(0)	0.850	(0)			18.000	(0)					[illegible].138
	SITE-177	SITE-177	3.000	(0)	0.660	(0)			38.000	(0)					-[illegible].960
	SITE-178	SITE-178	4.000	(0)	0.960	(0)			17.000	(0)					-[illegible].118
	SITE-179	SITE-179	4.000	(0)	0.840	(0)			18.000	(0)					-[illegible].227
	SITE-180	SITE-180	3.500	(0)	0.700	(0)			15.500	(0)					
699-47-50	SITE-205	SITE-205	30.950	(0)	0.570	(0)			10[illegible].300	(0)	7.630	(0)			
	SITE-181	SITE-181	31.000	(0)	0.660	(0)			100.000	(0)					[illegible].881
699-49-55B	SITE-183	SITE-183	15.700	(0)	0.370	(0)			20.000	(0)					[illegible].252
	SITE-184	SITE-184	9.500	(0)	0.260	(0)			2[illegible].000	(0)					6.422
	SITE-185	SITE-185	10.600	(0)	0.230	(0)			17.000	(0)					9.173
699-50-45	SITE-203	SITE-203	2[illegible].870	(0)	0.490	(0)			[illegible]	(0)	0.930	(0)			
	SITE-186	SITE-186	22.000	(0)	0.600	(0)			18.000	(0)					34.400
699-50-48	SITE-204	SITE-204	[illegible]	(0)	0.800	(0)			[illegible]	(0)	0.120	(0)			
	SITE-187	SITE-187	[illegible]5.000	(0)	0.640	(0)			21.000	(0)					-[illegible].538
699-51-46	SITE-188	SITE-188	[illegible].000	(0)	0.540	(0)			[illegible]	(0)					-[illegible].978
	SITE-201	SITE-201	[illegible]	(0)	0.460	(0)			32.850	(0)	1.180	(0)			
699-52-46A	SITE-202	SITE-202	25.[illegible]50	(0)	0.460	(0)			[illegible]	(0)	0.430	(0)			
	SITE-189	SITE-189	25.000	(0)	0.470	(0)			[illegible]	(0)					[illegible].138
699-52-48	SITE-199	SITE-199	4.990	(0)	0.710	(0)			35.[illegible]	(0)					
	SITE-190	SITE-190	[illegible]4.000	(0)	0.640	(0)			24.[illegible]	(0)					[illegible].235

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-53-50	SITE-191	SITE-191	21.000	(0)	0.600	(0)			29.000	(0)					-0.200
	SITE-200	SITE-200	20.990	(0)	0.420	(0)			18.930	(0)	1.050	(0)			
699-54-57	SITE-192	SITE-192	12.900	(0)	0.530	(0)			20.000	(0)					-11.758
699-56-53	SITE-196	SITE-196	28.000	(0)	0.200	(0)			< 1.000	(0)					3.853
	SITE-197	SITE-197	27.000	(0)	0.140	(0)			2.000	(0)					9.336

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SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHRGE BALANCE
STATION-03	82-51	82-51	< 1.000	(1)	< 1.000	(1)			< 1.000	(1)	1.670	(1)			
STATION-04	82-61	82-61	< 1.000	(1)	< 1.000	(1)			< 1.000	(1)	1.310	(1)			
STATION-14	82-20	82-20	< 1.000	(1)	< 1.000	(1)			< 1.000	(1)	< 1.070	(1)	< 1.000	(1)	
STATION-20	82-58	82-58	< 1.000	(1)	< 1.000	(1)			< 1.000	(1)	< 1.000	(1)			
STATION-25	82-66	82-66	< 1.000	(1)	< 1.000	(1)			< 1.000	(1)	1.670	(1)			

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
SP-BENNETT	SITE-218	SITE-218	5.870	(0)	0.270	(0)			10.000	(0)					0.093
	79-13	79-13	13.700	(1)	2.300	(1)			16.900	(1)	10.000	(1)			-5.291
	85-362	85-362	11.000	(1)	0.290	(1)			13.800	(1)	13.400	(1)			1.782
		85-363	11.100	(1)	0.290	(1)			13.800	(1)	13.400	(1)			1.821
	86-190	86-190	11.600	(1)	0.310	(1)			15.000	(1)	13.300	(1)			0.580
		86-191	11.700	(1)	0.310	(1)			14.600	(1)	13.200	(1)			0.587
SP-BENSON	SITE-217	SITE-217	3.120	(0)	0.280	(0)			11.000	(0)					-8.997
SP-BUTLER	79-1	79-1	5.400	(1)	0.100	(1)			18.700	(1)	9.700	(1)	1.600	(1)	-4.933
		79-50	4.800	(1)	0.100	(1)			18.400	(1)	8.000	(1)	2.200	(1)	-3.705
SP-GULCH	84-359	84-359	23.000	(1)	0.400	(1)			31.800	(1)	21.400	(1)			1.388
		84-383	22.700	(1)	0.400	(1)			31.500	(1)	21.200	(1)			0.975
SP-JUNIPER	SITE-215	SITE-215	4.670	(0)	0.500	(0)			18.000	(0)					-0.802
	79-2	79-2	6.900	(1)	0.600	(1)			30.900	(1)	< 0.600	(1)	< 1.200	(1)	2.904
		79-43	6.900	(1)	0.600	(1)			30.500	(1)	< 0.600	(1)	< 1.100	(1)	0.727
	81-115	81-115	4.630	(1)	0.530	(1)			12.000	(1)					4.918
		81-161	4.630	(1)	0.530	(1)			12.000	(1)					5.495
	83-372	83-305	6.110	(1)	0.460	(1)			28.750	(1)					1.661
		83-372	6.110	(1)	0.460	(1)			28.570	(1)					-0.380
SP-TO-SNIVELY	79-34	79-19	4.700	(1)	< 0.300	(1)			20.900	(1)	8.600	(1)	0.700	(1)	-5.870
		79-34	6.900	(1)	< 0.300	(1)			20.900	(1)	8.100	(1)	0.800	(1)	-0.073
	82-362	82-362	3.700	(1)	0.300	(1)			13.000	(1)	8.400	(1)			-1.235
		82-377	3.700	(1)	0.300	(1)			13.000	(1)	8.400	(1)			-1.842
	83-396	83-311	4.350	(1)	0.280	(1)			12.650	(1)					3.735
		83-396	4.270	(1)	0.280	(1)			12.480	(1)					3.160
SP-LOZIER	79-6	79-44	1.900	(1)	< 0.500	(1)			4.200	(1)	4.800	(1)	< 0.500	(1)	2.203
		79-6	1.900	(1)	< 0.500	(1)			5.200	(1)	4.700	(1)	< 0.500	(1)	0.774
	81-186	81-116	3.730	(1)	0.310	(1)			7.140	(1)	10.250	(1)			1.022
		81-186	3.730	(1)	0.310	(1)			7.140	(1)	11.050	(1)			0.480
	83-316	83-316	5.030	(1)	0.270	(1)			10.000	(1)	8.480	(1)			-[illegible].620
		83-343	5.030	(1)	0.270	(1)			10.140	(1)	8.680	(1)			-[illegible].013
SP-MAIDEN	79-100	79-67	3.300	(1)	0.200	(1)			7.500	(1)	5.200	(1)			
		79-96	3.400	(1)	0.400	(1)			8.000	(1)	2.700	(1)			
	83-420	83-420	3.820	(1)	0.180	(1)			9.240	(1)	6.860	(1)			[illegible].197
		83-435	3.760	(1)	0.180	(1)			9.240	(1)	6.860	(1)			3.159
SP-OBSERVATORY	81-119	81-119	3.030	(1)	0.190	(1)			10.330	(1)	9.400	(1)			[illegible].988
		81-157	3.030	(1)	0.190	(1)			10.330	(1)	9.400	(1)			1.302
	83-433	83-433	3.280	(1)	0.160	(1)			12.520	(1)	5.590	(1)			0.587
		83-461	3.280	(1)	0.160	(1)			12.520	(1)	5.480	(1)			1.356
	84-392	84-310	3.140	(1)	0.130	(1)			13.090	(1)	6.230	(1)			0.285
		84-392	3.170	(1)	0.130	(1)			13.170	(1)	6.300	(1)			1.415

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
SP-OBSERVATORY	84-329	84-329	3.500	(1)	0.400	(1)			11.700	(1)	3.500	(1)			
		84-366	3.400	(1)	0.400	(1)			12.100	(1)	4.000	(1)			
	85-359	85-359	3.020	(1)	0.190	(1)			11.300	(1)	4.510	(1)			0.760
		85-360	3.030	(1)	0.210	(1)			[illegible].200	(1)	4.130	(1)			1.762
	86-178	86-178	3.260	(1)	0.200	(1)			12.000	(1)	6.610	(1)			1.626
		86-179	3.230	(1)	0.190	(1)			12.000	(1)	6.480	(1)			1.211
SP-RAILROAD	79-76	79-76	19.600	(1)	3.700	(1)			30.000	(1)	< 0.500	(1)	< 1.000	(1)	-18.885
SP-RATTLESNAKE	SITE-216	SITE-216	3.850	(0)	0.360	(0)			10.000	(0)					-[illegible].940
	79-88	79-87	5.300	(1)	0.400	(1)			10.400	(1)	0.200	(1)			3.550
		79-88	5.300	(1)	0.500	(1)			11.000	(1)	0.200	(1)	< 0.500	(1)	1.823
	83-412	83-412	7.300	(1)	0.500	(1)			12.440	(1)					3.698
		83-466	7.300	(1)	0.490	(1)			12.520	(1)					3.474
SP-SNIVELY	79-49	79-37	3.000	(1)	0.300	(1)			18.500	(1)	10.000	(1)	0.800	(1)	1.268
		79-49	3.500	(1)	0.300	(1)			15.600	(1)	8.100	(1)	0.800	(1)	0.794
SP-SULFUR	79-29	79-29	6.300	(1)	0.300	(1)			25.700	(1)	11.600	(1)	3.800	(1)	-5.828
		79-36	6.000	(1)	0.200	(1)			25.000	(1)	11.300	(1)	3.000	(1)	-5.528
	83-409	83-409	5.220	(1)	0.340	(1)			11.500	(1)	5.160	(1)			1.557
		83-442	5.200	(1)	0.330	(1)			11.500	(1)	5.170	(1)			[illegible].235
SP-UNNAMED-02	79-75	79-75	3.500	(1)	< 0.500	(1)			6.500	(1)	3.200	(1)	< 0.500	(1)	5.352
		79-93	3.400	(1)	< 0.500	(1)			6.500	(1)	2.700	(1)	< 0.500	(1)	
SP-UNNAMED-16	79-73	79-73	4.100	(1)	0.600	(1)			6.400	(1)					-1.907
		79-82	3.400	(1)					5.700	(1)					
SP-UNNAMED-26	79-98	79-98	7.600	(1)	0.400	(1)			5.300	(1)	< 0.500	(1)	< 1.000	(1)	-[illegible].493
SP-UNNAMED-29	79-16	79-16	[illegible].100	(1)					11.200	(1)	1.800	(1)			
		79-24	6.800	(1)					10.600	(1)	2.300	(1)			
SP-UP SNIVELY	79-71	79-69	3.800	(1)	0.200	(1)			[illegible]	(1)					[illegible].235
		79-71	3.900	(1)	0.200	(1)			8.100	(1)	5.100	(1)	< 1.000	(1)	[illegible].043
	81-126	81-126	4.830	(1)	0.300	(1)			10.000	(1)	5.810	(1)			[illegible].108
		81-200	4.960	(1)	0.300	(1)			10.200	(1)	5.610	(1)			[illegible].559
	83-503	83-503	5.490	(1)	0.230	(1)			[illegible]	(1)	5.280	(1)			[illegible]
		83-547	5.300	(1)	0.230	(1)			[illegible]	(1)	5.330	(1)			-[illegible].064
	86-193	86-193	5.050	(1)	0.310	(1)			[illegible]	(1)	8.920	(1)			[illegible].514
		86-194	5.120	(1)	0.310	(1)			[illegible]	(1)	8.090	(1)			[illegible].051
SP-UR2-07	85-343	85-343	2.450	(1)	0.410	(1)			7.390	(1)	1.480	(1)			[illegible].741
		85-344	2.400	(1)	0.400	(1)			7.200	(1)	1.330	(1)			[illegible].554
	86-159	86-159	4.[illegible]	(1)	0.360	(1)			11.[illegible]	(1)	5.160	(1)			[illegible].168
		86-160	4.620	(1)	0.360	(1)			11.500	(1)	5.000	(1)			0.576

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
SP-UR6-20	85-346	85-346	4.470	(1)	0.450	(1)			11.000	(1)					0.230
		85-347	4.520	(1)	0.430	(1)			11.200	(1)					0.343
	86-162	86-162	6.640	(1)	0.450	(1)			13.400	(1)	5.780	(1)			-0.070
		86-163	6.480	(1)	0.430	(1)			13.400	(1)	5.750	(1)			0.012
SP-UR7-22	85-349	85-349	3.540	(1)	0.470	(1)			16.300	(1)	4.880	(1)			0.836
		85-350	3.490	(1)	0.470	(1)			16.200	(1)	5.290	(1)			0.654
	86-153	86-153	7.030	(1)	0.520	(1)			23.600	(1)	8.120	(1)			-0.786
		86-154	7.100	(1)	0.520	(1)			23.700	(1)	8.200	(1)			-0.678
SP-WARM	84-358	84-358	8.400	(1)	0.700	(1)			16.200	(1)					0.933
		84-371	8.500	(1)	0.500	(1)			16.300	(1)					1.220
SP-YR3-04	85-333	85-333	4.630	(1)	0.360	(1)			11.800	(1)	1.550	(1)			0.312
		85-334	4.630	(1)	0.360	(1)			12.000	(1)	1.910	(1)			-0.021
	86-150	86-150	7.070	(1)	0.390	(1)			14.100	(1)	3.460	(1)			-0.039
		86-151	7.080	(1)	0.370	(1)			14.200	(1)	3.520	(1)			-0.022
SP-YR5-08	85-336	85-336	5.550	(1)	0.380	(1)			10.120	(1)					0.348
		85-337	5.620	(1)	0.380	(1)			10.250	(1)					0.184
	86-147	86-147	16.900	(1)	0.370	(1)			18.900	(1)	39.800	(1)			1.479
		86-148	16.900	(1)	0.360	(1)			18.900	(1)	39.700	(1)			1.469
SP-YR7-14	85-339	85-339	7.470	(1)	0.200	(1)			11.900	(1)	0.800	(1)			0.151
		85-340	7.400	(1)	0.200	(1)			11.900	(1)					0.244
	86-156	86-156	6.610	(1)	0.200	(1)			11.700	(1)	3.390	(1)			-0.143
		86-157	6.620	(1)	0.200	(1)			11.700	(1)	3.920	(1)			0.239

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE. SURFACE
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
COLD CREEK	84-317	84-317	[illegible].700	(1)	0.600	(1)			13.500	(1)					
		84-336	7.700	(1)	0.600	(1)			13.500	(1)					
	84-302	84-302	[illegible].800	(1)	0.600	(1)			13.700	(1)					[illegible].358
		84-345	7.800	(1)	0.600	(1)			13.300	(1)					[illegible].997
	85-223	85-223	7.200	(1)	0.570	(1)			13.300	(1)					[illegible].779
		85-224	6.900	(1)	0.550	(1)			12.300	(1)					[illegible].848
CR-DC-14	83-258	83-211	0.820	(1)	0.120	(1)			11.500	(1)					-1.030
		83-258	0.860	(1)	0.120	(1)			11.300	(1)					[illegible].110
CR-HTS	SITE-221	SITE-221	5.500	(0)	0.460	(0)			7.000	(0)					[illegible].008
CR-V-BR	84-330	84-330	[illegible].800	(1)	< 0.500	(1)			[illegible].800	(1)					
		84-361	1.800	(1)	< 0.500	(1)			8.300	(1)					
	84-311	84-311	1.700	(1)	< 0.500	(1)			9.000	(1)					[illegible]
		84-356	[illegible].700	(1)	< 0.500	(1)			[illegible].000	(1)					[illegible]
	85-206	85-206	1.100	(1)	0.320	(1)			13.400	(1)					[illegible].391
		85-207	1.100	(1)	0.290	(1)			12.900	(1)					[illegible].541
	85-266	85-266	1.020	(1)	0.190	(1)			[illegible].130	(1)					[illegible].419
		85-267	1.010	(1)	0.200	(1)			[illegible].120	(1)					-3.267
	86-70	86-70	0.870	(1)	0.230	(1)			10.700	(1)	ND	(1)			[illegible].226
		86-71	0.930	(1)	0.250	(1)			11.000	(1)	ND	(1)			[illegible].739
	86-109	86-109	1.070	(1)	0.130	(1)			11.500	(1)	0.150	(1)			1.184
		86-110	1.100	(1)	0.130	(1)			11.600	(1)	ND	(1)			1.165
YR-HR	85-210	85-210	2.200	(1)					[illegible]	(1)					
		85-211	2.200	(1)					5.000	(1)					
	85-269	85-269	6.170	(1)	0.210	(1)			17.000	(1)	1.560	(1)			[illegible].822
		85-270	5.200	(1)	0.210	(1)			15.000	(1)	1.510	(1)			2.095
	86-67	86-67	5.500	(1)	0.180	(1)			12.[illegible]	(1)	0.390	(1)			1.901
		86-68	5.510	(1)	0.150	(1)			12.[illegible]	(1)	2.120	(1)			[illegible].445
	86-118	86-118	5.550	(1)	0.190	(1)			[illegible]	(1)	3.970	(1)			-[illegible].[illegible]55
		86-119	5.600	(1)	0.200	(1)			13.000	(1)	3.980	(1)			-[illegible].737

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
RRL-06A	82-40	82-35	13.800	(1)	0.500	(1)			46.100	(1)	27.400	(1)			1.172
		82-40	13.800	(1)	0.500	(1)			45.800	(1)	27.000	(1)			1.494
199-B04-04	SITE-41	SITE-41	6.600	(0)	0.200	(0)	0.100	(0)	42.000	(0)	1.100	(0)			2.282
199-D05-12	SITE-80	SITE-80	16.000	(0)	0.200	(0)	0.100	(0)	46.000	(0)	16.000	(0)	0.080	(0)	-3.171
199-D08-03	SITE-72	SITE-72	11.000	(0)	0.200	(0)	0.100	(0)	51.000	(0)	3.300	(0)			6.207
199-F05-01	SITE-82	SITE-82	2.600	(0)	0.100	(0)			14.000	(0)	4.000	(0)	0.060	(0)	-1.427
199-H04-03	SITE-81	SITE-81	8.800	(0)	0.300	(0)	0.300	(0)	160.000	(0)	1700.000	(0)	0.250	(0)	-1.827
199-K-19	SITE-83	SITE-83	2.600	(0)	0.200	(0)			42.000	(0)	5.300	(0)	0.030	(0)	-5.010
199-N-15	SITE-42	SITE-42	2.500	(0)	0.100	(0)			16.000	(0)	4.900	(0)			5.088
299-E26-08	SITE-165	SITE-165	9.500	(0)	0.680	(0)			29.000	(0)					5.317
299-E33-12	SITE-169	SITE-169	5.800	(0)	2.600	(0)			70.000	(0)					22.100
399-01-01	SITE-244	SITE-244	7.900	(0)	0.500	(0)	0.040	(0)	18.000	(0)	19.000	(0)			-0.189
399-01-03	SITE-43	SITE-43	31.000	(0)	0.500	(0)	0.100	(0)	25.000	(0)	4.100	(0)			1.053
399-02-01	SITE-245	SITE-245	9.800	(0)	0.500	(0)	0.010	(0)	17.000	(0)	12.000	(0)			-3.172
399-03-01	SITE-246	SITE-246	9.500	(0)	0.400	(0)	0.010	(0)	19.000	(0)	15.000	(0)			-0.344
399-04-10	SITE-44	SITE-44	12.000	(0)	0.800	(0)	7.000	(0)	27.000	(0)	3.300	(0)			3.107
399-08-04	SITE-140	SITE-140	8.600	(0)	0.300	(0)			23.000	(0)	11.000	(0)			-1.825
699-HAN-19	SITE-3	SITE-3	3.100	(0)	0.400	(0)	0.100	(0)	20.000	(0)	4.200	(0)			0.058
699-S03-E12	SITE-22	SITE-22	3.700	(0)	0.500	(0)	0.100	(0)	25.000	(0)	13.700	(0)			-0.328
	SITE-141	SITE-141	4.600	(0)	0.300	(0)			15.000	(0)	14.000	(0)			-1.812
699-S03-25	SITE-7	SITE-7	23.000	(0)	0.500	(0)	0.100	(0)	81.000	(0)	0.270	(0)			1.531
	SITE-142	SITE-142	22.000	(0)	0.500	(0)			98.000	(0)	1.200	(0)			1.148
	86-55	86-55	23.500	(1)	0.700	(1)			90.590	(1)	0.400	(1)			0.554
		86-56	23.100	(1)	0.740	(1)			90.590	(1)	0.360	(1)			0.430
	86-130	86-130	22.100	(1)	0.660	(1)			89.600	(1)	0.410	(1)			1.056
		86-131	21.700	(1)	0.700	(1)			88.700	(1)	0.420	(1)			0.206
699-S06-E04D	SITE-11	SITE-11	3.400	(0)	0.400	(0)	0.200	(0)	2.200	(0)	6.800	(0)			15.185
699-S08-19	SITE-46	SITE-46	22.000	(0)	1.300	(0)	0.100	(0)	12.000	(0)	0.960	(0)			3.305

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	Cl MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-S03-19	SITE-84	SITE-84	22.000	(0)	1.300	(0)	0.100	(0)	13.000	(0)	3.900	(0)	0.120	(0)	..026
699-S11-E12A	SITE-4	SITE-4	5.800	(0)	0.300	(0)	0.100	(0)	25.000	(0)	22.000	(0)			1.241
699-S12-03	SITE-45	SITE-45	18.000	(0)	0.600	(0)	0.200	(0)	43.000	(0)	1.900	(0)			.893
	SITE-143	SITE-143	17.000	(0)	0.400	(0)	0.100	(0)	44.000	(0)	8.400	(0)			-0.804
699-S19-E13	SITE-120	SITE-120	24.000	(0)	0.400	(0)	0.100	(0)	41.000	(0)	14.000	(0)			..593
699-S24-19	85-213	85-213	5.100	(1)	0.110	(1)			12.000	(1)					.408
		85-214	5.200	(1)	0.350	(1)			12.500	(1)					.803
	85-291	85-291	5.710	(1)	0.280	(1)			13.290	(1)					.397
		85-292	5.700	(1)	0.350	(1)			13.430	(1)					2.985
699-S29-E12	SITE-21	SITE-21	5.100	(0)	0.400	(0)	0.100	(0)	24.000	(0)	14.100	(0)			-.447
699-S30-E15A	SITE-144	SITE-144	4.100	(0)	0.200	(0)			15.000	(0)	20.000	(0)			.521
699-01-18	SITE-145	SITE-145	9.000	(0)	0.400	(0)	< 0.010	(0)	87.000	(0)	26.000	(0)			-.634
699-02-03	SITE-1	SITE-1	8.900	(0)	0.300	(0)	0.100	(0)	48.000	(0)	22.000	(0)			.544
699-02-33	SITE-85	SITE-85	5.600	(0)	0.400	(0)	0.100	(0)	34.000	(0)	1.400	(0)	0.210	(0)	-3.205
	SITE-146	SITE-146	5.800	(0)	0.300	(0)	0.200	(0)	36.000	(0)	2.500	(0)			0.815
699-04-E06	SITE-47	SITE-47	7.100	(0)	0.400	(0)	0.100	(0)	40.000	(0)	1.900	(0)			.814
699-08-17	SITE-23	SITE-23	11.000	(0)	0.400	(0)	0.100	(0)	51.000	(0)	29.800	(0)			-..752
699-08-25	SITE-32	SITE-32	8.500	(0)	0.400	(0)	0.100	(0)	65.000	(0)	23.000	(0)			-1.114
699-08-32	SITE-19	SITE-19	5.500	(0)	0.400	(0)	0.100	(0)	45.000	(0)	9.300	(0)			.393
699-09-E02	SITE-16	SITE-16	3.520	(0)	0.400	(0)			25.000	(0)	1.200	(0)			370
699-10-E12	SITE-147	SITE-147	8.200	(0)	0.300	(0)			29.000	(0)	17.000	(0)			451
	SITE-247	SITE-247	9.400	(0)	0.300	(0)	0.040	(0)	28.000	(0)	13.000	(0)			.258
699-11-45A	SITE-148	SITE-148	5.200	(0)	0.300	(0)			13.000	(0)	4.100	(0)			.476
	85-263	85-263	4.550	(1)	0.610	(1)			17.750	(1)	6.750	(1)			.025
		85-264	4.590	(1)	0.380	(1)			17.900	(1)	6.080	(1)			.500
	86-43	86-43	4.680	(1)	0.370	(1)			18.400	(1)	5.690	(1)			-.688
		86-44	4.620	(1)	0.340	(1)			19.200	(1)	5.620	(1)			-.563
	86-124	86-124	4.550	(1)	0.360	(1)			19.200	(1)	6.760	(1)			.651
		86-125	4.650	(1)	0.370	(1)			19.100	(1)	6.540	(1)			-1.634
699-13-01A	SITE-60	SITE-60	7.700	(0)	0.400	(0)	0.100	(0)	39.000	(0)	2.000	(0)			.084

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-14-38	SITE-61	SITE-61	4.200	(0)	0.500	(0)	0.100	(0)	20.000	(0)					1.943
	SITE-86	SITE-86	4.000	(0)	0.400	(0)			21.000	(0)	0.580	(0)	0.090	(0)	-5.749
699-15-15B	SITE-13	SITE-13	6.000	(0)	0.400	(0)	0.100	(0)	57.000	(0)	16.000	(0)			0.839
	SITE-149	SITE-149	6.700	(0)	0.300	(0)	< 0.010	(0)	84.000	(0)	21.000	(0)			-0.636
699-15-26	SITE-24	SITE-24	9.800	(0)	0.500	(0)	0.100	(0)	57.000	(0)	29.700	(0)			-0.252
	SITE-150	SITE-150	8.800	(0)	0.400	(0)	< 0.010	(0)	80.000	(0)	26.000	(0)			-0.274
699-17-05	SITE-18	SITE-18	14.000	(0)	0.300	(0)	0.100	(0)	53.000	(0)	53.000	(0)			1.593
	SITE-151	SITE-151	19.000	(0)	0.200	(0)	0.200	(0)	65.000	(0)	6.200	(0)			
699-19-43	SITE-48	SITE-48	6.900	(0)	0.500	(0)	0.100	(0)	67.000	(0)	2.300	(0)			1.513
	SITE-121	SITE-121	7.400	(0)	0.400	(0)	0.100	(0)	71.000	(0)	12.000	(0)			-2.609
699-19-58	85-229	85-229	3.600	(1)	0.370	(1)			23.500	(1)					0.847
		85-230	3.600	(1)	0.380	(1)			23.600	(1)					1.435
	85-260	85-260	3.450	(1)	0.450	(1)			22.200	(1)					1.599
		85-261	3.380	(1)	0.430	(1)			22.300	(1)					2.017
	86-40	86-40	3.580	(1)	0.400	(1)			22.800	(1)	ND	(1)			0.127
		86-41	3.540	(1)	0.390	(1)			22.800	(1)	ND	(1)			-0.356
	86-121	86-121	3.520	(1)	0.420	(1)			22.800	(1)	ND	(1)			-0.851
		86-122	3.530	(1)	0.330	(1)			23.400	(1)	ND	(1)			-1.785
699-19-88	85-278	85-278	3.760	(1)	0.420	(1)			14.000	(1)	0.420	(1)			3.090
		85-279	3.700	(1)	0.420	(1)			15.100	(1)					2.584
	86-64	86-64	3.590	(1)	0.350	(1)			13.500	(1)	0.790	(1)			1.447
		86-65	3.600	(1)	0.360	(1)			13.700	(1)	0.780	(1)			1.745
	86-127	86-127	3.560	(1)	0.350	(1)			13.400	(1)	1.890	(1)			0.720
		86-128	3.550	(1)	0.350	(1)			13.400	(1)	1.900	(1)			1.381
699-20-E05-0	SITE-49	SITE-49	6.400	(0)	0.300	(0)	0.100	(0)	24.000	(0)	2.500	(0)			4.983
699-20-20	SITE-25	SITE-25	14.000	(0)	0.400	(0)	0.100	(0)	51.000	(0)	53.000	(0)			-0.308
699-24-33	SITE-28	SITE-28	9.200	(0)	0.600	(0)	0.100	(0)	64.000	(0)	27.400	(0)			-0.730
699-24-46	SITE-122	SITE-122	3.400	(0)	0.400	(0)			22.000	(0)	0.440	(0)			-0.767
699-24-95	85-288	85-288	4.420	(1)	0.490	(1)			15.260	(1)					2.687
		85-289	4.390	(1)	0.490	(1)			15.330	(1)					2.630
	86-61	86-61	4.270	(1)	0.500	(1)			13.600	(1)	ND	(1)			0.091
		86-62	4.190	(1)	0.480	(1)			13.600	(1)	ND	(1)			0.469
	86-115	86-115	4.460	(1)	0.480	(1)			13.600	(1)	ND	(1)			0.524
		86-116	4.460	(1)	0.490	(1)			13.700	(1)	ND	(1)			-0.024
699-25-55	SITE-100	SITE-100	7.000	(0)	0.600	(0)	0.100	(0)	34.000	(0)	15.000	(0)			-0.830

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L (A)	F MG/L (A)	BR MG/L (A)	SO4 MG/L (A)	NO3 MG/L (A)	PO4 MG/L (A)	CHARGE BALANCE
699-26-15	SITE-26	SITE-26	13.000 (0)	0.400 (0)		55.000 (0)	39.300 (0)		-0.938
699-26-15A	SITE-263	SITE-263	14.000 (0)	0.400 (0)	0.034 (0)	51.000 (0)	44.300 (0)		[illegible].386
699-27-04	SITE-101	SITE-101	5.800 (0)	0.300 (0)	0.100 (0)	27.000 (0)	21.000 (0)		[illegible].227
699-27-08	SITE-5	SITE-5	13.000 (0)	0.200 (0)	0.100 (0)	48.000 (0)	58.000 (0)		[illegible].288
	SITE-30	SITE-30	13.000 (0)	0.300 (0)		50.000 (0)	57.400 (0)		-1.991
	SITE-50	SITE-50	12.000 (0)	0.300 (0)	0.100 (0)	52.000 (0)	13.100 (0)		[illegible].620
	SITE-76	SITE-76	11.000 (0)	0.300 (0)	0.100 (0)	49.000 (0)	13.100 (0)		[illegible].674
	SITE-87	SITE-87	10.000 (0)	0.300 (0)	0.100 (0)	56.000 (0)	58.000 (0)	0.060 (0)	-5.153
699-28-40	SITE-68	SITE-68	7.500 (0)	0.500 (0)	0.100 (0)	55.000 (0)	3.000 (0)		[illegible].56[illegible]
699-31-31	SITE-69	SITE-69	10.000 (0)	0.700 (0)	0.100 (0)	54.000 (0)	11.200 (0)		[illegible].322
	SITE-102	SITE-102	11.000 (0)	0.700 (0)	0.100 (0)	56.000 (0)	34.000 (0)		-[illegible].594
699-31-53B	SITE-88	SITE-88	8.300 (0)	0.400 (0)	0.100 (0)	33.000 (0)	8.000 (0)	0.090 (0)	-4.537
699-32-22	SITE-17	SITE-17	17.000 (0)	0.400 (0)	0.100 (0)	86.000 (0)	75.000 (0)		[illegible].326
	SITE-27	SITE-27	17.000 (0)	0.400 (0)		35.000 (0)	61.900 (0)		0.481
	SITE-51	SITE-51	28.000 (0)	0.400 (0)	0.100 (0)	84.000 (0)	16.100 (0)		[illegible].550
	SITE-65	SITE-65	14.000 (0)	0.400 (0)	0.100 (0)	81.000 (0)	16.500 (0)		[illegible].516
	SITE-89	SITE-89	15.000 (0)	0.400 (0)		56.000 (0)	75.000 (0)	0.080 (0)	-[illegible].266
699-32-70B	SITE-70	SITE-70	13.000 (0)	0.500 (0)	0.100 (0)	25.000 (0)	4.200 (0)		[illegible].959
	SITE-90	SITE-90	12.000 (0)	0.500 (0)		24.000 (0)	18.000 (0)	1.200 (0)	-3.961
	SITE-152	SITE-152	12.000 (0)	0.400 (0)	< 0.010 (0)	25.000 (0)	17.000 (0)		-0.923
699-32-72	SITE-35	SITE-35	15.000 (0)	0.400 (0)	0.100 (0)	27.000 (0)	5.200 (0)		[illegible].478
699-32-77	SITE-103	SITE-103	11.000 (0)	0.800 (0)		20.000 (0)	< 6.600 (0)		[illegible].953
699-33-42	SITE-12	SITE-12	[illegible].100 (0)	0.600 (0)	0.100 (0)	[illegible].400 (0)	49.000 (0)		[illegible].309
	SITE-29	SITE-29	11.000 (0)	0.700 (0)		60.000 (0)	34.500 (0)		-1.917
	SITE-52	SITE-52	12.000 (0)	0.700 (0)	0.100 (0)	55.000 (0)	7.100 (0)		4.003
	SITE-67	SITE-67	14.000 (0)	0.700 (0)	0.100 (0)	52.000 (0)	6.000 (0)		7.066
	SITE-91	SITE-91	16.000 (0)	0.600 (0)	0.100 (0)	59.000 (0)	24.000 (0)	0.060 (0)	-[illegible].826
699-33-56	SITE-8	SITE-8	7.500 (0)	0.300 (0)	0.100 (0)	36.000 (0)	11.200 (0)		-[illegible].102
	SITE-40	SITE-40	7.300 (0)	0.400 (0)		30.000 (0)	10.700 (0)		-[illegible].923
	SITE-53	SITE-53	7.700 (0)	0.500 (0)	0.100 (0)	34.000 (0)	2.500 (0)		[illegible].710
	SITE-62	SITE-62	7.800 (0)	0.500 (0)	0.100 (0)	33.000 (0)	2.600 (0)		[illegible].554
	SITE-92	SITE-92	7.600 (0)	0.500 (0)	0.100 (0)	32.000 (0)	9.700 (0)	0.090 (0)	-4.448
699-34-39A	SITE-93	SITE-93	11.000 (0)	0.600 (0)		50.000 (0)	33.000 (0)	0.080 (0)	-[illegible].320
699-34-42	SITE-33	SITE-33	11.000 (0)	0.700 (0)		54.000 (0)	44.200 (0)		[illegible].306

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP. MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-34-42	SITE-153	SITE-153	11.000	(0)	0.600	(0)	< 0.010	(0)	45.000	(0)	26.000	(0)			-1.471
699-34-51	SITE-66	SITE-66	8.200	(0)	0.500	(0)	0.100	(0)	47.000	(0)	2.400	(0)			3.435
699-35-09	SITE-31	SITE-31	8.700	(0)	0.400	(0)	0.100	(0)	30.000	(0)	19.500	(0)			-1.070
	SITE-104	SITE-104	11.000	(0)	0.400	(0)	0.100	(0)	38.000	(0)	24.000	(0)			-2.947
	SITE-264	SITE-264	12.000	(0)	0.400	(0)	0.040	(0)	34.000	(0)	33.700	(0)			2.078
699-35-66	SITE-77	SITE-77	11.000	(0)	0.400	(0)	0.100	(0)	27.000	(0)	5.600	(0)			5.637
	SITE-94	SITE-94	14.000	(0)	0.400	(0)	0.100	(0)	28.000	(0)	25.000	(0)	0.120	(0)	-3.779
699-35-70	SITE-36	SITE-36	16.000	(0)	0.400	(0)	0.200	(0)	26.000	(0)	22.900	(0)			1.791
699-35-78	SITE-54	SITE-54	6.900	(0)	0.500	(0)			13.000	(0)	0.240	(0)			2.023
699-36-61A	SITE-95	SITE-95	7.700	(0)	0.400	(0)	0.100	(0)	32.000	(0)	17.000	(0)	0.090	(0)	-0.202
699-37-43	SITE-34	SITE-34	3.600	(0)	0.600	(0)			45.000	(0)	0.900	(0)			-2.611
	SITE-173	SITE-173	19.000	(0)	0.460	(0)			305.000	(0)					0.818
699-37-82A	SITE-105	SITE-105	13.000	(0)	0.300	(0)	0.100	(0)	59.000	(0)	< 43.000	(0)			5.504
699-38-70	SITE-37	SITE-37	32.000	(0)	0.400	(0)	0.200	(0)	24.000	(0)	256.000	(0)			0.023
699-39-E3	SITE-248	SITE-248	6.000	(0)	0.300	(0)	0.040	(0)	20.000	(0)	23.000	(0)			-2.125
699-39-01	SITE-249	SITE-249	11.000	(0)	0.400	(0)	0.040	(0)	38.000	(0)	34.000	(0)			-0.584
699-39-39	SITE-266	SITE-266	5.600	(0)	0.300	(0)	0.030	(0)	35.000	(0)	0.680	(0)			-0.461
699-40-01	SITE-10	SITE-10	6.900	(0)	0.400	(0)	0.100	(0)	28.000	(0)	24.000	(0)			3.402
	SITE-106	SITE-106	9.300	(0)	0.400	(0)	0.100	(0)	31.000	(0)	< 32.000	(0)			0.991
	SITE-250	SITE-250	12.000	(0)	0.400	(0)	< 0.040	(0)	35.000	(0)	31.000	(0)			-0.685
	SITE-265	SITE-265	12.000	(0)	0.400	(0)	0.043	(0)	36.000	(0)	41.200	(0)			-1.031
699-40-33	SITE-55	SITE-55	3.600	(0)	0.900	(0)			2.700	(0)	0.010	(0)			3.987
	SITE-251	SITE-251	6.900	(0)	0.900	(0)	0.020	(0)	0.800	(0)	< 0.400	(0)			0.535
699-40-62	SITE-56	SITE-56	8.300	(0)	0.400	(0)	0.100	(0)	39.000	(0)	4.400	(0)			3.863
699-41-01	SITE-252	SITE-252	12.000	(0)	0.400	(0)	0.010	(0)	35.000	(0)	31.000	(0)			-1.167
699-41-23	SITE-15	SITE-15	15.000	(0)	0.400	(0)			77.000	(0)	53.000	(0)			0.575
	SITE-113	SITE-113	9.600	(0)	0.500	(0)			61.000	(0)	40.000	(0)			0.260
699-42-02	SITE-154	SITE-154	11.000	(0)	0.300	(0)	< 0.010	(0)	38.000	(0)	31.000	(0)			-0.278
699-42-12	SITE-2	SITE-2	13.000	(0)	0.400	(0)	0.100	(0)	49.000	(0)	28.000	(0)			1.861

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-42-12	SITE-155	SITE-155	12.000	(0)	0.400	(0)	< 0.010	(0)	60.000	(0)	37.000	(0)			0.460
	SITE-267	SITE-267	14.000	(0)	0.400	(0)	0.043	(0)	56.000	(0)	41.200	(0)			0.867
699-42-40A	SITE-174	SITE-174	7.000	(0)	0.700	(0)			37.000	(0)					1.044
699-42-40C	SITE-175	SITE-175	8.700	(0)					29.000	(0)					
699-42-42	SITE-114	SITE-114	14.000	(0)	0.500	(0)	0.200	(0)	57.000	(0)	< 36.000	(0)			0.978
699-43-03	SITE-253	SITE-253	12.000	(0)	0.400	(0)	0.050	(0)	37.000	(0)	27.000	(0)			0.610
699-43-88	SITE-123	SITE-123	21.000	(0)	0.300	(0)	0.300	(0)	57.000	(0)	23.000	(0)			-0.377
699-44-04	SITE-254	SITE-254	14.000	(0)	0.400	(0)	0.040	(0)	35.000	(0)	31.000	(0)			-0.688
699-45-04	SITE-255	SITE-255	13.000	(0)	0.400	(0)	0.050	(0)	38.000	(0)	24.000	(0)			0.419
699-45-42	SITE-57	SITE-57	3.800	(0)	0.600	(0)			29.000	(0)	3.300	(0)			5.074
	SITE-268	SITE-268	2.100	(0)	0.600	(0)	< 0.010	(0)	20.000	(0)	5.300	(0)			0.174
699-45-69	SITE-96	SITE-96	20.000	(0)	0.400	(0)	0.200	(0)	62.000	(0)	34.000	(0)	0.030	(0)	-0.742
699-46-05	SITE-156	SITE-156	12.000	(0)	0.400	(0)	< 0.010	(0)	52.000	(0)	30.000	(0)			-0.507
	SITE-256	SITE-256	14.000	(0)	0.400	(0)	0.040	(0)	50.000	(0)	24.000	(0)			-0.572
699-46-21A	SITE-75	SITE-75	12.000	(0)	0.500	(0)	0.100	(0)	54.000	(0)	2.300	(0)			0.029
	SITE-124	SITE-124	17.000	(0)	0.500	(0)	0.100	(0)	61.000	(0)	17.000	(0)			-0.605
699-47-06	SITE-257	SITE-257	7.400	(0)	0.400	(0)	0.040	(0)	31.000	(0)	10.000	(0)			0.197
699-47-46	SITE-269	SITE-269	21.000	(0)	0.500	(0)	0.120	(0)	78.000	(0)	14.200	(0)			0.610
699-48-07	SITE-258	SITE-258	1.400	(0)	0.200	(0)	< 0.010	(0)	14.000	(0)	1.400	(0)			0.363
699-48-18	SITE-125	SITE-125	11.000	(0)	0.200	(0)	0.100	(0)	52.000	(0)	3.500	(0)			0.699
699-48-71	SITE-59	SITE-59	11.000	(0)	0.500	(0)	0.100	(0)	24.000	(0)	5.100	(0)			0.182
699-49-13	SITE-259	SITE-259	4.800	(0)	0.400	(0)	0.030	(0)	27.000	(0)	5.300	(0)			0.704
699-49-55	SITE-9	SITE-9	24.000	(0)	0.300	(0)	0.200	(0)	150.000	(0)	12.000	(0)			0.586
	SITE-39	SITE-39	23.000	(0)	0.500	(0)	0.400	(0)	150.000	(0)	12.000	(0)			-0.585
	SITE-58	SITE-58	23.000	(0)	0.500	(0)	0.200	(0)	190.000	(0)	3.700	(0)			0.545
	SITE-78	SITE-78	25.000	(0)	0.500	(0)	0.300	(0)	180.000	(0)	3.700	(0)			0.578
	SITE-97	SITE-97	29.000	(0)	0.400	(0)	0.200	(0)	170.000	(0)	16.000	(0)	0.030	(0)	-0.946
	SITE-126	SITE-126	26.000	(0)	0.300	(0)	0.200	(0)	210.000	(0)	4.900	(0)			-1.800
	SITE-157	SITE-157	22.000	(0)	0.400	(0)	0.200	(0)	230.000	(0)	3.900	(0)			0.181

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)
699-49-55A	SITE-182	SITE-182	21.000	(0)	0.540	(0)		
699-49-57	SITE-38	SITE-38	9.200	(0)	0.900	(0)	0.100	(0)
699-49-79	SITE-20	SITE-20	11.000	(0)	0.300	(0)	0.300	(0)
699-50-08	SITE-64	SITE-64	11.000	(0)	0.400	(0)	0.100	(0)
699-50-28B	SITE-63	SITE-63	8.400	(0)	0.600	(0)	0.100	(0)
699-50-42	SITE-14	SITE-14	11.000	(0)	0.500	(0)	0.100	(0)
	SITE-115	SITE-115	12.000	(0)	0.500	(0)	0.100	(0)
	SITE-271	SITE-271	16.000	(0)	0.500	(0)	0.080	(0)
699-50-53	SITE-270	SITE-270	53.000	(0)	0.400	(0)	0.350	(0)
699-50-85	SITE-127	SITE-127	11.000	(0)	0.300	(0)		
699-51-63	SITE-116	SITE-116	9.500	(0)	0.500	(0)	0.100	(0)
699-53-103	SITE-160	SITE-160	4.500	(0)	0.800	(0)	0.100	(0)
699-53-47B	SITE-272	SITE-272	4.200	(0)	0.200	(0)	< 0.010	(0)
699-54-34	SITE-273	SITE-273	12.000	(0)	0.700	(0)	0.110	(0)
699-55-50C	SITE-79	SITE-79	2.700	(0)	0.200	(0)	0.100	(0)
	SITE-128	SITE-128	3.000	(0)	0.200	(0)		
	SITE-193	SITE-193	2.000	(0)	0.270	(0)		
	SITE-274	SITE-274	4.700	(0)	0.200	(0)	< 0.010	(0)
699-55-76	SITE-71	SITE-71	21.000	(0)	0.400	(0)	0.500	(0)
	SITE-117	SITE-117	17.000	(0)	0.400	(0)	0.200	(0)
	SITE-129	SITE-129	17.000	(0)	0.300	(0)	0.200	(0)
699-55-89	SITE-118	SITE-118	7.500	(0)	0.300	(0)	0.100	(0)
699-56-53	SITE-194	SITE-194	3.700	(0)				
	SITE-195	SITE-195	3.700	(0)				
699-57-25A	SITE-119	SITE-119	6.100	(0)	0.600	(0)	0.100	(0)
	SITE-275	SITE-275	6.700	(0)	0.500	(0)	0.030	(0)
699-57-29A	SITE-276	SITE-276	7.800	(0)	0.400	(0)	0.030	(0)
699-57-83	SITE-130	SITE-130	7.500	(0)	0.300	(0)	0.100	(0)
699-59-58	SITE-107	SITE-107	5.900	(0)	1.400	(0)		

SAMPLING LOCATION	SAMPLE NUMBER	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-49-55A	SITE-182	209.000	(0)					-0.917
699-49-57	SITE-38	99.000	(0)	270.000	(0)			-0.733
699-49-79	SITE-20	45.000	(0)	44.000	(0)			0.806
699-50-08	SITE-64	45.000	(0)	3.000	(0)			3.685
699-50-28B	SITE-63	28.000	(0)	0.720	(0)			0.780
699-50-42	SITE-14	39.000	(0)	3.100	(0)			2.200
	SITE-115	39.000	(0)	0.090	(0)			1.343
	SITE-271	35.000	(0)	2.300	(0)			0.763
699-50-53	SITE-270	97.000	(0)	23.900	(0)			1.681
699-50-85	SITE-127	21.000	(0)	21.000	(0)			-2.063
699-51-63	SITE-116	22.000	(0)	< 7.100	(0)			1.005
699-53-103	SITE-160	1.400	(0)					1.119
699-53-47B	SITE-272	9.700	(0)	0.800	(0)			0.264
699-54-34	SITE-273	36.000	(0)	15.100	(0)			1.002
699-55-50C	SITE-79	12.000	(0)	0.160	(0)			0.258
	SITE-128	15.000	(0)	0.800	(0)			9.583
	SITE-193	18.000	(0)					-13.174
	SITE-274	15.000	(0)	1.510	(0)			0.186
699-55-76	SITE-71	85.000	(0)	0.370	(0)			2.403
	SITE-117	83.000	(0)	< 0.580	(0)			-2.139
	SITE-129	46.000	(0)	0.090	(0)			0.560
699-55-89	SITE-118	19.000	(0)	< 2.400	(0)			-1.652
699-56-53	SITE-194	8.400	(0)					
	SITE-195	8.400	(0)					
699-57-25A	SITE-119	24.000	(0)	3.300	(0)			3.179
	SITE-275	22.000	(0)	3.800	(0)			0.537
699-57-29A	SITE-276	22.000	(0)	2.600	(0)			0.251
699-57-83	SITE-130	20.000	(0)					-0.676
699-59-58	SITE-107	16.000	(0)	< 0.930	(0)			8.269

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SAMPLE TYPE, UNCONFINED
ANALYSIS GROUP, MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-59-58	SITE-277	SITE-277	5.900	(0)	1.300	(0)	0.010	(0)	15.000	(0)	0.830	(0)			1.570
699-60-32	SITE-278	SITE-278	7.600	(0)	0.500	(0)	0.020	(0)	21.000	(0)	4.800	(0)			1.357
699-80-57	SITE-198	SITE-198	13.000	(0)	1.600	(0)			1.300	(0)					-3.438
699-62-31	SITE-131	SITE-131	5.300	(0)	0.400	(0)			31.000	(0)	6.200	(0)			-3.216
	SITE-279	SITE-279	6.900	(0)	0.400	(0)	0.040	(0)	30.000	(0)	7.100	(0)			-9.161
699-53-25A	SITE-132	SITE-132	11.000	(0)	0.300	(0)	0.100	(0)	80.000	(0)	19.000	(0)			0.201
699-63-55	SITE-280	SITE-280	8.700	(0)	1.400	(0)	0.010	(0)	17.000	(0)	1.100	(0)			. 088
699-63-58	SITE-281	SITE-281	8.000	(0)	1.200	(0)	0.030	(0)	22.000	(0)	13.300	(0)			1.236
699-63-90	SITE-74	SITE-74	9.100	(0)	0.400	(0)	0.100	(0)	28.000	(0)	1.290	(0)			2.712
	SITE-133	SITE-133	21.000	(0)	0.300	(0)	0.100	(0)	30.000	(0)	5.800	(0)			-7.246
699-64-27	SITE-158	SITE-158	30.000	(0)	0.200	(0)	0.200	(0)	180.000	(0)	30.000	(0)			1.404
699-65-50	SITE-73	SITE-73	8.300	(0)	1.000	(0)	0.100	(0)	15.000	(0)	0.320	(0)			-1.599
	SITE-134	SITE-134	7.200	(0)	1.100	(0)			18.000	(0)	1.300	(0)			-1.544
	SITE-282	SITE-282	8.200	(0)	1.200	(0)	0.020	(0)	17.000	(0)	1.000	(0)			-0.586
699-66-103	85-203	85-203	1.900	(1)	0.110	(1)			16.400	(1)					1.867
		85-204	1.800	(1)	0.510	(1)			16.500	(1)					2.930
	86-73	86-73	1.870	(1)	0.240	(1)			15.700	(1)	1.150	(1)			1.068
		86-74	1.950	(1)	0.360	(1)			15.500	(1)	0.780	(1)			0.015
	86-112	86-112	2.100	(1)	0.200	(1)			16.900	(1)	1.640	(1)			0.927
		86-113	2.000	(1)	0.200	(1)			16.100	(1)	1.270	(1)			1.287
	85-294	85-294	2.050	(1)	0.260	(1)			16.900	(1)	1.270	(1)			1.893
		85-295	2.060	(1)	0.240	(1)			16.800	(1)	0.500	(1)			1.886
699-66-39	SITE-135	SITE-135	21.000	(0)	0.300	(0)	0.100	(0)	100.000	(0)	0.040	(0)			-0.803
699-66-58	SITE-136	SITE-136	6.200	(0)	0.800	(0)			20.000	(0)	1.800	(0)			-0.335
699-66-64	SITE-137	SITE-137	5.000	(0)	0.500	(0)			17.000	(0)	1.800	(0)			-2.444
699-67-98	SITE-260	SITE-260	6.700	(0)	0.300	(0)	0.060	(0)	20.000	(0)	4.000	(0)			2.005
699-69-38	SITE-6	SITE-6	14.000	(0)	0.100	(0)	0.100	(0)	64.000	(0)	15.000	(illegible)			7.049
699-71-30	SITE-108	SITE-108	18.000	(0)	0.500	(0)	0.200	(0)	57.000	(0)	27.000	(illegible)			1.851
699-71-52	SITE-138	SITE-138	7.300	(0)	0.400	(0)	0.100	(0)	45.000	(0)	3.500	(0)			0.839
699-72-73	SITE-109	SITE-109	5.100	(0)	0.400	(0)			18.000	(0)	40.030	(0)			-3.687

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: MAJOR

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL MG/L	(A)	F MG/L	(A)	BR MG/L	(A)	SO4 MG/L	(A)	NO3 MG/L	(A)	PO4 MG/L	(A)	CHARGE BALANCE
699-72-88	SITE-98	SITE-98	3.900	(0)	0.200	(0)			42.000	(0)	3.400	(0)	0.150	(0)	-3.911
	SITE-261	SITE-261	6.900	(0)	0.200	(0)	0.030	(0)	35.000	(0)	3.600	(0)			0.681
699-72-92	SITE-262	SITE-262	6.000	(0)	0.200	(0)	0.050	(0)	26.000	(0)	5.300	(0)			-0.045
699-77-36	SITE-110	SITE-110	12.000	(0)	0.700	(0)	0.200	(0)	44.000	(0)	< 160.000	(0)			3.812
699-78-62	SITE-111	SITE-111	4.300	(0)	0.500	(0)	0.100	(0)	47.000	(0)	< 4.000	(0)			-1.739
699-81-58	SITE-159	SITE-159	1.300	(0)	0.100	(0)			15.000	(0)	1.700	(0)			-0.118
699-83-47	SITE-112	SITE-112	4.300	(0)	0.500	(0)	0.100	(0)	46.000	(0)	< 4.900	(0)			-1.718
699-87-55	SITE-99	SITE-99	3.800	(0)	0.400	(0)			25.000	(0)	13.000	(0)			0.951
699-90-45	SITE-139	SITE-139	3.700	(0)	0.600	(0)			23.000	(0)	2.500	(0)			-3.830

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LIST OF ANALYSIS METHODS FOR MAJOR ANIONS

SPECIE	(A)	ANALYSIS METHOD
BR	0	Unclassified
	1	IC
	2	HPLC
CL	0	Unclassified
	1	IC
F	0	Unclassified
	1	IC
NO3	0	Unclassified
	1	IC
PO4	0	Unclassified
	1	IC
SO4	0	Unclassified
	1	IC

HPLC: High Performance Liquid Chromatography
IC: Ion Chromatography
Unclassified: Analysis comes from a non-BWIP documented source and the method is not specified in this data package.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
BLRK	85-255	85-255	< 0.060	(1)			< 0.016	(1)	0.024	(1)			< 0.017	(1)
		85-256	< 0.060	(1)			< 0.016	(1)	0.033	(1)			< 0.017	(1)
DB-01	81-19	81-15	0.020	(1)			0.059	(1)	0.011	(1)			< 0.010	(1)
		81-19	< 0.010	(1)			0.130	(1)	0.014	(1)			< 0.010	(1)
	81-65	81-65	< 0.017	(1)			0.210	(1)	0.005	(1)			< 0.004	(1)
		81-70	< 0.017	(1)			0.210	(1)	0.005	(1)			< 0.004	(1)
	82-27	82-27	< 0.075	(1)			0.210	[illegible]	0.011	(1)			< 0.015	(1)
		82-87	< 0.075	(1)			0.200	(1)	0.011	(1)			< 0.015	(1)
	85-32	85-32	< 0.013	(1)			0.190	(1)	0.004	(1)			< 0.003	(1)
		85-33	< 0.013	(1)			0.190	(1)	0.009	(1)			< 0.003	(1)
DB-02	79-65	CP123	0.080	(1)			0.200	(1)					< 0.010	(1)
	81-13	81-11	0.200	(1)			0.150	(1)	0.190	(1)			< 0.010	(1)
		81-13	0.200	(1)			0.150	[illegible]	0.200	(1)			< 0.010	(1)
	81-10	81-10	0.070	(1)			0.140	(1)	0.220	(1)			< 0.010	[illegible]
		81-7	0.090	(1)			0.150	(1)	0.130	(1)			< 0.010	(1)
DB-04	79-77	CP116	0.100	(1)			0.100	(1)	2.300	(1)			< 0.010	(1)
DB-07	79-80	CP121	0.170	(1)			0.650	(1)	0.010	(1)			< 0.010	(1)
	83-413	83-413	< 0.080	(1)			0.490	(1)	0.011	(1)			< 0.010	(1)
		83-448	< 0.080	(1)			0.480	(1)	0.011	(1)			< 0.012	(1)
	85-216	85-216	< 0.060	(1)			0.630	(1)	0.009	(1)			< 0.017	[illegible]
		85-217	< 0.060	(1)			0.620	(1)	0.062	(1)			< 0.017	(1)
DB-09	79-28	CP115	0.080	(1)			0.090	(1)	0.012	(1)			< 0.010	(1)
	83-472	83-410	< 0.080	(1)			< 0.020	(1)	0.010	(1)			< 0.010	(1)
		83-472	< 0.080	(1)			< 0.020	(1)	0.0[illegible]	(1)			< 0.010	(1)
DB-11	85-18	85-18	< 0.0[illegible]	(1)			0.007	(1)	0.042	(1)			< 0.003	(1)
		85-10	< 0.013	(1)			0.010	(1)	0.041	(1)			< 0.003	(1)
	86-52	86-52	< 0.200	(1)			< 0.100	(1)	0.062	(1)				
		86-53	< 0.200	(1)			< 0.100	(1)	0.033	(1)				
	81-57	81-57	0.042	(1)			0.025	(1)	0.023	(1)			< 0.005	(1)
DB-12	63-05	63-95	< 0.020	(1)			0.022	(1)	0.043	(1)			0.022	(1)
	81-25	81-25	0.070	(1)			0.030	(1)	0.170	(1)			< 0.005	(1)
		81-42	0.070	(1)			0.030	(1)	0.100	(1)			< 0.005	(1)
DB-13	83-404	83-404	< 0.080	(1)			< 0.020	(1)	0.0[illegible]	(1)			< 0.010	(1)
		83-455	< 0.080	(1)			< 0.020	[illegible]	0.014	(1)			< 0.010	[illegible]
DB-14	81-162	81-139	0.030	(1)			0.520	[illegible]	0.025	(1)			< 0.004	(1)
		81-162	0.004	(1)			0.530	[illegible]	0.004	(1)			< 0.004	(1)
DB-15	79-17	79-17	< 0.510	(1)			< 0.005	[illegible]	0.1[illegible]	(1)			< 0.010	(1)
		79-4	0.040	(1)			< 0.010	(1)	0.120	(1)	< 0.010	(1)	< 0.010	(1)

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
BERK	85-255	85-255	< 0.032	(1)	< 0.006	(1)	0.052	(1)	< 0.008	(1)	0.053	(1)	< 0.034	(1)
		85-256	< 0.032	(1)	< 0.006	(1)	0.072	(1)	< 0.008	(1)	0.048	(1)	< 0.034	(1)
DB-01	81-19	81-15	0.004	(1)	< 0.002	(1)	0.038	(1)	0.087	(1)	0.201	(1)	0.161	(1)
		81-19	< 0.003	(1)	< 0.002	(1)	0.050	(1)	0.048	(1)	< 0.100	(1)	< 0.030	(1)
	81-65	81-65	< 0.006	(1)	< 0.003	(1)	0.360	(1)	0.015	(1)	0.006	(1)	0.110	(1)
		81-70	< 0.006	(1)	< 0.003	(1)	0.370	(1)	0.015	(1)	0.005	(1)	0.110	(1)
	82-27	82-27	< 0.036	(1)	< 0.006	(1)	0.120	(1)	0.015	(1)	< 0.003	(1)	0.100	(1)
		82-87	< 0.036	(1)	< 0.006	(1)	0.130	(1)	0.014	(1)	< 0.003	(1)	0.100	(1)
	85-32	85-32	< 0.007	(1)	0.002	(1)	0.049	(1)	0.015	(1)	0.003	(1)	0.099	(1)
		85-33	< 0.007	(1)	0.002	(1)	0.049	(1)	0.015	(1)	0.003	(1)	0.102	(1)
DB-02	79-65	CP123	< 0.003	(1)	0.010	(1)	0.030	(1)			< 0.020	(1)	< 0.030	(1)
	81-13	81-11	0.010	(1)	0.009	(1)	0.680	(1)			0.374	(1)	0.270	(1)
		81-13	0.005	(1)	< 0.005	(1)	0.690	(1)	< 0.005	(1)	0.399	(1)	0.280	(1)
	81-10	81-10	0.004	(1)	< 0.005	(1)	0.130	(1)	< 0.005	(1)	0.336	(1)	0.260	(1)
		81-7	0.005	(1)	0.005	(1)	0.130	(1)	< 0.005	(1)	0.374	(1)	0.240	(1)
DB-04	79-77	CP116	< 0.003	(1)	0.024	(1)	1.030	(1)			< 0.024	(1)	< 0.030	(1)
DB-07	79-89	CP121	< 0.003	(1)	0.020	(1)	0.500	(1)			< 0.020	(1)	< 0.030	(1)
	83-413	83-413	< 0.040	(1)	< 0.010	(1)	0.030	(1)	0.007	(1)	0.005	(1)	0.050	(1)
		83-448	< 0.040	(1)	< 0.010	(1)	0.030	(1)	0.008	(1)	0.006	(1)	0.050	(1)
	85-216	85-218	< 0.032	(1)	0.006	(1)	0.197	(1)	< 0.008	(1)	< 0.005	(1)	0.049	(1)
		85-217	< 0.032	(1)	0.008	(1)	0.202	(1)	< 0.008	(1)	0.005	(1)	0.040	(1)
DB-09	79-28	CP115	< 0.003	(1)	0.016	(1)	0.220	(1)			< 0.020	(1)	< 0.030	(1)
	83-472	83-410	< 0.040	(1)	< 0.010	(1)	0.030	(1)	0.006	(1)	0.006	(1)	< 0.020	(1)
		83-472	< 0.040	(1)	< 0.010	(1)	0.040	(1)	0.007	(1)	0.005	(1)	< 0.020	(1)
DB-11	85-18	85-18	< 0.007	(1)	< 0.001	(1)	0.092	(1)	0.016	(1)	0.053	(1)	< 0.008	(1)
		85-19	< 0.007	(1)	< 0.001	(1)	0.090	(1)	0.017	(1)	0.052	(1)	< 0.008	(1)
	86-52	86-52			< 0.012	(1)	0.087	(1)	0.021	(1)	0.047	(1)	< 0.600	(1)
		86-53			< 0.012	(1)	0.088	(1)	0.020	(1)	0.048	(1)	< 0.600	(1)
	81-57	81-57	0.004	(1)	< 0.005	(1)	0.108	(1)			0.336	(1)	0.131	(1)
DB-12	63-95	63-85	< 0.005	(1)	< 0.005	(1)	< 0.005	(1)					< 0.020	(1)
	81-25	81-25	0.007	(1)	0.010	(1)	0.060	(1)			0.316	(1)	0.210	(1)
		81-42	0.010	(1)	0.010	(1)	0.060	(1)			0.304	(1)	0.210	(1)
DB-13	83-404	83-404	< 0.040	(1)	< 0.010	(1)	0.070	(1)	0.020	(1)	0.030	(1)	< 0.020	(1)
		83-455	< 0.040	(1)	< 0.010	(1)	0.070	(1)	0.020	(1)	0.030	(1)	< 0.020	(1)
DB-14	81-162	81-139	< 0.006	(1)	< 0.003	(1)	0.153	(1)	0.002	(1)	0.008	(1)	0.110	(1)
		81-162	< 0.006	(1)	< 0.003	(1)	0.170	(1)	0.003	(1)	0.007	(1)	0.110	(1)
DB-15	79-17	79-17	< 0.003	(1)	< 0.002	(1)	0.020	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		79-4	< 0.010	(1)	< 0.010	(1)	0.020	(1)			< 0.020	(1)	< 0.010	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SN MG/L	(A)	ZN MG/L	(A)
BERX	85-255	85-255	< 0.030	(1)			< 0.180	(1)	0.054	(1)	< 0.020	(1)
		85-256	< 0.030	(1)			< 0.180	(1)	0.055	(1)	< 0.020	(1)
DB-01	81-19	81-15	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	[illegible]	(1)	0.002	(1)
		81-19	< 0.020	(1)	< 0.200	(1)	< 0.010	(1)	0.010	(1)	< 0.002	(1)
	81-65	81-65	< 0.008	(1)	0.080	(1)	< 0.043	(1)	0.002	(1)	< 0.004	(1)
		81-70	< 0.008	(1)	0.080	(1)	< 0.043	(1)	0.002	(1)	< 0.004	(1)
	82-27	82-27	< 0.028	(1)	< 0.340	(1)	< 0.160	(1)	0.002	(1)	< 0.150	(1)
		82-87	< 0.025	(1)	< 0.340	(1)	< 0.160	(1)	0.002	(1)	< 0.015	(1)
	85-32	85-32	< 0.003	(1)			< 0.040	(1)	< 0.000	(1)	< 0.004	(1)
		85-33	< 0.003	(1)			< 0.040	(1)	< 0.000	(1)	< 0.004	(1)
DB-02	79-65	CP123									0.020	(1)
	81-13	81-11	< 0.010	(1)	< 0.200	(1)	< [illegible]	(1)	0.004	(1)	0.020	(1)
		81-13	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	0.030	(1)
	81-10	81-10	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.002	(1)	0.020	(1)
		81-[illegible]	< 0.010	(1)	0.300	(1)	< 0.100	(1)	0.003	(1)	0.02[illegible]	(1)
DB 04	79-77	CP116									0.100	(1)
DB-07	79-88	CP121									0.020	(1)
	83-413	83-413	< 0.030	(1)	< 0.340	(1)	< 0.[illegible]	(1)	0.008	(1)	< 0.010	(1)
		83-448	< 0.030	(1)	< 0.340	(1)	< 0.[illegible]	(1)	0.008	(1)	< 0.010	(1)
	85-216	85-216	< 0.030	(1)			< 0.180	(1)	0.008	(1)	< 0.020	(1)
		85-217	< 0.030	(1)			< 0.180	(1)	0.008	(1)	< 0.020	(1)
DB-09	79-28	CP115									0.050	(1)
	83-472	83-410	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-472	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
DB 11	85-18	85-13	< 0.003	(1)			< 0.040	(1)	0.049	(1)	< 0.004	(1)
		85-18	< 0.003	(1)			< 0.040	(1)	0.049	(1)	< [illegible]	(1)
	86-52	86-52							0.[illegible]58	(1)	< [illegible]	(1)
		86-53							0.055	(1)	< 0.040	(1)
	81-57	81-57	< 0.010	(1)	< 0.020	(1)	< 0.100	(1)	0.080	(1)	0.0[illegible]	(1)
DB-12	63-95	63-95									< 0.005	(1)
	81-25	81-25	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	[illegible]	(1)	0.050	(1)
		81-42	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.050	(1)	0.030	[illegible]
DB-13	83-404	83-404	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.050	(1)	< 0.010	(1)
		83-455	< 0.030	(1)	< 0.340	(1)	< 0.150	[illegible]	0.050	(1)	< 0.010	(1)
DB-14	81-162	81-139	< 0.008	(1)	0.110	(1)	< 0.040	(1)	0.007	(1)	0.003	(1)
		81-162	< 0.008	(1)	0.130	(1)	< 0.040	(1)	0.007	(1)	0.006	(1)
DB-15	79-17	79-17	< 0.02[illegible]	(1)	< 0.200	(1)	0.1[illegible]	(1)	0.145	(1)	0.080	(1)
		79-4[illegible]	< 0.010	(1)	< 0.100	(1)	< 0.0[illegible]	(1)	0.160	(1)	0.100	(1)

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
DB-15	79-35	79-20	< 0.020	(1)			< 0.005	(1)	0.020	(1)			< 0.010	(1)
		79-35	< 0.010	(1)			< 0.005	(1)	0.020	(1)			< 0.010	(1)
	79-33	79-27	< 0.020	(1)			< 0.010	(1)	< 0.005	(1)			< 0.010	(1)
		79-33	< 0.020	(1)			< 0.010	(1)	< 0.005	(1)	< 0.010	(1)	< 0.010	(1)
	79-15	79-15	0.330	(1)			0.110	(1)	0.260	(1)			0.050	(1)
		79-46	0.330	(1)			0.110	(1)	0.265	(1)			0.050	(1)
	79-39	79-39	0.340	(1)			0.090	(1)	0.268	(1)			0.050	(1)
		79-8	0.370	(1)			0.090	(1)	0.260	(1)			0.050	(1)
	79-31	79-31	0.320	(1)			0.030	(1)	0.240	(1)			< 0.010	(1)
		79-5	0.340	(1)			0.040	(1)	0.018	(1)			< 0.010	(1)
	79-51	79-51	0.100	(1)			1.250	(1)	0.032	(1)			< 0.010	(1)
		79-61	0.080	(1)			1.280	(1)	0.025	(1)			< 0.010	(1)
	79-85	79-74	1.380	(1)			1.270	(1)	0.097	(1)			< 0.010	(1)
		79-85	1.470	(1)			1.300	(1)	0.046	(1)			< 0.010	(1)
	79-80	79-80	0.600	(1)			1.300	(1)	0.130	(1)			< 0.010	(1)
		79-99	0.600	(1)			1.270	(1)	< 0.005	(1)			< 0.010	(1)
	79-62	79-62	0.140	(1)			0.900	(1)	0.034	(1)			< 0.010	(1)
		79-84	0.070	(1)			0.960	(1)	0.150	(1)			< 0.010	(1)
	79-90	79-90	1.400	(1)			1.050	(1)	0.067	(1)			< 0.010	(1)
		79-95	0.400	(1)			0.950	(1)	0.026	(1)			< 0.010	(1)
	80-35	80-35	10.600	(1)			0.910	(1)	0.200	(1)			< 0.010	(1)
		80-41	9.100	(1)			0.870	(1)	0.160	(1)			< 0.010	(1)
	80-24	80-24	< 0.010	(1)			0.850	(1)	< 0.005	(1)			< 0.010	(1)
		80-74	< 0.010	(1)			0.910	(1)	< 0.005	(1)			< 0.010	(1)
	80-77	80-42	0.020	(1)			0.820	(1)	< 0.005	(1)			< 0.010	(1)
		80-77	< 0.010	(1)			0.810	(1)	< 0.005	(1)			< 0.010	(1)
	80-1	80-1	0.030	(1)			1.300	(1)	0.016	(1)			< 0.010	(1)
		80-51	< 0.010	(1)			1.300	(1)	< 0.005	(1)			< 0.010	(1)
DC-01	SITE-230	SITE-230	0.100	(0)			0.060	(0)						
	SITE-226	SITE-226	0.700	(0)			0.060	(0)						
	SITE-227	SITE-227	0.500	(0)			0.560	(0)						
	SITE-228	SITE-228					0.740	(0)						
	SITE-229	SITE-229	0.800	(0)			0.580	(0)						
	SITE-231	SITE-231	0.100	(0)			0.050	(0)						
	SITE-232	SITE-232	0.100	(0)			0.060	(0)						
	SITE-233	SITE-233	0.100	(0)			0.100	(0)						
	SITE-234	SITE-234	0.400	(0)			0.450	(0)						
	SITE-235	SITE-235					0.040	(0)						
	SITE-236	SITE-236	1.200	(0)			0.730	(0)						
	SITE-237	SITE-237	1.100	(0)										
	SITE-238	SITE-238	0.100	(0)										
	SITE-239	SITE-239	1.100	(0)			0.720	(0)						
	SITE-240	SITE-240	1.100	(0)			0.650	(0)						
	SITE-241	SITE-241	1.100	(0)			0.170	(0)						
	SITE-242	SITE-242	0.900	(0)			0.850	(0)						
	SITE-243	SITE-243	1.300	(0)			0.380	(0)						

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
DB-15	79-35	79-20	< 0.010	(1)	< 0.002	(1)	0.050	(1)	< 0.020	(1)	0.012	(1)	< 0.030	(1)
		79-35	< 0.003	(1)	< 0.002	(1)	0.050	(1)			0.033	(1)	< 0.030	(1)
	79-33	79-27	< 0.010	(1)	< 0.010	(1)	0.150	(1)	< 0.020	(1)	< 0.020	(1)	< 0.010	(1)
		79-33	< 0.010	(1)	< 0.010	(1)	0.140	(1)			< 0.020	(1)	< 0.010	(1)
	79-15	79-15	0.080	(1)	0.050	(1)	0.130	(1)	< 0.020	(1)	0.058	(1)	0.270	(1)
		79-46	0.080	(1)	0.060	(1)	0.2[illegible]	(1)	< 0.020	(1)	0.057	(1)	0.310	(1)
	79-39	79-39	0.060	(1)	0.049	(1)	0.234	(1)	< 0.020	(1)	0.059	(1)	0.180	(1)
		79-8	0.070	(1)	0.053	(1)	0.240	(1)	< 0.020	(1)	0.060	(1)	0.210	(1)
	79-31	79-31	< 0.003	(1)	< 0.002	(1)	0.250	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		79-5	< 0.003	(1)	< 0.002	(1)	0.2[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	79-51	79-51	< 0.003	(1)	< 0.002	(1)	0.110	(1)	< 0.020	(1)	< 0.020	(1)	0.600	(1)
		79-61	< 0.003	(1)	0.020	(1)	0.[illegible]00	(1)	< 0.020	(1)	< 0.020	(1)	0.500	(1)
	79-85	79-74	< 0.003	(1)	< 0.002	(1)	3.280	(1)	< 0.020	(1)	0.050	(1)	0.500	(1)
		79-85	< 0.003	(1)	< 0.002	(1)	3.320	(1)	< 0.020	(1)	0.060	(1)	0.600	(1)
	79-80	79-80	< 0.003	(1)	< 0.002	(1)	0.700	(1)	< 0.020	(1)	0.030	(1)	< 0.030	(1)
		79-99	0.020	(1)	< 0.002	(1)	2.400	(1)			0.040	(1)	0.060	(1)
	79-62	79-62	0.020	(1)	0.020	(1)	0.320	(1)	< 0.020	(1)	0.280	(1)	< 0.030	(1)
		79-84	0.020	(1)	0.030	(1)	0.180	(1)	< 0.020	(1)	0.280	(1)	0.400	(1)
	79-90	79-90	0.030	(1)	< 0.002	(1)	0.700	(1)	< 0.020	(1)	0.260	(1)	0.390	(1)
		79-95	0.030	(1)	0.020	(1)	0.830	(1)	< 0.020	(1)	0.260	(1)	0.280	(1)
	80-35	80-35	0.020	(1)	< 0.002	(1)	6.300	(1)	< 0.020	(1)	0.128	(1)	< 0.030	(1)
		80-41	0.020	(1)	0.010	(1)	5.600	(1)	< 0.020	(1)	< 0.020	(1)	0.300	(1)
	80-24	80-24	< 0.003	(1)	< 0.002	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-74	< 0.003	(1)	< 0.002	(1)	0.100	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-77	80-42	< 0.003	(1)	< 0.002	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	0.200	(1)
		80-77	< 0.003	(1)	< 0.002	(1)	0.080	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-1	80-1	< 0.003	(1)	< 0.002	(1)	0.270	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-51	< 0.030	(1)	< 0.002	(1)	0.110	(1)	< 0.020	(1)	< 0.020	(1)	0.300	(1)
DC-01	SITE-230	SITE-230					0.250	(0)						
	SITE-226	SITE-226					0.050	(0)						
	SITE-227	SITE-227					0.050	(0)						
	SITE-228	SITE-228												
	SITE-229	SITE-229												
	SITE-231	SITE-231					0.050	(0)						
	SITE-232	SITE-232					0.1[illegible]	(0)						
	SITE-233	SITE-233					1.400	(0)						
	SITE-234	SITE-234					0.570	(0)						
	SITE-235	SITE-235					0.020	(0)						
	SITE-236	SITE-236												
	SITE-237	SITE-237					0.200	(0)						
	SITE-238	SITE-238					1.0[illegible]	(0)						
	SITE-239	SITE-239					0.100	(0)						
	SITE-240	SITE-240					0.150	(0)						
	SITE-241	SITE-241					0.550	(0)						
	SITE-242	SITE-242					1.300	(0)						
	SITE-243	SITE-243					2.100	(0)						

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
DB-15	79-35	79-20	< 0.020	(1)	0.100	(1)	< 0.100	(1)	0.012	(1)	0.060	(1)
		79-35	< 0.020	(1)	0.240	(1)	< 0.100	(1)	0.011	(1)	0.060	(1)
	79-33	79-27	< 0.010	(1)	0.150	(1)	< 0.100	(1)	0.007	(1)	0.010	(1)
		79-33	< 0.010	(1)	0.150	(1)	< 0.010	(1)	0.006	(1)	0.010	(1)
	79-15	79-15	0.030	(1)	0.600	(1)	0.290	(1)	0.060	(1)	0.060	(1)
		79-46	0.040	(1)	0.600	(1)	0.340	(1)	0.060	(1)	0.060	(1)
	79-39	79-39	0.030	(1)	0.660	(1)	0.300	(1)	0.059	(1)	0.060	(1)
		79-8	0.020	(1)	0.700	(1)	0.300	(1)	0.059	(1)	0.060	(1)
	79-31	79-31	< 0.020	(1)	0.500	(1)	< 0.100	(1)	0.007	(1)	0.030	(1)
		79-5	< 0.020	(1)	0.420	(1)	< 0.100	(1)	0.007	(1)	0.040	(1)
	79-51	79-51	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.008	(1)	< 0.010	(1)
		79-61	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.007	(1)	< 0.010	(1)
	79-85	79-74	< 0.020	(1)	< 0.200	(1)	0.200	(1)	0.012	(1)	0.100	(1)
		79-85	< 0.020	(1)	< 0.200	(1)	< 0.10[illegible]	(1)	0.013	(1)	0.200	(1)
	79-80	79-80	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.006	(1)	0.040	(1)
		79-99									0.050	(1)
	79-62	79-62	< 0.020	(1)	0.600	(1)	< 0.100	(1)	0.011	(1)	0.080	(1)
		79-84	< 0.020	(1)	0.600	(1)	< 0.100	(1)	0.011	(1)	0.080	(1)
	79-90	79-90	< 0.020	(1)	0.500	(1)	< 0.100	(1)	< 0.001	(1)	0.560	(1)
		79-95	< 0.020	(1)	0.450	(1)	< 0.100	(1)	0.012	(1)	0.560	(1)
	80-35	80-35	< 0.020	(1)	0.300	(1)	< 0.100	(1)	0.016	(1)	0.600	(1)
		80-41	< 0.020	(1)	0.230	(1)	0.120	(1)	0.015	(1)	0.620	(1)
	80-24	80-24	< 0.020	(1)	< 0.200	(1)	0.120	(1)	< 0.001	(1)	0.040	(1)
		80-74	< 0.020	(1)	< 0.200	(1)	0.140	(1)	< 0.001	(1)	0.010	(1)
	80-77	80-42	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.007	(1)	0.020	(1)
		80-77	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.007	(1)	< 0.020	(1)
	80-1	80-1	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.006	(1)	< 0.010	(1)
		80-51	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.005	(1)	< 0.010	(1)
DC-01	SITE-230	SITE-230										
	SITE-226	SITE-226										
	SITE-227	SITE-227										
	SITE-228	SITE-228										
	SITE-229	SITE-229										
	SITE-231	SITE-231										
	SITE-232	SITE-232										
	SITE-233	SITE-233										
	SITE-234	SITE-234										
	SITE-235	SITE-235										
	SITE-236	SITE-236										
	SITE-237	SITE-237										
	SITE-238	SITE-238										
	SITE-239	SITE-239										
	SITE-240	SITE-240										
	SITE-241	SITE-241										
	SITE-242	SITE-242										
	SITE-243	SITE-243										

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
DC-02-A2	80-4	80-25	77.100	(1)			1.400	(1)	0.330	(1)			< 0.010	(1)
		80-4	13.800	(1)			1.100	(1)	0.430	(1)			0.010	(1)
	SITE-213	SITE-213	< 0.050	(0)										
DC-03	80-27	80-27	1.680	(1)			0.150	(1)	5.470	(1)			< 0.010	(1)
		80-81	1.180	(1)			0.070	(1)	1.320	(1)			< 0.010	(1)
DC-05	79-30	79-30	0.300	(1)			0.500	(1)	0.020	(1)			< 0.010	(1)
		79-32	0.210	(1)			0.500	(1)	0.020	(1)			< 0.010	(1)
DC-06	80-161	80-147	< 0.010	(1)			1.200	(1)	< 0.005	(1)			< 0.010	(1)
		80-161	0.050	(1)			1.240	(1)	< 0.005	(1)			< 0.010	(1)
	80-72	80-22	0.490	(1)			1.300	(1)	0.280	(1)			0.010	(1)
		80-72	57.100	(1)			1.600	(1)	0.130	(1)			0.020	(1)
	SITE-214	SITE-214	< 0.050	(0)										
	80-238	80-201	< 0.010	(1)			1.260	(1)	< 0.005	(1)			< 0.010	(1)
		80-238	< 0.010	(1)			1.350	(1)	< 0.005	(1)			< 0.010	(1)
	80-101	80-186	0.060	(1)			0.860	(1)	< 0.005	(1)			< 0.010	(1)
		80-101	< 0.010	(1)			0.770	(1)	< 0.005	(1)			< 0.010	(1)
	80-13	80-13	0.040	(1)			1.000	(1)	< 0.005	(1)			< 0.010	(1)
		80-58	0.100	(1)			0.980	(1)	< 0.005	(1)			< 0.010	(1)
	79-50	79-59	0.170	(1)			1.040	(1)	< 0.005	(1)			< 0.010	(1)
		79-97	0.160	(1)			1.000	(1)	< 0.005	(1)			0.010	(1)
	81-45	81-45	0.090	(1)			0.090	(1)	< 0.005	(1)			< 0.005	(1)
		81-8	0.090	(1)			0.900	[illegible]	< 0.005	(1)			< 0.005	(1)
	80-118	80-118	0.070	(1)			1.210	[illegible]	< 0.005	(1)			< 0.010	(1)
		80-133	0.140	(1)			1.130	(1)	0.010	(1)			0.010	(1)
	80-15	80-15	0.090	(1)			1.240	(1)	< 0.005	(1)			< 0.010	(1)
		80-70	0.100	(1)			1.270	(1)	< 0.005	(1)			< 0.010	(1)
	81-82	81-76	< 0.080	(1)			1.310	[illegible]	0.010	(1)			< 0.010	[illegible]
		81-82	< 0.080	(1)			1.310	[illegible]	0.004	(1)			< 0.010	[illegible]
	80-29	80-29	0.130	(1)			1.520	[illegible]	< 0.005	(1)			< 0.010	[illegible]
		80-37	< 0.010	(1)			1.450	(1)	< 0.005	(1)			< 0.010	[illegible]
	79-58	79-57	0.150	(1)			1.410	[illegible]	0.089	(1)			< 0.010	[illegible]
		79-58	0.120	(1)			1.450	[illegible]	0.080	(1)			< 0.010	[illegible]
	80-75	80-45	0.050	(1)			1.200	(1)	< 0.005	(1)			< 0.010	(1)
		80-75	0.050	(1)			1.170	[illegible]	< 0.005	(1)			< 0.010	[illegible]
DC-07	82-23	82-23	0.410	(1)			1.800		[illegible]	(1)			< 0.020	[illegible]
		82-56	0.470	(1)			1.820		[illegible]	(1)			< 0.020	(1)
	82-10	82-10	0.250	(1)			1.870		[illegible]	(1)			< [illegible]	[illegible]
		82-33	0.390	(1)			1.879		[illegible]	(1)			< [illegible]	(1)
			0.454	(2)										
	80-39	80-39	0.330	(1)			0.540	[illegible]	[illegible]	(1)			< 0.010	[illegible]
		80-98	0.300	(1)			0.370	[illegible]	[illegible]	(1)			< 0.010	(1)
	80-11	80-11	0.230	(1)			0.800	(1)	< 0.005	(1)			< 0.010	(1)
		80-19	0.200	(1)			0.800	[illegible]	< 0.005	(1)			< 0.010	(1)
	79-52	79-52	0.840	(1)			1.800	[illegible]	0.230	(1)			< 0.010	(1)

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE. CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
DC-02-A2	80-4	80-25	0.090	(1)	0.060	(1)	48.600	(1)	< 0.020	(1)	0.844	(1)	0.500	(1)
		80-4	0.080	(1)	0.110	(1)	32.300	(1)	< 0.020	(1)	0.646	(1)	0.500	(1)
	SITE-213	SITE-213												
DC-03	80-27	80-27	0.003	(1)	0.180	(1)	0.180	(1)	0.340	(1)	0.017	(1)	0.410	(1)
		80-81	< 0.003	(1)	0.060	(1)	0.030	(1)	0.240	(1)	0.010	(1)	0.470	(1)
DC-05	79-30	79-30	< 0.003	(1)	0.016	(1)	0.400	(1)	0.100	(1)	< 0.020	(1)	< 0.030	(1)
		79-32	< 0.003	(1)	< 0.002	(1)	0.250	(1)	0.100	(1)	< 0.020	(1)	< 0.030	(1)
DC-06	80-161	80-147	< 0.003	(1)	< 0.002	(1)	0.350	(1)			0.039	(1)	< 0.030	(1)
		80-161	< 0.003	(1)	< 0.002	(1)	0.400	(1)			0.168	(1)	< 0.030	(1)
	80-72	80-22	0.090	(1)	0.050	(1)	46.800	(1)	< 0.020	(1)	2.268	(1)	0.500	(1)
		80-72	0.090	(1)	0.040	(1)	51.500	(1)	< 0.020	(1)	2.299	(1)	0.600	(1)
	SITE-214	SITE-214												
	80-238	80-201	0.020	(1)	< 0.002	(1)	< 0.010	(1)			< 0.020	(1)	0.440	(1)
		80-238	0.030	(1)	< 0.002	(1)	0.020	(1)			< 0.020	(1)	0.520	(1)
	80-191	80-186	< 0.003	(1)	< 0.002	(1)	0.060	(1)			0.051	(1)	0.580	(1)
		80-191	< 0.003	(1)	< 0.002	(1)	0.040	(1)			< 0.020	(1)	< 0.030	(1)
	80-13	80-13	< 0.003	(1)	< 0.002	(1)	4.100	(1)	< 0.020	(1)	0.181	(1)	0.700	(1)
		80-58	0.030	(1)	< 0.002	(1)	4.100	(1)	< 0.020	(1)	0.160	(1)	0.900	(1)
	79-59	79-59	< 0.003	(1)	< 0.002	(1)	0.760	(1)	< 0.020	(1)	0.030	(1)	0.400	(1)
		79-97	0.010	(1)	< 0.002	(1)	0.700	(1)	< 0.020	(1)	0.020	(1)	0.400	(1)
	81-45	81-45	< 0.005	(1)	< 0.005	(1)	0.040	(1)			0.226	(1)	0.440	(1)
		81-8	< 0.005	(1)	< 0.005	(1)	0.040	(1)			0.216	(1)	0.400	(1)
	80-118	80-118	< 0.003	(1)	0.009	(1)	0.200	(1)	< 0.020	(1)	< 0.020	(1)	0.660	(1)
		80-133	0.020	(1)	0.025	(1)	0.140	(1)	< 0.020	(1)	< 0.020	(1)	0.900	(1)
	80-15	80-15	0.012	(1)	0.005	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	0.650	(1)
		80-70	0.010	(1)	0.006	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	0.710	(1)
	81-82	81-76	< 0.036	(1)	< 0.002	(1)	< 0.006	(1)	0.013	(1)	< 0.001	(1)	0.610	(1)
		81-82	< 0.036	(1)	< 0.002	(1)	0.100	(1)	0.012	(1)	< 0.004	(1)	0.600	(1)
	80-29	80-29	< 0.003	(1)	0.002	(1)	0.004	(1)	< 0.020	(1)	0.040	(1)	0.420	(1)
		80-37	< 0.003	(1)	< 0.002	(1)	< 0.002	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	79-58	79-57	< 0.003	(1)	< 0.002	(1)	0.020	(1)	< 0.020	(1)	< 0.020	(1)	0.750	(1)
		79-58	< 0.003	(1)	< 0.002	(1)	0.009	(1)	< 0.020	(1)	< 0.020	(1)	0.560	(1)
	80-75	80-45	< 0.003	(1)	< 0.002	(1)	0.010	(1)	< 0.020	(1)	< 0.020	(1)	0.160	(1)
		80-75	< 0.003	(1)	< 0.002	(1)	< 0.002	(1)	< 0.020	(1)	< 0.020	(1)	0.230	(1)
DC-07	82-23	82-23	< 0.030	(1)	< 0.006	(1)	0.140	(1)	< 0.006	(1)	< 0.003	(1)	0.080	(1)
		82-56	< 0.030	(1)	< 0.006	(1)	0.130	(1)	< 0.006	(1)	< 0.003	(1)	0.100	(1)
	82-10	82-10	< 0.030	(1)	< 0.006	(1)	0.170	(1)	< 0.006	(1)	< 0.003	(1)	0.470	(1)
		82-33	< 0.030	(1)	< 0.006	(1)	0.190	(1)	< 0.006	(1)	< 0.003	(1)	0.440	(1)
											0.005	(2)		
	80-39	80-39	< 0.003	(1)	< 0.002	(1)	1.300	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-98	< 0.003	(1)	< 0.002	(1)	1.340	(1)	< 0.020	(1)	0.051	(1)	< 0.030	(1)
	80-11	80-11	< 0.003	(1)	< 0.002	(1)	2.100	(1)	< 0.020	(1)	< 0.020	(1)	0.200	(1)
		80-19	< 0.003	(1)	< 0.002	(1)	2.300	(1)	< 0.020	(1)	< 0.020	(1)	0.250	(1)
	79-52	79-52	< 0.003	(1)	< 0.002	(1)	1.600	(1)	< 0.020	(1)	0.020	(1)	0.600	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
DC-02-A2	80-4	80-25	< 0.020	(1)	2.400	(1)	1.300	(1)	0.217	(1)	2.860	(1)
		80-4	< 0.020	(1)	1.500	(1)	0.850	(1)	0.119	(1)	2.200	(1)
	SITE-213	SITE-213										
DC-03	80-27	80-27	< 0.020	(1)	1.700	(1)	< 0.100	(1)	22.300	(1)	0.010	(1)
		80-81	< 0.020	(1)	1.520	(1)	< 0.100	(1)	16.300	(1)	0.010	(1)
DC-05	79-30	79-30	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.220	(1)	0.020	(1)
		79-32	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.210	(1)	< 0.020	(1)
DC-06	80-161	80-147	< 0.020	(1)	0.240	(1)	< [illegible]	(1)	< 0.001	(1)	0.140	(1)
		80-161	< 0.020	(1)	0.420	(1)	< 0.100	(1)	< 0.001	(1)	0.150	(1)
	80-72	80-22	0.160	(1)	0.400	(1)	0.300	(1)	0.010	(1)	3.100	(1)
		80-72	0.150	(1)	0.700	(1)	0.400	(1)	0.014	(1)	3.400	(1)
	SITE-214	SITE-214										
	80-238	80-201	< 0.020	(1)	0.500	(1)	< 0.100	(1)	0.004	(1)	< 0.002	(1)
		80-238	< 0.020	(1)	0.400	(1)	< 0.100	(1)	0.004	(1)	< 0.002	(1)
	80-191	80-186	< 0.020	(1)	0.260	(1)	< 0.100	(1)	0.007	(1)	0.030	(1)
		80-191	< 0.020	(1)	0.250	(1)	< 0.100	(1)	0.003	(1)	< 0.002	(1)
	80-13	80-13	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.016	(1)	0.080	(1)
		80-58	< 0.020	(1)	0.400	(1)	< 0.100	(1)	0.017	(1)	0.090	(1)
	79-59	79-59	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.009	(1)	0.040	(1)
		79-97	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	< 0.009	(1)	0.030	(1)
	81-45	81-45	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.008	(1)	< 0.005	(1)
		81-8	< 0.010	(1)	0.300	(1)	< [illegible]	(1)	0.005	(1)	< 0.005	(1)
	80-118	80-118	< 0.020	(1)	< 0.200	(1)	0.110	(1)	0.003	(1)	0.200	(1)
		80-133	0.030	(1)	< 0.200	(1)	0.100	(1)	0.009	(1)	0.110	(1)
	80-15	80-15	0.020	(1)	0.200	(1)	[illegible]	(1)	0.008	(1)	0.030	(1)
		80-70	0.030	(1)	0.360	(1)	0.100	(1)	0.007	(1)	0.030	(1)
	81-82	81-76	< 0.020	(1)	0.230	(1)	< 0.100	(1)	0.008	(1)	< 0.015	(1)
		81-82	< 0.020	(1)	0.200	(1)	< [illegible]	(1)	0.007	(1)	< 0.015	(1)
	80-20	80-29	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	0.002	(1)
		80-37	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	< 0.001	(1)	< 0.002	(1)
	79-58	79-57	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	0.005	(1)	< 0.010	(1)
		79-58	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	[illegible]	(1)	< 0.010	(1)
	80-75	80-45	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.007	(1)	0.010	(1)
		80-75	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.007	(1)	0.010	(1)
DC-07	82-23	82-23	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	0.050	(1)
		82-56	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.012	(1)	0.050	(1)
	82-10	82-10	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.010	(1)	0.050	(1)
		82-33	< 0.070	(1)	< 0.340	(1)	< 0.150	(1)	0.010	(1)	0.050	(1)
	80-39	80-39	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	0.009	(1)	0.240	(1)
		80-98	< 0.020	(1)	0.200	(1)	< 0.100	(1)	0.008	(1)	0.250	(1)
	80-11	80-11	< 0.020	(1)	< 0.200	(1)	0.100	(1)	0.007	(1)	0.030	(1)
		80-19	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.007	(1)	0.030	(1)
	79-52	79-52	< 0.020	(1)	< 0.200	(1)	0.130	(1)	0.009	(1)	0.070	(1)

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SAMPLE TYPE CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
DC-07	79-52	79-55	0.830	(1)			1.000	(1)	< 0.010	(1)			< 0.010	(1)
	80-103	80-103	1.760	(1)			1.610	(1)	4.470	(1)			0.015	(1)
		80-163	1.490	(1)			1.580	(1)	0.650	(1)			< 0.010	(1)
	80-188	80-178	0.190	(1)			2.220	(1)	0.510	(1)			< 0.010	(1)
		80-188	0.150	(1)			2.210	(1)	< 0.005	(1)			< 0.010	(1)
	80-196	80-177	43.900	(1)			2.550	(1)	0.140	(1)			< 0.010	(1)
		80-196	36.000	(1)			2.620	(1)	0.140	(1)			< 0.010	(1)
DC-12	80-80	80-62	0.050	(1)			0.940	(1)	< 0.005	(1)			< 0.010	(1)
		80-80	0.040	(1)			0.930	(1)	0.014	(1)			< 0.010	(1)
	80-100	80-100	< 0.010	(1)			0.860	(1)	< 0.005	(1)			< 0.010	(1)
		80-63	< 0.010	(1)			0.940	(1)	< 0.005	(1)			< 0.010	(1)
	80-97	80-73	< 0.010	(1)			0.760	(1)	< 0.005	(1)			< 0.010	(1)
		80-97	< 0.010	(1)			0.760	(1)	< 0.005	(1)			< 0.010	(1)
	80-32	80-32	< 0.010	(1)			1.280	(1)	< 0.005	(1)			< 0.010	(1)
		80-68	< 0.010	(1)			1.330	(1)	1.090	(1)			< 0.010	(1)
	80-82	80-23	< 0.010	(1)			0.810	(1)	< 0.005	(1)			< 0.010	(1)
		80-82	< 0.010	(1)			0.800	(1)	< 0.005	(1)			< 0.010	(1)
	80-124	80-102	0.080	(1)			0.860	(1)	0.007	(1)			< 0.010	(1)
		80-124	0.080	(1)			0.840	(1)	< 0.005	(1)			< 0.010	(1)
	80-101	80-101	3.460	(1)			0.780	(1)	< 0.005	(1)			< 0.010	(1)
		80-169	3.140	(1)			0.750	(1)	< 0.005	(1)			< 0.010	(1)
	80-174	80-174	< 0.010	(1)			0.800	(1)	0.196	(1)			< 0.010	(1)
	80-209	80-209	< 0.010	(1)			0.730	(1)	< 0.005	(1)			< 0.010	(1)
		80-242	< 0.010	(1)			0.720	(1)	< 0.005	(1)			< 0.010	(1)
	80-233	80-233	0.040	(1)			0.780	(1)	0.008	(1)			< 0.010	(1)
		80-243	0.050	(1)			0.880	(1)	< 0.005	(1)			< 0.010	(1)
	80-234	80-208	0.050	(1)			0.790	(1)	< 0.005	(1)			< 0.005	(1)
		80-234	0.060	(1)			0.780	(1)	< 0.005	(1)			< 0.005	(1)
	81-61	81-61	0.013	(1)			0.700	(1)	< 0.005	(1)			< 0.010	(1)
		81-72	0.300	(1)			0.750	(1)	< 0.005	(1)			< 0.010	(1)
	82-85	82-47	0.194	(1)			0.850	(1)	0.003	(1)			< 0.015	(1)
			0.230	(2)										
		82-85	0.220	(1)			0.860	(1)	0.003	(1)			< 0.015	(1)
DC-14	80-3	80-3	0.050	(1)			0.120	(1)	0.054	(1)			< 0.010	(1)
		80-34	0.060	(1)			0.130	(1)	0.053	(1)			< 0.010	(1)
	80-53	80-16	0.030	(1)			< 0.005	(1)	0.064	(1)			< 0.010	(1)
		80-53	0.030	(1)			< 0.005	(1)	0.061	(1)			< 0.010	(1)
	80-47	80-47	0.060	(1)			< 0.005	(1)	0.058	(1)			< 0.010	(1)
		80-85	0.030	(1)			< 0.005	(1)	0.058	(1)			< 0.010	(1)
	80-69	80-69	< 0.010	(1)			0.070	(1)	< 0.005	(1)			< 0.010	(1)
		80-83	< 0.010	(1)			0.070	(1)	< 0.005	(1)			< 0.010	(1)
	80-99	80-55	< 0.010	(1)			0.068	(1)	< 0.005	(1)			< 0.010	(1)
		80-99	0.020	(1)			0.067	(1)	< 0.005	(1)			< 0.010	(1)
	80-89	80-36	< 0.010	(1)			0.070	(1)	0.235	(1)			< 0.010	(1)
		80-89	< 0.010	(1)			0.070	(1)	< 0.005	(1)			< 0.010	(1)
	80-71	80-2	0.020	(1)			0.040	(1)	0.028	(1)			< 0.010	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
DC-07	79-52	79-55	< 0.003	(1)	< 0.002	(1)	1.500	(1)	< 0.050	(1)	0.020	(1)	0.530	(1)
	80-103	80-103	0.050	(1)	1.020	(1)	30.100	(1)	< 0.020	(1)	0.305	(1)	0.800	(1)
		80-163	0.050	(1)	0.019	(1)	29.100	(1)	< 0.020	(1)	0.236	(1)	0.850	(1)
	80-188	80-178	0.006	(1)	< 0.002	(1)	1.360	(1)			0.018	(1)	1.400	(1)
		80-188	0.009	(1)	< 0.002	(1)	1.4[illegible]	(1)			0.921	(1)	1.200	(1)
	80-196	80-177	0.230	(1)	0.260	(1)	106.000	(1)			50.500	(1)	1.020	(1)
		80-196	0.160	(1)	0.200	(1)	70.500	(1)			41.900	(1)	0.580	(1)
DC-12	80-80	80-62	< 0.003	(1)	< 0.002	(1)	0.070	(1)	< 0.020	(1)	< 0.020	(1)	0.240	(1)
		80-80	< 0.003	(1)	< 0.002	(1)	0.080	(1)	< 0.020	(1)	< 0.020	(1)	0.210	(1)
	80-100	80-100	< 0.003	(1)	< 0.002	(1)	< 0.002	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-63	< 0.003	(1)	< 0.002	(1)	0.020	(1)	< 0.020	(1)	0.082	(1)	0.050	(1)
	80-97	80-73	< 0.003	(1)	< 0.002	(1)	0.014	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-97	< 0.003	(1)	< 0.002	(1)	0.014	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-32	80-32	< 0.003	(1)	< 0.002	(1)	0.210	(1)			< 0.020	(1)	< 0.030	(1)
		80-68	< 0.003	(1)	< 0.002	(1)	0.200	(1)			< 0.020	(1)	< 0.030	(1)
	80-82	80-23	< 0.003	(1)	< 0.002	(1)	0.040	(1)	< 0.020	(1)	0.007	(1)	< 0.030	(1)
		80-82	0.005	(1)	< 0.002	(1)	0.180	(1)	< 0.020	(1)	0.007	(1)	< 0.030	(1)
	80-124	80-102	< 0.003	(1)	0.009	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	0.250	(1)
		80-124	0.006	(1)	0.010	(1)	0.060	(1)	< 0.020	(1)	< 0.020	(1)	0.310	(1)
	80-101	80-101	0.010	(1)	< 0.002	(1)	18.400	(1)	< 0.020	(1)	0.041	(1)	< 0.030	(1)
		80-169	< 0.003	(1)	< 0.002	(1)	9.500	(1)	< 0.020	(1)	0.026	(1)	< 0.030	(1)
	80-174	80-174	< 0.003	(1)	< 0.002	(1)	0.180	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-209	80-209	< 0.003	(1)	< 0.002	(1)	0.120	(1)			< 0.020	(1)	< 0.030	(1)
		80-242	< 0.003	(1)	< 0.002	(1)	0.[illegible]20	(1)			< 0.020	(1)	< 0.030	(1)
	80-233	80-233	0.020	(1)	< 0.002	(1)	2.000	(1)			0.032	(1)	0.200	(1)
		80-243	0.020	(1)	0.008	(1)	2.150	(1)			0.033	(1)	0.200	(1)
	80-234	80-208	< 0.005	(1)	< 0.005	(1)	0.050	(1)			0.242	(1)	[illegible]	(1)
		80-234	< 0.005	(1)	< 0.005	(1)	0.040	(1)			0.223	(1)	0.170	(1)
	81-61	81-61	0.002	(1)	< 0.002	(1)	0.050	(1)	< 0.100	(1)	< 0.100	(1)	0.240	(1)
		81-62	0.004	(1)	< 0.002	(1)	0.0[illegible]	(1)	< 0.100	(1)	0.150	(1)	0.230	(1)
	82-85	82-67	< 0.036	(1)	< 0.006	(1)	0.260	(1)	0.024	(1)	0.008	(2)	0.350	(1)
		[illegible]									0.004	(2)		
		82-95	< 0.036	(1)	< 0.006	(1)	0.3[illegible]	(2)	[illegible].020	(2)	0.005	[illegible]	0.15[illegible]	[illegible]
DC-14	80-3	80-3	< 0.003	(1)	< 0.002	(1)	0.2[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	0.170	(1)
		80-34	< 0.003	(1)	< 0.002	(1)	0.17[illegible]	(1)	[illegible].020	(1)	< 0.020	(1)	0.250	(1)
	80-53	80-16[illegible]	< 0.003	(1)	< 0.002	(1)	0.650	(1)	< 0.020	(1)	< 0.020	(1)	0.040	(1)
		80-53	< 0.003	(1)	< 0.002	(1)	0.610	(1)	< 0.020	(1)	< 0.020	(1)	0.070	(1)
	80-47	80-47	< 0.003	(1)	0.005	(1)	0.20[illegible]	(1)	< 0.020	(1)	0.074	(1)	0.130	(1)
		80-35	< 0.003	(1)	< 0.002	(1)	0.[illegible]	(1)	< 0.020	(1)	0.063	(1)	0.050	(1)
	80-69	80-69	0.011	(1)	< 0.002	(1)	0.040	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-83	< 0.003	(1)	< 0.002	(1)	0.042	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-99	80-55	0.010	(1)	< 0.002	(1)	0.02[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-99	0.010	(1)	< 0.002	(1)	< 0.007	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-89	80-36	0.010	(1)	< 0.002	(1)	0.01[illegible]	(1)	< 0.020	(1)	< 0.002	(1)	< 0.030	(1)
		80-89	0.010	(1)	< 0.002	(1)	0.320	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-71	80-2	< 0.003	(1)	< 0.002	(1)	0.030	(1)	< 0.020	(1)	0.008	(1)	< 0.030	(1)

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SAMPLE TYPE. CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
DC-07	79-52	79-55	< 0.020	(1)	0.400	(1)	< 0.100	(1)	0.008	(1)	0.070	(1)
	80-103	80-103	0.980	(1)	0.900	(1)	< 0.100	(1)	0.150	(1)	0.780	(1)
		80-163	0.046	(1)	0.830	(1)	0.130	(1)	0.042	(1)	0.670	(1)
	80-188	80-178	< 0.020	(1)	0.240	(1)	< 0.100	(1)	0.023	(1)	0.420	(1)
		80-188	< 0.020	(1)	0.340	(1)	< 0.100	(1)	0.022	(1)	0.460	(1)
	80-196	80-177	< 0.020	(1)	0.650	(1)	1.560	(1)	0.040	(1)	12.200	(1)
		80-196	< 0.020	(1)	0.490	(1)	1.290	(1)	0.060	(1)	8.500	(1)
DC-12	80-80	80-62	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.010	(1)	< 0.010	(1)
		80-80	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.010	(1)	< 0.010	(1)
	80-100	80-100	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.005	(1)	< 0.002	(1)
		80-63	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.009	(1)	< 0.002	(1)
	80-97	80-73	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.031	(1)	< 0.002	(1)
		80-97	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.030	(1)	< 0.002	(1)
	80-32	80-32	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.025	(1)	< 0.002	(1)
		80-68	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.025	(1)	< 0.002	(1)
	80-82	80-23	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.025	(1)	< 0.002	(1)
		80-82	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.025	(1)	< 0.002	(1)
	80-124	80-102	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	< 0.012	(1)	< 0.002	(1)
		80-124	0.020	(1)	< 0.200	(1)	0.120	(1)	0.012	(1)	< 0.002	(1)
	80-101	80-101	< 0.020	(1)	0.230	(1)	< 0.100	(1)	0.005	(1)	0.185	(1)
		80-169	< 0.020	(1)	0.240	(1)	< 0.100	(1)	0.003	(1)	0.110	(1)
	80-174	80-174	< 0.020	(1)	0.340	(1)	< 0.100	(1)	0.001	(1)	0.007	(1)
	80-209	80-209	< 0.020	(1)	0.260	(1)	< 0.100	(1)	0.005	(1)	< 0.002	(1)
		80-242	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	< 0.002	(1)
	80-233	80-233	< 0.020	(1)	0.250	(1)	< 0.100	(1)	0.007	(1)	0.130	(1)
		80-243	< 0.020	(1)	0.260	(1)	< 0.100	(1)	0.008	(1)	0.140	(1)
	80-234	80-208	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.016	(1)	< 0.005	(1)
		80-234	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.015	(1)	< 0.005	(1)
	81-61	81-61	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	< 0.002	(1)
		81-72	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	< 0.002	(1)
	82-85	82-47	< 0.026	(1)	< 0.340	(1)	< 0.160	(1)	0.003	(1)	< 0.015	(1)
		82-85	< 0.026	(1)	< 0.340	(1)	< 0.160	(1)	0.003	(1)	< 0.015	(1)
DC-14	80-3	80-3	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.090	(1)	< 0.010	(1)
		80-34	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.035	(1)	< 0.010	(1)
	80-53	80-16	< 0.020	(1)	0.260	(1)	< 0.100	(1)	0.049	(1)	0.020	(1)
		80-53	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.048	(1)	0.020	(1)
	80-47	80-47	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.102	(1)	0.040	(1)
		80-85	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.107	(1)	0.040	(1)
	80-69	80-69	0.020	(1)	0.430	(1)	< 0.100	(1)	0.011	(1)	0.006	(1)
		80-83	< 0.020	(1)	0.260	(1)	< 0.100	(1)	0.011	(1)	< 0.002	(1)
	80-99	80-55	< 0.020	(1)	0.280	(1)	< 0.100	(1)	0.061	(1)	0.007	(1)
		80-99	< 0.020	(1)	0.320	(1)	< 0.100	(1)	0.061	(1)	< 0.002	(1)
	80-89	80-36	< 0.020	(1)	0.300	(1)	< 0.100	(1)	0.009	(1)	< 0.002	(1)
		80-89	0.020	(1)	0.410	(1)	< 0.100	(1)	0.009	(1)	< 0.002	(1)
	80-71	80-2	< 0.020	(1)	1.450	(1)	< 0.100	(1)	0.048	(1)	< 0.002	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
PC-14	80-71	80-71	0.026	(1)			0.042	(1)	0.031	(1)			< 0.010	(1)
	80-144	80-136	[illegible]	(1)			[illegible]	(1)	0.016	(1)			< 0.010	(1)
		80-144	0.040	(1)			0.030	(1)	0.012	(1)			< 0.010	(1)
	80-189	80-127	0.030	(1)			0.020	(1)	0.013	(1)			< 0.010	(1)
		80-189	0.020	(1)			0.030	(1)	0.006	(1)			< 0.010	(1)
	80-112	80-112	0.030	(1)			0.030	(1)	0.011	(1)			< 0.010	(1)
		80-168	< 0.010	(1)			< 0.010	(1)	< 0.005	(1)			< 0.010	(1)
	80-157	80-157	< 0.010	(1)			[illegible]	(1)	< 0.005	(1)			< 0.010	(1)
		80-183	< [illegible]	(1)			[illegible]	(1)	< 0.005	(1)			< 0.010	(1)
	80-155	80-155	< 0.010	(1)			[illegible]	(1)	< 0.005	(1)			< 0.010	(1)
		80-185	< 0.010	(1)			0.032	(1)	< 0.005	(1)			< 0.010	(1)
	80-104	80-104	< 0.010	(1)			0.030	(1)	< 0.005	(1)			< 0.010	(1)
		80-125	< 0.010	(1)			0.034	(1)	< 0.005	(1)			< 0.010	(1)
	80-129	80-115	0.100	(1)			0.060	(1)	< 0.005	(1)			< 0.010	(1)
		80-129	0.120	(1)			0.070	(1)	< 0.005	(1)			< 0.010	(1)
	80-170	80-156	< 0.010	(1)			0.030	(1)	< 0.005	(1)			< 0.010	(1)
		80-170	0.020	(1)			0.060	(1)	< 0.005	(1)			< 0.010	(1)
	80-117	80-117	< 0.010	(1)			< 0.010	(1)	< 0.005	(1)			< 0.010	(1)
		80-151	< 0.010	(1)			< 0.010	(1)	< 0.005	(1)			< 0.010	(1)
	80-213	80-213	0.210	(1)			0.580	(1)	0.023	(1)			0.020	(1)
		80-236	0.110	(1)			0.590	(1)	< 0.003	(1)			< 0.010	(1)
	81-20	81-20	0.100	(1)			0.510	(1)	0.015	(1)			< 0.005	(1)
		81-22	0.080	(1)			0.520	(1)	0.015	(1)			< 0.005	(1)
	81-30	81-25	0.110	(1)			[illegible]	(1)	0.020	(1)			< 0.010	(1)
		81-30	0.120	(1)			0.980	(1)	0.020	(1)			< 0.010	(1)
			[illegible]	(2)										
	81-44	81-44	0.130	(1)			1.350	(1)	0.010	(1)			< 0.010	(1)
			0.075	(2)										
		81-47	0.120	(1)			1.420	(1)	0.013	(1)			< 0.005	(1)
	81-141	81-141	< 0.050	(1)			1.390	(1)	[illegible]	(1)			< 0.030	(1)
	82-8	82-42	0.140	(1)			1.410	(1)	[illegible]	(1)			< 0.030	(1)
		82-8	0.100	(1)			1.420	(1)	0.005	(1)			< 0.010	(1)
	83-156	83-156	< 0.078	(1)			1.430	(1)	0.005	(1)			< 0.030	
			0.010	(2)										
		83-197	< 0.030	(1)			1.420	(1)	0.005	(1)			< 0.010	(1)
	83-152	83-152	< 0.079	(1)			1.420	(1)	0.005	(1)			< 0.010	(1)
			0.010	(2)										
		83-193	< 0.080	(1)			1.430	(1)	0.005	(1)			< 0.010	(1)
	83-157	83-157	< 0.076	(1)			1.450	(1)	0.005	(1)			< 0.010	(1)
			0.005	(2)										
		83-179	< 0.080	(1)			1.430	(1)	0.005	(1)			< 0.010	(1)
	83-178	83-103	< 0.080	(1)			1.410	(1)	0.003	(1)			< 0.010	(1)
		83-178	< 0.075	(1)			1.400	(1)	0.003	(1)			< 0.010	(1)
			0.007	(2)										
	83-183	83-123	< 0.080	(1)			1.100	(1)	0.004	(1)			< 0.010	(1)
		83-183	< 0.080	(1)			1.100	(1)	0.004	(1)			< 0.010	(1)
			0.008	(2)										
	83-154	83-154	< 0.076	(1)			1.730	(1)	0.024	(1)			< 0.010	(1)

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
DC-14	80-71	80-71	0.008	(1)	< 0.002	(1)	0.050	(1)	< 0.020	(1)	0.009	(1)	< 0.030	(1)
	80-144	80-136	< 0.003	(1)	< 0.002	(1)	0.050	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-144	< 0.003	(1)	< 0.002	(1)	0.070	(1)	0.030	(1)	< 0.020	(1)	< 0.030	(1)
	80-189	80-127	< 0.003	(1)	< 0.002	(1)	0.040	(1)	0.042	(1)	< 0.020	(1)	< 0.030	(1)
		80-189	< 0.003	(1)	< 0.002	(1)	0.019	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-112	80-112	0.006	(1)	0.007	(1)	0.024	(1)	0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-168	< 0.003	(1)	< 0.002	(1)	< 0.005	(1)	0.030	(1)	< 0.020	(1)	< 0.030	(1)
	80-157	80-157	< 0.003	(1)	< 0.002	(1)	0.060	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-183	< 0.003	(1)	< 0.002	(1)	0.190	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-155	80-155	0.010	(1)	< 0.002	(1)	< 0.010	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-185	< 0.003	(1)	< 0.002	(1)	< 0.005	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-104	80-104	< 0.003	(1)	< 0.002	(1)	0.015	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-125	< 0.003	(1)	< 0.002	(1)	0.040	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-129	80-115	< 0.003	(1)	< 0.002	(1)	0.030	(1)			0.034	(1)	0.220	(1)
		80-129	0.010	(1)	< 0.002	(1)	0.010	(1)			0.020	(1)	0.270	(1)
	80-170	80-156	< 0.003	(1)	< 0.002	(1)	< 0.010	(1)			< 0.020	(1)	< 0.030	(1)
		80-170	0.010	(1)	0.007	(1)	0.010	(1)			0.049	(1)	0.190	(1)
	80-117	80-117	< 0.003	(1)	< 0.002	(1)	0.074	(1)			< 0.020	(1)	< 0.030	(1)
		80-151	0.007	(1)	< 0.002	(1)	0.080	(1)			< 0.020	(1)	< 0.030	(1)
	80-213	80-213	0.030	(1)	0.030	(1)	0.100	(1)			< 0.020	(1)	0.940	(1)
		80-236	0.010	(1)	< 0.002	(1)	0.090	(1)			< 0.020	(1)	0.260	(1)
	81-20	81-20	< 0.005	(1)	0.007	(1)	0.120	(1)			0.260	(1)	0.800	(1)
		81-22	< 0.005	(1)	< 0.005	(1)	0.100	(1)			0.260	(1)	0.750	(1)
	81-30	81-16	< 0.010	(1)	< 0.005	(1)	0.030	(1)	0.185	(1)	0.281	(1)	0.870	(1)
		81-30	0.010	(1)	< 0.005	(1)	0.020	(1)	0.060	(1)	0.319	(1)	0.910	(1)
											0.001	(2)		
	81-44	81-44	0.008	(1)	0.009	(1)	0.120	(1)	0.041	(1)	0.268	(1)	0.810	(1)
											0.002	(2)		
		81-47	0.010	(1)	< 0.005	(1)	0.070	(1)	0.160	(1)	0.272	(1)	0.783	(1)
	81-141	81-141	< 0.040	(1)	< 0.005	(1)	0.030	(1)	0.013	(1)	< 0.003	(1)	0.610	(1)
	82-8	82-42	< 0.040	(1)	< 0.006	(1)	< 0.006	(1)	0.032	(1)	< 0.004	(1)	0.620	(1)
		82-8	< 0.040	(1)	< 0.006	(1)	0.006	(1)	0.031	(1)	< 0.004	(1)	0.610	(1)
	83-156	83-156	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.033	(1)	< 0.004	(1)	0.620	(1)
											0.001	(2)		
		83-197	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.032	(1)	< 0.004	(1)	0.610	(1)
	83-152	83-152	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.036	(1)	< 0.004	(1)	0.640	(1)
											0.001	(2)		
		83-193	< 0.040	(1)	< 0.010	(1)	0.010	(1)	0.036	(1)	< 0.004	(1)	0.640	(1)
	83-157	83-157	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.035	(1)	< 0.004	(1)	0.640	(1)
											0.002	(2)		
		83-179	< 0.040	(1)	< 0.010	(1)	0.010	(1)	0.036	(1)	< 0.004	(1)	0.660	(1)
	83-178	83-103	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.032	(1)	< 0.004	(1)	0.610	(1)
		83-178	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.033	(1)	< 0.004	(1)	0.610	(1)
											0.001	(2)		
	83-183	83-123	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.034	(1)	< 0.004	(1)	0.630	(1)
		83-183	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.035	(1)	< 0.004	(1)	0.630	(1)
											0.001	(2)		
	83-154	83-154	< 0.040	(1)	< 0.010	(1)	0.010	(1)	0.032	(1)	< 0.004	(1)	0.750	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
DC-14	80-71	80-71	< 0.020	(1)	1.470	(1)	< 0.100	(1)	0.049	(1)	0.006	(1)
	80-144	80-136	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.017	(1)	< 0.002	(1)
		80-144	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.019	(1)	0.017	(1)
	80-189	80-127	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.017	(1)	0.010	(1)
		80-189	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.017	(1)	< 0.002	(1)
	80-112	80-112	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.012	(1)	< 0.002	(1)
		80-168	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.008	(1)	< 0.002	(1)
	80-157	80-157	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.064	(1)	< 0.002	(1)
		80-183	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.056	(1)	< 0.002	(1)
	80-155	80-155	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.010	(1)	0.007	(1)
		80-185	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.008	(1)	< 0.002	(1)
	80-104	80-104	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.010	(1)	< 0.002	(1)
		80-125	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.013	(1)	< 0.002	(1)
	80-129	80-115	< 0.020	(1)	0.220	(1)	0.130	(1)	< 0.001	(1)	< 0.002	(1)
		80-129	< 0.020	(1)	0.270	(1)	0.180	(1)	< 0.001	(1)	< 0.002	(1)
	80-170	80-156	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	< 0.001	(1)	< 0.002	(1)
		80-170	< 0.020	(1)	0.350	(1)	0.2[illegible]	(1)	< 0.001	(1)	0.020	(1)
	80-117	80-117	< 0.020	(1)	0.300	(1)	< 0.100	(1)	0.005	(1)	< 0.002	(1)
		80-151	< 0.020	(1)	0.230	(1)	< 0.100	(1)	0.005	(1)	< 0.002	(1)
	80-213	80-213	0.050	(1)	0.260	(1)	0.370	(1)	0.014	(1)	0.010	(1)
		80-236	0.020	(1)	0.250	(1)	0.170	(1)	0.012	(1)	< 0.002	(1)
	81-20	81-20	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.044	(1)	0.005	(1)
		81-22	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.045	(1)	< 0.005	(1)
	81-30	81-16	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.028	(1)	0.010	(1)
		81-30	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.030	(1)	0.010	(1)
	81-44	81-44	0.070	(1)	< 0.200	(1)	< 0.100	(1)	0.070	(1)	0.020	(1)
		81-47	0.012	(1)	< 0.200	(1)	< 0.100	(1)	0.0[illegible]	(1)	0.006	(1)
	81-141	81-141	< 0.030	(1)	< 0.150	(1)	< 0.[illegible]	(1)	[illegible]	(1)	0.020	(1)
	82-8	82-42	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	[illegible]	(1)	< 0.010	(1)
		82-8	< 0.030	(1)	0.340	(1)	< 0.150	(1)	0.004	(1)	< 0.015	(1)
	83-156	83-156	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-197	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
	83-152	83-152	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.004	(1)	< 0.020	(1)
		83-193	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.004	(1)	< 0.010	(1)
	83-157	83-157	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.004	(1)	< 0.020	(1)
		83-179	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.004	(1)	0.050	(1)
	83-178	83-103	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-178	< 0.030	(1)	0.640	(1)	< 0.[illegible]	(1)	0.003	(1)	< 0.010	(1)
	83-183	83-123	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-183	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
	83-154	83-154	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
DC-14	83-154	83-154	0.024	(2)										
		83-191	< 0.080	(1)			1.740	(1)	0.008	(1)			< 0.010	(1)
	83-150	83-108	< 0.080	(1)			1.740	(1)	0.004	(1)			< 0.010	(1)
		83-150	< 0.076	(1)			1.730	(1)	0.004	(1)			< 0.010	(1)
			0.014	(2)										
	83-266	83-233	0.080	(1)			1.430	(1)	0.004	(1)			< 0.010	(1)
		83-266	0.080	(1)			1.390	(1)	0.004	(1)			< 0.010	(1)
			0.009	(2)										
	83-261	83-203	0.080	(1)			1.110	(1)	0.005	(1)			< 0.010	(1)
		83-261	0.080	(1)			1.120	(1)	0.005	(1)			< 0.010	(1)
			0.012	(2)										
DC-15	80-56	80-31	< 0.010	(1)			0.050	(1)	0.061	(1)			< 0.010	(1)
		80-56	< 0.010	(1)			0.050	(1)	0.063	(1)			< 0.010	(1)
	80-54	80-54	< 0.020	(1)			0.020	(1)	0.068	(1)			< 0.010	(1)
		80-76	< 0.020	(1)			0.020	(1)	0.074	(1)			< 0.010	(1)
	80-57	80-57	< 0.010	(1)			0.045	(1)	0.058	(1)			< 0.010	(1)
		80-65	< 0.010	(1)			0.038	(1)	0.065	(1)			< 0.010	(1)
	80-87	80-87	< 0.010	(1)			0.085	(1)	0.033	(1)			< 0.010	(1)
		80-94	< 0.010	(1)			0.086	(1)	0.017	(1)			< 0.010	(1)
	80-137	80-137	0.040	(1)			0.260	(1)	< 0.005	(1)			< 0.012	(1)
		80-197	0.030	(1)			0.260	(1)	< 0.005	(1)			< 0.010	(1)
	80-176	80-176	< 0.010	(1)			0.210	(1)	< 0.005	(1)			< 0.010	(1)
		80-999	0.034	(1)			0.220	(1)	0.009	(1)			< 0.010	(1)
	80-135	80-135	0.070	(1)			0.220	(1)	0.008	(1)			< 0.010	(1)
		80-149	0.053	(1)			0.230	(1)	< 0.005	(1)			< 0.010	(1)
	80-120	80-120	< 0.010	(1)			0.220	(1)	0.012	(1)			< 0.010	(1)
		80-139	< 0.010	(1)			0.210	(1)	< 0.005	(1)			< 0.010	(1)
	80-131	80-108	0.100	(1)			0.290	(1)	< 0.005	(1)			< 0.010	(1)
		80-131	0.070	(1)			0.290	(1)	< 0.005	(1)			< 0.010	(1)
	80-193	80-114	< 0.010	(1)			0.190	(1)	< 0.005	(1)			< 0.010	(1)
		80-193	< 0.010	(1)			0.210	(1)	< 0.005	(1)			< 0.010	(1)
	81-41	81-24	0.070	(1)			0.350	(1)	0.010	(1)			< 0.005	(1)
		81-41	0.110	(1)			0.360	(1)	0.013	(1)			0.007	(1)
	81-2	81-2	0.700	(1)			0.510	(1)	0.032	(1)			< 0.005	(1)
		81-36	0.700	(1)			0.520	(1)	0.033	(1)			< 0.015	(1)
	81-46	81-46	0.150	(1)			0.650	(1)	0.020	(1)			< 0.010	(1)
		81-50	0.150	(1)			0.650	(1)	0.020	(1)			< 0.010	(1)
			0.160	(2)										
	81-33	81-32	0.100	(1)			0.810	(1)	0.030	(1)			< 0.010	(1)
			0.032	(2)										
		81-33	0.110	(1)			0.770	(1)	0.020	(1)			< 0.010	(1)
	81-27	81-27	< 0.080	(1)			0.880	(1)	0.004	(1)			< 0.010	(1)
		81-74	< 0.020	(1)			0.810	(1)	0.004	(1)			< 0.004	(1)
			0.044	(2)										
	81-64	81-64	0.140	(1)			0.812	(1)	0.015	(1)			< 0.012	(1)
		81-80	0.080	(1)			0.790	(1)	0.010	(1)			< 0.010	(1)
			0.060	(2)										

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	[illegible] MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
DC-14	83-154	83-154									0.002	(2)		
		83-191	< 0.040	(1)	< 0.010	(1)	< [illegible]	(1)	0.032	(1)	< 0.004	(1)	0.750	[illegible]
	83-150	83-108	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.031	(1)	< 0.004	(1)	0.740	(1)
		83-150	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.032	(1)	< 0.004	(1)	0.740	[illegible]
											0.001	(2)		
	83-266	83-233	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.034	(1)	< 0.004	(1)	0.630	(1)
		83-266	< 0.040	(1)	< 0.010	(1)	< [illegible]	(1)	0.033	(1)	< 0.004	(1)	0.630	(1)
											0.001	(2)		
	83-251	83-203	< 0.040	(1)	< 0.010	(1)	0.010	(1)	0.034	(1)	< 0.004	(1)	0.620	(1)
		83-261	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	0.035	(1)	< 0.004	(1)	0.640	(1)
											0.002	(2)		
DC-15	80-56	80-31	< 0.003	(1)	< 0.002	(1)	0.110	(1)	< 0.020	(1)	0.055	(1)	< 0.030	[illegible]
		80-56	< 0.003	(1)	< 0.002	(1)	0.120	(1)	< 0.020	(1)	0.055	(1)	< 0.030	[illegible]
	80-54	80-54	< 0.003	(1)	< 0.002	(1)	0.050	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	[illegible]
		80-76	< 0.003	(1)	< 0.002	(1)	0.060	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	[illegible]
	80-57	80-57	0.007	(1)	< 0.002	(1)	0.320	(1)	< 0.020	(1)	0.033	(1)	< 0.030	[illegible]
		80-55	< 0.003	(1)	< 0.002	(1)	0.320	(1)	< 0.020	(1)	0.034	(1)	< 0.030	(1)
	80-87	80-87	0.005	(1)	< 0.002	(1)	0.500	(1)	0.030	(1)	0.038	(1)	< 0.030	(1)
		80-94	< 0.003	(1)	< 0.002	(1)	[illegible]	(1)	0.050	(1)	0.038	[illegible]	< 0.030	[illegible]
	80-137	80-137	< 0.003	(1)	< 0.002	(1)	0.020	(1)	< 0.020	(1)	< 0.020	(1)	0.100	[illegible]
		80-197	< 0.003	(1)	< 0.002	(1)	0.020	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-176	80-176	< 0.003	(1)	< 0.002	(1)	0.010	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-999	< 0.003	(1)	0.008	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	0.140	[illegible]
	80-135	80-135	< 0.003	(1)	0.010	(1)	0.010	(1)	0.017	(1)	< 0.020	(1)	0.190	(1)
		80-149	< 0.003	(1)	< 0.002	(1)	0.110	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	80-120	80-120	< 0.003	(1)	< 0.002	(1)	0.050	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		80-139	< 0.003	(1)	< 0.002	(1)	[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	< [illegible]	(1)
	80-131	80-108	< 0.003	(1)	< 0.002	(1)	[illegible]	(1)			0.045	(1)	0.290	[illegible]
		80-131	< 0.003	(1)	< 0.002	(1)	[illegible]	(1)			0.042	(1)	0.200	[illegible]
	80-193	80-114	< 0.003	(1)	< 0.002	(1)	0.040	(1)			< 0.020	(1)	< 0.030	[illegible]
		80-193	< 0.003	(1)	< 0.002	(1)	0.040	(1)			0.048	(1)	< 0.030	[illegible]
	81-41	81-24	< 0.005	(1)	0.008	(1)	[illegible]	(1)			0.256	(1)	0.720	
		81-41	0.010	(1)	0.010	(1)	[illegible]	(1)			0.265	(1)	0.830	[illegible]
	81-2	81-2	0.330	(1)	0.010	(1)	15.0[illegible]	(1)			[illegible]	(1)	0.840	[illegible]
		81-36	0.030	(1)	0.020	(1)	15.4[illegible]	(1)			0.340	(1)	[illegible]	
	81-46	81-46	0.003	(1)	< 0.005	(1)	[illegible]	(1)	0.530	(1)	0.370	(1)	0.830	[illegible]
		81-50	0.010	(1)	< 0.005	(1)	0.230	(1)	0.890	(1)	0.391	(1)	0.830	(1)
											0.013	(2)		
	81-33	81-32	0.005	(1)	< 0.005	(1)	[illegible]	(1)	0.460	(1)	0.351	(1)	[illegible]	[illegible]
											0.003	(2)		
		81-33	0.010	(1)	< 0.005	(1)	[illegible]	(1)	0.039	(1)	0.472	(1)	0.990	[illegible]
	81-27	81-27	< 0.003	(1)	< 0.002	(1)	0.040	(1)	0.007	(1)	< 0.001	(1)	0.600	[illegible]
		81-74	< 0.006	(1)	< 0.003	(1)	[illegible]	(1)	0.006	(1)	< 0.001	(1)	0.590	[illegible]
											0.003	(2)		
	81-64	81-64	< 0.036	(1)	< 0.002	(1)	[illegible]	(1)	[illegible]	(1)	0.309	(1)	[illegible]	[illegible]
		81-80	0.010	(1)	< 0.002	(1)	0.390	(1)	0.082	(1)	0.130	(1)	1.080	[illegible]
											0.017	(2)		

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
DC-14	83-154	83-154										
		83-191	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
	83-150	83-108	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-150	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
	83-266	83-233	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-266	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
	83-261	83-203	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-261	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
DC-15	80-56	80-31	< 0.020	(1)	0.300	(1)	< 0.100	(1)	0.064	(1)	0.110	(1)
		80-56	< 0.020	(1)	0.300	(1)	< 0.100	(1)	0.065	(1)	0.110	(1)
	80-54	80-54	< 0.020	(1)	0.280	(1)	< 0.100	(1)	0.051	(1)	0.020	(1)
		80-76	< 0.020	(1)	0.200	(1)	< 0.100	(1)	0.052	(1)	0.020	(1)
	80-57	80-57	< 0.020	(1)	0.300	(1)	< 0.100	(1)	0.032	(1)	0.080	(1)
		80-65	< 0.020	(1)	0.250	(1)	< 0.100	(1)	0.034	(1)	0.070	(1)
	80-87	80-87	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.018	(1)	0.040	(1)
		80-94	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.018	(1)	0.043	(1)
	80-137	80-137	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.003	(1)	< 0.002	(1)
		80-197	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.003	(1)	< 0.002	(1)
	80-176	80-176	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.002	(1)	< 0.002	(1)
		80-999	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.005	(1)	< 0.002	(1)
	80-135	80-135	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.005	(1)	< 0.002	(1)
		80-149	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.005	(1)	< 0.002	(1)
	80-120	80-120	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	< 0.002	(1)
		80-139	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.004	(1)	< 0.002	(1)
	80-131	80-108	< 0.020	(1)	0.260	(1)	< 0.100	(1)	< 0.001	(1)	< 0.002	(1)
		80-131	< 0.020	(1)	< 0.200	(1)	0.180	(1)	< 0.001	(1)	< 0.002	(1)
	80-193	80-114	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	< 0.001	(1)	0.030	(1)
		80-193	< 0.020	(1)	0.280	(1)	< 0.100	(1)	0.002	(1)	0.030	(1)
	81-41	81-24	0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.030	(1)	0.030	(1)
		81-41	0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.030	(1)	0.023	(1)
	81-2	81-2	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.028	(1)	0.320	(1)
		81-36	< 0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.030	(1)	0.330	(1)
	81-46	81-46	< 0.010	(1)	0.440	(1)	< 0.100	(1)	0.040	(1)	0.008	(1)
		81-50	0.010	(1)	0.490	(1)	< 0.100	(1)	0.040	(1)	0.010	(1)
	81-33	81-32	< 0.010	(1)	< 0.200	(1)	0.610	(1)	0.030	(1)	0.010	(1)
		81-33	0.010	(1)	< 0.200	(1)	< 0.100	(1)	0.030	(1)	< 0.005	(1)
	81-27	81-27	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.008	(1)	< 0.002	(1)
		81-74	< 0.008	(1)	0.100	(1)	< 0.043	(1)	0.008	(1)	< 0.004	(1)
	81-64	81-64	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.024	(1)	< 0.015	(1)
		81-80	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.023	(1)	< 0.002	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
DC-1S	81-86	81-85	0.100	(1)			0.740	(1)	< 0.005	(1)			< 0.010	(1)
		81-96	0.190	(1)			0.760	(1)	< 0.005	(1)			< 0.010	(1)
			0.500	(2)										
	81-69	81-69	0.050	(1)			0.780	(1)	0.007	(1)			< 0.010	(1)
		81-84	0.040	(1)			0.740	(1)	< 0.005	(1)			< 0.010	(1)
			0.025	(2)										
	82-94	82-41	0.360	(1)			2.340	(1)	0.009	(1)			< 0.015	(1)
		82-94	0.360	(1)			2.320	(1)	0.013	(1)			< 0.015	(1)
			0.930	(2)										
DC-16A	81-109	81-109	< 0.080	(1)			< 0.020	(1)	0.030	(1)			< 0.020	(1)
		81-167	< 0.080	(1)			< 0.020	(1)	0.030	(1)			< 0.020	(1)
	82-17	82-17	< 0.080	(1)			0.020	(1)	0.003	(1)			< 0.020	(1)
		82-55	< 0.080	(1)			< 0.020	(1)	0.007	(1)			< 0.020	(1)
	82-93	82-45	< 0.080	(1)			0.050	(1)	0.024	(1)			< 0.010	(1)
		82-93	< 0.080	(1)			0.050	(1)	0.024	(1)			< 0.010	(1)
			0.018	(2)										
	82-19	82-19	< 0.080	(1)			0.500	(1)	[illegible]	(1)			< 0.010	(1)
		82-88	< 0.080	(1)			0.510	(1)	0.007	(1)			< 0.010	(1)
			0.130	(2)										
	82-188	82-140	< 0.080	(1)			0.500	(1)	0.005	(1)			< 0.010	(1)
			0.022	(2)										
		82-188	< 0.080	(1)			0.600	(1)	0.005	(1)			< 0.010	(1)
	82-124	82-124	< 0.080	(1)			0.630	(1)	0.007	(1)			< 0.010	(1)
			0.043	(2)										
		82-172	< 0.080	(1)			0.620	(1)	0.007	(1)			< 0.010	(1)
	82-143	82-126	< 0.080	(1)			0.610	(1)	0.028	(1)			< 0.010	(1)
			0.052	(2)										
		82-143	< 0.080	(1)			0.620	(1)	0.028	(1)			< 0.010	(1)
	82-202	82-202	< 0.070	(1)			0.540	(1)	0.017	(1)			< 0.010	(1)
			0.102	(2)										
		82-228	< 0.070	(1)			0.550	(1)	0.017	(1)			< 0.010	(1)
	82-322	82-322	< 0.080	(1)			1.430	(1)	0.014	(1)			< 0.010	(1)
			0.039	(2)										
		82-361	< 0.080	(1)			1.450	(1)	[illegible]	(1)			< 0.010	(1)
	82-332	82-332	< 0.080	(1)			1.500	(1)	0.020	(1)			< 0.010	(1)
		82-358	< 0.080	(1)			1.500	(1)	0.019	(1)			< 0.010	(1)
			0.030	(2)										
	82-430	82-430	0.290	(1)			2.600	(1)	0.013	(1)			< 0.010	(1)
			0.041	(2)										
		82-473	0.280	(1)			2.600	(1)	0.013	(1)			< 0.010	(1)
	83-29	83-29	< 0.080	(1)			2.570	(1)	0.013	(1)			< 0.010	(1)
		83-41	< 0.080	(1)			2.600		[illegible]	(1)			< 0.010	(1)
DC-16B	83-147	83-147	< 0.080	(1)			0.080	(1)	0.026	(1)			< 0.010	(1)
		83-185	< 0.080	(1)			0.070	(1)	0.024	(1)			< 0.010	(1)
DC-16C	83-100	83-100	0.250	(1)			3.900	(1)	[illegible]	(1)			< 0.010	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
DC-15	81-96	81-85	< 0.003	(1)	< 0.002	(1)	0.160	(1)	0.120	(1)	0.247	(1)	1.130	(1)
		81-96	0.010	(1)	< 0.002	(1)	1.010	(1)	0.110	(1)	0.216	(1)	0.980	(1)
											0.055	(2)		
	81-69	81-69	< 0.003	(1)	< 0.002	(1)	0.060	(1)	0.103	(1)	< 0.100	(1)	1.070	(1)
		81-84	0.010	(1)	< 0.002	(1)	0.050	(1)	0.110	(1)	< 0.100	(1)	1.000	(1)
											0.014	(2)		
	82-94	82-41	< 0.036	(1)	< 0.006	(1)	0.140	(1)	0.019	(1)	< 0.003	(1)	0.470	(1)
		82-94	< 0.036	(1)	< 0.006	(1)	0.160	(1)	0.020	(1)	0.004	(1)	0.470	(1)
											0.003	(2)		
DC-16A	81-109	81-109	0.230	(1)	< 0.006	(1)	0.080	(1)	0.007	(1)	0.013	(1)	< 0.020	(1)
		81-167	0.220	(1)	< 0.006	(1)	0.090	(1)	< 0.006	(1)	0.016	(1)	< 0.020	(1)
	82-17	82-17	< 0.040	(1)	< 0.006	(1)	0.070	(1)	0.020	(1)	0.030	(1)	< 0.020	(1)
		82-55	< 0.040	(1)	< 0.006	(1)	0.060	(1)	0.017	(1)	0.028	(1)	< 0.020	(1)
	82-93	82-45	< 0.040	(1)	< 0.006	(1)	0.090	(1)	0.028	(1)	0.040	(1)	< 0.020	(1)
		82-93	< 0.040	(1)	< 0.006	(1)	0.090	(1)	0.029	(1)	0.040	(1)	< 0.020	(1)
											0.063	(2)		
	82-19	82-19	0.080	(1)	< 0.006	(1)	0.100	(1)	< 0.006	(1)	< 0.003	(1)	0.150	(1)
		82-88	0.080	(1)	< 0.006	(1)	0.110	(1)	< 0.006	(1)	< 0.003	(1)	0.150	(1)
											0.003	(2)		
	82-188	82-140	< 0.030	(1)	< 0.006	(1)	0.070	(1)	< 0.006	(1)	0.004	(1)	0.200	(1)
											0.005	(2)		
		82-188	< 0.030	(1)	< 0.006	(1)	0.070	(1)	< 0.006	(1)	0.005	(1)	0.200	(1)
	82-124	82-124	0.050	(1)	< 0.006	(1)	0.050	(1)	0.007	(1)	0.004	(1)	0.100	(1)
											0.003	(2)		
		82-172	0.050	(1)	< 0.006	(1)	0.050	(1)	0.010	(1)	0.004	(1)	0.110	(1)
	82-143	82-126	0.060	(1)	< 0.006	(1)	0.070	(1)	0.019	(1)	< 0.003	(1)	0.130	(1)
											0.003	(2)		
		82-143	0.060	(1)	< 0.006	(1)	0.060	(1)	0.020	(1)	< 0.003	(1)	0.140	(1)
	82-202	82-202	0.100	(1)	< 0.006	(1)	1.810	(1)	0.011	(1)	0.069	(1)	0.040	(1)
											0.105	(2)		
		82-228	0.090	(1)	< 0.006	(1)	2.230	(1)	0.013	(1)	0.091	(1)	0.040	(1)
	82-322	82-322	< 0.030	(1)	< 0.006	(1)	0.030	(1)	0.110	(1)	< 0.003	(1)	0.130	(1)
											0.003	(2)		
		82-361	< 0.030	(1)	< 0.006	(1)	0.020	(1)	0.110	(1)	< 0.003	(1)	0.160	(1)
	82-332	82-332	< 0.030	(1)	< 0.006	(1)	9.300	(1)	0.025	(1)	0.140	(1)	0.150	(1)
		82-358	< 0.030	(1)	< 0.006	(1)	8.500	(1)	0.024	(1)	0.140	(1)	0.150	(1)
											0.167	(2)		
	82-430	82-430	0.160	(1)	< 0.006	(1)	0.100	(1)	< 0.006	(1)	0.007	(1)	0.250	(1)
											0.010	(2)		
		82-473	0.160	(1)	< 0.006	(1)	0.100	(1)	< 0.006	(1)	0.008	(1)	0.250	(1)
	83-29	83-29	0.060	(1)	< 0.010	(1)	0.080	(1)	0.014	(1)	0.007	(1)	0.240	(1)
		83-41	0.060	(1)	< 0.010	(1)	0.100	(1)	0.017	(1)	0.008	(1)	0.024	(1)
DC-16B	83-147	83-147	< 0.040	(1)	< 0.010	(1)	0.430	(1)	0.025	(1)	0.044	(1)	0.030	(1)
		83-185	< 0.040	(1)	< 0.010	(1)	0.430	(1)	0.027	(1)	0.047	(1)	0.020	(1)
DC-16C	83-100	83-100	< 0.040	(1)	< 0.010	(1)	3.600	(1)	0.010	(1)	0.092	(1)	0.390	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
DC-15	81-96	81-85	< 0.020	(1)	< 0.200	(1)	< 1.00[illegible]	[illegible]	[illegible].010	(1)	0.010	[illegible]
		81-06	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.011	(1)	0.040	(1)
	81-69	81-69	< 0.020	(1)	< 0.200	(1)	< 0.[illegible]00	(1)	0.011	(1)	0.010	(1)
		81-84	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.010	(1)	0.010	(1)
	82-94	82-41	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.012	(1)	< 0.015	(1)
		82-94	< 0.026	(1)	< 0.340	(1)	< 0.160	(1)	0.012	(1)	< 0.015	(1)
DC-15A	81-109	81-109	< 0.030	(1)	< 0.340	(1)	< [illegible]	(1)	0.061	(1)	< 0.0[illegible]	(1)
		81-167	< 0.030	(1)	< 0.340	(1)	< 0.160	(1)	0.064	(1)	< 0.020	(1)
	82-17	82-17	< 0.030	(1)	< 0.340	(1)	< 0.160	(1)	0.042	(1)	< 0.020	(1)
		82-55	< 0.030	(1)	< 0.340	(1)	< 0.160	(1)	0.042	(1)	< 0.020	(1)
	82-93	82-45	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.044	(1)	< 0.010	(1)
		82-93	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.043	(1)	< 0.010	(1)
	82-19	82-19	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.015	(1)	< 0.010	(1)
		82-88	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.015	(1)	< 0.010	(1)
	82-188	82-140	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	< 0.010	(1)
		82-188	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	< 0.010	(1)
	82-124	82-124	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	< 0.010	(1)
		82-172	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	< 0.010	(1)
	82-143	82-126	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
		82-143	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
	82-202	82-202	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.014	(1)	< 0.010	(1)
		82-228	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.015	(1)	< 0.010	(1)
	82-322	82-322	< 0.020	(1)	0.500	(1)	< 0.150	(1)	0.019	(1)	< 0.015	(1)
		82-361	< 0.020	(1)	0.500	(1)	< 0.150	(1)	0.018	(1)	< 0.010	(1)
	82-332	82-332	< 0.020	(1)	0.460	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
		82-358	< 0.020	(1)	0.400	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
	82-430	82-430	< 0.020	(1)	0.500	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
		82-473	< 0.020	(1)	0.470	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
	83-29	83-29	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
		83-41	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
DC-16B	83-147	83-147	< 0.030	(1)	0.410	(1)	< 0.150	(1)	0.030	(1)	< 0.010	(1)
		83-185	< 0.030	(1)	0.350	(1)	< 0.150	(1)	0.030	(1)	< 0.010	(1)
DC-16C	83-100	83-100	< 0.030	(1)	2.000	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
DC-16C	83-100	83-30	0.250	(1)			3.900	(1)	0.047	(1)			< 0.010	(1)
	83-259	83-215	< 0.080	(1)			0.810	(1)	0.010	(1)			< 0.010	(1)
		83-259	< 0.080	(1)			0.800	(1)	0.020	(1)			< 0.010	(1)
DC-18	86-166	86-166	< 0.200	(1)			0.105	(1)	< 0.003	(1)				
		86-167	< 0.200	(1)			0.106	(1)	< 0.003	(1)				
DC-15C	84-53	84-53	< 0.070	(1)			0.800	(1)	0.004	(1)			< 0.010	(1)
		84-84	< 0.070	(1)			0.810	(1)	0.004	(1)			< 0.010	(1)
	84-40	84-40	< 0.070	(1)			0.780	(1)	0.004	(1)			< 0.010	(1)
		84-77	< 0.070	(1)			0.780	(1)	0.004	(1)			< 0.010	(1)
	84-75	84-29	0.090	(1)			0.660	(1)	0.002	(1)			< 0.010	(1)
		84-75	0.080	(1)			0.660	(1)	0.002	(1)			< 0.010	(1)
	84-86	84-18	0.210	(1)			0.650	(1)	0.004	(1)			< 0.010	(1)
		84-86	0.180	(1)			0.640	(1)	0.003	(1)			< 0.010	(1)
DC-20C	84-9	84-49	< 0.070	(1)			0.570	(1)	0.004	(1)			< 0.010	(1)
		84-9	< 0.070	(1)			0.580	(1)	0.004	(1)			< 0.010	(1)
DC-22C	84-105	84-105	< 0.070	(1)			0.360	(1)	0.005	(1)			< 0.010	(1)
		84-153	< 0.070	(1)			0.360	(1)	0.004	(1)			< 0.010	(1)
DC-23GR	86-133	86-133	< 0.200	(1)			0.225	(1)	0.006	(1)				
		86-134	< 0.200	(1)			0.222	(1)	0.006	(1)				
	86-141	86-141	< 0.200	(1)			0.203	(1)	0.004	(1)				
		86-142	< 0.200	(1)			0.204	(1)	0.005	(1)				
	86-181	86-181	< 0.200	(1)			0.446	(1)	< 0.003	(1)				
		86-182	< 0.200	(1)			0.448	(1)	< 0.003	(1)				
ENYEART	SITE-209	SITE-209												
	SITE-210	SITE-210	0.100	(0)			0.040	(0)						
	84-166	84-166	< 0.070	(1)			0.033	(1)	0.017	(1)			< 0.015	(1)
		84-184	< 0.070	(1)			0.034	(1)	0.017	(1)			< 0.015	(1)
	85-180	85-180	< 0.060	(1)			0.017	(1)	0.032	(1)			< 0.017	(1)
		85-181	< 0.060	(1)			0.016	(1)	0.051	(1)			< 0.017	(1)
FORD	SITE-206	SITE-206												
	SITE-207	SITE-207	0.090	(0)			0.090	(0)						
	SITE-219	SITE-219	< 0.050	(0)										
	85-188	85-188	< 0.060	(1)			< 0.018	(1)	0.020	(1)			< 0.017	(1)
		85-189	< 0.060	(1)			< 0.016	(1)	0.020	(1)			< 0.017	(1)
	85-303	85-303	< 0.060	(1)			< 0.020	(1)	0.016	(1)			< 0.017	(1)
		85-304	< 0.060	(1)			< 0.016	(1)	0.018	(1)			< 0.017	(1)
MCGEE	SITE-220	SITE-220	< 0.050	(0)										
	82-7	82-52	< 0.080	(1)			< 0.020	(1)	0.021	(1)			< 0.010	(1)
		82-7	< 0.080	(1)			< 0.020	(1)	0.021	(1)			< 0.010	(1)
	85-175	85-175	< 0.060	(1)			0.022	(1)	0.011	(1)			< 0.017	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
DC-16C	83-100	83-30	< 0.040	(1)	< 0.010	(1)	3.4[illegible]	(1)	0.010	(1)	0.087	(1)	0.380	[illegible]
	83-259	83-215	< 0.040	(1)	< 0.010	(1)	1.070	(1)	0.007	(1)	0.030	(1)	0.190	(1)
		83-259	< 0.040	(1)	< 0.010	(1)	1.060	(1)	0.007	(1)	0.030	(1)	0.180	(1)
DC-18	86-166	86-166			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-167			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.800	[illegible]
DC-19C	84-53	84-53	< 0.030	(1)	< 0.006	(1)	0.170	(1)	0.003	(1)	0.022	(1)	0.290	(1)
		84-84	< 0.030	(1)	< 0.006	(1)	0.180	(1)	0.009	(1)	0.021	(1)	0.300	(1)
	84-40	84-40	< 0.030	(1)	< 0.006	(1)	0.320	(1)	0.009	(1)	0.018	(1)	0.260	[illegible]
		84-77	< 0.030	(1)	< 0.006	(1)	0.320	(1)	0.008	(1)	0.019	(1)	0.260	[illegible]
	84-75	84-29	< 0.040	(1)	< 0.010	(1)	1.310	(1)	0.013	(1)	0.047	(1)	0.310	(1)
		84-75	< 0.040	(1)	< 0.010	(1)	1.330	(1)	0.012	(1)	0.043	(1)	0.300	(1)
	84-86	84-18	< 0.040	(1)	< 0.010	(1)	1.050	[illegible]	0.010	(1)	0.045	(1)	0.310	[illegible]
		84-86	< 0.040	(1)	< 0.010	(1)	0.950	(1)	0.003	(1)	0.044	(1)	0.290	[illegible]
DC-20C	84-9	84-49	< 0.030	(1)	< 0.006	(1)	0.580	[illegible]	0.003	(1)	0.030	(1)	0.240	(1)
		84-9	< 0.030	(1)	< 0.006	(1)	0.570	(1)	0.008	(1)	0.030	(1)	0.240	(1)
DC 22C	84-105	84-105	< 0.030	(1)	< 0.006	(1)	0.050	(1)	0.030	(1)	< 0.004	(1)	0.12[illegible]	[illegible]
		84-153	< 0.030	(1)	< 0.006	(1)	0.030	(1)	0.008	(1)	< 0.004	(1)	0.120	(1)
DC-23GR	86-133	86-133			< 0.030	(1)	< 0.030	(1)	< 0.018	(1)	< 0.010	(1)	< 0.600	[illegible]
		86-134			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	[illegible]
	86-141	86-141			< 0.030	(1)	< 0.030	(1)	< 0.018	(1)	< 0.010	(1)	< 0.600	(1)
		86-142			< 0.030	(1)	< 0.030	[illegible]	< 0.018	(1)	< 0.010	(1)	< 0.600	[illegible]
	86-181	86-181			< 0.030	(1)	< 0.030	[illegible]	< 0.018	(1)	< 0.010	(1)	< 0.600	[illegible]
		86-182			< 0.030	(1)	< 0.030	(1)	< 0.018	(1)	< 0.010	(1)	< 0.600	(1)
ENYEART	SITE-209	SITE-209					0.05[illegible]	(0)						
	SITE-210	SITE-210	< 0.030	(0)			0.130	(0)			< 0.020	(0)		
	84-168	84-168	< 0.036	(1)	< 0.006	(1)	0.074	(1)	0.016	(1)	0.057	(1)	< 0.020	[illegible]
		84-184	< 0.036	(1)	< 0.006	(1)	0.07[illegible]	(1)	0.015	(1)	0.057	(1)	< 0.020	(1)
	85-180	85-180	< 0.032	(1)	< 0.006	(1)	0.050	(1)	< 0.008	(1)	0.032	(1)	< 0.034	(1)
		85-181	< 0.032	(1)	< 0.006	(1)	0.045	(1)	< 0.008	(1)	0.032	(1)	< 0.034	[illegible]
FORD	SITE-206	SITE-206					0.020	(0)						
	SITE-207	SITE-207	< 0.030	(0)	< 0.050	(0)	0.080	(0)	< 0.020	(0)	0.200	(0)		
	SITE-219	SITE-219												
	85-188	85-188	< 0.032	(1)	< 0.006	(1)	0.12[illegible]	(1)	0.014	(1)	0.065	(1)	< 0.034	[illegible]
		85-189	< 0.032	(1)	< 0.006	(1)	0.140	(1)	0.014	(1)	0.064	(1)	< 0.034	[illegible]
	85-303	85-303	< 0.032	(1)	< 0.006	(1)	0.092	[illegible]	0.014	(1)	0.056	(1)	< 0.034	[illegible]
		85-304	< 0.032	(1)	< 0.006	(1)	0.10[illegible]	(1)	0.013	(1)	0.062	(1)	< 0.034	[illegible]
MCGEE	SITE-220	SITE-220												
	82-7	82-52	< 0.030	(1)	< 0.006	(1)	0.[illegible]	[illegible]	0.013	(1)	0.058	(1)	< 0.020	[illegible]
		82-7	< 0.030	(1)	< 0.006	(1)	0.060	(1)	0.014	(1)	0.054	(1)	< 0.020	[illegible]
	85-175	85-175	< 0.032	(1)	< 0.006	(1)	0.05[illegible]	(1)	< 0.008	(1)	0.034	(1)	< 0.034	[illegible]

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
DC-16C	83-100	83-30	< 0.030	(1)	2.100	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
	83-259	83-215	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.005	(1)	< 0.010	(1)
		83-259	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.005	(1)	< 0.010	(1)
DC-18	86-166	86-166							0.002	(1)	< 0.040	(1)
		86-167							0.002	(1)	< 0.040	(1)
DC-19C	84-53	84-53	< 0.020	(1)	0.440	(1)	< 0.150	(1)	0.006	(1)	0.020	(1)
		84-84	< 0.020	(1)	0.410	(1)	< 0.150	(1)	0.006	(1)	0.020	(1)
	84-40	84-40	< 0.020	(1)	0.470	(1)	< 0.150	(1)	0.008	(1)	0.160	(1)
		84-77	< 0.020	(1)	0.430	(1)	< 0.150	(1)	0.009	(1)	0.160	(1)
	84-75	84-29	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.009	(1)	1.340	(1)
		84-75	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.009	(1)	1.490	(1)
	84-86	84-18	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.020	(1)	0.020	(1)
		84-86	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.017	(1)	< 0.010	(1)
DC-20C	84-9	84-49	< 0.020	(1)	0.350	(1)	< 0.150	(1)	0.005	(1)	0.040	(1)
		84-9	< 0.020	(1)	0.400	(1)	< 0.150	(1)	0.005	(1)	0.040	(1)
DC-22C	84-105	84-105	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.006	(1)	< 0.010	(1)
		84-153	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.006	(1)	< 0.010	(1)
DC-23GR	86-133	86-133							0.013	(1)	< 0.040	(1)
		86-134							0.013	(1)	< 0.040	(1)
	86-141	86-141							0.014	(1)	< 0.040	(1)
		86-142							0.014	(1)	< 0.040	(1)
	86-181	86-181							0.005	(1)	< 0.040	(1)
		86-182							0.005	(1)	< 0.040	(1)
ENYEART	SITE-209	SITE-209										
	SITE-210	SITE-210			0.010	(0)						
	84-166	84-166	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.065	(1)	< 0.015	(1)
		84-184	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.065	(1)	< 0.015	(1)
	85-180	85-180	< 0.030	(1)			< 0.180	(1)	0.057	(1)	< 0.020	(1)
		85-181	< 0.030	(1)			< 0.180	(1)	0.057	(1)	< 0.020	(1)
FORD	SITE-206	SITE-206										
	SITE-207	SITE-207	< 0.050	(0)			< 0.100	(0)	< 0.050	(0)	< 0.010	(0)
	SITE-219	SITE-219										
	85-188	85-188	< 0.030	(1)			< 0.180	(1)	0.072	(1)	< 0.020	(1)
		85-189	< 0.030	(1)			< 0.180	(1)	0.071	(1)	< 0.020	(1)
	85-303	85-303	< 0.030	(1)			< 0.130	(1)	0.054	(1)	< 0.020	(1)
		85-304	< 0.030	(1)			< 0.180	(1)	0.061	(1)	< 0.020	(1)
MCGEE	SITE-220	SITE-220										
	82-7	82-52	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.059	(1)	< 0.010	(1)
		82-7	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.057	(1)	< 0.010	(1)
	85-175	85-175	< 0.030	(1)			< 0.180	(1)	0.054	(1)	< 0.020	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
MCGEE	85-175	85-178	< 0.050	(1)			0.017	(1)	0.032	(1)			< 0.017	(1)
	85-300	85-300	< 0.060	(1)			< 0.020	(1)	0.022	(1)			< 0.017	(1)
		85-301	< 0.060	(1)			< 0.020	(1)	0.022	(1)			< 0.017	(1)
	86-34	86-34	< 0.200	(1)			< 0.100	(1)	0.020	(1)				
		86-35	< 0.200	(1)			< 0.100	(1)	0.021	(1)				
	80-64	80-64	0.036	(1)			0.025	(1)	0.018	(1)			< 0.010	(1)
		80-88	0.020	(1)			0.023	(1)	0.0??	(1)			< 0.010	(1)
	81-70	81-73	0.040	(1)			< 0.005	(1)	0.033	(1)			< 0.010	(1)
		81-79	0.050	(1)			< 0.005	(1)	0.025	(1)			< 0.010	(1)
	81-54	81-54	0.050	(1)			< 0.005		0.080	(1)			< 0.010	(1)
		81-56	0.050	(1)			< 0.005		0.052	(1)			< 0.010	(1)
	82-64	82-11	< 0.080	(1)			< 0.020	(1)	0.022	(1)			< 0.010	(1)
		82-64	< 0.080	(1)			< 0.020	(1)	0.02?	(1)			< 0.010	(1)
	82-263	82-263	< 0.030	(1)			< 0.020	(1)	0.009	(1)			< 0.010	(1)
		82-283	< 0.080	(1)			< 0.020	(1)	0.009	(1)			< 0.010	(1)
	82-397	82-325	< 0.080	(1)			0.020	(1)	0.011	(1)			< 0.010	(1)
		82-397	< 0.080	(1)			0.020		0.011	(1)			< 0.010	(1)
	82-424	82-424	0.250	(1)			< 0.020	(1)	0.006	(1)			< 0.010	(1)
		82-474	0.260	(1)			< 0.020	(1)	0.005	(1)			< 0.010	(1)
	82-436	82-436	0.250	(1)			< 0.02?		0.003	(1)			< 0.010	
		82-498	0.240	(1)			< 0.02?		0.003	(1)			< 0.010	(1)
	83-32	83-32	< 0.080	(1)			< 0.020	(1)	0.011	(1)			< 0.010	(1)
		83-63	< 0.080	(1)			< 0.020	(1)	0.011	(1)			< 0.010	(1)
	83-83	83-27	< 0.080	(1)			< 0.020	(1)	0.007	(1)			< 0.010	(1)
		83-83	< 0.080	(1)			< 0.020		0.007	(1)			< 0.010	(1)
	83-188	83-113	< 0.080	(1)			< 0.020	(1)	0.008	(1)			< 0.010	(1)
		83-188	< 0.080	(1)			< 0.020	(1)	0.005	(1)			< 0.010	(1)
	83-373	83-323	< 0.080	(1)			0.040	(1)	0.009	(1)			< 0.010	(1)
			0.020	(2)										
		83-373	< 0.080	(1)			0.030	(1)	0.008	(1)			< 0.010	(1)
			0.024	(2)										
	83-331	83-331	< 0.060	(1)			0.050	(1)	< 0.002	(1)			< 0.010	(1)
			0.046	(2)										
		83-344	< 0.030	(1)			0.050	(1)	< 0.001	(1)			< 0.010	(1)
			0.053	(2)										
	83-450	83-450	< 0.080	(1)			0.080		0.004	(1)			< 0.010	
		83-474	< 0.080	(1)			0.060		< 0.001	(1)			< 0.010	
	83-476	83-417	< 0.080	(1)			0.040		0.002	(1)			< 0.010	
		83-476	< 0.080	(1)			0.040		0.002	(1)			< 0.010	(1)
	83-513	83-513	< 0.080	(1)			0.110		< 0.002	(1)			< 0.010	(1)
		83-545	< 0.080	(1)			0.110	(1)	< 0.002	(1)			< 0.010	
	84-24	84-24	0.080	(1)			0.120		< 0.00?	(1)			< 0.010	
		84-38	0.110	(1)			0.130		< 0.001	(1)			< 0.010	
DURIAN	85-194	85-194	< 0.050	(1)			< 0.015		0.022	(1)			< 0.017	
		85-195	< 0.060	(1)			< 0.013		0.024	(1)			< 0.017	
XXI-02	82-68	82-28	< 0.080	(1)			0.380		0.027	(1)			< 0.010	

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
MCGEE	85-175	85-176	< 0.032	(1)	< 0.006	(1)	0.052	(1)	< 0.008	(1)	0.034	(1)	< 0.034	(1)
	85-300	85-300	< 0.032	(1)	< 0.006	(1)	0.134	(1)	0.015	(1)	0.053	(1)	< 0.034	(1)
		85-301	< 0.032	(1)	< 0.006	(1)	0.135	(1)	0.017	(1)	0.054	(1)	< 0.034	(1)
	86-34	86-34			< 0.012	(1)	0.114	(1)	0.018	(1)	0.044	(1)	< 0.600	(1)
		86-35			< 0.012	(1)	0.113	(1)	0.017	(1)	0.044	(1)	< 0.600	(1)
	80-64	80-64	0.008	(1)	< 0.002	(1)	0.098	(1)	< 0.020	(1)	0.057	(1)	< 0.030	(1)
		80-88	0.008	(1)	< 0.002	(1)	0.096	(1)	< 0.020	(1)	0.057	(1)	< 0.030	(1)
	81-79	91-73	< 0.036	(1)	< 0.002	(1)	0.150	(1)	0.091	(1)	0.290	(1)	0.110	(1)
		81-79	< 0.036	(1)	< 0.002	(1)	0.150	(1)	0.082	(1)	0.360	(1)	< 0.030	(1)
	81-54	81-54	< 0.036	(1)	< 0.002	(1)	0.260	(1)	0.074	(1)	0.403	(1)	< 0.020	(1)
		81-56	< 0.036	(1)	< 0.002	(1)	0.260	(1)	0.105	(1)	0.505	(1)	0.310	(1)
	82-64	82-11	< 0.030	(1)	< 0.006	(1)	0.050	(1)	0.013	(1)	0.058	(1)	< 0.020	(1)
		82-64	< 0.030	(1)	< 0.006	(1)	0.050	(1)	0.010	(1)	0.058	(1)	< 0.020	(1)
	82-263	82-263	< 0.030	(1)	< 0.006	(1)	0.160	(1)	0.011	(1)	0.048	(1)	< 0.010	(1)
		82-283	< 0.030	(1)	< 0.006	(1)	0.170	(1)	0.010	(1)	0.049	(1)	< 0.010	(1)
	82-397	82-325	< 0.030	(1)	< 0.006	(1)	0.100	(1)	0.016	(1)	0.048	(1)	< 0.020	(1)
		82-397	< 0.030	(1)	< 0.006	(1)	0.100	(1)	0.017	(1)	0.050	(1)	< 0.020	(1)
	82-424	82-424	< 0.030	(1)	< 0.006	(1)	0.160	(1)	0.009	(1)	0.045	(1)	< 0.020	(1)
		82-474	< 0.030	(1)	< 0.006	(1)	0.160	(1)	0.011	(1)	0.046	(1)	< 0.020	(1)
	82-436	82-436	< 0.030	(1)	< 0.006	(1)	0.060	(1)	0.011	(1)	0.045	(1)	< 0.020	(1)
		82-498	< 0.030	(1)	< 0.006	(1)	0.060	(1)	0.010	(1)	0.046	(1)	< 0.020	(1)
	83-32	83-32	< 0.040	(1)	< 0.010	(1)	0.490	(1)	0.013	(1)	0.062	(1)	< 0.020	(1)
		83-63	< 0.040	(1)	< 0.010	(1)	0.500	(1)	0.012	(1)	0.064	(1)	< 0.020	(1)
	83-83	83-27	< 0.040	(1)	< 0.010	(1)	0.110	(1)	0.013	(1)	0.046	(1)	< 0.020	(1)
		83-83	< 0.040	(1)	< 0.010	(1)	0.120	(1)	0.014	(1)	0.046	(1)	< 0.020	(1)
	83-188	83-113	< 0.040	(1)	< 0.010	(1)	0.110	(1)	0.016	(1)	0.042	(1)	< 0.020	(1)
		83-188	< 0.040	(1)	< 0.010	(1)	0.110	(1)	0.016	(1)	0.044	(1)	< 0.020	(1)
	83-373	83-323	< 0.040	(1)	< 0.010	(1)	0.060	(1)	0.014	(1)	< 0.004 0.005	(1) (2)	< 0.020	(1)
		83-373	< 0.040	(1)	< 0.010	(1)	0.060	(1)	0.014	(1)	< 0.004 0.005	(1) (2)	< 0.020	(1)
	83-331	83-331	< 0.040	(1)	< 0.010	(1)	0.080	(1)	0.017	(1)	< 0.004 0.005	(1) (2)	< 0.020	(1)
		83-344	< 0.040	(1)	< 0.010	(1)	0.090	(1)	0.013	(1)	< 0.004 0.005	(1) (2)	< 0.020	(1)
	83-460	83-460	< 0.040	(1)	< 0.010	(1)	0.060	(1)	0.015	(1)	< 0.004	(1)	< 0.020	(1)
		83-474	< 0.040	(1)	< 0.010	(1)	0.050	(1)	0.013	(1)	< 0.004	(1)	< 0.020	(1)
	83-476	83-417	< 0.040	(1)	< 0.010	(1)	0.070	(1)	0.016	(1)	0.004	(1)	< 0.020	(1)
		83-476	< 0.040	(1)	< 0.010	(1)	0.050	(1)	0.015	(1)	< 0.004	(1)	< 0.020	(1)
	83-513	83-513	< 0.040	(1)	< 0.010	(1)	0.130	(1)	0.011	(1)	< 0.004	(1)	0.050	(1)
		83-545	< 0.040	(1)	< 0.010	(1)	0.140	(1)	0.012	(1)	0.004	(1)	0.050	(1)
	84-24	84-24	< 0.040	(1)	< 0.010	(1)	0.190	(1)	0.017	(1)	0.005	(1)	0.030	(1)
		84-38	< 0.040	(1)	< 0.010	(1)	0.170	(1)	0.020	(1)	0.005	(1)	0.040	(1)
OBRIAN	85-194	85-194	< 0.032	(1)	< 0.006	(1)	0.210	(1)	0.012	(1)	0.068	(1)	< 0.034	(1)
		85-195	< 0.032	(1)	< 0.006	(1)	0.210	(1)	0.016	(1)	0.056	(1)	< 0.034	(1)
RRI-02	82-68	82-28	0.040	(1)	< 0.006	(1)	6.300	(1)	0.012	(1)	0.081	(1)	0.100	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SB MG/L	(A)	ZN MG/L	(A)
MCGEE	85-175	85-176	< 0.030	(1)			< 0.180	(1)	0.056	(1)	< 0.020	(1)
	85-300	85-300	< 0.030	(1)			< 0.180	(1)	0.057	(1)	< 0.020	(1)
		85-301	< 0.030	(1)			< 0.180	(1)	0.057	(1)	< 0.020	(1)
	86-34	86-34							0.057	(1)	< 0.040	(1)
		86-35							0.058	(1)	< 0.040	(1)
	80-64	80-64	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.062	(1)	< 0.002	(1)
		80-88	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.062	(1)	< 0.002	(1)
	81-79	81-73	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.064	(1)	< 0.002	(1)
		81-79	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.055	(1)	< 0.002	(1)
	81-54	81-54	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.055	(1)	< 0.015	(1)
		81-56	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.064	(1)	< 0.015	(1)
	82-64	82-11	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.062	(1)	< 0.010	(1)
		82-64	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.052	(1)	< 0.010	(1)
	82-263	82-263	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.058	(1)	< 0.010	(1)
		82-283	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.057	(1)	< 0.010	(1)
	82-397	82-325	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.061	(1)	< 0.010	(1)
		82-397	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.051	(1)	< 0.010	(1)
	82-424	82-424	< 0.020	(1)	< 0.340	(1)	0.170	(1)	0.051	(1)	< 0.010	(1)
		82-474	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.062	(1)	< 0.010	(1)
	82-436	82-436	< 0.020	(1)	< 0.340	(1)	0.200	(1)	0.050	(1)	< 0.010	(1)
		82-498	< 0.020	(1)	< 0.340	(1)	0.200	(1)	0.062	(1)	< 0.010	(1)
	83-32	83-32	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.050	(1)	< 0.010	(1)
		83-63	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.050	(1)	< 0.010	(1)
	83-83	83-27	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.063	(1)	< 0.010	(1)
		83-83	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.064	(1)	< 0.010	(1)
	83-188	83-113	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.054	(1)	< 0.010	(1)
		83-188	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.054	(1)	< 0.010	(1)
	83-373	83-323	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.015	(1)	< 0.010	(1)
		83-373	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.015	(1)	< 0.010	(1)
	83-331	83-331	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-344	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.002	(1)	< 0.010	(1)
	83-460	83-460	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.002	(1)	< 0.010	(1)
		83-474	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.001	(1)	< 0.010	(1)
	83-476	83-417	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-476	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	< 0.002	(1)	< 0.010	(1)
	83-513	83-513	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.003	(1)	< 0.010	(1)
		83-545	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.004	(1)	< 0.010	(1)
	84-24	84-24	< 0.030	(1)			< 0.150	(1)	0.003	(1)	< 0.010	(1)
		84-38	< 0.030	(1)			< 0.150	(1)	0.033	(1)	< 0.010	(1)
DURIAN	85-194	85-194	< 0.030	(1)			< 0.150	(1)	0.058	(1)	< 0.020	(1)
		85-195	< 0.030	(1)			< 0.150	(1)	0.056	(1)	< 0.020	(1)
KRL-02	82-68	82-28	< 0.030	(1)	0.420	(1)	< 0.150	(1)	0.009	(1)	0.050	(1)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
RRL-02	82-68	82-68	< 0.080	(1)			0.380	(1)	0.019	(1)			< 0.010	(1)
			0.043	(2)										
	82-65	82-65	< 0.080	(1)			0.360	(1)	0.005	(1)			< 0.010	(1)
		82-75	< 0.080	(1)			0.350	(1)	0.002	(1)			< 0.010	(1)
			0.042	(2)										
	82-170	82-163	< 0.080	(1)			1.110	(1)	0.025	(1)			< 0.010	(1)
			0.087	(2)										
		82-170	< 0.080	(1)			1.090	(1)	0.024	(1)			< 0.010	(1)
	82-122	82-122	< 0.080	(1)			2.610	(1)	0.004	(1)			< 0.010	(1)
			0.027	(2)										
		82-192	< 0.080	(1)			2.680	(1)	0.003	(1)			< 0.010	(1)
	82-401	82-401	0.410	(1)			3.500	(1)	0.002	(1)			< 0.010	(1)
			0.129	(2)										
		82-479	0.410	(1)			3.510	(1)	0.002	(1)			< 0.010	(1)
	84-7	84-43	< 0.080	(1)			2.900	(1)	< 0.001	(1)			< 0.015	(1)
		84-7	< 0.090	(1)			2.910	(1)	< 0.001	(1)			< 0.010	(1)
	82-364	82-364	< 0.070	(1)			3.440	(1)	0.004	(1)			< 0.010	(1)
			0.096	(2)										
		82-381	0.080	(1)			3.520	(1)	0.005	(1)			< 0.010	(1)
	82-309	82-309	0.110	(1)			3.140	(1)	0.003	(1)			< 0.010	(1)
			0.195	(2)										
		82-351	0.100	(1)			3.090	(1)	0.007	(1)			< 0.010	(1)
	82-456	82-413	0.350	(1)			3.480	(1)	0.002	(1)			< 0.010	(1)
		82-456	0.330	(1)			3.510	(1)	0.005	(1)			< 0.010	(1)
RRL-14	82-403	82-403	0.320	(1)			2.250	(1)	0.004	(1)			< 0.010	(1)
			0.075	(2)										
		82-489	0.410	(1)			2.240	(1)	0.005	(1)			< 0.010	(1)
STEM-1	85-252	85-252	< 0.060	(1)			< 0.016	(1)	0.015	(1)			< 0.017	(1)
		85-253	< 0.060	(1)			< 0.016	(1)	0.014	(1)			< 0.017	(1)
	85-297	85-297	< 0.060	(1)			< 0.016	(1)	0.019	(1)			< 0.017	(1)
		85-298	< 0.060	(1)			< 0.016	(1)	0.018	(1)			< 0.017	(1)
	86-31	86-31	< 0.200	(1)			< 0.100	(1)	0.017	(1)				
		86-32	< 0.200	(1)			< 0.100	(1)	0.017	(1)				
STEM-2	86-19	86-19	< 0.200	(1)			< 0.100	(1)	0.018	(1)				
		86-20	< 0.200	(1)			< 0.100	(1)	0.018	(1)				
299-E18-01	SITE-161	SITE-161							0.059	(0)			< 0.038	(0)
	SITE-162	SITE-162												
	SITE-163	SITE-163												
	SITE-164	SITE-164												
299-E28-08	SITE-166	SITE-166												
	SITE-167	SITE-167							0.092	(0)				
	SITE-168	SITE-168							0.092	(0)				

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
RRI-02	82-68	82-68	0.040	(1)	< 0.008	(1)	6.600	(1)	0.011	(1)	0.085	(1)	0.100	[illegible]
											0.115	(2)		
	82-65	82-65	< 0.030	(1)	< 0.006	(1)	0.[illegible]	(1)	0.007	(1)	0.011	(1)	0.[illegible]	(1)
		82-75	< 0.030	(1)	< 0.006	(1)	0.320	(1)	< 0.006	(1)	0.009	(1)	0.110	(1)
											0.011	(2)		
	82-170	82-163	< 0.030	(1)	< 0.006	(1)	0.100	(1)	0.018	(1)	0.016	(1)	0.050	(1)
											0.030	(2)		
		82-170	< 0.030	(1)	< 0.006	(1)	0.110	(1)	0.017	(1)	0.015	(1)	0.050	(1)
	82-122	82-122	< 0.030	(1)	< 0.006	(1)	0.820	(1)	0.020	(1)	0.032	(1)	0.110	(1)
											0.050	(2)		
		82-392	< 0.030	(1)	< 0.006	(1)	0.810	(1)	0.020	(1)	0.031	(1)	0.130	(1)
	82-401	82-401	< 0.030	(1)	< 0.006	(1)	0.130	(1)	0.026	(1)	0.004	(1)	0.280	(1)
											0.005	(2)		
		82-479	< 0.030	(1)	< 0.006	(1)	0.130	(1)	0.025	(1)	0.004	(1)	0.270	(1)
	84-7	84-43	< 0.036	(1)	< 0.006	(1)	0.080	(1)	0.023	(1)	< 0.004	(1)	0.290	(1)
		84-7	< 0.040	(1)	< 0.006	(1)	0.090	[illegible]	0.023	(1)	< 0.004	(1)	0.290	(1)
	82-364	82-364	< 0.030	(1)	< 0.006	(1)	0.050	[illegible]	0.042	(1)	< 0.003	(1)	0.270	[illegible]
											0.001	(2)		
		82-381	< 0.030	(1)	< 0.008	(1)	[illegible]	(1)	0.064	(1)	< 0.003	(1)	0.230	[illegible]
	82-309	82-309	< 0.030	(1)	< 0.006	(1)	0.340	(1)	0.026	(1)	0.007	(1)	0.240	(1)
											0.009	(2)		
		82-351	< 0.030	(1)	< 0.006	(1)	0.120	(1)	0.027	(1)	0.007	(1)	0.240	(1)
	82-456	82-413	< 0.030	(1)	< 0.006	(1)	0.080	(1)	0.042	(1)	< 0.004	(1)	0.260	(1)
		82-456	< 0.030	(1)	< 0.006	(1)	0.050	(1)	0.041	(1)	< 0.004	(1)	0.260	(1)
RRI-14	82-403	82-403	< 0.030	(1)	< 0.006	(1)	0.170	(1)	0.021	(1)	< 0.004	(1)	0.390	(1)
											0.005	(2)		
		82-489	< 0.030	(1)	< 0.006	(1)	0.20[illegible]	(1)	0.022	(1)	0.004	(1)	0.390	[illegible]
STEM-1	85-252	85-252	< 0.032	(1)	< 0.006	(1)	0.04[illegible]	(1)	< 0.008	(1)	0.037	(1)	< 0.034	[illegible]
		85-253	< 0.032	(1)	< 0.006	(1)	0.0[illegible]	(1)	< 0.008	(1)	0.03[illegible]	(1)	< 0.034	[illegible]
	85-297	85-297	< 0.032	(1)	< 0.006	(1)	0.0[illegible]	(1)	0.012	(1)	0.042	[illegible]	< 0.034	
		85-298	< 0.032	(1)	< 0.006	(1)	0.024	(1)	0.012	(1)	0.049	[illegible]	< 0.034	
	86-31	86-31			< 0.012	(1)	0.035	(1)	< 0.036	(1)	0.033	(1)	< 0.600	(1)
		86-32			< 0.012	(1)	0.0[illegible]	(1)	< 0.0[illegible]	(1)	0.032	(1)	< 0.5[illegible]	(1)
STEM-2	86-19	86-19			< 0.012	(1)	0.0[illegible]	(1)	< 0.015	(1)	0.035	(1)	< 0.6[illegible]	(1)
		86-20			< 0.012	(1)	0.048	(1)	< 0.013	(1)	0.034	(1)	< 0.500	(1)
299-E16-01	SITE-161	SITE-161	< 0.030	(0)	< 0.001	(0)	0.040	[illegible]						
	SITE-162	SITE-162					< 0.030	[illegible]						
	SITE-163	SITE-163					0.040	[illegible]						
	SITE-164	SITE-164					0.0[illegible]	[illegible]						
299-E26-08	SITE-166	SITE-166					< [illegible]	[illegible]						
	SITE-167	SITE-167	< 0.012	(0)	< 0.001	(0)	< 0.030	[illegible]						
	SITE-168	SITE-168	< 0.012	(0)	< 0.001	(0)	< 0.030	(0)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
RRL-02	82-68	82-68	< 0.030	(1)	0.420	(1)	< 0.150	(1)	0.009	(1)	0.050	(1)
	82-65	82-65	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.005	(1)	0.020	(1)
		82-75	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.005	(1)	< 0.010	(1)
	82-170	82-163	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.040	(1)	< 0.010	(1)
		82-170	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.040	(1)	< 0.010	(1)
	82-122	82-122	< 0.020	(1)	3.500	(1)	< 0.150	(1)	0.010	(1)	< 0.010	(1)
		82-192	< 0.020	(1)	3.200	(1)	< 0.150	(1)	0.010	(1)	< 0.010	(1)
	82-401	82-401	< 0.020	(1)	1.300	(1)	< 0.150	(1)	0.009	(1)	< 0.010	(1)
		82-479	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.009	(1)	< 0.010	(1)
	84-7	84-43	< 0.026	(1)			< 0.150	(1)	0.015	(1)	< 0.015	(1)
		84-7	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.015	(1)	< 0.010	(1)
	82-364	82-364	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.005	(1)	< 0.010	(1)
		82-381	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.006	(1)	0.020	(1)
	82-309	82-309	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	0.020	(1)
		82-351	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	0.020	(1)
	82-456	82-413	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.011	(1)	< 0.010	(1)
		82-456	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.010	(1)	< 0.010	(1)
RRL-14	82-403	82-403	< 0.020	(1)	0.500	(1)	< 0.150	(1)	0.009	(1)	< 0.010	(1)
		82-489	< 0.020	(1)	0.500	(1)	0.170	(1)	0.010	(1)	0.030	(1)
STEM-1	85-252	85-252	< 0.030	(1)			< 0.180	(1)	0.056	(1)	< 0.020	(1)
		85-253	< 0.030	(1)			< 0.180	(1)	0.056	(1)	< 0.020	(1)
	85-297	85-297	< 0.030	(1)			< 0.180	(1)	0.062	(1)	< 0.020	(1)
		85-298	< 0.030	(1)			< 0.180	(1)	0.063	(1)	< 0.020	(1)
	86-31	86-31							0.063	(1)	< 0.040	(1)
		86-32							0.063	(1)	< 0.040	(1)
STEM-2	86-19	86-19							0.062	(1)	< 0.040	(1)
		86-20							0.061	(1)	< 0.040	(1)
299-E16-01	SITE-161	SITE-161	< 0.012	(0)			< 0.020	(0)			0.081	(0)
	SITE-162	SITE-162										
	SITE-163	SITE-163										
	SITE-164	SITE-164										
299-E26-08	SITE-166	SITE-166										
	SITE-167	SITE-167	< 0.002	(0)			< 0.049	(0)			0.117	(0)
	SITE-168	SITE-168	< 0.002	(0)			< 0.049	(0)			0.117	(0)

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
299-E33-12	SITE-170	SITE-170												
	SITE-171	SITE-171							0.093	(0)			< 0.008	(0)
	SITE-172	SITE-172							0.098	(0)			< 0.008	(0)
699-S11-E12A	80-61	80-61	0.050	(1)			0.043	(1)	0.049	(1)			< 0.01[illegible]	[illegible]
		80-[illegible]	0.030	(1)			0.043	[illegible]	0.049	(1)			< 0.0[illegible]	[illegible]
	80-180	80-138	0.090	(1)			0.050	(1)	< 0.005	(1)			< 0.010	(1)
		80-180	0.070	(1)			0.040	(1)	3.230	(1)			< 0.010	(1)
699-42-40C	SITE-176	SITE-176												
	SITE-177	SITE-177												
	SITE-178	SITE-178												
	SITE-179	SITE-179												
	SITE-180	SITE-180							0.110	(0)			< 0.010	(0)
699-47-50	SITE-181	SITE-181							0.033	(0)			< 0.018	(0)
699-49-55B	SITE-183	SITE-183												
	SITE-184	SITE-184												
	SITE-185	SITE-185							0.105	(0)			< 0.014	(0)
699-50-45	SITE-186	SITE-186							0.090	(0)			< 0.01[illegible]	(0)
699-50-48	SITE-187	SITE-187							0.044	(0)			< 0.037	(0)
699-51-46	SITE-188	SITE-188							0.0[illegible]	(0)			< 0.160	(0)
699-52-46A	SITE-189	SITE-189							0.059	(0)			< 0.005	(0)
699-52-48	SITE-190	SITE-190							0.064	(0)			< 0.008	(0)
699-53-50	SITE-191	SITE-191							[illegible]	(0)			< 0.010	(0)
699-54-57	SITE-192	SITE-192							[illegible]	(0)				
699-56-53	SITE-196	SITE-196							[illegible]	(0)			< 0.0[illegible]	(0)
	SITE-197	SITE-197							0.098	(0)			< 0.012	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
299-E33-12	SITE-170	SITE-170					< 0.030	(0)						
	SITE-171	SITE-171	< 0.009	(0)	< 0.001	(0)	< 0.030	(0)			< 0.002	(0)		
	SITE-172	SITE-172	< 0.009	(0)	< 0.001	(0)	< 0.030	(0)			< 0.002	(0)		
699-S11-E12A	80-61	80-61	0.009	(1)	< 0.002	(1)	0.074	(1)	< 0.020	(1)	0.052	(1)	< 0.030	(1)
		80-7	0.008	(1)	< 0.002	(1)	0.084	(1)	< 0.020	(1)	0.006	(1)	< 0.030	(1)
	80-180	80-138	< 0.003	(1)	< 0.002	(1)	0.080	(1)			0.071	(1)	< 0.030	(1)
		80-180	< 0.003	(1)	< 0.002	(1)	0.080	(1)			0.064	(1)	< 0.030	(1)
699-42-40C	SITE-176	SITE-176					2.720	(0)						
	SITE-177	SITE-177					< 0.030	(0)						
	SITE-178	SITE-178					< 0.030	(0)						
	SITE-179	SITE-179					< 0.030	(0)						
	SITE-180	SITE-180	< 0.030	(0)	< 0.006	(0)	0.008	(0)			0.100	(0)		
699-47-50	SITE-181	SITE-181			< 0.001	(0)	0.060	(0)						
699-49-55B	SITE-183	SITE-183					< 0.030	(0)						
	SITE-184	SITE-184					< 0.030	(0)						
	SITE-185	SITE-185			< 0.001	(0)	< 0.030	(0)			< 0.003	(0)		
699-50-45	SITE-186	SITE-186	< 0.010	(0)	< 0.001	(0)	0.040	(0)						
699-50-48	SITE-187	SITE-187	< 0.030	(0)	< 0.001	(0)	< 0.030	(0)			0.033	(0)		
699-51-46	SITE-188	SITE-188			< 0.001	(0)	0.300	(0)						
699-52-46A	SITE-189	SITE-189	< 0.007	(0)	< 0.001	(0)	< 0.030	(0)			< 0.003	(0)		
699-52-48	SITE-190	SITE-190	< 0.007	(0)	< 0.001	(0)	< 0.030	(0)			0.005	(0)		
699-53-50	SITE-191	SITE-191			< 0.001	(0)	0.030	(0)						
699-54-57	SITE-192	SITE-192			< 0.001	(0)	< 0.030	(0)						
699-56-53	SITE-196	SITE-196			< 0.001	(0)	< 0.030	(0)						
	SITE-197	SITE-197			< 0.001	(0)	< 0.030	(0)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
299-E33-12	SITE-170	SITE-170										
	SITE-171	SITE-171	< 0.002	(0)			< 0.048	(0)			0.097	(0)
	SITE-172	SITE-172	< 0.002	(0)			< 0.043	(0)			0.097	(0)
699-S11-E12A	80-61	80-61	< 0.020	(1)	0.200	(1)	< 0.100	(1)	0.115	(1)	0.012	(1)
		80-7	< 0.020	(1)	0.200	(1)	< 0.100	(1)	0.118	(1)	0.010	(1)
	80-180	80-138	< 0.020	(1)	0.260	(1)	< 0.100	(1)	0.092	(1)	< 0.002	(1)
		80-180	< 0.020	(1)	0.200	(1)	< 0.100	(1)	0.100	(1)	< 0.002	(1)
699-42-40C	SITE-176	SITE-176										
	SITE-177	SITE-177										
	SITE-178	SITE-178										
	SITE-179	SITE-179										
	SITE-180	SITE-180	< 0.020	(0)			< 0.150	(0)			0.020	(0)
699-47-50	SITE-181	SITE-181	< 0.002	(0)			< 0.028	(0)			0.007	(0)
699-49-55B	SITE-183	SITE-183										
	SITE-184	SITE-184										
	SITE-185	SITE-185	< 0.002	(0)			< 0.015	(0)			0.140	(0)
699-50-45	SITE-186	SITE-186	< 0.006	(0)			< 0.025	(0)			0.117	(0)
699-50-48	SITE-187	SITE-187	< 0.018	(0)			< 0.013	(0)			0.085	(0)
699-51-46	SITE-188	SITE-188	< 0.003	(0)			< 0.018	(0)			0.150	(0)
699-52-46A	SITE-189	SITE-189	< 0.003	(0)			< 0.011	(0)			[illegible]	(0)
699-52-48	SITE-190	SITE-190	< 0.003	(0)			< [illegible]	(0)			0.088	(0)
699-53-50	SITE-191	SITE-191	< 0.014	(0)			< [illegible]	(0)			[illegible]	(0)
699-54-57	SITE-192	SITE-192	< 0.014	(0)			< [illegible]	(0)			0.22[illegible]	(0)
699-56-53	SITE-196	SITE-196	< 0.014	(0)			< [illegible]	(0)			[illegible]	(0)
	SITE-197	SITE-197	< 0.014	(0)			< 0.02[illegible]	(0)			[illegible]	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
STATION-03	82-51	82-51	< 0.076	(1)			< 0.023	(1)	0.016	(1)			< 0.015	(1)
STATION-04	82-61	82-61	0.233	(1)			< 0.023	(1)	0.009	(1)			< 0.015	(1)
STATION-07	82-92	82-92	< 0.076	(1)			< 0.023	(1)	0.002	(1)			< 0.015	(1)
STATION-14	82-20	82-20	< 0.076	(1)			< 0.023	(1)	0.003	(1)			< 0.015	(1)
STATION-17	82-70	82-70	< 0.076	(1)			< 0.023	(1)	0.002	(1)			< 0.015	(1)
STATION-20	82-58	82-58	< 0.076	(1)			< 0.023	(1)	0.001	(1)			< 0.015	(1)
	82-74	82-74	< 0.076	(1)			< 0.023	(1)	< 0.001	(1)			< 0.015	(1)
STATION-25	82-83	82-83	0.111	(1)			< 0.023	(1)	0.004	(1)			< 0.015	(1)
	82-66	82-66	< 0.076	(1)			< 0.023	(1)	< 0.001	(1)			< 0.015	(1)
STATION-26	82-91	82-91	< 0.076	(1)			< 0.023	(1)	0.001	(1)			< 0.015	(1)
	82-98	82-98	< 0.076	(1)			< 0.023	(1)	< 0.001	(1)			< 0.015	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
STATION-03	82-51	82-51	< 0.036	(1)	< 0.006	(1)	0.063	(1)	< 0.006	(1)	0.006	(1)	< 0.020	(1)
STATION-04	82-61	82-61	< 0.036	(1)	< 0.006	(1)	0.493	(1)	< 0.006	(1)	0.024	(1)	< 0.020	(1)
STATION-07	82-92	82-92	< 0.036	(1)	< 0.006	(1)	0.087	(1)	< 0.008	(1)	0.005	(1)	< 0.020	(1)
STATION-14	82-20	82-20	< 0.036	(1)	< 0.006	(1)	0.202	(1)	< 0.006	(1)	0.007	(1)	< 0.020	(1)
STATION-17	82-70	82-70	< 0.036	(1)	< 0.006	(1)	[illegible]	(1)	< 0.008	(1)	0.010	(1)	< 0.020	(1)
STATION-20	82-58	82-58	< 0.036	(1)	< 0.006	(1)	0.803	(1)	< 0.005	(1)	0.009	(1)	< 0.020	(1)
	82-74	82-74	< 0.036	(1)	< 0.006	(1)	0.141	(1)	< 0.006	(1)	0.004	(1)	< 0.020	(1)
STATION-25	82-83	82-83	< 0.036	(1)	< 0.006	(1)	0.248	(1)	< 0.006	(1)	0.008	(1)	< 0.020	(1)
	82-66	82-66	< 0.036	(1)	< 0.008	(1)	0.124	(1)	< 0.008	(1)	0.010	(1)	< 0.020	(1)
STATION-26	82-91	82-91	< 0.036	(1)	< 0.006	(1)	1.037	(1)	< 0.005	(1)	0.020	(1)	< 0.020	(1)
	82-08	82-98	< 0.036	(1)	< 0.006	(1)	0.085	(1)	< 0.008	(1)	0.012	(1)	< 0.020	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER		NI MG/L	(A)		P MG/L	(A)		PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
STATION-03	82-51	82-51	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)	0.001	(1)	5.840	(1)
STATION-04	82-61	82-61	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)	0.002	(1)	13.755	(1)
STATION-07	82-92	82-92	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)	0.001	(1)	8.231	(1)
STATION-14	82-20	82-20	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)	0.001	(1)	10.434	(1)
STATION-17	82-70	82-70	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)			6.598	(1)
STATION-20	82-58	82-58	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)			8.638	(1)
	82-74	82-74	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)			7.673	(1)
STATION-25	82-83	82-83	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)	0.001	(1)	7.416	(1)
	82-66	82-66	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)			4.235	(1)
STATION-26	82-91	82-91	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)			7.290	(1)
	82-98	82-98	<	0.026	(1)	<	0.340	(1)	<	0.155	(1)			4.867	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
SP-BENNETT	SITE-218	SITE-218	< 0.050	(0)										
	79-13	79-13	0.060	(1)			< 0.005	[illegible]	[illegible]	(1)			< 0.01[illegible]	(1
	85-362	85-362	< 0.200	(1)			< 0.100	[illegible]	0.011	(1)				
		85-363	< 0.200	(1)			< 0.100	[illegible]	0.011	(1)				
	86-190	86-190	< 0.200	(1)			< 0.100	[illegible]	0.008	(1)				
		86-191	< 0.200	(1)			< 0.100	[illegible]	0.007	(1)				
SP-BENSON	SITE-217	SITE-217	< 0.050	(0)										
SP-BUTLER	79-1	79-1	0.300	(1)			0.022	(1)	0.250	(1)			0.049	(1
		79-50	0.310	(1)			0.030	[illegible]	0.250	(1)			0.049	(1)
SP-GULCH	84-359	84-359	< 0.070	(1)			< 0.022	(1)	0.024	(1)			< 0.015	(1
		84-383	< 0.070	(1)			< 0.022	(1)	0.024	(1)			< 0.015	(1
SP-JUNIPER	SITE-215	SITE-215	< 0.050	(0)										
	79-2	79-2	0.040	(1)			< 0.005	[illegible]	0.018	(1)	< 0.010	(1)	< 0.0[illegible]	[illegible]
		79-43	0.050	(1)			< 0.005	[illegible]	0.010	(1)	< 0.010	(1)	< 0.010	(1)
	81-115	81-115	< 0.017	(1)			0.002	[illegible]	0.009	(1)			< 0.004	(1)
		81-161	< 0.017	(1)			< 0.012	(1)	0.008	(1)			< 0.004	[illegible]
	83-372	83-305	< 0.080	(1)			< 0.020	[illegible]	0.010	(1)			< 0.010	
		83-372	< 0.080	(1)			< 0.020	[illegible]	0.010	(1)			< 0.010	(1
SP-10 SNIVELY	79-34	79-19	0.040	(1)			< 0.007	[illegible]	< 0.005	(1)			< 0.01[illegible]	(1
		79-34	0.040	(1)			0.04[illegible]	[illegible]	< 0.015	(1)			< 0.01[illegible]	[illegible]
	82-362	82-362	< 0.080	(1)			< 0.020	[illegible]	0.000	(1)			< 0.010	[illegible]
		82-377	< 0.080	(1)			< 0.020	[illegible]	0.003	[illegible]			< 0.010	
	83-396	83-311	< 0.080	(1)			< 0.020	[illegible]	[illegible]	[illegible]			< 0.015	
		83-396	< 0.050	(1)			< 0.02[illegible]	[illegible]	0.010	(1)			< 0.010	[illegible]
SP-LOZIER	79-6	[illegible]	[illegible]	(1)			< 0.005		< 0.035	(1)			< 0.010	[illegible]
		79-8	0.070	(1)			< 0.005	(1)	< 0.005	(1)			< 0.010	
	81-188	81-116	< 0.017	(1)			< 0.012	[illegible]	0.006	(1)			< 0.004	
		81-[illegible]	< 0.017	(1)			< 0.012		[illegible]	(1)			< 0.004	
	83-316	83-316	< 0.030	(1)			< 0.020		0.030	(1)			< 0.010	
		83-343	< 0.080	(1)			< 0.020		0.040	(1)			< 0.010	[illegible]
SP-MAIDEN	79-100	79-57	0.025	(1)			< 0.005		[illegible]	[illegible]			< 0.0[illegible]	
		79-96	0.030	(1)			< 0.005		0.012	(1)	< 0.010	(1)	< 0.010	[illegible]
	83-420	83-420	< 0.080	(1)			< 0.02[illegible]		0.005	(1)			< 0.01[illegible]	
		83-435	< 0.030	(1)			< 0.020	[illegible]	0.005	(1)			< 0.010	
SP-OBSERVATORY	81-119	81-119	< 0.017	(1)			0.050	[illegible]	0.004	(1)			< 0.006	[illegible]
		81-157	< 0.017	(1)			[illegible]		0.004	(1)			< 0.004	(1)
	83-433	83-433	< 0.030	(1)			< 0.020		0.010	(1)			< 0.010	[illegible]
		83-461	< 0.080	(1)			< [illegible]		[illegible]	(1)			< 0.010	
	84-392	84-310	< 0.020	(1)			< [illegible]		[illegible]	(1)			< 0.015	
		84-392	< 0.070	(1)			< 0.023		[illegible]	(1)			< 0.015	

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
SP-BENNETT	SITE-218	SITE-218												
	79-13	79-13	< 0.003	(1)	< 0.002	(1)	0.007	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	85-362	85-362			< 0.012	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		85-363			< 0.012	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
	86-190	86-190			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-191			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
SP-BENSON	SITE-217	SITE-217												
SP-BUTLER	79-1	79-1	0.061	(1)	0.057	(1)	0.057	(1)	< 0.020	(1)	0.055	(1)	0.320	(1)
		79-50	0.060	(1)	0.059	(1)	0.067	(1)	< 0.020	(1)	0.054	(1)	0.300	(1)
SP-GULCH	84-359	84-359	< 0.038	(1)	< 0.006	(1)	< 0.006	(1)	< 0.006	(1)	< 0.003	(1)	< 0.020	(1)
		84-383	< 0.028	(1)	< 0.006	(1)	< 0.006	(1)	< 0.006	(1)	< 0.003	(1)	< 0.020	(1)
SP-JUNIPER	SITE-215	SITE-215												
	79-2	79-2	< 0.003	(1)	< 0.002	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		79-43	< 0.003	(1)	< 0.002	(1)	0.010	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	81-115	81-115	< 0.006	(1)	< 0.003	(1)	< 0.002	(1)	0.008	(1)	0.013	(1)	0.001	(1)
		81-161	< 0.006	(1)	< 0.003	(1)	0.030	(1)	0.008	(1)	0.008	(1)	< 0.005	(1)
	83-372	83-305	< 0.040	(1)	< 0.010	(1)	0.040	(1)	0.010	(1)	0.004	(1)	< 0.020	(1)
		83-372	< 0.040	(1)	< 0.010	(1)	0.050	(1)	0.010	(1)	< 0.004	(1)	< 0.020	(1)
SP-LO-SNIVELY	79-34	79-19	< 0.003	(1)	< 0.002	(1)	0.010	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		79-34	< 0.003	(1)	< 0.002	(1)	< 0.002	(1)	< 0.020	(1)	< 0.020	(1)	0.040	(1)
	82-362	82-362	< 0.030	(1)	< 0.006	(1)	< 0.006	(1)	< 0.006	(1)	< 0.003	(1)	< 0.020	(1)
		82-377	< 0.030	(1)	< 0.006	(1)	< 0.006	(1)	< 0.006	(1)	< 0.003	(1)	< 0.020	(1)
	83-396	83-311	< 0.040	(1)	< 0.010	(1)	0.020	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	(1)
		83-396	< 0.040	(1)	< 0.010	(1)	0.030	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	(1)
SP-LOZIER	79-6	79-44	< 0.003	(1)	< 0.002	(1)	0.010	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		79-6	< 0.003	(1)	< 0.002	(1)	0.020	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	81-186	81-116	< 0.006	(1)	< 0.003	(1)	0.020	(1)	< 0.003	(1)	0.002	(1)	< 0.005	(1)
		81-186	< 0.006	(1)	< 0.003	(1)	< 0.002	(1)	< 0.003	(1)	< 0.001	(1)	< 0.005	(1)
	83-316	83-316	< 0.040	(1)	< 0.010	(1)	< 0.010	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	(1)
		83-343	< 0.040	(1)	< 0.010	(1)	0.020	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	(1)
SP-MAIDEN	79-100	79-67	< 0.003	(1)	0.051	(1)	0.025	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
		79-96	< 0.003	(1)	0.050	(1)	0.022	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
	83-420	83-420	< 0.040	(1)	< 0.010	(1)	0.010	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	(1)
		83-435	< 0.040	(1)	< 0.010	(1)	0.010	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	(1)
SP-OBSERVATORY	81-119	81-119	< 0.006	(1)	< 0.003	(1)	< 0.002	(1)	< 0.003	(1)	< 0.001	(1)	0.002	(1)
		81-157	< 0.006	(1)	< 0.003	(1)	< 0.002	(1)	< 0.003	(1)	0.001	(1)	< 0.002	(1)
	83-433	83-433	< 0.040	(1)	< 0.010	(1)	0.010	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	(1)
		83-461	< 0.040	(1)	< 0.010	(1)	0.010	(1)	< 0.010	(1)	< 0.004	(1)	0.020	(1)
	84-392	84-310	< 0.036	(1)	< 0.006	(1)	< 0.006	(1)	< 0.006	(1)	< 0.004	(1)	< 0.020	(1)
		84-392	< 0.036	(1)	< 0.006	(1)	< 0.006	(1)	< 0.006	(1)	< 0.004	(1)	< 0.020	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
SP-BENNETT	SITE-218	SITE-218										
	79-13	79-13	< 0.020	(1)	< 0.200	(1)	< 0.300	(1)	0.105	(1)	< 0.010	(1)
	85-362	85-362							0.108	(1)	< 0.040	(1)
		85-363							0.108	(1)	< 0.040	(1)
	86-190	86-190							0.109	(1)	< 0.040	(1)
		86-191							0.109	(1)	< 0.040	(1)
SP-BENSON	SITE-217	SITE-217										
SP-BUTLER	79-1	79-1	0.028	(1)	0.570	(1)	0.330	(1)	0.140	(1)	0.049	(1)
		79-50	0.030	(1)	0.590	(1)	0.320	(1)	0.140	(1)	0.049	(1)
SP-GULCH	84-359	84-359	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.229	(1)	0.058	(1)
		84-383	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.227	(1)	0.061	(1)
SP-JUNIPER	SITE-215	SITE-215										
	79-2	79-2	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	0.083	(1)	< 0.010	(1)
		79-43	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	0.079	(1)	< 0.010	(1)
	81-115	81-115	< 0.008	(1)	0.100	(1)	< 0.043	(1)	0.080	(1)	< 0.004	(1)
		81-161	< 0.008	(1)	0.070	(1)	< 0.043	(1)	0.080	(1)	< 0.004	(1)
	83-372	83-305	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.080	(1)	[illegible]	(1)
		83-372	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.080	(1)	< 0.010	(1)
SP-LO SHIVELY	79-34	79-19	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	0.082	(1)	< 0.010	(1)
		79-34	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	[illegible]	(1)	< 0.010	(1)
	82-362	82-362	< 0.020	(1)	< 0.340	(1)	< 0.150	(1)	0.089	(1)	< 0.010	(1)
		82-377	< 0.020	(1)	< 0.340	(1)	< [illegible]	(1)	0.088	(1)	< 0.010	(1)
	83-396	83-311	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.090	(1)	< [illegible]	(1)
		83-386	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.090	(1)	< 0.010	(1)
SP-LOZIER	79-6	79-44	< 0.020	(1)	0.200	(1)	[illegible]	(1)	[illegible]	(1)	< 0.010	(1)
		79-6	< 0.020	(1)	0.200	(1)	0.300	(1)	0.093	(1)	< 0.010	(1)
	81-186	81-116	< 0.008	(1)	0.110	(1)	< 0.043	(1)	0.090	(1)	0.004	(1)
		81-186	< 0.008	(1)	0.080	(1)	< 0.043	(1)	[illegible]	(1)	< 0.004	(1)
	83-316	83-316	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	[illegible]	(1)	< 0.010	(1)
		83-343	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.090	(1)	< 0.010	(1)
SP-MAIDEN	79-100	79-67	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	0.073	(1)	< 0.010	(1)
		79-96	< 0.020	(1)	< 0.200	(1)	< [illegible]	(1)	0.072	(1)	< 0.010	(1)
	83-420	83-420	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.070	(1)	< 0.010	(1)
		83-435	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.070	(1)	< 0.010	(1)
SP-OBSERVATORY	81-119	81-119	< 0.008	(1)	0.150	(1)	< 0.043	(1)	0.070	(1)	0.007	(1)
		81-157	< 0.008	(1)	0.500	(1)	< 0.043	(1)	0.070	(1)	0.010	(1)
	83-433	83-433	< 0.030	(1)	< 0.340	(1)	< [illegible]	(1)	0.070	(1)	< 0.010	(1)
		83-461	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.070	(1)	< 0.010	(1)
	84-392	84-310	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.067	(1)	< 0.015	(1)
		84-392	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.068	(1)	< 0.015	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
SP-OBSERVATORY	84-329	84-329	< 0.065	(1)			< 0.014	(1)	< 0.003	(1)			< 0.017	(1)
		84-366	< 0.065	(1)			< 0.014	(1)	< 0.004	(1)			< 0.017	(1)
	85-359	85-359	< 0.100	(1)			< 0.050	(1)	0.003	(1)				
		85-360	< 0.100	(1)			< 0.050	(1)	0.003	(1)				
	86-178	86-178	< 0.200	(1)			< 0.100	(1)	< 0.003	(1)				
		86-179	< 0.200	(1)			< 0.100	(1)	< 0.003	(1)				
SP-RAILROAD	79-76	79-76	< 0.010	(1)			< 0.030	(1)	< 0.005	(1)			< 0.010	(1)
		79-81	< 0.010	(1)			< 0.030	(1)	< 0.005	(1)			< 0.010	(1)
SP-RATTLESNAKE	SITE-216	SITE-216	< 0.050	(0)										
	79-88	79-87	0.054	(1)			0.083	(1)	0.075	(1)			< 0.010	(1)
		79-88	0.070	(1)			0.074	(1)	0.073	(1)			< 0.010	(1)
	83-412	83-412	< 0.080	(1)			< 0.020	(1)	0.060	(1)			< 0.010	(1)
		83-466	< 0.080	(1)			< 0.020	(1)	0.060	(1)			< 0.010	(1)
SP-SNIVELY	79-49	79-37	0.070	(1)			< 0.005	(1)	0.010	(1)			< 0.010	(1)
		79-49	0.080	(1)			< 0.005	(1)	0.010	(1)			< 0.010	(1)
SP-SULFUR	79-29	79-29	< 0.010	(1)			0.030	(1)	< 0.005	(1)			< 0.010	(1)
		79-36	< 0.010	(1)			0.030	(1)	< 0.005	(1)			< 0.010	(1)
	83-409	83-409	< 0.080	(1)			< 0.020	(1)	0.030	(1)			< 0.010	(1)
		83-442	< 0.080	(1)			< 0.020	(1)	0.030	(1)			< 0.010	(1)
SP-UNNAMED-02	79-75	79-75	0.190	(1)			0.030	(1)	0.020	(1)			< 0.010	(1)
SP-UNNAMED-16	79-73	79-73	0.074	(1)			0.035	(1)	0.022	(1)			< 0.010	(1)
		79-82	0.045	(1)			0.080	(1)	0.021	(1)			< 0.010	(1)
SP-UNNAMED-26	79-98	79-54	0.150	(1)			0.070	(1)	0.152	(1)			0.020	(1)
		79-98	0.200	(1)			0.050	(1)	0.183	(1)			< 0.010	(1)
SP-UNNAMED-29	79-16	79-16	0.090	(1)			0.027	(1)	0.030	(1)			< 0.010	(1)
		79-24	0.093	(1)			0.030	(1)	0.030	(1)			< 0.010	(1)
SP-UP-SNIVELY	79-71	79-69	0.080	(1)			< 0.005	(1)	< 0.010	(1)			0.020	(1)
		79-71	0.070	(1)			< 0.005	(1)	< 0.010	(1)			0.013	(1)
	81-126	81-126	< 0.120	(1)			< 0.010	(1)	0.004	(1)			< 0.020	(1)
		81-200	< 0.120	(1)			< 0.010	(1)	0.005	(1)			< 0.020	(1)
	83-503	83-503	< 0.080	(1)			< 0.020	(1)	0.003	(1)			< 0.010	(1)
		83-547	< 0.080	(1)			< 0.020	(1)	0.003	(1)			< 0.010	(1)
	86-193	86-193	< 0.200	(1)			< 0.100	(1)	< 0.003	(1)				
		86-194	< 0.200	(1)			< 0.100	(1)	< 0.003	(1)				
SP-UR2-07	85-343	85-343	< 0.100	(1)			< 0.050	(1)	0.020	(1)				
		85-344	< 0.100	(1)			< 0.050	(1)	0.019	(1)				
	86-159	86-159	< 0.200	(1)			< 0.100	(1)	0.018	(1)				
		86-160	< 0.200	(1)			< 0.100	(1)	0.019	(1)				

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
SP-OBSERVATORY	84-329	84-329	< 0.034	(1)	< 0.005	(1)	0.012	(1)	< 0.008	(1)	< 0.003	(1)	< 0.038	(1)
		84-366	< 0.034	(1)	< 0.005	(1)	0.029	(1)	< 0.008	(1)	< 0.003	(1)	< 0.038	(1)
	85-350	85-350			< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	(1)
		85-360			< 0.006	(1)	< 0.0[illegible]	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	
	86-178	86-178			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-179			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
SP-RAILROAD	79-76	79-76	< 0.003	(1)	< 0.002	(1)	0.0[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	< 0.0[illegible]	(1)
		79-81	< 0.003	(1)	< 0.002	(1)	0.030	(1)	< 0.020	(1)	< 0.020	(1)	< 0.030	(1)
SP-RATTLESNAKE	SITE-216	SITE-216												
	79-88	79-87	< 0.003	(1)	< 0.002	(1)	0.[illegible]	(1)	< 0.020	(1)	1.050	(1)	< 0.030	(1)
		79-88	< 0.003	(1)	< 0.002	(1)	0.2[illegible]0	(1)	< 0.020	(1)	1.050	(1)	< 0.030	(1)
	83-412	83-412	< 0.040	(1)	< 0.010	(1)	0.02[illegible]	(1)	< 0.010	(1)	0.200	(1)	< 0.020	(1)
		83-466	< 0.040	(1)	< 0.010	(1)	0.030	(1)	< 0.010	(1)	0.200	(1)	< 0.020	(1)
SP-SNIVELY	79-49	79-37	< 0.003	(1)	< 0.002	(1)	0.[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	< [illegible]	(1)
		79-49	< 0.003	(1)	< 0.002	(1)	0.029	(1)	< 0.020	(1)	< 0.020	(1)	0.030	(1)
SP-SULFUR	79-29	79-29	< 0.003	(1)	< 0.002	(1)	0.[illegible]	(1)			< 0.020	(1)	< 0.030	(1)
		79-36	< 0.003	(1)	< 0.002	(1)	0.10[illegible]	(1)			< 0.020	(1)	< 0.030	
	83-409	83-409	< 0.040	(1)	< 0.010	(1)	0.020	(1)	< 0.010	(1)	0.010	(1)	< 0.020	(1)
		83-442	< 0.040	(1)	< 0.010	(1)	0.030	(1)	< 0.010	(1)	0.010	(1)	< 0.020	
SP-UNNAMED-02	79-75	79-75	0.010	(1)	0.030	(1)	0.020	(1)	< 0.020	(1)	< 0.020	(1)	0.190	(1)
SP-UNNAMED-16	79-73	79-73	< 0.003	(1)	< 0.002	(1)	0.0[illegible]	(1)	< 0.020	(1)	0.040	(1)	0.054	(1)
		79-82	< 0.003	(1)	< 0.002	(1)	0.[illegible]	(1)	< 0.020	(1)	0.030	(1)	0.020	(1)
SP-UNNAMED-20	79-98	79-54	< 0.003	(1)	< 0.002	(1)	4.[illegible]	(1)	< 0.020	(1)	1.0[illegible]	(1)	< 0.0[illegible]	
		79-98	< 0.003	(1)	< 0.002	(1)	4.[illegible]	(1)	< 0.020	(1)	1.0[illegible]	(1)	< 0.030	
SP-UNNAMED-29	79-16	79-16	< 0.003	(1)	< 0.002	(1)	0.[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	0.120	
		79-24	< 0.003	(1)	< 0.002	(1)	0.0[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	0.124	(1)
SP-UP-SNIVELY	79-71	79-69	0.020	(1)	0.030	(1)	< 0.0[illegible]	(1)	< 0.020	(1)	< 0.020	(1)	0.220	
		79-71	0.020	(1)	0.030	(1)	< 0.020	(1)	0.020	(1)	< 0.02[illegible]	(1)	0.290	
	81-126	81-126	< 0.040	(1)	< 0.005	(1)	< 0.005	(1)	< 0.009	(1)	0.005	(1)	< 0.[illegible]	
		81-200	< 0.040	(1)	< 0.005	(1)	< 0.005	(1)	< 0.009	(1)	0.009	(1)	< 0.[illegible]	
	83-503	83-503	< 0.040	(1)	< 0.010	(1)	< 0.0[illegible]		< 0.0[illegible]	(1)	< 0.004	(1)	< 0.020	
		83-547	< 0.040	(1)	< 0.010	(1)	< 0.0[illegible]	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	
	86-193	86-193			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.[illegible]	
		86-194			< 0.030	(1)	< 0.0[illegible]	(1)	< 0.016	(1)	< 0.010	(1)	< 0.[illegible]	
SP-UR2-07	85-343	85-343			< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	< 0.004	(1)	< 0.030	
		85-344			< 0.006	(1)	< 0.0[illegible]	(1)	< 0.008	(1)	< 0.004	(1)	< 0.[illegible]	
	86-159	86-159			< 0.030	(1)	< 0.0[illegible]	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	
		86-160			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	

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SAMPLE TYPE. SPRING·
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
SP-OBSERVATORY	84-329	84-329	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.064	(1)	< 0.200	(1)
		84-366	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.063	(1)	< 0.020	(1)
	85-359	85-359							0.058	(1)	< 0.020	(1)
		85-360							0.060	(1)	< 0.020	(1)
	86-178	86-178							0.064	(1)	< 0.040	(1)
		86-179							0.064	(1)	< 0.040	(1)
SP-RAILROAD	79-76	79-76	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.056	(1)	< 0.010	(1)
		79-81	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.051	(1)	< 0.010	(1)
SP-RATTLESNAKE	SITE-216	SITE-216										
	79-88	79-87	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.206	(1)	< 0.010	(1)
		79-88	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.201	(1)	< 0.010	(1)
	83-412	83-412	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.190	(1)	< 0.010	(1)
		83-466	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.190	(1)	< 0.010	(1)
SP-SNIVELY	79-49	79-37	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.083	(1)	< 0.010	(1)
		79-49	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.082	(1)	0.210	(1)
SP-SULFUR	79-29	79-29	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.143	(1)	< 0.010	(1)
		79-36	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.143	(1)	< 0.010	(1)
	83-409	83-409	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.100	(1)	< 0.010	(1)
		83-442	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.100	(1)	< 0.010	(1)
230 SP-UNNAMED-02	79-75	79-75	< 0.020	(1)	0.360	(1)	0.210	(1)	0.060	(1)	0.250	(1)
SP-UNNAMED-16	79-73	79-73	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.090	(1)	0.020	(1)
		79-82	< 0.020	(1)	0.330	(1)	< 0.100	(1)	0.090	(1)	0.010	(1)
SP-UNNAMED-26	79-98	79-54	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.108	(1)	0.020	(1)
		79-98	< 0.020	(1)	< 0.200	(1)	< 0.100	(1)	0.107	(1)	< 0.010	(1)
SP-UNNAMED-29	79-16	79-16	< 0.020	(1)	0.310	(1)	0.130	(1)	0.120	(1)	< 0.010	(1)
		79-24	< 0.020	(1)	0.340	(1)	0.133	(1)	0.120	(1)	< 0.010	(1)
SP-UP SNIVELY	79-71	79-69	0.029	(1)	0.460	(1)	0.160	(1)	0.080	(1)	0.010	(1)
		79-71	< 0.020	(1)	0.480	(1)	0.180	(1)	0.082	(1)	0.010	(1)
	81-126	81-126	< 0.020	(1)	< 0.200	(1)	< 0.150	(1)	0.090	(1)	< 0.020	(1)
		81-200	< 0.020	(1)	< 0.200	(1)	< 0.150	(1)	0.080	(1)	< 0.020	(1)
	83-503	83-503	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.090	(1)	0.020	(1)
		83-547	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.090	(1)	0.020	(1)
	86-193	86-193							0.092	(1)	< 0.040	(1)
		86-194							0.090	(1)	< 0.040	(1)
SP-UR2-07	85-343	85-343							0.086	(1)	< 0.020	(1)
		85-344							0.086	(1)	< 0.020	(1)
	86-159	86-159							0.091	(1)	< 0.040	(1)
		86-160							0.091	(1)	< 0.040	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
SP-DR6-20	85-346	85-346	< [illegible]	(1)			< 0.050	(1)	0.011	(1)				
		85-347	< 0.100	(1)			< 0.050	(1)	0.011	(1)				
	86-162	86-162	< 0.200	(1)			< 0.100	(1)	0.010	(1)				
		86-163	< 0.200	(1)			< 0.100	(1)	0.010	(1)				
SP-DR7-22	85-349	85-349	< 0.100	(1)			< 0.050	(1)	0.008	(1)				
		85-350	< 0.100	(1)			< 0.050	(1)	0.008	(1)				
	86-153	86-153	< 0.200	(1)			< 0.100	(1)	0.013	(1)				
		86-154	< 0.200	(1)			< 0.100	(1)	0.015	(1)				
SP WARM	84-358	84-358	< 0.070	(1)			0.034	(1)	[illegible]	(1)			< 0.015	(1)
		84-371	< 0.070	(1)			0.032	(1)	0.004	(1)			< 0.015	(1)
SP-YR3-04	85-333	85-333	< 0.060	(1)			< 0.016	(1)	0.008	(1)			< 0.017	(1)
		85-334	< 0.060	(1)			< 0.016	(1)	0.009	(1)			< 0.017	(1)
	86-150	86-150	< 0.200	(1)			< 0.100	(1)	0.007	(1)				
		86-151	< 0.200	(1)			< 0.100	(1)	0.007	(1)				
SP-YR5-08	85-336	85-336	< 0.050	(1)			< 0.018	(1)	0.005	(1)			< 0.017	(1)
		85-337	< 0.060	(1)			< 0.018	(1)	0.008	(1)			< 0.017	(1)
	86-147	86-147	< 0.200	(1)			< 0.100	(1)	0.009	(1)				
		86-148	< 0.200	(1)			< 0.100	(1)	0.010	(1)				
23 SP-YR7-14	85-339	85-339	< 0.060	(1)			< 0.015	(1)	0.009	(1)			< 0.017	[illegible]
		85-340	< 0.060	(1)			< 0.016	(1)	0.008	(1)			< 0.017	(1)
	86-156	86-156	< 0.200	(1)			< 0.100	(1)	0.009	(1)				
		86-157	< 0.200	(1)			< 0.100	(1)	0.009	(1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
SP-DR6-20	85-346	85-346			< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	(1)
		85-347			< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	(1)
	86-162	86-162			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-163			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
SP-DR7-22	85-349	85-349			< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	(1)
		85-350			< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	(1)
	86-153	86-153			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-154			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
SP-WARM	84-358	84-358	< 0.036	(1)	< 0.006	(1)	0.026	(1)	< 0.006	(1)	0.004	(1)	< 0.020	(1)
		84-371	< 0.036	(1)	< 0.006	(1)	0.034	(1)	< 0.006	(1)	0.004	(1)	< 0.020	(1)
SP-YR3-04	85-333	85-333	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
		85-334	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
	86-150	86-150			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-151			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
SP-YR5-08	85-336	85-336	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
		85-337	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
	86-147	86-147			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-148			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
SP-YR7-14	85-339	85-339	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
		85-340	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
	86-156	86-156			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-157			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
SP-URB-20	85-346	85-346							0.080	(1)	< 0.020	(1)
		85-347							0.081	(1)	< 0.020	(1)
	86-162	86-162							0.084	(1)	< 0.040	(1)
		86-163							0.084	(1)	< 0.040	(1)
SP-UR7-22	85-349	85-349							0.040	(1)	< 0.020	(1)
		85-350							0.040	(1)	< 0.020	(1)
	86-153	86-153							0.056	(1)	< 0.040	(1)
		86-154							0.056	(1)	< 0.040	(1)
SP-WARM	84-358	84-358	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.080	(1)	< 0.150	(1)
		84-371	< 0.026	(1)	< 0.340	(1)	< 0.150	(1)	0.080	(1)	< 0.150	(1)
SP-YR3-04	85-333	85-333	< 0.030	(1)			< 0.180	(1)	0.048	(1)	< 0.020	(1)
		85-334	< 0.030	(1)			< 0.180	(1)	0.047	(1)	< 0.020	(1)
	86-150	86-150							0.054	(1)	< 0.040	(1)
		86-151							0.054	(1)	< 0.040	(1)
SP-YR5-08	85-336	85-336	< 0.030	(1)			< 0.180	(1)	0.074	(1)	< 0.020	(1)
		85-337	< 0.030	(1)			< 0.180	(1)	0.066	(1)	< 0.020	(1)
	86-147	86-147							0.120	(1)	< 0.040	(1)
		86-148							0.120	(1)	< 0.040	(1)
SP-YR7-14	85-339	85-339	< 0.030	(1)			< 0.180	(1)	[illegible]	(1)	< 0.020	(1)
		85-340	< 0.030	(1)			< 0.180	(1)	[illegible]	(1)	< 0.020	(1)
	86-156	86-156							0.059	(1)	< 0.040	(1)
		86-157							0.059	(1)	< 0.040	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SURFACE
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
COLD CREEK	84-317	84-317	< 0.065	(1)			< 0.014	(1)	0.024	(1)			< 0.017	(1)
		84-336	< 0.065	(1)			< 0.014	(1)	0.024	(1)			< 0.017	(1)
	84-302	84-302	< 0.065	(1)			< 0.017	(1)	0.024	(1)			< 0.034	(1)
		84-345	< 0.065	(1)			< 0.014	(1)	0.024	(1)			< 0.017	(1)
	85-223	85-223	< 0.060	(1)			0.016	(1)	0.040	(1)			< 0.017	(1)
		85-224	< 0.060	(1)			< 0.016	(1)	0.027	(1)			< 0.017	(1)
CR-DC-14	83-258	83-211	< 0.090	(1)			< 0.020	(1)	0.034	(1)			< 0.020	(1)
		83-258	< 0.080	(1)			< 0.020	(1)	0.031	(1)			< 0.010	(1)
CR-HIS	SITE-221	SITE-221	< 0.050	(0)										
CR-V-BR	84-330	84-330	< 0.065	(1)			< 0.014	(1)	0.029	(1)			< 0.017	(1)
		84-361	< 0.065	(1)			< 0.014	(1)	0.028	(1)			< 0.017	(1)
	84-311	84-311	< 0.065	(1)			< 0.014	(1)	0.028	(1)			< 0.017	(1)
		84-356	< 0.065	(1)			< 0.014	(1)	0.030	(1)			< 0.017	(1)
	85-206	85-206	< 0.060	(1)			< 0.016	(1)	0.032	(1)			< 0.017	(1)
		85-207	< 0.060	(1)			< 0.016	(1)	0.032	(1)			< 0.017	(1)
	85-266	85-266	< 0.060	(1)			< 0.015	(1)	0.025	(1)			< 0.020	(1)
		85-267	< 0.060	(1)			< 0.015	(1)	0.023	(1)			< 0.020	(1)
	86-70	86-70	< 0.200	(1)			< 0.100	(1)	0.028	(1)				
		86-71	< 0.200	(1)			< 0.100	(1)	0.028	(1)				
	86-109	86-109	< 0.200	(1)			< 0.100	(1)	0.028	(1)				
		86-110	< 0.200	(1)			< 0.100	(1)	0.029	(1)				
YR-HR	85-210	85-210	< 0.060	(1)			< 0.016	(1)	0.012	(1)			< 0.017	(1)
		85-211	< 0.060	(1)			0.018	(1)	0.014	(1)			< 0.017	(1)
	85-269	85-269	< 0.100	(1)			< 0.050	(1)	0.026	(1)				
		85-270	< 0.100	(1)			< 0.050	(1)	0.026	(1)				
	86-67	86-67	< 0.200	(1)			< 0.100	(1)	0.018	(1)				
		86-68	< 0.200	(1)			< 0.100	(1)	0.019	(1)				
	86-118	86-118	< 0.200	(1)			< 0.100	(1)	0.018	(1)				
		86-119	< 0.200	(1)			< 0.100	(1)	0.018	(1)				

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SAMPLE TYPE: SURFACE
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
COLD CREEK	84-317	84-317	< 0.034	(1)	< 0.005	(1)	[illegible]	(1)	0.008	(1)	0.003	(1)	< 0.038	[illegible]
		84-336	< 0.034	(1)	< 0.005	(1)	0.010	(1)	0.008	(1)	0.004	(1)	< 0.038	(1)
	84-302	84-302	< 0.034	(1)	< 0.005	(1)	[illegible]	(1)	< 0.008	(1)	< 0.003	(1)	< 0.039	[illegible]
		84-345	< 0.034	(1)	< 0.005	(1)	[illegible]	(1)	< 0.008	(1)	< 0.003	(1)	< 0.035	[illegible]
	85-223	85-223	< 0.032	(1)	< 0.006	(1)	0.020	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	[illegible]
		85-224	< 0.032	(1)	< 0.006	(1)	0.022	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
[illegible] DC-14	83-258	83-211	< 0.040	(1)	< 0.006	(1)	[illegible]	(1)	< 0.006	(1)	0.004	(1)	< 0.020	(1)
		83-258	< 0.040	(1)	< 0.010	(1)	0.030	(1)	< 0.010	(1)	< 0.004	(1)	< 0.020	[illegible]
CR-HTS	SITE-221	SITE-221												
CR-V-BR	84-330	84-330	< 0.034	(1)	< 0.005	(1)	< [illegible]	(1)	< 0.008	(1)	< 0.003	(1)	< 0.038	[illegible]
		84-361	< 0.034	(1)	< 0.005	(1)	0.015	(1)	< 0.008	(1)	< 0.003	(1)	< 0.038	[illegible]
	84-311	84-311	< 0.034	(1)	< 0.005	(1)	< 0.008	(1)	< 0.008	(1)	< 0.003	(1)	< 0.038	(1)
		84-356	< 0.034	(1)	< 0.005	(1)	< 0.007	(1)	< 0.008	(1)	< 0.003	(1)	< 0.038	[illegible]
	85-206	85-206	< 0.032	(1)	< 0.006	(1)	< [illegible]	(1)	< [illegible]	(1)	< 0.005	(1)	< 0.034	[illegible]
		85-207	< 0.032	(1)	< 0.006	(1)	< [illegible]	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	[illegible]
	85-266	85-266	< 0.030	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.030	[illegible]
		85-267	< 0.030	(1)	< 0.006	(1)	< [illegible]	(1)	< 0.008	(1)	< 0.005	(1)	< 0.030	[illegible]
	86-70	86-70			< 0.012	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-71			< 0.012	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
	86-109	86-109			< 0.030	(1)	< [illegible]	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	[illegible]
		86-110			< 0.030	(1)	< [illegible]	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	[illegible]
YR-BR	85-210	85-210	< 0.032	(1)	< 0.006	(1)	[illegible]	(1)	< 0.008	(1)	0.012	(1)	< 0.034	[illegible]
		85-211	< 0.032	(1)	< 0.006	(1)	[illegible]	(1)	< 0.008	(1)	0.012	(1)	< 0.034	[illegible]
	85-269	85-269			< 0.006	(1)	< [illegible]	(1)	< 0.008	(1)	0.017	(1)	< 0.300	[illegible]
		85-270			< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	0.017	(1)	< 0.300	[illegible]
	86-67	86-67			< 0.012	(1)	0.044	(1)	< 0.015	(1)	0.015	(1)	< 0.600	[illegible]
		86-68			< 0.012	(1)	0.043	(1)	< 0.015	(1)	0.016	(1)	< 0.600	(1)
	86-118	86-118			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	0.028	(1)	< 0.600	(1)
		86-110			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	0.028	(1)	< 0.600	(1)

(A) SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE. SURFACE
ANALYSIS GROUP. TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
COLD CREEK	84-317	84-317	< 0.017	(1)	0.540	(1)	< 0.200	(1)	0.104	(1)	< 0.020	(1)
		84-336	< 0.017	(1)	0.540	(1)	< 0.200	(1)	0.105	(1)	< 0.020	(1)
	84-302	84-302	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.102	(1)	< 0.020	(1)
		84-345	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.102	(1)	< 0.020	(1)
	85-223	85-223	< 0.030	(1)			< 0.180	(1)	0.096	(1)	< 0.020	(1)
		85-224	< 0.030	(1)			< 0.180	(1)	0.092	(1)	< 0.020	(1)
CR-DC-14	83-258	83-211	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.102	(1)	< 0.040	(1)
		83-258	< 0.030	(1)	< 0.340	(1)	< 0.150	(1)	0.100	(1)	0.030	(1)
CR-HIS	SITE-221	SITE-221										
CR-V-BR	84-330	84-330	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.078	(1)	< 0.020	(1)
		84-361	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.075	(1)	< 0.020	(1)
	84-311	84-311	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.076	(1)	< 0.020	(1)
		84-356	< 0.017	(1)	< 0.540	(1)	< 0.200	(1)	0.077	(1)	< 0.020	(1)
	85-206	85-206	< 0.030	(1)			< 0.180	(1)	0.114	(1)	< 0.020	(1)
		85-207	< 0.030	(1)			< 0.180	(1)	0.114	(1)	< 0.020	(1)
	85-266	85-266	< 0.030	(1)			< 0.020	(1)	0.077	(1)	< 0.020	(1)
		85-267	< 0.030	(1)			< 0.200	(1)	0.071	(1)	< 0.020	(1)
	86-70	86-70							0.092	(1)	< 0.040	(1)
		86-71							0.090	(1)	< 0.040	(1)
	86-109	86-109							0.096	(1)	< 0.040	(1)
		86-110							0.100	(1)	< 0.040	(1)
YR-BR	85-210	85-210	< 0.030	(1)			< 0.180	(1)	0.059	(1)	< 0.020	(1)
		85-211	< 0.030	(1)			< 0.180	(1)	0.059	(1)	< 0.020	(1)
	85-269	85-269							0.133	(1)	< 0.020	(1)
		85-270							0.133	(1)	< 0.020	(1)
	86-67	86-67							0.102	(1)	< 0.040	(1)
		86-68							0.102	(1)	< 0.040	(1)
	86-118	86-118							0.109	(1)	< 0.040	(1)
		86-119							0.108	(1)	< 0.040	(1)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
RRL-06A	82-40	82-35	< 0.080	(1)			< 0.020	(1)	0.050	(1)			< 0.020	[illegible]
		82-40	< 0.060	(1)			< 0.020	(1)	0.050	(1)			< 0.020	(1)
199-B04-04	SITE-41	SITE-41			0.002	(0)	0.010	[illegible]						
199-D05-12	SITE-80	SITE-80	< 0.050	(0)	0.005	(0)	0.030	(0)	0.0[illegible]0	(0)			< 0.005	(0)
199-D08-03	SITE-72	SITE-72	0.050	(0)	0.004	(0)	0.007	(0)	0.070	(0)			< 0.005	(0)
199-F05-01	SITE-82	SITE-82	< 0.050	(0)	0.003	(0)	0.030	[illegible]	0.070	(0)			< 0.005	(0)
199-H04-03	SITE-81	SITE-81	< 0.050	(0)	0.010	(0)	0.050	(0)	0.070	(0)			< 0.005	(0)
199-K-19	SITE-83	SITE-83	< 0.050	(0)	0.003	(0)	0.010	(0)	0.0[illegible]0	(0)			< 0.005	(0)
199-N-15	SITE-42	SITE-42			0.002	(0)	0.010	(0)						
299-E26-06	SITE-165	SITE-165							0.031	(0)			< 0.012	(0)
299-E33-12	SITE-169	SITE-169							0.025	(0)			< 0.018	(0)
399-01-01	SITE-244	SITE-244	< 0.050	(0)			0.050	(0)	0.050	(0)			< 0.005	(0)
399-01-03	SITE-43	SITE-43	0.020	(0)	0.002	(0)	0.020	(0)						
399-02-01	SITE-245	SITE-245	< 0.050	(0)			0.050	(0)	0.050	(0)			< 0.005	(0)
399-03-01	SITE-246	SITE-246	< 0.050	(0)			0.050	(0)	0.055	(0)			< 0.005	(0)
399-04-10	SITE-44	SITE-44	0.020	(0)	0.001	(0)	0.03[illegible]	[illegible]					0.002	(0)
399-08-04	SITE-140	SITE-140	< 0.050	(0)			0.010	[illegible]	0.030	(0)			< 0.005	(0)
699-HAN-19	SITE-3	SITE-3			0.010	(0)								
699-S03-E12	SITE-22	SITE-22	0.040	(0)	0.016	(0)	0.02[illegible]	[illegible]	[illegible]	(0)			0.004	[illegible]
	SITE-141	SITE-141	< 0.050	(0)			0.010	(0)	0.030	(0)			< 0.005	(0)
699-S03-25	SITE-7	SITE-7	0.[illegible]0	(0)	0.008	(0)	0.05[illegible]	[illegible]	[illegible]	(0)	< 0.009	(0)	< 0.002	(0)
	SITE-142	SITE-142	0.250	(0)			0.070	[illegible]	0.0[illegible]0	(0)			0.005	[illegible]
	86-55	86-55	< 0.200	(1)			< 0.100	[illegible]	[illegible]	(1)				
		86-56	< 0.200	(1)			< 0.100	[illegible]	[illegible]	(1)				
	86-130	86-130	< 0.[illegible]	(1)			< 0.[illegible]	[illegible]	[illegible]	(1)				
		86-131	< 0.20[illegible]	(1)			< 0.[illegible]	(1)	0.058	(1)				
699-S06-E04D	SITE-11	SITE-11	0.030	(0)	0.001	(0)	0.020	[illegible]	[illegible]	(0)			< 0.002	[illegible]
699-S08-19	SITE-46	SITE-46	0.010	(0)	0.009	(0)	0.150	[illegible]						

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L (A)	CU MG/L (A)	FE MG/L (A)	LI MG/L (A)	MN MG/L (A)	MO MG/L (A)
RRL-06A	82-40	82-35	< 0.030 (1)	0.009 (1)	< 0.006 (1)	< 0.006 (1)	0.008 (1)	< 0.020 (1)
		82-40	< 0.030 (1)	0.010 (1)	< 0.006 (1)	< 0.006 (1)	0.008 (1)	< 0.020 (1)
199-B04-04	SITE-41	SITE-41	0.010 (0)		0.030 (0)	0.010 (0)	0.004 (0)	0.002 (0)
199-D05-12	SITE-80	SITE-80	0.100 (0)	< 0.010 (0)	< 0.005 (0)	0.010 (0)	0.001 (0)	0.010 (0)
199-D08-03	SITE-72	SITE-72	0.100 (0)		0.003 (0)	0.005 (0)	0.030 (0)	0.010 (0)
199-F05-01	SITE-82	SITE-82	< 0.050 (0)	< 0.010 (0)	0.010 (0)	< 0.010 (0)	0.007 (0)	0.010 (0)
199-H04-03	SITE-81	SITE-81	1.000 (0)	0.100 (0)	0.005 (0)	0.010 (0)	0.003 (0)	0.010 (0)
199-K-19	SITE-83	SITE-83	0.100 (0)	< 0.010 (0)	< 0.005 (0)	< 0.010 (0)	< 0.001 (0)	< 0.010 (0)
199-N-15	SITE-42	SITE-42			0.030 (0)			
299-E26-08	SITE-165	SITE-165		0.049 (0)	< 0.030 (0)		0.114 (0)	
299-E33-12	SITE-169	SITE-169		< 0.001 (0)	0.050 (0)			
399-01-01	SITE-244	SITE-244	< 0.050 (0)	< 0.010 (0)	0.007 (0)	< 0.005 (0)	0.003 (0)	< 0.010 (0)
399-01-03	SITE-43	SITE-43		0.001 (0)	0.030 (0)		0.004 (0)	0.025 (0)
399-02-01	SITE-245	SITE-245	< 0.050 (0)	< 0.010 (0)	0.050 (0)	< 0.005 (0)	0.001 (0)	< 0.010 (0)
399-03-01	SITE-246	SITE-246	< 0.050 (0)	< 0.010 (0)	0.010 (0)	< 0.005 (0)	< 0.001 (0)	< 0.010 (0)
399-04-10	SITE-44	SITE-44	0.010 (0)	0.001 (0)	0.030 (0)		0.004 (0)	0.006 (0)
399-08-04	SITE-140	SITE-140	< 0.050 (0)	< 0.010 (0)	< 0.005 (0)	0.010 (0)	0.003 (0)	< 0.010 (0)
699-HAN-19	SITE-3	SITE-3		0.002 (0)	0.050 (0)			
699-S03-E12	SITE-22	SITE-22	0.004 (0)	0.001 (0)	0.020 (0)		0.002 (0)	0.020 (0)
	SITE-141	SITE-141	< 0.050 (0)	< 0.010 (0)	0.010 (0)	0.007 (0)	0.003 (0)	0.010 (0)
699-S03-25	SITE-7	SITE-7	0.010 (0)	0.011 (0)	1.600 (0)	0.008 (0)	0.250 (0)	0.008 (0)
	SITE-142	SITE-142	< 0.050 (0)	< 0.010 (0)	0.030 (0)	0.030 (0)	0.100 (0)	0.010 (0)
	86-55	86-55		< 0.012 (1)	0.120 (1)	< 0.016 (1)	0.108 (1)	< 0.500 (1)
		86-56		< 0.012 (1)	0.120 (1)	< 0.016 (1)	0.107 (1)	< 0.500 (1)
	86-130	86-130		< 0.030 (1)	0.039 (1)	< 0.016 (1)	0.110 (1)	< 0.600 (1)
		86-131		< 0.030 (1)	0.035 (1)	< 0.016 (1)	0.108 (1)	< 0.600 (1)
699-S06-E0B	SITE-11	SITE-11	< 0.001 (0)	0.004 (0)	0.130 (0)	0.007 (0)	0.480 (0)	0.005 (0)
699-S08-19	SITE-46	SITE-46			0.020 (0)		0.020 (0)	0.005 (0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
RRL-06A	82-40	82-35	< 0.030	(1)	< 0.340	(1)	< 0.160	(1)	0.160	(1)	0.450	(1)
		82-40	< 0.030	(1)	< 0.340	(1)	< 0.160	(1)	0.160	(1)	0.440	(1)
199-B04-04	SITE-41	SITE-41	0.002	(0)					0.220	(0)	0.009	(0)
199-D05-12	SITE-80	SITE-80	< 0.050	(0)	0.030	(0)	1.000	(0)	0.300	(0)	< 0.005	(0)
199-D08-03	SITE-72	SITE-72	< 0.050	(0)			< 0.030	(0)	0.300	(0)	< 0.005	(0)
199-F05-01	SITE-82	SITE-82	< 0.050	(0)	0.020	(0)	[illegible]	(0)	0.100	(0)	< 0.005	(0)
199-H04-03	SITE-81	SITE-81	< 0.050	(0)	0.080	(0)	1.000	(0)	0.300	(0)	< 0.005	(0)
199-K-19	SITE-83	SITE-83	< 0.050	(0)	0.010	(0)	0.500	(0)	0.100	(0)	0.010	(0)
199-N-15	SITE-42	SITE-42	0.003	(0)			[illegible]	(0)	0.140	(0)	0.009	(0)
299-E26-08	SITE-165	SITE-165	< 0.003	(0)			< [illegible]	(0)			0.083	(0)
299-E33-12	SITE-169	SITE-169	< 0.052	(0)			< [illegible]	(0)			0.190	(0)
399-01-01	SITE-244	SITE-244	< 0.050	(0)	0.080	(0)	< [illegible]	(0)	0.100	(0)	0.010	(0)
229 399-01-03	SITE-43	SITE-43	0.002	(0)					0.140	(0)	0.020	(0)
399-02-01	SITE-245	SITE-245			0.100	(0)	< [illegible]	(0)	0.100	(0)	0.010	(0)
399-03-01	SITE-246	SITE-246	< 0.050	(0)	0.120	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
399-04-10	SITE-44	SITE-44	0.003	(0)			0.002	(0)	0.180	(0)	0.010	(0)
399-08-04	SITE-140	SITE-140	< 0.050	(0)	0.030	(0)	< 0.030	(0)	0.300	(0)	0.100	(0)
699-HAN-19	SITE-3	SITE-3			0.030	(0)						
699-S03-E12	SITE-22	SITE-22	0.004	(0)			[illegible]	(0)	[illegible]	(0)		
	SITE-141	SITE-141	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-S03-25	SITE-7	SITE-7	0.004	(0)	0.060	(0)	[illegible]	(0)	0.180	(0)	0.030	(0)
	SITE-142	SITE-142	< 0.050	(0)	0.030	(0)	0.030	(0)	0.390	(0)	0.010	(0)
	86-55	86-55							0.251	(1)	< 0.040	(1)
		86-56							0.249	(1)	< 0.040	(1)
	86-130	86-130							0.254	(1)	< 0.040	(1)
		86-131							0.250	(1)	< 0.040	(1)
699-S06-E04D	SITE-11	SITE-11	0.005	(0)	0.020	(0)	0.004	(0)	0.220	(0)	1.600	(0)
699-S08-19	SITE-48	SITE-48	0.002	(0)					[illegible]	(0)	[illegible]	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
699-S08-19	SITE-84	SITE-84	< 0.050	(0)	0.013	(0)	0.100	(0)	0.050	(0)			< 0.005	(0)
699-S11-E12A	SITE-4	SITE-4	0.052	(0)	0.012	(0)	0.013	(0)	0.053	(0)			< 0.002	(0)
699-S12-03	SITE-45	SITE-45			0.005	(0)	0.040	(0)						
	SITE-143	SITE-143	< 0.050	(0)			0.007	(0)	0.030	(0)			< 0.005	(0)
699-S19-E13	SITE-120	SITE-120	0.300	(0)			< 0.005	(0)	0.050	(0)			< 0.005	(0)
699-S24-19	85-213	85-213	< 0.080	(1)			0.024	(1)	0.039	(1)			< 0.017	(1)
		85-214	< 0.060	(1)			0.025	(1)	0.039	(1)			< 0.017	(1)
	85-291	85-291	< 0.100	(1)			< 0.050	(1)	0.034	(1)			< 0.017	(1)
		85-292	< 0.100	(1)			< 0.050	(1)	0.035	(1)			< 0.017	(1)
699-S29-E12	SITE-21	SITE-21	0.010	(0)	0.006	(0)	0.030	(0)	0.060	(0)			0.006	(0)
699-S30-E15A	SITE-144	SITE-144	< 0.050	(0)			0.010	(0)	0.050	(0)			< 0.005	(0)
699-01-18	SITE-145	SITE-145	0.070	(0)			0.010	(0)	0.050	(0)			0.005	(0)
699-02-03	SITE-1	SITE-1	0.007	(0)	0.014	(0)	0.012	(0)	0.050	(0)			< 0.002	(0)
699-02-33	SITE-85	SITE-85	< 0.050	(0)	0.007	(0)	0.010	(0)	0.050	(0)			< 0.005	(0)
	SITE-146	SITE-146	0.070	(0)			0.010	(0)	0.030	(0)			0.005	(0)
699-04-E06	SITE-47	SITE-47	0.010	(0)	0.007	(0)	0.010	(0)						
699-08-17	SITE-23	SITE-23	0.020	(0)	0.008	(0)	0.020	(0)	0.040	(0)			0.006	(0)
699-08-25	SITE-32	SITE-32	0.020	(0)	0.007	(0)	0.030	(0)	0.040	(0)			0.006	(0)
699-08-32	SITE-19	SITE-19	0.010	(0)	0.001	(0)	0.017	(0)	0.044	(0)	< 0.004	(0)	< 0.002	(0)
699-09-E02	SITE-16	SITE-16	0.065	(0)	0.010	(0)	0.020	(0)	0.048	(0)	< 0.003	(0)	< 0.002	(0)
699-10-E12	SITE-147	SITE-147	< 0.050	(0)			0.050	(0)	0.050	(0)			< 0.005	(0)
	SITE-247	SITE-247	< 0.050	(0)			0.030	(0)	0.050	(0)			< 0.005	(0)
699-11-45A	SITE-148	SITE-148	< 0.050	(0)			< 0.010	(0)	0.050	(0)			< 0.005	(0)
	85-263	85-263	< 0.060	(1)			< 0.015	(1)	0.044	(1)			< 0.020	(1)
		85-264	< 0.060	(1)			< 0.015	(1)	0.045	(1)			< 0.020	(1)
	86-43	86-43	< 0.200	(1)			< 0.100	(1)	0.045	(1)				
		86-44	< 0.200	(1)			< 0.100	(1)	0.045	(1)				
	86-124	86-124	< 0.200	(1)			< 0.100	(1)	0.043	(1)				
		86-125	< 0.200	(1)			< 0.100	(1)	0.052	(1)				
699-13-01A	SITE-60	SITE-60	0.070	(0)	0.014	(0)	0.030	(0)	0.052	(0)			< 0.005	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	NI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-S08-19	SITE-84	SITE-84	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.030	(0)	0.010	(0)
699-S11-E12A	SITE-4	SITE-4	0.008	(0)	0.007	(0)	0.330	(0)	0.005	(0)	0.012	(0)	0.002	(0)
699-S12-03	SITE-45	SITE-45					0.020	(0)					0.004	(0)
	SITE-143	SITE-143	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.007	(0)	[illegible]	(0)	< 0.010	[illegible]
699-S19-E13	SITE-120	SITE-120	< 0.050	(0)	< 0.010	(0)	0.020	(0)	0.010	(0)	0.005	(0)	0.010	(0)
699-S24-10	85-213	85-213	< 0.032	(1)	< 0.006	(1)	< [illegible]	(1)	< 0.008	(1)	< 0.005	(1)	< [illegible]	(1)
		85-214	< 0.032	(1)	< 0.006	(1)	< [illegible]	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
	85-291	85-291	< 0.033	(1)	< 0.006	(1)	< [illegible]	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
		85-282	< 0.033	(1)	< 0.006	(1)	< 0.015	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
699-S29-E12	SITE-21	SITE-21	0.008	(0)	0.002	(0)	[illegible]	(0)			0.004	(0)	0.005	[illegible]
699-S30-E15A	SITE-144	SITE-144	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.010	(0)	0.001	(0)	< 0.010	(0)
699-01-18	SITE-145	SITE-145	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-02-03	SITE-1	SITE-1	0.004	(0)	0.010	(0)	0.060	(0)	0.005	(0)	< 0.001	(0)	0.005	(0)
699-02-33	SITE-85	SITE-85	< 0.050	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.050	(0)	< 0.010	(0)
	SITE-146	SITE-146	< 0.050	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.010	(0)	0.010	(0)
699-04-E06	SITE-47	SITE-47					[illegible]	(0)	0.010	(0)			0.008	(0)
699-08-17	SITE-23	SITE-23	0.008	(0)	0.002	(0)	[illegible]	(0)			[illegible]	(0)	0.010	(0)
699-08-25	SITE-32	SITE-32	0.008	(0)	0.002	(0)	[illegible]	(0)			0.004	(0)	0.010	(0)
699-08-32	SITE-19	SITE-19	< 0.001	(0)	0.002	(0)	[illegible]	(0)	0.006	(0)	[illegible]	[illegible]	[illegible]	(0)
699-09-E02	SITE-16	SITE-16	< 0.008	(0)	0.007	(0)	0.130	(0)	0.010	(0)	0.140	[illegible]	0.007	[illegible]
699-10-E12	SITE-147	SITE-147	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	[illegible]	(0)	0.001	(0)	0.010	[illegible]
	SITE-247	SITE-247	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.005	(0)	< [illegible]	(0)
699-11-45A	SITE-148	SITE-148	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	[illegible]	(0)	[illegible]	(0)	< 0.010	
	85-263	85-263	< 0.030	(1)	< 0.008	(1)	[illegible]	(1)	< 0.008	(1)	[illegible]	(1)	< 0.030	
		85-264	< 0.030	(1)	< 0.006	(1)	[illegible]	(1)	< [illegible]	(1)	0.144	(1)	< 0.030	
	86-43	86-43			< 0.012	(1)	[illegible]	(1)	< 0.015	(1)	0.120	(1)	< 0.600	
		86-44			< 0.012	(1)	[illegible]	(1)	< 0.016	(1)	0.119	(1)	< 0.600	
	86-124	86-124			< 0.030	(1)	[illegible]	(1)	< [illegible]	(1)	0.139	(1)	< 0.600	
		86-125			< 0.030	(1)	[illegible]	(1)	< 0.025	(1)	0.149	(1)	< 0.600	
699-13-01A	SITE-60	SITE-60	< 0.050	(0)			< 0.005	(0)	0.010	(0)	0.001	(0)	0.010	

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
699-S08-19	SITE-84	SITE-84	< 0.050	(0)	0.040	(0)	1.000	(0)	0.100	(0)	< 0.005	(0)
699-S11-E12A	SITE-4	SITE-4	< 0.002	(0)	0.050	(0)	0.017	(0)	0.180	(0)	0.030	(0)
699-S12-03	SITE-45	SITE-45	0.003	(0)					0.210	(0)	0.070	(0)
	SITE-143	SITE-143	< 0.050	(0)	0.040	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-S19-E13	SITE-120	SITE-120	< 0.050	(0)	0.040	(0)	0.500	(0)	0.300	(0)	< 0.005	(0)
699-S24-19	85-213	85-213	< 0.030	(1)			< 0.180	(1)	0.144	(1)	< 0.020	(1)
		85-214	< 0.030	(1)			< 0.180	(1)	0.144	(1)	< 0.020	(1)
	85-291	85-291	< 0.030	(1)			< 0.180	(1)	0.151	(1)	< 0.020	(1)
		85-292	< 0.030	(1)			< 0.180	(1)	0.152	(1)	< 0.020	(1)
699-S29-E12	SITE-21	SITE-21	0.006	(0)			0.007	(0)	0.200	(0)	0.010	(0)
699-S30-E15A	SITE-144	SITE-144	< 0.050	(0)	0.030	(0)	< 0.030	(0)	0.300	(0)	< 0.009	(0)
699-01-18	SITE-145	SITE-145	< 0.050	(0)	0.030	(0)	0.050	(0)	0.300	(0)	0.010	(0)
699-02-03	SITE-1	SITE-1	< 0.002	(0)	0.020	(0)	0.010	(0)	0.200	(0)	0.010	(0)
699-02-33	SITE-85	SITE-85	< 0.050	(0)	0.070	(0)	1.000	(0)	0.100	(0)	< 0.005	(0)
	SITE-146	SITE-146	< 0.050	(0)	0.020	(0)	0.030	(0)	0.100	(0)	< 0.009	(0)
699-04-E06	SITE-47	SITE-47	0.003	(0)					0.220	(0)	0.010	(0)
699-08-17	SITE-23	SITE-23	0.006	(0)			0.006	(0)	0.200	(0)	0.120	(0)
699-08-25	SITE-32	SITE-32	0.006	(0)			0.006	(0)	0.190	(0)		
699-08-32	SITE-19	SITE-19	0.003	(0)	0.090	(0)	0.002	(0)	0.190	(0)	0.010	(0)
699-09-E02	SITE-15	SITE-16	0.002	(0)	0.040	(0)	0.005	(0)	0.190	(0)	0.017	(0)
699-10-E12	SITE-147	SITE-147	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.100	(0)	0.100	(0)
	SITE-247	SITE-247	< 0.050	(0)	0.030	(0)	< 0.030	(0)	0.300	(0)	0.010	(0)
699-11-45A	SITE-148	SITE-148	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.100	(0)	0.700	(0)
	85-263	85-263	< 0.030	(1)			< 0.200	(1)	0.190	(1)	0.363	(1)
		85-264	< 0.030	(1)			< 0.200	(1)	0.191	(1)	0.388	(1)
	86-43	86-43							0.177	(1)	0.572	(1)
		86-44							0.180	(1)	0.556	(1)
	86-124	86-124							0.181	(1)	0.354	(1)
		86-125							0.181	(1)	0.350	(1)
699-13-01A	SITE-60	SITE-60	0.050	(0)			< 0.030	(0)	0.300	(0)	< 0.005	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
699-14-38	SITE-61	SITE-61	0.070	(0)	0.004	(0)	0.030	(0)	0.070	(0)			< 0.005	(0)
	SITE-86	SITE-86	< 0.050	(0)	0.004	(0)	0.030	(0)	0.070	(0)			< 0.005	(0)
699-15-15B	SITE-13	SITE-13	0.005	(0)	0.004	(0)	0.020	(0)	0.051	(0)	< 0.004	(0)	< 0.002	(0)
	SITE-149	SITE-149	< 0.050	(0)			0.010	(0)	0.050	(0)			< 0.005	(0)
699-15-26	SITE-24	SITE-24	0.010	(0)	0.018	(0)	0.030	(0)	0.080	(0)			0.008	(0)
	SITE-150	SITE-150	< 0.050	(0)			0.030	(0)	0.050	(0)			< 0.005	(0)
699-17-05	SITE-18	SITE-18	0.470	(0)	0.004	(0)	0.015	(0)	0.037	(0)	< 0.004	(0)	< 0.002	(0)
	SITE-151	SITE-151	< 0.050	(0)			0.010	(0)	0.030	(0)			< 0.005	(0)
699-19-43	SITE-48	SITE-48			0.002	(0)	0.010	(0)						
	SITE-121	SITE-121	0.100	(0)			< 0.050	(0)	0.050	(0)			< 0.050	(0)
699-19-58	85-229	85-229	< 0.060	(1)			0.020	(1)	0.081	(1)			< 0.017	(1)
		85-230	0.060	(1)			0.020	(1)	0.052	(1)			< 0.017	(1)
	85-260	85-260	< 0.060	(1)			< 0.015	(1)	0.055	(1)			< 0.020	(1)
		85-261	< 0.060	(1)			< 0.015	(1)	0.05[illegible]	(1)			< 0.020	(1)
	86-40	86-40	< 0.200	(1)			< 0.100	(1)	0.053	(1)				
		86-41	< 0.200	(1)			< 0.100	(1)	0.058	(1)				
	86-121	86-121	< 0.200	(1)			< 0.100	(1)	0.065	(1)				
		86-122	< 0.200	(1)			< 0.100	(1)	0.054	(1)				
699-19-88	85-278	85-278	< [illegible]	(1)			< 0.05[illegible]	(1)	0.008	(1)				
		85-279	< 0.100	(1)			< 0.050	(1)	0.008	(1)				
	86-64	86-64	< 0.200	(1)			< 0.100	(1)	0.011	(1)				
		86-65	< 0.200	(1)			< 0.100	(1)	0.010	(1)				
	86-127	86-127	< 0.200	(1)			< 0.100	(1)	0.009	(1)				
		86-128	< 0.200	(1)			< 0.100	(1)	0.009	(1)				
699-20-E05-0	SITE-49	SITE-49			0.005	(0)	0.0[illegible]	(0)	[illegible]	(0)				
699-20-20	SITE-25	SITE-25	0.010	(0)	0.013	(0)	0.030	(0)	0.090	(0)			0.007	(0)
699-24-33	SITE-28	SITE-28	0.010	(0)	0.004	(0)	0.040	(0)	0.050	(0)			0.007	(0)
699-24-46	SITE-122	SITE-122	0.100	(0)			< 0.005	(0)	0.070	(0)			< 0.005	(0)
699-24-95	85-288	85-288	< 0.050	(1)			< 0.050	(1)	[illegible]	(1)			< 0.017	(1)
		85-289	< 0.050	(1)			< 0.050	(1)	0.058	(1)			< 0.017	(1)
	86-61	86-61	< 0.200	(1)			< 0.100	(1)	0.042	(1)				
		86-62	< 0.200	(1)			< 0.100	(1)	0.043	(1)				
	86-115	86-115	< 0.200	(1)			< 0.100	(1)	0.047	(1)				
		86-116	< 0.200	(1)			< 0.100	(1)	0.047	(1)				
699-25-55	SITE-100	SITE-100	0.500	(0)			0.030	(0)	[illegible]	(0)			0.010	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-14-38	SITE-61	SITE-61	< 0.050	(0)			0.050	(0)	0.010	(0)	0.070	(0)	0.010	(0)
	SITE-86	SITE-86	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.050	(0)	0.010	(0)
699-15-15B	SITE-13	SITE-13	< 0.001	(0)	0.002	(0)	0.020	(0)	0.006	(0)	0.040	(0)	0.003	(0)
	SITE-149	SITE-149	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.007	(0)	< 0.010	(0)
699-15-26	SITE-24	SITE-24	0.006	(0)	0.002	(0)	0.020	(0)	0.010	(0)	0.004	(0)	0.020	(0)
	SITE-150	SITE-150	< 0.050	(0)	< 0.010	(0)	< 0.010	(0)	0.010	(0)	< 0.001	(0)	0.010	(0)
699-17-05	SITE-18	SITE-18	0.001	(0)	0.004	(0)	3.800	(0)	0.005	(0)	0.055	(0)	< 0.001	(0)
	SITE-151	SITE-151	< 0.050	(0)	< 0.010	(0)	0.030	(0)	0.007	(0)	0.001	(0)	0.010	(0)
699-19-43	SITE-48	SITE-48					0.010	(0)	0.010	(0)			0.003	(0)
	SITE-121	SITE-121	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.001	(0)	< 0.010	(0)
699-19-58	85-229	85-229	< 0.032	(1)	< 0.006	(1)	0.470	(1)	< 0.008	(1)	0.106	(1)	< 0.034	(1)
		85-230	< 0.032	(1)	< 0.006	(1)	0.480	(1)	0.009	(1)	0.107	(1)	< 0.034	(1)
	85-260	85-260	< 0.030	(1)	< 0.006	(1)	0.470	(1)	< 0.008	(1)	0.101	(1)	< 0.034	(1)
		85-261	< 0.030	(1)	< 0.006	(1)	0.480	(1)	< 0.008	(1)	0.105	(1)	< 0.034	(1)
	86-40	86-40			< 0.012	(1)	0.430	(1)	< 0.016	(1)	0.101	(1)	< 0.600	(1)
		86-41			< 0.120	(1)	0.429	(1)	< 0.016	(1)	0.100	(1)	< 0.600	(1)
	86-121	86-121			< 0.030	(1)	0.448	(1)	< 0.016	(1)	0.108	(1)	< 0.600	(1)
		86-122			< 0.030	(1)	0.438	(1)	< 0.016	(1)	0.105	(1)	< 0.600	(1)
699-19-88	85-278	85-278			< 0.006	(1)	0.022	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	(1)
		85-279			< 0.006	(1)	0.024	(1)	< 0.008	(1)	< 0.004	(1)	< 0.300	(1)
	86-64	86-64			< 0.012	(1)	0.033	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-65			< 0.012	(1)	< 0.030	(1)	< 0.018	(1)	< 0.010	(1)	< 0.600	(1)
	86-127	86-127			< 0.030	(1)	0.034	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-128			< 0.030	(1)	0.035	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
699-20-E05-0	SITE-49	SITE-49			0.001	(0)	0.020	(0)			0.020	(0)	0.002	(0)
699-20-20	SITE-25	SITE-25	0.007	(0)	0.002	(0)	0.020	(0)	0.010	(0)	0.004	(0)	0.005	(0)
699-24-33	SITE-28	SITE-28	0.007	(0)	0.002	(0)	0.030	(0)			0.004	(0)	0.030	(0)
699-24-46	SITE-122	SITE-122	< 0.050	(0)	< 0.010	(0)	0.050	(0)	0.010	(0)	0.070	(0)	0.010	(0)
699-24-95	85-288	85-288	< 0.032	(1)	< 0.006	(1)	0.245	(1)	< 0.008	(1)	0.014	(1)	< 0.035	(1)
		85-289	< 0.032	(1)	< 0.006	(1)	0.250	(1)	< 0.008	(1)	0.014	(1)	< 0.035	(1)
	86-61	86-61			< 0.012	(1)	0.537	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
		86-62			< 0.012	(1)	0.535	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	(1)
	86-115	86-115			< 0.030	(1)	0.695	(1)	< 0.016	(1)	0.019	(1)	< 0.600	(1)
		86-116			< 0.030	(1)	0.690	(1)	< 0.016	(1)	0.018	(1)	< 0.600	(1)
699-25-55	SITE-100	SITE-100	0.070	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.007	(0)	0.030	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
699-14-38	SITE-61	SITE-61	< 0.050	(0)			0.030	(0)	0.100	(0)	< 0.005	(0)
	SITE-86	SITE-86	< 0.050	(0)	0.030	(0)	1.000	(0)	0.100	(0)	< 0.005	(0)
699-15-15B	SITE-13	SITE-13	< 0.002	(0)	0.050	(0)	0.003	(0)	0.200	(0)	0.100	(0)
	SITE-149	SITE-149	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.300	(0)	0.030	(0)
699-15-26	SITE-24	SITE-24	0.006	(0)			0.006	(0)	0.200	(0)		
	SITE-150	SITE-150	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.300	(0)	< 0.009	(0)
699-17-05	SITE-18	SITE-18	0.005	(0)	0.070	(0)	0.010	(0)	0.190	(0)	0.050	(0)
	SITE-151	SITE-151	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.100	(0)	0.010	(0)
699-19-43	SITE-48	SITE-48	0.002	(0)					0.240	(0)	0.230	(0)
	SITE-121	SITE-121	< 0.050	(0)	0.030	(0)	0.300	(0)	0.300	(0)	0.700	(0)
699-19-58	85-229	85-229	< 0.030	(1)			< 0.180	(1)	0.140	(1)	< 0.020	(1)
		85-230	< 0.030	(1)			< 0.180	(1)	0.141	(1)	< 0.020	(1)
	85-260	85-260	< 0.030	(1)			< 0.180	(1)	0.139	(1)	< 0.020	(1)
		85-261	< 0.030	(1)			< 0.1[illegible]	(1)	0.140	(1)	< 0.020	(1)
	86-40	86-40							0.136	(1)	< 0.040	(1)
		86-41							0.135	(1)	< 0.040	(1)
	86-121	86-121							0.137	(1)	< 0.040	(1)
		86-122							0.135	(1)	< 0.040	(1)
245 699-19-88	85-278	85-278							0.1[illegible]	(1)	< 0.020	(1)
		85-279							0.107	(1)	< 0.020	(1)
	86-64	86-64							0.104	(1)	< 0.040	(1)
		86-65							0.105	(1)	< 0.040	(1)
	86-127	86-127							0.106	(1)	< 0.040	(1)
		86-128							0.107	(1)	< 0.040	(1)
699-20-E05-0	SITE-49	SITE-49	0.002	(0)					0.200	(0)	0.008	(0)
699-20-20	SITE-25	SITE-25	0.007	(0)			0.00[illegible]	(0)	0.[illegible]0	(0)	0.030	(0)
699-24-33	SITE-28	SITE-28	0.007	(0)			0.007	(0)	0.2[illegible]0	(0)		
699-24-46	SITE-122	SITE-122	< 0.050	(0)	0.010	(0)	1.000	(0)	[illegible]	(0)	< 0.005	(0)
699-24-95	85-288	85-288	< 0.030	(1)			< 0.1[illegible]	(1)	[illegible]	(1)	0.608	(1)
		85-289	< 0.030	(1)			< 0.140	(1)	0.[illegible]3	(1)	0.618	(1)
	86-61	86-61							0.[illegible]0	(1)	0.1[illegible]	(1)
		86-62							0.152	(1)	0.[illegible]2	(1)
	86-115	86-115							0.[illegible]9	(1)	[illegible]	(1)
		86-116							0.170	(1)	0.074	(1)
699-25-55	SITE-100	SITE-100	0.100	(0)	0.040	(0)	0.700	(0)	0.[illegible]0	(0)	0.010	(0)

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SAMPLE TYPE. UNCONFINED
ANALYSIS GROUP. TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
699-26-15	SITE-26	SITE-26	0.010	(0)	0.007	(0)	0.030	(0)	0.070	(0)			0.007	(0)
699-26-15A	SITE-263	SITE-263	< 0.050	(0)			0.030	(0)	0.050	(0)			< 0.005	(0)
699-27-04	SITE-101	SITE-101	0.500	(0)			0.030	(0)	0.070	(0)			0.010	(0)
699-27-08	SITE-5	SITE-5	0.006	(0)	0.009	(0)	0.015	(0)	0.065	(0)	< 0.006	(0)	< 0.002	(0)
	SITE-30	SITE-30	0.020	(0)	0.005	(0)	0.020	(0)	0.060	(0)			0.007	(0)
	SITE-50	SITE-50			0.006	(0)	0.020	(0)	0.100	(0)				
	SITE-76	SITE-76	0.070	(0)	0.009	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
	SITE-87	SITE-87	< 0.050	(0)	0.008	(0)	0.050	(0)	0.100	(0)			< 0.005	(0)
699-28-40	SITE-68	SITE-68	0.070	(0)	0.007	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
699-31-31	SITE-69	SITE-69	0.070	(0)	0.009	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
	SITE-102	SITE-102	0.500	(0)			0.030	(0)	0.050	(0)			0.007	(0)
699-31-53B	SITE-88	SITE-88	0.070	(0)	0.006	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
699-32-22	SITE-17	SITE-17	0.100	(0)	0.003	(0)	0.015	(0)	0.044	(0)	< 0.005	(0)	< 0.003	(0)
	SITE-27	SITE-27	0.010	(0)	0.002	(0)	0.030	(0)	0.050	(0)			0.007	(0)
	SITE-51	SITE-51			0.003	(0)	0.020	(0)	0.100	(0)			0.002	(0)
	SITE-65	SITE-65	0.100	(0)	0.005	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
	SITE-89	SITE-89	< 0.050	(0)	0.007	(0)	0.030	(0)	0.070	(0)	< 0.001	(0)	< 0.005	(0)
699-32-70B	SITE-70	SITE-70	0.050	(0)	0.005	(0)	0.010	(0)	0.030	(0)			< 0.005	(0)
	SITE-90	SITE-90	< 0.050	(0)	0.005	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
	SITE-152	SITE-152	< 0.050	(0)			0.010	(0)	0.070	(0)			< 0.005	(0)
699-32-72	SITE-35	SITE-35	0.010	(0)			0.020	(0)	0.020	(0)			0.005	(0)
699-32-77	SITE-103	SITE-103	0.500	(0)			0.030	(0)	0.030	(0)			< 0.005	(0)
699-33-42	SITE-12	SITE-12	0.075	(0)	0.001	(0)	0.030	(0)	0.037	(0)			< 0.002	(0)
	SITE-29	SITE-29	0.020	(0)	0.001	(0)	0.040	(0)	0.040	(0)			0.006	(0)
	SITE-52	SITE-52			0.001	(0)	0.030	(0)						
	SITE-67	SITE-67	0.070	(0)	0.006	(0)	0.030	(0)	0.030	(0)			< 0.005	(0)
	SITE-91	SITE-91	< 0.050	(0)	0.005	(0)	0.030	(0)	0.050	(0)	< 0.001	(0)	< 0.005	(0)
699-33-56	SITE-8	SITE-8	0.090	(0)	0.005	(0)	0.016	(0)	0.053	(0)			< 0.002	(0)
	SITE-40	SITE-40	0.010	(0)	0.002	(0)	0.020	(0)	0.070	(0)			0.007	(0)
	SITE-53	SITE-53			0.002	(0)	0.020	(0)	0.100	(0)				
	SITE-62	SITE-62	0.070	(0)	0.006	(0)	0.030	(0)	0.070	(0)			< 0.005	(0)
	SITE-92	SITE-92	0.070	(0)	0.006	(0)	0.030	(0)	0.070	(0)			< 0.005	(0)
699-34-39A	SITE-93	SITE-93	< 0.050	(0)	0.006	(0)	0.030	(0)	0.030	(0)			< 0.005	(0)
699-34-42	SITE-33	SITE-33	0.020	(0)	0.004	(0)	0.030	(0)	0.050	(0)			0.007	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-26-15	SITE-26	SITE-26	0.007	(0)	0.002	(0)	[illegible]	(0)			0.004	(0)	[illegible]	[illegible]
699-26-15A	SITE-263	SITE-263	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.001	(0)	< 0.010	(0)
699-27-04	SITE-101	SITE-101	0.070	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.010	(0)	0.010	(0)
699-27-08	SITE-5	SITE-5	0.004	(0)	0.002	(0)	0.020	(0)	0.005	(0)	0.012	(0)	0.002	[illegible]
	SITE-30	SITE-30	0.007	(0)	0.002	(0)	[illegible]	(0)			0.020	(0)	0.004	[illegible]
	SITE-50	SITE-50					[illegible]	(0)	0.010	(0)	0.009	(0)	0.001	[illegible]
	SITE-76	SITE-76	< 0.050	(0)			[illegible]	(0)	0.010	(0)	0.001	(0)	< 0.010	[illegible]
	SITE-87	SITE-87	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.001	(0)	< 0.010	(0)
699-28-40	SITE-68	SITE-68	< 0.050	(0)			[illegible]	(0)	0.007	(0)	0.001	(0)	0.030	(0)
699-31-31	SITE-69	SITE-69	< 0.050	(0)			[illegible]	(0)	0.007	(0)	0.003	(0)	0.030	[illegible]
	SITE-102	SITE-102	0.070	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.005	(0)	0.030	(0)
699-31-53B	SITE-98	SITE-88	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.001	(0)	[illegible]	[illegible]
699-32-22	SITE-17	SITE-17	0.004	(0)	0.005	(0)	0.120	(0)	0.005	(0)	0.012	(0)	0.003	[illegible]
	SITE-27	SITE-27	0.007	(0)	0.002	(0)	[illegible]	(0)			0.020	(0)	0.010	[illegible]
	SITE-51	SITE-51			0.001	(0)	[illegible]	(0)	0.010	(0)	0.020	(0)	0.003	[illegible]
	SITE-65	SITE-65	< 0.050	(0)			[illegible]	(0)	0.007	(0)	0.005	(0)	0.010	[illegible]
	SITE-89	SITE-89	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.003	(0)	0.010	[illegible]
699-32-70B	SITE-70	SITE-70	< 0.050	(0)			[illegible]	(0)	0.005	(0)	0.003	(0)	0.030	(0)
	SITE-00	SITE-90	0.050	(0)	< 0.010	(0)	< [illegible]	(0)	< 0.010	(0)	0.001	[illegible]	[illegible]	[illegible]
	SITE-152	SITE-152	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.001	[illegible]	[illegible]	[illegible]
699-32-72	SITE-35	SITE-35	0.005	(0)	0.001	(0)	[illegible]	(0)	[illegible]	(0)	0.003	(0)	0.010	[illegible]
699-32-77	SITE-103	SITE-103	< 0.050	(0)	< 0.010	(0)	0.010	(0)	< 0.010	(0)	0.003	(0)	0.030	[illegible]
699-33-42	SITE-12	SITE-12	0.005	(0)	0.025	(0)	[illegible]	(0)	0.007	(0)	0.050	(0)	[illegible]	[illegible]
	SITE-29	SITE-29	0.008	(0)	0.002	(0)	[illegible]	(0)			0.004	(0)	[illegible]	[illegible]
	SITE-52	SITE-52					0.120	(0)	0.010	(0)	0.040	(0)	0.009	[illegible]
	SITE-67	SITE-67	< 0.050	(0)			[illegible]	(0)	0.010	(0)	0.010	(0)	0.010	[illegible]
	SITE-91	SITE-91	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	[illegible]	(0)	0.010	(0)	< 0.010	[illegible]
699-33-56	SITE-8	SITE-8	0.008	(0)	0.008	(0)	2.400	(0)	0.007	(0)	0.098	(0)	[illegible]	[illegible]
	SITE-40	SITE-40	0.007	(0)	0.002	(0)	[illegible]	(0)	0.010	(0)	0.056	(0)	0.030	[illegible]
	SITE-53	SITE-53					0.030	(0)	0.010	(0)			0.012	(0)
	SITE-62	SITE-62	< 0.050	(0)			[illegible]	(0)	0.010	(0)	0.003	(0)	0.030	[illegible]
	SITE-92	SITE-92	< 0.050	(0)	< 0.010	(0)	< [illegible]	(0)	0.010	(0)	0.001	(0)	0.030	[illegible]
699-34-39A	SITE-93	SITE-93	< 0.050	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.007	(0)	0.010	[illegible]
699-34-42	SITE-33	SITE-33	0.007	(0)	0.001	(0)	[illegible]	(0)			0.050	(0)	0.030	[illegible]

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SAMPLE TYPE. UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L (A)	P MG/L (A)	PB MG/L (A)	SR MG/L (A)	ZN MG/L (A)
699-26-15	SITE-26	SITE-26	0.007 (0)		0.007 (0)	0.230 (0)	
699-26-15A	SITE-263	SITE-263	< 0.050 (0)	0.010 (0)	< 0.030 (0)	0.300 (0)	0.010 (0)
699-27-04	SITE-101	SITE-101	0.070 (0)	0.020 (0)	0.500 (0)	0.300 (0)	< 0.005 (0)
699-27-08	SITE-5	SITE-5	< 0.002 (0)	0.020 (0)	0.004 (0)	0.250 (0)	0.120 (0)
	SITE-30	SITE-30	0.007 (0)		0.007 (0)	0.240 (0)	0.060 (0)
	SITE-50	SITE-50	0.002 (0)		0.002 (0)	0.280 (0)	0.060 (0)
	SITE-76	SITE-76	< 0.050 (0)		< 0.030 (0)	0.300 (0)	0.030 (0)
	SITE-87	SITE-87	< 0.050 (0)	0.020 (0)	1.000 (0)	0.300 (0)	0.030 (0)
699-28-40	SITE-68	SITE-68	< 0.050 (0)		< 0.030 (0)	0.300 (0)	< 0.005 (0)
699-31-31	SITE-69	SITE-69	< 0.050 (0)		< 0.030 (0)	0.300 (0)	0.005 (0)
	SITE-102	SITE-102	0.070 (0)	0.030 (0)	0.700 (0)	0.300 (0)	< 0.005 (0)
699-31-53B	SITE-88	SITE-88	< 0.050 (0)	0.030 (0)	1.000 (0)	0.100 (0)	0.100 (0)
699-32-22	SITE-17	SITE-17	0.003 (0)	0.040 (0)	0.004 (0)	0.270 (0)	0.012 (0)
	SITE-27	SITE-27	0.007 (0)		0.007 (0)	0.260 (0)	0.010 (0)
	SITE-51	SITE-51	0.003 (0)		0.002 (0)	0.280 (0)	0.020 (0)
	SITE-65	SITE-65	< 0.050 (0)	0.040 (0)	< 0.030 (0)	0.300 (0)	< 0.005 (0)
	SITE-89	SITE-89	< 0.050 (0)	0.020 (0)	1.000 (0)	0.300 (0)	< 0.005 (0)
699-32-70B	SITE-70	SITE-70	< 0.050 (0)		< 0.030 (0)	0.100 (0)	0.005 (0)
	SITE-90	SITE-90	< 0.050 (0)	0.380 (0)	1.000 (0)	0.100 (0)	< 0.005 (0)
	SITE-152	SITE-152	< 0.050 (0)	0.050 (0)	< 0.030 (0)	0.300 (0)	0.010 (0)
699-32-72	SITE-35	SITE-35	0.005 (0)		0.005 (0)	0.110 (0)	0.020 (0)
699-32-77	SITE-103	SITE-103	< 0.050 (0)	0.060 (0)	0.700 (0)	0.100 (0)	< 0.005 (0)
699-33-42	SITE-12	SITE-12	0.005 (0)	0.030 (0)	0.010 (0)	0.200 (0)	0.020 (0)
	SITE-29	SITE-29	0.006 (0)		0.006 (0)	0.170 (0)	0.010 (0)
	SITE-52	SITE-52	0.002 (0)			0.200 (0)	0.010 (0)
	SITE-67	SITE-67	< 0.050 (0)		< 0.030 (0)	0.100 (0)	< 0.005 (0)
	SITE-91	SITE-91	< 0.050 (0)	0.020 (0)	1.000 (0)	0.100 (0)	< 0.005 (0)
699-33-56	SITE-8	SITE-8	0.003 (0)	0.020 (0)	0.030 (0)	0.180 (0)	0.400 (0)
	SITE-40	SITE-40	0.007 (0)		0.007 (0)	0.170 (0)	0.110 (0)
	SITE-53	SITE-53	0.002 (0)			0.240 (0)	0.210 (0)
	SITE-62	SITE-62	< 0.050 (0)		< 0.030 (0)	0.300 (0)	< 0.005 (0)
	SITE-92	SITE-92	< 0.050 (0)	0.030 (0)	1.000 (0)	0.300 (0)	0.100 (0)
699-34-39A	SITE-93	SITE-93	< 0.050 (0)	0.030 (0)	1.000 (0)	0.100 (0)	< 0.005 (0)
699-34-42	SITE-33	SITE-33	0.007 (0)		0.007 (0)	0.170 (0)	0.020 (0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
699-34-42	SITE-153	SITE-153	0.050	(0)			0.030	(0)	0.030	(0)			0.005	(0)
699-34-51	SITE-66	SITE-66	0.100	(0)	0.006	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
699-35-09	SITE-31	SITE-31	0.030	(0)	0.004	(0)	0.020	(0)	0.070	(0)			0.008	(0)
	SITE-104	SITE-104	0.500	(0)			0.030	(0)	0.070	(0)			0.007	(0)
	SITE-264	SITE-264	< 0.050	(0)			0.030	(0)	0.070	(0)			< 0.005	(0)
699-35-66	SITE-77	SITE-77	0.070	(0)	0.004	(0)	0.010	(0)	0.030	(0)			< 0.005	(0)
	SITE-94	SITE-94	< 0.050	(0)	0.004	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
699-35-70	SITE-36	SITE-36	0.010	(0)	0.001	(0)	0.020	(0)	0.050	(0)			0.008	(0)
699-35-78	SITE-54	SITE-54			0.003	(0)	0.030	(0)						
699-36-61A	SITE-95	SITE-95	0.050	(0)	0.006	(0)	0.030	(0)	0.070	(0)			< 0.005	(0)
699-37-43	SITE-34	SITE-34	0.010	(0)	0.006	(0)	0.030	(0)	0.040	(0)			0.006	(0)
	SITE-173	SITE-173							0.059	(0)				
699-37-82A	SITE-105	SITE-105	0.500	(0)			0.010	(0)	0.050	(0)			< 0.005	(0)
699-38-70	SITE-37	SITE-37	0.010	(0)	0.002	(0)	0.020	(0)	0.100	(0)			0.010	(0)
699-39-E3	SITE-248	SITE-248	< 0.050	(0)			0.030	(0)	0.030	(0)			< 0.005	(0)
699-39-01	SITE-249	SITE-249	< 0.050	(0)			0.030	[illegible]	[illegible]	(0)			< 0.005	(0)
699-39-39	SITE-268	SITE-268	< 0.050	(0)			0.050	(0)	0.050	(0)			< 0.005	(0)
699-40-01	SITE-10	SITE-10	0.130	(0)	0.004	(0)	0.015	[illegible]	0.040	(0)	< 0.003	(0)	< 0.002	(0)
	SITE-106	SITE-106	0.300	(0)			0.010	[illegible]	0.070	(0)			< 0.005	(0)
	SITE-250	SITE-250	< 0.050	(0)			0.030	[illegible]	[illegible]	(0)			< 0.002	(0)
	SITE-265	SITE-265	< 0.050	(0)			0.030	[illegible]	0.070	(0)			< 0.005	(0)
699-40-33	SITE-55	SITE-55	0.010	(0)	0.009	(0)	0.030	[illegible]						
	SITE-251	SITE-251	< 0.250	(0)			0.050	[illegible]	[illegible]	(0)			< 0.002	(0)
699-40-62	SITE-56	SITE-56			0.002	(0)	0.020	(0)						
699-41-01	SITE-252	SITE-252	< 0.050	(0)			0.030	[illegible]	0.070	(0)			< 0.005	(0)
699-41-23	SITE-15	SITE-15	0.014	(0)	0.002	(0)	0.020	[illegible]	0.033	(0)	< 0.004	(0)	< 0.002	[illegible]
	SITE-113	SITE-113	0.050	(0)			[illegible]	[illegible]	0.050	(0)			0.007	(0)
699-42-02	SITE-154	SITE-154	0.100	(0)			0.050	(0)	0.250	(0)			< 0.005	[illegible]
699-42-12	SITE-2	SITE-2	0.010	(0)	0.008	(0)	0.020	(0)	0.050	(0)	< 0.006	(0)	< 0.002	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-34-42	SITE-153	SITE-153	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.001	(0)	0.010	(0)
699-34-51	SITE-66	SITE-66	< 0.050	(0)			0.010	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-35-09	SITE-31	SITE-31	0.006	(0)	0.010	(0)	0.010	(0)	0.010	(0)	0.004	(0)	0.010	(0)
	SITE-104	SITE-104	0.070	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.003	(0)	0.030	(0)
	SITE-264	SITE-264	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.010	(0)	0.001	(0)	0.010	(0)
699-35-66	SITE-77	SITE-77	< 0.050	(0)			0.005	(0)	0.007	(0)	0.030	(0)	0.010	(0)
	SITE-94	SITE-94	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.001	(0)	0.030	(0)
699-35-70	SITE-36	SITE-36	0.001	(0)	0.001	(0)	0.010	(0)			0.110	(0)	0.030	(0)
699-35-78	SITE-54	SITE-54					0.030	(0)	0.010	(0)			0.007	(0)
699-36-61A	SITE-95	SITE-95	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-37-43	SITE-34	SITE-34	0.006	(0)	0.002	(0)	0.030	(0)	0.020	(0)	0.100	(0)	0.030	(0)
	SITE-173	SITE-173	< 0.018	(0)	< 0.001	(0)	< 0.030	(0)			0.008	(0)		
699-37-82A	SITE-105	SITE-105	< 0.050	(0)	< 0.010	(0)	0.005	(0)	0.010	(0)	< 0.001	(0)	0.010	(0)
699-38-70	SITE-37	SITE-37	0.010	(0)	0.003	(0)	0.010	(0)	0.010	(0)	0.007	(0)	0.005	(0)
699-39-E3	SITE-248	SITE-248	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.007	(0)	< 0.010	(0)
699-39-01	SITE-249	SITE-249	< 0.050	(0)	< 0.010	(0)	0.005	(0)	0.007	(0)	0.001	(0)	< 0.010	(0)
699-39-39	SITE-266	SITE-266	< 0.050	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.030	(0)	0.010	(0)
699-40-01	SITE-10	SITE-10	0.003	(0)	0.022	(0)	0.180	(0)	0.005	(0)	0.017	(0)	0.002	(0)
	SITE-106	SITE-106	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.003	(0)	0.010	(0)
	SITE-250	SITE-250	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	< 0.001	(0)	< 0.010	(0)
	SITE-265	SITE-265	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.010	(0)	< 0.001	(0)	< 0.010	(0)
699-40-33	SITE-55	SITE-55			0.002	(0)	0.170	(0)	0.020	(0)	0.050	(0)	0.003	(0)
	SITE-251	SITE-251	< 0.050	(0)	< 0.010	(0)	0.100	(0)	0.010	(0)	0.050	(0)	< 0.010	(0)
699-40-62	SITE-56	SITE-56					0.030	(0)	0.010	(0)			0.007	(0)
699-41-01	SITE-252	SITE-252	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.010	(0)	< 0.001	(0)	< 0.010	(0)
699-41-23	SITE-15	SITE-15	0.001	(0)	0.002	(0)	0.310	(0)	0.005	(0)	0.025	(0)	0.007	(0)
	SITE-113	SITE-113	0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.005	(0)	0.030	(0)
699-42-02	SITE-154	SITE-154	< 0.050	(0)	< 0.010	(0)	0.100	(0)	0.010	(0)	0.001	(0)	< 0.010	(0)
699-42-12	SITE-2	SITE-2	0.005	(0)	0.002	(0)	0.030	(0)	0.007	(0)	0.004	(0)	0.005	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
699-34-42	SITE-153	SITE-153	< 0.050	(0)	0.030	(0)	0.030	(0)	0.100	(0)	< 0.009	(0)
699-34-51	SITE-66	SITE-66	< 0.050	(0)			[illegible]	(0)	[illegible]	(0)	< 0.005	(0)
699-35-00	SITE-31	SITE-31	0.005	(0)			[illegible]	(0)	0.210	(0)	0.030	(0)
	SITE-104	SITE-104	0.070	(0)	0.020	(0)	[illegible]	(0)	0.300	(0)	< 0.005	(0)
	SITE-264	SITE-264	< 0.050	(0)	0.010	(0)	< [illegible]	(0)	0.300	(0)	< 0.009	(0)
699-35-66	SITE-77	SITE-77	< 0.050	(0)			< [illegible]	(0)	0.100	(0)	0.005	(0)
	SITE-94	SITE-94	< 0.050	(0)	0.040	(0)	1.000	(0)	0.300	(0)	< 0.005	(0)
699-35-70	SITE-36	SITE-36	0.008	(0)			[illegible]	(0)	[illegible]	(0)	0.040	(0)
699-35-78	SITE-54	SITE-54	0.002	(0)					0.100	(0)	[illegible]	(0)
699-36-61A	SITE-95	SITE-95	< 0.050	(0)	0.030	(0)	1.000	(0)	0.100	(0)	< 0.005	(0)
699-37-43	SITE-34	SITE-34	0.006	(0)			[illegible]	(0)	0.210	(0)	0.020	(0)
	SITE-173	SITE-173	< 0.003	(0)			< [illegible]	(0)			[illegible]	(0)
699-37-82A	SITE-105	SITE-105	< 0.050	(0)	0.010	(0)	[illegible]	(0)	[illegible]	(0)	< 0.005	(0)
699-38-70	SITE-37	SITE-37	0.010	(0)			[illegible]	(0)	0.330	(0)	[illegible]	(0)
699-39-E3	SITE-248	SITE-248	< 0.050	(0)	0.030	(0)	< [illegible]	(0)	0.300	(0)	< 0.009	(0)
699-39-01	SITE-249	SITE-249	< 0.050	(0)	0.020	(0)	< [illegible]	(0)	[illegible]	(0)	< [illegible]	(0)
699-39-39	SITE-266	SITE-266	< 0.050	(0)	< 0.010	(0)	< [illegible]	(0)	0.100	(0)	< [illegible]	(0)
699-40-01	SITE-10	SITE-10	0.002	(0)	0.070	(0)	[illegible]	[illegible]	[illegible]	(0)	0.010	(0)
	SITE-106	SITE-106	< 0.050	(0)	0.030	(0)	[illegible]	(0)	0.300	(0)	< 0.005	(0)
	SITE 250	SITE-250	< 0.050	(0)	0.040	(0)	< [illegible]	(0)	[illegible]	(0)	< [illegible]	[illegible]
	SITE-265	SITE-265	< 0.050	(0)	0.020	(0)	< [illegible]	(0)	[illegible]	(0)	0.010	(0)
699-40-33	SITE-55	SITE-55	0.003	(0)					[illegible]	(0)	0.010	(0)
	SITE-251	SITE-251	< 0.050	(0)	0.040	(0)	< [illegible]	(0)	[illegible]	(0)	< 0.010	(0)
699-40-62	SITE-56	SITE-56	0.003	(0)					[illegible]	(0)	0.005	(0)
699-41-01	SITE-252	SITE-252	< 0.050	(0)	0.020	(0)	< [illegible]	(0)	0.300	(0)	< 0.009	(0)
699-41-23	SITE-15	SITE-15	[illegible]	(0)	0.030	(0)	< [illegible]	(0)	0.250	(0)	0.030	(0)
	SITE-113	SITE-113	[illegible]	(0)	0.030	(0)	0.700	(0)	0.300	(0)	0.010	(0)
699-42-02	SITE-154	SITE-154	< [illegible]	(0)	0.020	(0)	< [illegible]	(0)	1.000	(0)	< [illegible]	(0)
699-42-12	SITE-2	SITE-2	< 0.002	(0)	0.010	(0)	0.002	(0)	0.250	(0)	0.010	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L (A)	AS MG/L (A)	B MG/L (A)	BA MG/L (A)	CD MG/L (A)	CO MG/L (A)
699-42-12	SITE-155	SITE-155	< 0.050 (0)		0.010 (0)	0.050 (0)		< 0.005 (0)
	SITE-267	SITE-267	< 0.050 (0)		0.030 (0)	0.070 (0)		< 0.005 (0)
699-42-40A	SITE-174	SITE-174				0.045 (0)		
699-42-40C	SITE-175	SITE-175						
699-42-42	SITE-114	SITE-114	0.300 (0)		0.030 (0)	0.070 (0)		0.007 (0)
699-43-03	SITE-253	SITE-253	< 0.050 (0)		0.030 (0)	0.050 (0)		< 0.005 (0)
699-43-88	SITE-123	SITE-123	0.300 (0)		< 0.005 (0)	0.040 (0)		< 0.005 (0)
699-44-04	SITE-254	SITE-254	< 0.050 (0)		0.030 (0)	0.050 (0)		< 0.005 (0)
699-45-04	SITE-255	SITE-255	< 0.050 (0)		0.030 (0)	0.030 (0)		< 0.005 (0)
699-45-42	SITE-57	SITE-57		0.002 (0)	0.009 (0)			
	SITE-268	SITE-268	< 0.050 (0)		0.030 (0)	0.030 (0)		< 0.005 (0)
699-45-69	SITE-96	SITE-96	0.050 (0)	0.004 (0)	0.030 (0)	0.030 (0)		< 0.005 (0)
252 699-46-05	SITE-156	SITE-156	< 0.050 (0)		0.010 (0)	0.030 (0)		0.005 (0)
	SITE-256	SITE-256	< 0.050 (0)		0.030 (0)	0.050 (0)		< 0.005 (0)
699-46-21A	SITE-75	SITE-75	0.070 (0)	0.005 (0)	0.010 (0)	0.050 (0)		< 0.005 (0)
	SITE-124	SITE-124	0.100 (0)		< 0.005 (0)	0.100 (0)		0.007 (0)
699-47-06	SITE-257	SITE-257	< 0.050 (0)		0.030 (0)	0.030 (0)		< 0.005 (0)
699-47-46	SITE-269	SITE-269	< 0.050 (0)		0.030 (0)	0.050 (0)		< 0.005 (0)
699-48-07	SITE-258	SITE-258	< 0.050 (0)		0.010 (0)	0.030 (0)		< 0.005 (0)
699-48-18	SITE-125	SITE-125	0.100 (0)		< 0.005 (0)	0.040 (0)		< 0.005 (0)
699-48-71	SITE-59	SITE-59		0.001 (0)	0.009 (0)			
699-49-13	SITE-259	SITE-259	< 0.050 (0)		0.030 (0)	0.030 (0)		< 0.005 (0)
699-49-55	SITE-9	SITE-9	0.100 (0)	0.011 (0)	0.020 (0)	0.034 (0)	< 0.010 (0)	< 0.002 (0)
	SITE-39	SITE-39	0.010 (0)	0.004 (0)	0.020 (0)	0.040 (0)		0.006 (0)
	SITE-58	SITE-58		0.003 (0)	0.020 (0)	0.100 (0)		
	SITE-78	SITE-78	0.100 (0)	0.011 (0)	0.030 (0)	0.030 (0)		< 0.005 (0)
	SITE-97	SITE-97	< 0.050 (0)	0.013 (0)	0.030 (0)	0.030 (0)	< 0.001 (0)	< 0.005 (0)
	SITE-126	SITE-126	0.100 (0)		< 0.005* (0)	0.030 (0)		0.007 (0)
	SITE-157	SITE-157	0.070 (0)		0.030 (0)	0.030 (0)		< 0.005 (0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-42-12	SITE-155	SITE-155	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.007	(0)	< 0.010	(0)
	SITE-267	SITE-267	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.003	(0)	< 0.010	(0)
699-42-40A	SITE-174	SITE-174	< 0.031	(0)	< 0.001	(0)	< 0.030	(0)			0.014	(0)		
699-42-40C	SITE-175	SITE-175					< 0.05[illegible]	(0)						
699-42-42	SITE-114	SITE-114	0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-43-03	SITE-253	SITE-253	< 0.050	(0)	< 0.010	(0)	0.0[illegible]	(0)	0.010	(0)	0.001	(0)	< 0.010	(0)
699-43-88	SITE-123	SITE-123	< 0.050	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.030	(0)	0.010	(0)
699-44-04	SITE-254	SITE-254	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	< 0.001	(0)	< 0.010	(0)
699-45-04	SITE-255	SITE-255	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.010	(0)	< 0.001	(0)	0.010	(0)
699-45-42	SITE-57	SITE-57					0.010	(0)	0.010	(0)	0.040	(0)	0.007	(0)
	SITE-268	SITE-268	< 0.050	(0)	< 0.010	(0)	0.070	(0)	0.007	(0)	0.010	(0)	0.010	(0)
699-45-69	SITE-96	SITE-96	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.003	(0)	< 0.010	(0)
699-46-05	SITE-156	SITE-156	< 0.050	(0)	< 0.010	(0)	0.0[illegible]	(0)	0.010	(0)	0.001	(0)	0.030	(0)
	SITE-256	SITE-256	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	< 0.001	(0)	< 0.010	[illegible]
699-46-21A	SITE-75	SITE-75	< 0.050	(0)			0.010	(0)	0.010	(0)	0.003	(0)	0.010	[illegible]
	SITE-124	SITE-124	0.070	(0)	< 0.010	(0)	0.0[illegible]	(0)	0.010	(0)	0.007	(0)	0.030	[illegible]
699-47-06	SITE-257	SITE-257	< 0.050	(0)	< 0.010	(0)	0.0[illegible]	(0)	0.007	(0)	0.001	(0)	< 0.010	[illegible]
699-47-46	SITE-269	SITE-269	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	< 0.001	(0)	0.010	(0)
699-48-07	SITE-258	SITE-258	< 0.050	(0)	< 0.010	(0)	0.007	(0)	< 0.005	(0)	< 0.001	(0)	< 0.010	(0)
699-48-18	SITE-125	SITE-125	< 0.050	(0)	< 0.010	(0)	0.005	(0)	0.010	(0)	0.030	(0)	< 0.0[illegible]	
699-48-71	SITE-59	SITE-59					0.010	(0)	0.010	(0)			0.0[illegible]	[illegible]
699-49-13	SITE-259	SITE-259	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.007	(0)	0.003	(0)	< 0.030	[illegible]
699-49-55	SITE-9	SITE-9	< 0.003	(0)	0.001	(0)	0.350	(0)	0.005	(0)	0.0[illegible]	(0)	0.0[illegible]	(0)
	SITE-39	SITE-39	0.008	(0)	0.002	(0)	0.020	(0)	0.010	(0)	0.0[illegible]	(0)	0.0[illegible]5	[illegible]
	SITE-58	SITE-58					0.010	(0)	0.010	(0)	0.070	(0)	0.015	[illegible]
	SITE-78	SITE-78	< 0.050	(0)			0.0[illegible]	(0)	0.007	(0)	0.005	(0)	0.030	[illegible]
	SITE-97	SITE-97	< 0.050	(0)	< 0.010	(0)	< 0.095	(0)	0.010	(0)	0.003	(0)	0.030	[illegible]
	SITE-126	SITE-126	0.070	(0)	< 0.010	(0)	0.020	(0)	0.010	(0)	0.003	(0)	0.050	(0)
	SITE-157	SITE-157	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.010	(0)	0.010	(0)	0.030	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
699-42-12	SITE-155	SITE-155	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.300	(0)	0.010	(0)
	SITE-267	SITE-267	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.300	(0)	0.010	(0)
699-42-40A	SITE-174	SITE-174	< 0.003	(0)			< 0.008	(0)			0.095	(0)
699-42-40C	SITE-175	SITE-175										
699-42-42	SITE-114	SITE-114	0.070	(0)	0.020	(0)	0.700	(0)	0.300	(0)	< 0.005	(0)
699-43-03	SITE-253	SITE-253	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.300	(0)	< 0.009	(0)
699-43-88	SITE-123	SITE-123	< 0.050	(0)	0.010	(0)	0.300	(0)	0.100	(0)	< 0.005	(0)
699-44-04	SITE-254	SITE-254	< 0.050	(0)	0.030	(0)	< 0.030	(0)	0.300	(0)	0.010	(0)
699-45-04	SITE-255	SITE-255	< 0.050	(0)	0.030	(0)	0.030	(0)	0.300	(0)	< 0.009	(0)
699-45-42	SITE-57	SITE-57	0.002	(0)			0.002	(0)	0.210	(0)	0.003	(0)
	SITE-268	SITE-268	< 0.050	(0)	< 0.010	(0)	< 0.030	(0)	0.100	(0)	0.010	(0)
699-45-69	SITE-96	SITE-96	< 0.050	(0)	0.010	(0)	1.000	(0)	0.300	(0)	< 0.005	(0)
699-46-05	SITE-156	SITE-156	< 0.050	(0)	0.020	(0)	0.050	(0)	0.300	(0)	< 0.009	(0)
	SITE-256	SITE-256	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.300	(0)	< 0.009	(0)
699-46-21A	SITE-75	SITE-75	< 0.050	(0)			< 0.030	(0)	0.300	(0)	< 0.005	(0)
	SITE-124	SITE-124	0.070	(0)	0.010	(0)	0.500	(0)	0.300	(0)	< 0.005	(0)
699-47-06	SITE-257	SITE-257	< 0.050	(0)	0.050	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-47-46	SITE-269	SITE-269	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.300	(0)	0.030	(0)
699-48-07	SITE-258	SITE-258	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-48-18	SITE-125	SITE-125	< 0.050	(0)	0.030	(0)	0.300	(0)	0.300	(0)	0.010	(0)
699-48-71	SITE-59	SITE-59	0.003	(0)					0.170	(0)	0.003	(0)
699-49-13	SITE-259	SITE-259	< 0.050	(0)	0.050	(0)	< 0.030	(0)	0.100	(0)	0.010	(0)
699-49-55	SITE-9	SITE-9	< 0.003	(0)	0.080	(0)	< 0.003	(0)	0.250	(0)	< 0.008	(0)
	SITE-39	SITE-39	0.008	(0)			0.008	(0)	0.270	(0)		
	SITE-58	SITE-58	0.004	(0)					0.320	(0)	0.013	(0)
	SITE-78	SITE-78	< 0.050	(0)			< 0.030	(0)	0.300	(0)	< 0.005	(0)
	SITE-97	SITE-97	< 0.050	(0)	0.010	(0)	1.000	(0)	0.300	(0)	< 0.005	(0)
	SITE-126	SITE-126	0.070	(0)			0.300	(0)	0.300	(0)	< 0.005	(0)
	SITE-157	SITE-157	< 0.050	(0)	0.020	(0)	0.030	(0)	0.300	(0)	< 0.009	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
699-49-55A	SITE-182	SITE-182												
699-49-57	SITE-38	SITE-38	0.050	(0)	0.004	(0)	0.030	(0)	0.090	(0)			0.010	(0)
699-49-79	SITE-20	SITE-20	0.130	(0)			0.012	(0)	0.030	(0)	< 0.004	(0)	< 0.002	(0)
699-50-08	SITE-64	SITE-64	0.070	(0)	0.008	(0)	0.030	(0)	0.050	(0)			< 0.005	(0)
699-50-28B	SITE-63	SITE-63	0.070	(0)	0.007	(0)	0.010	(0)	0.050	(0)			< 0.005	(0)
699-50-42	SITE-14	SITE-14	0.230	(0)	0.004	(0)	0.015	(0)	0.025	(0)	< 0.005	(0)	< 0.002	(0)
	SITE-115	SITE-115	0.500	(0)			0.030	(0)	0.030	(0)			0.010	(0)
	SITE-271	SITE-271	< 0.050	(0)			0.030	(0)	0.050	(0)			< 0.005	(0)
699-50-53	SITE-270	SITE-270	< 0.050	(0)			0.030	(0)	0.030	(0)			< 0.005	(0)
699-50-85	SITE-127	SITE-127	0.300	(0)			< 0.005	(0)	0.040	(0)			0.007	(0)
699-51-63	SITE-116	SITE-116	0.500	(0)			0.010	(0)	0.030	(0)			0.007	(0)
699-53-103	SITE-160	SITE-160					0.020	(0)						
699-53-47B	SITE-272	SITE-272	< 0.050	(0)			0.010	(0)	0.030	(0)			< 0.005	(0)
699-54-34	SITE-273	SITE-273	< 0.050	(0)			0.030	(0)	0.070	(0)			0.011	(0)
699-55-50C	SITE-70	SITE-70	0.050	(0)	0.006	(0)	0.010	(0)	0.007	(0)			< 0.005	(0)
	SITE-128	SITE-128	0.300	(0)			< 0.005	(0)	0.020	(0)			0.007	(0)
	SITE-193	SITE-193							0.015	(0)			< 0.010	(0)
	SITE-274	SITE-274	< 0.050	(0)			0.030	(0)	0.010	(0)			< 0.005	(0)
699-55-76	SITE-71	SITE-71	0.050	(0)	0.002	(0)	0.010	(0)	0.030	(0)			< 0.005	(0)
	SITE-117	SITE-117	0.300	(0)			0.030	(0)	0.030	(0)			0.005	(0)
	SITE-129	SITE-129	0.100	(0)			< 0.005	(0)	0.030	(0)			< 0.005	(0)
699-55-89	SITE-118	SITE-118	0.500	(0)			0.010	(0)	0.050	(0)			< 0.005	(0)
699-56-53	SITE-194	SITE-194												
	SITE-195	SITE-195												
699-57-25A	SITE-119	SITE-119	0.500	(0)			0.030	(0)	0.030	(0)			0.005	(0)
	SITE-275	SITE-275	< 0.050	(0)			0.030	(0)	0.010	(0)			< 0.005	(0)
699-57-29A	SITE-276	SITE-276	< 0.050	(0)			0.030	(0)	0.020	(0)			< 0.005	(0)
699-57-83	SITE-130	SITE-130	0.100	(0)			< 0.005	(0)	0.020	(0)			0.007	(0)
699-59-58	SITE-107	SITE-107	0.300	(0)			0.030	(0)	0.030	(0)			0.007	(0)

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SD-BWI-DP-061 Rev. 1

SAMPLE TYPE UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-49-55A	SITE-182	SITE-182					< 0.030	(0)						
699-49-57	SITE-38	SITE-38	0.014	(0)	0.033	(0)	0.120	(0)	0.010	(0)	0.007	(0)	0.020	(0)
699-49-79	SITE-20	SITE-20	< 0.001	(0)	0.007	(0)	0.580	(0)	0.003	(0)	0.023	(0)	0.002	(0)
699-50-08	SITE-64	SITE-64	< 0.050	(0)			< 0.005	(0)	0.010	(0)	0.001	(0)	0.012	(0)
699-50-28B	SITE-63	SITE-63	< 0.050	(0)			< 0.005	(0)	0.010	(0)	0.011	(0)	0.030	(0)
699-50-42	SITE-14	SITE-14	< 0.008	(0)	0.010	(0)	0.970	(0)	0.006	(0)	0.023	(0)	0.005	(0)
	SITE-115	SITE-115	0.070	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.050	(0)	0.030	(0)
	SITE-271	SITE-271	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.070	(0)	< 0.010	(0)
699-50-53	SITE-270	SITE-270	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-50-85	SITE-127	SITE-127	0.070	(0)	0.010	(0)	0.020	(0)	0.010	(0)	0.005	(0)	0.030	(0)
699-51-63	SITE-116	SITE-116	0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.003	(0)	0.030	(0)
699-53-103	SITE-160	SITE-160					0.120	(0)	0.020	(0)	0.060	(0)		
699-53-47B	SITE-272	SITE-272	< 0.050	(0)	< 0.010	(0)	0.030	(0)	0.007	(0)	0.003	(0)	< 0.010	(0)
699-54-34	SITE-273	SITE-273	< 0.050	(0)	< 0.010	(0)	1.000	(0)	0.010	(0)	0.100	(0)	< 0.010	(0)
699-55-50C	SITE-79	SITE-79	< 0.050	(0)			0.005	(0)	0.005	(0)	0.001	(0)	< 0.010	(0)
	SITE-128	SITE-128	0.070	(0)	< 0.010	(0)	0.040	(0)	0.010	(0)	0.003	(0)	0.030	(0)
	SITE-193	SITE-193	< 0.013	(0)	< 0.001	(0)	< 0.030	(0)			< 0.001	(0)		
	SITE-274	SITE-274	< 0.050	(0)	< 0.010	(0)	0.005	(0)	0.010	(0)	0.001	(0)	0.010	(0)
699-55-76	SITE-71	SITE-71	< 0.050	(0)			0.005	(0)	0.005	(0)	0.100	(0)	0.010	(0)
	SITE-117	SITE-117	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.010	(0)	0.030	(0)
	SITE-129	SITE-129	< 0.050	(0)	< 0.010	(0)	0.020	(0)	0.010	(0)	0.070	(0)	0.010	(0)
699-55-89	SITE-118	SITE-118	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.007	(0)	0.010	(0)
699-56-53	SITE-194	SITE-194					< 0.050	(0)						
	SITE-195	SITE-195					< 0.050	(0)						
699-57-25A	SITE-119	SITE-119	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.001	(0)	0.030	(0)
	SITE-275	SITE-275	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-57-29A	SITE-276	SITE-276	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	< 0.001	(0)	0.010	(0)
699-57-83	SITE-130	SITE-130	0.070	(0)	< 0.010	(0)	0.020	(0)	0.010	(0)	0.005	(0)	0.030	(0)
699-59-58	SITE-107	SITE-107	0.050	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.001	(0)	0.030	(0)

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
699-49-55A	SITE-182	SITE-182										
699-49-57	SITE-38	SITE-38	0.010	(0)			0.010	(0)	0.390	(0)	0.070	(0)
699-49-79	SITE-20	SITE-20	0.003	(0)	0.040	(0)	0.007	(0)	0.150	(0)	0.045	(0)
699-50-08	SITE-64	SITE-64	< 0.050	(0)			< 0.030	(0)	0.300	(0)	< 0.005	(0)
699-50-28B	SITE-63	SITE-63	< 0.050	(0)			< 0.030	(0)	0.300	(0)	0.300	(0)
699-50-42	SITE-14	SITE-14	0.003	(0)	0.030	(0)	0.005	(0)	0.190	(0)	0.100	(0)
	SITE-115	SITE-115	0.070	(0)			0.300	(0)	0.100	(0)	< 0.005	(0)
	SITE-271	SITE-271	< 0.050	(0)	< 0.010	(0)	< 0.030	(0)	0.100	(0)	0.010	(0)
699-50-53	SITE-270	SITE-270	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.300	(0)	0.010	(0)
699-50-85	SITE-127	SITE-127	0.100	(0)	0.020	(0)	0.500	(0)	0.100	(0)	0.007	(0)
699-51-63	SITE-116	SITE-116	0.070	(0)	0.040	(0)	0.500	(0)	0.100	(0)	< 0.005	(0)
699-53-103	SITE-160	SITE-160	0.002	(0)					0.090	(0)	0.003	(0)
699-53-47B	SITE-272	SITE-272	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.300	(0)	< 0.000 (?)	(0)
699-54-34	SITE-273	SITE-273	< 0.050	(0)	< 0.010	(0)	< 0.030	(0)	0.300	(0)	0.700	(0)
699-55-50C	SITE-79	SITE-79	< 0.050	(0)			< 0.030	(0)	0.100	(0)	< 0.005	(0)
	SITE-128	SITE-128	0.070	(0)	0.040	(0)	0.300	(0)	0.100	(0)	< 0.005	(0)
	SITE-193	SITE-193	< 0.003	(0)			< 0.020	(0)			0.101	(0)
	SITE-274	SITE-274	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.100	(0)	0.010	(0)
699-55-76	SITE-71	SITE-71	< 0.050	(0)			< 0.030	(0)	0.300	(0)	0.005	(0)
	SITE-117	SITE-117	0.050	(0)	0.010	(0)	0.300	(0)	0.100	(0)	< 0.005	(0)
	SITE-129	SITE-129	< 0.050	(0)			0.100	(0)	0.300	(0)	< 0.005	(0)
699-55-89	SITE-118	SITE-118	< 0.050	(0)	0.010	(0)	0.700	(0)	0.300	(0)	< 0.005	(0)
699-56-53	SITE-194	SITE-194										
	SITE-195	SITE-195										
699-57-25A	SITE-119	SITE-119	0.050	(0)	0.050	(0)	0.700	(0)	0.300	(0)	< 0.005	(0)
	SITE-275	SITE-275	< 0.050	(0)	0.030	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-57-29A	SITE-276	SITE-276	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.300	(0)	< 0.009	(0)
699-57-83	SITE-130	SITE-130	0.070	(0)	0.010	(0)	0.500	(0)	0.100	(0)	0.010	(0)
699-59-58	SITE-107	SITE-107	0.050	(0)	0.050	(0)	0.700	(0)	0.300 (?)	(0)	< 0.005	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
699-59-58	SITE-277	SITE-277	< 0.050	(0)			0.030	(0)	0.010	(0)			< 0.005	(0)
699-60-32	SITE-278	SITE-278	< 0.050	(0)			0.030	(0)	0.010	(0)			< 0.005	(0)
699-60-57	SITE-198	SITE-198							0.029	(0)			< 0.003	(0)
699-62-31	SITE-131	SITE-131	0.100	(0)			< 0.005	(0)	0.050	(0)			0.010	(0)
	SITE-279	SITE-279	< 0.050	(0)			0.030	(0)	0.050	(0)			< 0.005	(0)
699-63-25A	SITE-132	SITE-132	0.100	(0)			< 0.005	(0)	0.050	(0)			< 0.005	(0)
699-63-55	SITE-280	SITE-280	< 0.050	(0)			0.050	(0)	0.010	(0)			< 0.005	(0)
699-63-58	SITE-281	SITE-281	< 0.050	(0)			0.050	(0)	0.010	(0)			< 0.005	(0)
699-63-90	SITE-74	SITE-74	0.070	(0)	0.004	(0)	0.010	(0)	0.010	(0)			< 0.005	(0)
	SITE-133	SITE-133	0.100	(0)			< 0.005	(0)	0.020	(0)			0.007	(0)
699-64-27	SITE-158	SITE-158	0.100	(0)			0.010	(0)	0.070	(0)			0.005	(0)
699-65-50	SITE-73	SITE-73	0.070	(0)	0.014	(0)	0.030	(0)	0.010	(0)			< 0.005	(0)
	SITE-134	SITE-134	0.300	(0)			< 0.005	(0)	0.020	(0)			0.007	(0)
	SITE-282	SITE-282	< 0.050	(0)			0.050	(0)	0.010	(0)			< 0.005	(0)
699-66-103	85-203	85-203	0.150	(1)			0.040	(1)	0.012	(1)			< 0.017	(1)
		85-204	< 0.060	(1)			< 0.024	(1)	0.008	(1)			< 0.017	(1)
	86-73	86-73	< 0.200	(1)			< 0.100	(1)	0.005	(1)				
		86-74	< 0.200	(1)			< 0.100	(1)	0.005	(1)				
	86-112	86-112	< 0.200	(1)			< 0.100	(1)	0.008	(1)				
		86-113	< 0.200	(1)			< 0.100	(1)	0.007	(1)				
	85-294	85-294	< 0.060	(1)			< 0.016	(1)	0.003	(1)			< 0.017	(1)
		85-295	< 0.060	(1)			< 0.016	(1)	< 0.003	(1)			< 0.017	(1)
699-66-39	SITE-135	SITE-135	0.100	(0)			< 0.005	(0)	0.020	(0)			0.007	(0)
699-66-58	SITE-136	SITE-136	0.300	(0)			< 0.005	(0)	0.020	(0)			0.007	(0)
699-66-64	SITE-137	SITE-137	0.100	(0)			< 0.005	(0)	0.020	(0)			0.007	(0)
699-67-98	SITE-260	SITE-260	< 0.050	(0)			0.030	(0)	0.010	(0)			< 0.005	(0)
699-69-38	SITE-6	SITE-6	0.110	(0)	0.003	(0)	0.010	(0)	0.062	(0)	< 0.010	(0)	< 0.003	(0)
699-71-30	SITE-108	SITE-108	0.300	(0)			0.030	(0)	0.050	(0)			0.005	(0)
699-71-52	SITE-138	SITE-138	0.100	(0)			< 0.005	(0)	0.040	(0)			< 0.005	(0)
699-72-73	SITE-109	SITE-109	0.500	(0)			0.030	(0)	0.030	(0)			0.010	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-59-58	SITE-277	SITE-277	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.007	(0)	< 0.001	(0)	0.010	[illegible]
699-60-32	SITE-278	SITE-278	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-60-57	SITE-198	SITE-198	< 0.002	(0)	< 0.001	(0)	< 0.030	(0)			0.050	(0)		
699-62-31	SITE-131	SITE-131	0.070	(0)	< 0.010	(0)	0.500	(0)	0.010	(0)	0.200	(0)	0.030	[illegible]
	SITE-279	SITE-279	< 0.050	(0)	< 0.010	(0)	0.050	(0)	0.010	(0)	0.070	(0)	< 0.010	(0)
699-63-25A	SITE-132	SITE-132	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.001	(0)	< 0.010	(0)
699-63-55	SITE-280	SITE-280	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.010	(0)	0.001	(0)	0.030	(0)
699-63-58	SITE-281	SITE-281	< 0.050	(0)	< 0.010	(0)	0.005	(0)	0.007	(0)	< 0.001	(0)	< 0.010	[illegible]
699-63-90	SITE-74	SITE-74	< 0.050	(0)			0.010	(0)	0.007	(0)	0.001	(0)	0.010	(0)
	SITE-133	SITE-133	0.070	(0)	< 0.010	(0)	0.030	(0)	0.010	(0)	0.003	(0)	0.030	(0)
699-64-27	SITE-158	SITE-158	< 0.050	(0)	< 0.010	(0)	0.010	(0)	0.030	(0)	0.007	(0)	0.010	(0)
699-65-50	SITE-73	SITE-73	< 0.050	(0)			[illegible]	(0)	0.007	(0)	0.001	(0)	0.010	(0)
	SITE-134	SITE-134	0.070	(0)	< 0.010	(0)	0.050	(0)	0.010	(0)	0.003	(0)	0.050	(0)
	SITE-282	SITE-282	< 0.050	(0)	< 0.010	(0)	0.00[illegible]	(0)	0.007	(0)	< 0.001	(0)	0.010	(0)
699-66-103	85-203	85-203	< 0.032	(1)	0.025	(1)	0.030	(1)	0.019	(1)	< 0.005	(1)	0.073	(1)
		85-204	< 0.032	(1)	0.012	(1)	0.015	(1)	< 0.008	(1)	< 0.005	(1)	0.038	(1)
	86-73	86-73			< 0.012	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	[illegible]
		86-74			< 0.012	(1)	< 0.030	(1)	< 0.018	(1)	< 0.010	(1)	< 0.600	(1)
	86-112	86-112			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.500	(1)
		86-113			< 0.030	(1)	< 0.030	(1)	< 0.016	(1)	< 0.010	(1)	< 0.600	[illegible]
	85-294	85-294	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
		85-295	< 0.032	(1)	< 0.006	(1)	< 0.009	(1)	< 0.008	(1)	< 0.005	(1)	< 0.034	(1)
699-66-39	SITE-135	SITE-135	0.070	(0)	< 0.010	(0)	0.02[illegible]	(0)	[illegible]	(0)	0.003	(0)	0.050	(0)
699-66-58	SITE-136	SITE-136	0.070	(0)	< 0.010	(0)	0.040	(0)	0.010	(0)	0.003	(0)	0.030	[illegible]
699-66-64	SITE-137	SITE-137	0.070	(0)	0.010	(0)	0.03[illegible]	(0)	0.010	(0)	0.003	(0)	0.02[illegible]	(0)
699-67-98	SITE-250	SITE-260	< 0.050	(0)	< 0.010	(0)	0.0[illegible]	(0)	0.010	(0)	< 0.001	(0)	< 0.010	(0)
699-69-38	SITE-6	SITE-6	< 0.003	(0)	0.003	(0)	0.330	(0)	0.016	(0)	0.250	(0)	0.005	(0)
699-71-30	SITE-108	SITE-108	< 0.050	(0)	< 0.010	(0)	[illegible]	(0)	0.010	(0)	0.003	(0)	0.010	[illegible]
699-71-52	SITE-138	SITE-138	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.003	(0)	< 0.010	[illegible]
699-72-73	SITE-109	SITE-109	0.070	(0)	< 0.010	(0)	0.01[illegible]	(0)	[illegible]	(0)	0.010	(0)	0.03[illegible]	[illegible]

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SR MG/L	(A)	ZN MG/L	(A)
699-59-58	SITE-277	SITE-277	< 0.050	(0)	0.020	(0)	< 0.030	(0)	0.100	(0)	0.010	(0)
699-60-32	SITE-278	SITE-278	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.300	(0)	0.030	(0)
699-60-57	SITE-198	SITE-198	< 0.003	(0)			< 0.009	(0)			0.006	(0)
699-62-31	SITE-131	SITE-131	0.070	(0)	0.010	(0)	0.500	(0)	0.100	(0)	3.000	(0)
	SITE-279	SITE-279	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.100	(0)	0.300	(0)
699-63-25A	SITE-132	SITE-132	< 0.050	(0)	0.050	(0)	0.500	(0)	0.500	(0)	0.007	(0)
699-63-55	SITE-280	SITE-280	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.100	(0)	0.010	(0)
699-63-58	SITE-281	SITE-281	< 0.050	(0)	0.030	(0)	< 0.030	(0)	0.100	(0)	0.050	(0)
699-63-90	SITE-74	SITE-74	< 0.050	(0)			< 0.030	(0)	0.100	(0)	< 0.005	(0)
	SITE-133	SITE-133	0.100	(0)	0.010	(0)	0.500	(0)	0.100	(0)	0.007	(0)
699-64-27	SITE-158	SITE-158	< 0.050	(0)	0.030	(0)	0.030	(0)	0.700	(0)	0.010	(0)
699-65-50	SITE-73	SITE-73	< 0.050	(0)			< 0.030	(0)	0.100	(0)	0.005	(0)
	SITE-134	SITE-134	0.100	(0)	0.050	(0)	0.500	(0)	0.100	(0)	0.010	(0)
	SITE-282	SITE-282	< 0.050	(0)	0.010	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-66-103	85-203	85-203	0.036	(1)			< 0.180	(1)	0.113	(1)	< 0.020	(1)
		85-204	< 0.030	(1)			< 0.180	(1)	0.111	(1)	< 0.020	(1)
	86-73	86-73							0.104	(1)	< 0.040	(1)
		86-74							0.102	(1)	< 0.040	(1)
	86-112	86-112							0.110	(1)	< 0.040	(1)
		86-113							0.110	(1)	< 0.040	(1)
	85-294	85-294	< 0.030	(1)			< 0.180	(1)	0.103	(1)	< 0.020	(1)
		85-295	< 0.030	(1)			< 0.180	(1)	0.103	(1)	< 0.020	(1)
699-66-39	SITE-135	SITE-135	0.070	(0)			0.100	(0)	0.100	(0)	< 0.005	(0)
699-66-58	SITE-136	SITE-136	0.070	(0)	0.040	(0)	0.500	(0)	0.100	(0)	0.100	(0)
699-66-64	SITE-137	SITE-137	0.100	(0)	0.030	(0)	0.500	(0)	0.100	(0)	0.100	(0)
699-67-98	SITE-260	SITE-260	< 0.050	(0)	0.040	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-69-38	SITE-6	SITE-6	< 0.003	(0)	1.500	(0)	0.010	(0)	0.400	(0)	0.050	(0)
699-71-30	SITE-108	SITE-108	0.050	(0)	0.050	(0)	< 0.030	(0)	0.500	(0)	< 0.005	(0)
699-71-52	SITE-138	SITE-138	< 0.050	(0)	0.010	(0)	0.300	(0)	0.100	(0)	< 0.005	(0)
699-72-73	SITE-109	SITE-109	0.100	(0)	0.040	(0)	0.700	(0)	0.100	(0)	0.010	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AL MG/L	(A)	AS MG/L	(A)	B MG/L	(A)	BA MG/L	(A)	CD MG/L	(A)	CO MG/L	(A)
699-72-88	SITE-98	SITE-98	< 0.050	(0)	0.005	(0)	0.030	(0)	0.050	(0)	< 0.001	(0)	< 0.005	(0)
	SITE-261	SITE-261	< 0.050	(0)			0.030	(0)	0.030	(0)			< 0.005	(0)
699-72-92	SITE-262	SITE-262	< 0.050	(0)			0.010	(0)	0.030	(0)			< 0.005	(0)
699-77-36	SITE-110	SITE-110	0.300	(0)			0.100	(0)	0.070	(0)			< 0.005	(0)
699-78-62	SITE-111	SITE-111	0.300	(0)			0.010	(0)	0.030	(0)			< 0.005	(0)
699-81-58	SITE-159	SITE-159	< 0.050	(0)			< 0.005	(0)	0.010	(0)			< 0.005	(0)
699-83-47	SITE-112	SITE-112	0.300	(0)			0.010	(0)	0.250	(0)			< 0.005	(0)
699-87-55	SITE-99	SITE-99	< 0.050	(0)	0.011	(0)	0.030	(0)	0.030	(0)			< 0.005	(0)
699-90-45	SITE-139	SITE-139	0.100	(0)			< 0.005	(0)	0.050	(0)			0.010	(0)

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SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CR MG/L	(A)	CU MG/L	(A)	FE MG/L	(A)	LI MG/L	(A)	MN MG/L	(A)	MO MG/L	(A)
699-72-88	SITE-98	SITE-98	< 0.050	(0)	< 0.010	(0)	0.030	(0)	< 0.010	(0)	0.005	(0)	< 0.010	(0)
	SITE-261	SITE-261	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.007	(0)	< 0.001	(0)	< 0.010	(0)
699-72-92	SITE-262	SITE-262	< 0.050	(0)	< 0.010	(0)	< 0.005	(0)	< 0.005	(0)	< 0.001	(0)	< 0.010	(0)
699-77-36	SITE-110	SITE-110	< 0.050	(0)	< 0.010	(0)	0.007	(0)	0.030	(0)	< 0.001	(0)	0.010	(0)
699-78-62	SITE-111	SITE-111	0.100	(0)	< 0.010	(0)	0.005	(0)	0.010	(0)	0.003	(0)	0.010	(0)
699-81-58	SITE-159	SITE-159	< 0.050	(0)	< 0.010	(0)	0.005	(0)	0.005	(0)	0.003	(0)	0.010	(0)
699-83-47	SITE-112	SITE-112	0.070	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	0.003	(0)	0.030	(0)
699-87-55	SITE-99	SITE-99	0.100	(0)	< 0.010	(0)	< 0.005	(0)	0.010	(0)	< 0.001	(0)	0.030	(0)
699-90-45	SITE-139	SITE-139	0.050	(0)	< 0.010	(0)	0.500	(0)	0.010	(0)	0.500	(0)	0.030	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: TRACE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	NI MG/L	(A)	P MG/L	(A)	PB MG/L	(A)	SN MG/L	(A)	ZN MG/L	(A)
699-72-88	SITE-98	SITE-98	< 0.050	(0)	0.050	(0)	1.000	(0)	0.100	(0)	< 0.005	(0)
	SITE-261	SITE-261	< 0.050	(0)	0.060	(0)	< 0.030	(0)	0.100	(0)	< 0.008	(0)
699-72-92	SITE-262	SITE-262	< 0.050	(0)	0.030	(0)	< 0.030	(0)	0.100	(0)	< 0.009	(0)
699-77-36	SITE-110	SITE-110	< 0.050	(0)	0.040	(0)	0.500	(0)	0.700	(0)	< 0.005	(0)
699-78-62	SITE-111	SITE-111	< 0.050	(0)	0.050	(0)	0.500	(0)	0.200	(0)	0.070	(0)
699-81-58	SITE-159	SITE-159	< 0.050	(0)	< 0.010	(0)	< 0.020	(0)	0.100	(0)	< 0.009	(0)
699-83-47	SITE-112	SITE-112	< 0.050	(0)	0.030	(0)	0.500	(0)	0.300	(0)	< 0.005	(0)
699-87-55	SITE-99	SITE-99	< 0.050	(0)	0.020	(0)	1.000	(0)	0.300	(0)	< 0.005	(0)
699-90-45	SITE-139	SITE-139	0.050	(0)	0.030	(0)	0.500	(0)	0.300	(0)	0.030	(0)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

LIST OF ANALYSIS METHODS FOR TRACE CONSTITUENTS

SPECIE	(A)	ANALYSIS METHOD
AL	0	Unclassified
	1	ICP
	2	AA
AS	0	Unclassified
	2	AA
B	0	Unclassified
	1	ICP
BA	0	Unclassified
	1	ICP
CD	0	Unclassified
	1	ICP
CO	0	Unclassified
	1	ICP
CR	0	Unclassified
	1	ICP
CU	0	Unclassified
	1	ICP
FE	0	Unclassified
	1	ICP
	2	AA
LI	0	Unclassified
	1	ICP
MN	0	Unclassified
	1	ICP
	2	AA
MO	0	Unclassified
	1	ICP
NI	0	Unclassified
	1	ICP
P	0	Unclassified
	1	ICP
PB	0	Unclassified
	1	ICP
SR	0	Unclassified
	1	ICP
[illegible]	0	Unclassified
	1	ICP

AA: Graphite Furnace Atomic Adsorption Spectrophotometry
ICP: Inductively Coupled Plasma Atomic Emission Spectrometry
Unclassified: Analysis comes from a non-BWIP documented source and the method is not specified in this data package.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: GAS

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AR MOLE%(REL)	C MON MOLE%(REL)	CH4 MOLE%(REL)	CO2 MOLE%(REL)	HE MOLE%(REL)	H2 MOLE%(REL)	N2 MOLE%(REL)	O2 MOLE%(REL)
DB-13	83-404	83-404	0.870	< 0.100	15.600	0.070	0.010	< 0.010	83.300	0.020
DB-15	79-17	79-17	< 0.010	< 0.100	< 0.010	0.200	< 0.010	0.130	0.650	0.010
	79-35	79-35	< 0.010	< 0.010	< 0.010	0.010	< 0.010	0.100	0.270	0.020
	79-33	79-33	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.010	0.020	0.010
	79-15	79-15	0.350	14.400	29.200	0.060	< 0.010	0.330	7.570	0.180
	79-39	79-39	0.050	< 0.100	4.400	0.070	< 0.010	0.100	2.500	0.030
	79-51	79-51	0.090	< 0.100	96.300	0.030	< 0.010	< 0.010	3.580	< 0.010
		79-61	0.080	< 0.100	96.000	0.010	< 0.010	< 0.010	3.870	< 0.010
		79-92	0.080	< 0.100	96.100	0.020	< 0.010	< 0.010	3.800	< 0.010
	79-85	79-74	0.930	2.820	3.980	0.040	< 0.010	0.060	74.100	18.100
		79-85	0.880	3.100	7.070	0.040	< 0.010	0.040	70.300	18.600
	79-80	79-80	0.080	< 0.100	94.870	< 0.010	< 0.010	0.820	4.210	0.020
		79-99	0.070	< 0.100	95.070	< 0.010	< 0.001	0.850	4.000	< 0.010
	79-62	79-62	< 0.010	< 0.100	83.060	1.330	< 0.010	4.350	10.880	0.380
		79-84	0.190	< 0.100	91.980	0.100	< 0.010	< 0.010	7.620	0.110
	80-35	80-35	0.220	< 0.100	86.900	0.200	< 0.010	1.070	10.900	0.710
		80-41	0.180	< 0.100	89.800	0.220	< 0.010	1.280	8.340	0.180
	80-24	80-24	0.110	< 0.100	94.400	0.010	0.010	0.090	5.400	< 0.010
		80-74	0.110	< 0.100	94.300	0.020	< 0.010	0.050	5.500	< 0.010
	80-77	80-42	0.160	< 0.100	91.100	< 0.010	< 0.010	0.950	7.770	< 0.010
		80-77	0.160	< 0.100	90.500	< 0.010	0.020	0.940	8.380	< 0.010
	80-1	80-1	0.090	< 0.100	94.300	< 0.018	< 0.010	< 0.010	5.600	< 0.010
		80-51	0.150	< 0.100	93.800	< 0.010	< 0.010	< 0.010	6.060	< 0.010
DC-05	79-30	79-30	0.160	4.720	93.400	< 0.010	0.010	< 0.010	1.700	< 0.010
DC-06	80-238	80-238	1.120	< 0.100	0.570	< 0.010	0.280	< 0.010	98.000	< 0.010
	80-15	80-15	1.350	< 0.100	< 0.010	0.160	0.390	< 0.010	97.600	0.490
	80-29	80-29	1.160	< 0.100	0.480	0.040	0.310	0.170	97.800	< 0.010
		80-37	1.600	< 0.100	0.900	< 0.010	0.350	0.200	96.800	0.120
	79-58	79-57	1.140	< 0.100	0.770	< 0.020	0.300	0.240	97.500	< 0.020
		79-58	1.170	< 0.100	0.750	< 0.010	0.260	0.190	97.600	0.050
	80-75	80-45	1.230	< 0.100	1.580	< 0.010	0.420	0.230	95.000	< 0.010
		80-75	1.540	< 0.100	1.950	< 0.010	0.320	0.290	96.000	0.190
DC-07	82-23	82-23	1.190	2.300	4.320	< 0.010	0.210	0.080	91.300	0.590
		82-56	1.130	1.800	4.390	< 0.010	0.210	0.090	92.000	0.370
	82-10	82-10A	1.010	< 0.100	4.140	0.020	0.190	< 0.010	94.600	< 0.010
		82-10B	1.100	2.000	5.160	< 0.010	0.200	0.030	91.000	0.540
		82-33	1.100	3.200	5.190	< 0.010	0.200	0.030	89.700	0.640
DC-12	80-80	80-80	0.140	< 0.100	95.900	0.500	< 0.010	< 0.010	3.420	< 0.010
	80-100	80-100	0.110	< 0.100	92.100	< 0.010	< 0.010	< 0.010	7.780	< 0.010
		80-40	0.130	< 0.100	94.100	< 0.010	< 0.010	< 0.010	5.790	0.010
	80-97	80-97	0.120	1.800	92.700	0.060	< 0.010	< 0.010	5.200	0.110
	80-32	80-32	0.120	< 0.100	91.900	0.130	< 0.010	< 0.010	7.860	< 0.010
	80-124	80-124	0.140	< 0.100	91.500	0.040	< 0.010	< 0.010	8.300	< 0.010

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE. CONFINED
ANALYSIS GROUP: GAS

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AR MOLE%(REL)	C MON MOLE%(REL)	CH4 MOLE%(REL)	CO2 MOLE%(REL)	HE MOLE%(REL)	H2 MOLE%(REL)	N2 MOLE%(REL)	O2 MOLE%(REL)
DC-12	80-234	80-234	0.830	< 0.100	0.110	0.020	< 0.010	< 0.010	99.200	0.020
DC-14	80-144	80-144	0.950	< 0.100	< 0.010	0.070	< 0.010	0.390	98.500	< 0.010
	80-112	80-112	1.190	< 0.100	< 0.010	0.080	< 0.010	< 0.010	98.700	< 0.010
	80-155	80-155	0.970	< 0.100	< 0.010	< 0.010	< 0.010	< 0.010	99.000	< 0.010
	80-104	80-104	1.140	< 0.100	< 0.010	0.020	< 0.010	< 0.010	98.800	< 0.010
	80-170	80-170	1.240	< 0.100	< 0.010	0.040	< 0.010	< 0.010	98.700	< [illegible]
	80-117	80-117	1.110	< 0.100	< 0.010	< 0.010	0.010	< 0.010	98.800	0.050
	81-30	81-30	99.700	< 0.100	< 0.010	0.060	< 0.010	< 0.010	0.190	0.010
	82-8	82-8	1.100	< 0.100	< 0.010	0.860	< 0.010	< 0.010	98.000	< 0.010
	82-315	82-315	1.270	< 0.500	0.070	< 0.010	0.180	< 0.020	98.000	< 0.010
	83-156	83-156	1.010	< 0.100	0.140	0.020	0.380	< 0.010	98.500	[illegible]
	83-152	83-152	0.980	< 0.100	< 0.010	0.150	0.570	< 0.010	98.300	0.050
	83-157	83-157	1.110	< 0.100	0.150	< 0.010	0.440	< 0.010	98.300	< 0.010
	83-178	83-178	1.060	< 0.100	0.140	< 0.010	0.430	< 0.010	98.400	< 0.010
	83-183	83-183	1.030	< 0.100	0.110	0.060	0.400	< 0.010	98.400	< 0.010
	83-154	83-154	1.020	< 0.100	0.140	0.020	0.410	< 0.010	98.400	< 0.010
	83-150	83-150	0.850	< 0.100	0.050	0.020	0.060	< 0.010	84.300	14.600
	83-266	83-266	1.040	< 0.100	< 0.010	0.050	0.510	< 0.010	98.400	< 0.010
	83-261	83-261	0.940	< 0.100	< 0.010	0.020	0.020	< 0.010	80.600	18.500
DC-15	80-57	80-65	0.250	5.600	82.500	0.510	< 0.010	0.080	11.100	< 0.010
	80-87	80-87	0.080	< 0.100	96.700	0.070	< 0.010	< 0.010	3.180	< 0.010
	80-137	80-137	0.170	< 0.100	87.900	0.010	< 0.010	< 0.010	11.900	< 0.010
	80-176	80-176	0.250	< 0.100	80.000	< 0.010	< 0.010	< 0.010	19.700	< 0.010
	80-135	80-135	0.320	< 0.100	78.200	< 0.010	< 0.010	< 0.010	21.500	< 0.010
	80-120	80-120	0.410	< 0.100	65.700	< 0.010	0.030	< 0.010	33.800	< 0.010
	80-131	80-131	1.140	< 0.100	0.140	0.010	0.120	< 0.010	98.500	0.050
	80-193	80-193	1.140	< 0.100	0.350	< 0.010	0.110	< 0.010	97.800	0.55[illegible]
	82-94	82-94	1.060	< 0.100	1.270	0.120	0.120	< 0.010	97.500	< 0.010
DC-16A	82-17	82-17	1.200	< 0.100	< 0.010	0.200	< 0.010	< [illegible]	98.500	< 0.010
		82-55	1.200	< 0.100	< 0.010	0.300	< 0.010	< 0.020	98.400	< 0.010
	82-93	82-93	1.110	< 0.100	9.920	0.410	< 0.010	< 0.010	88.500	0.100
	82-19	82-19	0.140	< 0.100	92.400	0.030	< 0.010	< 0.010	7.440	< [illegible]
		82-19A	0.140	< 0.100	92.400	[illegible]	< 0.010	< [illegible]	7.440	< [illegible]
		82-19B	0.210	1.800	87.900	0.010	< 0.010	< 0.010	8.800	1.330
		82-72	0.100	1.000	91.900	< 0.010	< 0.010	< 0.010	6.500	0.460
		82-88	0.100	1.000	91.900	< [illegible]	< 0.010	< 0.010	6.500	0.460
	82-188	82-140	0.690	< 0.100	30.300	[illegible]	< 0.010	0.370	54.500	14.[illegible]
		82-188	0.130	< 0.100	94.400	[illegible]	< 0.010	0.020	5.480	< [illegible]
		82-188A	1.190	< 0.100	0.650	[illegible]	< 0.010	< 0.010	77.200	21.00[illegible]
	82-124	82-124	0.480	< 0.100	69.000	0.120	< 0.010	0.180	30.200	< 0.010
		82-135	0.810	< 0.100	4.580	0.120	< 0.010	0.020	74.500	19.900
		82-139	0.920	< 0.100	2.180	[illegible]	< 0.010	0.010	75.700	21.00[illegible]
	82-143	82-168	0.030	< 0.100	96.200	[illegible]	< 0.010	< 0.010	3.580	[illegible]
	82-231	82-214A	0.140	< 0.100	89.400	0.010	< 0.010	0.040	8.820	[illegible]
		82-214B	0.120	< 0.100	92.800	< [illegible]	< 0.010	0.040	6.050	[illegible]

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: GAS

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AR MOLE%(REL)	C MON MOLE%(REL)	CH4 MOLE%(REL)	CO2 MOLE%(REL)	HE MOLE%(REL)	H2 MOLE%(REL)	N2 MOLE%(REL)	O2 MOLE%(REL)
DC-16A	82-231	82-279A	0.170	< 0.100	87.400	0.030	< 0.010	0.040	10.200	2.170
		82-279B	0.180	< 0.100	86.200	0.030	< 0.010	0.040	11.200	2.350
	82-322	82-322	0.060	< 0.100	96.600	0.060	< 0.010	0.010	3.280	< 0.010
		82-334	0.040	< 0.100	98.000	< 0.010	0.140	< 0.010	1.860	< 0.010
		82-355	0.040	< 0.100	98.000	< 0.010	0.010	< 0.010	1.910	< 0.010
		82-394	0.060	< 0.100	98.000	< 0.010	< 0.010	< 0.010	1.910	< 0.010
	82-339	82-313	0.030	< 0.500	98.700	0.020	< 0.006	< 0.010	1.230	< 0.010
		82-339	< 0.100	< 0.500	99.000	< 0.100	< 0.100	0.200	0.700	< 0.100
		82-345	0.040	< 0.500	98.700	0.020	< 0.006	< 0.010	1.200	< 0.010
	82-419	82-419	0.030	< 0.100	98.300	< 0.010	< 0.001	< 0.010	1.670	0.010
	82-430	82-430	0.030	< 0.100	98.000	0.020	< 0.010	0.040	1.780	0.090
		82-464	0.030	< 0.100	98.200	< 0.010	< 0.010	< 0.010	1.730	0.010
	83-29	83-20	0.240	< 0.100	75.900	0.040	< 0.010	< 0.010	19.000	4.800
		83-29	0.030	< 0.100	98 400	< 0.010	< 0.010	< 0.010	1.590	< 0.010
		83-54	0.030	< 0.100	98.500	0.010	< 0.010	< 0.010	1.490	< 0.010
DC-19C	84-53	84-53	1.040	< 0.100	15.400	0.050	< 0.010	< 0.010	69.100	14.400
	84-40	84-40A	0.800	< 0.100	68.100	1.300		< 0.010	29.600	0.100
		84-40B	1.200	< 0.100	57.900	0.300	< 0.003	< 0.010	40.600	< 0.010
		84-44	0.940	< 0.100	40.600	0.010	0.004	< 0.010	58.500	< 0.010
	84-75	84-73	0.870	2.800	50.500	0.010	0.007	< 0.010	45.700	< 0.010
		84-75	0.790	2.400	47.800	0.070	< 0.010	0.030	48.800	0.040
	84-86	84-46	0.680	1 800	60.000	0.010	< 0.010	< 0.010	37.400	< 0.010
		84-86	0.660	0.900	56.000	0.080	< 0.010	0.100	41.200	0.980
DC-20C	84-9	84-76	0.730	< 0.100	68.800	0.080	0.006	< 0.010	30.400	0.040
		84-9	0.800	< 0.100	46.300	0.010	< 0.003	< 0.010	53.000	< 0.010
DC-22C	84-105	84-105	0.350	< 0.100	82.400	0.360	< 0.001	< 0.100	16.700	0.170
ENYEART	84-166	84-166	1.440	< 0.100	31.500	4.770	< 0.010	0.110	55.400	6.790
MCGEE	82-7	82-7	1.000	< 0.100	44.000	0.200	< 0.010	< 0.010	46.000	< 0.010
	82-64	82-64	0.900	< 0.100	33.400	0.850	< 0.010	< 0.010	64.800	< 0.010
	82-263	82-248A	0.940	< 0.500	34.400	0.190	< 0.010	0.100	64.200	0.150
		82-248B	0.950	< 0.500	34.500	0.110	< 0.010	0.090	64.290	0.110
	82-397	82-343	0.980	< 0.100	33.600	0.200	< 0.010	0.040	65.200	< 0.010
		82-373	0.960	< 0.100	33.700	0.210	< 0.010	0.040	65.100	< 0.010
		82-397	1.080	< 0.100	21.200	0.660	< 0.010	< 0.010	77.100	< 0.010
	82-424	82-424	0.750	< 0.500	27.700	0.240	< 0.010	< 0.010	71.000	0.290
		82-428	0.970	< 0.100	31.800	0.250	< 0.010	0.060	68.900	0.020
		82-486	0.960	< 0.100	32.000	0.290	< 0.010	0.060	66.700	0.030
	82-436	82-436	0.900	< 0.100	28.700	0.330	< 0.010	< 0.010	70.000	< 0.010
	83-32	83-85	0.930	< 0.100	26.600	0.670	< 0.010	< 0.010	71.000	0.360
	83-83	83-83	0.910	< 0.100	28.400	0.370	< 0.010	< 0.010	70.300	0.070
	83-188	83-188	0.850	< 0.100	26.500	0.150	< 0.010	0.020	72.500	< 0.010
	83-331	83-331	1.020	< 0.100	54.200	0.360	< 0.010	< 0.010	44.100	0.320
	83-476	83-476	0.700	4 900	50.300	0.060	< 0.010	< 0.010	44.000	0.040

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: GAS

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	AR MOLE%(REL)	C MON MOLE%(REL)	CH4 MOLE%(REL)	CO2 MOLE%(REL)	HE MOLE%(REL)	H2 MOLE%(REL)	N2 MOLE%(REL)	O2 MOLE%(REL)
MCGEE	83-513	83-513	0.050	4.700	19.100	0.040	0.040	< 0.010	75.100	0.030
	84-24	84-24	0.890	< 0.100	31.000	0.090	0.060	< 0.010	67.900	0.010
RRL-02	82-65	82-65	0.250	< 0.100	83.300	0.040	< 0.010	0.220	16.200	< 0.010
	82-401	82-401	0.040	< 0.100	97.600	0.040	< 0.010	< 0.010	2.360	< 0.010
		82-414	0.760	< 0.100	19.800	0.070	< 0.010	< 0.010	62.700	16.700
		82-479	0.020	< 0.100	98.200	< 0.010		0.170	1.450	< 0.010
	84-7	84-47	0.020	< 0.100	98.700	< 0.010	< 0.010	0.020	1.260	< 0.010
	82-364	82-364	0.030		97.800	0.040	< 0.010	0.200	1.690	0.140
		82-370	0.050	< 0.100	96.700	< 0.010	< 0.010	0.110	3.110	0.030
		82-391A	0.030	< 0.500	97.800	0.020	0.010	0.160	1.970	< 0.010
		82-391B	0.030	< 0.500	97.900	0.010	0.010	0.150	1.370	< 0.010
		82-391C	0.040	< 0.500	97.200	0.020	0.010	0.170	2.210	0.310
	82-309	82-383	0.080	< 0.100	96.200	< 0.010	< 0.010	0.130	3.560	0.070
	82-456	82-411	0.020	< 0.100	98.800	< 0.010	< 0.010	< 0.010	1.080	< 0.010
		82-445	0.020	< 0.100	98.300	< 0.010	< 0.010	< 0.010	1.540	< 0.010
		82-456	0.030	< 0.100	97.500	< 0.010	0.020	0.030	2.430	0.030
RRL-06B	83-25	83-25	0.040	< 0.100	97.800	0.040	< 0.010	< 0.010	2.080	< 0.010
		83-69	0.060	< 0.100	96.500	0.020	0.290	< 0.010	2.720	0.040
RRL-14	82-403	82-418	0.020	< 0.100	98.300	< 0.010	< 0.010	< 0.010	1.850	0.020
		82-448	0.020	< 0.100	98.400	< 0.010	< 0.010	< 0.010	1.610	< 0.010
	84-11	84-11	0.040	< 0.100	97.900	0.010	0.010	< 0.010	2.020	< 0.010
	83-151	83-151	0.260	< 0.100	97.500	0.350	< 0.010	< 0.010	2.170	< 0.010
	83-49	83-49	0.040	< 0.100	98.000	0.020	< 0.010	< 0.010	1.900	0.030
		83-96	0.040	< 0.010	98.000	0.010	< 0.010	< 0.010	1.910	0.030

ANALYSIS METHOD= MASS SPECTROMETRY.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE	(A)	CL36/CL ATOM RATIO	+/- RANGE	(A)	C14PMC %	+/- RANGE	(A)
BERK	85-255	85-255							7.300E+00	1.20000E+00	(1)
DB-01	81-19	81-19							2.700E+00	8.00000E-01	(1)
	81-65	81-65							3.100E+00	8.00000E-01	(1)
	82-27	82-27	8.500E+07	2.00000E+06	(1)	1.050E-13	2.00000E-15	(1)	6.300E+00	1.10000E+00	(1)
		82-87							2.500E+00	8.00000E-01	(1)
	85-32	85-32							1.700E+00	1.20000E+00	(1)
DB-02	81-13	81-13							1.100E+01	1.50000E+00	(1)
	81-10	81-10							2.200E+00	6.00000E-01	(1)
DB-07	83-413	83-413							4.300E+00	1.50000E+00	(1)
	85-216	85-216							3.000E+00	1.40000E+00	(1)
DB-09	83-472	83-472							2.210E+01	2.10000E+00	(1)
DB-11	85-4	85-4							2.600E+00	1.20000E+00	(1)
	85-15	85-15							1.800E+00	9.00000E-01	(1)
	85-18	85-18							2.400E+00	1.50000E+00	(1)
		85-19									
	86-52	86-52							3.400E+00	1.10000E+00	(1)
		86-53							4.600E+00	1.50000E+00	(1)
DB-12	81-25	81-25							8.200E+00	8.00000E-01	(1)
DB-13	80-159	80-159							9.200E+00	1.20000E+00	(1)
	83-404	83-404							1.100E+01	1.60000E+00	(1)
DB-14	81-152	81-139							< 2.100E+00		(1)
		81-152							3.500E+00	1.00000E+00	(1)
DB-15	79-17	79-17									
		79-22									
	79-35	79-20									
		79-35									
	79-33	79-27									
		79-33									
	79-15	79-15									
		79-38									
	79-39	79-39							3.200E+00	1.10000E+00	(1)
		79-8									
	79-31	79-31									
		79-5									
	79-51	79-51									
	79-85	79-66									
		79-85									
	79-80	79-80							5.700E+00	1.60000E+00	(1)
	79-62	79-62							4.000E+00	1.70000E+00	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
BERK	85-255	85-255	5.000E-02	6.00000E-02	(1)						
DB-01	81-19	81-19	1.470E+00	1.00000E-01	(1)						
	81-65	81-65	2.680E+00	9.00000E-02	(1)						
	82-27	82-27	5.400E-01	6.00000E-02	(1)	7.000E-03		(1)			
		82-87									
	85-32	85-32	2.000E-02	8.00000E-02	(1)						
DB-02	81-13	81-13	7.810E+00	2.70000E-01	(1)						
	81-10	81-10	2.900E-01	5.00000E-02	(1)	4.200E-02		(1)			
DB-07	83-413	83-413	5.000E-02	8.00000E-02	(1)						
	85-216	85-216	8.000E-02	1.00000E-01	(1)						
DB-09	83-472	83-472	6.300E-01	1.10000E-01	(1)						
DB-11	85-4	85-4	1.600E-01	9.00000E-02	(1)						
	85-15	85-15	1.300E-01	9.00000E-02	(1)						
	S5-18	85-18									
		85-19	8.000E-02	1.00000E-01	(1)						
	86-52	86-52	3.000E-02	8.00000E-02	(1)						
		86-53									
DB-12	81-25	81-25	1.130E+00	7.00000E-02	(1)	4.000E-03		(1)			
DB-13	80-159	80-159									
	83-404	83-404	6.000E-02	7.00000E-02	(1)						
DB-14	81-162	81-139									
		81-162	2.590E+00	1.30000E-01	(1)						
DB-15	79-17	79-17	1.080E+01	2.00000E-01	(1)	4.600E+00	4.00000E-01	(1)	4.400E+00	4.00000E-01	(1)
		79-22	1.060E+01	2.00000E-01	(1)						
	79-35	79-20	2.600E-01	4.00000E-02	(1)						
		79-35	9.000E-01	7.00000E-02	(1)	1.900E-02	2.00000E-03	(1)	2.700E-02	2.00000E-03	(1)
	79-33	79-27				3.300E-02	3.80000E-02	(1)	2.700E-02	2.40000E-02	(1)
		79-33	1.100E-01	4.00000E-02	(1)	4.200E-02	7.00000E-03	(1)	4.400E-02	7.00000E-03	(1)
	79-15	79-15	1.200E-01	5.00000E-02	(1)	6.900E-02	3.20000E-02	(1)	7.800E-02	2.30000E-02	(1)
		79-38	1.100E-01	6.00000E-02	(1)						
	79-39	79-39	1.000E-01	5.00000E-02	(1)	4.700E-01	3.00000E-02	(1)	5.300E-01	3.00000E-02	(1)
		79-8				5.500E-01	6.00000E-02	(1)	5.700E-01	5.00000E-02	(1)
	79-31	79-31				2.000E-01	1.00000E-02	(1)	2.000E-01	1.00000E-02	(1)
		79-5	2.300E-01	5.00000E-02	(1)						
	79-51	79-51	2.500E-01	5.00000E-02	(1)	1.800E-01	1.00000E-02	(1)	1.800E-01	1.00000E-02	(1)
	79-85	79-66	1.200E-01	6.00000E-02	(1)						
		79-85	1.900E-01	5.00000E-02	(1)	6.900E-01	3.00000E-02	(1)	5.500E-01	3.00000E-02	(1)
	79-80	79-80	1.500E-01	6.00000E-02	(1)	3.600E-01	2.00000E-02	(1)	2.700E-02	1.00000E-02	(1)
	79-62	79-62									

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U235 DPM/L	+/- RANGE	(A)	U234/U238 ATOM RATIO	+/- RANGE	(A)	U235/U238 ATOM RATIO	+/- RANGE	(A)
BERK	85-255	85-255									
DB-01	81-19	81-19									
	81-65	81-65									
	82-27	82-27				1.000E-04		(1)	7.300E-03		(1)
		82-87									
	85-32	85-32									
DB-02	81-13	81-13									
	81-10	81-10				1.200E-04	7.00000E-05	(1)	7.210E-03	7.00000E-05	(1)
DB-07	83-413	83-413									
	85-216	85-216									
DB-09	83-472	83-472									
DB-11	85-4	85-4									
	85-15	85-15									
	85-18	85-18									
		85-19									
	86-52	86-52									
		85-53									
DB-12	81-25	81-25				8.800E-05	7.00000E-08	(1)	7.100E-03	2.00000E-04	(1)
DB-13	80-159	80-159									
	83-404	83-404									
DB-14	81-162	81-139									
		81-162									
DB-15	79-17	79-17	3.370E+00	2.70000E-01	(1)	7.000E-05	8.00000E-05	(1)			
		79-22									
	79-35	79-20									
		79-35	[illegible].400E-02	1.00000E-03	(1)	[illegible]	1.[illegible]E-05	(1)			
	79-33	79-27	2.400E-02	2.70000E-02	(1)	6.000E-05	8.70000E-05	(1)			
		79-33	3.100E-02	5.00000E-03	(1)	7.800E-05	1.70000E-05	(1)			
	79-15	79-15	5.100E-02	2.30000E-02	(1)	8.300E-05	4.60000E-05	(1)			
		79-38									
	79-39	79-39	3.500E-01	2.00000E-02	(1)	8.300E-05	8.[illegible]E-05	(1)			
		79-8	4.000E-01	4.00000E-02	(1)	7.700E-05	1.00000E-05	(1)			
	79-31	79-31	1.400E-01	1.00000E-02	(1)	7.500E-05	8.00000E-06	(1)			
		79-5									
	79-51	79-51	1.400E-01	1.00000E-02	(1)	7.300E-05	5.[illegible]E-06	(1)			
	79-85	79-66									
		79-85	5.100E-01	3.00000E-02	(1)	5.800E-05	3.00000E-06	(1)			
	79-80	79-80	2.700E-01	1.00000E-02	(1)	5.500E-05	4.00000E-06	(1)			
	79-62	79-62									

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE	(A)	CL36/CL ATOM RATIO	+/- RANGE	(A)	C14PMC %	+/- RANGE	(A)
DB-15	79-90	79-86									
	80-35	80-35							< 1.900E+00		(1)
		80-41									
	80-24	80-24							3.400E+00	1.20000E+00	(1)
	80-77	80-77							< 2.400E+00		(1)
		80-92									
	80-1	80-1							3.400E+00	1.10000E+00	(1)
		80-51									
DC-01	SITE-230	SITE-230									
	SITE-227	SITE-227									
	SITE-228	SITE-228									
	SITE-231	SITE-231									
	SITE-232	SITE-232									
	SITE-233	SITE-233									
	SITE-234	SITE-234									
	SITE-235	SITE-235									
	SITE-236	SITE-236									
	SITE-237	SITE-237									
	SITE-238	SITE-238									
	SITE-240	SITE-240									
	SITE-241	SITE-241									
	SITE-242	SITE-242									
DC-02-A2	SITE-213	SITE-213									
DC-05	79-30	79-30									
DC-06	SITE-214	SITE-214									
	80-238	80-238	1.530E+08	9.00000E+06	(1)	7.000E-14	4.00000E-15	(1)	1.810E+01	1.70000E+00	(1)
	80-191	80-186									
		80-191	2.300E+08	2.50000E+07	(1)	4.800E-14	5.00000E-15	(1)	8.500E+00	1.70000E+00	(1)
	81-45	81-26									
		81-45	3.700E+07	5.00000E+06	(1)	1.500E-14	2.00000E-15	(1)	2.450E+01	2.30000E+00	(1)
	80-118	80-118	1.080E+08	8.00000E+06	(1)	4.000E-14	3.00000E-15	(1)			
	80-15	80-15	< 3.400E+07		(1)	< 7.000E-15		(1)			
	81-82	81-82	2.060E+08	1.00000E+07	(1)	4.200E-14	2.00000E-15	(1)			
	80-29	80-29	2.800E+07	1.00000E+07	(1)	1.700E-14	6.00000E-15	(1)	< 8.300E+00		(1)
	79-58	79-57							< 5.700E+00		(1)
		79-58							1.240E+01	1.70000E+00	(1)
	80-75	80-18									
		80-75	3.200E+07	1.00000E+07	(1)	2.400E-14	8.00000E-15	(1)			
DC-07	82-23	82-23							3.370E+01	1.70000E+00	(1)
	82-10	82-10									
	80-103	80-103							2.740E+01	2.40000E+00	(1)
		80-183									
	80-196	80-196							5.250E+01	2.10000E+00	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP, RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T. TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
DB-15	79-90	79-88	2.880E+00	9.00000E-02	(1)						
	80-35	80-35									
		80-41	1.100E-01	5.00000E-02	(1)						
	80-24	80-24									
	80-77	80-77									
		80-92	9.000E-02	5.00000E-02	(1)						
	80-1	80-1	4.000E-02	5.00000E-02	(1)						
		80-51	7.000E-02	5.00000E-02	(1)						
DC-01	SITE-230	SITE-230	2.300E+01	1.00000E+00	(0)						
	SITE-227	SITE-227	1.100E+00	2.00000E-01	(0)						
	SITE-228	SITE-228	1.000E+00	3.00000E-01	(0)						
	SITE-231	SITE-231	5.300E+00	4.00000E-01	(0)						
	SITE-232	SITE-232	2.200E+00	3.00000E-01	(0)						
	SITE-233	SITE-233	2.200E+00	3.00000E-01	(0)						
	SITE-234	SITE-234	2.300E+00	3.00000E-01	(0)						
	SITE-235	SITE-235	6.200E+00	4.00000E-01	(0)						
	SITE-236	SITE-236	1.300E+00	3.00000E-01	(0)						
	SITE-237	SITE-237	1.0[illegible]E+02	6.00000E+00	(0)						
	SITE-238	SITE-238	9.[illegible]E+00	6.00000E-01	(0)						
	SITE-240	SITE-240	2.000E+00	3.00000E-01	(0)						
	SITE-241	SITE-241	4.400E+00	4.00000E-01	(0)						
	SITE-242	SITE-242	1.780E+01	4.00000E-01	(0)						
DC-02-A2	SITE-213	SITE-213	1.640E+01	5.00000E-01	(0)						
DC-05	79-30	79-30	1.030E+00	6.00000E-02	(1)	6.300E-02	1.00000E-02	(1)	0.400E-02	1.30000E-02	(1)
DC-06	SITE-214	SITE-214	8.000E-02	4.00000E-02	(0)						
	80-238	80-238	-[illegible]E-01	8.00000E-02	(1)	4.000[illegible]		(1)			
	80-191	80-186	4.000E-02	7.00000E-02	(1)						
		80-191	9.000E-02	7.00000E-02	(1)	2.000E-[illegible]		(1)			
	81-45	81-26				3.[illegible]E-03		(1)			
		81-45	-2.000E-02	5.00000E-02	(1)						
	80-118	80-118	-6.000E-02	5.00000E-02	(1)	1.0[illegible]		(1)			
	80-15	80-15	1.200E-01	7.00000E-02	(1)	4.0[illegible]-03		(1)			
	81-82	81-82	[illegible]-02	5.00000E-02	(1)						
	80-29	80-29	-1.000E-02	4.00000E-02	(1)	2.[illegible]		[illegible]			
	79-58	79-57	-1.000E-02	5.00000E-02	(1)	3.[illegible]	1.[illegible]E-02	[illegible]	5.000E-02	1.80000E-02	(1)
		79-58				0.[illegible]	3.00000E-02	(1)	0.000E+00	2.00000E-02	[illegible]
	80-75	80-18	4.000E-02	5.00000E-02	(1)						
		80-75	9.000E-02	5.00000E-02	(1)	1.00[illegible]		(1)			
DC-07	82-23	82-23	6.740E+00	1.90000E-01	(1)	9.00[illegible]		(1)			
	82-10	82-10	5.150E+00	1.70000E-01	(1)	5.900E-02		(1)			
	80-103	80-103	5.050E+00	1.00000E-01	(1)						
		80-163	4.820E+00	1.80000E-01	(1)						
	80-196	80-196	4.700E+00	1.90000E-01	(1)						

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
DB-15	79-90	79-86						
	80-35	80-35						
		80-41						
	80-24	80-24						
	80-77	80-77						
		80-92						
	80-1	80-1						
		80-51						
DC-01	SITE-230	SITE-230						
	SITE-227	SITE-227						
	SITE-228	SITE-228						
	SITE-231	SITE-231						
	SITE-232	SITE-232						
	SITE-233	SITE-233						
	SITE-234	SITE-234						
	SITE-235	SITE-235						
	SITE-236	SITE-236						
	SITE-237	SITE-237						
	SITE-238	SITE-238						
	SITE-240	SITE-240						
	SITE-241	SITE-241						
	SITE-242	SITE-242						
DC-02-A2	SITE-213	SITE-213						
DC-05	79-30	79-30	4.600E-02	8.00000E-03 (1)	1.100E-04	3.00000E-05 (1)		
DC-06	SITE-214	SITE-214						
	80-238	80-238						
	80-191	80-186						
		80-191						
	81-45	81-26			4.100E-05	1.00000E-05 (1)	7 000E-03	2.00000E-04 (1)
		81-45						
	80-118	80-118						
	80-15	80-15						
	81-82	81-82						
	80-29	80-29						
	79-58	79-57	2 700E-02	9.00000E-03 (1)	1.200E-04	5.00000E-05 (1)		
		79-58	0.000E+00	2 00000E-02 (1)				
	80-75	80-18						
		80-75						
DC-07	82-23	82-23			7 100E-05	3.00000E-06 (1)	7.290E-03	5.00000E-05 (1)
	82 10	82-10			6.700E-05	5.00000E-06 (1)	7.300E+03	3.50000E-04 (1)
	80-103	80-103						
		80-163						
	80-196	80-196						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE	(A)	CL36/CL ATOM RATIO	+/- RANGE	(A)	C14PMC %	+/- RANGE	(A)
DC-12	80-80	80-62									
		80-80							3.600E+00	1.30000E+00	(1)
	80-100	80-100	2.610E+08	1.60000E+07	(1)	1.600E-13	1.00000E-14	(1)	< 1.900E+00		(1)
		80-63									
	80-97	80-73									
		80-97	3.900E+07	2.00000E+06	(1)	2.200E-14	1.00000E-15	(1)	< 1.500E+00		(1)
	80-32	80-32							4.000E+00	1.20000E+00	(1)
		80-79									
	80-82	80-82							3.500E+00	1.30000E+00	(1)
	80-124	80-124							2.800E+00	1.00000E+00	(1)
	80-174	80-174							6.000E+00	1.00000E+00	(1)
	80-209	80-209							9.400E+00	1.80000E+00	(1)
	80-234	80-234							1.830E+01	2.60000E+00	(1)
	81-61	81-61							1.290E+01	3.10000E+00	(1)
	82-85	82-85	4.000E+07	2.00000E+06	(1)	1.800E-14	1.00000E-15	(1)	3.500E+00	9.00000E-01	(1)
DC-14	80-3	80-3							5.200E+00	1.10000E+00	(1)
	80-53	80-53	1.270E+08	4.00000E+06	(1)	1.130E-12	4.00000E-14	(1)	4.000E+00	1.20000E+00	(1)
	80-47	80-47							4.900E+00	1.20000E+00	(1)
	80-69	80-69							< 1.900E+00		(1)
		80-83									
	80-99	80-99							< 1.300E+00		(1)
	80-89	80-36									
		80-89							< 3.100E+00		(1)
	80-71	80-71	5.700E+07	2.00000E+06	(1)	3.310E-13	1.00000E-14	(1)	5.500E+00	1.20000E+00	(1)
	80-144	80-144							1.900E+00	1.10000E+00	(1)
	80-189	80-127									
		80-189							< [illegible]E+00		(1)
	80-112	80-111									
		80-112	1.080E+08	7.00000E+06	(1)	9.400E-13	5.00000E-14	(1)	3.100E+00	1.10000E+00	(1)
	80-157	80-183							2.400E+00	1.30000E+00	(1)
	80-155	80-145									
		80-155							2.500E+00	9.00000E-01	(1)
	80-104	80-104							4.900E+00	1.10000E+00	(1)
	80-129	80-129							< 1.000E+00		(1)
	80-170	80-170							< 1.800E+00		(1)
	80-117	80-117	5.400E+07	2.00000E+06	(1)	4.500E-13	1.40000E-14	(1)	< 1.300E+00		(1)
	80-213	80-213	6.800E+07	1.00000E+06	(1)	5.700E-14	1.00000E-15	(1)	4.400E+00	7.00000E-01	(1)
	81-20	81-20	1.860E+08	2.20000E+07	(1)	5.000E-14	6.00000E-15	(1)	1.190E+01	1.30000E+00	(1)
	81-30	81-18									
		81-30	6.700E+07	2.80000E+07	(1)	1.700E-14	7.00000E-15	(1)			
	81-44	81-44							1.200E+01	1.80000E+00	(1)
	81-141	81-141							9.200E+00	1.90000E+00	(1)
	82-8	82-8	4.200E+07	8.00000E+06	(1)	[illegible]E-14	2.00000E-15	(1)	< 1.900E+00		(1)
	83-156	83-156									
	83-152	83-152									
	83-157	83-157									
	83-178	83-178									

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
DC-12	80-80	80-62	1.770E+00	8 00000E-02	(1)						
		80-80	1.800E+00	9.00000E-02	(1)	7.300E-02		(1)			
	80-100	80-100	4.200E-01	8.00000E-02	(1)	7.000E-03		(1)			
		80-63	1.000E-02	5.00000E-02	(1)						
	80-97	80-73	3.100E-01	6.00000E-02	(1)						
		80-97	3.400E-01	6.00000E-02	(1)	9.000E-03		(1)			
	80-32	80-32	1.170E+00	9.00000E-02	(1)	1.700E-01		(1)			
		80-79	1.260E+00	8.00000E-02	(1)						
	80-82	80-82	5.900E-01	7.00000E-02	(1)	5.500E-01		(1)			
	80-124	80-124	-1.100E-01	5.00000E-02	(1)	1.900E-01		(1)			
	80-174	80-174	4.100E+00	1.40000E-01	(1)	3.900E-02		(1)			
	80-209	80-209	2.480E+00	1 20000E-01	(1)	1.100E-02		(1)			
	80-234	80-234	9.270E+00	3.40000E-01	(1)	4.600E-01		(1)			
	81-61	81-61	1.600E-01	6.00000E-02	(1)						
	82-85	82-85	1.900E-01	7.00000E-02	(1)	1.800E-02		(1)			
DC-14	80-3	80-3	1.000E-01	6.00000E-02	(1)	4.600E-01		(1)			
	80-53	80-53	-8.000E-02	5.00000E-02	(1)	3.200E-01		(1)			
	80-47	80-47	7.000E-02	5.00000E-02	(1)	8 800E-01		(1)			
	80-69	80-69	1.200E-01	5 00000E-02	(1)	1.200E-02		(1)			
		80-83	-7 000E-02	5.00000E-02	(1)						
	80-99	80-99	2.300E-01	5 00000E-02	(1)						
	80-89	80-36	7.900E-01	6.00000E-02	(1)						
		80-89	7.600E-01	6.00000E-02	(1)						
	80-71	80-71	1.230E+00	6 00000E-02	(1)	7.400E-01		(1)			
	80-144	80-144	-3.000E-02	8.00000E-02	(1)						
	80-189	80-127	1.030E+00	7.00000E-02	(1)						
		80-189	9.500E-01	7.00000E-02	(1)	1.400E-01		(1)			
	80-112	80-111	1.000E-01	7.00000E-02	(1)						
		80-112	6.300E-01	6 00000E-02	(1)	1.100E-02		(1)			
	80-157	80-183	3.700E-01	6.00000E-02	(1)						
	80-155	80-145	5.200E-01	7.00000E-02	(1)						
		80-155	4.000E-02	5.00000E-02	(1)	1.070E-01		(1)			
	80-104	80-104	1.290E+00	7.00000E-02	(1)	3.200E-01		(1)			
	80-129	80-129	2.200E-01	7 00000E-02	(1)	8.200E-02		(1)			
	80-170	80-170	1.450E+00	8.00000E-02	(1)	1.300E-02		(1)			
	80-117	80-117	2.000E-02	7.00000E-02	(1)	1 300E-02		(1)			
	80-213	80-213	2.600E-01	5.00000E-02	(1)	1.210E-01		(1)			
	81-20	81-20	1.810E+00	1 10000E-01	(1)	1.800E-01		(1)			
	81-30	81-18	4.030E+01	1.10000E+00	(1)						
		81-30	2.200E-01	8.00000E-02	(1)	1.000E-02		(1)			
	81-44	81-44	1.380E+00	9.00000E-02	(1)	2.500E-02		(1)			
	81-141	31-141									
	82-8	82-8	7.000E-02	4.00000E-02	(1)	3.000E-03		(1)			
	83-156	83-156	1.000E-02	7 00000E-02	(1)						
	83-152	83-152	-5.000E-02	7 00000E-02	(1)						
	83-157	83-157	6.300E-01	9 00000E-02	(1)						
	83-178	83-178	1.300E-01	6.00000E-02	(1)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE	(A)	U234/U238 ATOM RATIO	+/- RANGE	(A)	U235/U238 ATOM RATIO	+/- RANGE	(A)
DC-12	80-80	80-62									
		80-80				1.850E-04	1.60000E-05	(1)	7.320E-03	8.00000E-05	(1)
	80-100	80-100				1.730E-04	8.00000E-06	(1)	7.280E-03	1.40000E-04	(1)
		80-63									
	80-87	80-73									
		80-97				1.650E-04	6.00000E-06	(1)	7.250E-03	8.00000E-05	(1)
	80-32	80-32				1.150E-04	2.00000E-06	(1)	7.260E-03	8.00000E-05	(1)
		80-79									
	80-82	80-82				5.800E-05	2.00000E-06	(1)	7.240E-03	4.00000E-05	(1)
	80-124	80-124				6.300E-05	3.00000E-06	(1)	7.310E-03	3.00000E-05	(1)
	80-174	80-174				7.700E-05	3.00000E-06	(1)	7.310E-03	4.00000E-05	(1)
	80-209	80-209				7.800E-05	2.00000E-05	(1)	7.490E-03	1.50000E-04	(1)
	80-234	80-234				4.900E-05	1.00000E-06	(1)	7.280E-03	5.00000E-05	(1)
	81-61	81-61									
	82-85	82-85				4.000E-05		(1)	7.300E-03		(1)
DC-14	80-3	80-3				1.530E-04	4.00000E-06	(1)	7.270E-03	3.00000E-05	(1)
	80-53	80-53				1.300E-04	4.00000E-06	(1)	7.280E-03	5.00000E-05	(1)
	80-47	80-47				1.100E-04	3.00000E-06	(1)	7.250E-03	3.00000E-05	(1)
	80-69	80-69				1.300E-04	4.00000E-06	(1)	7.190E-03	5.00000E-05	(1)
		80-83									
	80-99	80-99									
	80-89	80-36									
		80-89									
	80-71	80-71				8.800E-05	6.00000E-05	(1)	7.270E-03	1.00000E-04	(1)
	80-144	80-144									
	80-189	80-127									
		80-189				1.800E-04	7.00000E-06	(1)	7.220E-03	6.00000E-05	(1)
	80-112	80-111									
		80-112				1.800E-04	1.90000E-05	(1)	7.230E-03	5.00000E-05	(1)
	80-157	80-183									
	80-155	80-145									
		80-155				1.8[illegible]E-04	1.00000E-05	(1)	7.350E-03	1.20000E-04	(1)
	80-104	80-104				1.870E-04	3.00000E-06	(1)	7.300E-03	5.00000E-05	(1)
	80-129	80-129				1.880E-04	3.00000E-06	(1)	7.280E-04	3.00000E-05	(1)
	80-170	80-170				1.900E-04	1.50000E-05	(1)	7.340E-03	1.30000E-04	(1)
	80-117	80-117				1.790E-04	1.80000E-05	(1)	7.320E-03	1.10000E-04	(1)
	80-213	80-213				1.080E-04	4.00000E-06	(1)	7.280E-03	4.00000E-05	(1)
	81-20	81-20				1.8[illegible]E-04	5.00000E-06	(1)	7.280E-03	4.00000E-05	(1)
	81-30	81-18									
		81-30				1.600E-04	2.00000E-05	(1)	7.200E-03	2.00000E-04	(1)
	81-44	81-44				1.640E-04	1.00000E-05	(1)	7.200E-03	2.00000E-04	(1)
	81-141	81-141									
	82-8	82-8									
	83-156	83-156									
	83-152	83-152									
	83-157	83-157									
	83-178	83-178									

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE	(A)	CL36/CL ATOM RATIO	+/- RANGE	(A)	C14PMC %	+/- RANGE	(A)
DC-14	83-183	83-183									
	83-154	83-154							4.500E+00	1.00000E+00	(1)
	83-150	83-150									
	83-266	83-266							< 1.900E+00		(1)
	83-261	83-261									
DC-15	80-58	80-31									
		80-56							7.800E+00	1.30000E+00	(1)
	80-54	80-54	4.800E+07	4.00000E+06	(1)	3.600E-13	3.00000E-14	(1)	4.900E+00	1.10000E+00	(1)
		80-76									
	80-57	80-57							< 1.000E+00		(1)
	80-87	80-87	1.150E+08	9.00000E+06	(1)	3.800E-13	3.00000E-14	(1)	1.200E+00	7.00000E-01	(1)
	80-137	80-137	7.900E+07	3.00000E+06	(1)	8.800E-14	4.00000E-15	(1)	3.900E+00	1.30000E+00	(1)
	80-176	80-176	8.700E+07	6.00000E+06	(1)	1.400E-13	9.00000E-15	(1)	5.600E+00	1.40000E+00	(1)
	80-135	80-135							3.500E+00	1.10000E+00	(1)
	80-120	80-120							< 1.500E+00		(1)
		80-139									
	80-131	80-108							< 1.900E+00		(1)
		80-131	5.900E+07	2.00000E+06	(1)	5.300E-14	2.00000E-15	(1)	< 2.400E+00		(1)
	80-193	80-193	3.800E+07	2.00000E+06	(1)	3.100E-14	2.00000E-15	(1)	< 1.600E+00		(1)
	81-41	81-41	1.700E+08	2.60000E+07	(1)	6.300E-14	8.00000E-15	(1)	1.360E+01	1.20000E+00	(1)
	81-2	81-2							2.080E+01	7.00000E-01	(1)
	81-33	81-33									
		81-37									
	81-27	81-27	5.340E+08	2.90000E+07	(1)	1.660E-13	9.00000E-15	(1)	8.000E+00	2.00000E+00	(1)
	81-64	81-64	2.610E+08	1.60000E+07	(1)	5.000E-14	3.00000E-15	(1)	1.100E+01	1.30000E+00	(1)
	81-96	81-96									
	81-69	81-69	2.700E+07	4.00000E+06	(1)	7.000E-15	1.00000E-15	(1)	1.420E+01	1.30000E+00	(1)
	82-94	82-94							2.070E+01	6.00000E-01	(1)
DC-16A	81-109	81-109							2.020E+01	1.80000E+00	(1)
	82-17	82-17							2.030E+01	1.70000E+00	(1)
	82-93	82-93							7.700E+00	1.30000E+00	(1)
	82-19	82-19	1.120E+08	7.00000E+06	(1)	4.500E-14	3.00000E-15	(1)	4.700E+00	1.30000E+00	(1)
	82-188	82-188							3.200E+00	9.00000E-01	(1)
	82-124	82-124							5.000E+00	1.20000E+00	(1)
	82-143	82-143							1.610E+01	3.80000E+00	(1)
	82-202	82-202	6.700E+07	9.00000E+06	(1)	1.500E-14	2.00000E-15	(1)	3.070E+01	4.30000E+00	(1)
	82-322	82-322	5.200E+07	7.00000E+06	(1)	7.000E-15	1.00000E-15	(1)			
	82-332	82-332									
	82-430	82-430									
	83-29	83-29									
DC-16B	83-147	83-147							4.000E+00	9.00000E-01	(1)
DC-16C	83-100	83-100									
DC-19C	84-53	84-53							3.600E+00	1.20000E+00	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
DC-14	83-183	83-183	2.700E-01	7.00000E-02	(1)						
	83-154	83-154	1.400E-01	9.00000E-02	(1)						
	83-150	83-150	-4.000E-02	7.00000E-02	(1)						
	83-266	83-266	5.000E-02	7.00000E-02	(1)						
	83-261	83-261	3.200E-01	9.00000E-02	(1)						
DC-15	80-56	80-31	4.000E-02	6.00000E-02	(1)						
		80-56	1.600E-01	6.00000E-02	(1)	8.000E-03		(1)			
	80-54	80-54	2.500E-01	5.00000E-02	(1)	3.000E-02		(1)			
		80-76	1.300E-01	5.00000E-02	(1)						
	80-57	80-57	1.400E-01	4.00000E-02	(1)	5.000E-03		(1)			
	80-87	80-87	3.500E-01	6.00000E-02	(1)	2.900E-02		(1)			
	80-137	80-137	8.500E-01	8.00000E-02	(1)	8.700E-02		(1)			
	80-176	80-176	4.200E-01	6.00000E-02	(1)	1.300E-02		(1)			
	80-135	80-135	2.870E+00	1.10000E-01	(1)	5.500E-02		(1)			
	80-120	80-120	4.670E+00	1.20000E-01	(1)	6.300E-02		(1)			
		80-139	7.360E+00	2.80000E-01	(1)						
	80-131	80-108	3.200E-01	7.00000E-02	(1)						
		80-131	4.400E-01	7.00000E-02	(1)	[illegible]		(1)			
	80-193	80-193	6.900E-01	7.00000E-02	(1)	5.100E-02		(1)			
	81-41	81-41	9.000E-01	6.00000E-02	(1)	1.100E-01		(1)			
	81-2	81-2	3.800E+00	1.20000E-01	(1)	[illegible]		(1)			
	81-33	81-33	8.100E-01	6.00000E-02	(1)	1.300E-02		(1)			
		81-37	5.230E+01	1.50000E+00	(1)						
	81-27	81-27	6.300E-01	7.00000E-02	(1)	5.400E-02		(1)			
	81-64	81-64	1.480E+00	1.40000E-01	(1)						
	81-96	81-06	6.400E-01	5.00000E-02	(1)						
	81-69	81-69	1.500E-01	6.00000E-02	(1)						
	82-94	82-94	1.580E+00	7.00000E-02	(1)	5.300E-02		(1)			
DC-16A	81-109	81-109	3.010E+00	1.10000E-01	(1)	[illegible]		(1)			
	82-17	82-17	1.450E+00	8.00000E-02	(1)	1.900E-02		(1)			
	82-93	82-93	9.200E-01	7.00000E-02	(1)	6.400E-02		(1)			
	82-19	82-19	8.500E-01	9.00000E-02	(1)	4.100E-02		(1)			
	82-188	82-188	4.000E-01	1.00000E-01	(1)	[illegible]		(1)			
	82-124	82-124	4.300E-01	7.00000E-02	(1)	[illegible]		(1)			
	82-143	82-143	4.600E-01	8.00000E-02	(1)	3.700E-02		(1)			
	82-202	82-202	5.300E-01	8.00000E-02	(1)	1.700E-02		(1)			
	82-322	82-322	3.400E-01	8.00000E-02	(1)	1.000E-02		(1)			
	82-332	82-332	3.000E-01	8.00000E-02	(1)	8.000E-03		(1)			
	82-430	82-430	8.500E-01	7.00000E-02	(1)	2.900E-02		(1)			
	83-29	83-29	7.000E-01	7.00000E-02	(1)	8.000E-03		(1)			
DC-16B	83-147	83-147	3.000E-02	7.00000E-02	(1)						
DC-16C	83-100	83-100	1.600E-01	7.00000E-02	(1)						
DC-19C	84-53	84-53	2.700E-01	8.00000E-02	(1)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SD-BWI-DP-061 Rev. 1

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
DC-14	83-183	83-183						
	83-154	83-154						
	83-150	83-150						
	83-266	83-266						
	83-261	83-261						
DC-15	80-56	80-31						
		80-56						
	80-54	80-54			8.400E-05	8.00000E-06 (1)	7.260E-03	2.00000E-04 (1)
		80-76						
	80-57	80-57						
	80-87	80-87			8 100E-05	4.00000E-06 (1)	7.290E-03	7.00000E-05 (1)
	80-137	80-137			8.100E-05	8.00000E-06 (1)	7.240E-03	7.00000E-05 (1)
	80-176	80-176			1.470E-04	5.00000E-06 (1)	7.360E-03	4.00000E-05 (1)
	80-135	80-135			1.240E-04	4.00000E-06 (1)	7.300E-03	3.00000E-05 (1)
	80-120	80-120			1.330E-04	3.00000E-06 (1)	7.300E-03	4.00000E-05 (1)
		80-139						
	80-131	80-108						
		80-131			1.470E-04	4.00000E-05 (1)	7.270E-03	4.00000E-05 (1)
	80-193	80-193			1.330E-04	3.00000E-06 (1)	7.280E-03	5.00000E-05 (1)
	81-41	81-41			1.380E-04	4.00000E-06 (1)	7.240E-03	5.00000E-05 (1)
	81-2	81-2			6.000E-05	2.00000E-06 (1)	7.270E-03	3.00000E-05 (1)
	81-33	81-33			1.260E-04	1.00000E-05 (1)	7.050E-03	2.00000E-04 (1)
		81-37						
	81-27	81-27			1.430E-04	1.00000E-05 (1)	7.100E-03	1.50000E-04 (1)
	81-64	81-64						
	81-96	81-96						
	81-69	81-69						
	82-94	82-94			7.200E-05	2.00000E-06 (1)	7.170E-03	5.00000E-05 (1)
DC-16A	81-109	81-109			1.340E-04	2.00000E-06 (1)	7.280E-03	5.00000E-05 (1)
	82-17	82-17			1.200E-04	(1)	7.300E-03	(1)
	82-93	82-93			1.600E-04	6.00000E-06 (1)	7.290E-03	6.00000E-05 (1)
	82-19	82-19			1.650E-04	4.00000E-06 (1)	7.320E-03	5.00000E-05 (1)
	82-188	82-188			1.350E-04	7.00000E-06 (1)	7.270E-03	1.00000E-04 (1)
	82-124	82-124			1.320E-04	2.00000E-06 (1)	7.300E-03	1.00000E-04 (1)
	82-143	82-143			1.630E-04	3.00000E-06 (1)	7.270E-03	7.00000E-05 (1)
	82-202	82-202			1.320E-04	2.00000E-06 (1)	7.280E-03	1.50000E-04 (1)
	82-322	82-322			1.210E-04	2.00000E-06 (1)	7.310E-03	8.00000E-05 (1)
	82-332	82-332			1.080E-04	2.00000E-06 (1)	7.280E-03	5.00000E-05 (1)
	82-430	82-430			1.590E-04	1.00000E-06 (1)	7.270E-03	4.00000E-05 (1)
	83-29	83-29			8.400E-05	4.00000E-06 (1)	7.300E-03	6.00000E-05 (1)
DC-16B	83-147	83-147						
DC-16C	83-100	83-100						
DC-19C	84-53	84-53						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
DC-19C	84-40	84-40					6.300E+00	1.60000E+00 ( )
	84-75	84-75					1.660E+01	3.30000E+00 ( )
	84-86	84-86					8.000E+00	1.90000E+00 (1)
DC-20C	84-9	84-9					2.200E+00	1.40000E+00 (1)
DC-22C	84-105	84-105					2.300E+00	1.20000E+00 (1)
		84-153						
ENYEART	84-168	84-166					1.020E+01	9.00000E-01 (1)
	85-1	85-1					1.400E+01	1.20000E+00 (1)
	85-180	85-180					1.130E+01	1.20000E+00 (1)
		85-181					1.100E+01	1.20000E+00 (1)
FORD	SITE-219	SITE-219						
	85-188	85-188					1.020E+01	1.10000E+00 (1)
		85-189					1.070E+01	1.10000E+00 (1)
	85-303	85-303						
MCGEE	SITE-223	SITE-223					6.800E+00	3.00000E-01 ( )
	SITE-220	SITE-220						
	82-7	82-7					3.000E+00	7.00000E-01 ( )
	85-175	85-175					6.200E+00	1.10000E+00 ( )
		85-176					1.060E+01	1.20000E+00 (1)
	85-300	85-300						
	86-34	86-34					1.040E+01	2.40000E+00 ( )
		86-35					6.100E+00	2.20000E+00 ( )
	80-64	80-64					7.500E+00	1.10000E+00 ( )
		80-88						
	81-79	81-79	4.700E+07	1.00000E+06 (1)	6.770E-13	1.70000E-14 (1)	5.400E+00	1.20000E+00
	81-54	81-54	4.800E+07	1.00000E+06 (1)	6.950E-13	2.10000E-14 (1)	9.500E+00	1.30000E+00 ( )
	82-64	82-64					< 1.000E+00	( )
	82-263	82-263					1.530E+01	1.80000E+00 ( )
	82-397	82-397					1.440E+01	1.80000E+00 (1)
	82-424	82-424					6.900E+00	1.00000E+00 ( )
	82-436	82-436					8.300E+00	1.80000E+00 ( )
	83-32	83-32					7.000E+00	8.00000E-01 (1)
	83-83	83-83					8.100E+00	9.00000E-01 ( )
	83-188	83-188					3.300E+00	8.00000E-01 ( )
	83-373	83-373					4.300E+00	1.30000E+00 ( )
	83-331	83-331					3.700E+00	1.30000E+00 ( )
	83-460	83-460					< 1.300E+00	( )
	83-476	83-476					3.200E+00	9.00000E-01 ( )
	83-513	83-513						
	84-24	84-24					2.500E+00	5.00000E-01 ( )
OURIAN	85-194	85-194					1.260E+01	1.40000E+00 ( )
		85-195					1.470E+01	1.20000E+00 (1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
DC-19C	84-40	84-40	1.860E+00	1.00000E-01	(1)						
	84-75	84-75	1.680E+00	7.00000E-02	(1)						
	84-86	84-86	3.480E+00	1.40000E-01	(1)						
DC-20C	84-9	84-9	6.000E-02	7.00000E-02	(1)						
DC-22C	84-105	84-105	-1.000E-01	8.00000E-02	(1)						
		84-153	-2.000E-02	7.00000E-02	(1)						
ENYEART	84-166	84-166									
	85-1	85-1	-5.000E-02	9.00000E-02	(1)						
	85-180	85-180	1.100E-01	9.00000E-02	(1)						
		85-181	3.000E-02	9.00000E-02	(1)						
FORD	SITE-219	SITE-219	1.500E-01	4.00000E-02	(0)						
	85-188	85-188	-2.000E-02	7.00000E-02	(1)						
		85-189	4.000E-02	9.00000E-02	(1)						
	85-303	85-303	-5.000E-02	8.00000E-02	(1)						
MCGEE	SITE-223	SITE-223	< 5.000E-01		(0)						
	SITE-220	SITE-220	-3.000E-02	4.00000E-02	(0)						
	82-7	82-7	3.000E-02	6.00000E-02	(1)	< 3.000E-03		(1)			
	85-175	85-175	-3.000E-02	8.00000E-02	(1)						
		85-176	-2.000E-02	9.00000E-02	(1)						
	85-300	85-300	2.700E-01	1.00000E-01	(1)						
	86-34	86-34									
		86-35									
	80-64	80-64	-2.000E-02	5.00000E-02	(1)						
		80-88	1.200E-01	7.00000E-02	(1)						
	81-79	81-79	2.000E-02	4.00000E-02	(1)						
	81-54	81-54	1.900E-01	5.00000E-02	(1)						
	82-64	82-64	-6.000E-02	6.00000E-02	(1)	3.000E-03		(1)			
	82-263	82-263	5.000E-02	7.00000E-02	(1)	2.000E-03		(1)			
	82-397	82-397	0.000E+00	9.00000E-02	(1)	3.000E-03		(1)			
	82-424	82-424	0.000E+00	8.00000E-02	(1)	2.000E-03		(1)			
	82-436	82-436	0.000E+00	9.00000E-02	(1)	3.000E-03		(1)			
	83-32	83-32	-4.000E-02	6.00000E-02	(1)	2.000E-03		(1)			
	83-83	83-83	2.000E-02	6.00000E-02	(1)	1.300E-02		(1)			
	83-188	83-188	3.000E-01	1.00000E-01	(1)	2.000E-03		(1)			
	83-373	83-373	0.000E+00	7.00000E-02	(1)						
	83-331	83-331	-9.000E-02	7.00000E-02	(1)						
	83-460	83-460	4.000E-01	7.00000E-02	(1)	7.000E-03		(1)			
	83-476	83-476	-2.000E-02	6.00000E-02	(1)	1.800E-02		(1)			
	83-513	83-513	5.040E+00	1.50000E-01	(1)						
	84-24	84-24	7.000E-01	6.00000E-02	(1)						
OBRIAN	85-194	85-194	-4.000E-02	7.00000E-02	(1)						
		85-195	5.200E-01	1.00000E-01	(1)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
DC-19C	84-40	84-40						
	84-75	84-75						
	84-86	84-86						
DC-20C	84-9	84-9						
DC-22C	84-105	84-105						
		84-153						
ENYEAST	84-168	84-168						
	85-1	85-1						
	85-180	85-180						
		85-181						
FORD	SITE-219	SITE-219						
	85-188	85-188						
		85-189						
	85-303	85-303						
MCGEE	SITE-223	SITE-223						
	SITE-220	SITE-220						
	82-7	82-7						
	85-175	85-175						
		85-176						
	85-300	85-300						
	86-34	86-34						
		86-35						
	80-64	80-64						
		[illegible]-88						
	81-79	81-79						
	81-54	81-54						
	82-64	82-64						
	82-263	82-263						
	82-397	82-397						
	82-424	82-424						
	82-436	82-436						
	83-32	83-32						
	83-83	83-83			1.32[illegible]-04	2.00000E-06 (1)	7.260E-03	4.0000[illegible]E-05 [illegible])
	83-188	83-188						
	83-373	83-373						
	83-331	83-331						
	83-460	83-460			4.70[illegible]-05	4.00000E-06 (1)	7.280E-03	8.00000E-05 (1)
	83-476	83-476			1.550E-04	2.00000E-06 (1)	7.230E-03	7.00000E-05 (1)
	83-513	83-513						
	84-24	84-24						
OBRIAN	85-194	85-194						
		85-195						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
RRL-02	82-68	82-68						
	82-65	82-65					1.200E+00	6.00000E-01 (1)
	82-170	82-170					2.280E+01	6.30000E+00 (1)
	82-122	82-122	7.800E+07	1.70000E+07 (1)	9.000E-15	2.00000E-15 (1)	2.430E+01	4.50000E+00 (1)
	82-401	82-401					1.020E+01	2.30000E+00 (1)
	84-7	84-7					8.300E+00	2.40000E+00 (1)
	82-364	82-364	8.400E+07	8.00000E+06 (1)	1.100E-14	1.00000E-15 (1)	6.300E+00	1.40000E+00 (1)
	82-456	82-456					1.120E+01	2.50000E+00 (1)
STEM-1	85-252	85-252					2.140E+01	1.80000E+00 (1)
	85-297	85-297						
STEM-2	86-19	86-19					2.010E+01	2.40000E+00 (1)
		86-20					1.960E+01	2.40000E+00 (1)
299-E16-01	SITE-161	SITE-161						
	SITE-162	SITE-162						
	SITE-163	SITE-163						
	SITE-164	SITE-164						
299-E26-08	SITE-166	SITE-166						
	SITE-167	SITE-167						
	SITE-168	SITE-168						
299-E33-12	SITE-170	SITE-170						
	SITE-171	SITE-171						
	SITE-172	SITE-172						
699-S11-E12A	80-61	80-61					5.300E+00	9.00000E-01 (1)
699-42-40C	SITE-176	SITE-176						
	SITE-177	SITE-177						
	SITE-178	SITE-178						
	SITE-179	SITE-179						
	SITE-180	SITE-180						
699-47-50	SITE-205	SITE-205						
	SITE-181	SITE-181						
699-49-55B	SITE-183	SITE-183						
	SITE-184	SITE-184						
	SITE-185	SITE-185						
699-50-45	SITE-203	SITE-203						
	SITE-186	SITE-186						
699-50-48	SITE-204	SITE-204						
	SITE-187	SITE-187						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
RRL-02	82-68	82-68	1.100E+00	8.00000E-02	(1)	1.800E-02		(1)			
	82-65	82-65	9.800E-01	9.00000E-02	(1)	1.200E-02		(1)			
	82-170	82-170	6.340E+00	2.20000E-01	(1)	5.500E-02		(1)			
	82-122	82-122	8.000E-01	1.00000E-01	(1)	3.000E-03		(1)			
	82-401	82-401	4.440E+00	1.50000E-01	(1)	1.100E-02		(1)			
	84-7	84-7	7.900E-01	8.00000E-02	(1)						
	82-364	82-364	8.600E-01	1.10000E-01	(1)	8.000E-03		(1)			
	82-456	82-456	6.800E-01	8.00000E-02	(1)	4.000E-03		(1)			
STLM-1	85-252	85-252	-8.000E-02	7.00000E-02	(1)						
	85-297	85-297	1.400E-01	7.00000E-02	(1)						
STLM-2	86-19	86-19	1.000E-01	8.00000E-02	(1)						
		86-20									
299-E16-01	SITE-161	SITE-161	5.250E+00	2.20000E-01	(0)						
	SITE-162	SITE-162	3.000E-01	7.00000E-02	(0)						
	SITE-163	SITE-163	-1.000E-02	7.00000E-02	(0)						
	SITE-164	SITE-164	9.000E-02	6.00000E-02	(0)						
299-E26-08	SITE-166	SITE-166	-3.000E-02	6.00000E-02	(0)						
	SITE-167	SITE-167	1.040E+00	1.10000E-01	(0)						
	SITE-168	SITE-168	1.820E+00	1.10000E-01	(0)						
299-E33-12	SITE-170	SITE-170	5.450E+01	1.80000E+00	(0)						
	SITE-171	SITE-171	9.000E+01	2.10000E+00	(0)						
	SITE-172	SITE-172	1.030E+02	2.00000E+00	(0)						
699-S11-E12A	80-61	80-61	7.000E-02	4.00000E-02	(1)						
699-42-40C	SITE-176	SITE-176	3.740E+02	7.00000E+00	(0)						
	SITE-177	SITE-177	1.200E+01	4.00000E-01	(0)						
	SITE-178	SITE-178	5.980E+00	2.20000E-01	(0)						
	SITE-179	SITE-179	3.760E+00	1.30000E-01	(0)						
	SITE-180	SITE-180	4.180E+00	1.30000E-01	(0)						
699-47-50	SITE-205	SITE-205	3.082E+02	8.64000E+00	(0)						
	SITE-181	SITE-181	9.700E+01	3.10000E+00	(0)						
699-40-55B	SITE-183	SITE-183	2.400E-01	9.00000E-02	(0)						
	SITE-184	SITE-184	2.500E-01	8.00000E-02	(0)						
	SITE-185	SITE-185	2.200E-01	8.00000E-02	(0)						
699-50-45	SITE-203	SITE-203	1.600E-01	1.30000E-01	(0)						
	SITE-186	SITE-186	3.600E-01	7.00000E-02	(0)						
699-50-48	SITE-204	SITE-204	1.722E+01	3.80000E-01	(0)						
	SITE-187	SITE-187	4.100E+00	2.20000E-01	(0)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE	(A)	U234/U238 ATOM RATIO	+/- RANGE	(A)	U235/U238 ATOM RATIO	+/- RANGE	(A)
RRL-02	82-68	82-68				1.130E-04	4.00000E-06	(1)	7.300E-03	8.00000E-05	(1)
	82-65	82-65				1.500E-04	1.00000E-06	(1)	7.300E-03	1.00000E-04	(1)
	82-170	82-170				8.400E-05	1.00000E-06	(1)	7.300E-03	3.00000E-05	(1)
	82-122	82-122									
	82-401	82-401				6.600E-05	2.00000E-06	(1)	7.280E-03	6.00000E-05	(1)
	84-7	84-7									
	82-364	82-364				5.000E-05	2.00000E-06	(1)	7.380E-03	1.00000E-04	(1)
	82-456	82-456									
STEM-1	85-252	85-252									
	85-297	85-297									
STEM-2	86-19	86-19									
		86-20									
299-E16-01	SITE-161	SITE-161									
	SITE-162	SITE-162									
	SITE-163	SITE-163									
	SITE-164	SITE-164									
299-E26-08	SITE-166	SITE-166									
	SITE-167	SITE-167									
	SITE-168	SITE-168									
299-E33-12	SITE-170	SITE-170									
	SITE-171	SITE-171									
	SITE-172	SITE-172									
699-S11-E12A	80-61	80-61									
699-42-40C	SITE-176	SITE-176									
	SITE-177	SITE-177									
	SITE-178	SITE-178									
	SITE-179	SITE-179									
	SITE-180	SITE-180									
699-47-50	SITE-205	SITE-205									
	SITE-181	SITE-181									
699-49-55B	SITE-183	SITE-183									
	SITE-184	SITE-184									
	SITE-185	SITE-185									
699-50-45	SITE-203	SITE-203									
	SITE-186	SITE-186									
699-50-48	SITE-204	SITE-204									
	SITE-187	SITE-187									

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE. CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL33, ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
699-51-46	SITE-188	SITE-188						
	SITE-201	SITE-201						
699-52-46A	SITE-202	SITE-202						
	SITE-189	SITE-189						
699-52-48	SITE-199	SITE-199						
	SITE-190	SITE-190						
699-53-50	SITE-191	SITE-191						
	SITE-200	SITE-200						
699-54-57	SITE-192	SITE-192						
699-56-53	SITE-196	SITE-196						
	SITE-197	SITE-197						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
699-51-46	SITE-188	SITE-188	5.700E-01	9.00000E-02	(0)						
	SITE-201	SITE-201	-6.000E-02	1.60000E-01	(0)						
699-52-46A	SITE-202	SITE-202	4.500E-01	1.30000E-01	(0)						
	SITE-189	SITE-189	9.000E-02	8.00000E-02	(0)						
699-52-48	SITE-199	SITE-199	2.600E-01	1.60000E-01	(0)						
	SITE-190	SITE-190	2.800E-01	8.00000E-02	(0)						
699-53-50	SITE-191	SITE-191	4.500E-01	8.00000E-02	(0)						
	SITE-200	SITE-200	1.700E+00	1.90000E-01	(0)						
699-54-57	SITE-192	SITE-192	2.000E-02	9.00000E-02	(0)						
699-56-53	SITE-196	SITE-196	4.200E-01	8.00000E-02	(0)						
	SITE-197	SITE-197	-2.000E-02	6.00000E-02	(0)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE. CONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
699-51-46	SITE-188	SITE-188						
	SITE-201	SITE-201						
699 52-46A	SITE-202	SITE-202						
	SITE-189	SITE-189						
699-52-48	SITE-199	SITE-199						
	SITE-190	SITE-190						
699-53-50	SITE-191	SITE-191						
	SITE-200	SITE-200						
699-54-57	SITE-192	SITE-192						
699-56-53	SITE-196	SITE-196						
	SITE-197	SITE-197						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
STATION-03	82-51	82-51						
	82-81	82-81						
	82-78	82-78						
	82-179	82-179						
	82-138	82-138						
	83-90	83-90						
	83-46	83-46						
	83-118	83-118						
	83-189	83-189						
STATION-04	82-61	82-61						
	82-60	82-60						
	82-90	82-90						
	82-120	82-120						
	82-117	82-117						
	83-36	83-36						
	83-84	83-84						
	83-141	83-141						
	83-116	83-116						
	83-110	83-110						
	83-155	83-155						
	83-102	83-102						
STATION-07	82-92	82-92						
	82-57	82-57						
	82-44	82-44						
	82-138	82-136						
	82-185	82-185						
	83-43	83-43						
	83-23	83-23						
	83-187	83-187						
	83-148	83-148						
	83-159	83-169						
STATION-14	82-20	82-20						
	82-63	82-63						
	82-86	82-86						
	82-178	82-178						
	82-147	82-147						
	83-71	83-71						
	83-55	83-55						
	83-132	83-132						
	83-184	83-184						
	83-160	83-160						
	83-174	83-174						
STATION-17	82-70	82-70						
	82-80	82-80						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
STATION-03	82-51	82-51	1.630E+01	4.00000E-01	(1)						
	82-81	82-81	1.160E+01	3.00000E-01	(1)						
	82-78	82-78	1.810E+01	6.00000E-01	(1)						
	82-179	82-179	1.490E+01	4.00000E-01	(1)						
	82-138	82-138	1.690E+01	4.00000E-01	(1)						
	83-90	83-90	8.790E+00	2.90000E-01	(1)						
	83-46	83-46	5.700E+00	2.10000E-01	(1)						
	83-118	83-118	7.650E+00	2.60000E-01	(1)						
	83-189	83-189	9.080E+00	2.90000E-01	(1)						
STATION-04	82-61	82-61	1.810E+01	4.00000E-01	(1)						
	82-60	82-60	1.410E+01	4.00000E-01	(1)						
	82-90	82-90	1.760E+01	4.00000E-01	(1)						
	82-120	82-120	1.610E+01	5.00000E-01	(1)						
	82-117	82-117	1.840E+01	5.00000E-01	(1)						
	83-36	83-36	8.560E+00	3.20000E-01	(1)						
	83-84	83-84	5.410E+00	1.70000E-01	(1)						
	83-141	83-141	7.250E+00	1.70000E-01	(1)						
	83-116	83-116	3.160E+00	3.40000E-01	(1)						
	83-110	83-110	7.720E+00	3.00000E-01	(1)						
	83-155	83-155	9.010E+00	3.50000E-01	(1)						
	83-102	83-102	7.400E+00	3.00000E-01	(1)						
STATION-07	82-92	82-92	1.810E+01	4.00000E-01	(1)						
	82-57	82-57	1.380E+01	4.00000E-01	(1)						
	82-44	82-44	1.750E+01	5.00000E-01	(1)						
	82-136	82-136	1.580E+01	5.00000E-01	(1)						
	82-185	82-185	1.770E+01	5.00000E-01	(1)						
	83-43	83-43	9.480E+00	2.70000E-01	(1)						
	83-23	83-23	5.550E+00	2.00000E-01	(1)						
	83-187	83-187	7.510E+00	2.90000E-01	(1)						
	83-148	83-148	9.470E+00	3.80000E-01	(1)						
	83-159	83-169	7.520E+00	3.10000E-01	(1)						
STATION-14	82-20	82-20	1.820E+01	5.00000E-01	(1)						
	82-63	82-63	1.480E+01	4.00000E-01	(1)						
	82-55	82-66	1.920E+01	5.00000E-01	(1)						
	82-178	82-178	1.430E+01	3.00000E-01	(1)						
	82-147	82-147	1.570E+01	5.00000E-01	(1)						
	83-71	83-71	1.240E+01	4.00000E-01	(1)						
	83-55	83-55	5.100E+00	3.00000E-01	(1)						
	83-132	83-132	6.640E+00	3.90000E-01	(1)						
	83-184	83-184	8.770E+00	3.40000E-01	(1)						
	83-160	83-160	8.760E+00	3.50000E-01	(1)						
	83-174	83-174	1.110E+01	4.00000E-01	(1)						
STATION-17	82-70	82-70	8.110E+00	2.60000E-01	(1)						
	82-80	82-80	1.410E+01	4.00000E-01	(1)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
STATION-03	82-51	82-51						
	82-81	82-81						
	82-78	82-78						
	82-179	82-179						
	82-138	82-138						
	83-90	83-90						
	83-46	83-46						
	83-118	83-118						
	83-189	83-189						
STATION-04	82-61	82-61						
	82-60	82-60						
	82-90	82-90						
	82-120	82-120						
	82-117	82-117						
	83-36	83-36						
	83-84	83-84						
	83-141	83-141						
	83-116	83-116						
	83-110	83-110						
	83-155	83-155						
	83-102	83-102						
STATION-07	82-92	82-92						
	82-57	82-57						
	82-44	82-44						
	82-136	82-136						
	82-185	82-185						
	83-43	83-43						
	83-23	83-23						
	83-187	83-187						
	83-148	83-148						
	83-169	83-169						
STATION-14	82-20	82-20						
	82-63	82-63						
	82-86	82-86						
	82-178	82-178						
	82-147	82-147						
	83-71	83-71						
	83-55	83-55						
	83-132	83-132						
	83-184	83-184						
	83-160	83-160						
	83-174	83-174						
STATION-17	82-70	82-70						
	82-80	82-80						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE, PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
STATION-17	82-100	82-100						
	82-118	82-118						
	82-134	82-134						
	83-11	83-11						
	83-86	83-86						
	83-150	83-159						
	83-120	83-120						
	83-199	83-199						
	83-182	83-182						
	83-126	83-126						
STATION-20	82-58	82-58						
	82-74	82-74						
	82-1	82-1						
	82-96	82-96						
	82-196	82-196						
	82-197	82-197						
	83-37	83-37						
	83-34	83-34						
	83-170	83-170						
	83-130	83-130						
	83-119	83-119						
	83-158	83-158						
STATION-25	82-83	82-83						
	82-25	82-25						
	82-67	82-67						
	82-153	82-153						
	82-152	82-152						
	83-89	83-89						
	83-53	83-53						
	83-134	83-134						
	83-139	83-139						
	83-142	83-142						
	83-190	83-190						
STATION-26	82-91	82-91						
	82-98	82-98						
	82-71	82-71						
	82-39	82-39						
	82-116	82-116						
	82-108	82-108						
	83-3	83-3						
	83-70	83-70						
	83-163	83-163						
	83-177	83-177						
	83-171	83-171						
	83-167	83-167						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
STATION-17	82-100	82-100	1.030E+01	7.00000E-01	(1)						
	82-118	82-118	1.280E+01	3.00000E-01	(1)						
	82-134	82-134	1.590E+01	4.00000E-01	(1)						
	83-11	83-11	7.120E+00	2.10000E-01	(1)						
	83-86	83-86	5.620E+00	2.00000E-01	(1)						
	83-159	83-159	6.640E+00	2.10000E-01	(1)						
	83-120	83-120	8.510E+00	3.60000E-01	(1)						
	83-199	83-199	6.640E+00	2.80000E-01	(1)						
	83-182	83-182	7.700E+00	3.10000E-01	(1)						
	83-126	83-126	7.330E+00	3.10000E-01	(1)						
STATION-20	82-58	82-58	8.070E+00	2.80000E-01	(1)						
	82-74	82-74	1.460E+01	4.00000E-01	(1)						
	82-1	82-1	1.410E+01	4.00000E-01	(1)						
	82-96	82-96	2.340E+01	1.30000E+00	(1)						
	82-196	82-196	1.430E+01	4.00000E-01	(1)						
	82-197	82-197	1.550E+01	4.00000E-01	(1)						
	83-37	83-37	7.630E+00	2.70000E-01	(1)						
	83-34	83-34	4.880E+00	1.30000E-01	(1)						
	83-170	83-170	5.950E+00	2.00000E-01	(1)						
	83-130	83-130	6.740E+00	2.30000E-01	(1)						
	83-119	83-119	8.170E+00	3.30000E-01	(1)						
	83-158	83-158	7.950E+00	3.20000E-01	(1)						
STATION-25	82-83	82-83	7.800E+00	2.60000E-01	(1)						
	82-25	82-25	1.400E+01	4.00000E-01	(1)						
	82-67	82-67	2.160E+01	7.00000E-01	(1)						
	82-153	82-153	1.450E+01	4.00000E-01	(1)						
	82-152	82-152	1.490E+01	4.00000E-01	(1)						
	83-89	83-89	8.680E+00	2.80000E-01	(1)						
	83-53	83-53	5.400E+00	3.00000E-01	(1)						
	83-134	83-134	7.300E+00	2.50000E-01	(1)						
	83-139	83-139	9.640E+00	3.40000E-01	(1)						
	83-142	83-142	8.190E+00	3.20000E-01	(1)						
	83-190	83-190	6.310E+00	2.30000E-01	(1)						
STATION-26	82-91	82-91	7.930E+00	2.60000E-01	(1)						
	82-98	82-98	1.670E+01	5.00000E-01	(1)						
	82-71	82-71	1.530E+01	4.00000E-01	(1)						
	82-39	82-39	2.350E+01	1.00000E+00	(1)						
	82-116	82-116	1.460E+01	4.00000E-01	(1)						
	82-108	82-108	1.340E+01	4.00000E-01	(1)						
	83-3	83-3	8.540E+00	2.50000E-01	(1)						
	83-70	83-70	5.420E+00	1.90000E-01	(1)						
	83-163	83-163	7.150E+00	3.50000E-01	(1)						
	83-177	83-177	8.930E+00	3.20000E-01	(1)						
	83-171	83-171	7.120E+00	2.30000E-01	(1)						
	83-167	83-167	7.550E+00	3.00000E-01	(1)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
STATION-17	82-100	82-100						
	82-118	82-118						
	82-134	82-134						
	83-11	83-11						
	83-86	83-86						
	83-159	83-159						
	83-120	83-120						
	83-199	83-199						
	83-182	83-182						
	83-126	83-126						
STATION-20	82-58	82-58						
	82-74	82-74						
	82-1	82-1						
	82-96	82-96						
	82-196	82-196						
	82-197	82-197						
	83-37	83-37						
	83-34	83-34						
	83-170	83-170						
	83-130	83-130						
	83-119	83-119						
	83-158	83-158						
STATION-25	82-83	82-83						
	82-25	82-25						
	82-57	82-57						
	82-153	82-153						
	82-152	82-152						
	83-39	83-39						
	83-53	83-53						
	83-134	83-134						
	83-139	83-139						
	83-142	83-142						
	83-190	83-190						
STATION-26	82-91	82-91						
	82-98	82-98						
	82-71	82-71						
	82-39	82-39						
	82-116	82-116						
	82-108	82-108						
	83-3	83-3						
	83-70	83-70						
	83-163	83-163						
	83-177	83-177						
	83-171	83-171						
	83-167	83-167						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
STATION-26	83-131	83-131						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE. PRECIPITAT[illegible]
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE (A)	U MICROGRAM/L	+/- RANGE (A)	U234 DPM/L	+/- RANGE (A)
STATION-26	83-131	83-131	6.250E+00	2.60000E-01 (1)				

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
STATION-26	83-131	83-131						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
SP-BENNETT	SITE-218	SITE-218						
	79-13	79-13						
	85-362	85-362					7.080E+01	5.80000E+00 (A)
SP-BENSON	SITE-217	SITE-217						
SP-BUTLER	79-1	79-1						
SP-JUNIPER	SITE-215	SITE-215						
	79-2	79-2						
	81-115	81-115					2.320E+01	1.80000E+00 (A)
	83-372	83-372						
SP-LO-SNIVELY	79-34	79-34						
	82-362	82-362					5.840E+01	5.40000E+00 (A)
	83-396	83-396						
SP-TOZIER	79-6	79-44						
		79-6						
	81-186	81-186					6.770E+01	4.70000E+00 (A)
	83-316	83-316						
SP-MAIDEN	79-100	79-96					1.086E+02	6.60000E+00 (A)
	83-420	83-420						
SP-OBSERVATORY	81-119	81-119					8.920E+01	2.00000E+00 (A)
	83-433	83-492						
	84-322	84-392					1.018E+02	1.80000E+00 (A)
	85-359	85-359					1.055E+02	7.70000E+00 (A)
SP-RAILROAD	79-75	79-76						
SP-RATTLESNAKE	SITE-216	SITE-216						
	83-412	83-412						
SP-SNIVELY	79-49	79-49						
SP-SULFUR	79-29	79-29						
	83-409	83-409						
SP-UNNAMED-02	79 75	79-70						
		79-75						
SP-UNNAMED-16	79-73	79-82					1.134E+02	6.40000E+00 (A)
SP-UNNAMED-26	79-98	79-98						
SP-UNNAMED-29	79-16	79-15					1.074E+02	6.8000[illegible] (A)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
SP-BENNETT	SITE-218	SITE-218	3.700E-01	4.00000E-02	(0)						
	79-13	79-13	3.400E-01	4.00000E-02	(1)	3.200E-01	4.00000E-02	(1)	6.100E-01	4.00000E-02	(1)
	85-362	85-362	5.400E-01	9.00000E-02	(1)						
SP-BENSON	SITE-217	SITE-217	3.170E+00	2.40000E-01	(0)						
SP-BUTLER	79-1	79-1	1.520E+00	7.00000E-02	(1)	2.800E-01	4.00000E-02	(1)	5.400E-01	4.00000E-02	(1)
SP-JUNIPER	SITE-215	SITE-215	1.500E-01	4.00000E-02	(0)						
	79-2	79-2				7.800E-02	3.00000E-02	(1)	6.200E-02	2.70000E-02	(1)
	81-115	81-115	5.800E-01	5.00000E-02	(1)						
	83-372	83-372	-5.000E-02	8.00000E-02	(1)						
SP-TO-SNIVELY	79-34	79-34				3.700E-01	2.00000E-02	(1)	4.900E-01	2.00000E-02	(1)
	82-362	82-362	9.200E-01	8.00000E-02	(1)	3.500E-01		(1)			
	83-396	83-396	1.190E+00	1.10000E-01	(1)						
SP-LOZIER	79-6	79-44	5.650E+00	1.50000E-01	(1)						
		79-6				4.600E-01	3.00000E-02	(1)	6.900E-01	4.00000E-02	(1)
	81-186	81-186	4.240E+00	1.80000E-01	(1)						
	83-316	83-316	2.840E+00	1.20000E-01	(1)						
SP-MAIDEN	79-100	79-96									
	83-420	83-420	2.980E+00	1.20000E-01	(1)						
SP-OBSERVATORY	81-119	81-119	5.030E+00	2.10000E-01	(1)						
	83-433	83-492	4.790E+00	1.60000E-01	(1)						
	84-392	84-392	5.020E+00	1.40000E-01	(1)						
	85-359	85-359	4.740E+00	1.80000E-01	(1)						
SP-RAILROAD	79-76	79-76	7.170E+00	1.90000E-01	(1)	9.700E-02	7.00000E-03	(1)	1.400E-01	1.00000E-02	(1)
SP-RATTLESNAKE	SITE-216	SITE-216	4.700E-01	6.00000E-02	(0)						
	83-412	83-412	1.890E+00	7.00000E-02	(1)						
SP-SNIVELY	79-49	79-49				3.600E-01	3.00000E-02	(1)	4.700E-01	3.00000E-02	(1)
SP-SULFUR	79-29	79-29				6.000E-01	6.00000E-02	(1)	8.100E-01	6.00000E-02	(1)
	83-409	83-409	3.980E+00	1.70000E-01	(1)						
SP-UNNAMED-02	79-75	79-70	5.270E+00	1.30000E-01	(1)						
		79-75				1.400E+00	1.00000E-01	(1)	1.590E+00	1.10000E-01	(1)
SP-UNNAMED-18	79-73	79-82									
SP-UNNAMED-26	79-98	79-98	6.660E+00	1.30000E-01	(1)	7.700E-02	8.00000E-03	(1)	8.200E-02	7.00000E-03	(1)
SP-UNNAMED-29	79-16	79-16				1.440E+00	7.00000E-02	(1)	1.590E+00	8.00000E-02	(1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
SP-BENNETT	SITE-218 79-13 85-362	SITE-218 79-13 85-362	2.400E-01	3.00000E-02 (1)	1.400E-04	2.00000E-05 (1)		
SP-BENSON	SITE-217	SITE-217						
SP-BUTLER	79-1	79-1	2.100E-01	3.00000E-02 (1)	1.400E-04	2.00000E-05 (1)		
SP-JUNIPER	SITE-215 79-2 81-115 83-372	SITE-215 79-2 81-115 83-372	5.800E-02	2.30000E-02 (1)	6.000E-05	3.40000E-05 (1)		
SP-LO-SNIVELY	79-34 82-362 83-396	79-34 82-362 83-396	2.700E-01	2.00000E-02 (1)	9.800E-05 1.020E-04	8.00000E-06 (1) 1.00000E-06 (1)	7.240E-03	3.00000E-05 (1)
SP-LOZIER	79-6 81-186 83-316	79-44 79-6 81-186 83-316	3.400E-01	2.00000E-02 (1)	1.100E-04	1.00000E-05 (1)		
SP-MAIDEN	79-100 83-420	79-95 83-420						
SP-OBSERVATORY	81-119 83-433 84-392 85-359	81-119 83-492 84-392 85-359						
SP-RAILROAD	79-76	79-76	7.100E-02	5.00000E-03 (1)	1.100E-04	1.00000E-05 (1)		
SP-RATTLESNAKE	SITE-216 83-412	SITE-216 83-412						
SP-SNIVELY	79-49	79-49	2.700E-01	2.00000E-02 (1)	9.600E-05	9.00000E-06 (1)		
SP-SULFUR	79-29 83-409	79-29 83-409	4.500E-01	5.00000E-02 (1)	9.900E-05	1.30000E-05 (1)		
SP-UNNAMED-02	79-75	79-70 79-75	1.020E+00	8.00000E-02 (1)	8.500E-05	9.00000E-06 (1)		
SP-UNNAMED-16	79-73	79-82						
SP-UNNAMED-26	79-98	79-98	5.700E-02	6.00000E-03 (1)	7.900E-05	1.10000E-05 (1)		
SP-UNNAMED-29	79-16	79-16	1.060E+00	5.00000E-02 (1)	8.200E-05	6.00000E-06 (1)		

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
SP-UP-SNIVELY	79-71	79-71						
	81-126	81-126					8.090E+01	5.90000E+00 (1)
	83-503	83-503						
SP-UR2-07	85-343	85-343						
SP-UR6-20	85-346	85-346						
SP-UR7-22	85-349	85-349						
SP-WARM	84-358	84-358						
SP-YR3-04	85-333	85-333						
SP-YR5-08	85-336	85-336						
SP-YR7-14	85-339	85-339						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
SP-UP SHIVELY	79-71	79-71				4.600E-01	2.00000E-02	(1)	7.200E-01	4.00000E-02	(1)
	81-126	81-126	1.750E+00	1.00000E-01	(1)	4.170E-01		(1)			
	83-503	83-503	1.280E+00	6.00000E-02	(1)						
SP-UR2-07	85-343	85-343	2.580E+00	1.00000E-01	(1)						
SP-UR6-20	85-346	85-346	1.010E+00	1.00000E-01	(1)						
SP-UR7-22	85-349	85-349	1.390E+00	8.00000E-02	(1)						
SP-WARM	84-358	84-358	1.200E-01	8.00000E-02	(1)						
SP-YR3-04	85-333	85-333	4.500E-01	1.00000E-01	(1)						
SP-YR5-08	85-336	85-336	4.900E-01	9.00000E-02	(1)						
SP-YR7-14	85-339	85-339	1.070E+01	4.00000E-01	(1)						

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SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
SP-UP-SNIVELY	79-71	79-71	3.400E-01	2.00000E-02 (1)	1.160E-04	8.00000E-06 (1)		
	81-126	81-126			1.120E-04	2.00000E-06 (1)	7.250E-03	5.00000E-05 (1)
	83-503	83-503						
SP-UR2-07	85-343	85-343						
SP-UR6-20	85-346	85-346						
SP-UR7-22	85-349	85-349						
SP-WARM	84-358	84-358						
SP-YR3-04	85-333	85-333						
SP-YR5-08	85-336	85-336						
SP-YR7-14	85-339	85-339						

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SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SURFACE
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	Cl36 ATOMS/LITER	+/- RANGE (A)	Cl36/Cl ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
COLD CREEK	84-302	84-302					1.089E+02	1.80000E+00 (1)
	85-223	85-223					1.157E+02	8.20000E+00 (1)
CR-DC-14	83-258	83-258					1.212E+02	3.80000E+00 (1)
CR-DC-15	81-1	81-1						
CR-HIS	SITE-221	SITE-221						
CR-V BR	84-311	84-311					8.860E+01	3.70000E+00 (1)
	85-205	85-206					9.010E+01	2.10000E+00 (1)
	85-265	85-266					1.077E+02	1 10000E+01 (1)
	86-70	86-70						
YR-HR	85-210	85-210					1.200E+02	9.80000E+00 (1)
	85-269	85-269					1.152E+02	7.80000E+00 (1)
	86-67	86-67						

SAMPLE TYPE: SURFACE
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	T TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
COLD CREEK	84-302	84-302	6.460E+00	2.40000E-01	(1)						
	85-223	85-223	5.860E+00	1.80000E-01	(1)						
CR-DC-14	83-258	83-258	4.180E+01	1.10000E+00	(1)						
CR-DC-15	81-1	81-1	5.410E+01	1.50000E+00	(1)						
CR-HIS	SITE-221	SITE-221	7.830E+01	4.00000E-02	(0)						
CR-V-BR	84-311	84-311	2.970E+01	8.00000E-01	(1)						
	85-206	85-206	2.960E+01	8.00000E-01	(1)						
	85-266	85-266	2.510E+01	8.00000E-01	(1)						
	86-70	86-70	2.590E+01	8.00000E-01	(1)						
YR-HR	85-210	85-210	1.250E+01	4.00000E-01	(1)						
	85-269	85-269	1.350E+01	5.00000E-01	(1)						
	86-67	86-67	1.270E+01	4.00000E-01	(1)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: SURFACE
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
COLD CREEK	84-302	84-302						
	85-223	85-223						
CR-DC-14	83-258	83-258						
CR-DC-15	81-1	81-1						
CR-HTS	SITE-221	SITE-221						
CR-V-BR	84-311	84-311						
	85-206	85-206						
	85-266	85-266						
	86-70	86-70						
YR-HR	85-210	85-210						
	85-269	85-269						
	86-67	86-67						

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SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	CL36 ATOMS/LITER	+/- RANGE (A)	CL36/CL ATOM RATIO	+/- RANGE (A)	C14PMC %	+/- RANGE (A)
299-E26-08	SITE-165	SITE-165						
299-E33-12	SITE-169	SITE-169						
699-S03-25	86-55	86-55					2.430E+01	1.90000E+00 (1)
699-S24-19	85-213	85-213					1.120E+02	6.20000E+00 (1)
	85-291	85-291					8.710E+01	5.00000E+00 (1)
699-11-45A	85-263	85-263					4.980E+01	4.50000E+00 (1)
	86-43	86-43					6.220E+01	4.90000E+00 (1)
699-19-58	85-229	85-229					2.860E+01	2.50000E+00 (1)
	85-260	85-260					3.120E+01	3.10000E+00 (1)
	86-40	86-40					2.740E+01	2.40000E+00 (1)
699-19-88	85-278	85-278					4.820E+01	4.00000E+00 (1)
	86-64	86-64					5.730E+01	4.10000E+00 (1)
699-24-95	85-288	85-288					8.100E+01	4.40000E+00 (1)
	86-61	86-61					6.010E+01	4.00000E+00 (1)
699-37-43	SITE-173	SITE-173						
699-49-55A	SITE-182	SITE-182						
699-55-50C	SITE-193	SITE-193						
699-60-57	SITE-198	SITE-198						
699-66-103	85-203	85-203					8.240E+01	2.40000E+00 (1)
	86-73	86-73					8.060E+01	6.50000E+00 (1)
	85-294	85-294					8.480E+01	6.70000E+00 (1)

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	TRITIUM UNITS	+/- RANGE	(A)	U MICROGRAM/L	+/- RANGE	(A)	U234 DPM/L	+/- RANGE	(A)
299-E25-08	SITE-165	SITE-165	4.030E+02	7.00000E+00	(0)						
299-E33-12	SITE-169	SITE-169	4.260E+02	8.00000E+00	(0)						
699-S03-25	86-55	86-55	1.300E-01	8.00000E-02	(1)						
699-S24-19	85-213	85-213	1.640E+01	5.00000E-01	(1)						
	85-291	85-291	1.690E+01	5.00000E-01	(1)						
699-11-45A	85-263	85-263	1.000E-02	9.00000E-02	(1)						
	86-43	86-43	7.000E-02	8.00000E-02	(1)						
699-19-58	85-229	85-229	2.000E-01	8.00000E-02	(1)						
	85-260	85-260	-2.000E-01	1.00000E-01	(1)						
	86-40	86-40	-8.000E-02	6.00000E-02	(1)						
699-19-88	85-278	85-278	-4.000E-02	9.00000E-02	(1)						
	86-64	86-64	0.000E+00	7.00000E-02	(1)						
699-24-95	85-288	85-288	6.800E-01	1.10000E-01	(1)						
	86-61	86-61	6.500E-01	1.00000E-01	(1)						
699-37-43	SITE-173	SITE-173	2.890E+04	5.00000E+02	(0)						
699-49-55A	SITE-182	SITE-182	2.500E-01	3.00000E-02	(0)						
699-55-50C	SITE-193	SITE-193	4.520E+01	1.60000E+00	(0)						
699-60-57	SITE-198	SITE-198	2.140E+02	5.00000E+00	(0)						
699-66-103	85-203	85-203	5.440E+01	1.30000E+00	(1)						
	86-73	86-73	3.940E+01	1.10000E+00	(1)						
	85-294	85-294	6.530E+01	2.00000E+00	(1)						

SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP: RADIO

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	U238 DPM/L	+/- RANGE (A)	U234/U238 ATOM RATIO	+/- RANGE (A)	U235/U238 ATOM RATIO	+/- RANGE (A)
299-E26-08	SITE-165	SITE-165						
299-E33-12	SITE-169	SITE-169						
699-S03-25	86-55	86-55						
699-S24-19	85-213	85-213						
	85-291	85-291						
699-11-45A	85-263	85-263						
	86-43	86-43						
699-19-58	85-220	85-229						
	85-260	85-260						
	86-40	86-40						
699-19-88	85-278	85-278						
	86-64	86-64						
699-24-95	85-288	85-288						
	86-61	86-61						
699-37-43	SITE-173	SITE-173						
699-49-55A	SITE-182	SITE-182						
699-55-50C	SITE-193	SITE-193						
699-60-57	SITE-198	SITE-198						
699-66-103	85-203	85-203						
	86-73	86-73						
	85-294	85-294						

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SEE END OF THIS REPORT FOR A LISTING OF ANALYSIS METHODS.

LIST OF ANALYSIS METHODS FOR RADIOACTIVE ISOTOPES

SPECIE	(A)	ANALYSIS METHOD
CL36	1	Derived from CL36/CL ratio
CL36/CL	1	Tandem accelerator mass spectroscopy
C14PMC	0	Unclassified
	1	Proportional gas counting on methane
T	0	Unclassified
	1	Electro. enrich./H2 gas proportional counter
U	0	Unclassified
	1	Thermal emission mass spectrometry
	2	Alpha spectrometry
U234	1	Mass spectrometry
	2	Alpha spectrometry
U234/U238	1	Thermal emission mass spectrometry
	2	Alpha spectrometry
U235/U238	1	Thermal emission mass spectrometry
U238	1	Mass spectrometry
	2	Alpha spectrometry

Unclassified: Analysis comes from a non-BWIP documented source and the method is not specified in this data package.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
BLRK	85-255	85-255			-11.200	-138.000	-17.600	
DB-01	81-19	81-19			3.400	-147.000	-17.500	
	81-65	81-65			-18.300	-138.000	-17.300	20.500
	82-27	82-27			-18.400	-141.000	-17.400	17.000
		82-87			-18.200			21.600
	85-32	85-32			-18.100	-142.000	-17.400	18.300
DB-02	79-65	79-65				-148.000	-17.000	
	81-13	81-13			-16.100	-143.000	-15.800	[illegible]
	81-10	81-10			-15.400	[illegible]	-17.000	6.000
DB-04	79-77	79-77				-155.000	-17.000	
DB-07	79-80	79-80				-145.000	-18.400	
	83-413	83-413			6.600	-138.000	-15.700	
	85-216	85-216			7.100	-134.000	-17.300	
DB-09	79-28	79-28				-152.000	-17.800	
	83-472	83-472			-12.400	-145.000	-17.700	
DB-11	85-4	85-4			-10.000	-153.000	-18.500	9.400
	85-15	85-15			-9.800	-150.000	-18.500	7.400
	85-18	85-18			-9.400	[illegible]		15.900
	86-52	86-52			-10.000	-146.000	-18.800	
		86-53			-10.200			
DB-12	81-25	81-25			-13.600	-153.000	-18.800	
DB-13	80-159	80-159			-13.400			
	83-404	83-404			-13.100	[illegible]	-17.500	
DB-14	81-162	81-139			11.300			
		81-162			11.400	-124.000	-15.400	11.000
DB-15	79-17	79-17			-13.100	[illegible]	-17.200	-10.300
		79-22				[illegible]	-17.100	
		79-4				-150.000	-17.200	
	79-35	79-20				-148.000	-17.600	
		79-35			-23.800	[illegible]	-17.900	
	79-23	79-27				-152.000	-17.800	
		79-33			-15.500	-155.000	-17.900	
	79-15	79-15			-8.400	-150.000	-17.200	23.700
		79-38					-17.500	
	79-39	79-39			-6.500	[illegible]	-17.300	
		79-8			-8.500	-147.000	-17.100	0.600
	79-31	79-31			-3.900	[illegible]	-17.200	3.500
	79-25	79-25				149.000	-17.500	

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
DB-15	79-51	79-51			10.400	-135.000	-14.600	3.200
		79-61			1.500	-131.000	-14.800	1.800
		79-82				-133.000	-15.000	
	79-85	79-85			8.200	-135.000	-14.800	2.300
	79-80	79-68				-129.000	-15.000	
		79-80			15.900	-132.000	-14.800	
	79-62	79-62			17.400	-131.000	-15.100	
	79-90	79-90				-130.000	-15.400	
	80-35	80-35			16.000	-131.000	-14.000	3.300
	80-24	80-24			11.600	-132.000	-15.200	
		80-74					-15.000	
	80-77	80-77			13.300	-132.000	-15.400	-3.000
	80-1	80-1			11.600	-129.000	-15.000	
		80-30				-132.000		
DC-01	SITE-230	SITE-230			-13.300	-145.000	-17.200	
	SITE-226	SITE-226			-14.000			
	SITE-227	SITE-227			-2.900			
	SITE-231	SITE-231			-14.200			
	SITE-232	SITE-232			-14.300	-154.000	-18.300	
	SITE-233	SITE-233			-10.500	-150.000	-17.700	
	SITE-234	SITE-234			-4.000	-142.000	-16.900	
	SITE-235	SITE-235			15.400	-138.000	-15.500	
	SITE-236	SITE-236			13.200	-136.000	-15.600	
	SITE-237	SITE-237			1.400	-139.000	-15.900	
	SITE-238	SITE-238			-12.600	-151.000	-17.800	
	SITE-239	SITE-239			-7.000	-138.000	-16.000	
	SITE-240	SITE-240			-7.600	-148.000	-15.900	
	SITE-241	SITE-241			-7.300	-138.000	-15.900	
	SITE-242	SITE-242			-7.000	-138.000		
DC-02-A2	SITE-213	SITE-213			-10.470	-132.500	-15.350	1.960
DC-05	79-30	79-11				-120.000		
		79-30			-6.000	-132.000	-14.200	
DC-06	SITE-214	SITE-214			-19.200	-124.600	-15.000	-2.120
	80-238	80-238			-21.400	-131.000	-15.100	-6.200
	80-191	80-186				-115.000	-13.900	
		80-191			-18.000	-118.000	-13.900	15.000
	81-45	81-45			-15.800	-125.000	-14.100	5.000
	80-118	80-118			-21.300	-110.000	-13.600	4.700
	80-15	80-15				-120.000	-13.400	3.600
	81-82	81-82				-125.000	-14.500	
	80-29	80-29			-23.800	-125.000	-14.500	-6.100
		80-37					-14.300	
	79-58	79-57			-23.300	-125.000	-14.300	-1.700
		79-58			-23.200	-135.000	-14.400	0.100

ANALYSIS METHOD- MASS SPECTROMETRY.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
DC-06	80-75	80-45			-21.500			-13.200
		80-75			-21.700			
DC-07	82-23	82-23			-23.000	-122.000	-14.500	2.100
	82-10	82-10				-128.000	-14.300	
		82-33	-63.040					
	80-103	80-103			-22.800	-121.000	-13.000	
	80-196	80-177				-105.000		
		80-196			-23.100	-108.000	-12.700	2.100
DC-12	80-80	80-17				-139.000		
		80-80			12.800	-133.000	-15.800	
	80-100	80-100			15.200	-134.000	-15.800	
		80-63	-44.000					
	80-97	80-97	-43.700		14.800	-135.000	-15.900	
	80-32	80-32			8.000	-133.000	-15.300	
	80-82	80-82	-45.500		12.800	-134.000	-15.600	
	80-124	80-124	-44.200		15.200	-140.000	-16.800	
	80-174	80-143				-135.000		
		80-174			-24.800	-132.000	-16.400	
	80-208	80-208			3.600	-135.000	-18.200	
	80-234	80-234			2.500	-126.000	-13.100	10.300
	81-61	81-61			20.700	-125.000	-16.400	
	82-85	82-85			20.600	-139.000	-16.300	8.500
DC-14	80-3	80-3			-11.600	-147.000	-13.400	-4.200
		80-34				-150.000		
	80-53	80-53			-11.000	-155.000	-19.100	
		80-95				-153.000		
	80-47	80-47			-11.600	-155.000	-19.300	5.900
		80-85					-19.100	
	80-69	80-69			-12.800	[illegible]	-17.800	13.500
	80-99	80-99			-12.700	[illegible]	-17.900	8.800
	80-89	80-89			-12.600	-149.000	-17.800	
	80-71	80-71			-11.400	[illegible]	-18.000	[illegible]
	80-144	80-136					[illegible]	
		80-144			-12.200	[illegible]	-19.600	7.900
	80-189	80-127				[illegible]		
		80-189			-12.100	[illegible]	[illegible]	9.500
	80-112	80-112			-12.200	[illegible]	-18.500	
	80-157	80-183			-12.800	[illegible]	-19.200	11.900
	80-155	80-155			-12.400	[illegible]	[illegible]	2.800
	80-104	80-104			-12.300		[illegible]	9.300
		80-125				[illegible]		
		80-148			-12.300		-20.400	
	80-120	80-115				[illegible]		
		80-129			-12.500	[illegible]	-18.800	13.500
	80-170	80-156				[illegible]		

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
DC-14	80-170	80-170			-12.700	-152.000	-19.400	13.600
	80-117	80-117			-12.800	-148.000	-18.600	7.800
	80-213	80-213			-10.700	-136.000	-16.000	11.000
	81-20	81-20			-16.200	-127.000	-14.800	6.900
	81-30	81-30			-17.300	-115.000	-13.100	2.700
	81-44	81-44			-19.900	-121.000	-14.100	1.800
	81-141	81-141			-22.000			8.500
	82-8	82-8			-21.800	-115.000	-14.000	10.100
	83-156	83-156			-23.600	-113.000	-14.300	
	83-152	83-152			-22.900	-111.000	-14.200	
	83-157	83-157			-22.200	-113.000	-14.200	
	83-178	83-178			-23.400	-112.000	-13.900	
	83-183	83-183			-23.300	-113.000	-14.100	
	83-154	83-154			-21.900	-113.000	-14.200	
	83-150	83-150				-114.000	-14.000	
	83-266	83-266			-21.800	-115.000	-14.000	
	83-261	83-261				-114.000	-14.000	
DC-15	80-56	80-56			-13.300	-145.000	-17.300	
	80-54	80-54			-16.200	-145.000	-17.400	
	80-57	80-57	-63.600		4.100	-141.000	-17.100	
	80-87	80-87	-46.500		14.500	-138.000	-16.800	
	80-137	80-137	-67.100		0.300	-136.000	-17.200	
	80-176	80-176	-76.500	-264.700	-10.000	-139.000	-17.100	
	80-135	80-135	-69.800	-255.300	-8.400	-137.000	-17.500	-1.700
		80-149					-17.200	
	80-120	80-120	-88.200	-264.100	-5.200	-137.000	-17.400	
	80-131	80-108			-17.400		-17.300	28.700
		80-131			-17.000	-137.000	-16.500	33.800
	80-193	80-193			-22.100	-139.000	-17.400	
	81-41	81-41			-25.500	-122.000	-14.200	1.900
	81-2	81-2			-31.300	-124.000	-14.500	7.400
	81-33	81-33			-20.400	-122.000	-13.000	-3.500
	81-27	81-27			-31.500	-114.000	-13.500	4.000
	81-64	81-64			-28.800	-111.000	-13.300	-6.000
	81-96	81-96				-111.000	-13.400	
	81-69	81-69			-28.400	-110.000	-13.400	-8.200
	82-94	82-62				-121.000	-13.700	
		82-94			-30.700	-124.000	-13.100	-18.000
DC-16A	81-109	81-109			-11.100	-142.000	-17.900	-1.200
	82-17	82-17			-14.300	-145.000	-15.000	33.100
		82-55				-141.000	-15.300	
	82-93	82-93			-11.800	-145.000	-15.300	8.600
	82-19	82-19			9.400	-138.000	-16.400	7.900
		82-72	-44.880					
	82-188	82-188			10.700	-136.000	-15.000	
	82-124	82-124			-2.700	-137.000	-16.400	3.900

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
DC-16A	82-124	82-139	-63.900					
	82-143	82-101	-51.820					
		82-143			5.400	-124.000	[illegible]	9.300
	82-231	82-214A	-52.880					
	82-202	82-202			3.800	-124.000	[illegible]	8.500
	82-322	82-322				-110.000	-12.100	
		82-348	-46.940					
	82-332	82-332				-114.000	-12.000	
	82-430	82-430			5.100	-114.000	-11.300	11.200
		82-473	-44.790					
	83-29	83-29				-105.000	[illegible]	
		83-54	-47.780					
DC-16B	83-147	83-147			-0.800	-140.000	-13.500	
DC-19C	84-53	84-53				-123.000	-15.200	-6.100
	84-40	84-40			-4.100	-128.000	-15.500	6.000
	84-75	84-75			2.700	-121.000	-14.700	6.400
	84-86	84-85			10.000	-130.000	-15.100	3.900
DC-20C	84-9	84-9			1.300	-128.000	-15.800	5.200
DC-22C	84-105	84-105			7.300	-133.000	-18.500	9.800
		84-153				-130.000	-16.500	
DC-23GR	86-133	86-133				[illegible]	-13.900	
	86-141	86-141				-134.000	-17.600	
ENYEART	84-166	84-166			-12.300	[illegible]	[illegible]	
	85-1	85-1			-12.300	[illegible]	-17.700	
	85-180	85-180			-12.200	[illegible]	[illegible]	
		85-181			-12.400	[illegible]	[illegible]	
FORD	SITE-219	SITE-219			-6.310	[illegible]	[illegible]	-0.470
	85-188	85-189			-12.500	[illegible]	-17.400	21.600
		85-189			-12.600	[illegible]	-17.400	18.500
[illegible]	SITE-220	SITE-220			-14.510	[illegible]	[illegible]	-0.470
	82-7	82-7			-11.200	-148.000	-17.000	
	85-175	85-175			-11.100	[illegible]	-19.200	
		85-176			-11.200	-143.000	-19.000	8.800
	86-34	86-34			-11.400			
		86-35			-12.000			
	80-64	80-64	-51.800		-11.200	[illegible]	-17.300	
	81-79	81-79			-11.300	[illegible]	-19.400	-0.300
	81-54	81-54			-11.500	-142.000	-18.300	
	82-64	82-64			-11.100	[illegible]	-19.000	
	82-263	82-263			-11.100	-144.000	-27.900	

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
MCGEE	82-397	82-388	-40.850					
		82-397			-11.400	-144.000	-17.900	
	82-424	82-424			-11.600	-146.000	-18.000	
	82-436	82-436			-11.500	-148.000	-18.000	
	83-32	83-32			-11.200	-145.000	-18.400	
	83-83	83-83			-11.500	-146.000	-18.300	
	83-188	83-188			-11.000	-145.000	-18.800	
	83-373	83-373			-4.900	-144.000	-17.700	
	83-331	83-331			-4.100	-143.000	-17.400	
	83-460	83-460			-4.200	-142.000	-17.300	
	83-476	83-476			-4.500	-142.000	-17.600	
	83-513	83-513				-144.000	-17.500	
	84-24	84-24			-10.700	-145.000	-17.400	
DURIAN	85-194	85-194			-13.700	-133.000	-17.300	9.000
		85-105			-13.500	-135.000	-16.900	8.200
RRL-02	82-68	82-68				-134.000	-17.000	
	82-65	82-65			8.500	-136.000	-16.000	
	82-170	82-170			-0.300	-120.000	-13.200	2.500
	82-122	82-122			15.400	-114.000	-11.500	1.800
	82-401	82-401			15.300	-116.000	-11.600	7.800
	84-7	84-7			19.700	-112.000	-10.800	11.200
	82-364	82-336	-37.760					
		82-364			16.900	-110.000	-11.200	2.100
	82-309	82-351	-38.350					
	82-456	82-456	-38.280		16.400	-114.000	-11.100	5.800
RRL-14	82-403	82-403	-44.060					
		82-489	-43.910					
	83-49	83-96	-47.890					
STEM-1	85-252	85-252			-14.000	-130.000	-17.100	
	85-297	85-297						
STEM-2	86-19	86-19			-13.400	-148.000	-17.200	
		86-20			-13.400			
299-E16-01	SITE-161	SITE-161				-142.000	-15.600	
	SITE-162	SITE-162				-142.000	-16.800	
	SITE-163	SITE-163				-143.000	-16.900	
	SITE-164	SITE-164				-140.000	-16.200	7.400
299-E26-08	SITE-166	SITE-166				-141.000	-17.300	
	SITE-167	SITE-167				-142.000	-17.300	
	SITE-168	SITE-168				-142.000	-17.300	0.500
299-E33-12	SITE-170	SITE-170				-147.000	-15.400	

ANALYSIS METHOD- MASS SPECTROMETRY.

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SAMPLE TYPE: CONFINED
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
299-E33-12	SITE-171	SITE-171				-151.000	-18.300	
	SITE-172	SITE-172				-152.000	-18.300	6.200
699-S11-E12A	80-61	80-14				-1[illegible]5.000		
		80-61			-13.700	-145.000	-17.100	
		80-7					-16.900	
699-42-40C	SITE-176	SITE-176				-150.000	-18.500	2.700
	SITE-177	SITE-177				-155.000	-18.700	
	SITE-178	SITE-178				-158.000	-18.600	
	SITE-179	SITE-179				-155.000	-18.400	3.300
699-47-50	SITE-205	SITE-205				-139.000	-17.000	
	SITE-181	SITE-181				-142.000	-18.800	-1.400
699-49-55B	SITE-183	SITE-183				-148.000	-17.900	
	SITE-184	SITE-184				-148.000	-17.800	
	SITE-185	SITE-185				-145.000	-17.600	2.800
699-50-45	SITE-203	SITE-203				-136.000	-17.000	
	SITE-186	SITE-186				-146.000	-17.000	0.800
699-50-48	SITE-204	SITE-204				-140.000	-17.900	
	SITE-187	SITE-187				-1[illegible].000	-18.800	-1.200
699-51-46	SITE-188	SITE-188				-144.000	-18.500	1.500
	SITE-201	SITE-201				-1[illegible]9.000	-18.600	
699-52-46A	SITE-202	SITE-202				-137.000	[illegible]	
	SITE-189	SITE-189				-148.000	-16.900	0.500
699-52-48	SITE-199	SITE-199				-145.000	-18.000	
	SITE-190	SITE-190				-149.000	-17.800	[illegible]
699-53-50	SITE-191	SITE-191				-147.000	-17.300	-0.300
	SITE-200	SITE-200				-141.000	-18.400	
699-54-57	SITE-192	SITE-192				-149.000	-17.800	
699-56-51	SITE-196	SITE-196				-143.000	-17.600	
	SITE-197	SITE-197				-148.000	-17.200	3.600

ANALYSIS METHOD= MASS SPECTROMETRY.

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SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
STATION-03	82-89	82-89				-141.000	-18.400	
	82-51	82-51				-90.000	-9.700	
	82-81	82-81				-85.000	-9.300	
	82-78	82-78				-102.000	-13.000	
	82-179	82-179				-110.000	-10.500	
	82-138	82-138				-99.000	-9.900	
	83-90	83-90				-90.000	-10.100	
	83-46	83-46				-226.000	-29.000	
	83-118	83-118				-145.000	-19.000	
	83-189	83-189				-139.000	-17.900	
	83-114	83-114				-107.000	-13.100	
	83-143	83-143				-119.000	-14.800	
	83-277	83-277				-85.000	-9.800	
STATION-04	82-15	82-15				-139.000	-17.900	
	82-61	82-61				-102.000	-11.500	
	82-60	82-60				-94.000	-11.200	
	82-90	82-90				-102.000	-13.400	
	82-120	82-120				-101.000	-11.800	
	82-117	82-117				-111.000	-12.100	
	83-36	83-36				-101.000	-12.100	
	83-84	83-84				-234.000	-30.300	
	83-141	83-141				-152.000	-19.300	
	83-116	83-118				-121.000	-15.700	
	83-110	83-110				-107.000	-14.200	
	83-155	83-155				-137.000	-18.800	
	83-102	83-102				-121.000	-15.000	
	83-165	83-165				-109.000	-13.600	
	83-180	83-180				-110.000	-13.600	
	83-250	83-250				-100.000	-12.200	
STATION-07	82-45	82-46				-138.000	-18.100	
	82-92	82-92				-90.000	-10.400	
	82-57	82-57				-91.000	-9.700	
	82-44	82-44				-92.000	-12.500	
	82-136	82-136				-105.000	-11.000	
	82-185	82-185				-104.000	-10.600	
	83-43	83-43				-95.000	-10.400	
	83-23	83-23				-228.000	-29.600	
	83-187	83-187				-151.000	-19.600	
	83-148	83-148				-107.000	-14.000	
	83-169	83-169				-131.000	-16.900	
	83-181	83-181				-107.000	-12.100	
	83-124	83-124				-109.000	-14.000	
	83-208	83-208				-85.000	-11.400	
STATION-14	82-38	82-38				-135.000	-18.400	
	82-20	82-20				-92.000	-10.300	

ANALYSIS METHOD- MASS SPECTROMETRY.

SAMPLE TYPE: PRECIPI...
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	018 PPT	S34 PPT
STATION-14	82-63	82-63				-100.000	-11.000	
	82-86	82-86				-85.000	-10.900	
	82-178	82-178				-107.000	-11.500	
	82-147	82-147				-90.000	-10.000	
	83-71	83-71				-65.000	-6.500	
	83-55	83-55				-237.000	-28.700	
	83-132	83-132				-102.000	-13.200	
	83-184	83-184				-107.000	-13.900	
	83-160	83-160				-128.000	-17.300	
	83-174	83-174				-119.000	-15.600	
	83-128	83-128				-100.000	-12.200	
	83-149	83-149				-107.000	-12.800	
	83-295	83-295				[illegible]	-11.800	
	86-106	86-106				-138.000	-20.000	
STATION-17	82-99	82-99				-134.000	-17.800	
	82-53	82-53				-127.000	-16.600	
	82-95	82-95				-112.000	-14.100	
	82-70	82-70				-98.000	-10.100	
	82-80	82-80				-102.000	-13.400	
	82-100	82-100				-93.000	-12.600	
	82-118	82-118				-118.000	-14.700	
	82-134	82-134				-109.000	-13.200	
	83-11	83-11				-99.000	-11.700	
	83-86	83-86				-243.000	-31.300	
	83-159	83-159				-151.000	-19.800	
	83-120	83-120				-129.000	-15.[illegible]	
	83-199	83-199				-139.000	-14.[illegible]	
	83-182	83-182				-124.000	-19.000	
	83-128	83-128				-115.000	-15.400	
	83-162	83-162				-111.000	-14.400	
	83-255	83-255				[illegible]	-15.300	
	86-107	86-107				-142.000	-20.400	
STATION-20	82-50	82-50				-123.000	-17.800	
	82-16	82-16				-141.000	-18.700	
	82-26	82-26				-121.000	-15.000	
	82-58	82-58				-75.000	-10.300	
	82-74	82-74				[illegible]	-12.000	
	82-54	82-54				-145.000	-18.100	
	82-1	82-1				-100.000	-13.400	
	82-96	82-96				[illegible]	-14.900	
	82-196	82-196				-113.000	-13.400	
	82-197	82-197				-103.000	-12.000	
	83-37	83-37				-95.000	-11.200	
	83-34	83-34				-261.000	-30.000	
	83-170	83-170				-124.000	-16.900	
	83-130	83-130				-125.000	-17.000	

ANALYSIS METHOD= MASS SPECTROMETRY.

SAMPLE TYPE: PRECIPITATION
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
STATION-20	83-119	83-119				-158.000	-20.600	
	83-158	83-158				-139.000	-18.300	
STATION-25	82-9	82-9				-140.000	-18.500	
	82-76	82-76				-144.000	-18.700	
	82-24	82-24				-120.000	-15.400	
	82-83	82-83				-74.000	-7.600	
	82-66	82-66				-119.000	-13.100	
	82-79	82-79				-121.000	-13.900	
	82-25	82-25				-87.000	-10.700	
	82-67	82-67				-85.000	-11.000	
	82-153	82-153				-110.000	-12.000	
	82-152	82-152				-105.000	-11.500	
	83-89	83-89				-90.000	-10.700	
	83-53	83-53				-234.000	-29.700	
	83-134	83-134				-134.000	-16.900	
	83-139	83-139				-104.000	-13.400	
	83-142	83-142				-107.000	-14.700	
	83-190	83-190				-113.000	-14.400	
	83-198	83-198				-114.000	-13.800	
	83-135	83-135				-115.000	-14.200	
	83-217	83-217				-110.000	-12.900	
STATION-26	82-29	82-29				-140.000	-18.100	
	82-32	82-32				-135.000	-16.800	
	82-48	82-48				-134.000	-18.200	
	82-91	82-91				-83.000	-9.300	
	82-98	82-98				-99.000	-10.800	
	82-30	82-30				-140.000	-17.700	
	82-71	82-71				-101.000	-12.000	
	82-39	82-39				-92.000	-11.600	
	82-116	82-116				-96.000	-12.700	
	82-108	82-108				-104.000	-11.700	
	83-3	83-3				-94.000	-10.900	
	83-70	83-70				-237.000	-30.600	
	83-163	83-163				-142.000	-17.800	
	83-177	83-177				-112.000	-14.900	
	83-171	83-171				-123.000	-16.200	
	83-167	83-167				-149.000	-20.100	
	83-131	83-131				-114.000	-15.100	
	83-101	83-101				-105.000	-13.500	
	83-104	83-104				-115.000	-15.100	
	83-284	83-284				-102.000	-12.600	
	86-108	86-108				-139.000	-20.100	

ANALYSIS METHOD- MASS SPECTROMETRY.

SAMPLE TYPE: SPRING
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
SP-BENNETT	SITE-218	SITE-218			-5.700	-121.100	-15.750	-0.470
	79-13	79-13			-14.200	-128.000	-15.000	6.200
		79-7				-121.000		
	85-362	85-362			-11.500	-124.000	-16.000	2.800
SP-BENSON	SITE-217	SITE-217				-129.200	-16.400	-1.490
SP-BUTLER	79-1	79-1			-14.600	-132.000	-15.000	-0.100
		79-50				-137.000	-15.500	
SP-JUNIPER	SITE-215	SITE-215				-132.700	-16.750	8.670
	79-2	79-12				-133.000		
		79-2			-15.900	-133.000	-16.200	12.900
	81-115	81-115			-14.900	-135.000	-16.900	0.900
	83-372	83-372			-16.000	-135.000	-16.600	9.500
SP-LO-SNIVELY	79-34	79-34			-13.700	-134.000	-15.400	-3.000
		79-41					-16.300	
	82-362	82-362			-12.100	-128.000	-16.100	
	83-306	83-306			-13.500	-127.000	-15.600	-5.000
SP-LOZIER	79-6	79-26					-15.100	
		79-44				-127.000	-15.100	
		79-6			-11.900	-132.000	-15.300	4.300
	81-186	81-186			-12.300	-129.000	-15.700	3.500
	83-316	83-316			-14.600	-127.000	-15.400	4.100
SP-MAIDEN	79-100	79-100					-13.600	
		79-67				-122.000	-15.400	
		79-96			-13.600		-16.500	
	83-420	83-420				-125.000	-15.700	
SP-OBSERVATORY	81-119	81-119			-11.600	-119.000	-14.400	-3.300
	83-433	83-433			-13.700	-115.000	-13.700	
	84-392	84-392			-12.000	-113.000	-14.300	3.000
	85-359	85-359			-11.900	-117.000	-14.700	4.100
SP-RAILROAD	79-76	79-60				[illegible]		
		79-76			-13.000	-124.000	-14.900	
SP-RATTLESNAKE	SITE-216	SITE-216				-126.500	-13.400	-1.640
	79-88	79-87				-127.000		
		79-88			-13.200		-15.200	4.300
SP-SNIVELY	79-49	79-23				-135.000	-13.800	
		79-37						-1.200
		79-49			-14.100			

ANALYSIS METHOD= MASS SPECTROMETRY.

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SAMPLE TYPE: SPRING
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
SP-SULFUR	79-29	79-29			-13.700	-134.000	-15.300	4.000
	83-409	83-409				-127.000	-15.700	
SP-UNNAMED-02	79-75	79-75			-10.900	-126.000	-13.600	3.400
SP-UNNAMED-16	79-73	79-73				-127.000	-15.300	
		79-82			-14.500			
		79-84					-16.300	
SP-UNNAMED-26	79-98	79-54			-15.700			12.100
		79-98					-14.900	
SP-UNNAMED-29	79-16	79-16			-12.600	-136.000	-16.800	0.500
		79-48					-16.200	
SP-UP-SNIVELY	79-71	79-71			-10.900	-135 000	-16.100	2.900
	81-126	81-126			-10.500	-129.000	-17.000	-0.800
	83-503	83-503			-12.000	-135 000	-17.100	
SP-UR2-07	85-343	85-343				-116.000	-15.300	
SP-UR6-20	85-346	85-346				-118.000	-15.600	
SP-UR7-22	85-349	85-349				-108.000	-14 100	
SP-WARM	84-358	84-358				-127.000	-15.700	
SP-YR3-04	85-333	85-333				-117.000	-14.900	
SP-YR5-08	85-336	85-336				-124.000	-16.000	
SP-YR7-14	85-339	85-339				-128.000	-16.000	

ANALYSIS METHOD- MASS SPECTROMETRY.

SAMPLE TYPE: SURFACE
ANALYSIS GROUP: STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
COLD CREEK	84-302	84-302			-11.200	-110.000	-15.000	
	85-223	85-223			-10.000	-119.000	-15.500	
CR-DC-14	83-258	83-258			-6.700	-130.000	-17.700	
CR-HIS	SITE-221	SITE-221				-128.100	-15.600	2.730
CR-V-BR	84-311	84-311			-7.500	-128.000	-15.400	6.800
	85-206	85-206			-5.800	-138.000	-17.700	0.000
	85-266	85-266			-6.200	-125.000	-15.800	5.800
	86-70	86-70				-148.000	-17.200	
	86-109	86-109				-135.000	-17.000	
YR-HR	85-210	85-210			-8.500	-105.000	-14.500	
	85-269	85-269			-11.500	-103.000	-13.700	3.200
	86-67	86-67				-105.000	-14.100	
	86-118	86-118				-105.000	-14.600	

ANALYSIS METHOD: MASS SPECTROMETRY

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SAMPLE TYPE: UNCONFINED
ANALYSIS GROUP. STABLE

SAMPLING LOCATION	SAMPLING EVENT CODE	SAMPLE NUMBER	C13(CH4) PPT	D(CH4) PPT	C13 PPT	D PPT	O18 PPT	S34 PPT
RRL-06A	82-40	82-40				-127.000	-16.600	
299-E26-08	SITE-165	SITE-165				-139.000	-16.800	2.200
299-E33-12	SITE-169	SITE-169				-139.000	-17.100	3.400
699-S03-25	86-55	86-55			-15.300	-135 000	-16.800	-0.700
	86-130	86-130				-131 000	-16.700	
699-S24-19	85-213	85-213			-14.900	-109.000	-14.000	
	85-291	85-291			-14.800	-106.000	-14.400	5.800
699-11-45A	85-263	85-263			-10.200	-129.000	-16.300	3.600
	86-43	86-43			-10.500	-132 000	-16.400	4.400
	86-124	86-124				-126.000	-16.100	
699-19-58	85-229	85-229			-12.300	-127.000	-16.500	
	85-260	85-260			-12.400	-131.000	-16 500	5.200
	86-40	86-40			-12.500	-132.000	-16 600	6.500
	86-121	86-121				-120 000	-16.700	
699-19-88	85-278	85-278			-12.900	-127.000	-16.100	1.600
	86-64	86-64			-14.500	-132.000	-16 900	7.500
	86-127	86-127				-128.000	-16.700	
699-24-95	85-288	85-288			-16.300	-128.000	-15 400	7.400
	86-61	86-61			-14.700	137 000	-17.000	5.900
	86-115	86-115				-131 000	-16.600	
699-42-40A	SITE-174	SITE-174				-142.000	-15 700	3.000
699-49-55A	SITE-182	SITE-182				-144.000	-17.000	-1.500
699-55-50C	SITE-193	SITE-193				-133.000	-13.500	7.900
699-60-57	SITE-198	SITE-198				-143.000	-17.200	
699-66-103	85-203	85-203			-10.500	-136.000	-17.600	1.000
	86-73	86-73			-11.000	-136 000	-17 700	7.500
	86-112	86-112				-138.000	-17.900	
	85-294	85-294			-10.500	-133.000	-17.200	5.400

ANALYSIS METHOD- MASS SPECTROMETRY.

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APPENDIX B

LOCATION: DB-01

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
PRIEST RAPIDS					PACKER TOP= 1080.00			PACKER BOTTOM= 1139.00					
81-65	81-65	101.000	16.000	0.490	0.150	35.500	47.500	7.210	16.300		132.000	134.000	1.050
	81-70	100.000	15.800	0.500	0.150	35.500	47.400	7.200	16.200		132.000	134.000	0.636
82-27	82-27	99.700	15.300	0.430	0.100	35.400	46.600	7.080	16.300			136.000	0.118
	82-87	100.000	15.300	0.490	0.100	35.300	47.500	7.140	16.500			136.000	-0.079
85-32	85-32	101.000	15.800	0.420	0.084	33.600	48.000	7.200	17.000		138.000	137.000	-0.017
	85-33	100.000	15.700	0.430	0.095	33.600	48.000	7.200	17.000		138.000	137.000	-0.482

LOCATION: DB-07

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
MABTON						PACKER TOP= 597.00			PACKER BOTTOM= 812.00				
79-89	CP121 79-89	118.400	14.200	1.600	0.090	41.500	55.600	7.300	2.100				
83-413	83-413	117.000	12.600	1.460	0.100	38.370	56.500	7.680	0.900		170.000	170.000	0.695
	83-448	114.000	12.300	1.430	0.100	37.400	57 100	7.950	0.390		170.000	170.000	-0.877
85-216	85-216	113 100	12.300	1.390	0.100	36.800	52.700	8.300	0.860		163.000	164.000	0.859
	85-217	112.900	12.300	1.360	0.100	36.600	53.000	8.400	0.860		163.000	164.000	0.631

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
MABTON					PACKER TOP= 461.00			PACKER BOTTOM= 589.00					
79-28	CP115 79-28	75.100	12 200	0 560	0.130	31.400	0.800	0 100	1 200				
83-472	83-410	70.900	10 520	0 450	0 100	27 400	10 200	0 840	14 500		138 000	139 000	-0 442
	83-472	71 000	10 500	0 450	0 100	27 400	10 100	0.840	14 400		138 000	139 000	-0 313

LOCATION: DB-11

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
MABTON					PACKER TOP= 709.00				PACKER BOTTOM= 1020.00				
85-15	85-15										141.000	140.000	
85-4	85-4										140.000	143.000	
PRIEST RAPIDS					PACKER TOP= 1020.00				PACKER BOTTOM= 1210.00				
85-18	85-18	31.400	9.720	14.700	7.020	28.900	4.900	0.800			140.000	141.000	
	85-19	31.100	9.610	14.600	6.960	28.700	5.000	0.700			140.000	141.000	
86-52	86-52	32.300	9.450	14.900	7.180	30.400	4.180	0.770			141.000	140.000	
	86-53	32.700	9.640	15.000	7.240	30.400	4.160	0.770			141.000	140.000	

LOCATION DB-15

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
FRENCHMAN SPRINGS					PACKER TOP= 1300.00			PACKER BOTTOM= 1343.00					
79-62	79-62	155.000	14.500	2.200	0.240	41.000	97.800	16.900	20.100	2.900		146.800	1.350
	79-84	160.000	17.000	2.400	0.300	40.300	98.000	17.000	20.100	0.500		146.800	3.551
79-90	79-86											161.200	
	79-90	168.000	14.700	1.110	0.230	39.500	94.600	16.800	19.800	0.500		161.200	3.750
	79-95	164.000	16.600	2.700	0.400	43.500	96.800	17.000	19.800	0.500		161.200	3.042

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LOCATION: DC-06

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
ROCKY COULEE FT TO TD BELOW UMTANUM					PACKER TOP= 2260 00			PACKER BOTTOM= 4333.00					
SITE-214	SITE-214	233.000	3 200	1.300	470.000	53 700	125.000	41 000	96 000			163.100	63.449
80-238	80-201	217.000	3.260	1.170	0.010	61.800	129.000	39.900	95.200			166.600	-7.131
	80-238	214.000	3.560	1.270	0.020	64.700						166.600	
UMTANUM FB AND BELOW					PACKER TOP= 3242.00			PACKER BOTTOM= 3529.00					
80-15	80-15	361.000	4.060	2.140	0.025	34 500	211.000	35 400	189 000	1.300		83.200	3 451
	80-70	368 000	4 200	2.240	0.025	35.000	34.100	24.100	184 000	6.200		83.200	34.936
81-82	81-76	359 000	3 350	2.640	0.001	38 500	289 000	35.600	177 000		83.000	84.000	1.416
	81-82	360.000	3.380	2.700	0.010	38.500	289.000	35.600	177.000		83.000	84.000	1 567

LOCATION: DC-07

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
GRANDE RONDE					PACKER TOP= 4830.00			PACKER BOTTOM= 5008.00					
80-188	80-178	416 000	5 800	4 540	0.018	57 400	418 000	22 000	173 000			108.000	-0 644
	80 188	433 000	5 500	4.600	0.020	57.700	420.000	22 200	175 000			108 000	1 018
80 196	80 177	438 000	6 080	11 000	0.910	75.200	386.000	22 100	172 000			197.600	0 626
	80-196	420.000	6 250	17.700	1.200	77 500	332.000	20.800	153.000			197.600	4.900
ROCKY COULEE FB AND COHASSETT					PACKER TOP= 2952.00			PACKER BOTTOM= 3082.00					
80-11	80-11	199.000	5 000	2.400	0 060	43.200	97.500	24 300	78 700			141.200	2 334
	80-19	198.000	5.100	2.400	0.060	43.600	96.800	24 400	77 500			141.200	2.398
80-39	80-39	133.000	5.200	2.900	0.220	35.300	40.900	10.000	23 400			177.400	3 102
	80-98	134.000	5 000	2.800	0.210	35.200	39.600	10.800	28 000			177.400	2 851
ROCKY COULEE THRU UMTANUM					PACKER TOP= 2780.00			PACKER BOTTOM= 3948.00					
82-10	82-10	259.000	3.330	3.460	0.100	45.000	137.000	39.000	83.000		141.000	160.000	3.060
	82-10A										141.000	160.000	
	82-10B										141.000	160.000	
	82-33	258.000	3 310	3.470	0 100	45 000	136.000	39.000	83.000		141.000	160.000	3 010
82-23	82-23	235.000	3.060	3.730	0.100	45.900	126.000	37 000	74.000		158.000	180.000	-0 699
	82-56	226.000	2 810	3.820	0.100	46.600	126.000	38 300	74 500		158.000	180.000	-2.608

LOCATION: DC-12

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
ROCKY COULEE FT					PACKER TOP= 2408.00				PACKER BOTTOM= 2446.00				
80-101	80-101	143.000	15.700	2.280	0.760	51.800	107.000	13.000					
	80-169	148.000	16.100	2.060	0.710	50.800	107.000	13.100					
80-174	80-143						103.000	12.600				144.650	
	80-174	148.000	15.000	1.170	0.051	28.900	127.000	13.600	1.700			144.650	-2.430

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LOCATION. DC-14

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
GRANDE RONDE						PACKER TOP= 3260.00			PACKER BOTTOM= 3335.00				
82-315	82-315												
82-6	82-31						247.000	44.000	134.000			109.000	
	82-42	323.000	5.770	1.300	0.100	51.600	249.000	44.000	134.000			109.000	-0.137
	82-8	316.000	5.560	1.270	0.100	51.800						109.000	
83-150	83-108	334.000	5.680	1.290	0.100	54.300	253.000	49.000	140.000		108.000		-0.151
	83-150	335.000	5.770	1.410	0.103	54.700	253.000	49.000	140.000		108.000		[illegible]
83-152	83-152	336.000	5.730	1.560	0.103	53.200	254.000	49.700	141.000		110.000		[illegible]
	83-193	332.000	5.810	1.540	0.100	53.100	254.000	48.800	141.000		110.000		[illegible]
83-154	83-154	336.000	5.730	1.320	0.103	54.900	254.000	50.100	141.000		110.000	120.000	-1.005
	83-191	335.000	5.760	1.300	0.100	54.800	254.000	50.300	140.000		110.000	120.000	-1.207
83-156	83-156	337.000	5.810	1.290	0.103	53.700	253.000	48.400	141.000		103.000	110.000	0.203
	83-197	336.000	5.780	1.270	0.100	53.300	253.000	48.400	147.000		103.000	110.000	-0.370
83-157	83-157	338.000	5.900	1.320	0.103	54.300	254.000	50.700	140.000		114.000	123.000	-0.932
	83-179	337.000	5.880	2.070	0.100	54.500	254.000	49.900	140.000		114.000	123.000	-0.816
83-178	83-103	327.000	5.690	1.280	0.100	53.400	254.000	48.500	140.000		114.000	109.000	-1.268
	83-178	328.000	5.710	1.280	0.103	53.400	253.000	48.300	140.000		114.000	109.000	-0.985
83-183	83-123	331.000	5.850	1.290	0.100	53.400	254.000	49.800	141.000		107.000	118.000	-1.555
	83-183	330.000	5.880	1.290	0.103	53.100	254.000	49.800	141.000		107.000	118.000	-1.700
83-261	83-203	332.000	5.870	1.330	0.100	53.700	251.000	43.900	138.000		109.000	118.000	-0.749
	83-261	333.000	5.880	1.350	0.100	53.900	251.000	48.900	139.000		109.000	118.000	-0.596
83-266	83-233	336.000	5.820	1.300	0.100	55.300	252.000	50.100	140.000		110.000	117.000	-0.547
	83-266	326.000	5.660	1.300	0.100	54.500	251.000	50.100	140.000		110.000	117.000	-1.954

LOCATION: DC-16A

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
FRENCHMAN SPRINGS					PACKER TOP= 2266.00				PACKER BOTTOM= 2371.00				
82-202	82-202	217.000	30.200	3.870	0.100	33.700	263.000	12.300	5.100			107.600	0.324
	82-228	227.000	31.500	4.080	0.100	34.200	265.000	12.400	5.950			107.600	2.289
82-231	82-214A											107.600	
	82-214B											107.600	
	82-279A											107.600	
	82-279B											107.600	

LOCATION: FORD

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
PRIEST RAPIDS					PACKER TOP= 620.00			PACKER BOTTOM= 777.00					
SITE-206	SITE-206	27.000	8.500	19.000	12.000	30.000	5.800	0.500	1.800	0.100		155.000	-0.029
SITE-207	SITE-207	26.000	7.300	18.000	11.000	26.000	4.400	0.700	0.200			148.000	-0.0[illegible]
SITE-219	SITE-219	26.000	5.600	17.600	6.300	24.700	4.870	0.620	2.000			154.100	-10.445
85-188	85-188	26.700	7.240	18.500	10.600	27.600	4.800	0.790			148.000	145.000	
	85-189	26.500	7.260	18.600	10.600	27.600	4.700	0.700			148.000	145.000	
85-303	85-303	26.200	6.910	19.400	10.400	31.300	4.640	0.650			148.000	150.000	
	85-304	27.400	7.390	19.500	10.900	31.100	4.640	0.640			148.000	150.000	

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LOCATION RRL-02

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
COMASSETT FB					PACKER TOP= 3247.00			PACKER BOTTOM= 3344.00					
82-401	82-401	337 000	13 800	2.220	0.100	44.700	403.000	20 000	4.200		159.000	165.000	-2 190
	82-414										159.000	165.000	
	82-416										159.000	165.000	
	82-470	337.000	13.900	2 190	0 100	44.500	406 000	20 000	4.200		159.000	165 000	[illegible].453
84-7	84-43	351.000	13.400	2.360	0.100	49.200	420.000	14 000	0 970		146.000	149 000	0.485
	84-47										146.000	149.000	
	84-7	353.000	13.500	2.350	0 100	49 500	416.000	14 000	0 950		146.000	149.000	1.131

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LOCATION. SP-JUNIPER

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
					PACKER TOP= NOT APPLICABLE			PACKER BOTTOM= NOT APPLICABLE					
SITE-215	SITE-215	19.600	5.200	23 600	10.300	23.300	4.670	0 500	18 000			156.600	-3 802
79-2	79-12											152 800	
	79-2	30.000	6 900	24.700	17.800	26.100	6.900	0.600	30.900	0.600		152.800	2.994
	79-43	28.800	6.600	23.500	16.900	24.900	6 900	0.600	30 500	0.600		152.800	0.727
81-115	81-115	24.190	5 850	23.950	15.240	27.130	4 630	0 530	12 000		148.000	145.000	4 918
	81-161	24.640	5.950	24.160	15.360	27.270	4.630	0 530	12 000		146.000	145.000	5 495
83-372	83-305	24.570	5.910	27.810	17.000	26.890	6.110	0.460	28 750		153.000	154.000	1.661
	83-372	24 500	5.800	25.350	16.570	26.450	6.110	0.460	28 570		153.000	154.000	-0.380

LOCATION: SP-LOZIER

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
PACKER TOP= NOT APPLICABLE	PACKER BOTTOM= NOT APPLICABLE												
79-6	79-26											98 700	
	79-44	7.700	2.000	23 400	8.300	20 900	1.900	0.500	4.200	4 800		98 700	2 203
	79-6	7 600	1 800	23.000	9.100	20.700	1.900	0.500	5 200	4 700		98.700	0 774
81-186	81-116	7.850	1.260	24 080	8.940	23.340	3.730	0 310	7 140	10 250	91.420		1 022
	81-186	7.770	1.260	24.010	8 880	23.220	3 730	0 310	7 140	11 050	91 420		0.480
83-316	83-316	7 810	1.410	24.580	8 870	22.760	5.030	0.270	10 000	8.480	89.000	93 000	-0 620
	83-343	7.720	1 480	24.580	8.860	22.450	5.030	0.270	10 140	8.680	89 000	93 000	-0.313

LOCATION. SP-OBSERVATORY

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
PACKER TOP= NOT APPLICABLE								PACKER BOTTOM= NOT APPLICABLE					
81-119	81-118	7.540	1.740	21.990	10 570	18.230	3.030	0 190	10.330	9 400	91.970		0 965
	81-157	8.100	1 990	22 080	10 710	18.290	3.030	0 190	10.330	9.400	91.970		1 802
83-433	83-433	7 400	1 820	22 690	10 930	17 540	3.280	0.160	12 520	5.590	91.000	96.000	0.587
	83-461	7.420	1 900	23.110	11.070	17.730	3.280	0 160	12.520	5.480	91.000	96.000	1.356
	83-492										91.000	96.000	
84-329	84-329	7.380	1.830	22.500	10.900	18.100	3.500	0.400	11.700	3.500			
	84-366	7 330	1.790	22.200	10.800	18.000	3.400	0 400	12.100	4.000			
84-392	84-310	7.430	1.810	22.600	11 000	17.400	3.140	0 130	13 090	6.230	94.000	96.000	1.285
	84-392	7.830	2.000	23.900	11.200	17.600	3.170	0 [illegible]	13.170	6 300	94 000	96.000	1.415
85-359	85-359	7 100	1 580	[illegible]	10 400	17.900	3.020	0 190	11.300	4.510	93.000	91.000	0 769
	85-360	7.200	1 480	21 500	10.600	17 900	3.030	0.210	11.200	4 130	93.000	91.000	1.762
86-178	86-178	7.420	1.700	22 700	10.900	17 000	3.260	0 200	[illegible]	6.610	[illegible]	93.000	[illegible]
	86-179	7.360	1.600	22 500	10.800	16.900	3 230	0.180	[illegible]	6.480	94.000	93.000	1.211

LOCATION: SP-SULFUR

PACKER TOP- NOT APPLICABLE PACKER BOTTOM- NOT APPLICABLE

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
79-29	79-29	9.900	3 600	23.800	10.100	24 100	6.300	0.300	25 700	11.600		97.000	-5 828
	79-30	9.800	3 600	23.600	10 100	24.000	6.000	0.200	25 000	11.300		97 000	-5.528
83-409	83-409	9.870	2 970	25 820	9 330	25.640	5.220	0.340	11 500	5.160	102.000	99.000	1 857
	83-442	9.780	2.890	25.500	8.200	25.390	5.200	0.330	11.500	5.170	102.000	99.000	1.235

LOCATION. SP-UR2-07

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
						PACKER TOP= NOT APPLICABLE			PACKER BOTTOM= NOT APPLICABLE				
85-343	85-343	8.890	1.700	27.100	9.670	24.200	2.490	0.410	7.390	1.490	111.000	111.000	1.741
	85-344	8.930	1.690	26.900	9.620	24.200	2.400	0.400	7.290	1.330	111.000	111.000	1.554
86-159	86-159	8.920	1.530	28.700	9.830	19.300	4.720	0.360	11.700	5.160	108.000	109.000	0.168
	86-160	8.990	1.530	28.800	9.880	19.400	4.620	0.360	11.500	5.000	108.000	109.000	0.576

LOCATION SP-UR7-22

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
PACKER TOP= NOT APPLICABLE													
PACKER BOTTOM= NOT APPLICABLE													
85-349	85-340	11.200	2 370	17 300	12.300	23 000	3 540	0 470	16.300	4 880	80.000	92.000	0.836
	85-350	11.100	2 320	17.300	12.300	23 100	3.490	0 470	16 200	5 290	90 000	92.000	0 654
86-153	86-153	14.600	1.830	19.800	12.100	20 900	7.030	0 520	23 600	8 120	92.000	93 000	-0.796
	86-154	14.500	1.940	19.900	12 200	21 300	7 100	0 520	23 700	8.200	92.000	93.000	-0 676

LOCATION. SP-YR5-08

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
PACKER TOP= NOT APPLICABLE	PACKER BOTTOM= NOT APPLICABLE												
85-336	85-336	10.900	2.580	20.200	9.180	23.100	5.550	0.380	10.120		94.000	95.000	0.348
	85-337	10.700	2.550	20.300	9.200	23.500	5.620	0.380	10.250		94.000	95.000	0.184
86-147	86-147	12.600	2.690	33.500	15.400	20.000	16.900	0.370	18.[illegible]	39.800	97.000	96.000	1.479
	86-148	12.400	2.720	33.600	15.400	19.800	16.900	0.360	18.900	39.700	97.000	96.000	1.469

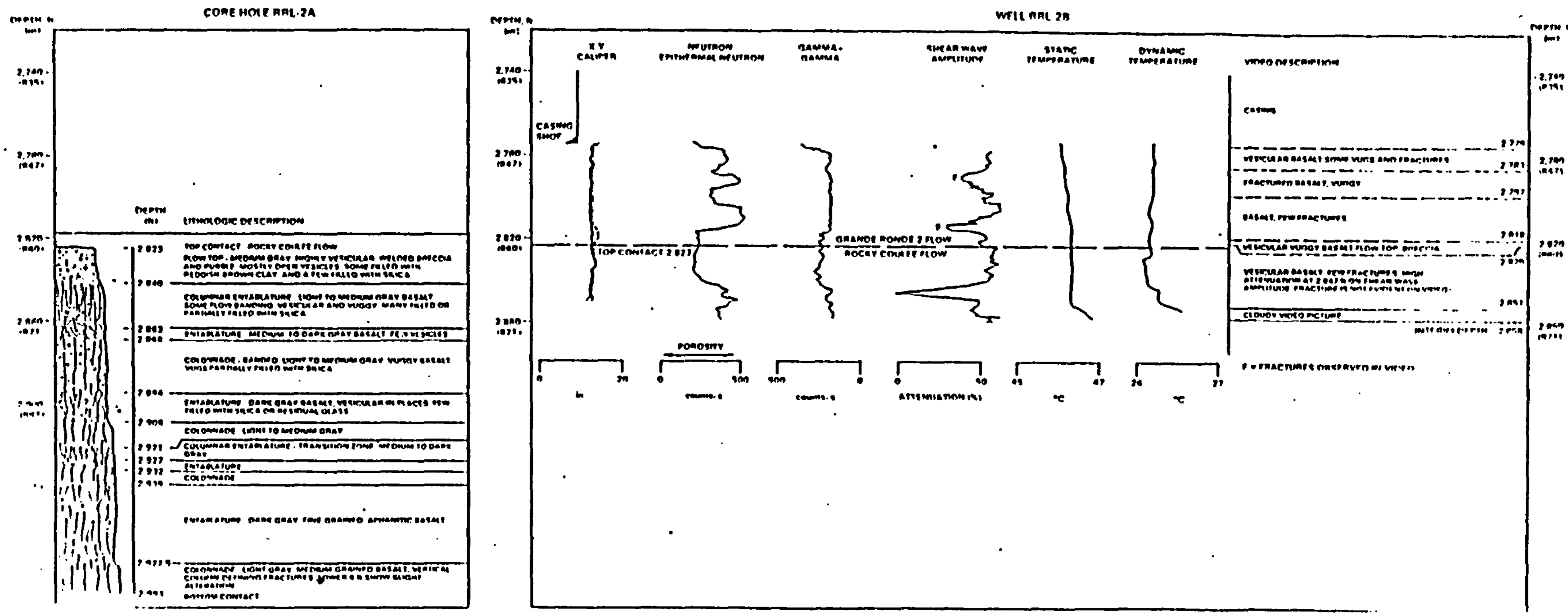


Figure 12. Composite ... ical Log Traces for the ... and Rocky Coulee Flows at ...

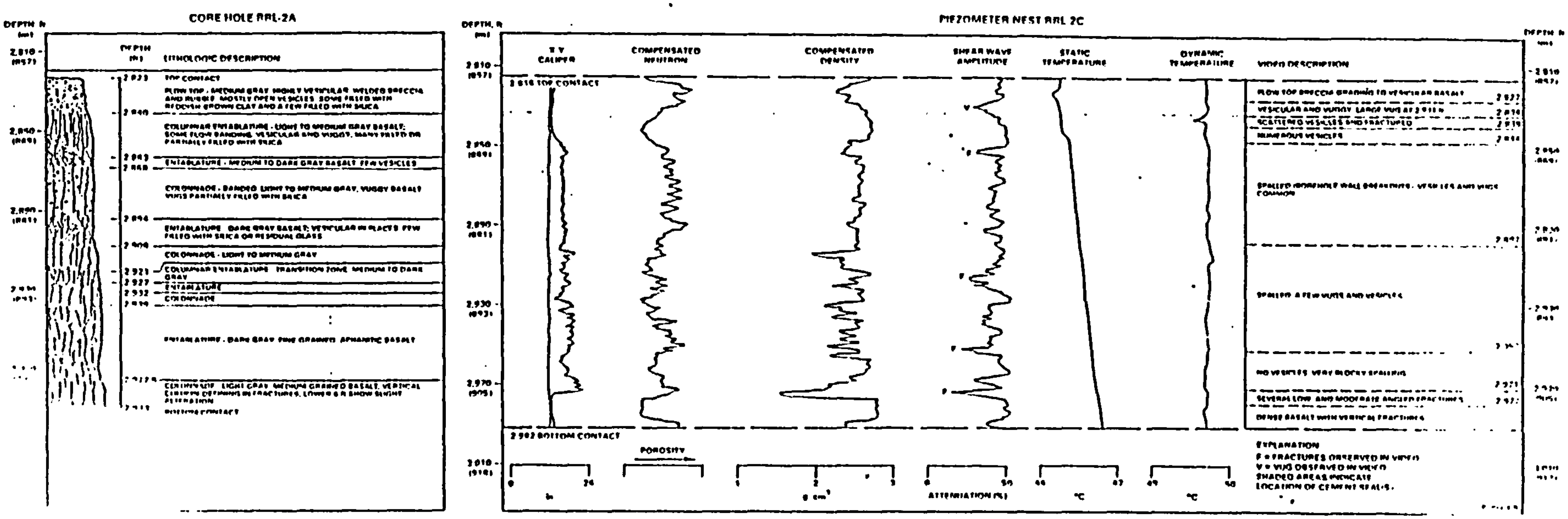


Figure 13. Composite Borehole Geophysical Log Traces for Rocky Coulee Flow at RRL-2.

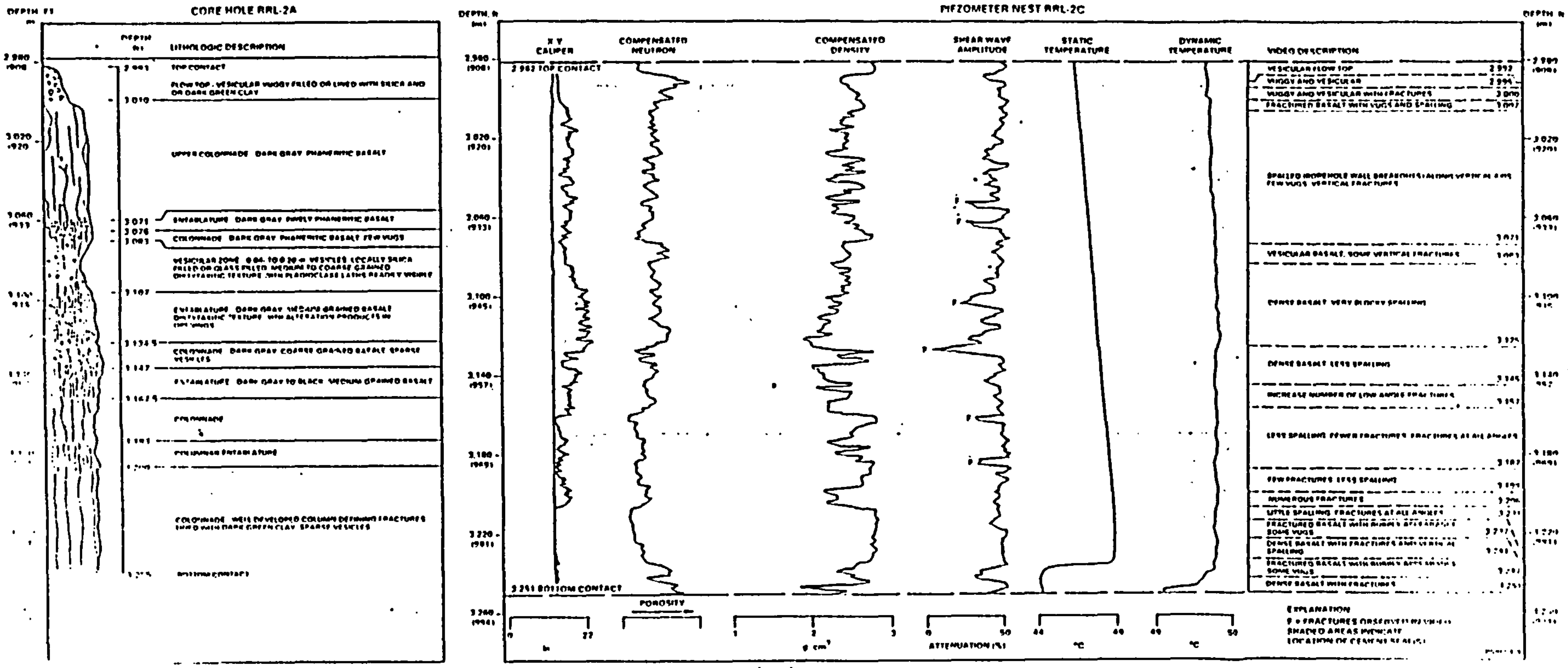


Figure 14. Composite Borehole Geophysical Log Traces for Cohassett Flow at RRL-2C.

PROJECT TITLE:

BASALT WASTE ISOLATION PROJECT AS-BUILT: WELL RRL-2B AND PIEZOMETER NEST RRL-2C

FOR:

ROCKWELL HANFORD OPERATIONS

BY:

KAISER ENGINEERS HANFORD CO.

DRAWING LIST

DWG NO	INDEX NO	DRAWING TITLE
CIVIL		
H-6-1586	0000	DRAWING LIST & VICINITY MAP
H-6-1587	0100/0500	SITE PLAN REFERENCE REPOSITORY LOCATION
H-6-1588	0500	RRL-2B & RRL-2C SCHEMATIC
H-6-1589	0500	AS-BUILT DETAILS PIEZOMETER STRING
H-6-1590	0100/0500	AS-BUILT SITE PLAN RRL-2 LOCATION
H-6-1591	0500	AS-BUILT RRL-2B AND RRL-2C WELL HEADS
	RRL-2B	
H-6-1592, SH 1	0500	AS-BUILT RRL-2B WELL
H-6-1592, SH 2	0500	AS-BUILT RRL-2B WELL
H-6-1592, SH 3	0500	AS-BUILT RRL-2B WELL
H-6-1592, SH 4	0500	AS-BUILT RRL-2B WELL
H-6-1592, SH 5	0500	AS-BUILT RRL-2B WELL
	RRL-2C	
H-6-1593, SH 1	0500	AS-BUILT RRL-2C PIEZOMETER NEST
H-6-1593, SH 2	0500	AS-BUILT RRL-2C PIEZOMETER NEST
H-6-1593, SH 3	0500	AS-BUILT RRL-2C PIEZOMETER NEST
H-6-1593, SH 4	0500	AS-BUILT RRL-2C PIEZOMETER NEST
H-6-1593, SH 5	0500	AS-BUILT RRL-2C PIEZOMETER NEST

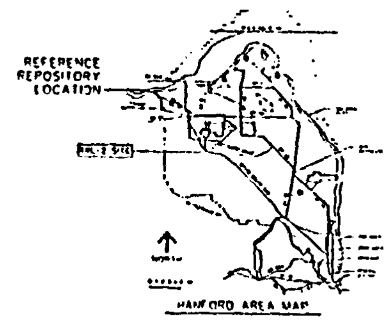
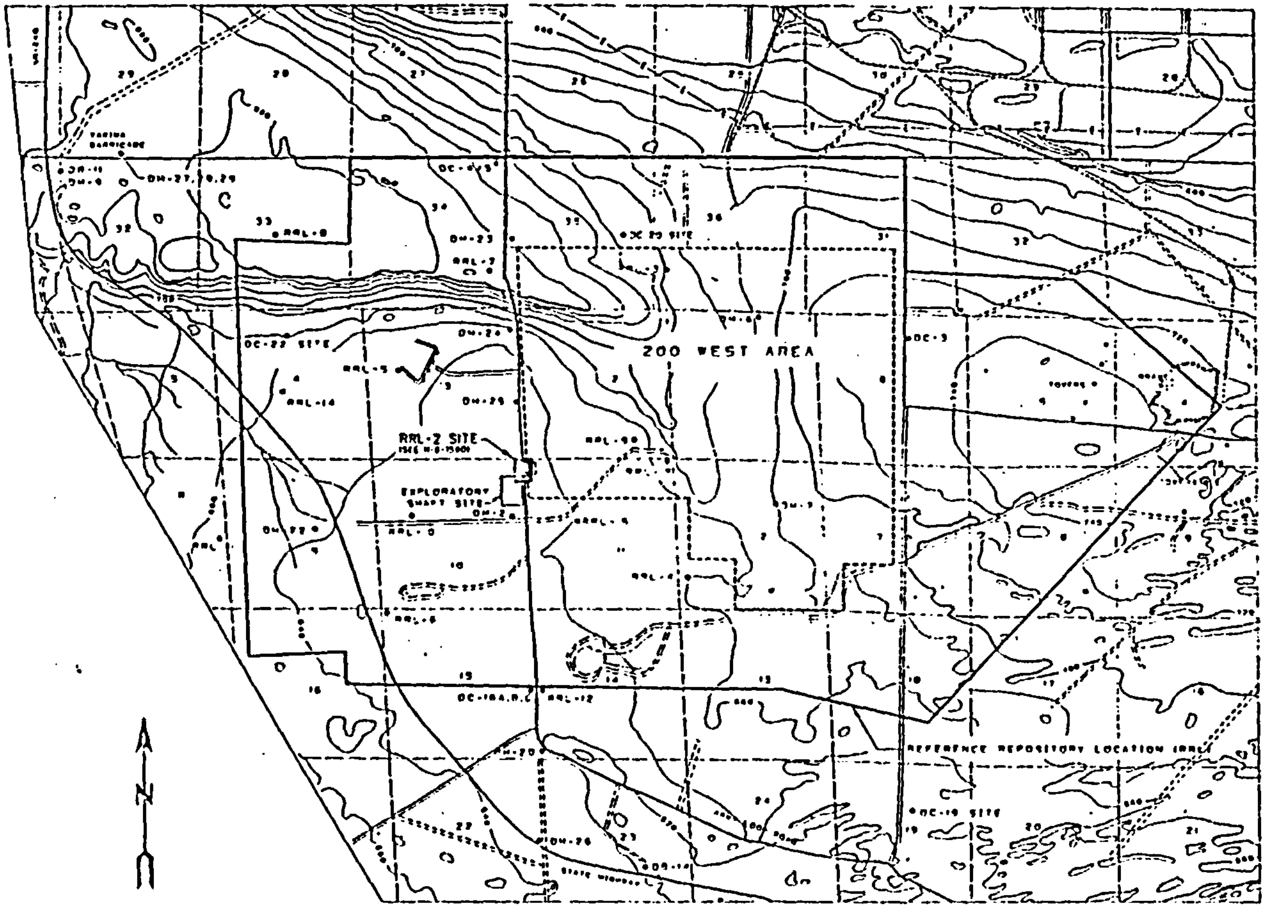


Figure A-1. Drawing List and Vicinity Map.



GENERAL NOTES

THE BASALT WASTE ISOLATION PROJECT (BWIP) HAS INSTALLED A SERIES OF DEEP (UP TO 3,700 FEET) PIEZOMETER NESTS (I.E., DC-19, DC-20, AND DC-22) IN 1983 AND 1984 TO ESTABLISH A HYDRAULIC HEAD BASELINE. THIS BASELINE IS A PREREQUISITE FOR BEGINNING OF LONG-TERM HYDRAULIC INTERFERENCE TESTS AND FOR AN UNDERSTANDING OF FLOW SYSTEM CONDITIONS. AS PART OF THIS WORK, THE RECENT COMPLETION OF WELL RRL-2B AND PIEZOMETER NEST RRL-2C REPRESENTS THE INITIAL STEP IN PREPARING FOR LARGE SCALE HYDRAULIC TESTING AT THE RRL-2 LOCATION. WELL RRL-2B WILL BE USED AS A PUMPING WELL. PIEZOMETER NEST RRL-2C, WHICH CONSISTS OF SIX PIEZOMETERS IN A SINGLE BOREHOLE, WILL ACT AS THE PRINCIPAL OBSERVATION WELL. THE EXISTING RRL-2A CORE HOLE ALSO WILL BE CONFIGURED TO SERVE AS AN OBSERVATION POINT. THE AS-BUILT DRAWINGS PROVIDED HEREIN DETAIL THE COMPLETION OF WELL RRL-2B AND PIEZOMETER NEST RRL-2C.

GEOLOGIC SETTING

THE RRL AND IMMEDIATE VICINITY ARE UNDERLAIN BY 500 TO 700 FT OF GLACIOFLUVIAL SEDIMENTS OF THE HANFORD FORMATION AND FLUVIAL SEDIMENTS OF THE RINGOLD FORMATION WHICH OVERLIE THE BASALTS OF THE COLUMBIA RIVER BASALT GROUP. BASALTS OF THE COLUMBIA RIVER BASALT GROUP ARE DIVIDED INTO THE SADDLE MOUNTAINS BASALT, APPROXIMATELY 800 FT OF BASALT FLOWS INTERBEDDED WITH SEDIMENTS OF THE ELLENSBURG FORMATION; THE WANAPUM BASALT, APPROXIMATELY 1,200 FT OF BASALT FLOWS INTERBEDDED WITH THIN DISCONTINUOUS SEDIMENTS OF THE ELLENSBURG FORMATION; AND THE GRANDE RONDE BASALT, MORE THAN 1,200 FT OF BASALT FLOWS. BASALT ATTITUDES IN THE AREA ARE CONSIDERED TO BE RELATIVELY FLAT WITH LESS THAN 5-DEGREE DIP.

Figure A-2. Site Plan Reference Repository Location.

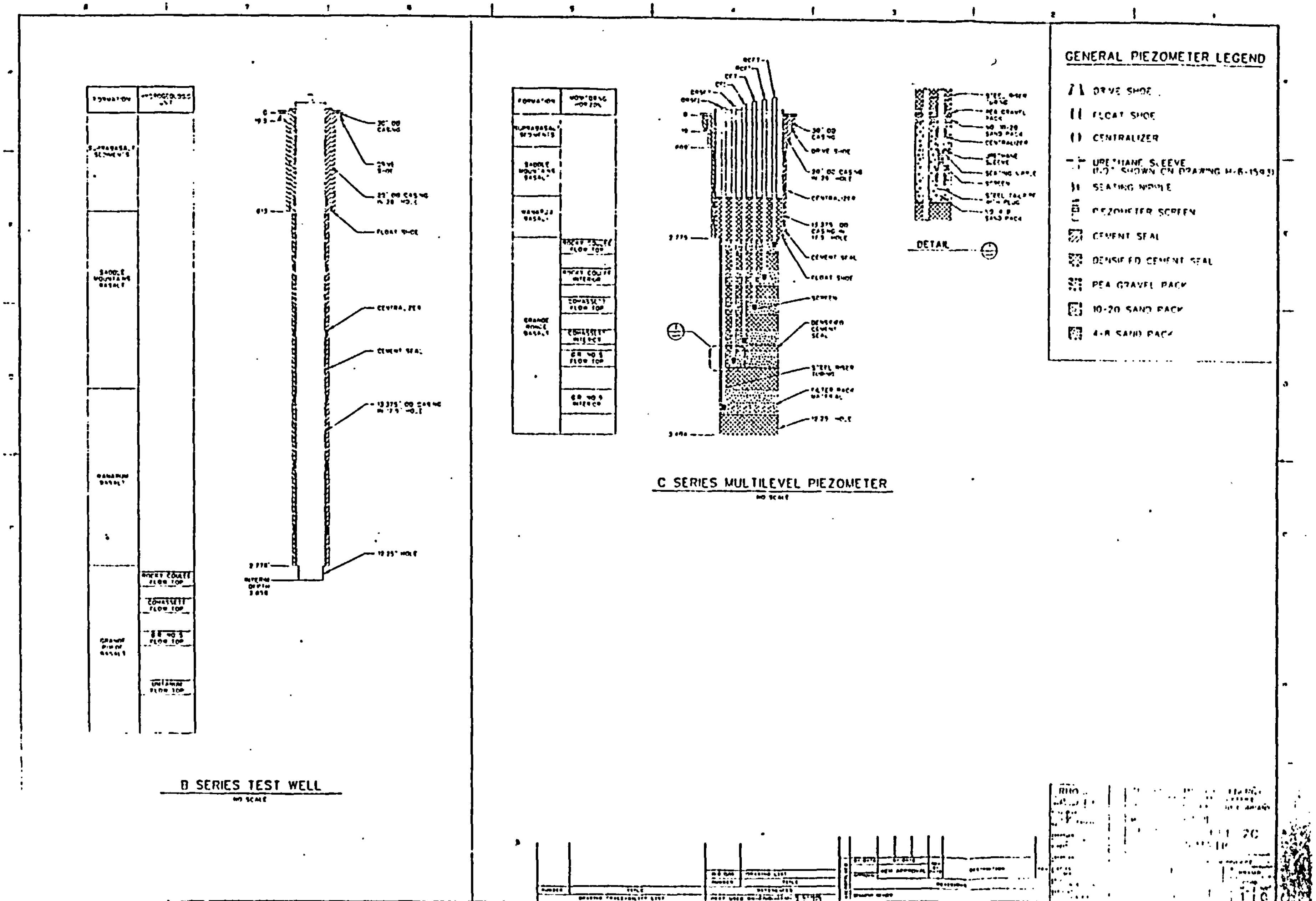
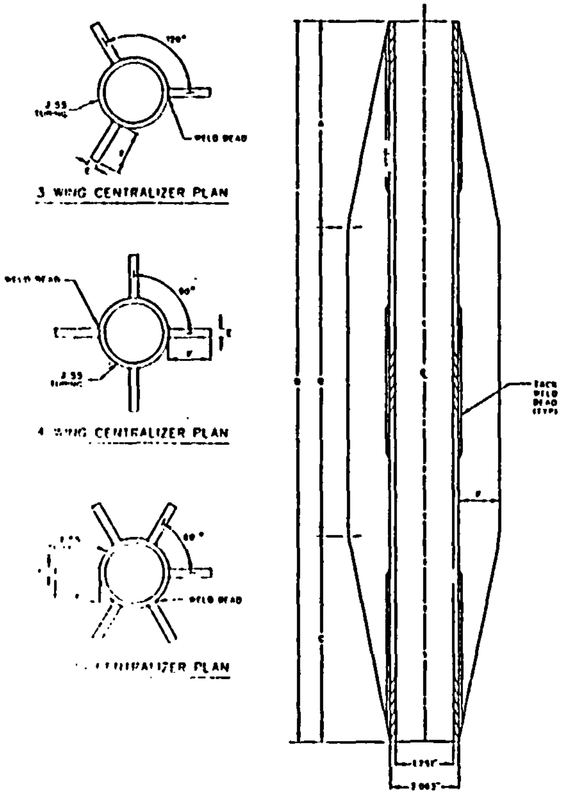


Figure A-3. Piezometer Nest RRL-2B and Well RRL-2C Schematic.

PIEZOMETER TUBE CENTRALIZER TABLE

BORE-HOLE	MONITORING HORIZON	MID-POINT DEPTH (FT)	(A) TOP, FT	(B) MIDDLE, FT	(C) BOTTOM, FT	(D) TOTAL LENGTH, (FT)	(E & F) THICKNESS BY WIDTH, (IN)	NUMBER OF WINGS
RRL-2C	ROCKY COULEE FLOW TOP	2705.8	33	98	49	202	1/4 X 3	3
		2797.0	33	95	50	200	1/4 X 3	4
		2817.0	32	97	33	202	1/4 X 3	4
		2820.7	35	93	33	200	1/4 X 3	4
RRL-2C	ROCKY COULEE FLOW INTERIOR	2853.6	32	92	33	202	1/4 X 3	3
		2874.7	33	98	47	200	1/4 X 3	4
		2904.3	33	100	48	199	1/4 X 3	4
		2912.0	33	48	32	133	1/4 X 3	4
RRL-2C	COHASSETT FLOW TOP	3132.0	32	96	33	201	1/4 X 3	3
		2930.2	34	95	32	201	1/4 X 3	4
		2979.1	36	92	32	202	1/4 X 3	4
		2990.0	36	49	56	149	1/4 X 3	4
RRL-2C	COHASSETT FLOW INTERIOR	3117.7	33	103	30	203	1/4 X 4	3
		3163.0	33	97	37	201	1/4 X 4	4
		3155.0	50	99	31	200	1/4 X 4	4
		3183.3	32	50	30	137	1/4 X 4	4
RRL-2C	GRANDE RONDE NO 5 FLOW TOP	3199.4	36	88	30	204	1/4 X 4	3
		3214.7	32	85	34	201	1/4 X 4	4
		3230.7	34	96	33	203	1/4 X 4	4
		3265.7	34	96	31	201	1/4 X 4	4
RRL-2C	GRANDE RONDE NO 5 FLOW INTERIOR	3274.4	33	95	35	193	1/4 X 4	3
		3299.6	45	105	60	210	1/4 X 4	3
		3317.1	50	100	49	199	1/4 X 4	4
		3327.1	51	100	52	206	1/4 X 4	4
		3336.9	52	45	53	150	1/4 X 4	[illegible]

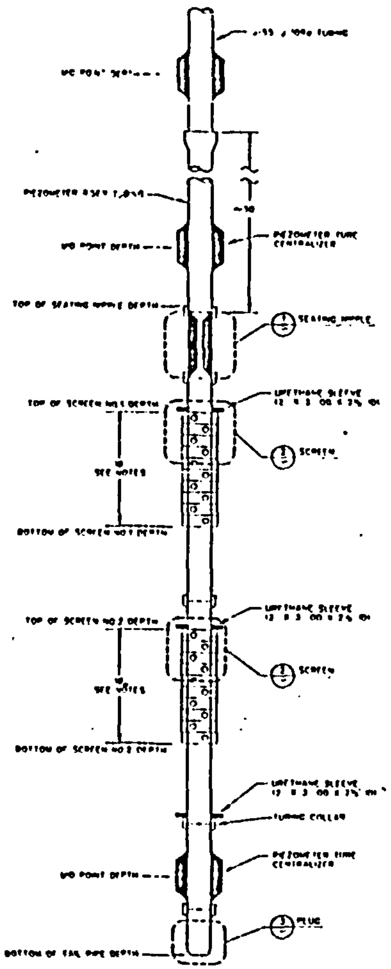


3 WING CENTRALIZER PLAN

4 WING CENTRALIZER PLAN

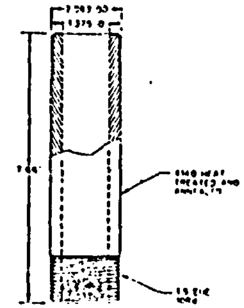
[illegible] CENTRALIZER PLAN

[illegible] TUBE CENTRALIZER



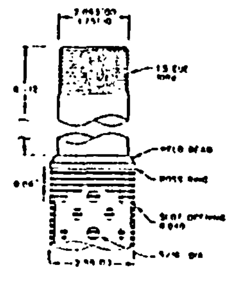
TYPICAL PIEZOMETER STRING

SCALE: NONE



SEATING NIPPLE (1)

SCALE: NONE



840 SLOT

SCREEN (2)

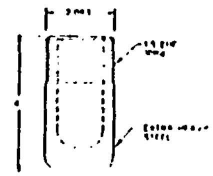
SCALE: NONE

NOTES:

1) THE SCREEN SECTIONS CONSIST OF A CONTINUOUS SLOT WIRE ROUND SCREEN JACKET OVER A PERFORATED PIPE BASE. THE SCREEN JACKET IS FABRICATED BY CIRCUMFERENTIALLY WRAPPING [illegible] SHAPED WIRE AROUND A CIRCULAR ARRAY OF [illegible] INTERNAL RODS. THE BOSS RINGS WERE WELDED TO THE ENDS OF THE SCREEN JACKET AND IN TURN WELDED TO THE PIPE BASE. THE SCREEN JACKET AND BOSS RINGS ARE FABRICATED FROM TYPE 316 L STAINLESS STEEL.

2) THE PIEZOMETER TUBING IS [illegible] OD BY [illegible] ID. [illegible] TUBING.

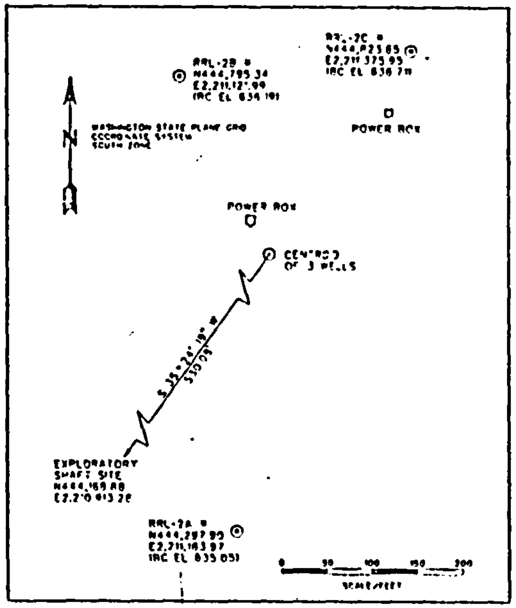
3) ACTUAL SCREEN LENGTHS INDICATED ON AS BUILT DRAWING [illegible].



PLUG (3)

Figure A-4. As-Built Details Piezometer String.

RRL-2 LOCATION



RRL-2 SITE PLAN

* = COORDINATES CORRESPOND TO CENTER OF CASING

CORE HOLE RRL-2A

CORE HOLE RRL-2A WAS COMPLETED IN 1982 TO ACQUIRE SUBSURFACE INFORMATION FOR ASSESSING THE OVERALL SUITABILITY OF THE EXPLORATORY SHAFT (ES) SITE, AND FOR THE DESIGN AND SELECTION OF PORTHOLE LOCATIONS. IT WAS COMPLETED AS A 2.98-INCH DIAMETER CORE HOLE TO A DEPTH OF 3,973 FEET. THE LONGEST STRING OF CASING WAS CEMENTED TO A DEPTH OF 2,713 FEET. THIS CORE HOLE WILL BE CONFIGURED WITH A STRADDLE-PACKER ASSEMBLY TO ACT AS AN OBSERVATION POINT DURING HYDRAULIC TESTING AT WELL RRL-2B. OTHER SELECTED FLOW TOPS WILL BE ISOLATED WITH BRIDGE PLUGS SET IN THE FLOW INTERIORS TO PREVENT VERTICAL HYDRAULIC INTERCONNECTION OF VARIOUS FLOW TOPS IN THE CORE HOLE.

WELL RRL-2B

WELL RRL-2B WILL BE UTILIZED PRINCIPALLY AS A PUMPING AND/OR INJECTION WELL FOR MULTIPLE WELL PUMPING TESTS AT THE RRL-2 LOCATION. THE WELL IS DESIGNED SUCH THAT SELECTED HYDROGEOLOGIC UNITS (e.g. ROCKY COULEE FLOW TOP, COHASSETT FLOW TOP, GRANDE RONDE NO. 5 FLOW TOP, AND [illegible] FLOW TOP) WITHIN THE GRANDE RONDE BASALT CAN BE TESTED BY THE DRILL AND TEST APPROACH. THIS APPROACH ALLOWS FOR HYDRAULIC TESTING A SELECTED HORIZON PRIOR TO DEEPENING THE WELL TO TEST ANOTHER HORIZON. UPON COMPLETION OF HYDRAULIC TESTING IN EACH HORIZON, THE WELL WILL BE LINED AND CEMENTED BEFORE DRILLING AND TESTING THE NEXT HORIZON.

PIEZOMETER NEST RRL-2C

BOREHOLE RRL-2C IS COMPLETED AS A PIEZOMETER NEST TO MEASURE HYDRAULIC HEAD AND FORMATION PRESSURE IN THREE FLOW TOPS (ROCKY COULEE, COHASSETT, AND GRANDE RONDE NO. 5) AND FORMATION PRESSURE IN THREE FLOW INTERIORS (ROCKY COULEE, COHASSETT, AND GRANDE RONDE NO. 5). THE PIEZOMETER STRINGS CONSIST OF A 1) TAILPIPE, 2) ONE OR MORE SCREEN SECTION(S) IN THE MONITORING HORIZON, 3) SEATING NIPPLE, 4) RISER TUBE TO GROUND SURFACE, AND 5) MULTIPLE-GRADATION FILTER PACK. EACH PIEZOMETER STRING IS PARTIALLY CENTRALIZED TO ACHIEVE STAND OFF OF THE SCREEN SECTION(S) FROM THE BOREHOLE WALL AND THE ADJACENT PIEZOMETER STRING(S). THE MULTILEVEL MONITORING HORIZONS ARE ISOLATED FROM EACH OTHER AND THE NEXT OVERLYING HYDROGEOLOGIC UNIT BY DENSIFIED [illegible] SEALS.

Figure A-5. As-Built Site Plan RRL-2 Location.

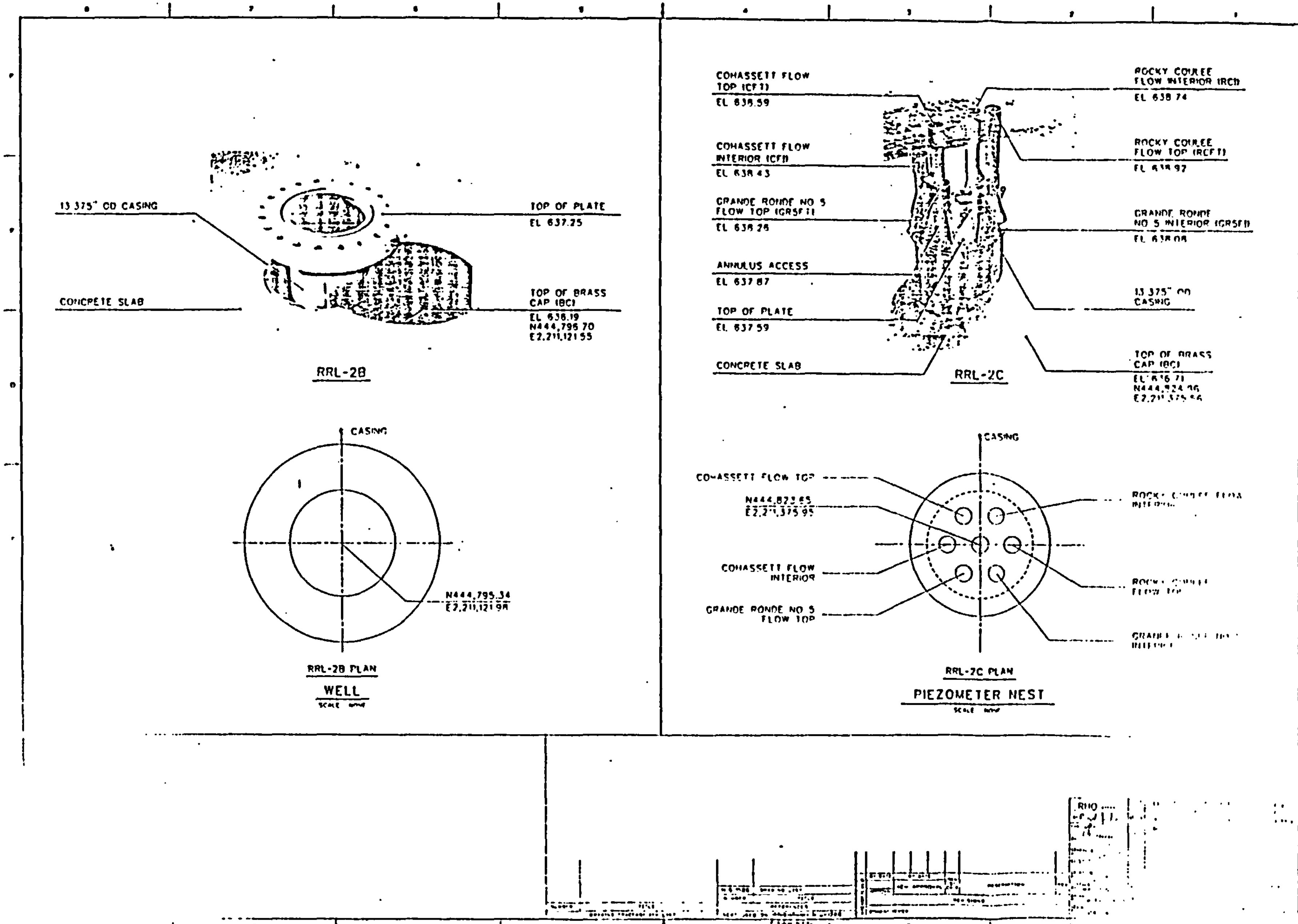


Figure A-6. As-Built Piezometer Nest RRL-2B and Well RRL-2C Well Heads.

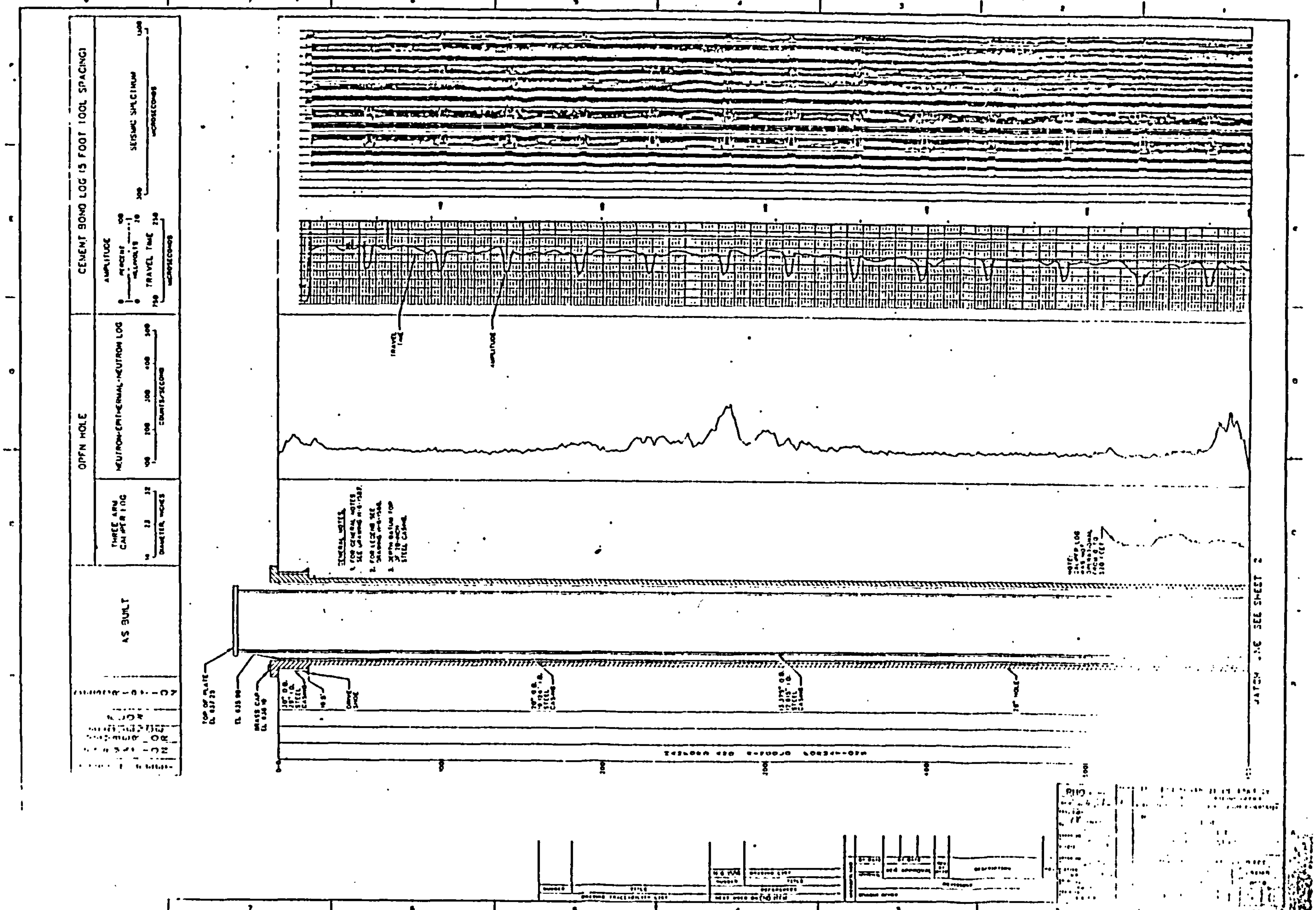


Figure A-7. As-Built Well RRL-2B. (sheet 1 of 5)

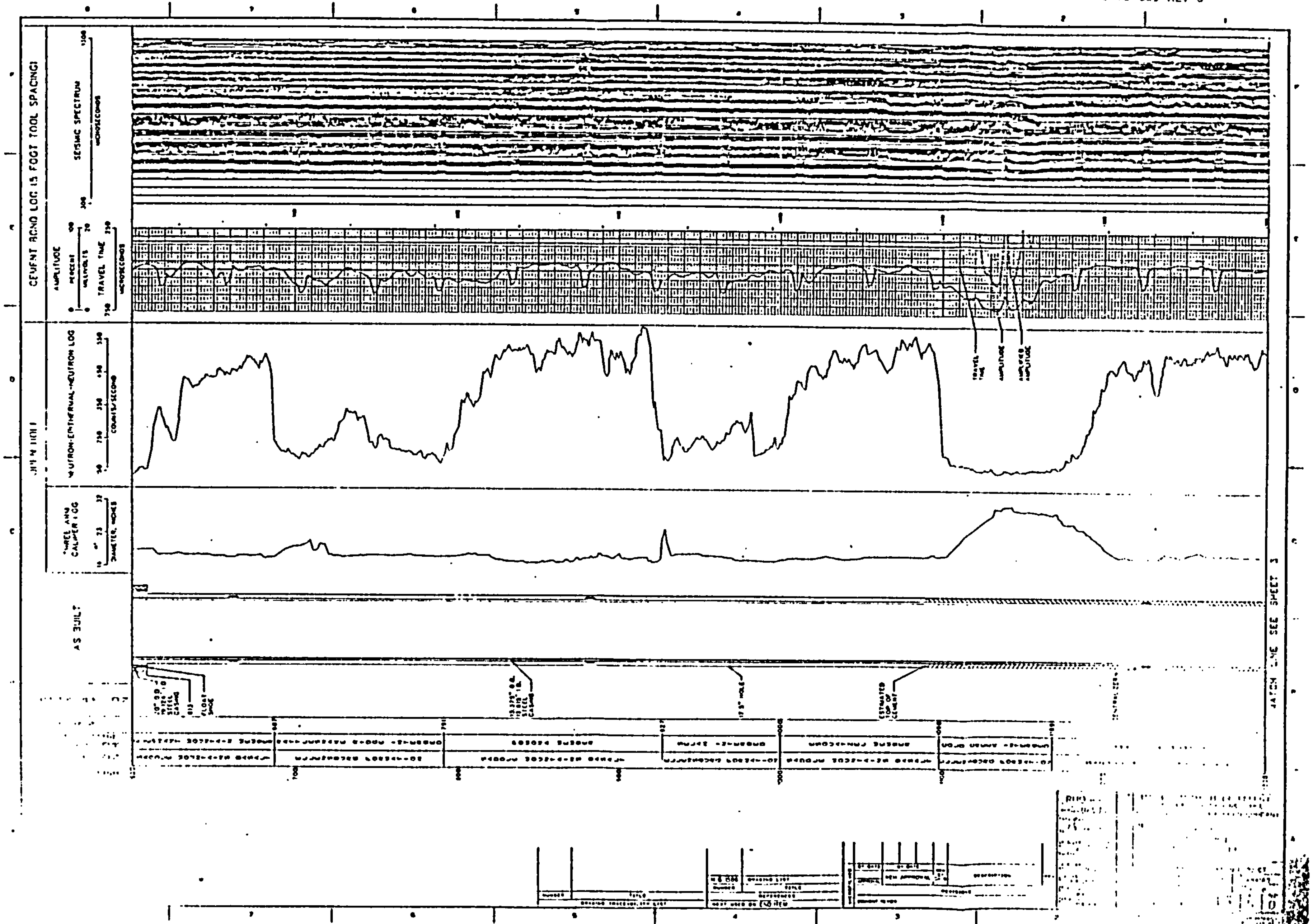


Figure A-7. As-Built Well RRL-2B. (sheet 2 of 5)

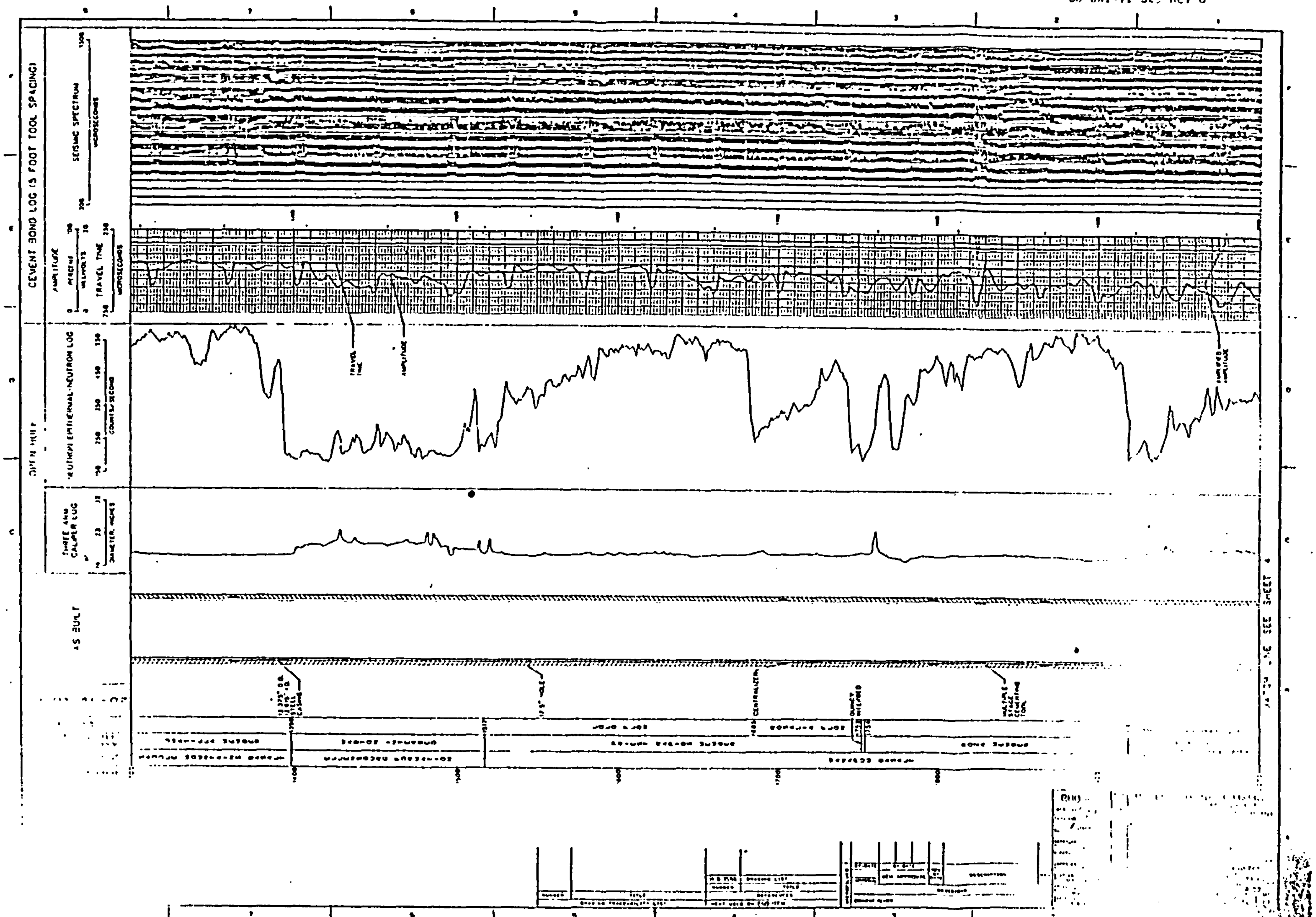


Figure A-7. As-Built Well RRL-2B. (sheet 3 of 5)

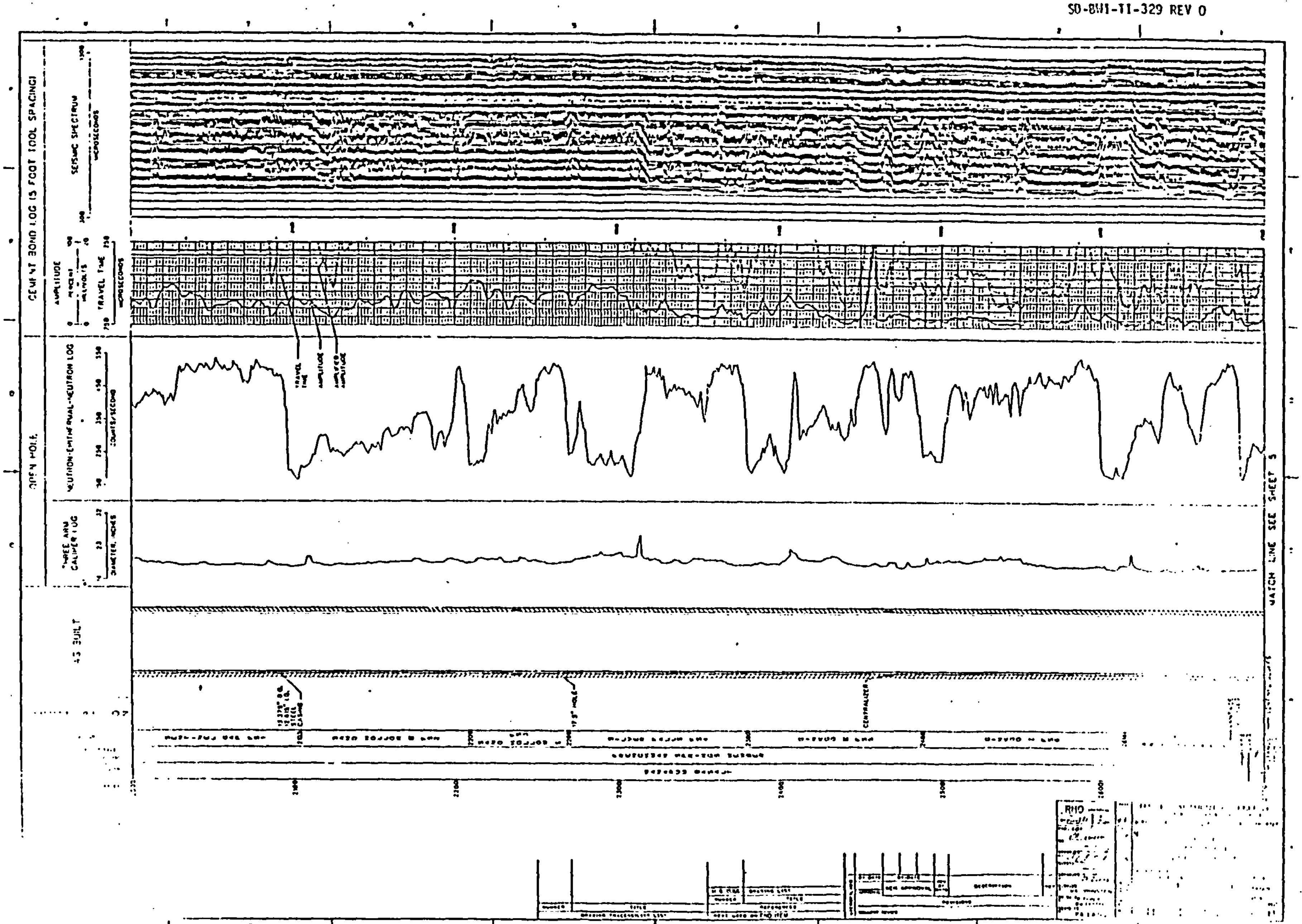


Figure A-7. As-Built Well RRL-2B. (sheet 4 of 5)

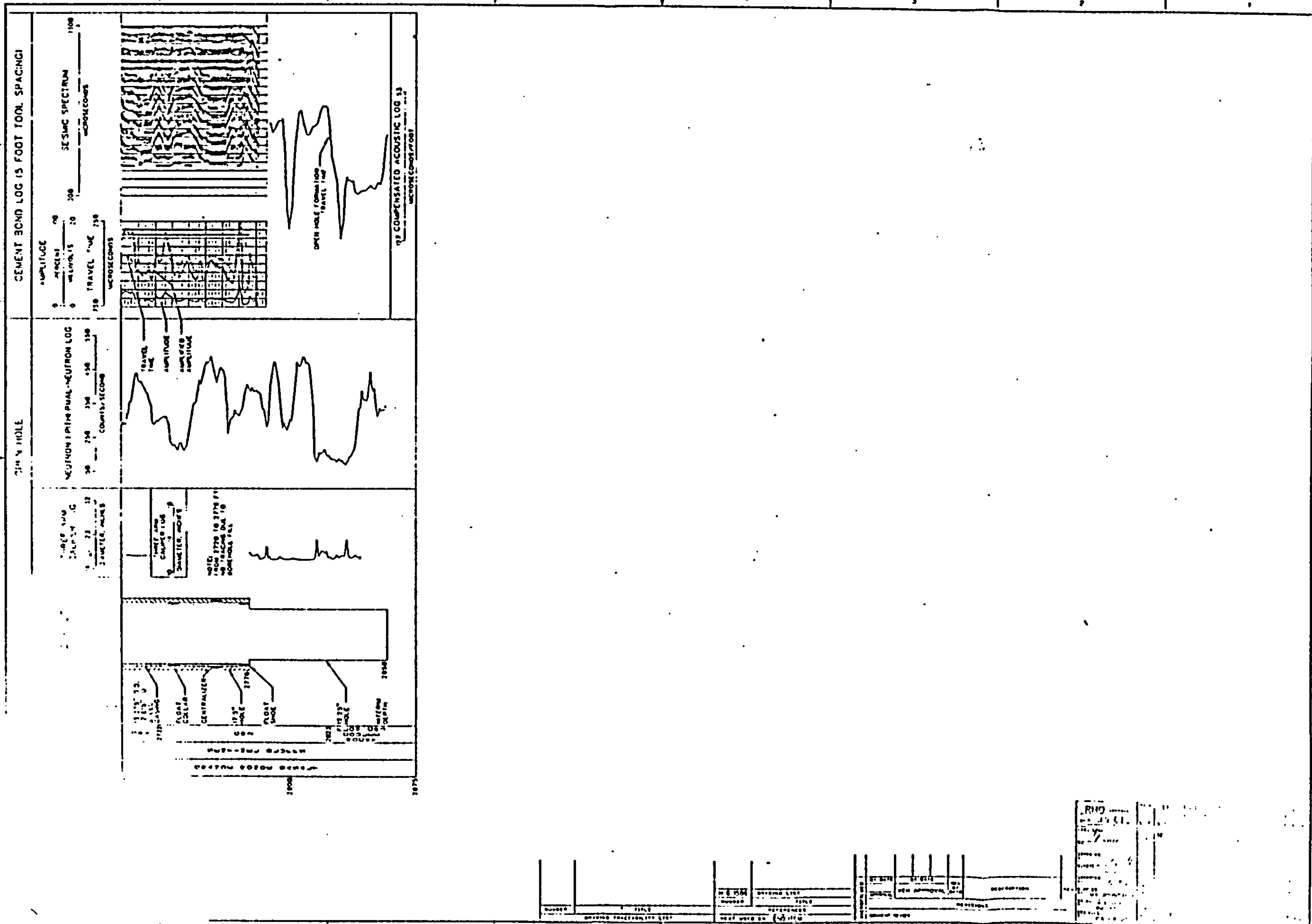


Figure A-7. As-Built Well RRL-2B. (sheet 5 of 5)

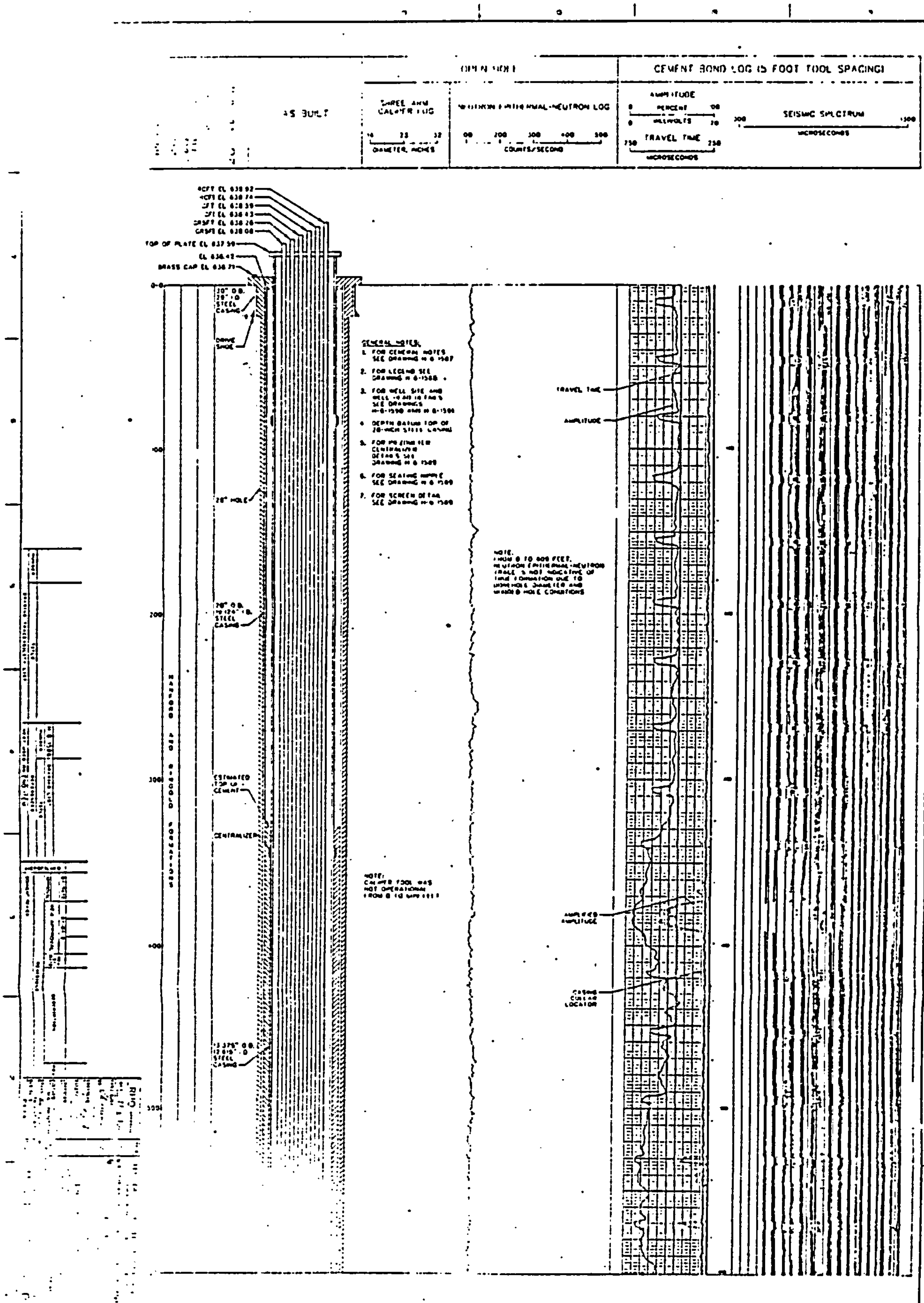


Figure A-8. Piezometer Nest RRL-2C. (sheet 1 of 5)

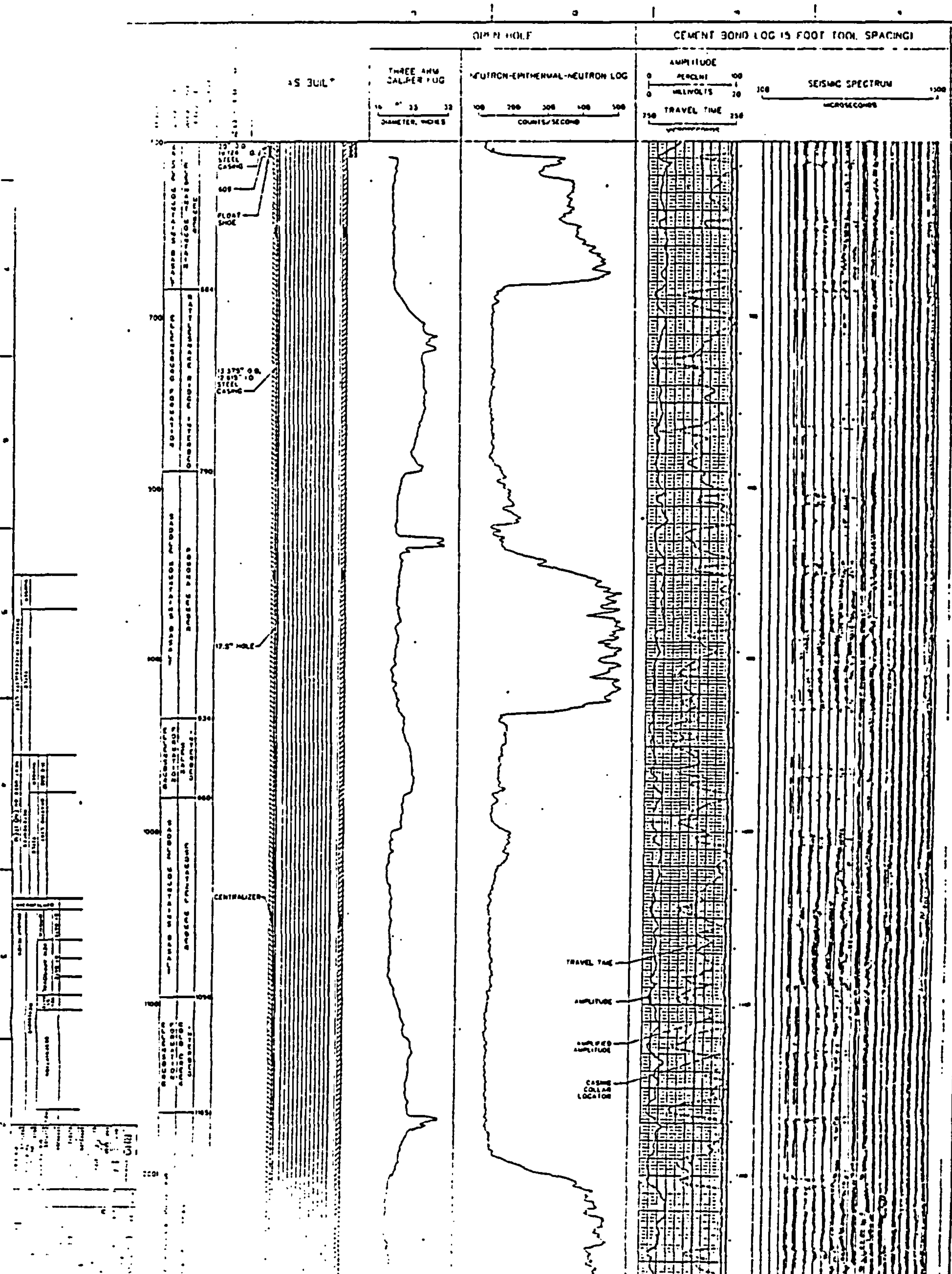


Figure A-8. Piezometer Nest RRL-2C. (sheet 2 of 5)

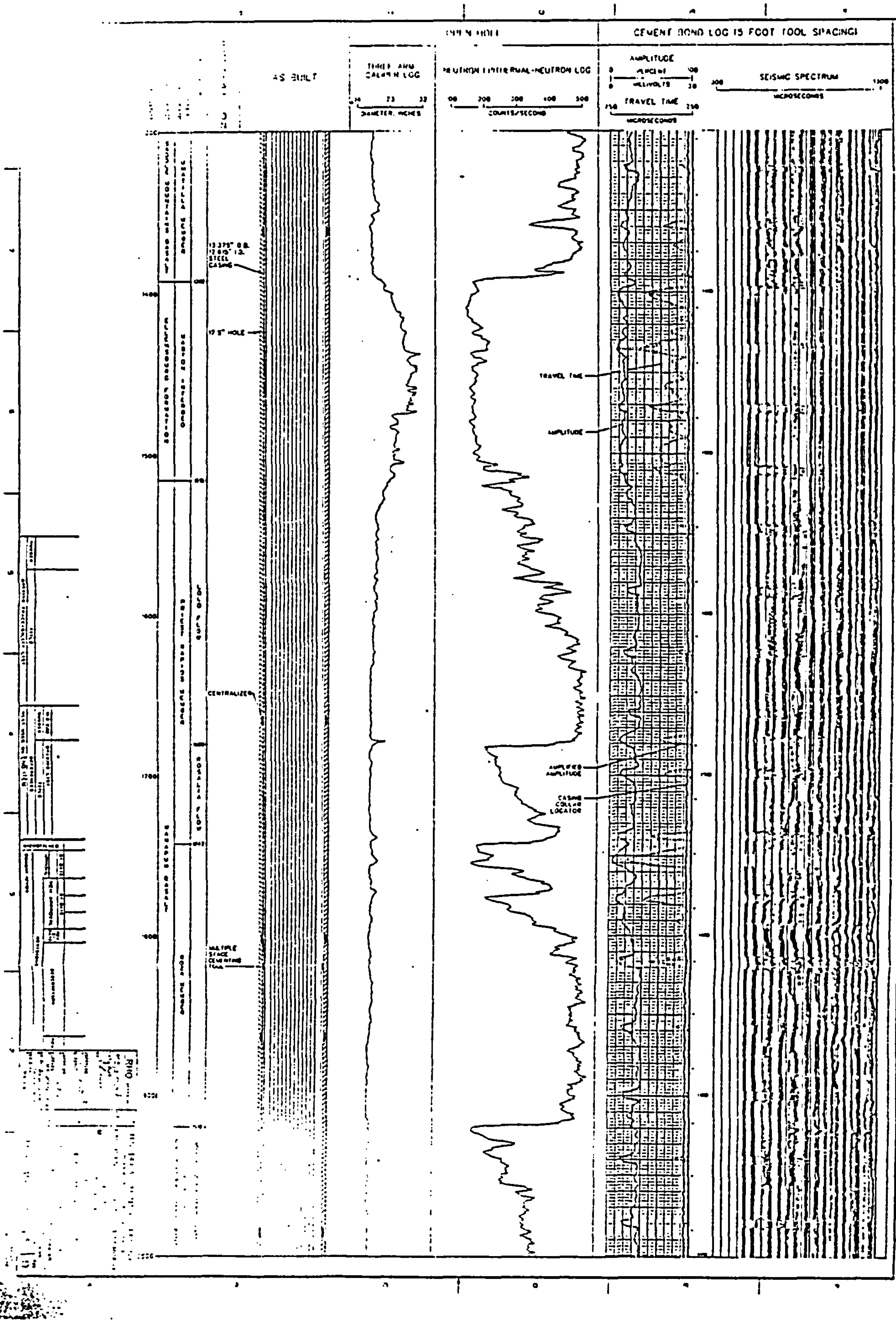


Figure A-8. Piezometer Nest RRL-2C. (sheet 3 of 5)

SD-BWI-TI-029 REV 0

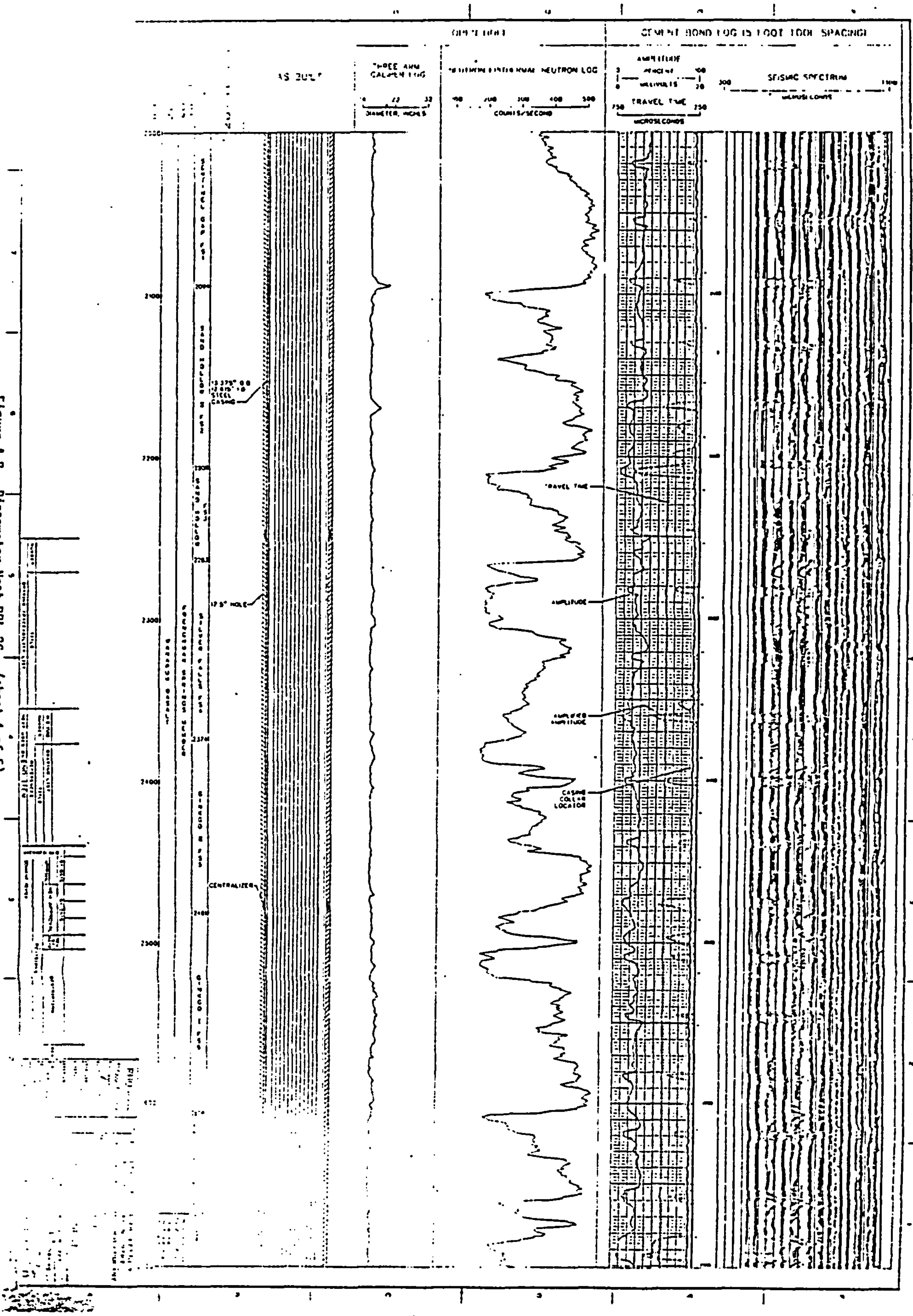


Figure A-8. Piezometer Nest RRL-2C. (sheet 4 of 5)

SD-CXI-TI-329 REV 0

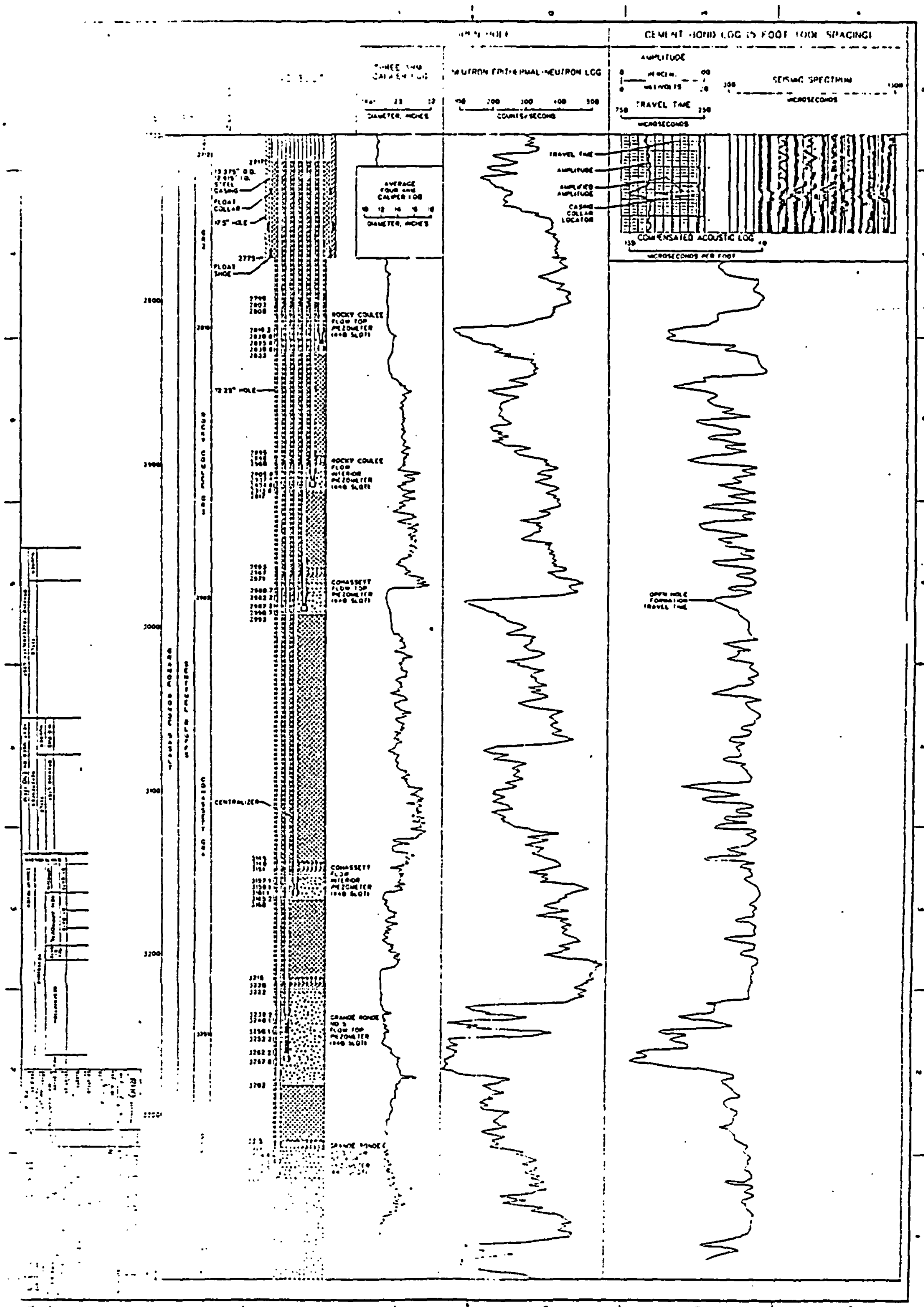


Figure A-8. Piezometer Nest RRL-2C. (sheet 5 of 5)

LOCATION: STEM-1

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
PRIEST RAPIDS TO UPPER FRENCHMAN SPRINGS					PACKER TOP= 469.00			PACKER BOTTOM= 970.00					
85-252	85-252	25.800	5.610	20.400	12.100	27.400	5.100	0.400			151.000	151.000	
	85-253	25.800	5.510	20.300	12.000	27.400	5.100	0.410			151.000	151.000	
85-297	85-297	26.300	6.120	21.200	12.800	29.700	4.930	0.590	0.190		156.000	156.000	1.749
	85-298	25.100	5.670	20.100	12.300	29.600	4.930	0.590	0.180		156.000	156.000	-0.646
86-31	86-31	25.200	5.720	20.300	12.600	27.300	4.870	0.570	0.190		157.000	157.000	-0.294
	86-32	25.400	5.710	20.400	12.600	27.400	4.830	0.570	0.190		157.000	157.000	-0.074

LOCATION. 299-E26-08

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
RATTLESNAKE RIDGE					PACKER TOP= 326.00			PACKER BOTTOM= 396.00					
SITE-166	SITE-166	20.000	10.400	19.000	8.200	79.000	7.900	0.510	35.000			99.000	-3.495
SITE-167	SITE-167	18.000	9.900	21.000	9.200	79.000	7.600	0.580	18.000			103.000	2.919
SITE-168	SITE-168	19.000	9.900	19.000	9.200	79.000	8.100	0.530	37.000			104.000	-5.488

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LOCATION: 699-S03-E12

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SIIE-141	SIIE-141	13.000	4.700	24.000	8.100	15.000	4.600	0.300	15.000	14.000	98.000		-1.812
SIIE-22	SIIE-22	17.000	7.000	26.000	3.100	15.000	3.700	0.500	25.000	13.700		82.000	-0.828

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LOCATION: 699-S08-19

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/l	MG MG/L	SI MG/L	CL MG/L	MG/L	SO4 MG/l	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SIIE-46	SIIE-46	32 000	7.600	41.000	9.800	18 000	22.000	1.300	12.000	0.960		160.000	3.305
SIIE-84	SIIE-84	36.000	7.800	36.000	8.900	18.000	22.000	1 300	13.000	3.900		172.000	-1.926

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LOCATION: 699-S12-03

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-143	SITE-143	24.000	5.800	42.000	9.600	15.000	17.000	0.400	44.000	8.400	130.000		-0.904
SITE-45	SITE-45	23.000	5.600	43.000	9.800	15.000	18.000	0.600	43.000	1.900		120.000	[illegible] 893

LOCATION. 699-10-E12

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
S11E-147	S11E-147	19.000	5.500	45.000	14.000	20.000	8.200	0.300	29.000	17.000	160.000		0.451
S11E-247	S11E-247	19.000	5.900	40.000	16.000	19.600	8.400	0.300	28.000	18.000	178.000		0.258

LOCATION: 699-14-38

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-61	SITE-61	17.000	6.000	34.000	11.000	22.000	4.200	0.500	20.000			140.000	1.943
SITE-86	SITE-86	17.000	5.700	30.000	9.400	23.000	4.000	0.400	21.000	0.580		148.000	-5.749

LOCATION: 699-15-26

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SIIE 150	SIIE-150	23.000	6.300	48.000	12.000	17.000	9.900	0.400	60.000	26.000	130.000		-0.274
SIIE-24	SIIE-24	22.000	7.300	46.000	12.000	17.000	9.800	0.500	57.000	29.700		124.000	-0.252

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LOCATION: 699-19-43

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-121	SITE-121	19.000	5.600	44.000	10.000	14.000	7.400	0.400	71.000	12.000		115.000	-2.609
SITE-48	SITE-48	18.000	5.700	43.000	11.000	13.000	6.900	0.500	67.000	2.300		110.000	1.613

LOCATION: 699-19-88

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
85-278	85-278	12.200	3.250	27 000	10.900	22.800	3.760	0.420	14.000	0.420	118.000	113.000	3.090
	85-279	12.100	3.210	27.000	10.800	22.800	3.700	0.420	15.100		116.000	113.000	2 584
86-127	86-127	11.500	3.480	27.000	10.600	21.100	3.560	0 350	13.400	1.890	118.000	117.000	0.720
	86-128	11.700	3.690	27.300	10.700	21.300	3.550	0.350	13.400	1.900	118.000	117 000	1.381
86-64	86-64	11.600	3.330	26.600	10 400	22.200	3.590	0.350	13.500	0.790	116.000	114.000	1.447
	86-65	11.700	3.300	26.800	10 500	22.200	3.600	0.360	13.700	0.790	118.000	114.000	1.748

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LOCATION. 699-27-08

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-30	SITE-30	19.000	6 900	54 000	11 000	16.000	13.000	0 300	50.000	57 400		122.000	-1 991
SITE-5	SITE-5	19.000	6 400	56 000	12.000	17.000	13.000	0.200	46 000	58.000		119.000	1.286
SITE-50	SITE-50	20.000	6 300	55.000	12.000	17.000	12.000	0.300	52.000	33.100		110.000	10 620
SITE-76	SITE-76	20.000	6.700	54.000	13.000	16.000	11.000	0.300	49 000	13.100		120.000	9.674
SITE-87	SITE-87	21.000	6.400	48.000	12.000	17.000	13.000	0.300	56 000	58.000		123.000	-5.153

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LOCATION: 699-32-22

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
S11E-17	S11E-17	31.000	7.000	53.000	14.000	14.000	17.000	0.400	66.000	75.000		105.000	1.325
S11E-27	S11E-27	29.000	7.200	53.000	13.000	15.000	17.000	0.400	65.000	61.900		113.000	0.461
S11E-51	S11E-51	29.000	6.500	51.000	13.000	14.000	28.000	0.400	64.000	16.100		110.000	4.550
S11E-65	S11E-65	30.000	6.900	50.000	14.000	14.000	14.000	0.400	61.000	16.500		110.000	10.516
S11E-89	S11E-89	29.000	6.600	46.000	13.000	16.000	15.000	0.400	66.000	75.000		115.000	-5.268

LOCATION. 699-33-42

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-12	SITE-12	31.000	6.900	41.000	13.000	18.000	3.100	0.800	2.400	49.000		107.000	[illegible]
SITE-29	SITE-29	29.000	7.000	38.000	12.000	19.000	11.000	0.700	50.000	34.500		117.000	-1.917
SITE-52	SITE-52	29.000	5.300	37.000	12.000	18.000	12.000	0.700	55.000	7.100		110.000	4.903
SITE-67	SITE-67	29.000	6.400	38.000	13.000	18.000	14.000	[illegible]	52.000	6.000		110.000	7.066
SITE-91	SITE-91	31.000	6.200	35.000	12.000	20.000	16.000	0.800	59.000	24.000		115.000	-1.826

LOCATION: 699-34-42

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-153	SITE-153	28.000	6.100	32.000	9.900	20.000	11.000	0.600	45.000	26.000	110.000		-1.471
SITE-33	SITE-33	32.000	7.300	37.000	11.000	20.000	11.000	0.700	54.000	44.200		113.000	-1.306

LOCATION. 699-35-66

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-77	SITE-77	20.000	5.800	43.000	13.000	18.000	11.000	0.400	27.000	5.600		140.000	[illegible].537
SITE-94	SITE-94	23.000	5.600	40.000	11.000	20.000	14.000	0.400	29.000	25.000		148.000	-3.779

LOCATION: 699-40-01

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-10	SITE-10	17.000	6.000	40.000	11.000	17.000	8.800	0.400	26.000	24.000		120.000	[illegible].402
SITE-106	SITE-106	10.000	5.800	50.000	11.000	14.000	9.300	0.400	31.000	32.000		123.000	0.991
SITE-250	SITE-250	18.000	5.700	44.000	12.000	17.800	12.000	0.400	35.000	31.000	129.000		-0.686
SITE-265	SITE-265	18.000	4.800	44.000	12.000	18.000	12.000	0.400	36.000	41.200	120.000		-1.031

LOCATION: 699-41-23

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
S11E-113	S11E-113	29.000	6.700	42.000	12.000	14.000	9.600	0.500	61.000	40.000		114.000	0.28[illegible]
S11E-15	S11E-15	30.000	7.300	48.000	15.000	17.000	15.000	0.400	[illegible]	53.000		108.000	0.575

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LOCATION: 699-42-40C

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
RATTLESNAKE RIDGE					PACKER TOP= 306.00			PACKER BOTTOM= 390.00					
SIIE-177	SIIE-177	35.000	14.400	10.000	3.700	72.000	3.000	0.660	38.000			122.000	-10.860
SIIE-178	SIIE-178	33.000	13.700	7.500	4.500	72.000	4.000	0.960	17.000			123.000	-8.118
SIIE-179	SIIE-179	35.000	13.600	10.000	4.600	72.000	4.000	0.840	16.000			125.000	-4.227
SIIE-180	SIIE-180	36.000	12.700	18.700	4.500		3.600	0.700	15.500				

LOCATION: 699-46-05

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	[illegible] MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
S11E-156	S11E-156	22.000	4.700	43.000	0.014	19.000	12.000	0.400	52.000	30.000	120.000		-14.597
S11E-256	S11E-256	22.000	5.200	42.000	13.000	17.300	14.000	0.400	50.000	24.000	123.000		-0.572

LOCATION. 699-47-50

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
RATTLESNAKE RIDGE					PACKER TOP= 260.00			PACKER BOTTOM= 295.00					
S11E-181	S11E-181	22.000	7.200	46.000	18.500	51.000	31.000	0.560	100.000			95.000	0.681
S11E-205	S11E-205	20.390	7.390	55.310	14.660		30.950	0.570	107.300	7.630			

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LOCATION: 699-49-55B

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	[illegible] MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
RATTLESNAKE RIDGE					PACKER TOP= 170.00			PACKER BOTTOM= 226.00					
SITE-183	SITE-183	11.000	6 900	38.000	11.900	73.000	16.700	0 370	20.000			120 000	3.262
SITE-184	SITE-184	12.000	6 800	38.000	12.200	73.000	9.600	0.260	21.000			122 000	6.422
SITE-185	SITE-185	12.000	6.800	38.000	12.400	71.000	10.600	0.230	17.[illegible]00			117.000	9 173

LOCATION: 699-50-45

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	[illegible] MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
RATTLESNAKE RIDGE					PACKER TOP= 133.00			PACKER BOTTOM= 178.00					
SIIE-186	SIIE-186	17.000	6.000	92.000	15.700	58.000	22.000	0.600	[illegible]			114.000	34.400
SIIE-203	SIIE-203	16.390	5.710	30.020	10.210		22.870	0.490	20.520	0.930			

LOCATION: 699-52-48

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
RATTLESNAKE RIDGE					PACKER TOP= 145.00			PACKER BOTTOM= 195.00					
SITE-190	SITE-190	50.000	6.400	6.200	1.900	59.000	4.000	0.640	24.000			147.000	-12.235
SITE-199	SITE-199	51.700	6.690	14.430	3.060		4.990	0.710	35.270				

LOCATION: 699-55-76

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-117	SITE-117	10.000	5.500	34.000	5.200	5.000	17.000	0.400	63.000	0.580		29.000	-2.139
SITE-129	SITE-129	8.600	4.800	28.000	4.900	6.000	17.000	0.300	46.000	0.090		43.000	1.560
SITE-71	SITE-71	14.000	5.900	41.000	8.100	4.100	21.000	0.400	55.000	0.370		46.000	2.403

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LOCATION: 699-57-25A

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	[illegible] MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-119	SITE-119	31.000	6.600	30.000	7.100	23.000	6.100	0.800	24.000	3.300		131.000	[illegible].179
SITE-275	SITE-275	31.000	5.600	24.000	7.300	19.000	6.700	0.500	22.000	3.800	126.000		0.537

LOCATION. 699-62-31

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED						PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE				
SITE-131	SITE-131	20.000	5.200	35.000	8.100	17.000	5.300	0.400	31.000	6.200		139.000	-0.216
SITE-279	SITE-279	21.000	5.000	35.000	8.700	18.000	6.900	0.400	30.000	7.100	128.000		-0.161

LOCATION 699-65-50

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED						PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE				
SITE-134	SITE-134	19.000	5.000	24.000	8.200	18.000	7.200	1.100	16.000	1.300		115.000	-1.544
SITE-282	SITE-282	21.000	4.800	24.000	8.200	18.000	6.200	1.200	17.000	1.900	116.000		-0.586
SITE-73	SITE-73	19.000	5.400	26.000	9.200	17.000	6.300	1.000	15.000	0.320		110.000	4.690

LOCATION: 699-72-88

Sampling Event Code	SAMPLE NUMBER	NA MG/L	K MG/L	CA MG/L	MG MG/L	SI MG/L	CL MG/L	F MG/L	SO4 MG/L	NO3 MG/L	Lab Alkalinity	Field Alkalinity	Charge Balance
UNCONFINED					PACKER TOP= NOT AVAILABLE			PACKER BOTTOM= NOT AVAILABLE					
SITE-261	SITE-261	9.700	4.300	33.000	7.600	15.900	6.900	0.700	35.000	3.600	101.000		[illegible].881
SITE-96	SITE-98	9.300	4.500	33.000	7.500	17.000	3.900	0.200	42.000	3.400		98.000	-3.911

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Rockwell Hanford Operations

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See reverse side for additional approvals

Abstract

(NOTE: Please limit the abstract to a total of 300 characters or less).

This document describes the design, drilling and construction of the well RRL-2B and piezometer nest RRL-2C at the RRL-2 location. Well RRL-2B will act as the discharge well for performing large-scale hydraulic tests in units of the Grande Ronde Basalt. Piezometer nest RRL-2C will act as the primary observation points in the vicinity of the RRL-2 location. Water levels will also be measured in RRL-2C as part of the piezometer baseline monitoring program.

Well RRL-2B is completed as a 12.25-in. (31.12-cm) open hole at the interim depth of 2,858 ft (871.1 m). On completion of testing the Rocky Coulee flow top, the well will be deepened to the next horizon for testing.

Piezometer nest RRL-2C consists of six piezometer tubes that allow monitoring of hydraulic heads in selected hydrogeologic units within the Grande Ronde Basalt between the depths of about 2,775 and 3,404 ft (846 and 1,038 m). These monitoring horizons, in order of increasing depth, are: the Rocky Coulee flow top, Rocky Coulee flow interior, Cohassett flow top, Cohassett flow interior, Grande Ronde No. 5 flow top (includes part of the Cohassett flow bottom) and Grande Ronde No. 5 flow interior. Each piezometer is isolated by densified cement seals ranging from about 30 to 150 ft (9 to 46 m) in length. After completing the piezometer installation, each piezometer was developed to remove particulates from the piezometer tubing. Each tube was then flushed with fresh system water above the seating nipple so that water of uniform composition existed in the piezometer tubes for hydraulic head monitoring

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Design, Drilling, and Construction of Well RRL-2B, and Piezometer Nest RRL-2C

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1.0 INTRODUCTION

The Basalt Waste Isolation Project (BWIP) is investigating the feasibility of using a thick, layered sequence of the Columbia River basalts beneath the Hanford Site in south-central Washington State as a host medium for high-level radioactive waste disposal (fig. 1). This project is sponsored by the U.S. Department of Energy (DOE) under the direction of the Office of Civilian Radioactive Waste Management as mandated by the Nuclear Waste Policy Act of 1982 (NWPA 1983). Rockwell Hanford Operations (Division of Rockwell International) serves as the prime contractor to the DOE for operating the BWIP.

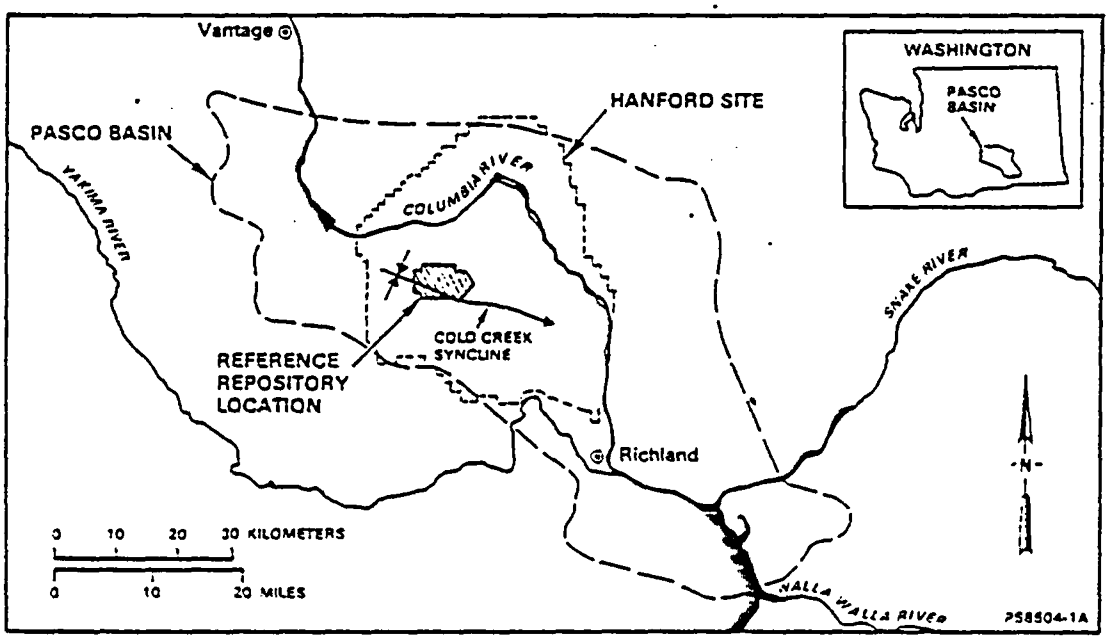


Figure 1. Hanford Site Location Map.

1.1 RATIONALE FOR CONSTRUCTING WELL RRL-2B AND PIEZOMETER NEST RRL-2C

In July 1983, members of the BWIP, together with the staff and consultants of the U.S. Nuclear Regulatory Commission (NRC) held a workshop to discuss strategies and requirements for hydrologic characterization of the Columbia River Basalt Group at the Hanford Site. As a result of the workshop, a four-stage strategy was developed for acquiring hydraulic head data and measuring hydraulic parameters based on multiple well pumping tests (Nuclear Regulatory Commission (NRC 1983)).

The first phase of large-scale hydraulic testing (stage 2 of the strategy) is planned for the RRL-2 location (NRC 1983). The installation of well RRL-2B (RRL-2B) and piezometer nest RRL-2C (RRL-2C) represents one step in preparing for hydraulic tests at the RRL-2 site. Well RRL-2B will be utilized as a pumping and/or injection well. Piezometer nest RRL-2C will be used as one of the principal observation points. An existing core hole RRL-2A, which is presently open in the Grande Ronde Basalt, will be configured as an observation well during the hydraulic testing at RRL-2B. The locations of the RRL-2 site and surrounding observation sites are shown in figure 2. The layout of the three wells at RRL-2 is shown in figure A-5.

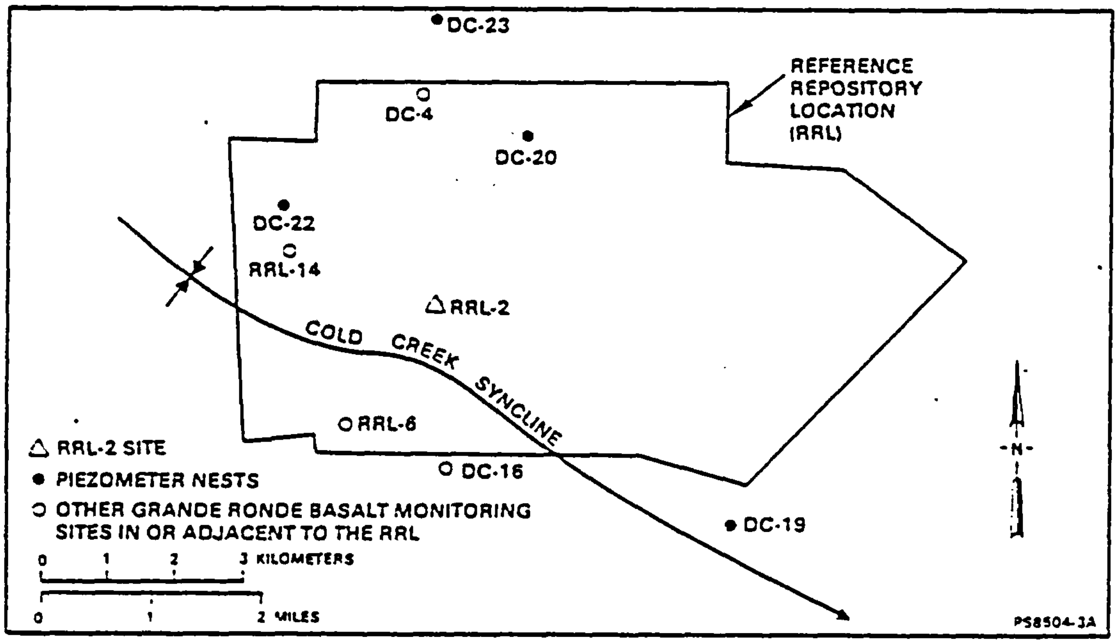


Figure 2. RRL-2 Site Location Map.

1.2 WELL AND PIEZOMETER NEST DESIGN

The following objectives of construction guided the design of RRL-2B.

- Provide hydraulically sound access to the Rocky Coulee flow top, Cohassett flow top, Grande Ronde 5 flow top, and Umtanum flow top, in turn, for pumping from the groundwater zones in each. Sound access to the flow tops implies that no pathway for interchange of water between these or other groundwater sources is created by the presence of the well.

- Provide adequate casing size (at least 10-in. (25.4-cm) ID) for setting a pump to at least a 2,400-ft (731.5-m) depth.
- Provide at least a 3.5-in.- (8.9-cm-) dia. (minimum) access hole through the Umtanum flow top.

Well RRL-2B was designed so that a hydraulic stress (induced by pumping, injecting, or pulsing) can be imposed on selected hydrogeologic units within the Grande Ronde Basalt (Rocky Coulee flow top, Cohassett flow top, Grande Ronde 5 flow top, and Umtanum flow top). Hydraulic testing will be done by the drill-test staged approach. This approach allows hydraulic testing of a single horizon (i.e., the Rocky Coulee flow top) prior to deepening the well to other testing horizons. On completion of hydraulic testing in each horizon, the test horizon will be cemented off and a centralized steel liner will be cemented in place across the test horizon before drilling to the next test horizon. This procedure will be repeated for the Cohassett flow top and Grande Ronde 5 flow top. The lowermost test horizon (Umtanum flow top) will not be lined or cemented. The conceptual design of RRL-2B is shown in figure 3.

The following objectives of construction guided the design of piezometer nest RRL-2C.

- Provide access for hydraulic head monitoring of selected flow tops and flow interiors within the Grande Ronde Basalt.
- Provide for hydraulic isolation of the selected horizons within the Grande Ronde Basalt.

Piezometer nest RRL-2C consists of six piezometers installed in a single borehole from about 2,775 to 3,404 ft (845.8 to 1,037.5 m) (fig. 4). Three of the six piezometers monitor the flow tops of the Rocky Coulee, Cohassett, and Grande Ronde 5 (which includes the Cohassett flow bottom). The other three piezometers were completed in the flow interiors of the Rocky Coulee, Cohassett, and Grande Ronde 5 flows. These monitoring horizons were isolated both from each other and from the next overlying hydrogeologic unit by densified cement.

This piezometer nest differs from the C-series piezometer nests (i.e., monitoring of flow tops within both the Wanapum and Grande Ronde Basalts) at the borehole cluster sites DC-19, DC-20, and DC-22 (Jackson et al. 1984, Jackson and Veatch 1985) in that the RRL-2C design permits pressure monitoring of basalt flow interiors, as well as flow tops within the Grande Ronde Basalt. This provides an opportunity to estimate vertical hydraulic conductivity of the flow interiors during later hydraulic testing.

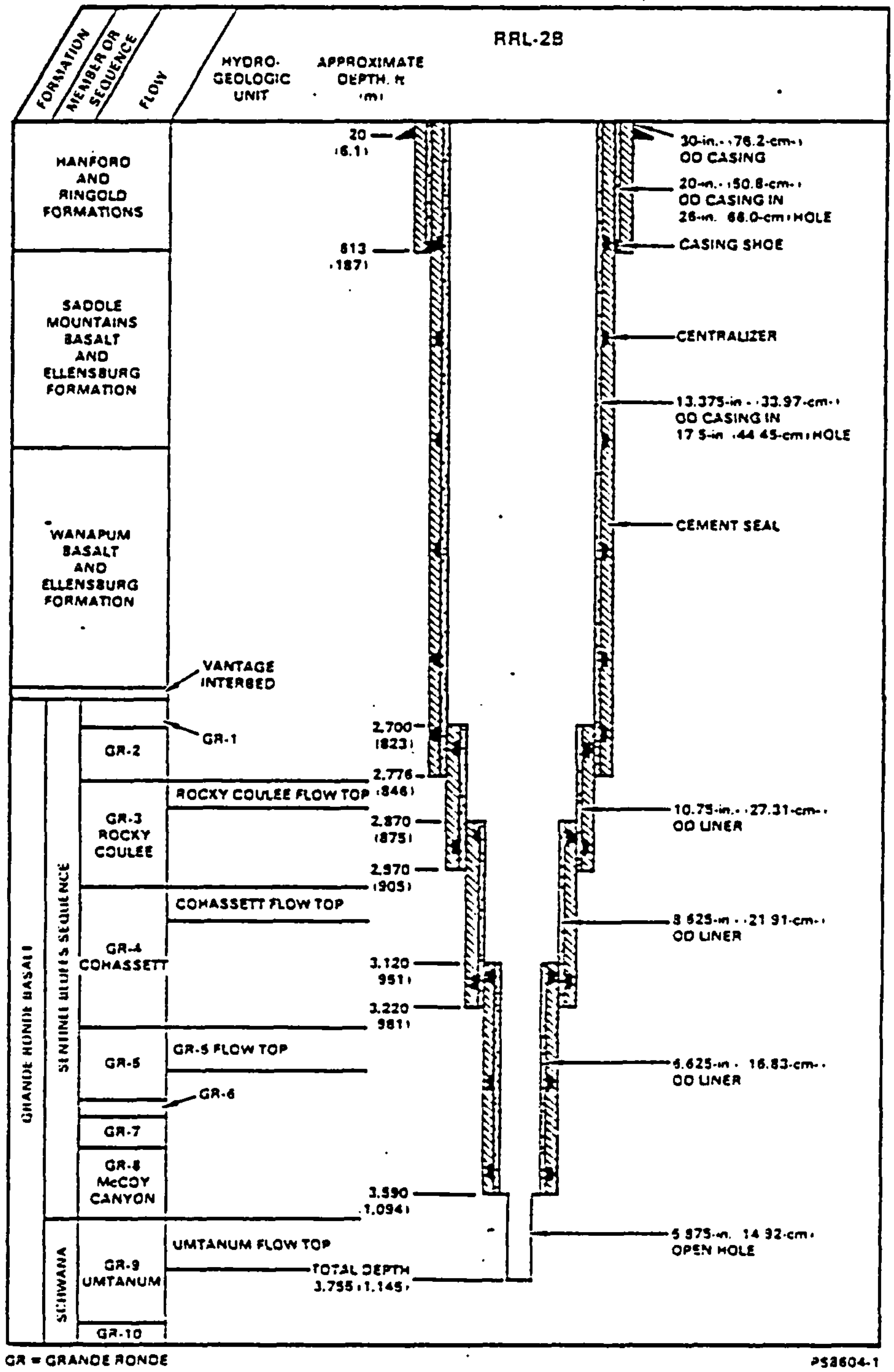


Figure 3. Conceptual Design of Well RRL-2B. Current drill depth is at 2,858 ft (871.1 m).

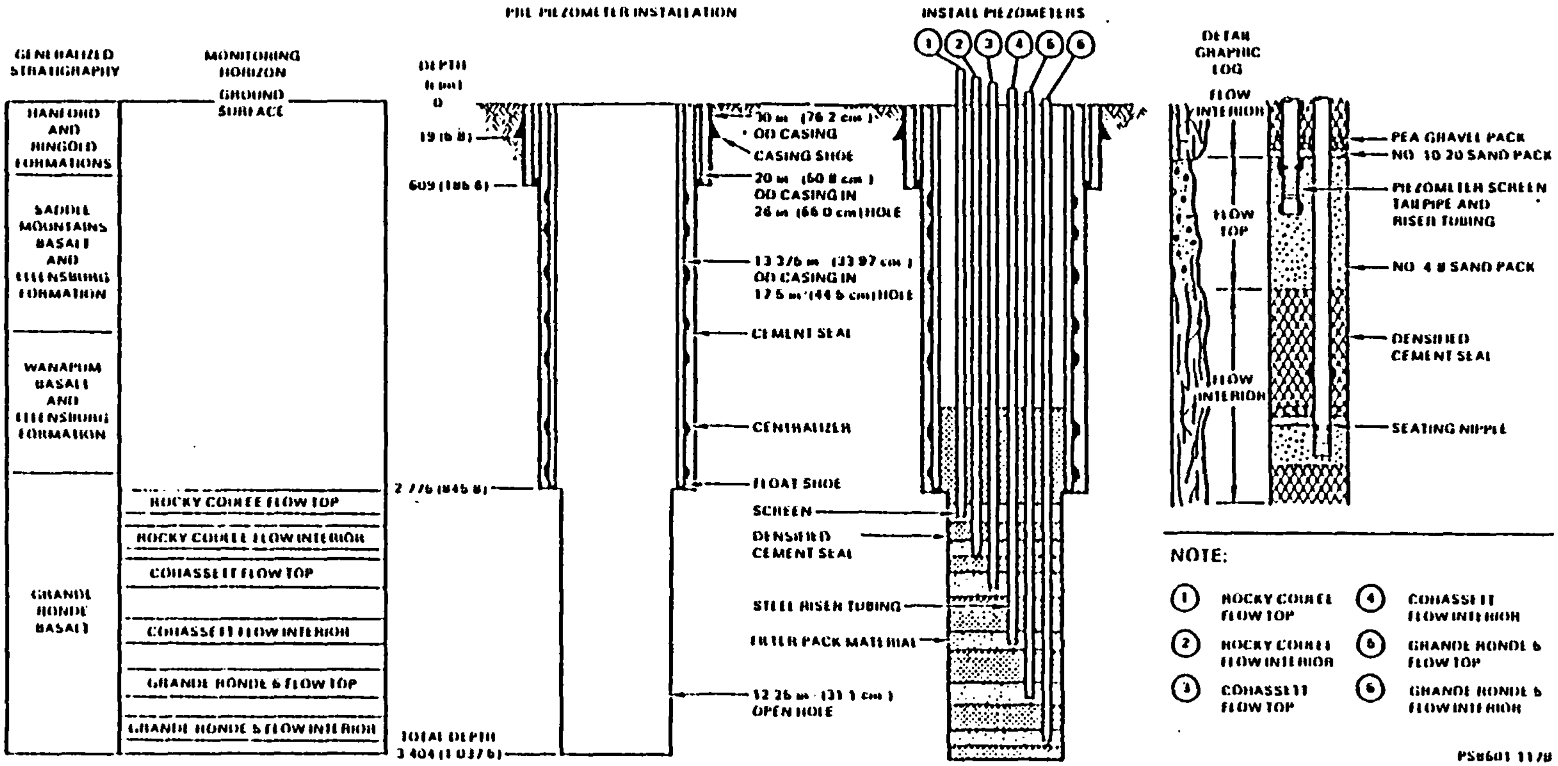


Figure 4. Configuration and Design Details of Piezometer Nest RRL-2C.

1.3 SCOPE

This report describes the first stage of completion of RRL-2B in the Rocky Coulee flow top and the design and installation of multilevel piezometers at RRL-2C. In addition, this report covers drilling methods, subsurface geologic conditions, borehole preparation, description and installation of the piezometers, as-builts, and post-installation piezometer development. The completion of RRL-2B and RRL-2C was guided by drilling and completion specifications (Jackson and Jones 1985).

2.0 HYDROGEOLOGY

2.1 STRATIGRAPHIC SETTING

The reference repository location is underlain by a thick sequence of Miocene-age tholeiitic basalt flows that are, in places, interbedded with and overlain by clastic sediments of Miocene or younger age (fig. 5). The basalt flows beneath the reference repository location and vicinity are part of the Columbia River Basalt Group, which consists of three formations in the Pasco Basin: Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt (Swanson et al. 1979). The sedimentary units interbedded with the basalts (principally in the Saddle Mountains Basalt) are part of the Ellensburg Formation (Brown 1959; Newcomb et al. 1972). The Grande Ronde Basalt accounts for about 81% of the total volume of basalt flows comprising the Columbia River Basalt Group (Reidel et al. 1982). The Cohassett flow, which occurs in the upper part of the Grande Ronde Basalt, is designated as the candidate horizon for repository studies (Long and WCC 1984) (see fig. 5).

Overlying the basalts and interbedded sediments are semiconsolidated sediments of the Mio-Pliocene age Ringold Formation (Merriam and Buwalda 1917). A thick sequence of Ringold Formation sediments occurs at the reference repository location where about 600 ft (180 m) of coarse- to fine-grained clastic sediments were deposited by fluvial processes. At the reference repository location, the Ringold Formation is informally subdivided into four fluvial facies: basal, lower, middle, and upper Ringold units (Tallman et al. 1981, Bjornstad 1984).

Overlying the Ringold Formation are Quaternary-age deposits of the Hanford Formation. These consist predominately of Pleistocene-age glaciofluvial sediments. Surficial deposits consisting of eolian sand overlies the Hanford Formation throughout the reference repository location.

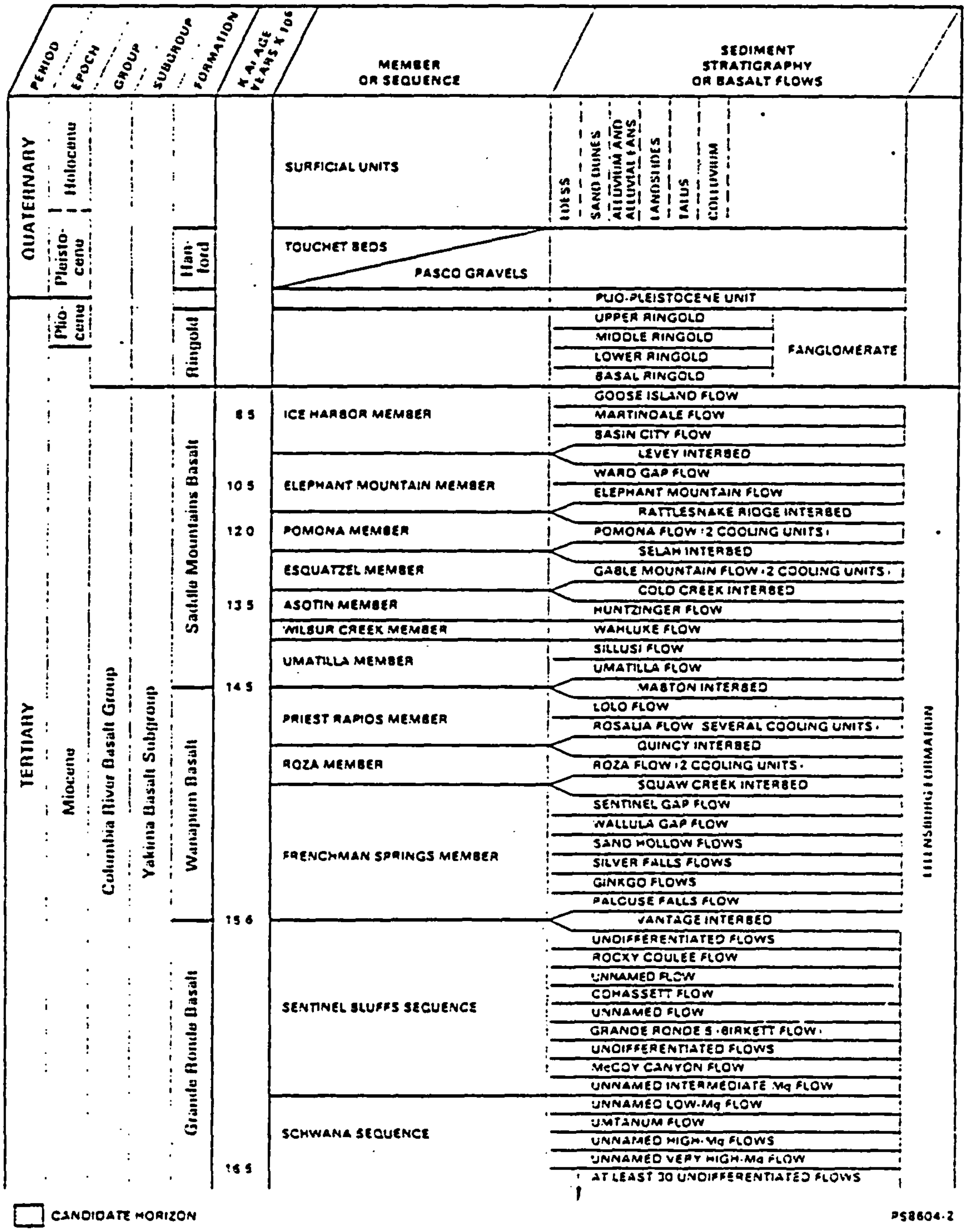


Figure 5. Stratigraphic Nomenclature of the Pasco Basin.

2.2 STRUCTURAL SETTING

The reference repository location is in the Cold Creek syncline (fig. 6) near the center of the Pasco Basin. The Pasco Basin is one of several structural and topographic basins located in the Yakima Fold Belt subprovince of the western Columbia Plateau (Myers et al. 1979). It is bounded on the north by the Saddle Mountains and on the south by the Rattlesnake Hills, both of which are anticlinal ridges. The western margin of the Pasco Basin is defined by the Naneum Ridge-Hog Ranch anticline. The Palouse Slope defines the eastern margin of both the Pasco Basin and Yakima Fold Belt. Myers et al. (1979), Myers (1981), and Caggiano and Duncan (1983) discuss the structure of the area in detail.

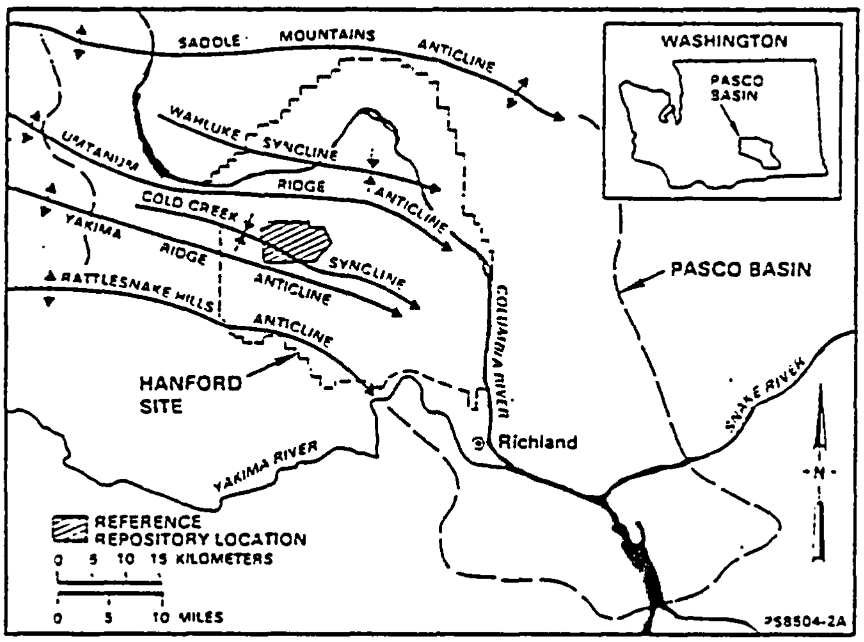


Figure 6. Major Synclines and Anticlines in the Pasco Basin.

Most of the anticlines in the Yakima Fold Belt are asymmetrical, tight folds, whereas the synclines between the anticlines are broad, open folds that are sediment filled. Major synclines in the Pasco Basin include the Wahluke and Cold Creek synclines (see fig. 6). The Wahluke syncline lies between the Saddle Mountains and Umtanum Ridge-Gable Mountain anticline. The Cold Creek syncline is a low-relief, sediment-filled trough lying between the Umtanum Ridge-Gable Mountain anticline to the north and the Yakima Ridge anticline to the south (see fig. 6).

2.3 HYDROLOGIC SETTING

The hydrogeology of the basalt sequence beneath the reference repository location and vicinity is known from core samples, borehole geophysical logs, and hydrologic test information obtained from boreholes. In general, the Columbia River Basalt Group beneath the reference repository location consists of a thick sequence of accordantly layered flood basalt flows overlain by glaciofluvial sediments and catastrophic flood deposits (Gephart et al. 1979, Gephart et al. 1983, Myers et al. 1979, DOE/RL 1982, DOE 1984). The stratigraphy of the Pasco Basin was shown in figure 5. Groundwater is in an unconfined to semiconfined state in the sediments overlying the basalt at the reference repository location.

Groundwater in the basalt sequence occurs primarily within the flow tops and within coarser-grained portions of sedimentary interbeds that typically are present in the Saddle Mountains and Wanapum Basalts. The dense basalt flow interiors and fine-grained sediments comprising the interbeds appear to act as confining horizons between the water-bearing basalt flow tops. Further hydrogeologic characterization activities will take place to identify and characterize potential groundwater flow paths in and adjacent to the reference repository location. The RRL-2 site and other piezometers, wells, and boreholes will play an integral part in this characterization.

3.0 DRILLING ACTIVITIES

3.1 GENERAL

The layout of RRL-2B, RRL-2C, core hole RRL-2A (existing), and the proposed exploratory shaft, is shown in figure A-5. Starter holes for RRL-2B and RRL-2C were drilled with a subcontracted cable tool rig and completed with a subcontracted rotary rig. Piezometer nest RRL-2C was completed before drilling RRL-2B so it would act as an observation point while drilling RRL-2B. Drilling of RRL-2C began on April 21, 1985 and was completed on May 24, 1985 at a depth of 3,404 ft (1,037.5 m) in 34 operating days. Drilling of well RRL-2B began on May 30, 1985. The first phase of drilling for RRL-2B was completed on June 29, 1985 to a depth of 2,858 ft (871.1 m) in 31 operating days.

3.2 DRILLING, CASING, AND CEMENTING

Refer to appendix B for information related to the drilling, casing, and cementing records on RRL-2B and RRL-2C. This appendix contains the daily drilling history, drilling progress graphs, mud drilling records, fluid-loss records, bit record summary, cementing summary for drilling operations, cementing and casing equipment list, casing depth summary, and deviation and gyro surveys. As-built drawings of RRL-2B and RRL-2C are in appendix A. All drilling and cementing records were documented on shift operations forms (fig. B-5). Copies are on file in the Basalt Records Management Center (BRMC).

3.2.1 Well RRL-2B

A cable tool rig drilled the starter hole at RRL-2B. The drill and drive method was used to set 30-in.- (76.2-cm-) OD butt-welded casing to a depth of 19.5 ft (5.9 m).

A rotary drilling rig was then mobilized to the site to deepen the borehole from 19.5 to 2,858 ft (5.9 to 871.1 m). This rig was instrumented with a Visulogger and Canary total gas detector systems. These systems electronically monitor parameters such as mud loss and gas during the drilling and tripping operations. Data is displayed on a video screen as well as permanently recorded by a high-speed printer. These records are on file in the BRMC.

A bentonitic drilling fluid was used to drill the 26-in. (66.0-cm) surface hole from 19.5 to 614 ft (5.9 to 187.1 m). No significant fluid losses occurred when drilling to 614 ft (187.1 m).

A string of 20-in. (50.8-cm) OD, grade H-40 steel casing (94 lb/ft (139.9 kg/m)) was set into the top of rock at a depth of 613 ft (186.8 m) (dense part of the Elephant Mountain Member). The casing string was cemented in place using the inner-string cementing method (Smith 1976). The cement slurry was mixed with a recirculating mixing system.

The cement composition consisted of American Petroleum Institute (API) Class G cement having an average slurry density of 15.8 lb/gal (1.89 kg/L) (table B-11). Additives in the lead-in slurry (72 bbl (11.4 m^3)) consisted of 2% calcium chloride ($CaCl_2$) and lost-circulation material (i.e., cellophane flakes). The tail-in slurry (123 bbl (19.6 m^3)) contained 2% $CaCl_2$. A total volume of 195 bbl (31.0 m^3) of cement slurry was pumped in one stage. Cement was circulated to the surface after pumping about 170 bbl (27.0 m^3) of slurry. Drilling resumed after waiting on the cement for about 8 h.

Tricone bits (17.5-in.- (44.45-cm-) dia.) were used to rotary drill below the surface casing to a depth of 2,780 ft (847.3 m) with a bentonitic-base mud. Four lost-circulation zones were encountered over this interval as shown in table B-4. The total volume of mud lost to these horizons was about 740 bbl (235 m^3). The loss of mud was controlled by adding lost-circulation material (i.e., cottonseed hulls, cedar fiber, and mud seal) and additional mud to the mud system as needed.

Fishing operations were required at depths of 1,083 ft (330.1 m); 1,766 ft (538.3 m); 2,057 ft (627.0 m); 2,197 ft (669.6 m); 2,219 ft (676.4 m); and 2,655 ft (809.2 m) as a result of twisted off collars, subshocks, and drill pipe. These operations normally took from 3 to 10 h to recover the tools and return to normal drilling operations.

A long string of 13.375-in. (33.973-cm) OD, grade K-55 steel centralized casing (61 and 54.50 lb/ft (90.8 and 81.1 kg/m)) was set in Grande Ronde 2 at a depth of 2,776 ft (846.1 m) after completing borehole geophysical logging. The casing accessories are listed in table B-10.

The long string of casing was cemented in place using the two-stage cementing technique (Smith 1976). This technique allows cementing behind the long string in two separated stages to reduce mud contamination and lessen the possibility of losing cement in formations, such as the upper part of the Wanapum Basalt.

The cement slurry placed behind the long-string casing consisted of API Class G cement having an average slurry density of 15.8 lb/gal (1.89 kg/L) (table B-11). For both stages, the cement slurry was preceded by mud, mud flush, and water flush. The cement slurry and preceding fluid were displaced with water and mud. Additives in the lead-in cement contained lost-circulation material (i.e., cellophane flakes). The tail-in cement contained no additives. The total slurry pumped was 241 bbl (38.3 m^3) during the first stage and 552 bbl (87.8 m^3) during the second stage. A temporary loss of circulation occurred prior to placing the second stage of cement.

After waiting on the cement for about 20 h, the cement plug was drilled out of the long string using a 12.25-in. (31.12-cm) tricone bit to a depth of 2,782 ft (848.0 m). At that depth, pressure testing of the casing shoe and a cement bond log were performed to help evaluate the integrity of the long-string casing.

Based on pressure testing, an additional cementing job was required across the casing shoe to improve its integrity. Approximately 17 bbl (2.7 m^3) of API Class G cement with a slurry density of 17.5 lb/gal (2.10 kg/L) were spot cemented between the interval of 2,674 and 2,782 ft (815.0 and 848.0 m). Pressure during a subsequent casing shoe pressure test held at 100 lbf/in^2 (0.69 MPa) surface shut-in pressure (about 200 lbf/in^2 (1.4 MPa) total pressure).

The open part of the borehole was drilled with Hanford system water using 12.25-in. (31.12-cm) tricone bits from 2,782 ft (848.0 m) to the interim depth of 2,858 ft (871.1 m). During drilling of this interval about 15 bbl (2.4 m^3) of water were lost to the Rocky Coulee flow top (2,815 to 2,842 ft (858.0 to 866.2 m)) over a period of about 8.4 h.

After the rotary rig was demobilized, borehole geophysical and gyro surveys were run to complete the drilling phase. The results for the gyro survey are tabulated in table B-13 and shown in figure B-3. Table C-1 lists borehole geophysical logs run in RRL-2B.

3.2.2 Piezometer Nest RRL-2C

A cable tool rig drilled the RRL-2C starter hole. The drill and drive method was used to set the 30-in.- (76.2-cm-) OD butt-welded casing to a depth of 19 ft (5.8 m). At that depth the drive shoe was spot cemented in place.

A rotary drilling rig was mobilized to the site to deepen the borehole from 19 to 3,404 ft (5.8 to 1,037.5 m). This rig was instrumented with a Visulogger data recording system to provide pertinent drilling data. Information was continuously monitored by video and recorded for later reference. These records are on file in the BRMC.

A bentonitic drilling fluid was used to drill the 26-in. (66.0-cm) surface hole from 19 to 610 ft (5.8 to 185.9 m). Lost-circulation material (i.e., cottonseed hulls) was added to the mud system to minimize fluid losses to the formation. Temporary fluid losses occurred at a depth of about 252 ft (76.8 m). Circulation was regained after losing an estimated 125 bbl (19.9 m^3) of drilling fluid.

A string of 20-in.- (50.8-cm-) OD, grade H-40 steel casing (94 lb/ft (139.9 kg/m)) was set into the top of rock (dense interior of the Elephant Mountain Member) at a depth of 609 ft (185.6 m). The surface casing was cemented in place using the inner-string cementing method previously described for RRL-2B.

The cement composition consisted of API Class G cement having an average slurry density of 15.8 lb/gal (1.89 kg/L) (table B-12). Additives in the lead-in slurry (61 bbl (9.7 m^3)) were 2% $CaCl_2$ and lost-circulation material (i.e., cellophane flakes). The tail-in slurry (164 bbl (26.1 m^3)) contained 2% $CaCl_2$. A total volume of 225 bbl (35.8 m^3) of cement slurry was placed in one stage. Cement was circulated at the surface after pumping about 62 bbl (9.8 m^3) of slurry. Drilling resumed after waiting on the cement for about 15 h.

Seventeen and one-half inch tricone bits were used to rotary drill from the surface casing to a depth of 2,776 ft (846.1 m) using a bentonitic-base mud. Four lost-circulation zones were encountered over the drill interval of 2,165 ft (659.9 m) as shown in table B-5. The total volume of mud lost to these horizons was about 690 bbl (110 m^3). The loss of mud was controlled by adding lost-circulation material (i.e., cottonseed hulls, cedar fiber, and mud seal) and additional mud to the mud system as needed.

Fishing operations were required at depths of 1,398 ft (426.1 m), 1,607 ft (489.8 m); 1,633 ft (497.7 m); and 1,648 ft (502.3 m) as a result of twisted off drill collars and (or) drill pipe. These operations normally required 10 to 24 h to recover the tools and return to normal drilling operations.

A long string of 13.375-in. (33.973-cm) OD, grade K-55 steel centralized casing (61 and 54.5 lb/ft (90.8 and 81.1 kg/m)) was set in Grande Ronde 2 at a depth of 2,775 ft (845.8 m). The casing was cemented in place using the two-stage cementing technique after completing the borehole geophysical logging. The casing accessories are listed in table B-10.

The cement slurry placed behind the long-string casing consisted of API Class G cement having an average slurry density of 15.8 lb/gal (1.89 kg/L) (table B-12). For both stages, the cement slurry was preceded by mud, mud flush and water flush, followed by the cement slurry. The first stage was displaced with water and mud, and the second stage was displaced with water. Lost-circulation material (i.e., cellophane flakes) was added to the lead-in cement for both stages. The tail-in slurry in the first stage contained no additives. One percent $CaCl_2$ was added to the second cementing stage. The total slurry pumped was 154 bbl (24.5 m^3) during the first stage and 379 bbl (60.3 m^3) during the second stage. Cement was not circulated to the surface.

After waiting on the cement for about 19 h, the cement plug was drilled out of the casing using a 12.25-in. (31.12-cm) tricone bit to a depth of 2,778 ft (846.7 m). At that depth the casing shoe was pressure tested, and a cement bond log was run. The results are given in section 3.3.

The open part of the borehole was drilled with Hanford system water using 12.25-in. (31.12-cm) tricone bits from 2,778 ft (846.7 m) to the total depth of 3,404 ft (1,037.5 m). During drilling of the interval, it was estimated that about 3,288 bbl (522.8 m^3) of water were lost to the Cohassett flow bottom and Grande Ronde 5 flow top (3,232 to 3,777 ft (985.1 to 1,151.2 m)) over a period of about 25 h.

After the rotary rig was demobilized, geophysical and gyro surveys were run in the borehole (table B-17). The results for the gyro survey are tabulated in table B-14 and shown in figure B-4. Table C-1 lists the borehole geophysical logs run in RRL-2C.

3.3 CASING INTEGRITY

3.3.1 Well RRL-2B

A preliminary evaluation of the integrity of the RRL-2B long-string casing (13.375-in. (33.973-cm) OD) was based on information provided from the cement bond log and the casing shoe pressure test. The casing shoe was isolated for pressure testing between a packer set above the casing shoe and the hole bottom. Because the initial pressure test was not positive, the casing shoe was spot cemented with 17 bbl (2.7 m^3) of API Class G cement (17.5 lb/gal (2.10 kg/L)). During subsequent pressure testing the overpressure pulse stabilized at a shut-in surface pressure of about 100 lbf/in^2 (0.69 MPa) (total pressure of about 200 lbf/in^2 (1.4 MPa)).

An acoustic cement bond log tool was run in RRL-2B. The purpose of running the cement bond log was to determine the presence or absence of cement behind the casing string and whether cement was bonded to the pipe, the formation, or both.

An initial bond log was run about 32 h (June 6, 1985) after cementing the long string of casing. This bond log indicated that several areas throughout the casing string lacked a good cement bond due to insufficient compressive strength of the cement.

On August 16, 1985, another bond log was run that indicated portions of the cement sheath had hardened over time to gain enough strength to propagate an acoustic signal (see fig. A-7). To test for the possible presence of a microannulus or channels, a bond log was run while the casing was under 750 lbf/in^2 (5.2 MPa) of pressure. The resulting log showed very little change from the previous cement bond log. This suggested that areas with little reduction in acoustic amplitude may contain channels rather than a microannulus.

The qualitative interpretation of the cement bond log for the long casing string is as follows.

Depth, ft (m)	Qualitative Interpretation
0-1,090 (0-332.2)	Free pipe
1,090-1,180 (332.2-359.7)	Good bond
1,180-1,400 (359.7-426.7)	Poor bond (essentially free pipe)
1,400-1,530 (426.7-466.3)	Fair to poor bond (partially cemented)
1,530-1,790 (466.3-545.6)	Poor bond
1,790-2,310 (545.6-704.1)	Fair to poor bond
2,310-2,440 (704.1-743.7)	Fair bond
2,440-2,776 (743.7-846.1)	Good bond

A 100% casing signal amplitude (fig. A-7) is attributed to the lack of a cement bond; i.e., a poor bond. A fair-to-good bond is indicated by a significant amplitude reduction, as well as strong formation signals. Areas where casing signals are still present, but amplitude reduction is at least 50%, suggest that the cement is not cured sufficiently to achieve adequate hardness or channels may be present.

3.3.2 Piezometer Nest RRL-2C

A cement bond log and casing shoe test were run to help evaluate the integrity of the long-string casing (13.375-in. (33.973-cm) OD) at RRL-2C. The pressure test involved isolating the casing shoe. This was accomplished by isolating the casing shoe between a packer set at a depth of 2,288 ft (697.4 m) inside the casing and the bottom of the borehole. The depth of the casing shoe was 2,775 ft (845.8 m), and the depth of the borehole was 2,778 ft (846.7 m). The interval between the packer and borehole bottom was then pressurized at 950, 500, and 250 lbf/in^2 (6.5, 3.4, and 1.7 MPa) (surface pressure readings). The test results were inconclusive with regard to the integrity of the casing shoe. Therefore, the uppermost piezometer densified cement seal was extended inside the casing as a precautionary measure.

A cement bond log was run on May 20, 1985, 24 h after cementing to examine the bonding of the cement sheath on the outside of the 13.375-in. (33.973-cm) casing. The qualitative interpretation of the cement bond log (fig. A-8) is as follows.

Depth, ft (m)	Qualitative Interpretation
0-320 (0-97.5)	Free pipe
320-430 (97.5-131.1)	Fair to good bond
430-500 (131.1-152.4)	Poor bond
500-1,510 (152.4-460.2)	Fair to good bond
1,510-1,730 (460.2-527.3)	Poor bond
1,730-1,800 (527.3-548.6)	Fair to good bond
1,800-2,160 (548.6-658.4)	Poor bond
2,160-2,775 (658.4-845.8)	Fair to good bond

As shown in figure A-8, there were no areas of 100% amplitude reduction, which suggests that the cement had not fully cured (i.e., hardened) at the time of logging.

3.4 HYDRAULIC HEAD RESPONSES TO DRILLING

During the drilling of RRL-2B and RRL-2C, ongoing piezometric monitoring was being carried out at the piezometer sites DC-19, -20, and -22; and core hole RRL-2A. Observed water-level data obtained at the sites provided the basis for evaluating the effect of RRL-2B and RRL-2C drilling disturbances on the monitored horizons within the basalt groundwater system.

The drilling of RRL-2B and RRL-2C appears to have had negligible effects on heads monitored in the unconsolidated sediments, Saddle Mountains Basalt, and Wanapum Basalt. In the Grande Ronde Basalt, a drilling disturbance from RRL-2B was observed in the Rocky Coulee flow top at RRL-2A and the recently completed RRL-2C. The response was attributed to losing about 15 bbl (2.4 m^3) of drilling fluid (water) over a period of about 8.42 h at RRL-2B. The pressure hydrographs illustrating the buildup at RRL-2A and RRL-2C are shown in figures 7 and 8, respectively. Raw data are on file in BRMC.

Circulation was lost during the drilling of the composite Cohassett flow bottom and Grande Ronde 5 flow top zone at RRL-2C. The fluid lost in this zone was estimated at 3,288 bbl (522.8 m^3) over a period of about 25.0 h. The areal extent of the disturbance caused by this fluid loss was not determined because no monitoring points existed for the Grande Ronde 5 flow top at that time.

4.0 SUBSURFACE GEOLOGY

4.1 GENERAL

Discussions of the subsurface geology in the vicinity of RRL-2A, RRL-2B, and RRL-2C are provided by Wintczak (1984) and Jackson et al. (1984). This section describes stratigraphic unit contacts and thicknesses encountered in RRL-2B and RRL-2C and compares those with predicted values based on nearby RRL-2A. It also describes the location of fractures, intraflow structures, and borehole wall breakouts in these boreholes for the Rocky Coulee, Cohassett, and Grande Ronde 5 flows.

4.2 METHODOLOGY

Stratigraphic interpretations are based on examination of chip samples, evaluation of rotary drilling rates and borehole geophysical logs from RRL-2B and RRL-2C, together with review of borehole television and borehole sonic televiewer logs.

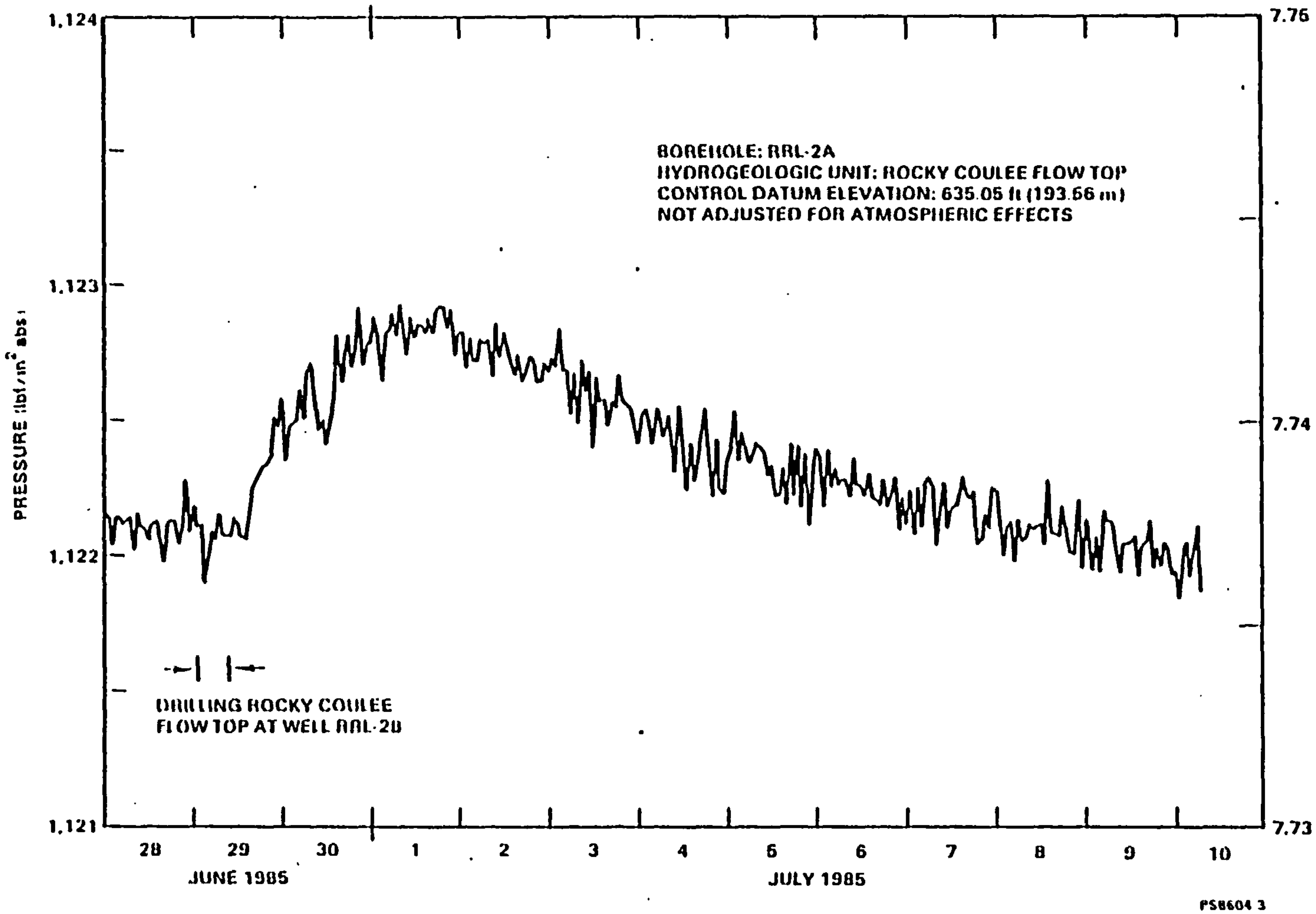


Figure 7. Pressure Hydrograph of Rocky Coulee Flow Top at Core Hole RRL-2A Drilling of Well RRL-2B.

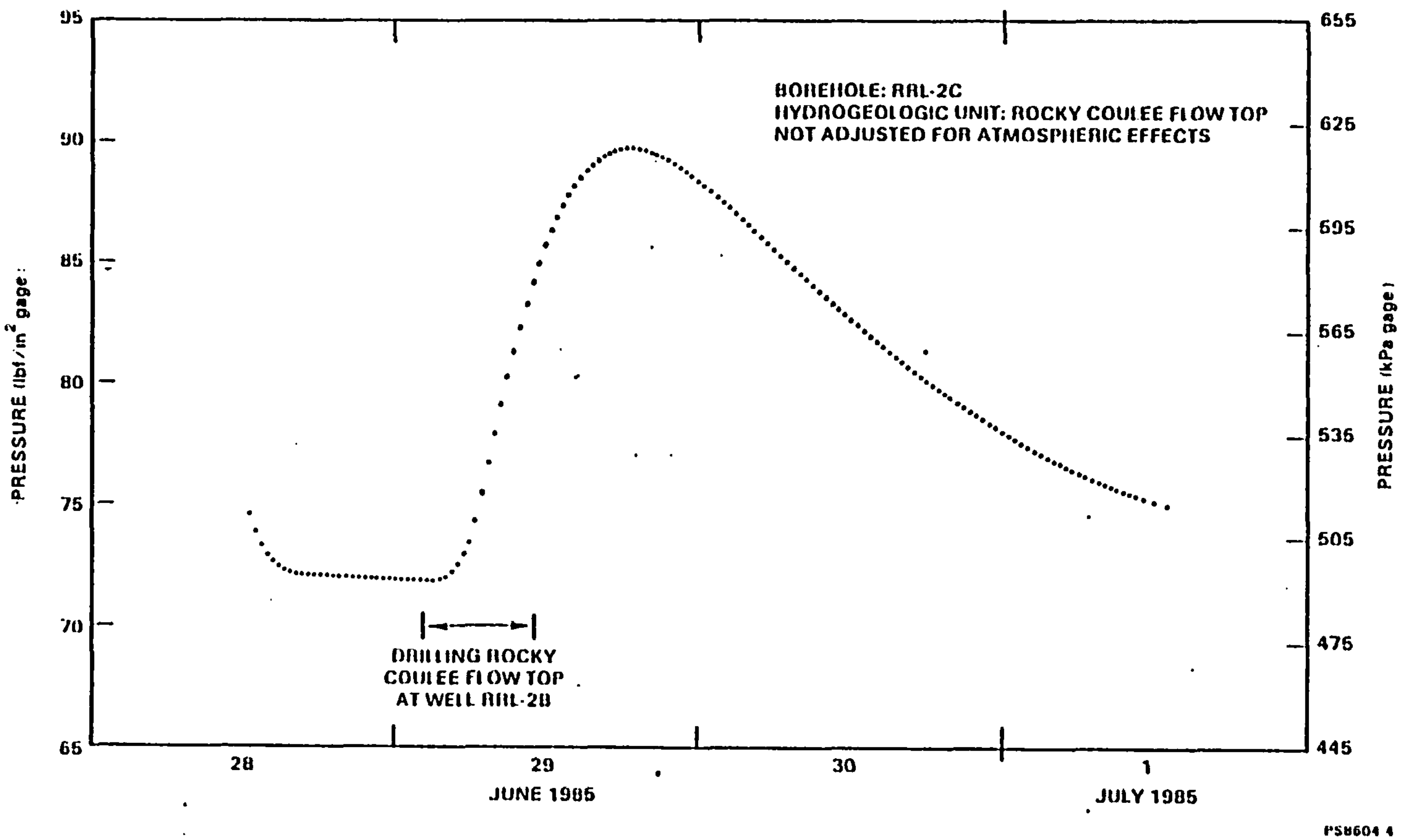


Figure 8. Pressure Hydrograph of Rocky Coulee Flow Top at Piezometer Nest RRL-2C During Drilling of Well RRL-2B.

Borehole geophysical logs were run to determine stratigraphic relationships, identify low- and high-porosity zones, rock properties, heat-flow relationships, and borehole conditions. The borehole geophysical logs run in RRL-2B and RRL-2C are given in figures 9 and 10. Selected log traces are shown on the as-built drawings in appendix A.

4.3 OBSERVED STRATIGRAPHY

Thickness predictions of the stratigraphic units expected to be encountered at RRL-2B and RRL-2C were based on analyses of unit isopachous maps. These data showed that thicknesses should be very close to those encountered in RRL-2A with the exception of the sediments overlying the basalt, which should be 5 ft (1.5 m) thinner. Variability was expected to be up to ±5 ft (±1.5 m) for the contact depths and ±10 ft (±3.1 m) for net stratigraphic thicknesses of units (Jackson and Jones 1985).

The stratigraphic units, contact drilled depth, stratigraphic thicknesses, and predicted values for RRL-2B and RRL-2C are listed in table 1. A general stratigraphic framework for the upper Grande Ronde Basalt at the RRL-2 site is provided in figure 11. Composite borehole geophysical log traces for the Rocky Coulee, Cohassett, and Grande Ronde 5 flows are shown in figures 12 through 15. These figures also contain the geologic log summary that was interpreted from core data in RRL-2A (Cross and Fairchild 1985) and a description of geologic features observed from the video surveys run in RRL-2B and RRL-2C.

4.3.1 Saddle Mountains Basalt

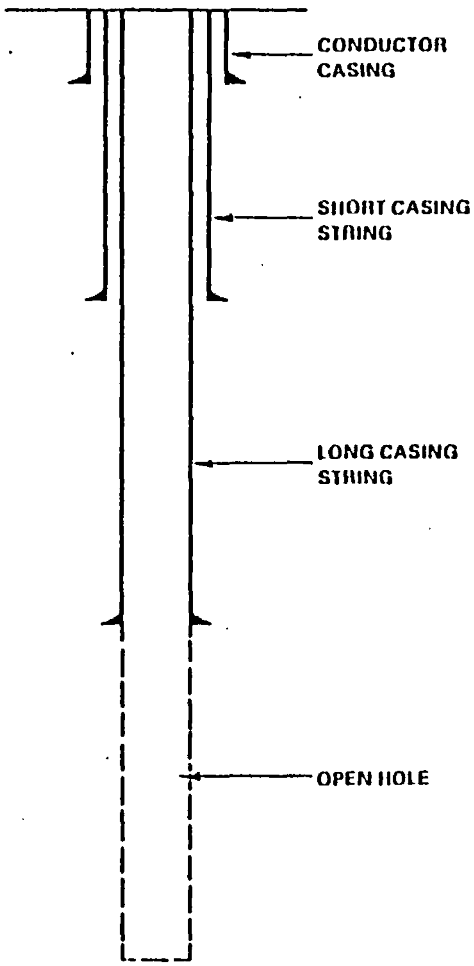
Observed net thickness of the Saddle Mountains Basalt was within ±3 ft (±0.9 m) of the predicted value of 795 ft (242 m) in both RRL-2B and RRL-2C. Thicknesses of individual units and interbeds within the formation varies similarly to other boreholes, such as at borehole cluster sites DC-19, DC-20, and DC-22 (Jackson et al. 1984).

4.3.2 Wanapum Basalt

Total Wanapum Basalt thickness at RRL-2B was 1,169 ft (356.3 m), which was 9 ft (2.7 m) thicker than predicted. Overall observed thickness of the Wanapum Basalt was 1,153 ft (351.4 m) at RRL-2C, which was 7 ft (2.1 m) thinner than predicted. All individual units within the Wanapum Basalt were within 10 ft (3.1 m) of the predicted values at both sites.

4.3.3 Grande Ronde Basalt

Thicknesses of those units penetrated in RRL-2B and RRL-2C were within 10 ft (3.1 m) of predicted values.

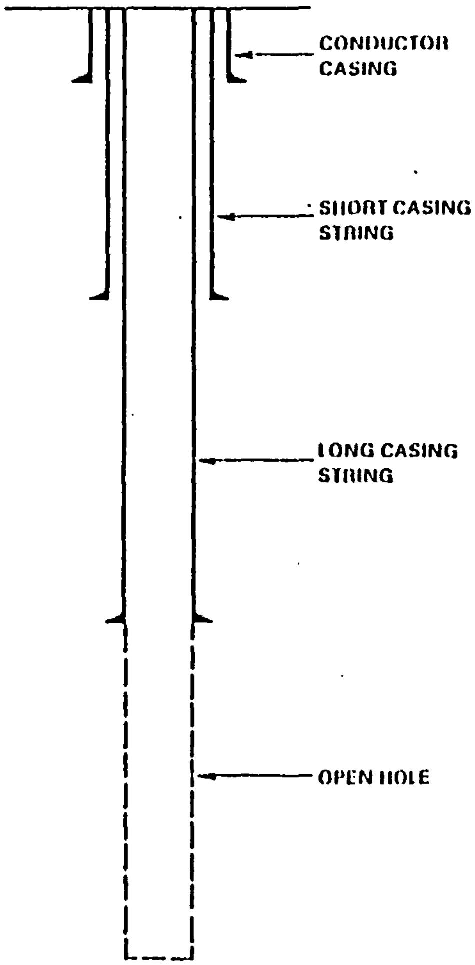


PRE-CASE LOGGING	POST-CASE LOGGING
NOT APPLICABLE	NOT APPLICABLE
THREE-ARM CALIPER NEUTRON-EPITHERMAL NEUTRON GAMMA-GAMMA SPONTANEOUS POTENTIAL/ RESISTIVITY NATURAL GAMMA	NOT APPLICABLE
FOUR-ARM CALIPER/ BOREHOLE VOLUME SPONTANEOUS POTENTIAL/ RESISTIVITY NEUTRON-EPITHERMAL NEUTRON GAMMA-GAMMA THREE-ARM CALIPER NATURAL GAMMA	CEMENT BOND LOG
FOUR-ARM CALIPER/ BOREHOLE VOLUME FULL-WAVE ACOUSTIC* SPONTANEOUS POTENTIAL/ RESISTIVITY NEUTRON-EPITHERMAL NEUTRON GAMMA-GAMMA NATURAL GAMMA BOREHOLE TELEVISION FLUID TEMPERATURE GYRO-SURVEY MAGNETOMETER THREE-ARM CALIPER	

*BOREHOLE COMPENSATED

PS8604 6

Figure 9. Geophysical Logging Schedule for Well RRL-2B.



PRE-CASE LOGGING	POST-CASE LOGGING
NOT APPLICABLE	NOT APPLICABLE
FOUR-ARM CALIPER NEUTRON-EPITHERMAL NEUTRON SPONTANEOUS POTENTIAL/ RESISTIVITY GAMMA-GAMMA NATURAL GAMMA THREE-ARM CALIPER	NOT APPLICABLE
FOUR-ARM CALIPER/ BOREHOLE VOLUME FULL-WAVE ACOUSTIC* SPONTANEOUS POTENTIAL/ RESISTIVITY NEUTRON-EPITHERMAL NEUTRON GAMMA-GAMMA NATURAL GAMMA THREE-ARM CALIPER	FLUID TEMPERATURE CEMENT BOND LOG
FOUR ARM CALIPER/ BOREHOLE VOLUME FULL-WAVE ACOUSTIC* SPONTANEOUS POTENTIAL/ RESISTIVITY NEUTRON-EPITHERMAL NEUTRON* GAMMA-GAMMA* NATURAL GAMMA BOREHOLE TELEVISION FLUID TEMPERATURE GYRO-SURVEY MAGNETOMETER DYNAMIC TEMPERATURE TELEVIEWER	

*BOREHOLE COMPENSATED

PS8604 6

Figure 10. Geophysical Logging Schedule for Piezometer Nest RRL-2C.

Table 1. Predicted/Observed Stratigraphic Thicknesses for Boreholes RRL-2B and RRL-2C. (sheet 1 of 3)

Stratigraphic unit	RRL-2A		RRL-2B and RRL-2C		RRL-2C		RRL-2B	
	Observed net thickness, ft (m)	Observed depth, ft (m)	Predicted net thickness, ft (m)	Predicted depth, ft (m)	Observed net thickness, ft (m)	Observed depth, ft (m)	Observed net thickness, ft (m)	Observed depth, ft (m)
Hanford/Ringold Formations	605 (184.4)	0-605 (0-184.4)	600 (182.9)	0-600 (0-182.9)	600 (182.9)	0-600 (0-182.9)	600 (182.9)	0-600 (0-182.9)
Saddle Mountains Basalt	794 (242.0)	794-1,399 (242.0-426.4)	795 (242.3)	600-1,395 (182.9-425.2)	792 (241.4)	600-1,392 (182.9-424.3)	798 (243.2)	600-1,398 (182.9-426.1)
Elephant Mountain Member	81 (24.7)	605-686 (184.4-209.1)	80 (24.4)	600-680 (182.9-207.3)	84 (25.6)	600-684 (182.9-208.5)	87 (26.5)	600-687 (182.9-209.4)
Rattlesnake Ridge interbed	96 (29.3)	686-782 (209.1-238.4)	95 (29.0)	680-775 (207.3-236.2)	106 (32.3)	684-790 (208.5-240.8)	104 (31.7)	687-791 (209.4-241.1)
Pomona Member	159.5 (48.6)	782-941.5 (238.4-287.0)	160 (48.8)	775-935 (236.2-285.0)	144 (43.9)	790-934 (240.8-284.7)	136 (41.4)	791-927 (241.1-282.5)
Selah interbed	44.5 (13.6)	941.5-986 (287.0-300.5)	45 (13.7)	935-980 (285.0-298.7)	46 (14.0)	934-980 (284.7-298.7)	73 (22.2)	927-1,000 (282.5-304.8)
Esquatzel Member	118 (36.0)	986-1,104 (300.5-336.5)	120 (36.6)	980-1,100 (298.7-335.3)	116 (35.4)	980-1,096 (298.7-334.1)	98 (29.9)	1,000-1,098 (304.8-334.7)
Cold Creek interbed	64 (19.5)	1,104-1,168 (336.5-356.0)	65 (19.8)	1,100-1,165 (335.3-355.1)	69 (21.0)	1,096-1,165 (334.1-355.1)	71 (21.6)	1,098-1,169 (334.7-356.3)
Umatilla Member	231 (70.4)	1,168-1,399 (356.0-426.4)	230 (70.1)	1,165-1,395 (355.1-425.2)	227 (69.2)	1,165-1,392 (355.1-424.3)	229 (69.8)	1,169-1,398 (356.3-426.1)
Mabton interbed	124 (37.8)	1,399-1,523 (426.4-464.2)	123 (37.5)	1,395-1,518 (425.2-462.7)	123 (37.5)	1,392-1,515 (424.3-461.8)	119 (36.3)	1,398-1,517 (426.1-462.4)
Wanapum Basalt	1,160 (353.6)	1,523-2,683 (464.2-817.8)	1,160 (353.6)	1,518-2,678 (462.7-816.3)	1,153 (351.4)	1,515-2,668 (461.8-813.2)	1,169 (356.3)	1,517-2,686 (462.4-818.7)
Priest Rapids Member	226.4 (69.0)	1,523-1,749.4 (464.2-533.2)	227 (69.2)	1,518-1,745 (462.7-531.9)	227 (69.2)	1,515-1,742 (461.8-531.0)	235 (71.6)	1,517-1,752 (462.4-534.0)
(Lolo flow)	166 (50.6)	1,523-1,689 (464.2-514.8)	165 (50.3)	1,518-1,683 (462.7-513.0)	165 (50.3)	1,515-1,680 (461.8-512.1)	168 (51.2)	1,517-1,685 (462.4-513.6)

Table 1. Predicted/Observed Stratigraphic Thicknesses for Boreholes RRL-2B and RRL-2C. (sheet 2 of 3)

Stratigraphic unit	RRL-2A		RRL-2B and RRL-2C		RRL-2C		RRL-2B	
	Observed net thickness, ft (m)	Observed depth, ft (m)	Predicted net thickness, ft (m)	Predicted depth, ft (m)	Observed net thickness, ft (m)	Observed depth, ft (m)	Observed net thickness, ft (m)	Observed depth, ft (m)
(Rosalia flow)	60.4 (18.4)	1,689-1,749.4 (514.8-533.2)	62 (18.9)	1,683-1,745 (513.0-531.9)	62 (18.9)	1,680-1,742 (512.1-531.0)	67 (20.4)	1,685-1,752 (513.6-534.0)
Quincy interbed	0.6 (0.2)	1,749.4-1,750 (533.2-533.4)	0	-	0	-	2 (0.6)	1,752-1,754 (534.0-534.6)
Roza Member	172 (52.4)	1,750-1,922 (533.4-585.8)	172 (52.4)	1,745-1,917 (531.9-584.3)	177 (53.9)	1,742-1,919 (531.0-584.9)	165 (50.3)	1,754-1,919 (534.6-584.9)
Frenchman Springs Member	761 (232.0)	1,922-2,683 (585.8-817.8)	761 (231.9)	1,917-2,678 (584.3-816.2)	749 (228.3)	1,919-2,668 (584.9-813.2)	767 (233.8)	1,919-2,686 (584.9-818.7)
Frenchman Springs 1 (Sentinel Gap)	182 (55.5)	2,683-2,104 (817.8-641.3)	182 (55.5)	1,917-2,099 (584.3-639.8)	174 (53.0)	1,920-2,094 (585.2-638.2)	184 (56.1)	1,919-2,103 (584.9-641.0)
Frenchman Springs 2 (Sand Hollow II)	113 (34.4)	2,104-2,217 (641.3-675.7)	113 (34.4)	2,099-2,212 (639.8-674.2)	112 (34.2)	2,094-2,206 (638.2-672.4)	106 (32.3)	2,103-2,209 (641.0-673.3)
Frenchman Springs 3 (Sand Hollow I)	56 (17.1)	2,217-2,273 (675.7-692.8)	56 (17.1)	2,212-2,268 674.2-691.3)	57 (17.4)	2,206-2,263 (672.4-689.8)	60 (18.3)	2,209-2,269 (673.3-691.6)
Frenchman Springs 4 (Silver Falls)	108 (32.9)	2,273-2,381 (692.8-725.7)	108 (32.9)	2,260-2,376 (691.3-724.2)	111 (33.8)	2,263-2,374 (689.8-723.6)	111 (33.8)	2,269-2,380 (691.6-725.4)
Frenchman Springs 5 (Ginkgo II)	108 (32.9)	2,381-2,489 (725.7-758.6)	108 (32.9)	2,376-2,484 (724.2-757.1)	107 (32.6)	2,374-2,481 (723.6-756.2)	108 (32.9)	2,380-2,488 (725.4-758.3)
Frenchman Springs 6 (Ginkgo I)	128 (39.0)	2,489-2,617 (758.6-797.7)	128 (39.0)	2,484-2,612 (757.1-796.1)	125 (38.1)	2,481-2,606 (756.2-794.3)	126 (38.4)	2,480-2,614 (758.3-796.7)
Frenchman Springs 7 (Palouse Falls)	66 (20.1)	2,617-2,683 (797.7-817.8)	66 (20.1)	2,612-2,678 (796.1-816.2)	62 (18.9)	2,606-2,668 (794.3-813.2)	72 (21.9)	2,614-2,686 (796.7-818.7)
Vantage interbed	4 (1.2)	2,683-2,687 (817.8-819.0)	4 (1.2)	2,678-2,682 (816.2-817.5)	0	-	4 (1.2)	2,686-2,690 (818.7-819.9)

Table 1. Predicted/Observed Stratigraphic Thicknesses for Boreholes RRL-2B and RRL-2C. (sheet 3 of 3)

Stratigraphic unit	RRL-2A		RRL-2B and RRL-2C		RRL-2C		RRL-2B	
	Observed net thickness, ft (m)	Observed depth, ft (m)	Predicted net thickness, ft (m)	Predicted depth, ft (m)	Observed net thickness, ft (m)	Observed depth, ft (m)	Observed net thickness, ft (m)	Observed depth, ft (m)
Grande Ronde Basalt-Sentinel Bluffs Sequence	920 (280.4)	2,687-3,607 (819.0-1,099.4)	920 (280.4)	2,682-3,602 (817.5-1,097.9)	-	-	-	-
Grande Ronde 1	34 (10.4)	2,687-2,721 (819.0-829.4)	34 (10.4)	2,682-2,716 (817.5-827.8)	44 (13.4)	2,668-2,712 (813.2-826.6)	32 (9.8)	2,690-2,722 (819.9-829.7)
Grande Ronde 2	102 (31.1)	2,721-2,823 (829.4-860.5)	102 (31.1)	2,716-2,818 (827.8-858.9)	104 (31.7)	2,712-2,816 (826.6-858.3)	101 (30.8)	2,722-2,823 (829.7-860.4)
Grande Ronde 3 (Rocky Coulee)	170 (51.8)	2,823-2,993 (860.5-912.3)	170 (51.8)	2,818-2,988 (858.9-910.7)	166 (50.6)	2,816-2,982 (858.3-908.9)	-	2,823-? (860.4-?)
Grande Ronde 4 (Cohassett)	262 (79.8)	2,993-3,255 (912.3-992.1)	262 (79.8)	2,988-3,250 (910.7-990.6)	269 (82.0)	2,982-3,251 (908.9-990.9)	-	a
Grande Ronde 5	133 (40.5)	3,255-3,388 (992.1-1,032.6)	133 (40.5)	3,250-3,383 (990.6-1,031.1)	131 (39.9)	3,251-3,382 (990.9-1,030.8)	-	-
Grande Ronde 6	29.5 (9.0)	3,388-3,417.5 (1,032.6-1,041.6)	30 (9.1)	3,383-3,413 (1,031.1-1,040.2)	-	3,382-? (1,030.8-?)	-	-
Grande Ronde 7	57.5 (17.6)	3,417.5-3,475 (1,041.6-1,059.2)	57 (17.4)	3,413-3,470 (1,040.2-1,057.6)	-	b	-	-
Grande Ronde 8 (McCoy Canyon)	132 (40.2)	3,475-3,607 (1,059.2-1,099.4)	132 (40.2)	3,470-3,602 (1,057.6-1,097.9)	-	-	-	-
Grande Ronde 9 (Umtanum)	232 (70.7)	3,607-3,839 (1,099.4-1,170.1)	232 (70.7)	3,602-3,834 (1,097.9-1,168.6)	-	-	-	-
Grande Ronde 10 (very high Mg)	64 (19.5)	3,839-3,903 (1,170.1-1,189.6)	64 (19.5)	3,834-3,898 (1,168.6-1,188.1)	-	-	-	-

[a]Interim total depth 2,858 ft (871.1 m)

[b]Total depth by log 3,404 ft (1,037.5 m)

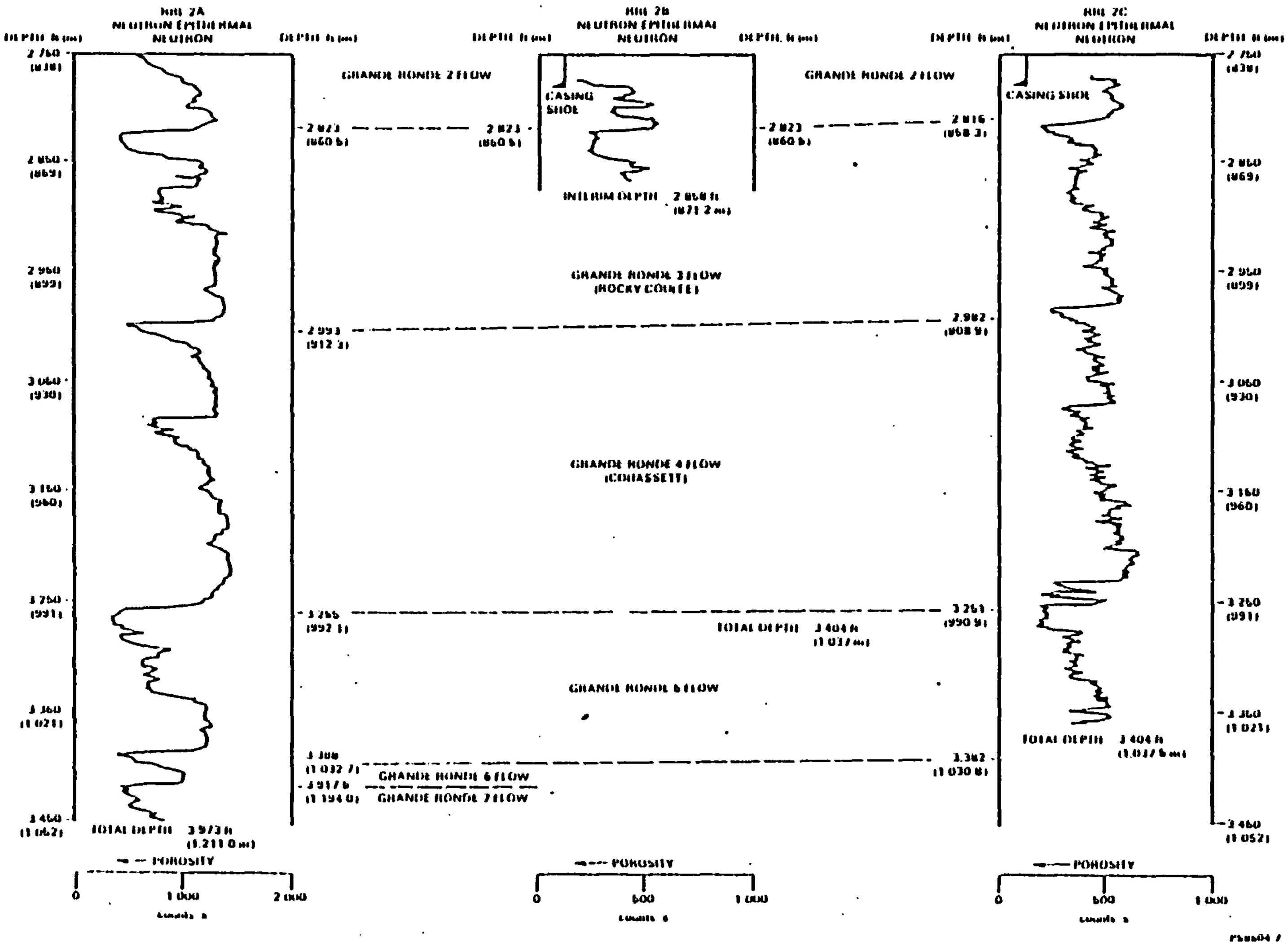


Figure 11. Neutron-Epithermal-Neutron Log Traces for Core Hole RRL-2A, Well RRL-2B, and Piezometer Nest RRL-2C.

Composite borehole geophysical log traces for part of the Grande Ronde 2 and Rocky Coulee flows at RRL-2B, and for the Rocky Coulee, Cohassett, and Grande Ronde 5 flows at RRL-2C are shown in figures 12 through 15. The borehole caliper log measures two diameters both of which are displayed in the figures. The compensated neutron log represents relative porosity as compared with limestone/sandstone calibration blocks. Because the porosity is calibrated to limestone/sandstone rather than basalt, the relative porosity responses are shown in figures 12 through 15. The compensated density values are recorded from aluminum and magnesium density calibrations, and assumes a 2.85 g/cm^3 matrix. Omnidirectional tools (neutron-epithermal neutron and gamma gamma) run in RRL-2B are recorded in counts per second and are used to indicate relative porosity and density. The full-wave acoustic log is used to obtain the shear wave amplitude. The data are collected by a multiple receiver tool at 3 and 5 ft (0.91 and 1.52 m) spacings. Static fluid temperature is measured in the open hole. The dynamic fluid temperature is run in the borehole while air-lift pumping.

The data suggest that gross intraflow structures (i.e., flow top) can be inferred by examining the video recording and comparing it to the core log for the RRL-2A. Features such as elongated borehole wall breakouts and in situ fractures were noted and examined from the video recording. As indicated by the X-Y caliper log trace, video survey, and televiewer log, borehole wall breakouts tend to be minimal in the basal part of the flow and the flow top. Significant breakouts occur in the upper and middle parts of the flow. The entablature zone, which appears to be more susceptible to extensive breakouts, typically shows a blocky shaped borehole wall. The elongated borehole wall breakouts are attributed to high in situ horizontal stresses that are known to exist in the RRL area (Paillet and Kim 1985).

In extensive breakout zones, the decentralized and compensated borehole geophysical tools could not obtain true formation signals. A determination as to the extent of fractures associated with breakouts cannot be made on the basis of existing borehole geophysical logs. Studies by Paillet and Kim (1985) for selected deep boreholes on the Hanford Site indicate that the effects of borehole wall breakouts are surficial and are confined to a relatively thin zone around the borehole; i.e., within one borehole diameter or less in width.

In situ fractures, indicated as a letter "F" on figures 12, 13, 14, and 15, are identified on the shear wave amplitude log and verified by examination of the video survey. These fractures appear on the video as significant in width (as compared with other fractures within the flow) or as fracture sets at a specific depth. Note that the depth scales in the plots are slightly distorted from true depth due to systematic errors in digitizing and graphic plotting with the computer. Fractures seen in the video were compared to the actual geophysical logs for correlation and depth correction. The temperature anomaly at 2,835 ft (864.1 m) in figure 13 represents a large vug. This depth is more accurately estimated at 2,831 ft (862.9 m).

At RRL-2B, the following interpretations were made from available borehole logging information (see fig. 12).

- Rocky Coulee Flow

- Borehole wall breakouts are minimal to the interim depth of 2,858 ft (871.1 m) in the Rocky Coulee flow. The average borehole diameter ranged from 12.5 to 13.5 in. (32 to 34 cm). The maximum diameter is 15.5 in. (39 cm).

- The apparent high porosity, between the depths of 2,821 and 2,847 ft (859.8 and 867.8 m), corresponds to the flow-top breccia and vesicular basalt in this interval.

- Intervals of apparent high porosity also were noted on the neutron log between the depths of 2,785 and 2,805 ft (848.9 and 855.0 m). This interval corresponds to a fractured vuggy basalt. Two fractures were also observed on the video that showed on the shear wave amplitude log. The hydrogeologic significance of these fractures is unknown.

- The dynamic fluid temperature log (fig. 12) does not provide adequate information to evaluate where groundwater production occurs within the flow top. The cause for this may be attributed to the low-volume velocities induced during air-lift pumping.

At RRL-2C, the following interpretations were made from available borehole logging information (see fig. 13 through 15).

- Rocky Coulee Flow

- Borehole wall breakouts are continuous between a depth of 2,845 and 2,974 ft (867.2 and 906.5 m). In this interval the average borehole diameter and maximum diameter are about 15 and 24 in. (38 and 61 cm), respectively.

- The apparent high porosity, as indicated on the neutron log, corresponds to the flow top between the depths of 2,816 and 2,834 ft (858.3 and 863.8 m). Within this interval, the principal groundwater-producing zone appears to be associated with a vuggy and vesicular area at a depth of 2,831 ft (862.9 m). Groundwater production from the zone was interpreted from the dynamic fluid temperature log, shear wave amplitude log, and video survey (see fig. 13).

- Several fractures present in the flow interior are indicated on the shear wave amplitude log trace. The hydrogeologic significance of these fractures is not known.

- <u>Cohassett Flow</u>

- Borehole wall breakouts are nearly continuous between a depth of 3,002 and 3,206 ft (915.0 and 977.2 m). In this interval the average borehole diameter ranged from 15 to 18 in. (38 to 46 cm). The maximum diameter is 23 in. (58 cm).

- The apparent high porosity, as indicated on the neutron log, corresponds to the vesicular flow top between the depth interval of about 2,982 and 3,000 ft (908.9 and 914.4 m).

- The Cohassett interior vesicular zone, between a depth of 3,071 and 3,083 ft (936.0 and 939.7 m), is evident by an apparent intermediate porosity response on the neutron log. An area of apparent high porosity below the vesicular zone is attributed to borehole wall breakouts as verified by the video survey.

- The zone from 3,232 to 3,251 ft (985.1 to 990.9 m) contains two zones of apparent high neutron-log porosity. They are identified as primary emplacement zones based on the natural gamma log response, video survey, and stratigraphic thickness relationships. This interval also corresponds closely to an anomalous zone on the dynamic fluid temperature log.

- Several fractures present in the flow interior are indicated on the shear wave amplitude log trace. The hydrogeologic significance of these fractures is not known.

- <u>Grande Ronde 5 Flow</u>

- Borehole wall breakouts are nearly continuous over the depth intervals of 3,254 to 3,358 ft (991.8 to 1,023.5 m). In these intervals, the average borehole diameter ranged from about 13 to 15 in. (33 to 38 cm). The maximum diameter is 17 in. (43 cm).

- The apparent high-porosity zone, as indicated on the neutron log, corresponds to the flow-top breccia and vesicular flow top between the depth of about 3,251 and 3,272 ft (990.9 and 997.3 m).

- A vesicular zone between the depths of 3,272 and 3,340 ft (997.3 and 1,018.0 m) is evident in the video survey. This zone appears to occur within the interior of the flow. The depth of the vesicular zone is not known because of a cloudy video display image due to the presence of some particulate matter in the borehole fluid.

- A dynamic fluid temperature anomaly (fig. 15) between 3,251 and 3,280 ft (990.9 and 999.7 m) indicates a potential zone of groundwater production.

5.0 BOREHOLE PREPARATION

The borehole preparation activities at RRL-2B and RRL-2C are summarized below. Supporting data and tables are provided in appendix D.

5.1 WELL RRL-2B

The borehole preparation involved circulating the open-hole part of the borehole with Hanford system water immediately after reaching the interim depth of 2,858 ft (871.1 m). This was done to remove drill cuttings that may have accumulated in the borehole during the drilling operations. In addition, it prepared the borehole for running the video camera survey and installing pumping equipment for large-scale hydrologic testing.

Limited borehole development also was performed by air-lift pumping while running the fluid temperature sonde on September 19, 1985. An estimated 1,000 gal (3.8 m^3) of fluid were removed from the borehole. Further flushing of the borehole was accomplished on October 17 and 18, 1985. The total volume of Hanford system water used to flush the borehole was about 48,000 gal (181.7 m^3). During circulation, an estimated 14,000 gal (53.0 m^3) of fluid were lost to the Rocky Coulee flow top. A video survey conducted October 26, 1985, indicated that only minor amounts of particulate matter remained suspended in the water after circulation.

Air-lift pumping was not used as the principal technique to develop the borehole due to the low transmissivity of the Rocky Coulee flow top. Preliminary estimates of transmissivity of the Rocky Coulee flow top range from 2 to 6 ft^2/d (0.2 to 0.6 m^2/d) in the vicinity of the RRL-2 site. This estimate is based on pulse testing of the Rocky Coulee flow top between RRL-2B and borehole RRL-2A and RRL-2C on October 16, 1985 (Stone 1985a). Pressure responses were analyzed using the pulse testing technique described by Johnson et al. (1966).

5.2 PIEZOMETER NEST RRL-2C

The open borehole was developed prior to installing the multilevel piezometers by pumping until the discharge water was essentially free of particulates.

A line-shaft turbine was used to pump the composite interval of the Grande Ronde Basalt in the 12.25-in. (31.12-cm) borehole below the grouted 13.375-in. (33.973-cm) casing. The average discharge rate was 59.6 gal/min (226 L/min) over a pumping period of 52.3 h between June 5 and 7, 1985. The volume of groundwater removed during the period was about 187,000 gal (707.9 m^3). The maximum drawdown was 61 ft (18.6 m). The 2.1-d specific capacity was 0.98 gal/min/ft (12.2 L/min/m).

Groundwater samples were collected for major constituent analyses during the pumping phase to assess hydrochemical recovery dynamics for a water-drilled borehole. Gas samples were collected from an experimental gas-separator barrel to evaluate well-head dissolved gas sampling procedures under two-phase flow conditions. These data are beyond the scope of this report and will be reported in the Hydrochemistry Data Base and in hydrochemical topical reports.

On June 7 and 10, 1985, additional pumping was done to run a dynamic fluid temperature survey and to obtain gas samples. The volume of formation water pumped from the borehole was about 16,600 gal (62.8 m^3). Therefore, the total volume of water removed from the borehole during composite pumping was about 203,600 gal (770.7 m^3).

Two potential zones of groundwater production were indicated on the dynamic fluid temperature survey in the open portion of the borehole (2,775 to 3,404 ft (845.8 to 1,037.5 m)) (see fig. 13 through 15). As indicated by temperature anomalies, a water zone occurs in a distinct vuggy zone at a depth of 2,831 ft (862.9 m), which stratigraphically occurs near the base of the Rocky Coulee flow top. Another water zone occurs between a depth of 3,232 and 3,280 ft (985.1 and 999.7 m), which corresponds to the Grande Ronde 5 flow top and Cohassett flow bottom. Based on drilling-loss data and borehole geophysical logs, the most productive zone appears to be the Grande Ronde 5 flow top.

The transmissivity of the Grande Ronde 5 flow top at RRL-2C was estimated from the specific-capacity data obtained during borehole development. The specific-capacity method (Theis et al. 1963) was employed over other conventional analytical methods because the water column in the pumped borehole was influenced by temperature and gas effects. These effects prevented analysis of the drawdown and recovery data that were monitored with shallow-pressure transducers. Using a specific capacity of 0.98 gal/min/ft (12.2 L/min/m) of drawdown gives a transmissivity of 280 ft^2/d (26 m^2/d). Because of the uncertainties discussed previously, the estimated transmissivity for the Grande Ronde 5 flow top falls between 200 and 300 ft^2/d (20 and 30 m^2/d) at RRL-2C.

6.0 PIEZOMETER INSTALLATION

6.1 PIEZOMETER DESIGN

The nested piezometers in RRL-2C will serve in determining the hydraulic properties of the pumped horizons (i.e., flow tops), as well as those of the adjacent flow interiors, during large-scale hydraulic testing at RRL-2B. Six piezometers designed for monitoring formation pressures and hydraulic heads in the Grande Ronde Basalt comprise RRL-2C. The six monitoring horizons are within the depth interval of 2,775 to 3,404 ft (845.8 to 1,037.5 m). These horizons are (with increasing depth) the Rocky Coulee flow top, Rocky Coulee flow interior, Cohassett flow top, Cohassett flow interior, Grande Ronde 5 flow top (which also includes part of the Cohassett flow bottom interval), and Grande Ronde 5 flow interior.

In general, these piezometers are monitoring facilities consisting of (1) a tail pipe; (2) one or more screened section(s) in the monitoring horizon; (3) a seating nipple; (4) a riser tube to the ground surface; (5) a multiple-gradation filter pack; and, (6) a densified cement seal. Each piezometer string is partially centralized to achieve standoff of the screen sections from the borehole wall and the adjacent piezometer strings in the borehole. This facilitates placement of the filter pack around the tailpipe, the screen sections, and the riser tubing. It also facilitates placement of the densified cement seal around the riser tubing above the filter pack. The six multilevel monitoring horizons are isolated from each other and the next overlying hydrogeologic horizon by densified cement seals. The configuration of the multilevel piezometer and the as-built details are summarized in figures A-3, A-4, and A-8 and in table E-1.

The placement of the piezometers was based on examination of a suite of borehole geophysical logs (fig. 12 through 14). Borehole geophysical logs were correlated to core data at the nearby RRL-2A. High and low porosity within a specific flow were qualitatively differentiated using the neutron-epithermal neutron and sonic logs to position the flow-top piezometers and provide approximate locations for the interior piezometers.

The vertical locations of the flow-interior piezometers at RRL-2C were further refined by using axisymmetrical and analytical (Neuman and Witherspoon 1968) models. These models were used to simulate drawdown in the basalt flow interior at various vertical distances from the pumped flow top. It should be noted that the simulated responses assumed a homogeneous and isotropic flow interior. Input parameters used in the models are given by Stone (1985b).

The results reported by Stone (1985a), indicate that the Rocky Coulee flow-interior piezometer should be placed about 60 ft (18.3 m) below the Rocky Coulee flow top; the Cohassett flow-interior piezometer should be placed about 80 ft (24.4 m) above the Grande Ronde 5 flow top; and, the Grande Ronde 5 flow-interior piezometer should be placed about 45 ft (13.7 m) below the Grande Ronde 5 flow top. These depths were used to finalize the location for the three flow-interior piezometers at RRL-2C.

6.2 PIEZOMETER MATERIALS

The piezometer materials installed at RRL-2C were similar to those used at the borehole cluster sites DC-19, DC-20, and DC-22 (Jackson et al. 1984). The components and their position with respect to the overall piezometer string are shown schematically in figures A-3, A-4, and A-8.

6.2.1 Tubing

The tailpipe and riser tubing is API, integral joint (IJ), 10-round (RD) thread, J-55 (low-carbon) steel tubing. The tubing weighs 3.25 lb/ft (4.8 kg/m). The yield strength is 55,000 lbf/in^2 (379.2 MPa), and the nominal diameter is 1.751-in. (4.448-cm) ID and 2.063-in. (5.240-cm) OD.

Preliminary galvanic corrosion studies by Rockwell (Anantatmula 1985) indicate a life expectancy for the low-carbon steel tubing of at least 30 yr. This estimate is based on static conditions and the assumption that the entire length of the low-carbon steel pipe is in contact with the Type 316-L stainless steel screen.

6.2.3 Screen

The screen sections consist of a continuous-slot, wire-wound screen jacket (2.56-in. (6.50-cm) OD) over a perforated pipe base (2.063-in. (5.240-cm) OD). The screen jacket is fabricated by circumferentially wrapping a 0.06-in. (1.52-mm) triangularly shaped wire around a circular array of 18 internal rods. The wire wrap provides inlet slots with sharp outer edges that widen inwardly to minimize clogging. The boss rings are welded to the ends of the screen jacket and, in turn, are welded to the pipe base. The screen jacket and boss rings are fabricated from corrosion-resistant Type 316-L stainless steel. The pipe base and screen jacket details are given in table 2. The screen slot opening is 0.040 in. (10.2 mm). The length of individual screen sections ranged from 2 to 10 ft (0.61 to 3.1 m).

Table 2. Pipe Base and Screen Jacket Details.

Description	Dimensions	
	Pipe base	
Inside diameter	1.751 in.	(4.448 cm)
Outside diameter	2.063 in.	(5.240 cm)
Weight	3.25 lb/ft	(4.8 kg/m)
Thread	2.06 in.	(5.23 cm) IJ, 10 RD
Diameter of holes	0.31 in.	(0.79 cm)
Number of holes	84	
Open area of holes	6.44 in^2/ft	(136.3 cm^2/m)
	Screen jacket	
Outside diameter	2.56 in.	(6.50 cm)
Open area 40/1,000-in. slot	38.6 in^2/ft	(817 cm^2/m)

RD = Round.
IJ = Integral joint.

6.2.4 Urethane Sleeves

Urethane sleeves were fitted on the screen sections to prevent adjacent riser piezometer strings in the borehole from touching the stainless steel screen. The sleeves are 2- by 3-in. (5.1- by 7.6-cm) OD by 2.125-in. (5.398-cm) ID. The sleeves are located on the top and bottom of each screen section. If more than one screen section were used (i.e., Grande Ronde 5 flow top), three sleeves were used as shown in figure A-4.

6.2.5 Seating Nipple

The seating nipple, 8 in. (20.3 cm) in length, is positioned about 2 ft (0.61 m) above the piezometer screen. It has a diameter of 1.375-in. (3.49-cm) ID and 2.063-in. (5.240-cm) OD and is made of low-carbon steel. A wire-line retrievable standing valve is placed in the seating nipple to seal the piezometer string above the screen so it can be checked for tubing leaks prior to placement of the filter pack and cement slurry seal. The seating nipple also provides a landing for the downhole pressure probe during piezometric monitoring.

6.2.6 Centralizers

Each piezometer string was partially centralized to achieve standoff of the screen sections from the borehole wall and adjacent piezometer strings in the borehole. The centralizers were spaced below and above each screen interval, near the pea gravel/dense-cement interface and 30 to 40 ft (9.1 to 12.2 m) above this interface. For the lowermost piezometer, an additional set of centralizers was located about 60 to 70 ft (18.3 to 21.3 m) above the screen. Centralizer plates were fabricated at the drill site with 0.375-in. (9.53-mm) thick, low-carbon flat steel. Individual centralizer plates were arranged radially and were welded onto the piezometer tubing at spacings ranging from 60 to 120 degrees.

6.2.7 Filter Pack

The filter pack consists of the monitoring horizon sand pack and the pea gravel pack. Gradation curves for these materials are shown in figure 16. The sand pack consists of well-rounded No. 10-20 and No. 4-8 silica sand. The finer sand pack (No. 10-20) is used to retard downward migration of the cement slurry into the coarser sand pack. The manufacturer's chemical description for the No. 4-8 and No. 10-20 sand is given in table E-8. The sand pack material was bagged in 100 lb (45.4 kg) waterproof bags.

The pea gravel pack consists of clean, washed, rounded gravel comprised of igneous and metamorphic rock material. This material was provided from a local sand and gravel quarry and delivered in bulk to the drill site. The coarser pea gravel was placed over the sand pack to prevent erosion of the sand pack material during placement of the next densified cement seal.

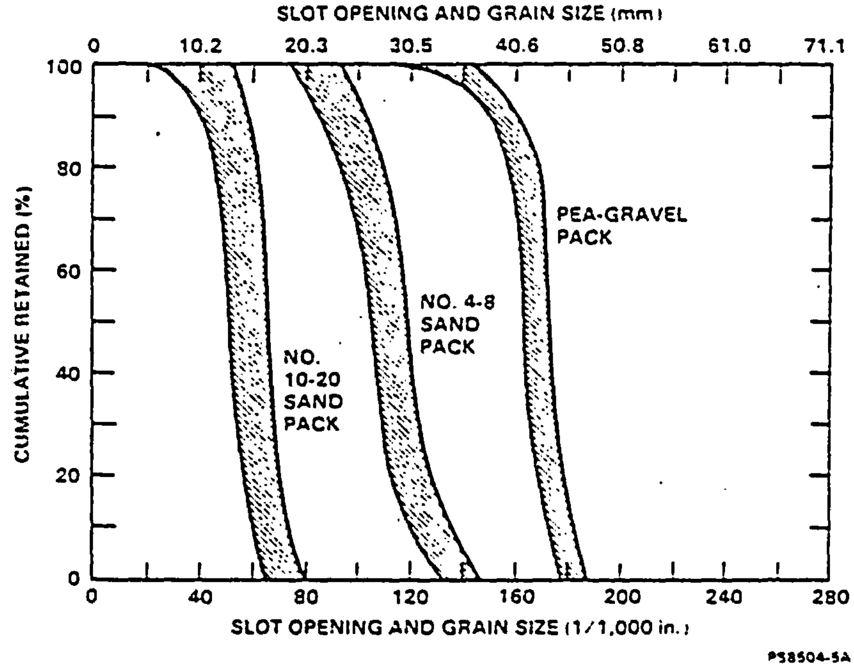


Figure 16. Number 10-20 and 4-8 Sands and Pea Gravel Gradation Envelopes.

6.2.8 Densified Cement Seal

The cement seals consist of API Class G cement. Class G cement is recommended for use from ground surface to a depth of 8,000 ft (2,440 m) (Smith 1976). The composition and physical properties of Class G cement used at RRL-2C are given in table E-6.

Class G cement with a friction reducer was mixed with Hanford system water to a high-density slurry of 17.5 lb/gal (2.10 kg/L). The water ratio and yield of the slurry was 3.38 gal/sack (12.80 L/sack), and 0.93 ft^3/sack (0.026 m^3/sack), respectively. High-density cement (i.e., low-water content) was used to minimize microannulus effects, provide high-compressive strengths, and low-matrix permeability.

A subcontracted cementing service company performed selected laboratory tests on the densified cement. The results are summarized below.

Thickening time	164 min
Compressive strength	
6 h	1,500 lbf/in^2 (10.3 MPa)
12 h	5,600 lbf/in^2 (38.6 MPa)
24 h	6,000+ lbf/in^2 (41.4+ MPa)
Hydraulic conductivity	
Composite	8 E-06 ft/d (2E-06 m/d)
Matrix	1 E-06 ft/d (3E-07 m/d)

The composite hydraulic conductivity refers to matrix hydraulic conductivity, as well as microannulus flow capacity. All samples were cured under simulated formation conditions.

In addition to these tests, hydraulic conductivity tests were performed. The results of these tests are given below.

Slurry density, lb/gal (kg/L)	Hydraulic conductivity, ft/d (m/d)
16.2 (1.94)	7 E-08 (2 E-08)
16.2* (1.94)	6 E-09 (2 E-09)
17.5 (2.10)	essentially impermeable

*1% $CaCl_2$

All laboratory test results are on file with BRMC.

6.3 PIEZOMETER INSTALLATION PROCEDURE

The installation procedure consists of a sequence of operations required to place and secure one piezometer tubing string in a borehole to monitor a specific horizon. This sequence of operations is repeated each time another piezometer tubing string is placed and secured in the borehole until the required number of piezometer tubing strings has been installed. Jackson and Jones (1985) provided the design and procedures to guide the piezometer installation at RRL-2C.

Each piezometer tubing string was field checked to determine internal openness and to identify possible major tubing breach defects, such as a tubing hole or split, or flawed tubing joint threads. This was accomplished by the following:

- Steam cleaning the piezometer tubing at the storage facility
- Inspecting piezometer tubing and joint threads while strapping (measuring tubing length) tubing on the workover-rig tubing racks
- Passing a steel rod through the piezometer tubing as it was transferred to the rig derrick rack
- Wrapping teflon tape on the piezometer tubing threads prior to tubing joint make-up

- Tightening each piezometer tubing joint in the rig derrick with hydraulic power tongs

- Performing an approximate 1-h seating nipple test under hydrostatic conditions.

The seating-nipple tubing test was run to verify that no major breaches existed in a piezometer string prior to securing it in the borehole with filter-pack material and a cement seal. This test involved installing a standing valve in the seating nipple and filling the piezometer tubing string with Hanford system water. After allowing the water to equilibrate for about 10 to 15 min, the water level inside the tubing was monitored for about 1 h.

The results of the seating nipple tubing test are summarized in table E-7. No major breaches were identified as a result of the installation process. The conclusion is based on tests run prior to securing the piezometer and after piezometer development activities. Minor head declines that did occur inside the tubing were attributed to worn standing valves, air bubbles escaping from the water that was used to fill the piezometer tubing, and temperature effects caused from temperature equilibration between the test water and the borehole annulus fluids.

The as-built details for the piezometer tubes are documented in figures A-1 through A-8 and the piezometer summary (table E-1). The detailed installation activity for each piezometer tubing string is documented in the piezometer installation activities (table E-2).

The general piezometer installation procedure using a workover rig was as follows.

- Accurately measure the length of work string.

- Run the working string in the borehole.

- Tag the bottom of the borehole with the work string.

- Calculate the volume of slurry to be placed as based on caliper log, place the basal cement seal through work string with cementing equipment.

- Wait on the cement 8 h and tag the top of the cement with the work string.

- Measure the deepest piezometer tubing accurately (Grande Ronde 5 flow interior), and run the piezometer tubing to the design depth. (Note: The piezometer tubing section exposed to the cement seal was sand blasted to enhance cement bonding to the tubing.)

- Run the seating nipple tubing test with the piezometer string tubing in tension.

- Run the work string into the borehole, calculate the volume of filter pack material to be placed as based on the caliper log, place the filter pack through the work string, and tag the top of the filter pack with the work string.

- Rig up the work string for cementing, calculate the volume of cement slurry required to be placed based on the caliper log, and place the cement through the work string with cementing equipment.

- Run a fluid temperature log after the cement has set for at least 4 h, wait on the cement at least 8 h, tag the top of the cement with the work string, and remove the work string from borehole.

- Run the next deepest piezometer tubing string (Grande Ronde 5 flow top) in the borehole and repeat the piezometer installation activities as outlined above.

- Secure the piezometer tubes with a locking cap and finish the well head after all the piezometer tubing strings have been installed.

6.3.1 Piezometer Seal Cementing

Placement Method. The balanced and two-plug methods were used to place the cement slurry seals that isolate the piezometer strings from each other in the borehole. Advantages of the balanced method are that it is simple and requires no special type of cementing equipment. A disadvantage is the possibility of the cement being contaminated from borehole fluids, especially when using small quantities of cement. Therefore, the balanced method was limited to the larger volumes of slurry placed in the borehole.

The balanced-method cement placement procedure was as follows.

- Place bottom of the work string, which includes a diverter tool near bottom of seal to be placed. (This tool forces the flow of the slurry into the borehole sidewall and upward in borehole.)

- Calculate required volume of cement as determined from the caliper log.

- Pump cement slurry at a slow rate (i.e., 2 bbl/min (318 L/min)).

- Follow cement with a predetermined amount of displacement water until the level of slurry outside the work string is balanced with level inside work string.

- Pull work string slowly from slurry.

The volume of cement slurries placed while using the balanced method is summarized in table E-4.

In the two-plug method, top (lead) and bottom wiper plugs isolate the cement slurry inside the work string from the borehole water and the displacement water during the placement process. In addition, a plug catcher is attached immediately above the diverter tool. The advantages of the two-plug method are (1) it minimizes the possibility of over displacement; (2) it reduces water and cement contamination; and, (3) small quantities of cement slurry can be placed accurately.

The two-plug method cement placement procedure was as follows.

- Place plug catcher at the same depth as the bottom of the cement seal to be placed.
- Calculate required volume of cement as determined from caliper log.
- Pump predetermined volume of lead water ahead of lead wiper plug.
- Release lead wiper plug from plug container.
- Pump cement slurry at a slow rate (i.e., 2 bbl/min (318 L/min)).
- Release top wiper plug from plug container.
- Chase top wiper plug with a predetermined amount of displacement water
- Pull work string slowly from slurry, see discussion below.

As the cement slurry is pumped through the work string and into the annulus, the bottom wiper will pass through the plug catcher and land in the lower part of the diverter tool. Pumping is terminated when the top plug is caught in the plug catcher, which is indicated by a rise in the pump pressure at the surface. At that time, the plug catcher is slowly pulled to just above the cement slurry. Then the work string is pressurized to about 1,000 lbf/in^2 (6.9 MPa) to shear a sliding sleeve in the plug catcher. This permits communication between the fluids inside the work string with the borehole fluids outside the work string, thereby preventing a sucking action that would disturb the slurry while the work string is pulled slowly from the borehole. The volume of cement slurries placed with the two-plug technique is summarized in table E-4.

Cement Mixing Equipment. The preblended cement was bulk transported to the borehole site prior to mixing. A truck-mounted recirculating cement mixing (RCM) system was used for the initial mixing of the cement slurry. It was then transferred to a separate truck-mounted batch mixer for final weighing. The slurry density was monitored with pressurized mud balance scales during mixing and an on-line densometer measuring system during pumping. The densified cement slurry was pumped with an RCM pumping unit at a rate of 1 to 2 bbl/min (150 to 320 L/min). Wet and dry cement samples were collected during mixing. The cementing equipment needed to place the cement seals is listed in table E-5.

7.0 PIEZOMETER DEVELOPMENT

The objective of piezometer development was to remove bulk particulate matter that accumulated in the screen, filter pack, and piezometer tubing during the installation process. This development provided confirmatory evidence of the piezometer operation. Activities associated with piezometer development include air-lift pumping, water circulation, piezometer cleanup sampling, and hydraulic-head monitoring. After development, seating-nipple tubing tests and short-term constant head injection tests were conducted. The results of these tests verified the structural integrity of the tubing with respect to tubing leaks and to obtain preliminary transmissivity values of three flow interiors and one flow top. Activities associated with the piezometer development at RRL-2C are summarized in appendix F.

7.1 METHODOLOGY

7.1.1 Air-Lift Method

This method consisted of injecting air through a 1-in. (2.54-cm) nominal plastic air line that extended about 250 ft (76.2 m) below the piezometer water surface. Water was discharged at the surface into a 60-degree v-notch weir. The discharge rate was measured with either the 60-degree v-notch weir or a calibrated container and stop watch. Preliminary groundwater development samples were collected to provide a qualitative indication of particulate cleanup.

The air-lift method was used to develop the Rocky Coulee and Grande Ronde 5 flow-top piezometers because these monitoring horizons were sufficiently transmissive to pump the particulate matter out of the piezometer tubing. The Cohassett flow top was not transmissive enough to use the air-lift method. Pertinent development activities for the Rocky Coulee and Grande Ronde 5 flow-top piezometers are summarized in table F-2.

7.1.2 Circulation Method

This method consisted of circulating Hanford system water through 0.957-in. (2.431-cm) ID tubing at a rate of 6 to 8 gal/min (23 to 30 L/min) inside the piezometer tubing. A 0.75-in. (1.91-cm) OD, 24-ft- (7.3-m-) long mule shoe was located just above the piezometer seating nipple prior to initiating circulation. During circulation, the mule shoe was lowered at a rate of about 1 ft (0.31 m) every 20 min past the seating nipple and into the screen section. In-flow into the piezometer through the Hydril tubing was measured with a 0.75- by 0.65-in. (1.91- by 1.65-cm) flow meter. Outflow was measured with a 60-degree v-notch weir at ground surface. Circulation was terminated when the return water was visually clear.

The circulation method also was used for the flow interior piezometers and the Cohassett flow-top piezometer because these monitoring horizons were not sufficiently transmissive to air lift the particulate matter out of the piezometer tubing. Piezometers developed with this method include the Rocky Coulee, Cohassett, and Grande Ronde 5 flow interior piezometers, and the Cohassett flow-top piezometer. The total volume of water circulated through these piezometer tubings is summarized in table F-2.

The circulation method also was used on the Rocky Coulee and Grande Ronde 5 flow-top piezometers after they became plugged during air-lift development. Hanford system water was circulated to open the piezometer tubing near the seating nipple. Subsequent air-lift pumping improved the discharge rate over previous pumping activities as summarized in table F-2.

7.1.3 Hydraulic-Head Monitoring

Water-level measurements were taken with either an electric water-level indicator or a steel tape, or both, during and after the piezometer installation and piezometer development activities. To monitor fluid pressures, near-surface pressure transducers were installed in the piezometer tubes. The pressure transducers were connected to a surface-based multichannel recording system. Detailed composite pressure hydrographs during the air-lift and circulation phases are shown in figures 17 through 24. A composite water-level hydrograph for the Grande Ronde piezometers following piezometer development is shown in figure 25.

7.1.4 Seating-Nipple Tubing Tests

Seating-nipple tubing tests were conducted in each piezometer subsequent to their development. The general procedures were described in 5.0. These tests were conducted to ensure that no major breaches in the tubing occurred during the installation process. The results of the seating-nipple tubing tests are summarized in table E-7.

Prior to removing the standing valve from the seating nipple, Hanford system water was circulated above the seating nipple so a column of water of uniform composition existed in the piezometer tubing for hydraulic head monitoring. The chemical composition of the flush water in each of the piezometers is summarized in table F-3.

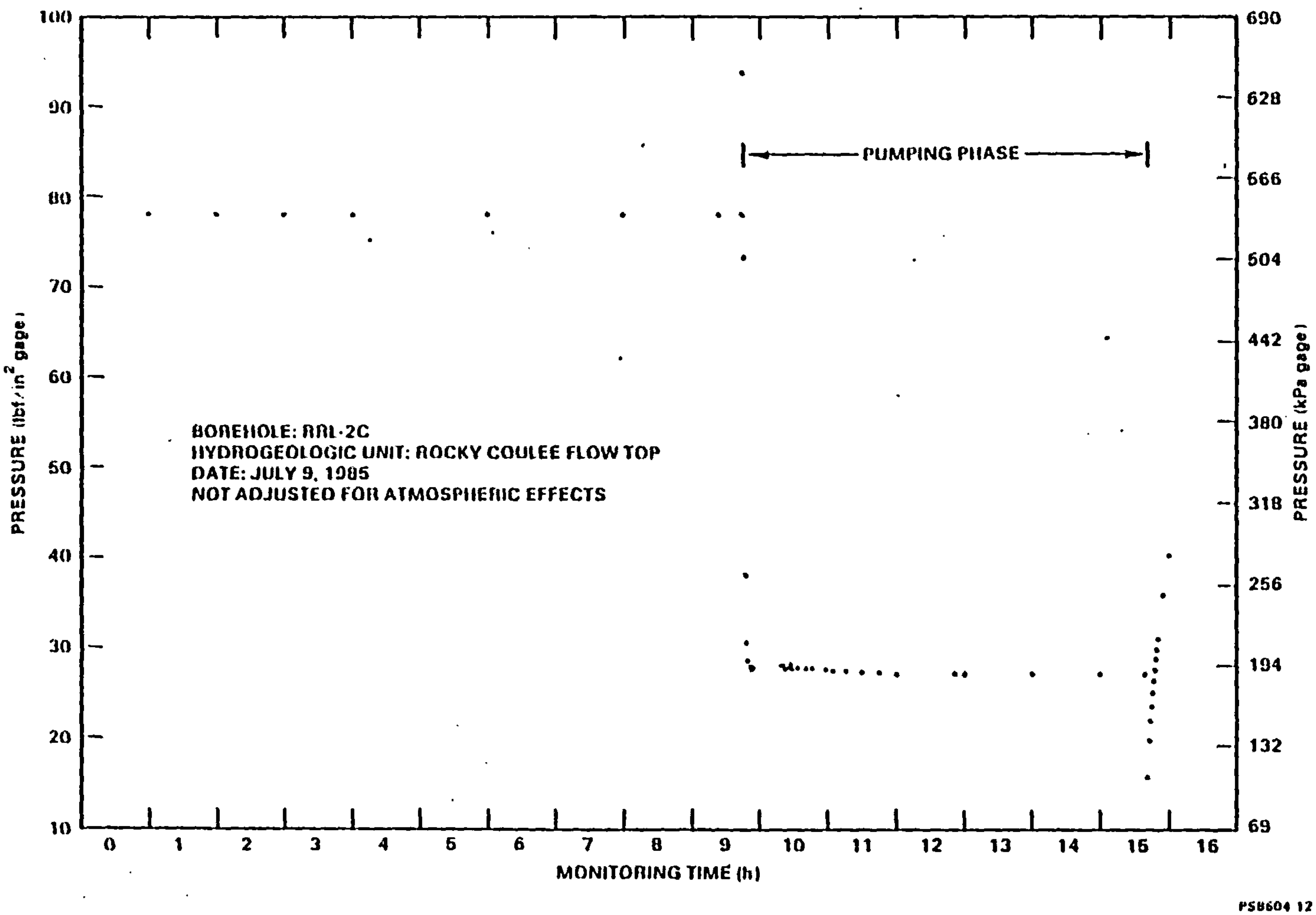


Figure 17. Pressure Hydrograph of Rocky Coulee Flow-Top Piezometer During its Development at Piezometer Nest RRL-2C.

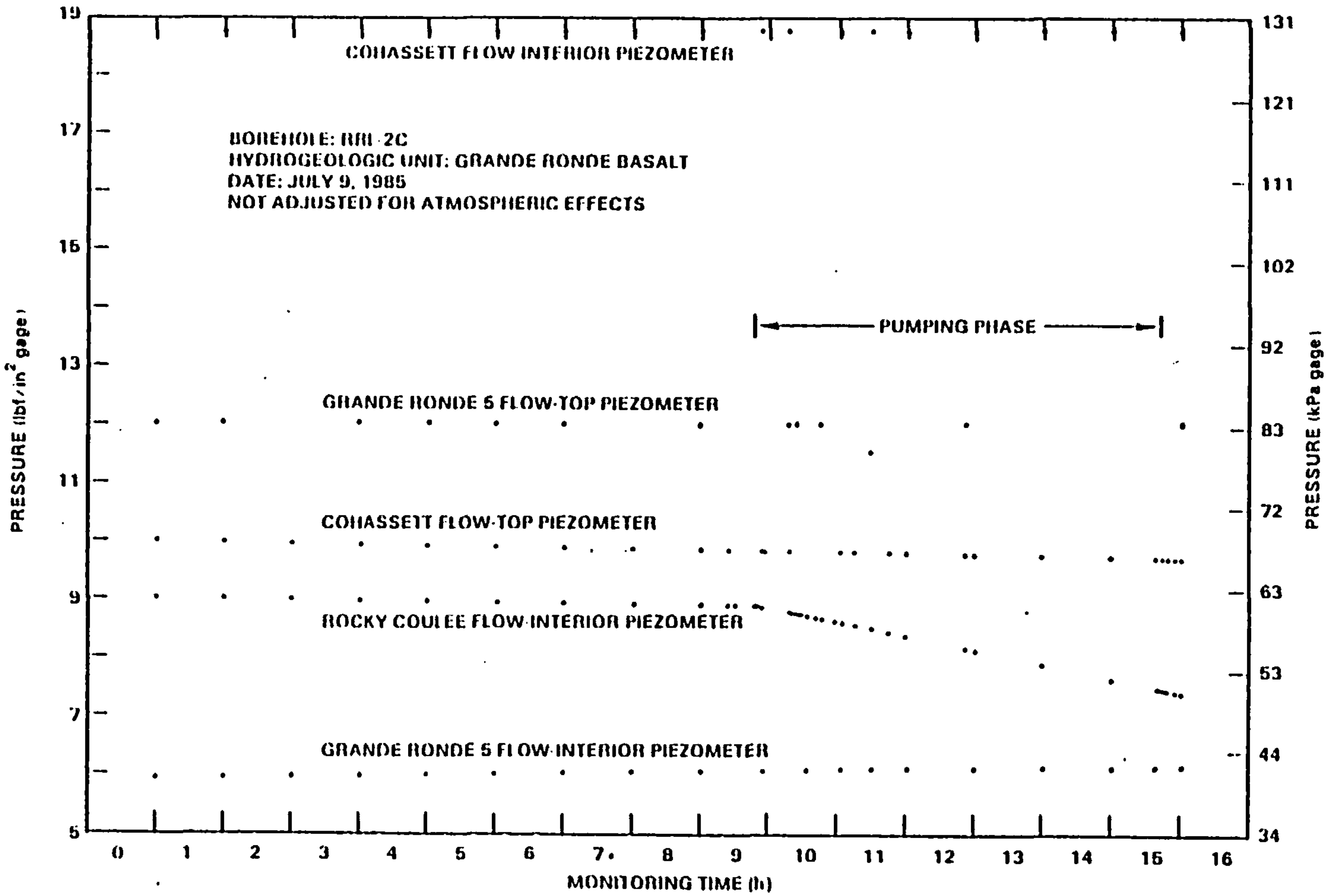


Figure 18. Composite Pressure Hydrographs of Piezometer Nest RRL-2C Piezometers During Development of Rocky Coulee Flow-Top Piezometer.

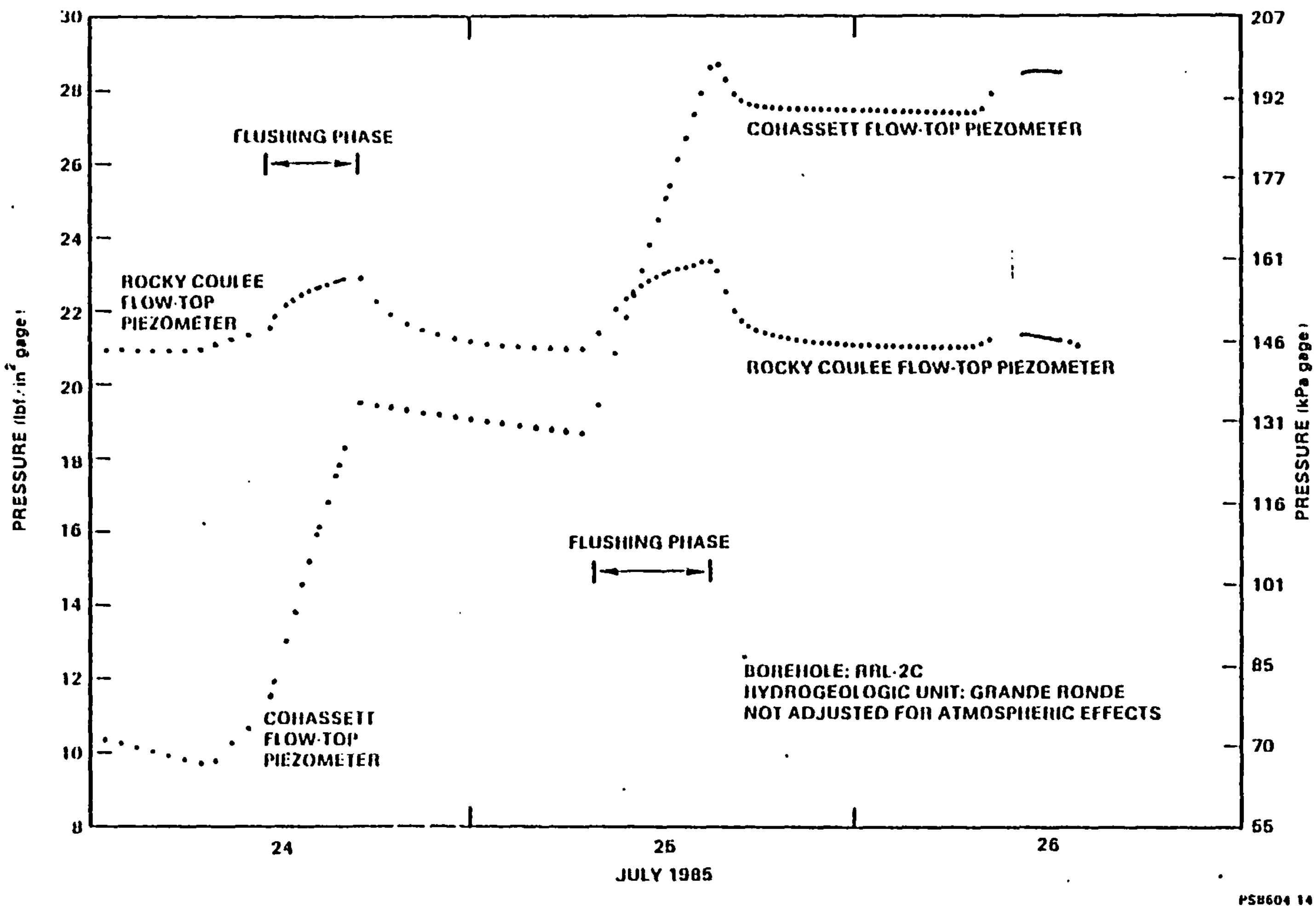


Figure 19. Composite Pressure Hydrographs of Piezometer Nest RRL-2C Piezometers During Flush Development of Rocky Coulee Flow-Interior Piezometers.

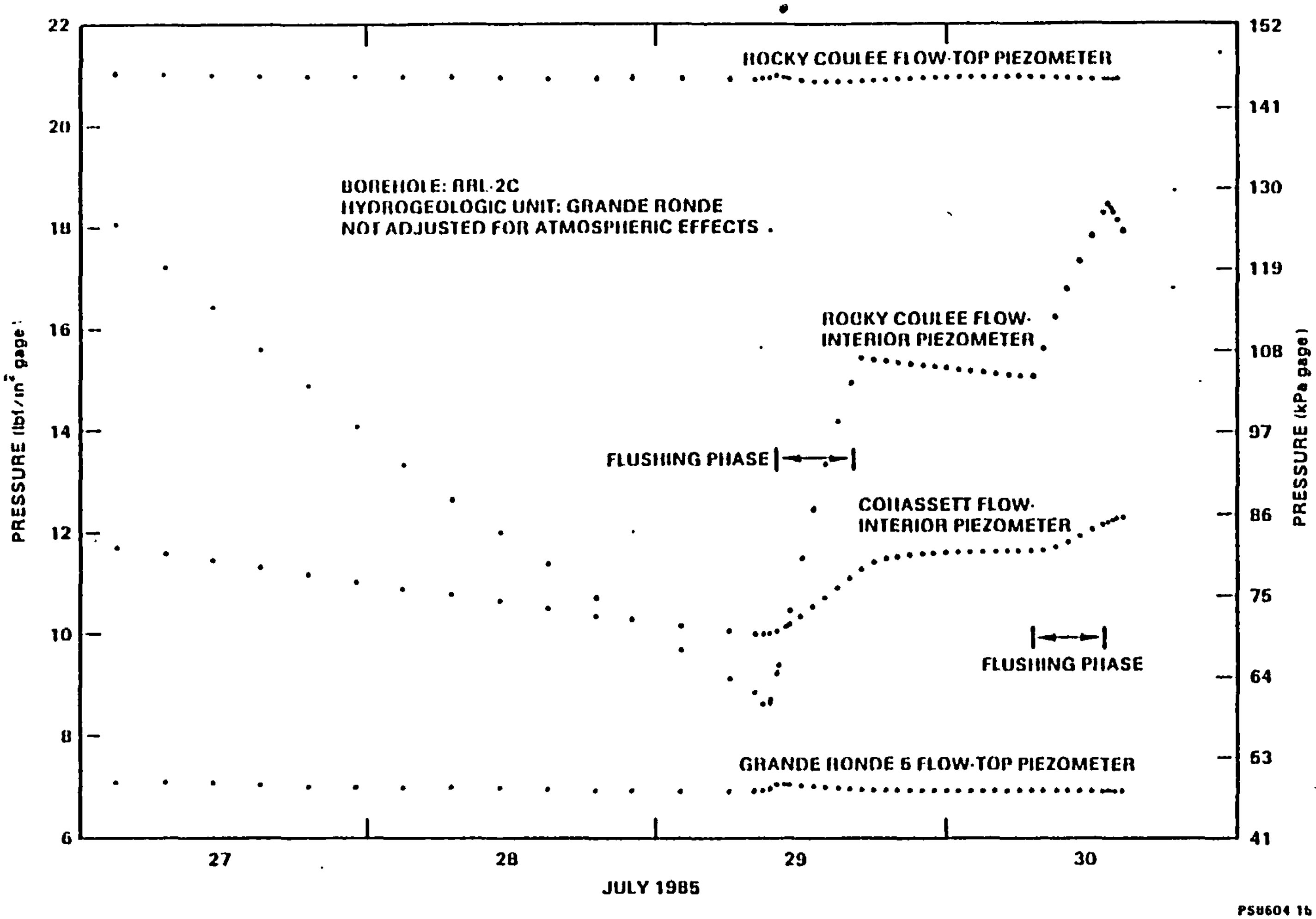


Figure 20. Composite Pressure Hydrographs of Piezometer Nest RRL-2C Piezometers During Flush Development of Cohassett Flow-Top Piezometer.

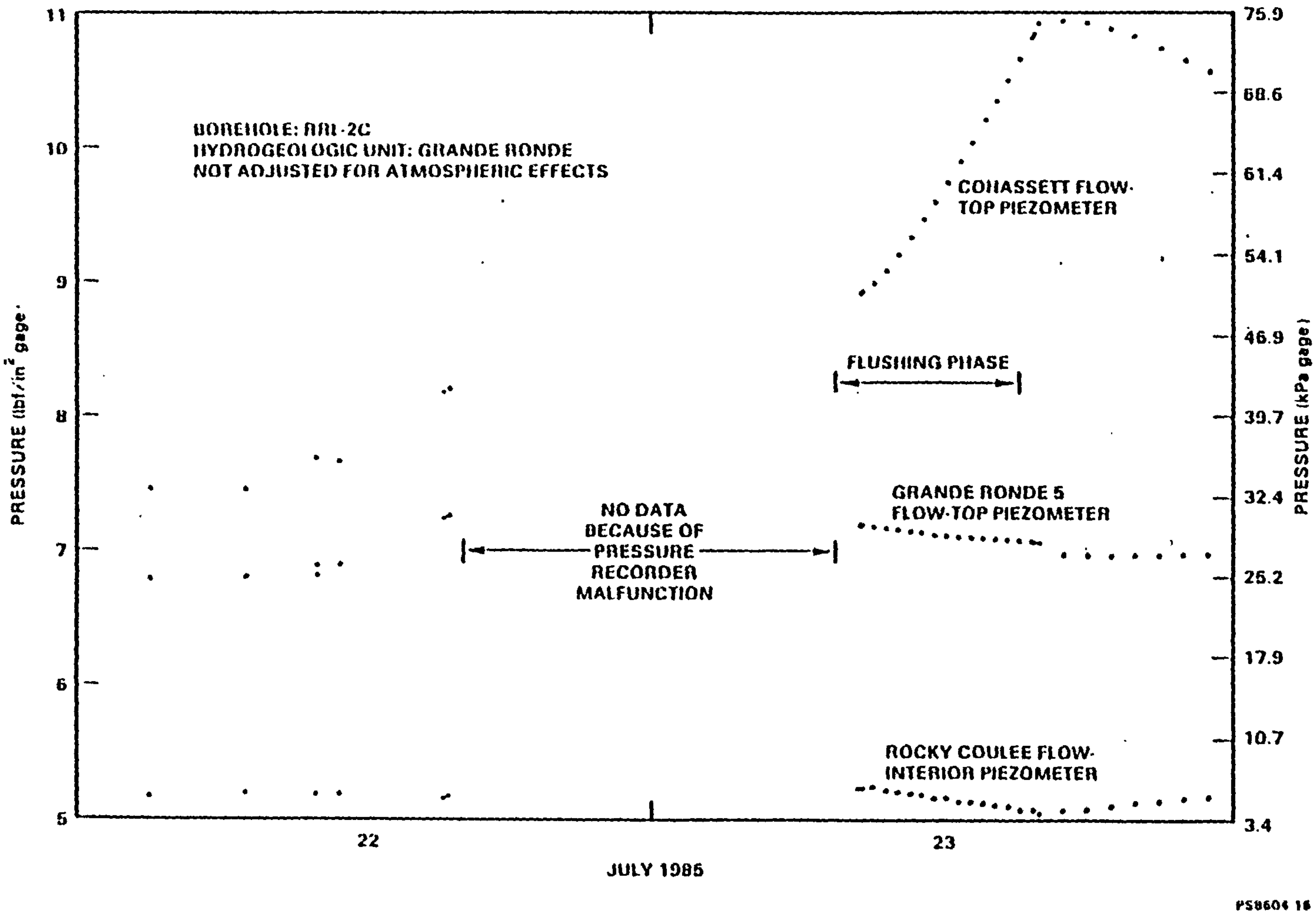


Figure 21. Composite Pressure Hydrographs of Piezometer Nest RRL-2C Piezometers During Flush Development of Cohassett Flow-Interior Piezometer.

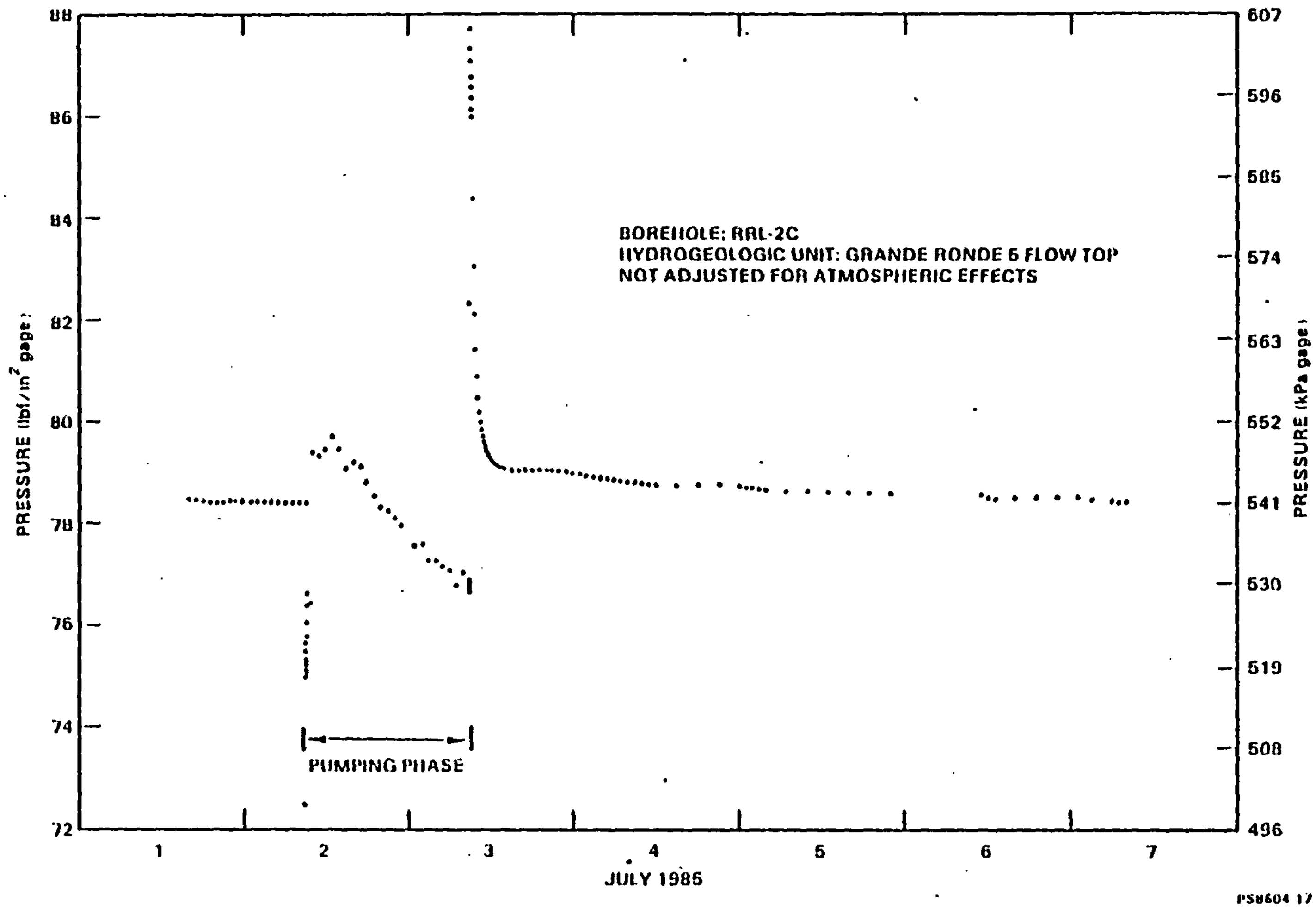


Figure 22. Pressure Hydrograph of the Grande Ronde 5 Flow-Top Piezometer During Air-Lift Development at Piezometer Nest RRL-2C.

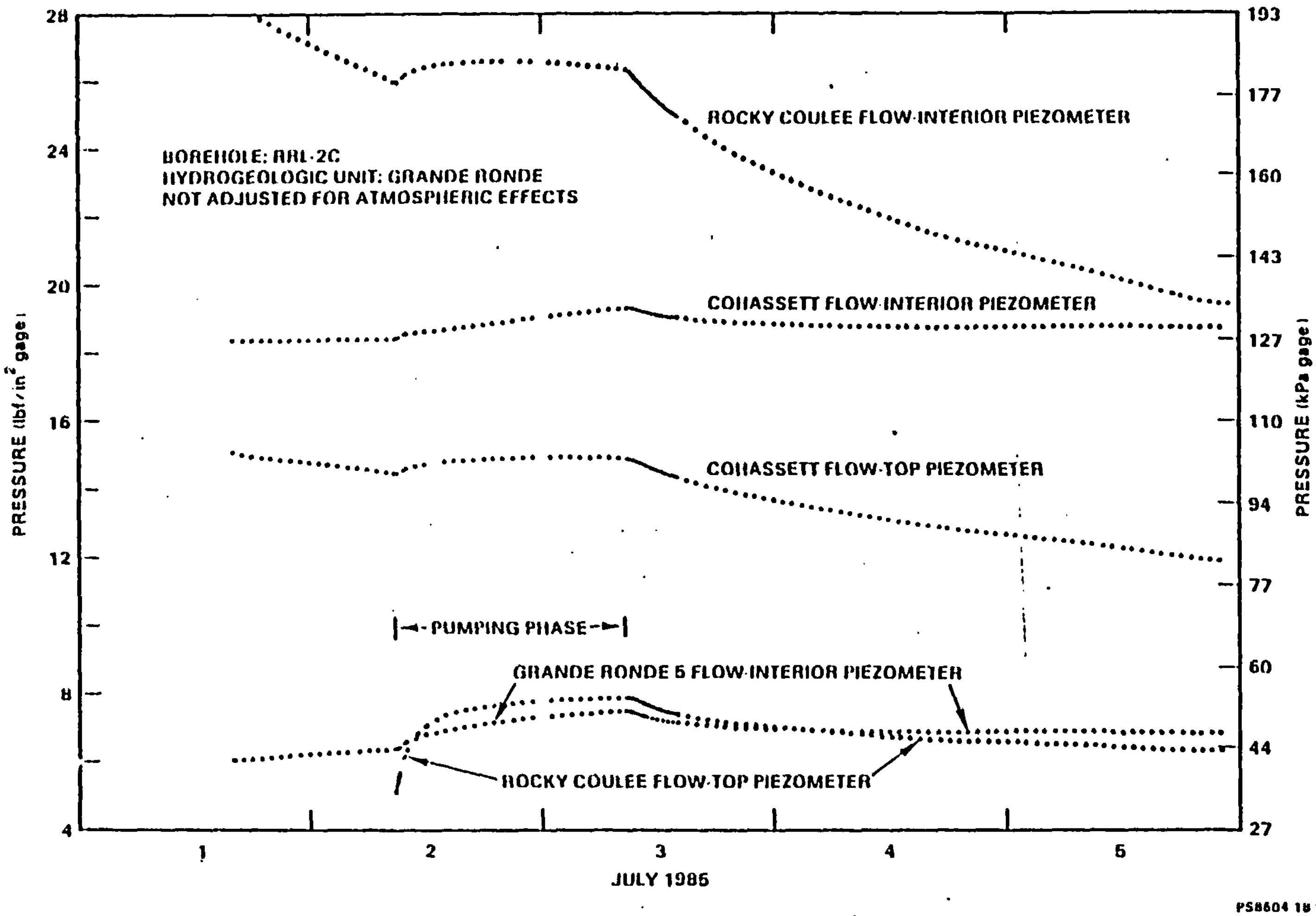


Figure 23. Composite Pressure Hydrographs of Piezometer Nest RRL-2C Piezometers During Air-Lift Development of the Grande Ronde 5 Flow Interior Piezometer.

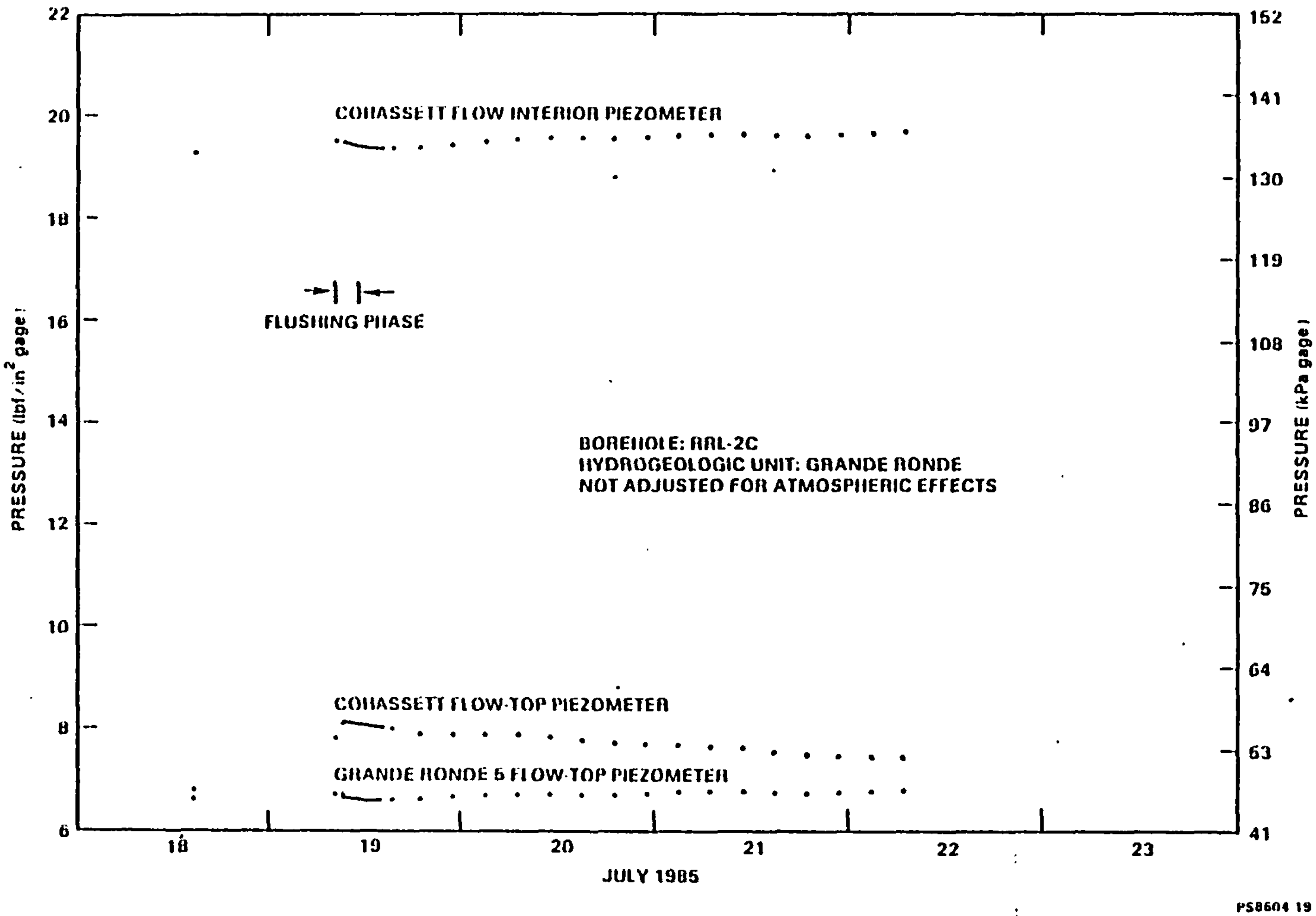


Figure 24. Composite Pressure Hydrographs of Piezometer Nest RRL-2C Piezometers During Flush Development of the Grande Ronde 5 Flow Interior Piezometer.

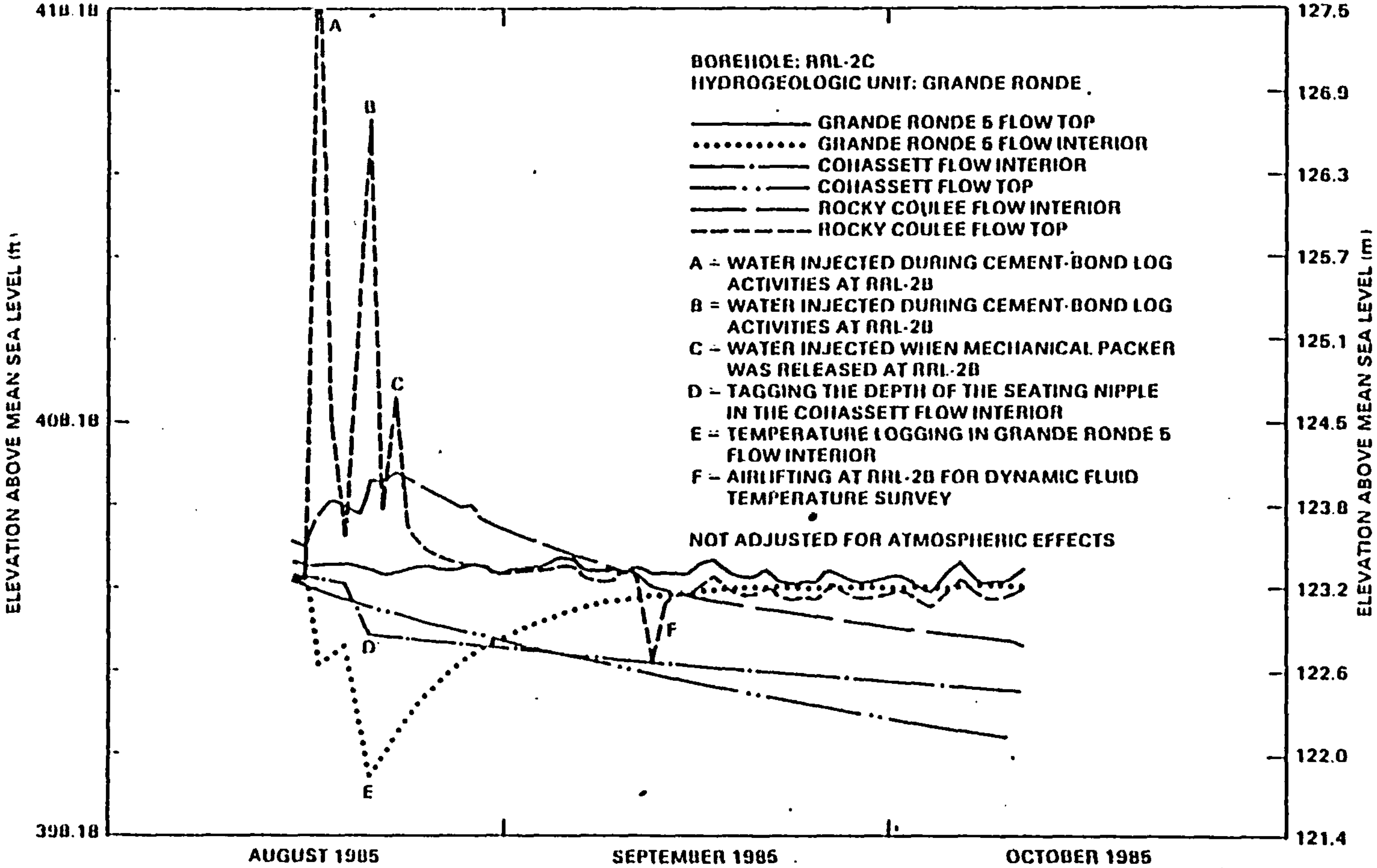


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Figure 25. Composite Observed Water-Level Hydrographs, August 15 to October 11, 1985, at Piezometer Nest RRL-2C.

7.1.5 Constant-Head Injection Tests

After completion of development activities, short-term constant head injection tests were conducted in the low hydraulic conductivity intervals (i.e., the Rocky Coulee, Cohassett, and Grande Ronde 5 interior piezometers, and the Cohassett flow-top piezometers). These tests were performed by filling the piezometer tubing with Hanford system water and monitoring the injection flow rate for 1 h using a graduated cylinder and stop watch. The final injection rates for these piezometers are shown in table F-4.

7.2 OBSERVED HYDRAULIC-HEAD RESPONSES IN PIEZOMETER NEST RRL-2C

7.2.1 Time-Variant Head Responses During Piezometer Development

This section describes observed hydraulic-head responses in the observation piezometers while air-lift development pumping or flushing. The observed head responses in the piezometers during the development phase are summarized in table 3. Field data is on file in BRMC.

Rocky Coulee Flow-Top Development. Pressure responses shown in figures 17 through 18 are associated with air-lift pumping the Rocky Coulee flow-top piezometer over a period of 5.92 h at an average discharge of about 0.3 gal/min (1.14 L/min). A rapid pressure drawdown of about 1.5 lbf/in^2 (10.3 kPa) ocurred in the Rocky Coulee flow-interior piezometer during pumping of the Rocky Coulee flow top. This response implies that vertical hydraulic connection exists between these two intervals. Minor pressure changes in the deeper piezometers are attributed to predevelopment water-level trends, temperature effects, and possibly other unidentified factors.

Rocky Coulee Flow-Interior Development. The Rocky Coulee flow-interior piezometer was developed using the circulation method. Water pressures were monitored in the adjacent Rocky Coulee flow-top and the Cohassett flow-top piezometers (see fig. 19).

A pressure change noted in the Rocky Coulee interior and Cohassett flow-top piezometers suggests hydraulic communication with the Rocky Coulee flow interior. During the injection phase of development, a pressure increase was noted in both intervals (see fig. 19). After circulation was stopped, the pressures began to decrease. In the case of the Rocky Coulee flow top, it returned to about the preinjection pressure level. The decline of pressures in the Cohassett flow top is thought to be influenced by borehole storage effects. During circulation, an increase in water pressure in the Rocky Coulee flow interior apparently produced a pressure increase in the Rocky Coulee flow-top and the Cohassett flow-top piezometers.

None of these pressure changes appears to be dominated by temperature effects. If temperature effects did dominate, the injection of cooler Hanford system water should have produced a decrease in the observed pressures. However, the observed pressure changes indicate an increase rather than decrease.

Table 3. Summary of Observed Hydrologic Responses Associated with Piezometer Development Activities at Piezometer Nest RRL-2C.

Stressed piezometer	Observation piezometer					
	Rocky Coulee flow top	Rocky Coulee flow interior	Cohassett flow top	Cohassett flow interior	Grande Ronde 5 flow top	Grande Ronde 5 flow interior
Rocky Coulee flow top	Air-lift pumped	Drawdown about 1.5 lbf/in² (10.3 kPa)	Questionable response	Minor temperature effect	Minor temperature effect	Minor temperature effect
Rocky Coulee flow interior	Build up about 2.5 lbf/in² (17.2 kPa)	Flushed	Build up about 10 lbf/in² (69.0 kPa)	Not monitored	Not monitored	Not monitored
Cohassett flow top	No response	Build up about 6.5 lbf/in² (44.8 kPa)	Flushed	Build up about 2 lbf/in² (13.8 kPa)	Minor temperature	Minor temperature effects
Cohassett flow interior	Not monitored	Minor temperature effects	Build up about 2 lbf/in² (13.8 kPa)	Flushed	Minor temperature effects	Not monitored
Grande Ronde 5 flow top	Temperature effects	Temperature effects	Temperature effects	Temperature effects	Air-lift pumped	Temperature effects
Grande Ronde 5 flow interior	Not monitored	Not monitored	Minor temperature effects	Minor temperature effects	Minor temperature effects	Flushed

The difference in shape between the Rocky Coulee flow-top and the Cohassett flow-top hydrographs may be related to the difference in transmissivities of these two intervals. A relatively higher transmissivity in the Rocky Coulee flow top had a greater dampening effect on the pressure transient during development of the Rocky Coulee flow interior. Hence, the response was less conspicuous than the one in the Cohassett flow top.

Cohassett Flow-Top Development. The Cohassett flow-top piezometer was developed using the circulation method. Water pressures were monitored in the piezometers of the Rocky Coulee and Grande Ronde 5 flow tops and the Rocky Coulee and Cohassett flow interiors.

A pressure buildup in two of these piezometers, the Rocky Coulee flow interior and the Cohassett flow interior, occurred while circulating in the Cohassett flow-top piezometer (see fig. 20). The response in the Rocky Coulee interior was similar to that described in the previous section on development of the Rocky Coulee interior; that is, in a step-wise fashion (see fig. 20). The response in the Cohassett flow interior, however, shows an interesting variation in that, after the first injection period, the pressure continued to increase at a slower rate. The reason for this response is not understood.

Two minor pressure changes are also observed in the Grande Ronde 5 and the Rocky Coulee flow-top piezometers at the start of circulation. This change may represent temperature effects. At the start of circulation, water at the bottom of the Cohassett flow-top piezometer moves uphole past the cooler borehole materials. This warmer slug of water moving uphole may have caused the slight pressure increase.

Cohassett Flow-Interior Development. The Cohassett flow-interior piezometer was developed using the circulation method. Water pressures were monitored in the adjacent Grande Ronde 5 flow-top and Cohassett flow-top piezometers, and in the Rocky Coulee flow-interior piezometer.

A pressure change was noted in all three monitored piezometers during the flushing activities. Only one of the pressure responses (the Cohassett flow-top piezometer) behaved in a manner indicating possible hydraulic communication with the Cohassett flow-interior piezometer (see fig. 21). While injecting water into the Cohassett interior, a pressure increase occurred in the Cohassett flow top. This is the type of response expected if these two intervals are hydraulically connected.

The pressure responses in the Grande Ronde 5 flow-top piezometer and the Rocky Coulee flow-interior piezometer represent changes that typically occur from temperature effects. A pressure decrease occurred in these piezometers during the development period and a pressure increase occured after development was stopped (see fig. 21). The decrease in pressure is attributed to a condensing of borehole water and, therefore, a lowering of hydraulic heads as the cooler Hanford system water circulates past the relatively warmer downhole water. The increase in pressure occurs as the cooled downhole water returns to quasi-static temperatures.

Grande Ronde 5 Flow-Top Development. The Grande Ronde 5 flow-top piezometer was developed using the air-lift method (see fig. 22). The average discharge rate was 5.5 gal/min (20.8 L/min) over a period of 24 h. Water pressures were monitored during development in the other five piezometers (Rocky Coulee flow top and flow interior, Cohassett flow top and flow interior, and Grande Ronde 5 flow-interior piezometers).

A slight pressure response was noted in the observation piezometers during and after air-lifting activities. As shown in figure 23, the pressure buildups occur at about the same time and in the same directions. Again, the pressure changes may be caused by temperature effects. The increase in pressure is a response to the Grande Ronde 5 flow-top water warming the surrounding observation piezometer water while air-lifting is in progress. The decrease in pressures occurs after air-lifting stops and the temperatures return to quasi-static conditions.

Grande Ronde 5 Flow-Interior Development. The Grande Ronde 5 flow-interior piezometer was developed using the circulation method. Water pressures were monitored in the adjacent Grande Ronde 5 flow top, the Cohassett flow-top, and the Cohassett flow-interior piezometers.

Minor pressure responses were noted in all three of these piezometers. In all cases the pressure changes can be attributed to temperature effects. A pressure decrease during the injection period and a pressure increase when circulation is terminated was shown in figure 24. This is the expected response while the surrounding piezometer water is cooled and as it returns to warmer quasi-static temperatures.

7.2.2 Time-Variant Head Responses After Piezometer Development

The composite water-level hydrograph (see fig. 25) for piezometer nest RRL-2C shows the time-variant responses of the six monitoring horizons after piezometer development between August 15 and October 11, 1985. Salient features of the composite hydrograph include the following.

- An observed water-level head difference exists between the monitoring horizons.
- Observed water levels in the Cohassett flow-top and flow-interior piezometers, and the Rocky Coulee flow-interior piezometer decline with respect to time.
- Observed water levels in the Grande Ronde 5 flow-top and flow-interior piezometers, and the Rocky Coulee flow-top piezometer rise with respect to time.

- A subdued water-level buildup occurred in the Rocky Coulee flow-interior piezometer during August, which appears to be associated with injection of water into the Rocky Coulee flow top at RRL-2B.

- Atmospheric pressure changes are influencing water levels in the Rocky Coulee and Grande Ronde 5 flow tops.

Under unstressed conditions (i.e., in a monitoring mode), the observed hydraulic heads in the Grande Ronde piezometers appear to be equilibrating to different elevations. This condition suggests that hydraulic isolation exists between the monitoring horizons. However, under stressed conditions (i.e., when air-lift pumping), pressure responses were observed in some of the adjacent monitoring horizons. This suggests that increased vertical leakage is occurring between some of the units (e.g., between the Rocky Coulee flow interior and flow top) when they are subjected to greater than normal vertical hydraulic gradients, such as those imposed by pumping.

Potential pathways that could act as vertical conduits to account for these responses include the following:

- Leaks in the piezometer tubing strings

- Inadequate cement seals with channels

- Enhanced hydraulic conductivity in the disturbed rock zone in the near vicinity of the borehole as a result of drilling

- Presence of in situ formation fractures

- Bedrock structural or stratigraphic discontinuities (i.e., faults and pinchouts).

An abbreviated discussion of these hypotheses is given below.

- Tubing tests performed before and after piezometer development indicated no apparent leaks in the six piezometer strings.

- State-of-the-art cementing practices were used to place the densified cement seals. Each seal was accurately located by tagging the top of the cement with the work string. The position and presence of the cement seal was further verified from fluid temperature logs.

- Acoustic logs, televiewer logs, caliper logs, and video camera surveys indicate that numerous breakouts (spalling) occurred in the borehole during drilling. Available borehole geophysical logs do not indicate, however, the extent of the disturbed rock zone or the connectivity of the fractures within this zone. Preliminary monitoring data show an apparent water-level elevation difference between piezometer horizons. This monitoring data suggests that the disturbed rock zone is not extensive.

- The existence of in situ fractures can be determined from geophysical logs and video surveys. Hydraulic testing in conjunction with geologic subsurface investigations (i.e., exploratory shaft and test facility) will be required to evaluate the effects of in situ fractures on the vertical transfer of groundwater through the flow interiors.

  As shown in the as-built drawings (fig. A-8), two of the densified cement seals (intervals 2,833 to 2,895, and 3,282, and 3,315 ft (863.5 to 882.4, and 1,000.4, and 1,010.4 m)) are opposite zones of intermediate porosity as compared to the flow top and dense-interior zones. Examination of hydraulic data at core hole RRL-2A indicates a horizontal transmissivity ranging from 10^{-5} to 10^{-4} ft^2/d (10^{-7} to 10^{-6} m^2/d) for the dense interior of the Rocky Coulee flow (Wintczak 1984, p. 58). The hydraulic properties of the intermediate porosity zones have not been evaluated quantitatively. However, the neutron-epithermal-neutron log, constant head injection test, and observed hydrologic responses during air-lift development indicate that these zones may possess relatively greater horizontal and vertical hydraulic conductivities than the dense interior.

- No major cross-cutting features (i.e., fault) or stratigraphic discontinuities have been identified in the evaluation of core logs at RRL-2A and borehole geophysical logs at RRL-2C. Therefore, the hypothesis that these types of features permit vertical hydraulic communication between piezometers during development is not supported by the current data.

At this time the amount of collected field data is insufficient to eliminate any of the hypotheses listed above (with the exception of the tubing leaks). Controlled field tests at RRL-2B and RRL-2C, and possibly hydraulic testing at other sites in the vicinity of the reference repository location are needed to determine the nature of vertical hydraulic communication between units tapped by the piezometers.

8.0 HYDRAULIC PROPERTY ESTIMATES

8.1 LOW-TRANSMISSIVE MONITORING INTERVALS

Constant-head injection tests of 1-h duration were run in the piezometers to obtain preliminary estimates of transmissivity of the Rocky Coulee flow interior, the Cohassett flow top, the Cohassett flow interior, and the Grande Ronde 5 flow interior. Estimates of transmissivity were determined by the Zeigler method (Zeigler 1976, p. 48, Eq. 43). Input parameters are given in table F-4. Estimates of transmissivity are summarized in table 4. As shown in table 4, these monitoring horizons possess transmissivities ranging from 10^{-4} to 10^{-3} ft^2/d (10^{-6} to 10^{-5} m^2/d). Estimates are given with one order of magnitude range because of the limited testing performed on these horizons.

Table 4. Preliminary Estimates of Hydraulic Properties Obtained from Borehole Development and Piezometer Development Activities.

Borehole number	Interval description	Test method	Estimated transmissivity, ft^2/d (m^2/d)	Storativity	Analysis method	Remarks
RRL-2B	Rocky Coulee flow top	Pulse	2-6 (0.2-0.6)	10^{-5}	Pulse (Johnson et al. 1966)	Data from observation points RRL-2C and RRL-2A
RRL-2C	Composite Grande Ronde	Borehole development pumping	200-300 (20-30)	--	Specific Capacity (Lohman 1972)	Principal water zone is Grande Ronde 5 flow top and Cohassett flow bottom
RRL-2C	Rocky Coulee flow interior	Constant head injection	10^{-4}-10^{-3} (10^{-6}-10^{-5})	--	Zeigler (1976)	1-h injection period
RRL-2C	Cohassett flow top	Constant head injection	10^{-4} (10^{-6})	--	Zeigler (1976)	1-h injection period
RRL-2C	Cohassett flow interior	Constant head injection	10^{-4} (10^{-6})	--	Zeigler (1976)	1-h injection period
RRL-2C	Grande Ronde 5 flow interior	Air-lift development	10^{-4}-10^{-3} (10^{-6}-10^{-5})	--	Zeigler (1976)	1-h injection period

8.2 HIGH-TRANSMISSIVE MONITORING INTERVALS

Air-lift pumping development was performed for the Rocky Coulee flow-top and the Grand Ronde 5 flow-top piezometers. Recovery data were not analyzed because borehole temperature effects masked the water-level recovery responses. Borehole storage effects also influenced the recovery data from the Rocky Coulee flow top.

The only available estimate of transmissivity for the Rocky Coulee flow top at RRL-2C is based on pulse testing at RRL-2B (see 5.0). Analysis of pressure buildup data at RRL-2C and RRL-2A indicate a transmissivity of 2 and 6 ft^2/d (0.2 to 0.6 m^2/d), respectively.

Transmissivity of the Grande Ronde 5 flow top was reported in 5.0. For this horizon, as determined from specific capacity data obtained during borehole development pumping, the transmissivity is estimated to be between 200 and 300 ft^2/d (20 and 30 m^2/d) at RRL-2C.

The values reported above should be considered preliminary. Longer testing at RRL-2B or at RRL-2C is required to establish representative input parameter values for numerical modeling purposes. These values, however, may be useful for designing future hydraulic tests at RRL-2B and predicting pretest hydraulic responses.

9.0 SUMMARY AND CONCLUSIONS

This report describes the design, drilling, and completion of RRL-2B and RRL-2C. Well RRL-2B will be used as a discharge well for performing large-scale pumping tests of selected Grande Ronde Basalt horizons. Piezometer nest RRL-2C will be one of the primary observation points during these tests. Water levels will also be measured in RRL-2C as part of the piezometric baseline monitoring programs.

Well RRL-2B is completed as a 12.25-in- (31.12-cm-) dia. borehole through the Rocky Coulee flow top. Its interim depth is 2,858 ft (871.1 m). On completion of testing, the well will be deepened to test the next horizon; i.e., Cohassett flow top.

Piezometer nest RRL-2C was completed in the Grande Ronde Basalt with six piezometers between a depth of about 2,775 and 3,404 ft (845.8 and 1,037.5 m). This is the first piezometer facility that has the capability of monitoring flow interiors. The piezometers monitor hydraulic heads in the Rocky Coulee flow top, Rocky Coulee flow interior, Cohassett flow top, Cohassett flow interior, Grande Ronde 5 flow top (which includes the Cohassett flow bottom), and Grande Ronde 5 flow interior. The piezometer tubes are isolated from each by densified cement seals ranging from 30 to 150 ft (9 to 48 m) in length.

After completing the piezometer installation, each piezometer was developed by either the air-lift pumping or circulation method. Under unstressed conditions, the piezometer water levels appear to be distinct as suggested by head differences and equilibration trends. Vertical propagation of hydraulic-head transients was observed in the interiors of the Rocky Coulee and Cohassett flows during the development. Controlled field tests are needed to identify formation or borehole characteristics that may provide pathways for vertical groundwater movement between flows under dynamic conditions.

10.0 ACKNOWLEDGMENTS

The completion of RRL-2B and RRL-2C was accomplished by the cooperative efforts of BWIP staff and subcontractors. Basalt Waste Isolation Project staff who assisted with the field drilling or piezometer installation included W. R. Brown, J. A. Bultena, T. S. Clawson, G. O. Henrie, H. D. Jamison, J. M. Jimenez, M. D. McElroy, G. L. Setbacken, S. J. Skurla, S. R. Strait, P. D. Thorne, D. C. Weekes, and T. J. Wood.

Mr. W. R. Brown assisted in the coordination of borehole geophysical logging activities. Mr. J. R. Bollier assisted in the preparation of the as-built drawings. Dr. R. Stone provided analysis of pulse test data. Dr. A. H. Lu, P. M. Rogers, and Dr. R. Stone provided design recommendations for the location of the flow interior piezometers.

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APPENDIX A

AS-BUILT DRAWINGS OF RRL-2B AND RRL-2C

Coordinates and Elevations listed in the following drawings are based on surveys available at the time of release of this document.

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Figures:

APPENDIX B

DRILLING OPERATION SUMMARIES

CONTENTS

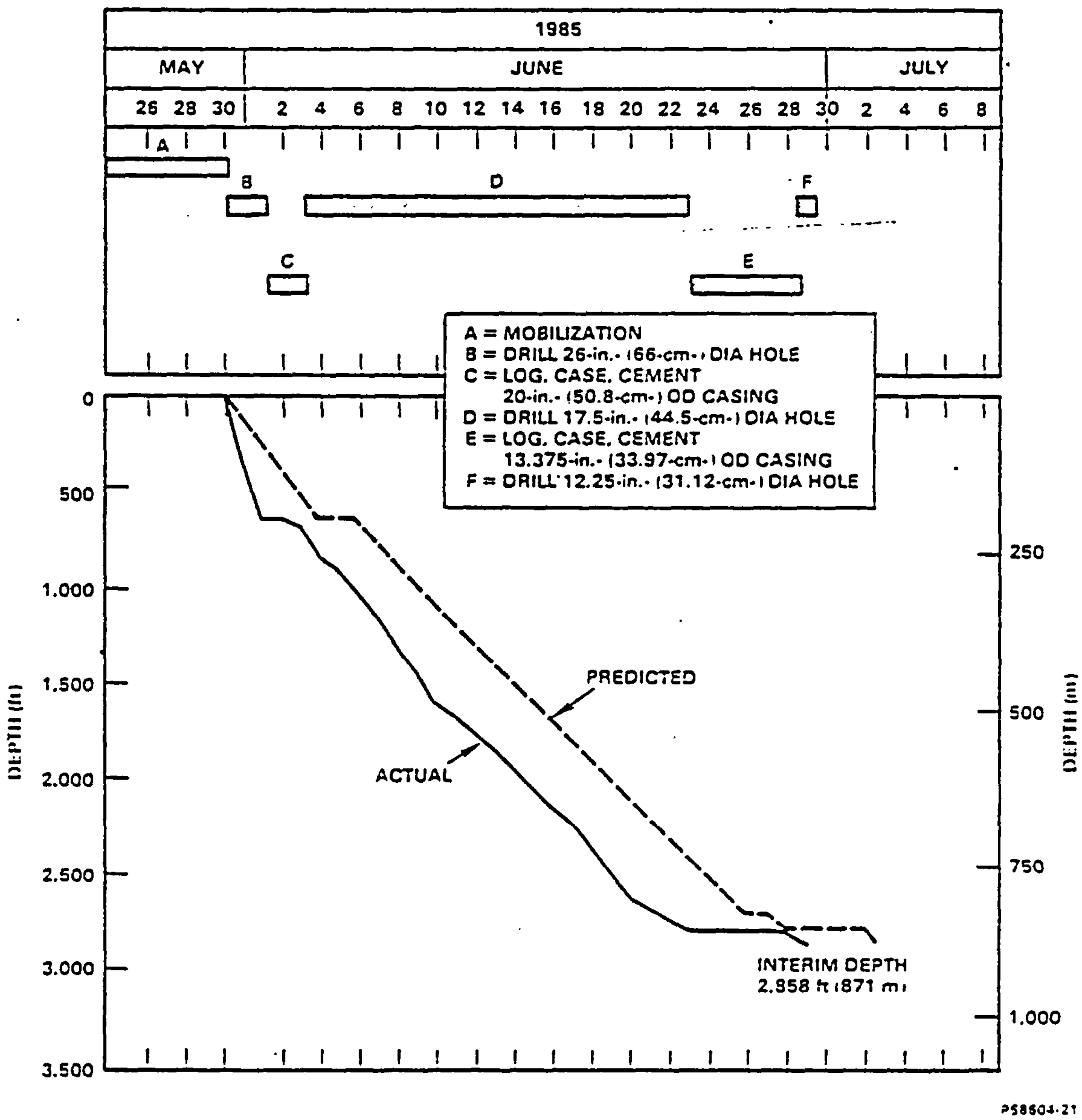

Figure B-1. Drilling Progress for Borehole RRL-2B.

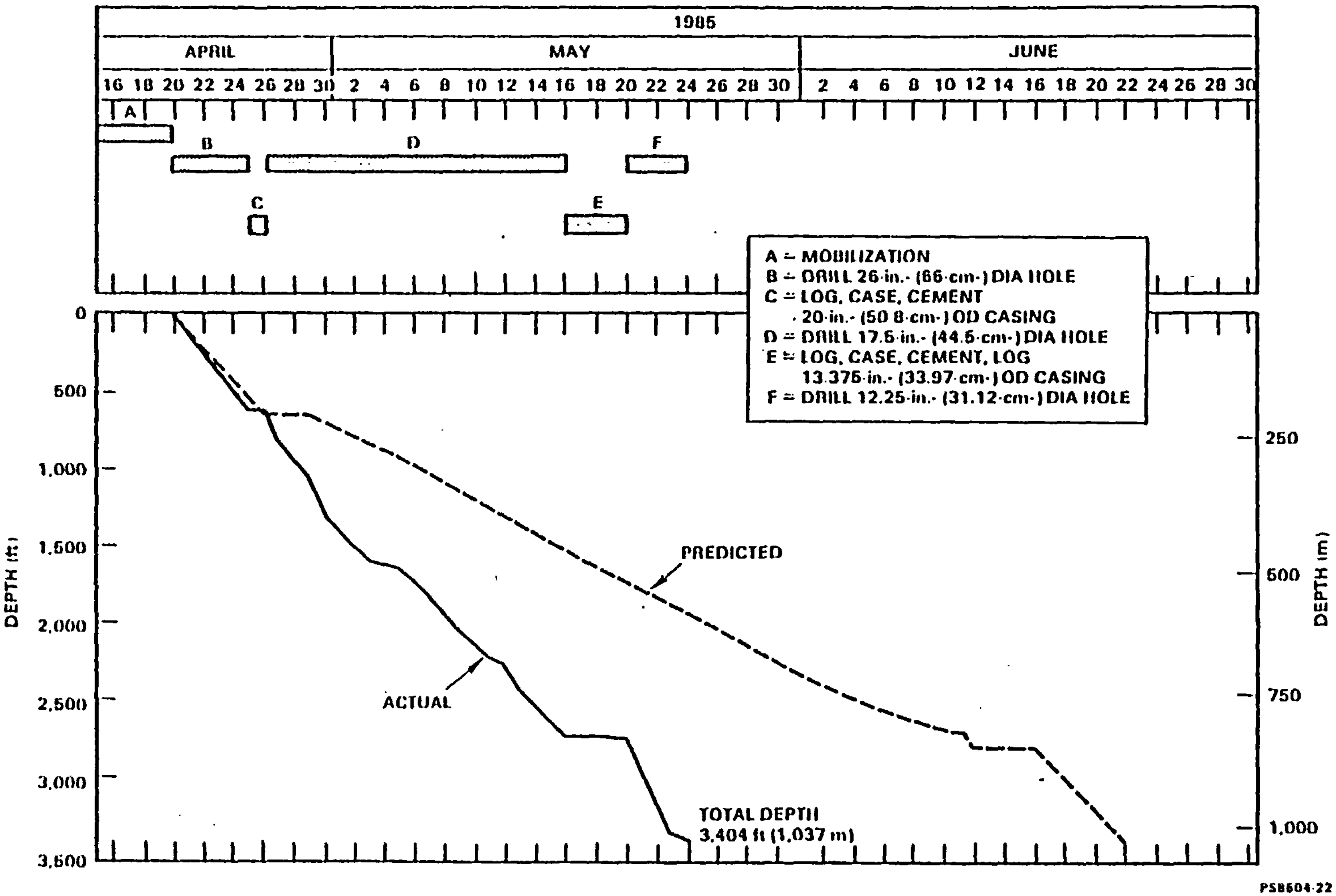

Figure B-2. Drilling Progress for Borehole RRL-2C.

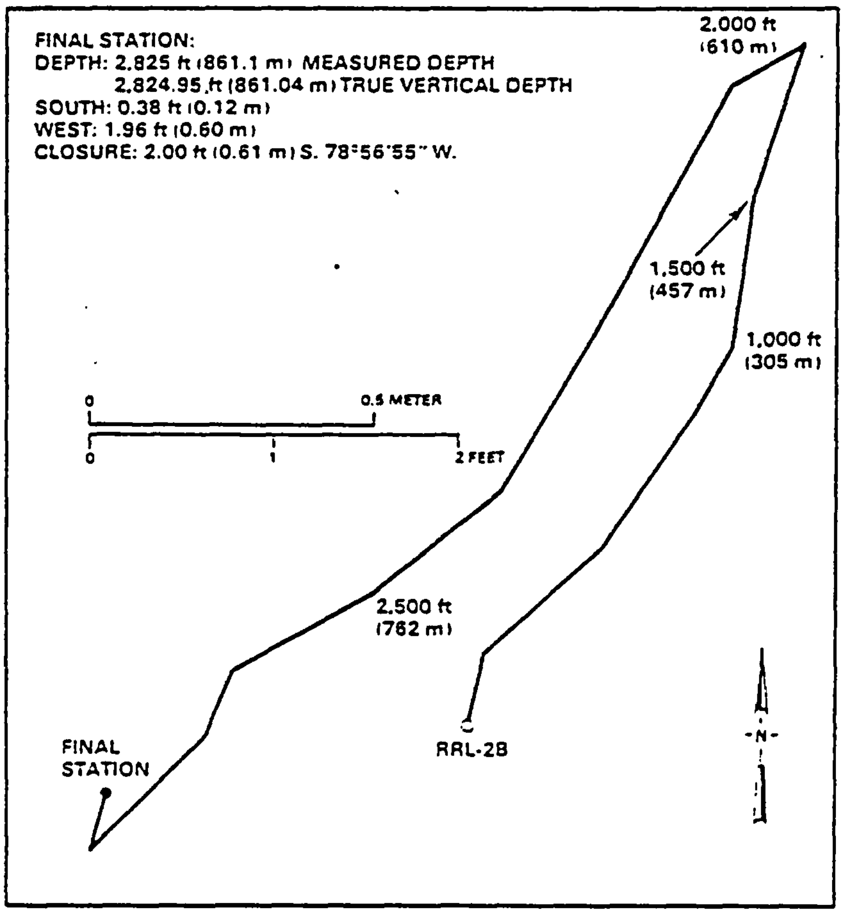

Figure B-3. Plan View of Course Direction of Borehole RRL-2B from Surface to Interim Depth, as Determined by Gyroscopic Survey.

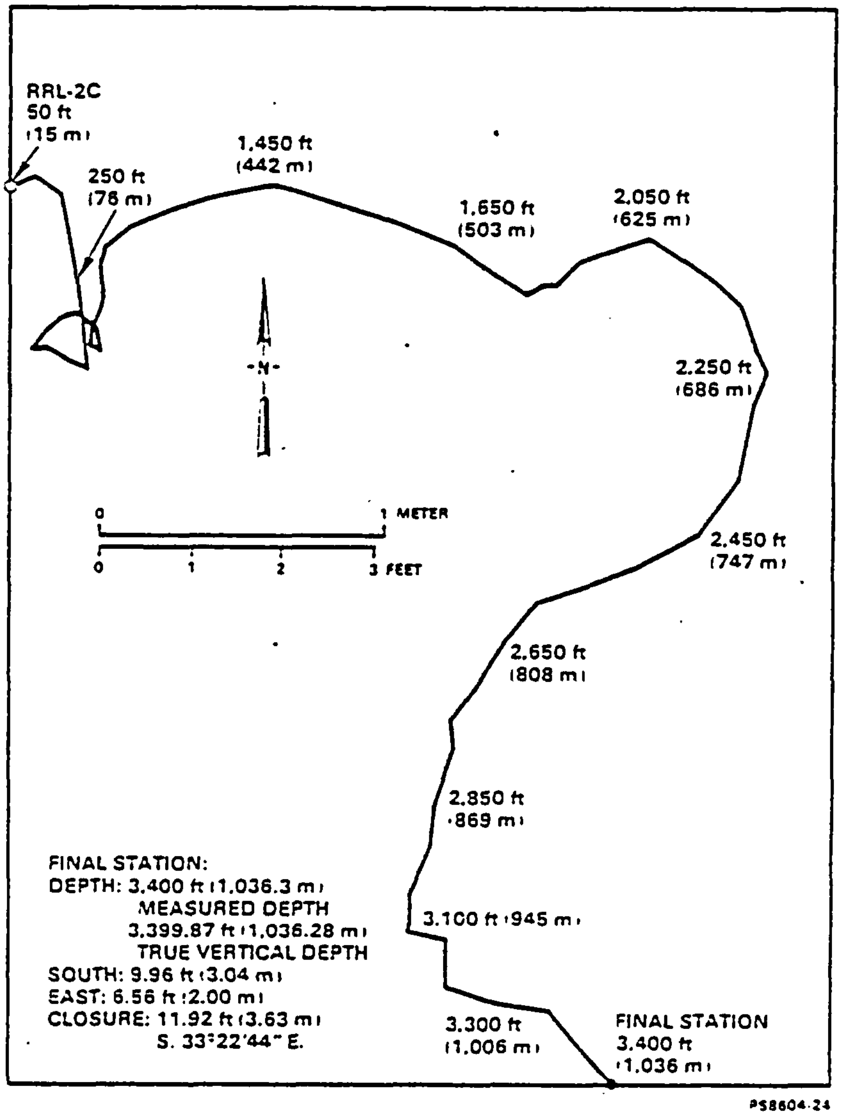

Figure 6-4. Plan View of Course Direction of Borehole RRL-2C from Surface to Total Depth as Determined by Gyroscopic Survey.

BWIP ROTARY RIG SHIFT REPORT OF OPERATIONS

PAGE 1 OF ____

Date	Hole Number	Location of Hole	Rockwell Contract No	Report Number

DRILLING ASSEMBLY (At end of tour)		BIT RECORD			MUD RECORD	
Bit	Ft.	Bit No			Vis.	Wt.
	Ft.	Size			WL.	Ph
	Ft.	Mfg			MUD & CHEMICALS ADDED (Type & Amount)	
	Ft.	Type				
	Ft.	Jets 1/32"				
	Ft.	Ser No				
Stands DP	Ft.	Depth Out				
Singles DP	Ft.	Depth In				
Kelly Down	Ft.	Total Ftg				
Total	Ft.	Total Hrs Run				
Wt. of String	Lbs.	CASING HISTORY				
DP Size / Wt. Ft. / Grade		Size	Weight Grade	Set At		
Total Shift Footage	Ft.					

Start Time
End Time
Rockwell Time
Contractor Time

PERSONNEL

Driller: ____________ (Acceptance)

Helpers

Pump No.	Pump Manufacturer	Type	Stroke Length

DEVIATION RECORD		FOOTAGES		FORMATION	Rotary RPM	Wt On Bit 1000	Pump Press	Pump No Liner Size	S.P.M.	Pump No Liner Size	S.P.M.	Method Run SOL-S PAR EL-P Com O-C
Depth	Dev.	From	To									

REMARKS

Report By ____________ Reviewed By ____________

Title ____________ Title ____________ Date: ____________

Signature ____________ Signature ____________

DISTRIBUTION: White - Site Data Control Clerk; Green - Team Leader; Canary - Contract File; Hard Buff - Retain at Worksite

RECORD ALL ENTRIES IN BLACK INK OR WITH THE TYPEWRITER. SINGLE LINE OUT ANY ERRORS, INITIAL AND DATE. ENTRIES MUST BE LEGIBLE ON ALL COPIES

BC 6400 175 8-85

Figure B-5. Shift Report of Operations Form.

Table B-1. Contractors and Service Companies. (sheet 1 of 2)

Company	Specialty
Air Drilling Services, Denver, CO	Compressors and service
Baroid Service, Bakersfield, CA	Mud products
Bill's Casing Tong Service, Marysville, CA	Tong service and laydown machine
Brinckerhoff-Signal Co., Casper, WY	Rotary drilling and welding services
Combined Petroleum Services, Inc., Grand Junction, CO	Mud cleaner
Christensen Oil Field Tools, Vernal, UT	Shock subs
Drilco, Kalispell, MT	Stabilizers and magnafluxing service
Eastman Whipstock, Casper, WY	Gyroscopic surveying
Economy Bit Service, Casper, WY	Bit retipping
Gearhart Industries	Geophysical logging
Getter Trucking, Casper, WY	Truck service
Grant Oil Tools Casper, WY	Rotating head
Haliburton Services, Evanston, WY	Cement products and services
Magcobar Dresser Industries	Mud products and services
Northwestern Mud Co., Spokane, WA	Mud products

Table B-1. Contractors and Service Companies. (sheet 2 of 2)

Company	Specialty
Northwest Rentals, Vancouver, WA	Bits
Onwego Drilling Co., Inc., Kennewick, WA	Cable tool entry holes and mobile office rental
Pacific Northwest Laboratories, Richland, WA	Geophysical logs
Portable Welding Specialists, Kittitas, WA	Welding
Pride Oil Well Service, Casper, WY	Workover rigs
Totco, Bakersfield, CA	Pit level recording equipment and gas detector and forklift rental
Wapato Fruit and Cold Storage, Wapato, WA	Water hauling, truck service, and forklift rental
Western Well Supply, Aloha, OR	Rotary tool machine work
Wyoming Casing Service, Dickenson, ND	Tong service and laydown machine

Table B-2. Borehole RRL-2B Daily Drilling History. (sheet 1 of 5)

Date	Activities
04/10/85-04/16/85	Cable tool set 19.5 ft (5.9 m) of 30-in. (76.2-cm) conductor pipe.
05/30/85	Nippled up and mixed spud mud. Drilled mouse and rat hole. Tripped in with retipped bit (no. 1) and drilled 26-in. (66.0-cm) hole from 19.5 to 94 ft (5.9 to 28.7 m). Deviation survey: 0.25° at 94 ft (28.7 m).
05/31/85	Drilled 26-in. (66.0-cm) hole from 94 to 381 ft (28.7 to 116.1 m) into overburden. Deviation survey: 0.5° at 219 ft (66.8 m).
06/01/85	Drilled 26-in. (66.0-cm) hole from 381 to 553 ft (116.1 to 168.6 m) into overburden. Tripped out to change to new bit (tip no. 2). Tripped in and drilled 26-in. (66.0-cm) hole from 553 to 614 ft (168.6 to 187.1 m). Reached top of basalt at about 600 ft (182.9 m). Deviation survey: 0° at 588 ft (179.2 m).
06/02/85	Drilled 26-in. (66.0-cm) hole from 614 to 618 ft (187.1 to 188.4 m) and circulated mud in order to run full suite of logs. Tripped out and ran borehole geophysical logs. Completed logging and tripped in hole to condition hole and mud prior to running casing. Ran 16 joints of 20-in. (50.8-cm) casing to a depth of 613 ft (186.8 m).
06/03/85	Circulated and cut off 20-in. (50.8-cm) casing prior to cementing. Cemented casing by subcontracted cementing service company. Waited on cement 8 h. Tripped in and drilled with new bit 17.5-in. (44.45-cm) (no. 3) and drilled cement and casing shoe. Drilling a 17.5-in. (44.45-cm) hole from 614 to 645 ft (187.1 to 196.6 m) in the Elephant Mountain Member.
06/04/85	Drilled 17.5-in. (44.45-cm) hole from 645 to 818 ft (196.6 to 249.3 m) through the Elephant Mountain Member, Rattlesnake Ridge interbed, and into the Pomona Member. No detectable fluid losses while drilling the interbed. Started running a methane gas detector. Deviation survey: 0° at 588 ft (179.2 m), 1° at 660 ft (201.2 m) and 0.75° at 813 ft (247.8 m).
06/05/85	Drilled 17.5-in. (44.45-cm) hole from 818 to 900 ft (249.3 to 274.3 m) in the Pomona Member. Deviation survey: 1° at 875 ft (266.7 m).

Table B-2. Borehole RRL-2B Daily Drilling History. (sheet 2 of 5)

Date	Activities
06/06/85	Drilled 17.5-in. (44.45-cm) hole from 900 to 1,045 ft (274.3 to 318.5 m) through the Pomona Member, Selah interbed and into the Esquatzel Member. Lost 178 bbl (28.3 m^3) in the Selah interbed. Deviation survey: 1/4° at 1,027 ft (313.0 m).
06/07/85	Drilled 17.5-in. (44.45-cm) hole from 1,045 to 1,069 ft (318.5 to 325.8 m) within the Esquaztel Member. Tripped out in morning in order to replace a cracked drill pipe (9th joint from top). Tripped in and drilled from 1,069 to 1,083 ft (325.8 to 330.1 m). At this point, the 16th joint of the drill pipe twisted off. Tripped in with overshot and retrieved fish. Tripped out and laid fish down. Tripped in with new bit (no. 4) and drilled 17.5-in. (44.45-cm) hole from 1,083 to 1,148 ft (330.1 to 349.9 m) through the Esquaztel Member and into the Cold Creek interbed.
06/08/85	Drilled 17.5-in. (44.45-cm) hole from 1,148 to 1,303 ft (349.9 to 397.2 m) through the Cold Creek interbed and into the Umatilla Member. Deviation survey: 0.25° at 1,212 ft (369.4 m).
06/09/85	Drilled 17.5-in. (44.45-cm) hole from 1,303 to 1,418 ft (397.2 to 432.2 m) through the Umatilla Member and into the Mabton interbed. Deviation survey: 0.5° at 1,336 ft (407.2 m).
06/10/85	Drilled 17.5-in. (44.45-cm) hole from 1,418 to 1,602 ft (432.2 to 488.3 m) through the Mabton interbed and into the Lolo flow of the Priest Rapids Member. No apparent fluid loss. Deviation survey: 0.5° at 1,550 ft (472.4 m).
06/11/85	Drilled 17.5-in. (44.45-cm) hole from 1,602 to 1,674 ft (488.3 to 510.2 m) in the Lolo flow of the Priest Rapids Member. Tripped out of hole for bit change. Laid down two 11-in. (27.9-cm) drill collars, and picked up two more 11-in. (27.9-cm) drill collars. No apparent fluid loss in past 24 h. Deviation survey: 0.25° at 1,640 ft (499.9 m).

Table B-2. Borehole RRL-2B Daily Drilling History. (sheet 3 of 5)

Date	Activities
06/12/85	Tripped in with new bit (5) and drilled 17.5-in. (44.45-cm) hole from 1,674 to 1,766 ft (510.2 to 538.3 m) through the Lolo flow, Rosalia flow, Quincy interbed and into the Roza Member. Lost about 520 bbl (82.7 m^3) of mud into the Roza flow top. Twisted off pin on shock sub. Picked up overshot, tripped in hole to fish for bottom collar and bit.
06/13/85	Tripped out of hole and laid down fish. Installed new shock sub. Tripped in hole and resumed drilling the Roza Member to 1,833 ft (558.7 m). Deviation survey: 0.5° at 1,826 ft (556.6 m).
06/14/85	Drilled 17.5-in. (44.45-cm) hole from 1,826 to 1,945 ft (556.6 to 592.8 m) through the Roza Member and into the Sentinel Gap flow. No apparent fluid loss last 24 h. Deviation survey: 0.5° at 1,918 ft (584.6 m).
06/15/85	Drilled 17.5-in. (44.45-cm) hole from 1,945 to 2,057 ft (592.8 to 627.0 m) in the Sentinel Gap flow. At this point, an 8-in. (20-cm) drill collar twisted off. Tripped out of hole and picked up overshot. Tripped in with overshot and began fishing. Retrieved fish and tripped out of hole. Deviation survey: 0.25° at 2,040 ft (621.8 m).
06/16/85	Picked up two 8-in. (20-cm) drill collars and tripped in hole. Drilled from 2,057 to 2,155 ft (627.0 to 656.8 m) through the Sentinel Gap flow and into the Frenchman Springs 2. No apparent fluid losses.
06/17/85	Drilled 17.5-in. (44.45-cm) hole from 2,155 to 2,184 ft (656.8 to 665.7 m) with the Frenchman Springs 2. Tripped out for bit change. Tripped in with new bit (no. 6) and drilled a 17.5-in. (44.45-cm) hole from 2,184 to 2,197 ft (665.7 to 669.7 m). At this point, the drill string twisted off at a 7-in. (18-cm) drill collar. Tripped out of hole and made up fish tool. Tripped in with fishing tool and retrieved fish. Laid down two 7-in. (18-cm) drill collars and picked up two 7-in. (18-cm) drill collars. Tripped in hole and resumed drilling. Drilled from 2,197 to 2,219 ft (669.6 to 676.4 m) through the Frenchman Springs 2 and into Frenchman Springs 3. Deviation survey: 0.75° at 2,164 ft (659.6 m).

Table B-2. Borehole RRL-2B Daily Drilling History. (sheet 4 of 5)

Date	Activities
06/18/85	Drilled 17.5-in. (44.45-cm) hole from 2,219 to 2,365 ft (676.4 to 720.9 m) through the Frenchman Springs 3 and into the Frenchman Springs 4. Encountered a lost-circulation zone between 2,305 and 2,310 ft (702.6 and 704.1 m), resulting in a loss of 25 bbl (4.0 m^3). Deviation survey: 0.75° at 2,347 ft (715.4 m).
06/19/85	Drilled 17.5-in. (44.45-cm) hole from 2,365 to 2,525 ft (720.9 to 769.6 m) through the Frenchman Springs 4, Frenchman Springs 5, and into the Ginkgo I. Deviation survey: 1.25° at 2,470 ft (752.9 m).
06/20/85	Drilled 17.5-in. (44.45-cm) hole from 2,525 to 2,655 ft (769.6 to 809.2 m) through Ginkgo I flow and into Frenchman Springs 7. At this point an 11-in. (28-cm) drill collar twisted off. Tripped out of hole. Deviation survey: 0.5° at 2,564 ft (781.5 m).
06/21/85	Tripped out and picked up fishing tools. Tripped in with overshot and fished. Tripped out of hole and reloaded fishing tools. Retrieved fish and tripped out of hole. Picked up two 11-in. (28-cm) drill collars. Changed bit to (rerun no. 3) and layed down four joints of drill pipe. Tripped in hole and drilled a 17.5-in. (44.45-cm) hole from 2,655 to 2,674 ft (809.2 to 815.0 m) within the Frenchman Springs 7.
06/22/85	Drilled 17.5-in. (44.45-cm) hole from 2,674 to 2,750 ft (815.0 to 838.2 m) through Frenchman Springs 7, the Vantage interbed, Grande Ronde 1, and into the Grande Ronde 2. Tripped out of hole to run neutron log and finished logging. Deviation survey: 0.5° at 2,722 ft (829.7 m).
06/23/85	Tripped in and drilled from 2,750 to 2,776 ft (838.2 to 846.1 m) within Grande Ronde 2. Stopped drilling and circulated for 2 h. Tripped out to run full suite of borehole geophysical logs.
06/24/85	Completed borehole geophysical logging and tripped back into hole to condition hole prior to running casing, strapped pipe out of hole; total depth is 2,780 ft (847.3 m). Rigged up casing crew and began to run casing.

Table B-2. Borehole RRL-2B Daily Drilling History. (sheet 5 of 5)

Date	Activities
06/25/85	Ran 13.375-in. (33.97-cm), K-55 ST and C casing to 2,780 ft (847.3 m) and pulled it back to set it at 2,776 ft (846.1 m). Cemented casing in two stages by subcontracted cementing service company.
06/26/85	Waited on cement and began nippling up. Tripped in hole and drilled out stage tool and cement plug. Tripped out of hole to run cement bond log.
06/27/85	Tripped in hole to drill out cement and casing shoe to 2,782 ft (848.0 m). Tripped out of hole and made up packer to test casing shoe. Tripped in and tested shoe and 2 ft (0.61 m) of rock. Had a small pressure bleed off and decided to test pipe. Pipe was OK, so tripped out and then spotted 100 sacks of cement. Cement plug at the bottom of the borehole was brought back up to 2,674 ft (815.0 m). Tripped out and waited on cement.
06/28/85	Waited on cement. Tripped in hole with drilling assembly and tagged top of cement at 2,669 ft (813.5 m). Drilled cement to 2,778 ft (846.7 m). Circulated hole and tripped out of hole with drilling assembly. Tripped in hole with packer and retested casing shoe. Tripped out of hole with packer. Tripped in hole with 12.25-in. (31.12-cm) bit to drill out remaining cement to 2,782 ft (848.0 m).
06/29/85	Drilled 12.25-in. (31.12-cm) hole with water from 2,782 to 2,840 ft (848.0 to 865.6 m) circulated hole and trip out to run logs. Completed logging and tripped in hole. Drilled with water from 2,840 to 2,858 ft (865.6 to 871.1 m) through Grande Ronde 2 and into the Rocky Coulee flow. Loss of about 15 bbl (2.4 m^3) of fluid in Rocky Coulee flow top. Tripped out and laid down pipe. Deviation survey: 0.5° at 2,840 ft (865.6 m). Cut off casing and welded a flange on. Rigged down.

Table B-3. Borehole RRL-2C Daily Drilling History. (sheet 1 of 5)

Date	Activities
03/30/85-04-09/85	Cable tool set 19 ft (5.8 m) of 30-in. (76.2-cm) conductor pipe; 7.21 ft^3 (0.20 m^3) of cement was placed in lower section of hole on 04/15/85.
04/15/85	Crews attended Pre-spud and Safety Meeting and First Aid Class.
04/16/85-04/21/85	Brinckerhoff-Signals Rig no. 80 rigged up and started drilling at 12:30 p.m. Mixed mud and drilled rat and mouse holes. Tripped in and drilled 26-in. (66.0 cm) hole from 19 to 102 ft (5.8 to 31.1 m) through unconsolidated sediments.
04/22/85	Drilled 26-in. (66.0-cm) surface hole from 102 to 273 ft (31.1 to 83.2 m). Encountered lost circulation zone at approximately 252 ft (76.8 m), resulting in a loss of 100 to 125 bbl (15.9 to 19.9 m^3) of fluid to formation over 12 h. Deviation survey: 0° at 100 ft (30.5 m).
04/23/85	Drilled 26-in. (66.0-cm) surface hole from 273 to 479 ft (83.2 to 146.0 m). Deviation survey: 0.25° at 283 ft (86.3 m), 0.25° at 376 ft (114.6 m).
04/24/85	Drilled 26-in. (66.0-cm) hole from 479 to 611 ft (146.0 to 186.2 m). Reached top of basalt at about 600 ft (182.9 m). Tripped out of hole to run borehole geophysical logs. Rigged up cementing equipment. Deviation survey: 0.5° at 498 ft (151.8 m).
04/25/85	Completed borehole geophysical logs at 9:00 a.m. Tripped back in hole with drill pipe and broke circulation. Circulated and conditioned hole prior to running casing. Ran 17 joints of 20-in. (50.8-cm) casing to a depth of 609 ft (185.6 m). Circulated the borehole and began nippling up to cement casing.
04/26/85	Cemented 20-in. (50.8-cm) casing by subcontracted cementing service. Waited on cement 15 h. Picked up drilling tools and tripped in hole. Tagged top of cement 596 ft (181.7 m); drilled cement and shoe. Changed to new bit (no. 2) at 610 ft (185.9 m). Drilled 17.5-in. (44.45-cm) hole from 610 to 633 ft (185.9 to 192.9 m) into the Elephant Mountain Member. No fluid losses encountered while drilling interbed. Deviation survey: 0.75° at 597 ft (182.0 m).

Table B-3. Borehole RRL-2C Daily Drilling History. (sheet 2 of 5)

Date	Activities
04/27/85	Drilled 17.5-in. (44.45-cm) hole from 633 to 809 ft (192.9 to 246.6 m) through Elephant Mountain Member, the Rattlesnake Ridge interbed and into the Pomona Member. No measurable fluid losses were encountered while drilling interbed. Deviation survey: 0.5° at 634 ft (193.2 m).
04/28/85	Drilled 17.5-in. (44.45-cm) hole from 809 to 917 ft (246.6 to 251.5 m) within the Pomona Member. Lost 60 bbl (9.5 m^3) of mud at about 825 ft (251.5 m). Deviation survey: 1° at 800 ft (243.8 m); 0.25° at 878 ft (267.6 m).
04/29/85	Drilled 17.5-in. (44.45-cm) hole from 917 to 1,070 ft (279.5 to 326.1 m) through the Pomona Member, Selah interbed and into the Esquatzel Member. Lost approximately 20 bbl (3.2 m^3) of mud while drilling through the Selah interbed. Tripped out of hole at 1,003 ft (305.7 m) for new bit (no. 3), changed out two 11-in. (28-cm) drill collars. Deviation survey: 0.5° at 1,028 ft (313.3 m).
04/30/85	Drilled 17.5-in. (44.45-cm) hole from 1,070 to 1,287 ft (326.1 to 392.3 m) through the Esquatzel Member, the Cold Creek interbed, and into the Umatilla Member. Deviation survey: 0.5° at 1,088 ft (331.6 m); 1° at 1,212 ft (369.4 m); 0.25° at 1,273 ft (388.0 m).
05/01/85	Drilled 17.5-in. (44.45-cm) hole from 1,287 to 1,398 ft (392.3 to 426.1 m) through the Umatilla Member and into the Mabton interbed. At this point, the drill string parted. Tripped out of hole and laid down two bad drill collars. Tripped back in hole with overshot and began fishing. Deviation survey: 0.25° at 1,373 ft (418.5 m).
05/02/85	Completed fishing at 6:00 a.m. and resumed drilling. Drilled from 1,398 to 1,551 ft (426.1 to 472.7 m) through Mabton interbed and encountered the top of Lolo flow of the Priest Rapids Member. Deviation survey: 1° at 1,526 ft (465.1 m).
05/03/85	Drilled 17.5-in. (44.45-cm) hole from 1,551 to 1,607 ft (472.8 to 489.8 m) into the Lolo flow. At this point, the drill string twisted off at the last tool joint above the 11-in. (28-cm) collar. Tripped out of hole and picked up fishing tools. Tripped in with overshot and began fishing. Deviation survey: 1° at 1,558 ft (474.9 m).

Table B-3. Borehole RRL-2C Daily Drilling History. (sheet 3 of 5)

Date	Activities
05/04/85	Finished fishing at 1:00 p.m. and then resumed drilling. Drilled from 1,607 to 1,633 ft (489.8 to 497.7 m). At this point, the drill string twisted off at the last joint above the 11-in. (28-cm) collar again. Tripped in hole with overshot and began fishing.
05/05/85	Retrieved fish and resumed drilling. Drilled 17.5-in. (44.45-cm) hole from 1,633 to 1,648 ft (497.7 to 502.3 m) within the Lolo flow. At this point, an 11-in. (28-cm) drill collar twisted off. Tripped out of hole and picked up fishing tools. Tripped in with overshot and retrieved fish.
05/06/85	Tripped in hole with new bit (no. 4) and drilled 17.5-in. (44.45-cm) hole from 1,648 to 1,679 ft (502.3 to 511.8 m) within the Lolo flow. Encountered high rotary torque. Tripped out to laydown near bit reamer. Tripped in hole and drilled from 1,679 to 1,728 ft (511.8 to 526.7 m) through the Lolo flow and into the Rosalia flow of the Priest Rapids Member. No fluid losses encountered while drilling through the Rosalia flow top. Deviation surveys: 0.5° at 1,650 ft (502.9 m); 0.75° at 1,679 ft (511.8 m).
05/07/85	Drilled 17.5-in. (44.45-cm) hole from 1,728 to 1,835 ft (526.7 to 559.3 m) through the Rosalia flow and into the Roza Member. Lost approximately 12 bbl (1.9 m^3) of drilling fluid while drilling the Roza flow top. Deviation survey: 0.25° at 1,768 ft (538.9 m).
05/08/85	Drilled 17.5-in. (44.45-cm) hole from 1,835 to 1,945 ft (559.3 to 592.8 m) through the Roza Member and into the Sentinel Gap flow of the Frenchman Springs Member. No apparent fluid loss. Deviation survey: 0.5° at 1,862 ft (567.5 m).
05/09/85	Drilled 17.5-in. (44.45-cm) hole from 1,945 to 2,067 ft (592.8 to 630.0 m) in the Sentinel Gap flow. Encountered lost-circulation zone at approximately 2,037 ft (620.9 m), resulting in a loss of 470 bbl (74.7 m^3) of mud over 24 h. Deviation survey: 0° at 2,015 ft (614.2 m).
05/10/85	Drilled 17.5-in. (44.45-cm) hole from 2,067 to 2,166 ft (630.0 to 660.2 m) through the Sentinel Gap flow and into the Frenchman Springs 2. No apparent fluid loss in last 24 h. Deviation survey: 0.5° at 2,109 ft (642.8 m).

Table B-3. Borehole RRL-2C Daily Drilling History. (sheet 4 of 5)

Date	Activities
05/11/85	Drilled 17.5-in. (44.45-cm) hole from 2,166 to 2,180 ft (660.2 to 664.5 m) within Frenchman Springs 2. Tripped out for new bit (no. 5). Tripped in and installed corrosion ring and changed wobble joint. Drilled 17.5-in. (44.45-cm) hole from 2,180 to 2,237 ft (664.5 to 681.8 m) through the Frenchman Springs 2 and into the Frenchman Springs 3. Deviation survey: 0.75° at 2,227 ft (678.8 m).
05/12/85	Drilled 17.5-in. (44.45-cm) hole from 2,237 to 2,341 ft (681.8 to 713.5 m) through the Frenchman Springs 3 and into the Frenchman Springs 4.
05/13/85	Drilled 17.5-in. (44.45-cm) hole from 2,341 to 2,444 ft (713.5 to 744.9 m) through the Frenchman Springs 4 and in the Frenchman Springs 5. Deviation survey: 0.5° at 2,352 ft (716.9 m); 0.5° at 2,444 ft (744.9 m).
05/14/85	Drilled 17.5-in. (44.45-cm) hole from 2,444 to 2,545 ft (744.9 to 775.7 m) through the Frenchman Springs 5 and in the Ginkgo I flow. Deviation survey: 0.75° at 2,538 ft (773.6 m).
05/15/85	Drilled 17.5-in. (44.45-cm) hole from 2,545 to 2,637 ft (775.7 to 803.8 m) through the Ginkgo I flow and into the Frenchman Springs 7. Encountered extremely rough drilling. No apparent fluid lost. Deviation survey: 0.25° at 2,629 ft (801.3 m).
05/16/85	Drilled 2,637 to 2,750 ft (803.8 to 838.2 m) through the Frenchman Springs 7, Grande Ronde 1 and into the Grande Ronde 2. Tripped out to run borehole geophysical log. Based on neutron log it was determined that the hole should be deepened to 2,776 ft (846.1 m) before running a full suite of logs. Deviation survey: 0.25° at 2,720 ft (829.1 m).
05/17/85	Tripped in with used bit (rerun no. 2). Drilled from 2,750 to 2,776 ft (838.2 to 846.1 m) within Grande Ronde 2. Circulated mud and tripped out of hole. Started running a full suite of borehole geophysical logs prior to running 13.375-in. (33.973-cm) casing.
05/18/85	Finished running logs. Tripped in hole to condition mud. Tripped out of hole. Rigged up for casing operation. Ran 2,802 ft (854.1 m) of 13.375-in. (33.973-cm), K-55 casing. Casing landed at 2,775 ft (845.8 m). Rigged up for cement.

Table B-3. Borehole RRL-2C Daily Drilling History. (sheet 5 of 5)

Date	Activities
05/19/85	Cemented 13.375-in. (33.973-cm) casing by subcontracted cementing service company. Cut off casing and nippled up flow line.
05/20/85	Finished nippling up rotating head. Tripped in hole and drilled out D.V. tool and shoe joint. Left 10 ft (3.1 m) of cement in shoe joint to squeeze against, if needed, as a precautionary measure. Tripped out of hole to run cement bond log. Finished logging and tripped in hole with new bit (no. 6). Drilled a 12.25-in. (31.1-cm) hole to 2,778 ft (846.7 m). Tripped out of hole and picked up testing packer. Tripped in hole with test packer, in order to test casing shoe.
05/21/85	Tripped in hole and drilled 12.25-in. (31.1-cm) hole from 2,778 to 2,966 ft (846.7 to 904.0 m) through the Grande Ronde 2 and Rocky Coulee flow into the Cohassett flow. No apparent fluid loss. Deviation survey: 0.25° at 2,896 ft (882.7 m).
05/22/85	Drilled 12.25-in. (31.1-cm) hole from 2,966 to 3,166 ft (904.0 to 965.0 m) in the Cohassett flow. No apparent fluid loss. Deviation survey: 0.75° at 3,018 ft (919.9 m).
05/23/85	Drilled 12.25-in. (31.1-cm) hole from 3,166 to 3,360 ft (965.0 to 1,024.1 m) through the Cohassett flow and into the Grande Ronde 5. Circulated mud at 3,360 ft (1,024.1 m) in preparation of running borehole geophysical logs. At a depth of 3,231 ft (984.8 m), started losing fluid at an approximate rate of 3.5 bbl/min (557 L/min). Tripped out of hole for a bit change. Deviation survey: 1° at 3,171 ft (966.5 m); 1° at 3,266 ft (995.5 m).
05/24/85	Tripped in with new bit (no. 7). Drilled from 3,360 to 3,404 ft (1,024.1 to 1,037.5 m) through the Grande Ronde 5 and into the Grande Ronde 6. Tripped out and laid down drill pipe and drill collars. Rotating head removed and mud pits cleaned. Borehole RRL-2C reached a total depth of 3,404 ft (1,037.5 m) in the Grande Ronde 6. Rig was released at 8:00 p.m.
05/25/85	Rig down.

Table 8-4. Estimated Fluid Loss During Drilling of Borehole RRL-2B.

Date	Depth interval where loss occurred, ft(m)	Geologic unit	Fluid loss, bbl (m^3)	Fluid
06/06/85	923-998 (281.3-304.2)	Selah interbed	178 (28.3)	Mud
06/12/85	1,746-1,784 (532.2-543.8)	Roza flow	520 (82.7)	Mud
06/19/85	2,305-2,310 (702.6-704.1)	Frenchman Springs 4	25 (4.0)	Mud
06/29/85	2,815-2,842 (858.0-866.2)	Rocky Coulee flow top	15 (2.4)	Water

Table 8-5. Estimated Fluid Loss During Drilling of Borehole RRL-2C.

Date	Depth interval where loss occurred, ft(m)	Geologic unit	Fluid loss, bbl (m^3)	Fluid
04/22/85	252 (76.8)	Ringold Formation	125 (19.9)	Mud
04/28/85	825 (251.5)	Pomona flow	60 (9.5)	Mud
04/29/85	575 (175.3)	Selah interbed	20 (3.2)	Mud
05/07/85	1,736 (529.1)	Priest Rapids/Roza flows	12 (1.9)	Mud
05/09/85	2,037 (620.9)	Sentinel Gap flow	470 (74.7)	Mud
05/23/85-05/24/85	3,232-3,272 (985.1-997.3)	Cohassett flow bottom and Grande Ronde 5 flow top	3,288 (522.8)	Water

Table B-6. Mud Drilling Record at Borehole RRL-2B. (sheet 1 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud viscosity, s	Mud weight, lb/gal (kg/L)	Water loss, in^3 (mL)	pH	Remarks
5-30-85	19-94 (5.8-28.7)	1	7,500 (3,402)	55	50	--	--	--	Spud Mud
5-31-85	94-381 (28.7-116.1)	1	9,200 (4,173)	62	58	8.8 (1.05)	--	7.5	
6-01-85	381-553 (116.1-168.6)	1	14,500 (6,577)	60	58	8.8 (1.05)	--	7.5	
6-01-85	553-614 (168.6-187.1)	2	20,000 (9,072)	60	58	8.8 (1.05)	--	7.5	Logging surface hole before running 20-in. (50.8-cm) casing to 613 ft (186.8 m)
6-02-85	--	--	--	55	51	8.9 (1.07)	--	8.0	
6-03-85	614-645 (187.1-196.6)	3	17,500 (7,938)	50	38	--	--	--	
6-04-85	645-818 (196.6-249.3)	3	14,000 (6,350)	57	39	8.8 (1.05)	--	10.2	
6-05-85	818-900 (249.3-274.3)	3	32,500 (14,742)	63	37	8.8 (1.05)	--	9.2	
6-06-85	900-1,045 (274.3-318.5)	3	20,000 (9,072)	63	42	8.8 (1.05)	0.63 (10.2)	8.8	

Table B-6. Mud Drilling Record at Well RRL-2B. (sheet 2 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud viscosity, s	Mud weight, lb/gal (kg/L)	Water loss, in^3 (mL)	pH	Remarks
6-07-85	1,045-1,083 (318.5-330.1)	3	42,500 (19,278)	60	46	8.9 (1.07)	--	9.0	LCM 6%
6-07-85	1,083-1,148 (330.1-349.9)	4	27,500 (12,474)	54	46	8.9 (1.07)	--	9.0	LCM 6%
6-08-85	1,148-1,303 (349.9-397.2)	4	35,000 (15,876)	52	49	8.9 (1.07)	0.38 (9.2)	9.3	LCM 2%
6-09-85	1,303-1,418 (397.2-432.2)	4	40,000 (18,144)	57	49	8.9 (1.07)	--	9.8	LCM 2%
6-10-85	1,418-1,602 (432.2-488.3)	4	37,000 (16,783)	58	57	8.8 (1.05)	--	9.0	LCM 6%
6-11-85	1,602-1,674 (488.3-510.2)	4	45,000 (20,412)	53	45	8.9 (1.07)	--	9.0	LCM 1%
6-12-85	1,674-1,766 (510.2-538.3)	5	42,500 (19,278)	50	45	8.9 (1.07)	0.73 (12.0)	9.5	LCM 1%
6-13-86	1,766-1,833 (538.3-558.7)	5	47,000 (21,319)	55	53	8.9 (1.07)	0.59 (9.6)	10.3	LCM 11%
6-14-85	1,833-1,945 (558.7-592.8)	5	48,000 (21,773)	59	53	9.0 (1.08)	0.62 (10.2)	10.6	LCM 12%
6-15-85	1,945-2,057 (592.8-627.0)	5	49,000 (22,226)	59	53	9.0 (1.08)	0.65 (10.6)	10.8	LCM 6%

Table B-6. Mud Drilling Record at Well RRL-2B. (sheet 3 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud viscosity, s	Mud weight, lb/gal (kg/L)	Water loss, in3 (mL)	pH	Remarks
6-16-85	2,057-2,155 (627.0-656.8)	5	48,000 (21,773)	59	52	8.9 (1.07)	0.68 (11.2)	11.0	LCM 3%
6-17-85	2,155-2,184 (656.8-665.7)	5	47,500 (21,546)	60	52	9.0 (1.08)	0.68 (11.2)	10.0	LCM 3%
6-17-85	2,184-2,219 (665.7-676.4)	6	45,000 (20,412)	58	52	9.0 (1.08)	0.68 (11.2)	10.0	LCM 3%
6-18-85	2,219-2,365 (676.4-720.8)	6	45,000. (20,412)	59	48	9.0 (1.08)	0.71 (11.6)	9.5	LCM 1%
6-19-85	2,365-2,525 (720.8-769.6)	6	39,000 (17,690)	63	45	9.0 (1.08)	0.72 (11.8)	9.0	LCM 2.5%
6-20-85	2,525-2,655 (769.6-809.2)	6	35,000 (15,876)	65	51	9.0 (1.08)	0.73 (12.0)	9.5	LCM 1%
6-21-85	2,655-2,684 (809.2-818.1)	RR-3	45,000 (20,412)	45	45	9.0 (1.08)	--	9.5	LCM 1%
6-22-85	2,684-2,750 (818.1-838.2)	RR-3	48,000 (21,773)	45	45	9.0 (1.08)	--	9.5	LCM 3%
6-23-85	2,750-2,776 (838.2-846.1)	RR-3	50,000 (22,680)	48	46	9.0 (1.08)	--	9.2	LCM 1%; Logging
6-24-85	--	RR-3	--	--	54	9.0 (1.08)	0.60 (9.8)	9.5	LCM 1%

Table B-6. Mud Drilling Record at Well RRL-2B. (sheet 4 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud viscosity, s	Mud weight, lb/gal (kg/L)	Water loss, in^3 (mL)	pH	Remarks
6-25-85	--	--	--	--	65	9.0 (1.08)	--	0.58 (9.5)	LCM; Run casing to 2,776 ft (846.1 m)
6-26-85	2,696-2,765 (821.7-842.8)	RR-7	15,000 (6,804)	49	--	--	--	--	Drill cement from 2,696 to 2,765 ft (821.7 to 842.8 m)
6-27-85	2,765-2,781 (842.8-847.6)	RR-7	20,000 (6,096)	50	--	--	--	--	Drill cement and shoe. Drilling with water
6-28-85	2,669-2,778 (813.5-846.7)	RR-7	25,000 (11,340)	50	--	--	--	--	Drilling cement
6-28-85	2,778-2,782 (846.7-847.9)	RR-7	5,000 (2,268)	55	--	--	--	--	Set packer and test. Drill cement
6-29-85	2,782-2,858 (847.9-871.1	RR-7	40,000 (18,144)	53	--	--	--	--	Drilling cement, circulated, survey, logging

LCM = lost circulation material (paper, wood fiber, cottonseed hulls).

Table B-7. Mud Drilling Record at Borehole RRL-2C. (sheet 1 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud visco-sity, s	Mud weight, lb/gal (kg/L)	Water loss, in^3 (mL)	pH	Remarks
04-21-85	37-102 (11.3-31.1)	1	7,500 (3,402)	58	52	-	-	-	Spud mud
04-22-85	102-273 (31.1-83.2)	1	7,500 (3,402)	59	48	8.8 (1.05)	-	9.0	Lost circulation at 252 ft (76.8 m)
4-23-85	273-479 (83.2-146.0)	1	8,300 (3,765)	60	60	8.9 (1.07)	-	8.6	
04-24-85	479-610 (146.0-185.9)	1	10,000 (4,536)	62	48	9.0 (1.08)	1.10 (18)	9.5	
04-25-85	-	-	-	-	50	8.8 (1.05)	-	10.0	Run casing to 609 ft (185.6 m)
04-26-85	610-633 (185.9-192.9)	2	30,000 (13,608)	40	47	8.8 (1.05)	1.10 (18)	10.0	
04-27-85	633-809 (192.9-246.6)	2	27,000 (8,229)	54	40	8.9 (1.07)	1.04 (17)	10.6	
04-28-85	809-917 (246.6-279.5)	2	39,000 (17,609)	65	42	8.8 (1.05)	1.04 (17)	9.6	LCM 7%
04-29-85	917-1,003 (279.5-305.7)	2	38,000 (17,237)	68	45	8.8 (1.05)	0.37 (6)	9.4	LCM 7%
04-30-85	1,003-1,287 (305.7-392.3)	3	40,000 (18,144)	70	45	8.8 (1.05)	0.48 (8)	9.4	LCM 7%

Table B-7. Mud Drilling Record at Borehole RRL-2C. (sheet 2 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud visco-sity, s	Mud weight, lb/gal (kg/L)	Water loss, in3 (mL)	pH	Remarks
05-01-85	1,287-1,398 (392.3-426.1)	3	38,000 (17,237)	70	42	8.8 (1.05)	0.50 (8.2)	8.8	LCM 6%
05-02-85	1,398-1,551 (426.1-472.7)	3	12,000 (5,443)	70	43	8.8 (1.05)	0.44 (7.2)	8.3	Fishing
05-03-85	1,551-1,607 (472.7-489.8)	3	35,000 (15,876)	70	42	9.0 (1.08)	0.44 (7.2)	8.3	LCM 6%
05-04-85	1,607-1,633 (489.8-497.7)	3	30,000 (13,608)	70	43	9.0 (1.08)	0.50 (8.2)	8.0	LCM 5%
05-05-85	1,633-1,648 (497.7-502.3)	3	43,000 (19,504)	60	40	9.2 (1.10)	0.50 (8.2)	8.0	Fishing
05-06-85	1,648-1,728 (502.3-526.7)	4	39,000 (17,690)	55	40	9.2 (1.10)	0.50 (8.2)	8.0	LCM 5%
05-07-85	1,728-1,835 (526.7-559.3)	4	35,000 (15,876)	55	46	9.0 (1.08)	0.49 (8.0)	8.0	LCM 4%*
05-08-85	1,835-1,945 (559.3-592.8)	4	45,000 (20,412)	55	44	9.0 (1.08)	0.54 (8.8)	9.0	
05-09-85	1,945-2,067 (592.8-630.0)	4	45,000 (20,412)	55	40	9.0 (1.08)	0.54 (8.8)	8.6	LCM 5%
05-10-85	2,067-2,166 (630.0-660.2)	4	42,000 (19,051)	53	50	8.9 (1.07)	0.56 (9.2)	8.3	LCM 9%
05-11-85	2,166-2,180 (660.2-664.5)	4	40,000 (18,144)	48	46	8.9 (1.07)	0.57 (9.4)	8.6	LCM 5%

Table B-7. Mud Drilling Record at Borehole RRL-2C. (sheet 3 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud viscosity, s	Mud weight, lb/gal (kg/L)	Water loss, in^3 (mL)	pH	Remarks
05-11-85	2,180-2,237 (664.5-681.8)	5	29,000 (13,154)	50	46	8.9 (1.07)	0.57 (9.4)	8.6	LCM 5%
05-12-85	2,237-2,341 (681.8-713.5)	5	38,000 (17,237)	42	40	8.9 (1.07)	0.59 (9.6)	9.6	LCM 4%
05-13-85	2,341-2,444 (713.5-744.9)	5	45,000 (20,412)	45	40	9.0 (1.08)	0.59 (9.6)	9.8	LCM 3%
05-14-85	2,444-2,545 (744.9-775.7)	5	42,000 (19,051)	45	40	9.0 (1.08)	0.59 (9.6)	9.8	LCM 3%
05-15-85	2,545-2,637 (775.7-803.8)	5	45,000 (20,412)	50	40	8.9 (1.07)	0.59 (9.6)	9.6	LCM 2%
05-16-85	2,637-2,750 (803.8-838.2)	5	50,000 (22,680)	50	40	8.9 (1.07)	0.63 (10.4)	9.5	LCM 2%
05-17-85	2,750-2,776 (838.2-846.1)	RR-2	45,000	52	54	8.9 (1.07)	0.57 (9.4)	9.5	LCM 1%
05-18-85	-	-	-	-	53	8.9 (1.07)	0.62 (10.2)	9.3	Run casing to 2,775 ft (845.8 m)
05-19-85	-	-	-	-	-	-	-	-	Drill with water
05-20-85	2,776-2,778 (846.1-846.7)	6	43,000	55	-	-	-	-	Drill with water
05-21-85	2,778-2,966 (846.7-904.0)	6	47,000	53	-	-	-	-	Drill with water

Table B-7. Mud Drilling Record at Borehole RRL-2C. (sheet 4 of 4)

Date	Interval, ft (m)	Bit no.	Average weight on bit, lb (kg)	Average, r/min	Mud visco-sity, s	Mud weight, lb/gal (kg/L)	Water loss, in^3 (mL)	pH	Remarks
05-22-85	2,966-3,166 (904.0-964.9)	6	42,000	53	-	-	-	-	Drill with water
05-23-85	3,166-3,360 (964.9-1,024.1)	6	35,000	70	-	-	-	-	Drill with water
05-24-85	3,360-3,400 (1,024.1-1,036.3)	7	40,000	70	-	-	-	-	Drill with water

LCM = Lost circulation material (paper, wood fiber, cottonseed hulls).

Table B-8. Bit Record at Borehole RRL-2B.

Bit no.	Size, in. (cm)	Type	Serial number	Manufacturer	Depth, ft (m)	Distance out, ft (m)	Footage, ft (m)	Hours	Rate, ft/h (m/h)	Remarks
1	26 (66.0)	R1	BD 865	Hughes	19 (5.8)	553 (168.6)	519 (158.2)	45.25	11.5 (3.5)	Prior use, RRL-2C, Retip
2	26 (66.0)	DJ	220 7V	Smith	553 (168.6)	614 (187.1)	61 (18.6)	3.75	16.3 (5.0)	Retip
3	17.5 (44.45)	X-44	ZS 234	Hughes	614 (187.1)	1,083 (330.1)	469 (143.0)	83.25	5.6 (1.7)	
4	17.5 (44.45)	X-44	ZS 287	Hughes	1,083 (330.1)	1,674 (510.2)	519 (158.2)	99.25	5.6 (1.7)	
5	17.5 (44.45)	X-44	ZS 215	Hughes	1,674 (510.2)	2,184 (665.7)	510 (155.5)	106.25	4.8 (1.5)	
6	17.5 (44.45)	4JS	AT 538	Smith	2,184 (665.7)	2,655 (809.2)	471 (143.6)	71.75	6.6 (2.0)	
RR-3	17.5 (44.45)	X-44	ZS 234	Hughes	2,655 (809.2)	2,780 (847.3)	125 (38.1)	32.25	3.8 (1.2)	
RR-7	12.25 (31.12)	F4	CK 5161	Smith	2,778 (846.7)	2,858 (871.1)	80 (24.4)	5.25	15.2 (4.6)	Bit used on previous drilling (RRL-2C). Interim depth 2,858 ft (871.1 m)

Table B-9. Bit Record at Borehole RRL-2C.

Bit no.	Size, in. (cm)	Type	Serial number	Manufacturer	Depth, ft (m)	Distance out, ft (m)	Footage, ft (m)	Hours	Rate, ft/h (m/h)	Remarks
1	26 (66.0)	R1	BD 865	Hughes	19 (5.8)	610 (185.9)	591 (180.1)	66.5	8.9 (2.7)	Overburden
2	17.5 (44.45)	4JS	SAW 327	Smith	610 (185.9)	1,003 (305.7)	393 (119.8)	55.5	7.1 (2.2)	Basalt
3	17.5 (44.45)	X44	ZS 287	Hughes	1,003 (305.7)	1,648 (502.3)	645 (196.6)	94	6.9 (2.1)	
4	17.5 (44.45)	4JS	AT 333	Smith	1,648 (502.3)	2,180 (664.5)	532 (162.2)	112.25	4.7 (1.4)	
5	17.5 (44.45)	4JS	SAE 182	Smith	2,180 (664.5)	2,750 (838.2)	570 (173.7)	119.75	4.8 (1.5)	
RR-2	17.5 (44.45)	4JS	SAW 327	Smith	2,750 (838.2)	2,776 (846.1)	26 (7.9)	8.25	3.2 (1.0)	
6	12.25 (31.12)	M88	162438	Security	2,776 (846.1)	3,360 (1,024.1)	584 (178.0)	60.25	9.7 (3.0)	
7	12.25 (31.12)	F4	878 LF	Smith	3,360 (1,024.1)	3,404 (1,037.5)	40 (12.2)	3	13.3 (4.1)	Total depth 3,404 ft (1,037.5 m)

Table B-10. RRL-2B and RRL-2C Cementing and Casing Equipment List.

20-in. (50.8-cm) OD Casing
75TC4 Pumping unit with recirculating mixer
75C3 Pumping unit with jet mixer
MX100T turbine batch mixer
985 ft^3 (28 m^3) bulk trailer
400 ft^3 (11 m^3) body load bulk truck
1,410 ft^3 (40 m^3) field storage bins (2)
In-line densometer
Pressurized mud scales
Double-valve slip-joint float shoe
Inner-string adapter

13.375-in. (33.97-cm) OD Casing
75TC4 Pumping unit with recirculating mixer
75C3 Pumping unit with jet mixer
MX100T turbine batch mixer
985 ft^3 (28 m^3) bulk trailer
400 ft^3 (11 m^3) body load bulk truck
1,410 ft^3 (40 m^3) field storage bins (2)
In-line densometer
Pressurized mud scale
Super seal float shoe
Super seal float collar
By-pass baffle
Multiple-stage cementing tool with free-fall plug set and by pass plug
E-Z LOK limit clamps
Fluid master centralizer (10 for RRL-2B and 11 for RRL-2C)
Plug container

Table B-11. Cementing Casing Summary at Borehole RRL-2B.

Casing outside diameter, in. (cm)	Interval, ft (m)	Stage numbers	Number of sacks	API class	Additives per sack	Slurry density, lb/gal (kg/L)	Mixed slurry, bbl (m^3)	Remarks
Casing Summary for 06/02/85								
20.0 (50.8)	0-613 (0-186.8)	1	350	G	0.25 lb (0.11 kg) Flocele, 2% $CaCl_2$	15.8 (1.9)	72 (11.5)	Lead
20.0 (50.8)	0-613 (0-186.8)	1	600	G	2% $CaCl_2$	15.8 (1.9)	123 (19.6)	Tail, circulated 15 bbl (2.4 m^3) to mud pit
Casing Summary for 06/25/85								
13.375 (33.973)	1,600-2,776 (487.7-846.1)	1	350	G	0.25 lb (0.11 kg) Flocele	15.8 (1.9)	71 (11.3)	Lead
13.375 (33.973)	1,600-2,776 (487.7-846.1)	1	830	G	Neat	15.8 (1.9)	170 (27.0)	Tail
13.375 (33.973)	0-1,800 (0-548.6)	2	350	G	0.25 lb (0.11 kg) Flocele	15.8 (1.9)	71 (11.3)	Lead, loss circulated during placement of the cement slurry regained during displacement
13.375 (33.973)	0-1,800 (0-548.6)	2	2,350	G	Neat	15.8 (1.9)	481 (76.5)	Tail
Casing Summary for 06/27/85								
--	2,674-2,782 (815.0-848.0)	1	100	G	0.75% CFR-2	17.5 (2.1)	17 (2.7)	Spot cemented float shoe

NOTE: Details of cementing contained in Shift Report of Operations.
API = American Petroleum Institute.
bbl = barrel (42 gal).
CFR = Cement friction reducer.

Table B-12. Cementing Casing Summary at Borehole RRL-2C.

Casing outside diameter, in. (cm)	Interval, ft (m)	Stage number	Number of sacks	API class	Additives per sack	Slurry density, lb/gal (kg/L)	Mixed slurry, bbl (m^3)	Remarks
				Casing Summary for 04/26/85				
20.0 (50.8)	0-610 (0-185.9)	1	300	G	0.25 lb (0.11 kg) Flocele, 2% $CaCl_2$	15.8 (1.9)	61 (9.7)	Lead
20.0 (50.8)	0-610 (0-185.9)		800	G	2% $CaCl_2$	15.8 (1.9)	164 (26.1)	Tail, circulated 63 bbl (10.0 m^3) to mud pit
				Casing Summary for 05/19/85				
13.375 (33.973)	1,600-2,775 (487.7-845.8)	1	350	G	0.25 lb (0.11 kg) Flocele	15.8 (1.9)	72 (11.5)	Lead
13.375 (33.973)	1,600-2,775 (487.7-845.8)		400	G	Neat	15.8 (1.9)	82 (13.0)	Tail
13.375 (33.973)	0-1,800 (0-548.6)	2	350	G	0.25 lb (0.11 kg) Flocele	15.8 (1.9)	72 (11.5)	Lead
13.375 (33.973)	0-1,800 (0-548.6)		1,850	G	1% $CaCl_2$	15.8 (1.9)	379 (60.3)	Tail, did not circulate cement to surface

NOTE: Details of cementing contained in Shift Report of Operations.
API = American Petroleum Institute.
bbl = barrel (42 gal).

Table B-13. Gyroscopic Survey at Borehole RRL-2B. (sheet 1 of 3)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical depth, ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
0	0 0	0 0	0	0.00	0.00	0.00	0.00
100 (30.5)	0 0	0 0	100 (30.5)	100.00 (30.48)	0.00	0.00	0.00
200 (61.0)	0 0	0 0	100 (30.5)	200.00 (60.96)	0.00	0.00	0.00
300 (91.4)	0 15	N 13 0 E	100 (30.5)	300.00 (91.44)	0.43 N (0.131)	0.10 E (0.030)	0.25 (0.076)
400 (121.9)	0 0	0 0	100 (30.5)	400.00 (121.92)	0.43 N (0.131)	0.10 E (0.030)	0.25 (0.076)
500 (152.4)	0 0	0 0	100 (30.5)	500.00 (151.40)	0.43 N (0.131)	0.10 E (0.030)	0.00 (0)
600 (182.9)	0 30	N 47 0 E	100 (30.5)	600.00 (182.88)	1.02 N 0.311)	0.74 E (0.226)	0.50 (0.152)
700 (213.4)	0 30	N 34 0 E	100 (30.5)	699.99 (213.36)	1.74 N (0.530)	1.22 E (0.372)	0.11 (0.034)
800 (243.8)	0 15	N 30 0 E	100 (30.5)	799.99 (243.84)	2.12 N (0.646)	1.44 E (0.439)	0.25 (0.076)
900 (274.3)	0 0	0 0	100 (30.5)	899.99 (274.32)	2.12 N (0.646)	1.44 E (0.439)	0.25 (0.076)

Table B-13. Gyroscopic Survey at Borehole RRL-2B. (sheet 2 of 3)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical depth, ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
1,000 (304.8)	0 0	0 0	100 (30.5)	999.99 (304.80)	2.12 N (0.65)	1.44 E (0.44)	0.00
1,100 (335.3)	0 0	0 0	100 (30.5)	1,099.99 (335.28)	2.12 N (0.65)	1.44 E (0.44)	0.00
1,200 (365.8)	0 0	0 0	100 (30.5)	1,199.99 (365.76)	2.12 N (0.65)	1.44 E (0.44)	0.00
1,300 (396.2)	0 30	N 8 0 E	100 (30.5)	1,299.99 (396.24)	2.99 N (0.91)	1.56 E (0.48)	0.50
1,400 (426.7)	0 0	0 0	100 (30.5)	1,399.99 (426.72)	2.99 N (0.91)	1.56 E (0.48)	0.50
1,500 (457.2)	0 0	0 0	100 (30.5)	1,499.99 (457.20)	2.99 N (0.91)	1.56 E (0.48)	0.00
1,600 (487.7)	0 30	N 17 0 E	100 (30.5)	1,599.98 (487.67)	3.82 N (1.16)	1.82 E (0.55)	0.50
1,700 (518.2)	0 0	0 0	100 (30.5)	1,699.98 (518.15)	3.82 N (1.16)	1.82 E (0.55)	0.50
1,800 (548.6)	0 0	0 0	100 (30.5)	1,799.98 (548.63)	3.82 N (1.16)	1.82 E (0.55)	0.00
1,900 (579.1)	0 0	0 0	100 (30.5)	1,899.98 (579.11)	3.82 N (1.16)	1.82 E (0.55)	0.00

Table B-13. Gyroscopic Survey at Borehole RRL-2B. (sheet 3 of 3)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical depth, ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
2,000 (609.6)	0 0	0 0	100 (30.5)	1,999.98 (609.59)	3.82 N (1.164)	1.82 E (0.555)	0.00
2,100 (640.1)	0 0	0 0	100 (30.5)	2,099.98 (640.07)	3.82 N (1.164)	1.82 E (0.555)	0.00
2,200 (670.6)	0 15	S 60 0 W	100 (30.5)	2,199.98 (670.55)	3.60 N (1.097)	1.44 E (0.439)	0.25
2,300 (701.0)	0 45	S 28 0 W	100 (30.5)	2,299.97 (701.03)	2.45 N (0.747)	0.83 E (0.253)	0.55
2,400 (731.5)	0 45	S 30 0 W	100 (30.5)	2,399.97 (731.51)	1.31 N (0.399)	0.17 E (0.052)	0.03
2,500 (762.0)	0 30	S 51 0 W	100 (30.5)	2,499.96 (761.79)	0.76 N (0.232)	0.51 W (0.155)	0.34
2,600 (792.5)	0 30	S 60 0 W	100 (30.5)	2,599.96 (792.47)	0.33 N (0.101)	1.26 W (0.384)	0.08
2,700 (823.0)	0 15	S 24 0 W	100 (30.5)	2,699.96 (822.95)	0.07 S (0.021)	1.44 W (0.439)	0.33
2,800 (853.4)	0 30	S 44 0 W	100 (30.5)	2,799.95 (853.42)	0.70 S (0.213)	2.05 W (0.625)	0.28
2,825 (861.1)	0 45	N 15 0 E	25 (7.6)	2,824.95 (861.04)	0.38 S (0.116)	1.96 W (0.597)	4.85

NOTE: Final closure - Direction: South 78 degrees, 57 minutes West.
Distance: 2.00 feet.

Table B-14. Gyroscopic Survey at Borehole RRL-2C. (sheet 1 of 7)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical depth, ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
50 (15.2)	0 5	N 64 0 E	0	50.00 (15.24)	0.03 N (0.009)	0.07 E (0.021)	0.00
100 (30.5)	0 15	N 66 0 E	50 (15.2)	100.00 (30.48)	0.12 N (0.037)	0.27 E (0.082)	0.33
150 (45.7)	0 25	S 55 0 E	50 (15.2)	150.00 (45.72)	0.09 S (0.027)	0.57 E (0.174)	0.72
200 (61.0)	0 30	S 6 0 E	50 (15.2)	200.00 (60.96)	0.52 S (0.158)	0.61 E (0.186)	0.78
250 (76.2)	0 35	S 13 0 E	50 (15.2)	249.99 (76.20)	1.02 S (0.311)	0.73 E (0.223)	0.21
300 (91.4)	0 30	S 8 0 E	50 (15.2)	299.99 (91.44)	1.45 S (0.442)	0.79 E (0.241)	0.19
350 (106.7)	0 30	S 8 0 E	50 (15.2)	349.99 (106.68)	1.88 S (0.573)	0.85 E (0.259)	0.00
400 (121.9)	0 10	S 4 0 E	50 (15.2)	399.99 (121.92)	2.03 S (0.619)	0.86 E (0.262)	0.67
450 (137.2)	0 15	N 63 0 W	50 (15.2)	449.99 (137.16)	1.93 S (0.588)	0.66 E (0.201)	0.73
500 (152.4)	0 20	N 59 0 W	50 (15.2)	499.99 (152.40)	1.78 S (0.543)	0.42 E (0.128)	0.17

Table B-14. Gyroscopic Survey at Borehole RRL-2C. (sheet 2 of 7)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical depth, ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
550 (167.6)	0 10	S 86 0 W	50 (15.2)	549.99 (167.64)	1.79 S (0.546)	0.27 E (0.082)	0.44
600 (182.9)	0 15	N 35 0 E	50 (15.2)	599.99 (182.88)	1.61 S (0.491)	0.40 E (0.122)	0.76
650 (198.1)	0 0	0 0	50 (15.2)	649.99 (198.12)	1.61 S (0.491)	0.40 E (0.122)	0.50
700 (213.4)	0 15	N 44 0 E	50 (15.2)	699.99 (213.36)	1.45 S (0.442)	0.55 E (0.168)	0.50
750 (228.6)	0 15	N 69 0 E	50 (15.2)	749.99 (228.60)	1.38 S (0.421)	0.75 E (0.229)	0.22
800 (243.8)	0 15	S 44 0 E	50 (15.2)	799.99 (243.84)	1.53 S (0.466)	0.90 E (0.274)	0.55
850 (259.1)	0 15	S 3 0 W	50 (15.2)	849.99 (259.08)	1.75 S (0.533)	0.89 E (0.271)	0.40
900 (274.3)	0 5	S 55 0 E	50 (15.2)	899.99 (274.32)	1.79 S (0.546)	0.95 E (0.290)	0.44
950 (289.6)	0 5	S 53 0 E	50 (15.2)	949.99 (289.56)	1.84 S (0.561)	1.01 E (0.308)	0.01
1,000 (304.8)	0 5	N 18 0 W	50 (15.2)	999.99 (304.80)	1.77 S (0.539)	0.99 E (0.302)	0.32

Table B-14. Gyroscopic Survey at Borehole RRL-2C. (sheet 3 of 7)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical depth, ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
1,050 (320.0)	0 15	N 10 0 W	50 (15.2)	1,049.99 (320.04)	1.55 S (0.472)	0.95 E (0.290)	0.34
1,100 (335.3)	0 20	N 15 0 E	50 (15.2)	1,099.98 (335.27)	1.27 S (0.387)	1.02 E (0.311)	0.30
1,150 (350.5)	0 15	N 1 0 W	50 (15.2)	1,149.98 (350.51)	1.05 S (0.320)	1.02 E (0.311)	0.23
1,200 (365.7)	0 15	N 4 0 W	50 (15.2)	1,199.98 (365.75)	0.84 S (0.256)	1.00 E (0.305)	0.03
1,250 (381.0)	0 15	N 15 0 E	50 (15.2)	1,249.98 (380.99)	0.63 S (0.192)	1.06 E (0.323)	0.17
1,300 (396.2)	0 25	N 52 0 E	50 (15.2)	1,299.98 (396.23)	0.40 S (0.122)	1.35 E (0.411)	0.53
1,350 (411.5)	0 30	N 68 0 E	50 (15.2)	1,349.98 (411.47)	0.24 S (0.073)	1.75 E (0.533)	0.30
1,400 (426.7)	0 40	N 72 0 E	50 (15.2)	1,399.98 (426.71)	0.06 S (0.018)	2.30 E (0.701)	0.34
1,450 (442.0)	0 40	N 78 0 E	50 (15.2)	1,449.97 (441.95)	0.06 S (0.018)	2.87 E (0.875)	0.14
1,500 (457.2)	0 45	S 73 0 E	50 (15.2)	1,499.97 (457.19)	0.13 S (0.040)	3.50 E (1.067)	0.73

Table B-14. Gyroscopic Survey at Borehole RRL-2C. (sheet 4 of 7)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical depth, ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
1,550 (472.4)	0 50	S 72 0 E	50 (15.2)	1,549.96 (472.43)	0.35 S (0.107)	4.19 E (1.277)	0.17
1,600 (487.7)	0 50	S 68 0 E	50 (15.2)	1,599.96 (487.67)	0.63 S (0.192)	4.87 E (1.484)	0.12
1,650 (502.9)	0 30	S 54 0 E	50 (15.2)	1,649.96 (502.91)	0.88 S (0.268)	5.22 E (1.591)	0.74
1,700 (518.2)	0 30	S 56 0 E	50 (15.2)	1,699.95 (518.14)	1.13 S (0.344)	5.58 E (1.701)	0.03
1,750 (533.4)	0 5	S 61 0 E	50 (15.2)	1,749.95 (533.38)	1.16 S (0.354)	5.64 E (1.719)	0.83
1,800 (548.6)	0 15	N 61 0 E	50 (15.2)	1,799.95 (548.62)	1.06 S (0.323)	5.83 E (1.777)	0.44
1,850 (563.9)	0 10	N 89 0 E	50 (15.2)	1,849.95 (563.86)	1.05 S (0.320)	5.98 E (1.823)	0.26
1,900 (579.1)	0 10	N 45 0 E	50 (15.2)	1,899.95 (579.10)	0.95 S (0.290)	6.08 E (1.853)	0.25
1,950 (594.4)	0 15	N 43 0 E	50 (15.2)	1,949.95 (594.34)	0.79 S (0.241)	6.23 E (1.899)	0.17
2,000 (609.6)	0 30	N 71 0 E	50 (15.2)	1,999.95 (609.58)	0.65 S (0.198)	6.64 E (2.024)	0.61

Table B-14. Gyroscopic Survey at Borehole RRL-2C. (sheet 5 of 7)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical, depth ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
2,050 (624.8)	0 25	N 72 0 E	50 (15.2)	2,049.95 (624.82)	0.54 S (0.165)	6.99 E (2.131)	0.17
2,100 (640.1)	0 25	S 58 0 E	50 (15.2)	2,099.95 (640.06)	0.73 S (0.223)	7.30 E (2.225)	0.70
2,150 (655.3)	0 30	S 56 0 E	50 (15.2)	2,149.95 (655.30)	0.97 S (0.296)	7.66 E (2.335)	0.17
2,200 (670.6)	0 30	S 46 0 E	50 (15.2)	2,199.94 (670.54)	1.28 S (0.390)	7.97 E (2.429)	0.17
2,250 (685.8)	0 35	S 19 0 E	50 (15.2)	2,249.94 (685.78)	1.76 S (0.536)	8.14 E (2.481)	0.53
2,300 (701.0)	0 20	S 25 0 E	50 (15.2)	2,299.94 (701.02)	2.02 S (0.616)	8.26 E (2.518)	0.51
2,350 (716.3)	0 25	S 23 0 W	50 (15.2)	2,349.94 (716.26)	2.36 S (0.719)	8.12 E (2.475)	0.63
2,400 (731.5)	1 0	S 11 0 W	50 (15.2)	2,399.93 (731.50)	3.21 S (0.978)	7.95 E (2.423)	1.20
2,450 (746.8)	0 50	S 34 0 W	50 (15.2)	2,449.93 (746.74)	3.82 S (1.164)	7.55 E (2.301)	0.80
2,500 (762.0)	0 55	S 61 0 W	50 (15.2)	2,499.92 (761.98)	4.20 S (1.280)	6.85 E (2.088)	0.83

Table B-14. Gyroscopic Survey at Borehole RRL-2C. (sheet 6 of 7)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical, depth ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
2,550 (777.2)	0 50	S 69 0 W	50 (15.2)	2,549.91 (777.21)	4.46 S (1.359)	6.17 E (1.881)	0.30
2,600 (792.5)	0 30	S 69 0 W	50 (15.2)	2,599.91 (792.45)	4.62 S (1.408)	5.76 E (1.756)	0.67
2,650 (807.7)	0 35	S 40 0 W	50 (15.2)	2,649.91 (807.69)	5.01 S (1.527)	5.43 E (1.655)	0.57
2,700 (823.0)	0 40	S 31 0 W	50 (15.2)	2,699.91 (822.93)	5.51 S (1.679)	5.13 E (1.564)	0.26
2,750 (838.2)	0 35	S 36 0 W	50 (15.2)	2,749.90 (838.17)	5.92 S (1.804)	4.84 E (1.475)	0.20
2,800 (853.4)	0 20	S 8 0 E	50 (15.2)	2,799.90 (853.41)	6.21 S (1.893)	4.88 E (1.487)	0.83
2,850 (868.7)	0 45	S 18 0 W	50 (15.2)	2,849.90 (868.65)	6.83 S (2.082)	4.67 E (1.423)	0.95
2,900 (883.9)	0 35	S 6 0 W	50 (15.2)	2,899.90 (883.89)	7.34 S (2.237)	4.62 E (1.408)	0.43
2,950 (899.2)	0 40	S 23 0 W	50 (15.2)	2,949.89 (899.13)	7.87 S (2.399)	4.39 E (1.338)	0.40
3,000 (914.4)	0 10	S 5 0 W	50 (15.2)	2,999.89 (914.37)	8.02 S (2.444)	4.38 E (1.335)	1.02

Table B-14. Gyroscopic Survey at Borehole RRL-2C. (sheet 7 of 7)

Measured depth, ft (m)	Drift angle, degree minute	Drift direction, degree minute	Course length, ft (m)	True vertical, depth ft (m)	Rectangular coordinates		Dogleg severity degrees/ 100 ft (30.5 m)
					ft (m)	ft (m)	
3,100 (944.9)	0 5	S 7 0 E	100 (30.5)	3,099.89 (944.85)	8.16 S (2.487)	4.40 E (1.341)	0.09
3,150 (960.1)	0 10	S 8 0 W	50 (15.2)	3,149.89 (960.09)	8.31 S (2.533)	4.38 E (1.335)	0.18
3,200 (975.4)	0 30	S 78 0 E	50 (15.2)	3,199.89 (975.33)	8.40 S (2.560)	4.81 E (1.466)	1.03
3,250 (990.6)	0 35	S 3 0 W	50 (15.2)	3,249.89 (990.57)	8.91 S (2.716)	4.78 E (1.457)	1.41
3,300 (1,005.8)	0 40	S 71 0 E	50 (15.2)	3,299.88 (1,005.80)	9.09 S (2.771)	5.33 E (1.625)	1.51
3,350 (1,021.1)	0 40	S 82 0 E	50 (15.2)	3,349.88 (1,021.04)	9.18 S (2.798)	5.90 E (1.798)	0.26
3,400 (1,036.3)	1 10	S 40 0 E	50 (15.2)	3,399.87 (1,036.28)	9.96 S (3.036)	6.56 E (1.999)	1.61

NOTE: Final closure - Direction: South 33 degrees, 23 minutes East.
Distance: 11.92 feet.

APPENDIX C

BOREHOLE GEOPHYSICAL LOG LISTING

CONTENTS

Tables:

Table C-1. Borehole RRL-2B Geophysical Log Listing. (sheet 1 of 2)

Well	Date logged	Geophysical log	Interval logged, ft (m)
		Pacific Northwest Laboratory	
RRL-2B	06/02/85	Spontaneous potential and resistivity	20-611 (6.1-186.2)
		Caliper	0-611 (0-186.2)
		Natural gamma	0-611 (0-186.2)
		Gamma-gamma	0-611 (0-186.2)
		Neutron-epithermal-neutron	0-611 (0-186.2)
RRL-2B	06/22/85	Neutron-epithermal-neutron	580-2,734 (176.8-833.3)
RRL-2B	06/23/85	Natural gamma	540-2,742 (164.6-835.8)
		Gamma-gamma	0-2,748 (0-837.6)
		Neutron-epithermal-neutron	2,650-2,670 (807.7-813.8)
		Magnetic	619-2,745 (188.7-836.7)
		Caliper	600-2,730 (182.9-832.1)
RRL-2B	06/24/85	Spontaneous potential and resistivity	0-2,740 (0-835.2)
		X-Y caliper	592-2,730 (180.4-832.1)
RRL-2B	06/29/85	Neutron-epithermal-neutron	2,724-2,840 (830.3-865.6)
		Neutron-epithermal-neutron	2,760-2,859 (841.2-871.4)
RRL-2B	07/25/85	Spontaneous potential and resistivity	2,776-2,858 (846.1-871.1)
		Magnetic	2,776-2,858 (846.1-871.1)
		Gamma-gamma	2,700-2,858 (823.0-871.1)
		Natural gamma	2,700-2,858 (823.0-871.1)
		Neutron-epithermal-neutron	2,700-2,858 (823.0-871.1)
		Fluid temperature	220-2,858 (67.1-871.1)
RRL-2B	08/01/85	X-Y caliper	2,650-2,857 (807.7-870.8)
RRL-2B	08/07/85	X-Y caliper	2,750-2,850 (838.2-868.7)
RRL-2B	09/03/85	Fluid temperature	230-2,858 (70.1-871.1)
RRL-2B	09/09/85	Fluid temperature	230-2,858 (70.1-871.1)
RRL-2B	09/11/85	Dynamic fluid temperature	2,700-2,859 (823.0-871.4)

Table C-1. Borehole RRL-2B Geophysical Log Listing. (sheet 2 of 2)

Well	Date logged	Geophysical log	Interval logged, ft	(m)
		Washington State University		
RRL-2B	07/24/85	Sonic	2,775-2,875	(845.8-876.3)
RRL-2B	09/16/85	Caliper	0-2,870	(0-874.8)
		Gearhart		
RRL-2B	06/26/85	Cement bond	0-2,719	(0-828.8)
RRL-2B	08/11/85	Cement bond/CCL	0-2,790	(0-850.4)
RRL-2B	08/21/85	Cement bond (at 750 lbf/in^2) (5.2 MPa)	0-2,330	(0-710.2)
		Westech Geophysical		
RRL-2B	08/20/85	Video camera	2,752-2,854	(838.8-869.9)
RRL-2B	10/24/85	Video camera	2,776-2,855	(846.1-870.2)

Table C-2. Borehole RRL-2C Geophysical Log Listing. (sheet 1 of 3)

Well	Date logged	Geophysical log	Interval logged, ft (m)
		Pacific Northwest Laboratory	
RRL-2C	04/25/85	Spontaneous potential and resistivity	19-609 (5.8-185.6)
		Natural gamma	0-608 (0-185.3)
		Magnetic	19-608 (5.8-185.3)
		X-Y caliper	0-608 (0-185.3)
		Caliper	0-609 (0-185.6)
		Neutron-epithermal-neutron	0-608 (0-185.3)
		Gamma-gamma	0-609 (0-185.6)
RRL-2C	05/16/85	Neutron-epithermal-neutron	2,160-2,749 (658.4-837.9)
RRL-2C	05/18/85	Spontaneous potential and resistivity	604-2,774 (184.1-845.5)
		Natural gamma	590-2,774 (179.8-845.5)
		Caliper	590-2,720 (179.8-829.1)
		Neutron-epithermal-neutron	600-2,774 (182.9-845.5)
		Gamma-gamma	590-2,774 (179.8-845.5)
RRL-2C	05/24/85	Neutron-epithermal-neutron	2-3,404 (0.6-1,037.5)
		Neutron-epithermal-neutron	2,946-3,359 (897.9-1,023.8)
		Gamma-gamma	2,700-3,359 (823.0-1,023.8)
RRL-2C	05/29/85	Caliper	2,750-3,404 (838.2-1,037.5)
		Fluid temperature	220-3,404 (67.1-1,037.5)
RRL-2C	05/30/85	Gamma-gamma	7-3,403 (2.1-1,037.2)
		Natural gamma	2,720-3,402 (829.1-1,036.9)
RRL-2C	06/01/85	Spontaneous potential and resistivity	2,774-3,404 (845.5-1,037.5)
		X-Y caliper	2,750-3,401 (838.2-1,036.6)
RRL-2C	06/10/85	Dynamic fluid temperature	2,700-3,400 (823.0-1,036.3)
RRL-2C	06/16/85	Fluid temperature	3,200-3,329 (975.4-1,014.7)
RRL-2C	06/18/85	Fluid temperature	3,000-3,226 (914.4-983.3)
RRL-2C	06/20/85	Fluid temperature	3,000-3,325 (914.4-1,013.5)
		Fluid temperature	2,900-3,328 (883.9-1,014.4)

Table C-2. Borehole RRL-2C Geophysical Log Listing. (sheet 2 of 3)

Well	Date logged	Geophysical log	Interval logged, ft	(m)
		Pacific Northwest Laboratory		
RRL-2C	06/22/85	Fluid temperature	2,800-3,328	(853.4-1,014.4)
RRL-2C	06/24/85	Fluid temperature	2,750-3,328	(838.2-1,014.4)
RRL-2C	06/26/85	Fluid temperature	2,650-3,328	(807.7-1,014.4)
RRL-2C	07/01/85	Fluid temperature	220-3,320	(67.1-1,011.9)
RRL-2C	08/16/85	Fluid temperature	240-3,327	(73.2-1,014.1)
RRL-2C	08/20/85	Fluid temperature	240-3,328	(73.2-1,014.4)
RRL-2C	09/1-3/85	Fluid temperature (Time Drive)	50	(15.2)
		Washington State University		
RRL-2C	03/29/85	Sonic	0-1,001	(0-305.1)
RRL-2C	05/17/85	Sonic	0-2,776	(0-846.1)
RRL-2C	06/03/85	Sonic	0-3,427	(0-1,044.5)
		Dresser Atlas		
RRL-2C	05/29/85	Densilog/neutron/gamma-ray four-arm caliper	224-3,403 2,775-3,404	(68.3-1,037.2) (845.8-1,037.5)
		Gearhart		
RRL-2C	05/20/85	Cement bond	0-2,766	(0-843.1)
		Westech Geophysical		
RRL-2C	06/13/85	Video camera	0-3,402	(0-1,036.9)

Table C-2. Borehole RRL-2C Geophysical Log Listing. (sheet 3 of 3)

Well	Date logged	Geophysical log	Interval logged, ft	(m)
United States Geological Survey				
RRL-2C	05/29/85	Televiewer	2,770-2,850	(844.3-868.7)
			2,850-2,930	(868.7-893.1)
			2,880-2,995	(877.8-912.9)
			3,010-3,090	(917.4-941.8)
			3,090-3,170	(941.8-966.2)
			3,100-3,120	(944.9-951.0)
			3,100-3,170	(944.9-966.2)
			3,170-3,250	(966.2-990.6)
			3,175-3,200	(967.7-975.4)
			3,250-3,330	(990.6-1,015.0)
			3,330-3,390	(1,015.0-1,033.3)
RRL-2C	06/02/85	Televiewer	2,770-2,850	(844.3-868.7)
			2,850-2,930	(868.7-893.1)
			2,930-3,010	(893.1-917.4)
			3,010-3,090	(917.4-941.8)
			3,090-3,170	(941.8-966.2)
			3,170-3,250	(966.2-990.6)
			3,250-3,330	(990.6-1,015.0)
			3,330-3,370	(1,015.0-1,027.2)

Table C-3. Post Installation Determination/Confirmation of Depths to Seating Nipples and Condition of Piezometers.

Well	Date logged	Tool used	Logged depth ft (m)	Calculated depth ft (m)	Piezometer
		Pacific Northwest Laboratory			
RRL-2C	08/12/85	1.44-in. (3.66-cm) by 4-ft (1.2-m) temperature sonde (4.06 ft (1.237 m) in length	2,820 (859.5)	2,819 (859.2)	Rocky Coulee flow top
			2,907 (886.1)	2,906 (885.7)	Rocky Coulee interior
			2,980 (908.3)	2,981 (908.6)	Cohassett flow top
RRL-2C	08/16/85	1.44-in. (3.66-cm) by 4-ft (1.2-m) temperature sonde	3,235 (986.0)	3,238 (986.9)	Grande Ronde 5 flow top
			3,327 (1,014.1)	3,327 (1,014.1)	Grande Ronde 5 interior
RRL-2C	08/20/85	1.44-in. (3.66-cm) by 4-ft (1.2-m) temperature sonde	3,157 (962.3)	3,157 (962.3)	Cohassett interior

APPENDIX D

BOREHOLE DEVELOPMENT

CONTENTS

Table D-1. RRL-2B Borehole Development Activities.

Date	Activity
09/11/85	Temperature sonde positioned at a depth of 2,700 ft (823.0 m) at about 0901 hours. Started monitoring downhole temperatures at 0902 hours. At 0911 hours began air lifting for the dynamic fluid temperature log. Terminated air lift at 1106 hours. Total discharge from Rocky Coulee flow top was about 1,000 gal (3.8 m^3).
10/17/85	At 1030 hours tagged bottom of borehole at a depth of 2,858 ft (871.1 m). Began circulating Hanford system water through working string at 1105 hours. Mule shoe was located at a depth of about 2,850 ft (868.7 m). Stopped circulating at 1630 hours for night. Total volume of water circulated was about 45,000 gal (170.3 m^3).
10/18/85	Conducted test to estimate percentage of water loss to Rocky Coulee flow top during circulation. Loss estimated at 15% of total water circulated. Began developmental circulation at 1008 hours. Terminated develop activities at 1600 hours. Total volume of water circulated was about 48,000 gal (181.7 m^3). It is estimated that the total fluid loss was about 14,000 gal (53.0 m^3).

Table D-2. RRL-2C Borehole Development Activities.

Date	Activity
06/04-05/85	Installed 200 hp line shaft turbine pump to 500 ft (152 m) by subcontracted pump service company.
06/05-07/85	Pumped composite Grande Ronde Basalt below 13.375-in. (33.97-cm) OD casing for about 3,138 min (52.3 h) at an average discharge rate of about 59.6 gal/min (226 L/min). During pumping preliminary groundwater samples and gas samples were collected for analysis. Pump pulled from borehole after 2030 hours on 06/07/85.
06/08-09/85	No activity.
06/10/85	Pump was on from 1130 to 1715 hours to obtain additional gas samples and to run dynamic fluid temperature survey. The average discharge rate was about 49 gal/min (186 L/min). Total volume pumped was 203,600 gal (770.7 m^3).
06/11/85	Workover rig moved on to site.
06/12/85	Bailing small amount of oil residual derived from line shaft pump.
06/13/85	Ran video survey. After survey added detergent solution (75 gal (.28 m^3) to 480 ft (146.3 m). Started air-lift pumping to further remove oil residual at 2320 hours.
06/14/85	Completed air-lift pumping at 0225 hours. An estimated 5,000 gal (18.9 m^3) of water removed from borehole by surging. Proceeded to piezometer installation activities.

Table D-3. Borehole Development Summary at RRL-2B and RRL-2C.

Borehole	Pumped horizon	Isolated interval, ft (m)	Total time pumping, min	Average discharge rate, gal/min (L/min)	Total volume removed, gal (m^3)	Remarks
RRL-2B	Rocky Coulee flow top	2,776-2,858 (846.1-871.1)	NA	NA	Loss 14,000 (53.0)	Circulated 48,000 gal (181.7 m^3) for cleanup
RRL-2B	Rocky Coulee flow top	2,776-2,858 (846.1-871.1)	115	8.7 (33)	1,000 (3.8)	Air-lift pumped for dynamic fluid temperature
RRL-2C	Composite Grande Ronde	2,775-3,404 (845.8-1,037.5)	3,475	58.6 (222)	203,600 (770.7)	Line shaft turbine pumping for cleanup
RRL-2C	Composite Grande Ronde	2,775-3,404 (845.8-1,037.5)	NA	NA	5,000 (18.9)	Surged borehole

NOTE: NA = Not applicable.

APPENDIX E

PIEZOMETER INSTALLATION

CONTENTS

Table E-1. Borehole RRL-2C Piezometer Summary. (sheet 1 of 3)

Description	Rocky Coulee flow top (depth, ft (m))	Rocky Coulee interior (depth, ft (m))	Cohassett flow top (depth, ft (m))	Cohassett flow interior (depth, ft (m))	Grande Ronde 5 flow top (depth, ft (m))	Grande Ronde 5 flow interior (depth, ft (m))
Top of cement	2,717 (828.1)	2,833 (863.5)	2,917 (889.1)	2,993 (912.3)	3,168 (965.6)	3,282 (1,000.4)
Top of pea gravel	2,799 (853.1)	2,895 (882.4)	2,963 (903.1)	3,145 (958.6)	3,215 (979.9)	3,315 (1,010.4)
Top of #10-20	2,803 (854.4)	2,898 (883.3)	2,967 (904.3)	3,148 (959.5)	3,220 (981.5)	NA
Top of #4-8	2,808 (855.9)	2,900 (883.9)	2,971 (905.6)	3,151 (960.4)	3,222 (982.1)	3,317 (1,011.0)
Centralizers						
#0 Top	NA	NA	NA	NA	NA	3,273.5 (997.76)
#0 Bottom	NA	NA	NA	NA	NA	3,275.5 (998.37)
#1 Top	2,764.8 (842.71)	2,852.4 (869.41)	2,931.8 (893.61)	3,116.7 (949.76)	3,188.4 (971.82)	3,288.4 (1,002.30)
#1 Bottom	2,766.8 (843.32)	2,854.4 (870.02)	2,933.8 (894.22)	3,118.7 (950.58)	3,190.4 (972.43)	3,290.5 (1,002.94)
#2 Top	2,796.8 (852.46)	2,893.2 (881.15)	2,958.2 (901.66)	3,144.6 (958.47)	3,213.7 (979.54)	3,316.1 (1,010.75)
#2 Bottom	2,798.8 (853.07)	2,895.2 (882.46)	2,960.2 (902.27)	3,146.6 (959.08)	3,215.7 (980.15)	3,318.1 (1,011.36)

Table E-1. Borehole RRL-2C Piezometer Summary. (sheet 2 of 3)

Description	Rocky Coulee flow top (depth, ft (m))	Rocky Coulee interior (depth, ft (m))	Cohassett flow top (depth, ft (m))	Cohassett flow interior (depth, ft (m))	Grande Ronde 5 flow top (depth, ft (m))	Grande Ronde 5 flow interior (depth, ft (m))
#3 Top	2,816.7 (858.53)	2,903.3 (884.93)	2,978.2 (907.76)	3,154.6 (961.52)	3,235.6 (986.21)	3,326.0 (1,013.77)
#3 Bottom	2,818.8 (859.17)	2,905.3 (885.54)	2,980.2 (908.36)	3,156.6 (962.13)	3,237.7 (986.85)	3,328.1 (983.92)
#4 Top	2,827.7 (861.88)	2,911.2 (887.33)	2,988.2 (910.80)	3,162.6 (963.96)	3,264.7 (995.08)	3,334.0 (1,016.20)
#4 Bottom	2,829.7 (862.49)	2,912.8 (887.82)	2,989.6 (911.23)	3,164.1 (964.42)	3,266.7 (995.69)	3,335.5 (1,016.66)
Top of seating nipple	2,819.3 (859.32)	2,905.8 (885.69)	2,980.7 (908.52)	3,157.1 (962.28)	3,238.2 (987.00)	3,328.6 (1,014.56)
Bottom of seating nipple	2,820.4 (859.66)	2,906.9 (886.02)	2,981.8 (908.85)	3,158.2 (962.62)	3,239.2 (987.31)	3,329.7 (1,014.89)
Screen						
#1 Top	2,820.8 (859.78)	2,907.8 (886.30)	2,982.2 (908.98)	3,159.1 (962.89)	3,240.1 (987.58)	3,330.6 (1,015.17)
#1 Bottom	2,825.8 (861.30)	2,909.8 (886.91)	2,987.2 (910.50)	3,161.1 (963.50)	3,250.1 (990.63)	3,332.6 (1,015.78)
Screen slot	40	40	40	40	40	40

Table E-1. Borehole RRL-2C Piezometer Summary. (sheet 3 of 3)

Description	Rocky Coulee flow top (depth, ft (m))	Rocky Coulee interior (depth, ft (m))	Cohassett flow top (depth, ft (m))	Cohassett flow interior (depth, ft (m))	Grande Ronde 5 flow top (depth, ft (m))	Grande Ronde 5 flow interior (depth, ft (m))
#2 Top	NA	NA	NA	NA	3,252.2 (991.27)	NA
#2 Bottom	NA	NA	NA	NA	3,262.2 (994.32)	NA
Screen slot	NA	NA	NA	NA	40	NA
Bottom of tailpipe	2,830.8 (862.83)	2,913.8 (888.13)	2,990.7 (911.57)	3,165.2 (964.75)	3,267.8 (996.02)	3,336.6 (1,017.00)
Top of lowermost cement seal	NA	NA	NA	NA	NA	3,337 (1,017.1)
Bottom of lowermost cement seal	NA	NA	NA	NA	NA	3,404 (1,037.5)
Bottom of borehole	NA	NA	NA	NA	NA	3,404 (1,037.5)

NOTE: Depth reported below datum is top of 20-inch O.D. steel casing.
Depths were not corrected for borehole deviation and stretch of tubing.
NA = Not applicable.

Table E-2. Borehole RRL-2C Piezometer Installation Activities.
(sheet 1 of 4)

Date	Activity
06/14/85	Strapped 2.875-in. (7.30-cm) working tubing*. With workover rig, tagged bottom of borehole with working string at 3,404 ft (1,037.5 m). Placed lowermost densified cement seal 1 at 1358 hours by subcontracted cementing service company. Tagged top of cement seal 1 at 3,337 ft (1,017.1 m) (2317 hours).
06/15/85	Installed Grande Ronde 5 flow-interior piezometer and set bottom of assembly at 3,336.6 ft (1,017.0 m). Conducted 1-hr seating nipple tubing test until 0530 hours and then welded piezometer string to well head. Placed first lift of no. 4-8 sand from 0943 to 1007 hours. Tagged top of no. 4-8 sand at 3,322 ft (1,012.6 m) (1200 hours). Since tag was too high, due to bridging, flushed borehole. Retagged at 3,326 ft (1,013.8 m) (1755 hours). Placed second lift of no. 4-8 sand from 1905 to 1953 hours. Tagged top of no. 4-8 sand at 3,317 ft (1,011.0 m) (2156 hours). Placed pea gravel from 2248 to 2255 hours. Tagged top of pea gravel at 3,315 ft (1,010.4 m) (2340 hours).
06/16/85	Placed densified cement seal 2 (between Grande Ronde 5 interior and Grande Ronde 5 flow-top piezometers) at 0802 hours by subcontracted cementing service company. Ran fluid temperature log at 1450 hours. Tagged top of cement seal 2 at 3,282 ft (1,000.4 m) (1720 hours). Flushed borehole with 420 gal (1.6 m^3) of water with diverter tool at 3,282 ft (1,000.4 m). Installed Grande Ronde 5 flow-top piezometer and set bottom of assembly at 3,267.8 ft (996.03 m). Started seating nipple tubing test at 2309 hours.

*The working tubing is J55 steel tubing, 2.875-in. OD by 2.441-in. ID (7.30-cm by 6.20-cm). The working tubing is used to tremie the cement slurry, filter-pack material, and to "tag" the depth of these materials.

Table E-2. Borehole RRL-2C Piezometer Installation Activities.
(sheet 2 of 4)

Date	Activity
06/17/85	Completed 56 min tubing test at 0005 hours and then welded piezometer string to well head. Placed first lift of no. 4-8 sand from 0350 to 0553 hours. Ran working tubing to 3,238 ft (986.9 m) to verify that sand was below top of screen. Placed second lift of no. 4-8 sand from 0612 to 0653 hours. Tagged no. 4-8 sand at 3,236 ft (986.3 m) (0845 hours). Placed third lift of no. 4-8 sand from 0855 to 0934 hours. Tagged top of no. 4-8 sand at 3,222 ft (982.1 m) (1045 hours). Placed no. 10-20 sand from 1106 to 1113 hours. Placed pea gravel from 1425 to 1437 hours. Tagged top of pea gravel at 3,215 ft (979.9 m) (1632 hours). Placed stage 1 of densified cement seal 3 (between Grande Ronde 5 flow-top and Cohassett flow-interior piezometers) at 2133 hours by subcontracted cementing service company.
06/18/85	Ran fluid temperature survey at 0520 hours. Tagged top of cement (stage 1, seal 3) at 3,188 ft (971.7 m) (0700 hours). Placed stage 2 of densified cement seal 3 at 1222 hours. Ran fluid temperature survey at 1805 hours. Tagged top of cement (stage 2, seal 3) at 3,168 ft (965.6 m) (2048 hours). Flushed borehole with 420 gal (1.6 m^3) of water with diverter tool at 3,168 ft (965.6 m). Swabbed water level in annulus to about 225 ft (68.6 m).
06/19/85	Installed Cohassett flow-interior piezometer and set bottom assembly at 3,165.2 ft (964.75 m). Conducted 1-h seating nipple test until 0430 hours and then welded piezometer string to well head. Placed first lift of no. 4-8 sand from 0750 to 0821 hours. Tagged no. 4-8 sand at 3,156 ft (962.0 m) (1106 hours). Placed second lift of no. 4-8 sand from 1205 to 1246 hours. Tagged top of no. 4-8 sand at 3,151 ft (960.4 m) (1500 hours). Placed no. 10-20 sand from 1537 to 1607 hours. Placed pea gravel from 1925 to 1933 hours. Tagged top of pea gravel at 3,145 ft (958.6 m) (2138 hours).
06/20/85	Placed stage 1 of seal 4 (between Cohassett flow-interior and Cohassett flow-top piezometers) at 0140 hours. Ran fluid temperature survey at 0800 hours. Tagged top of cement (stage 1, seal 4) at 3,136 ft (955.9 m) (1045 hours). Placed stage 2 of seal 4 at 1151 hours. Ran fluid temperature survey at 1824 hours. Tagged top of cement (stage 2, seal 4) at 2,993 ft (912.3 m) (2110 hours). Started circulating water with diverter tool at 2,997 ft (913.5 m).

Table E-2. Borehole RRL-2C Piezometer Installation Activities.
(sheet 3 of 4)

Date	Activity
06/21/85	Completed circulating water with final position of diverter tool at 2,993 ft (912.3 m) at 0325 hours. Evacuated water level in Cohassett flow-interior piezometer string to 224 ft (68.3 m) at 0332 hours. Installed Cohassett flow-top piezometer and set bottom of assembly at 2,990.7 ft (911.57 m). Conducted 58 min seating nipple tubing test until 1400 hours and then welded piezometer string to well head. Placed first lift of no. 4-8 sand from 1650 to 1716 hours. Ran working tubing to 2,982 ft (908.9 m) to verify that sand was below top of screen. Placed second lift of no. 4-8 sand from 1948 to 2200 hours. Tagged no. 4-8 sand at 2,974 ft (906.5 m) (2308 hours). Started placing third lift of no. 4-8 sand at 2331 hours.
06/22/85	Finished placing third lift of no. 4-8 sand at 0008 hours. Tagged top of no. 4-8 sand at 2,971 ft (905.6 m) (0139 hours). Placed no. 10-20 sand from 0217 to 0248 hours. Placed pea gravel from 0555 to 0609 hours. Tagged top of pea gravel at 2,963 ft (903.1 m) (0725 hours). Placed densified cement seal 5 (between Rocky Coulee flow-interior and Cohassett flow-top piezometers) at 1103 hours by subcontracted cementing service company. Ran fluid temperature survey at 1800 hours. Tagged top of cement (seal 5) at 2,917 ft (889.1 m) (1938 hours). Circulated water at 40 gal/min (151 L/min) with diverter tool within 6 ft (1.8 m) of top of cement from 1947 to 2220 hours. Retagged top of cement at 2,917 ft (889.1 m) (2227 hours).
06/23/85	Installed Rocky Coulee interior piezometer and set bottom of assembly at 2,913.8 ft (888.13 m). Conducted 1-h seating nipple tubing test until 0208 hours and then welded piezometer string to well head. Evacuated water level in Cohassett flow-top piezometer to about 170 ft (52 m). Placed first lift of no. 4-8 sand from 0559 to 0643 hours. Tagged no. 4-8 sand at 2,907 ft (886.1 m) (0835 hours). Placed second lift of no. 4-8 sand from 0856 to 0950 hours. Tagged top of no. 4-8 sand at 2,900 ft (883.9 m) (1124 hours). Placed no. 10-20 sand from 1145 to 1219 hours. Placed pea gravel from 1539 to 1550 hours. Tagged top of pea gravel at 2,894 ft (882.1 m) (1718 hours). Retagged top of pea gravel at 2,895 ft (882.4 m) (1945 hours). Placed densified cement seal 6 (between Rocky Coulee flow-top and Rocky Coulee flow-interior piezometers) at 2043 hours.

Table E-2. Borehole RRL-2C Piezometer Installation Activities.
(sheet 4 of 4)

Date	Activity
06/24/85	Ran fluid temperature survey at 0320 hours. Tagged top of cement seal 6 at 2,833 ft (863.5 m) (0510 hours). Circulated and air-lift pumped from 0525 to 1130 hours. Evacuated water level in the Rocky Coulee flow-interior piezometer to about 225 ft (69 m). Ran in Rocky Coulee flow-top piezometer and set bottom of assembly at 2,830.8 ft (862.83 m) (1638 hours). Conducted 1-h seating nipple tubing test until 1809 hours and then welded piezometer string to well head. Placed first lift of no. 4-8 sand from 2046 to 2231 hours. Tagged no. 4-8 sand at 2,815 ft (858.0 m) (2345 hours).
06/25/85	Placed second lift of no. 4-8 sand from 0017 to 0048 hours. Tagged top of no. 4-8 sand at 2,808 ft (855.9 m) (0223 hours). Placed no. 10-20 sand from 0232 to 0306 hours. Placed pea gravel from 0545 to 0551 hours. Tagged top of pea gravel at 2,799 ft (853.1 m) (0750 hours). Placed densified cement seal 7 at 0819 hours. Ran fluid temperature survey at 1400 hours.
06/26/85 and 06/27/85	Cleaned up site.
06/28/85	Tagged top of cement seal 7 at 2,717 ft (828.1 m) and demobilized support equipment.

Table E-3. Borehole RRL-2C Filter Pack Summary.

Monitoring Horizon	No. 4-8 Sand		No. 10-20 Sand		Pea Gravel	
	Depth interval ft (m)	Volume ft^3 (m^3)	Depth* interval ft (m)	Volume ft^3 (m^3)	Depth interval ft (m)	Volume ft^3 (m^3)
Rocky Coulee flow top	2,808-2,833 (855.9-863.5)	18.3 (0.52)	2,803-2,808 (854.4-855.9)	4.0 (0.11)	2,799-2,803 (853.1-854.4)	2.7 (0.076)
Rocky Coulee flow interior	2,900-2,917 (883.9-889.1)	14.7 (0.42)	2,898-2,900 (883.3-883.9)	2.4 (0.68)	2,895-2,898 (882.4-883.3)	3.5 (0.099)
Cohassett flow top	2,971-2,993 (905.6-912.3)	19.2 (0.54)	2,967-2,971 (904.3-905.6)	5.3 (0.15)	2,963-2,967 (903.1-904.3)	2.5 (0.071)
Cohassett flow interior	3,151-3,168 (960.4-965.6)	10.7 (0.30)	3,148-3,151 (959.5-960.4)	3.2 (0.091)	3,145-3,148 (958.6-959.5)	1.8 (0.051)
Grande Ronde 5 flow top	3,222-3,282 (982.1-1,000.4)	53.4 (1.51)	3,220-3,222 (981.5-982.1)	2.0 (0.057)	3,215-3,220 (979.9-981.5)	4.0 (0.11)
Grande Ronde 5 interior	3,337-3,317 (1,017.1-1,011.0)	15.7 (0.44)	- -	- -	3,315-3,317 (1,010.4-1,011.0)	1.4 (0.040)

*Estimated depth.

Table E-4. Borehole RRL-2C Piezometer Cement Seal Summary.

Date	Seal no	Stage no	Depth interval, ft (m)	API class	Additive	Slurry weight, lb/gal (kg/L)	Volume slurry pumped, ft^3 (m^3)	Placement method	Tool	Remarks
06/14/85	1	1	3,404-3,337 (1,037.5-1,017.1)	G	3/4% CFR-2	17.4 (2.09)	64.6 (1.83)	Balance	Diverter tool	Lowermost seal
06/16/85	2	1	3,315-3,282 (1,010.4-1,000.4)	G	3/4% CFR-2	17.4 (2.09)	33.7 (0.95)	Two-plug	Plug catcher, diverter tool	Between Grande Ronde 5 interior and Grande Ronde 5 flow-top piezometers
06/17/85	3	1	3,215-3,188 (979.9-971.7)	G	3/4% CFR-2	17.4 (2.09)	47.5 (1.35)	Two-plug	Plug catcher, diverter tool	Between Grande Ronde 5 flow-top and Cohassett interior piezometers
06/18/85	3	2	3,188-3,168 (971.7-965.6)	G	3/4% CFR-2	17.5 (2.10)	16.8 (0.48)	Two-plug	Plug catcher, diverter tool	Between Grande Ronde 5 flow-top and Cohassett interior piezometers
06/20/85	4	1	3,145-3,111 (958.6-948.2)	G	3/4% CFR-2	17.5 (2.10)	39.3 (1.11)	Balance	Diverter tool	Between Cohassett interior and Cohassett flow-top piezometers
06/20/85	4	2	3,111-2,993 (948.2-912.3)	G	3/4% CFR-2	17.5 (2.10)	126.3 (3.58)	Balance	Diverter tool	Between Cohassett interior and Cohassett flow-top piezometers
06/22/85	5	1	2,963-2,917 (903.1-889.1)	G	3/4% CFR-2	17.5 (2.10)	53.3 (1.51)	Balance	Diverter tool	Between Cohassett flow-top and Rocky Coulee interior piezometers
06/23/85	6	1	2,895-2,833 (882.4-863.5)	G	3/4% CFR-2	17.5 (2.10)	59.0 (1.67)	Balance	Diverter tool	Between Rocky Coulee interior and Rocky Coulee flow-top piezometers
06/26/85	7	1	2,799-2,717 (853.1-828.1)	G	3/4% CFR-2	17.5 (2.10)	61.8 (1.75)	Balance	Diverter tool	Uppermost seal

NOTE: API = American Petroleum Institute
CFR = Cement friction reducer.

Table E-5. List of Cementing Equipment Used to Place Densified Cement Seals.

75TC4 pumping unit with recirculating mixer
MX100T turbine batch mixer
985 ft^3 (27.9 m^3) bulk trailer
In-line densometer
Pressurized fluid mud balance
Continuous head plug container
Latch down plug catcher
Diverter tool

Table E-6. Chemical Composition and Physical Properties of Class G Cement.

Oxide analysis	
SiO_2	22.60%
Al_2O_3	3.56%
Fe_2O_3	4.77%
CaO	64.67%
MgO	0.90%
SO_3	2.14%
Loss on ignition	0.98%
Insoluble residue	0.26%
Total alkalies (as Na_2O)	0.40%
Chemical compounds	
$3CaO \cdot SiO_2$	54.6%
$2CaO \cdot SiO_2$	23.6%
$3CaO \cdot Al_2O_3$	1.4%
$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$	14.6%
Physical properties	
Blaine fineness	371.0 m^2/kg
Normal consistency	22.6%
Setting time - Vicat	
Initial	120.0 min
Final	255.0 min
False set	64.9%
Autoclave expansion	-0.70%
Air entrainment	8.4%
Compressive Strength	
1 day	
3 days	2,800.0 lbf/in^2 (19.3 MPa)
7 days	3,910.0 lbf/in^2 (27.0 MPa)

Table E-7. Borehole RRL-2C Seating Nipple Tubing Tests.

Piezometer tube	Date	Test duration, min	Head differential, ft (m)	Head drop, ft (cm)	Test type	Remarks
Grande Ronde 5 flow interior	06/15/85	60	244 (74.4)	0	Gravity	Tested prior to installing filter pack and cement seal
Grande Ronde 5 flow top	06/16/85-06/17/85	56	243 (74.1)	0	Gravity	Tested prior to installing filter pack and cement seal
Cohassett flow interior	06/19/85	60	218 (66.5)	0	Gravity	Tested prior to installing filter pack and cement seal
Cohassett flow top	06/21/85	58	275 (83.8)	0.47 (1.19)	Gravity	Tested prior to installing filter pack and cement seal, standing valve seals worn
Rocky Coulee flow interior	06/23/85	60	216 (65.8)	0	Gravity	Tested prior to installing filter pack and cement seal
Rocky Coulee flow top	06/24/85	60	248 (75.6)	0.12 (0.30)	Gravity	Tested prior to installing filter pack and cement seal
Grande Ronde 5 flow interior	07/23/85	60	232 (70.7)	0.02 (0.051)	Gravity	Tested after piezometer development activities, standing valve seals worn
Grande Ronde 5 flow top	08/13/85	60	233 (71.0)	0.04 (0.10)	Gravity	Tested after piezometer development activities
Cohassett flow interior	07/24/85	60	257 (78.3)	0	Gravity	Tested after piezometer development activities
Cohassett flow top	08/12/85	60	226 (68.9)	0	Gravity	Tested after piezometer development activities
Rocky Coulee flow interior	07/26/85	60	235 (71.6)	0	Gravity	Tested after piezometer development activities
Rocky Coulee flow top	08/13/85	60	234 (71.3)	0	Gravity	Tested after piezometer development activities

Table E-8. Manufacturer's Stated Filter Pack Material Chemical Specifications.

Chemical description	Sample size -4+8	Designation -10+20
SiO_2,%	97.3	97.8
Al_2O, %	0.45	1.20
MgO,%	0.01	0.01
CaO,%	0.02	0.03
K_2O,%	0.17	0.06
Na_2O,%	0.05	0.17
Fe_2O_3,%	0.15	0.12
TiO_2,%	0.02	0.02
LOI,%	0.26	0.33
Feldspar	1.50	5.10
Acid soluble, 15% HCl,%	0.28	0.34
Mud acid solubility (3HF: 12 HCl)	1.10	2.26
Acid demand at pH 3	2.80	0.31
pH 5	0.80	1.00
pH 7	0.40	0.60
Specific gravity	2.63	2.62
AWWA porosity, %	45.20	45.60

APPENDIX F

PIEZOMETER DEVELOPMENT

CONTENTS

Table F-1. Piezometer Development Activities at Piezometer Nest RRL-2C. (sheet 1 of 4)

Date	Activity
06/28/85	Installed shallow pressure transducer in piezometer tubes and started monitoring water levels.
06/29/85-06/30/85	Monitored water levels in piezometer tubes.
07/01/85	Ran fluid temperature log at 1034 hours in Grande Ronde 5 flow-top piezometer. At 1245 hours, started monitoring downhole temperatures with fluid temperature sonde set at a depth of 260 ft (79 m).
07/02/85	At 0900 hours, started air-lift development for the Grande Ronde 5 flow-top piezometer.
07/03/85	At 0900 hours, started air-lift development for the Grande Ronde 5 flow-top piezometer. Started monitoring water-level recovery.
07/04/85-07/08/85	Continued to monitor water levels.
07/09/85	Removed fluid temperature sonde from Grande Ronde 5 piezometer. From 0945 to 1540 hours, air-lift developed Rocky Coulee flow-top piezometer. Discontinued development because pressure transducers in Grande Ronde 5 flow-top and Rocky Coulee flow-top piezometers were not calibrated.
07/10/85	No activity.
07/11/85	Installed calibrated pressure transducers in the Grande Ronde 5 flow-top and Rocky Coulee flow-top piezometers. Installed pressure transducer in RRL-2B. From 1335 to 1430 hours, air-lift developed the Grande Ronde 5 flow top. Development discontinued due to insufficient flow because piezometer tube was plugged at seating nipple. Workover rig moved on site.
07/12/85	Rigged up workover rig.
07/13/85-07/14/85	No activity.
07/15/85	Flushed Grande Ronde 5 piezometer for about 2 h with Hanford system water through nominal 1-in. (2.5-cm) work string.

Table F-1. Piezometer Development Activities at Piezometer Nest RRL-2C. (sheet 2 of 4)

Date	Activity
07/16/85-07/17/85	No activity
07/18/85	Flushed Grande Ronde 5 for about 1.5 h until circulation was lost at the seating nipple. Tripped 1-in. (2.5-cm) hydril work string out of piezometer.
07/19/85	Flushed Grande Ronde 5 flow-interior piezometer for about 3 h with Hanford system water through 1-in. (2.5-cm) hydril work string.
07/20/85-07/21/85	No activity.
07/22/85	Mule shoe joint on 1-in. (2.5-cm) hydril work string replaced with 0.75-in.- (1.9-cm-) diameter tubing. Flushed Grande Ronde 5 flow interior piezometer for about 2.5 h with Hanford system water through hydril work string set as deep as bottom of tail pipe. Topped Grande Ronde 5 flow interior piezometer with water and monitored injection rate for 1 h. Aborted seating nipple tubing test run in Grande Ronde 5 flow interior due to inadequate seats in standing valve. Flushed Cohassett flow-interior piezometer for 1.5 h with Hanford system water.
07/23/85	Flushed Cohassett flow-interior piezometer for 1 h with Hanford system water. Ran 1-h seating nipple tubing test in Grande Ronde 5 flow-interior piezometer.
07/24/85	Flushed Rocky Coulee flow-interior piezometer for about 1.5 h with Hanford system water. Ran 1-h seating nipple tubing test in Cohassett flow-interior piezometer.
07/25/85	Flushed Rocky Coulee flow interior piezometer for about 6.5 h with Hanford system water.
07/26/85	Topped Rocky Coulee flow-interior piezometer with water and monitored injection rate for 1 h. Ran 1-h seating nipple tubing test in Rocky Coulee flow-interior piezometer. Flushed Cohassett flow interior piezometer for about 1 h with Hanford system water to obtain a sample of the flush water. From 1501 to 1520 hours, air-lift developed Cohassett flow-top piezometer, but development was terminated due to insufficient flow.

Table F-1. Piezometer Development Activities at Piezometer Nest RRL-2C. (sheet 3 of 4)

Date	Activity
7/27/85-07/28/85	No activity.
07/29/85	Flushed Cohassett flow-top piezometer for about 5 h with Hanford system water.
07/30/85	Continued to flush Cohassett flow top for about 4.5 h with Hanford system water. At 1550 hours started air-lift development for the Rocky Coulee flow-top piezometer.
07/31/85	At 0010 hours terminated air-lift development for Rocky Coulee flow-top piezometer due to insufficient flow. Flushed Rocky Coulee flow-top piezometer for about 1.5 h with Hanford system water.
08/01/85	Flushed Rocky Coulee flow-top piezometer for 2.5 h with Hanford system water. Topped Cohassett flow top with water and monitored injection rate for 1 h. Aborted seating nipple tubing test due to inadequate standing valve seals.
08/02/85	Prepared for redevelopment of Grande Ronde 5 flow-top piezometer.
08/03/85-08/04/85	No activity.
08/05/85	Aborted seating nipple tubing test in Cohassett flow-top piezometer due to inadequate standing valve seals. From 0940 to 1115 hours, air-lift developed Grande Ronde 5 flow top. Development discontinued due to equipment problems. From 1300 to 2230 hours, air-lift developed Grande Ronde 5 flow top using air-lift equipment arrangement.
08/06/85	From 0800 to 1025 hours, air-lift development continued in the Grande Ronde 5 flow-top piezometer. Installed standing valve in Grande Ronde 5 flow-top piezometer and circulated above seating nipple with Hanford system water. Retested tubing, but again seals in standing valve were inadequate.
08/07/85	Prepared to air-lift develop Rocky Coulee flow-top piezometer.

Table F-1. Piezometer Development Activities at Piezometer Nest RRL-2C. (sheet 4 of 4)

Date	Activity
08/08/85	From 0930 to 1520 hours, air-lift developed Rocky Coulee flow-top piezometer and started water-level recovery at RRL-2C and RRL-2B. Replaced seals in standing valve.
08/09/85	Installed standing valve in Rocky Coulee flow top and circulated above seating nipple with Hanford system water. Aborted seating nipple tubing test in Rocky Coulee flow-top piezometer due to inadequate seat.
08/10/85-08/11/85	No activity
08/12/85	Ran 1-h seating nipple tubing test in Cohassett flow-top piezometer. Ran 1-h seating nipple tubing test in Grande Ronde 5 flow top, but still had small leak around standing valve. Confirmed piezometer unobstructed and seating nipple depths with fluid temperature probe for the Rocky Coulee flow top, Rocky Coulee interior, and Cohassett flow-top piezometer. Installed standing valve in Rocky Coulee flow top and lightly tapped valve into seating nipple with sand line.
08/12/85	Evacuated water levels in Grande Ronde 5 flow-interior, Cohassett flow-interior, and Rocky Coulee flow-interior piezometers to about 280 ft (85 m).
08/13/85	Ran 1-h seating nipple tubing test in Rocky Coulee flow-top piezometer and Grande Ronde 5 flow top. Turned piezometer over to monitoring group for long-term hydraulic head monitoring.

Table F-2. RRL-2C Piezometer Development Summary. (sheet 1 of 2)

Date	Monitoring horizon	Isolated interval ft (m)	Pumping period min	Average discharge rate gal/min (L/min)	Total volume pumped gal (m^3)	Remarks
07/09/85	Rocky Coulee flow top	2,799-2,833 (853.1-863.5)	355	0.26 (0.98)	92 (0.35)	Air-lift pumped.
07/30/85	Rocky Coulee flow top	2,799-2,833 (853.1-863.5)	490	0.095 (0.36)	47 (0.18)	Circulated about 1900 gal (7.2 m^3) of Hanford system water with an estimated 95% water return on on 7/31/85 and 8/1/85.
08/08/85	Rocky Coulee interior	2,799-2,833 (853.1-863.5)	350	0.65 (2.46)	227 (0.86)	Air-lift pumped on 8/9/85. Flushed piezometer tubing above seating nipple with about 400 gal (1.5 m^3) of Hanford system water.
07/24/85-07/25/85	Rocky Coulee flow interior	2,895-2,917 (882.4-889.1)	-	-	-	Screen flushed with about 6,400 gal (24.2 m^3) of Hanford system water with an estimated 100% water return.
07/26/85	Cohassett flow top	2,963-2,993 (903.1-912.3)	19	-	-	Terminated air-lift development due to insufficient flow.
07/29/85-07/30/85	Cohassett flow top	2,963-2,993 (903.1-912.3)	-	-	-	Screen flushed with about 5,700 gal (21.6 m^3) of Hanford system water with an estimated 100% water return.

Table F-2. RRL-2C Piezometer Development Summary. (sheet 2 of 2)

Date	Monitoring horizon	Isolated interval ft (m)	Pumping period min	Average discharge rate gal/min (L/min)	Total volume pumped gal (m^3)	Remarks
07/22/85-07/23/85 and 07/26/85	Cohassett flow interior	3,145-3,168 (958.6-965.6)	- -	- -	- -	Screen flushed with 4,700 gal (17.8 m^3) of Hanford system water with an estimated 100% water return.
07/02/85-07/03/85	Grande Ronde 5 flow top	3,215-3,282 (979.9-1,000.4)	1,440	5.5 (20.8)	7,920 (30.0)	Air-lift pumped.
07/11/85	Grande Ronde 5 flow top	3,215-3,282 (979.9-1,000.4)	108	-	-	Air-lift development discontinued due to piezometer tube plugged at seat nipple.
07/15/85 and 07/18/85	Grande Ronde 5 flow top	3,215-3,282 (979.9-1,000.4)	-	-	-	Piezometer tubing flushed with about 145 gal (0.55 m^3) of Hanford system water before losing circulation at the seating nipple.
08/05/85-08/06/85	Grande Ronde 5 flow top	3,215-3,282 (979.9-1,000.4)	760	4.8 (18.2)	3,648 (13.8)	Air-lift pumped.
07/19/85 and 07/22/85	Grande Ronde 5 flow interior	3,315-3,334 (1,010.4-1,016.2)	-	-	-	Screen flushed with about 2,300 gal (8.7 m^3) of Hanford system water with an estimated 100% water return.

Table F-3. Chemical Quality of Water in Piezometer Tubes After Flushing with Hanford System Water.

Constituent	Rocky Coulee flow-top piezometer	Rocky Coulee flow-interior piezometer	Cohassett flow-top piezometer	Cohassett flow-interior piezometer	Grande Ronde 5 flow-top piezometer	Grande Ronde 5 flow-interior piezometer
Na^{+} (mg/L)	9.7	5.6	4.7	7.2	5.4	5.8
K^{+} (mg/L)	1.9	1.4	1.3	1.6	1.1	1.7
Ca^{+2} (mg/L)	13.5	14.6	15.2	14.0	12.5	11.4
Mg^{+2} (mg/L)	2.5	2.8	2.9	2.4	1.5	2.5
Si (mg/L)	<0.3	<0.3	<0.3	<0.3	<0.2	<0.3
F^{-} (mg/L)	0.2	0.2	0.2	0.2	1.2	0.2
Cl (mg/L)	10.0	7.2	5.1	7.9	8.6	7.5
SO_4^{2-} (mg/L)	21.1	17.8	23.4	19.3	22.5	18.8
TOC (mg/L)	5.2	4.1	3.0	3.4	3.8	4.2
TC (mg/L)	15.0	13.0	11.7	11.4	8.0	13.6
Conductivity (μmhos/cm)	165	125	148	134	--	--

Note: Samples taken on October 1985.

Table F-4. Parameter Values Used to Calculate Transmissivity (T) from Constant Head Injection Test (gravity induced).

Piezometer	Step duration min	Total injection head ft (m)	Final injection rate, Q_f mL/min	Radius of borehole, r_w ft (m)	Assumed radius of influence, R ft (m)
Rocky Coulee interior	60	~233 (71)	11.6	0.51 (0.16)	22 (6.7)
Cohassett flow top	30	~233 (71)	2.6	0.51 (0.16	30 (9.1)
Cohassett interior	60	~233 (71)	6.2	0.51 (0.16)	23 (7.0)
Grande Ronde 5 interior	60	~233 (71)	17.2	0.51 (0.10)	22 (6.7)

NOTE: $T = \frac{Q_f}{H_t} \frac{1}{2\pi} \ln \frac{R}{r_w}$

APPENDIX G

INTERNAL LETTERS

CONTENTS

Internal Letter

Rockwell International

Date May 10, 1985 No. 10330-85-040

TO R. L. Jackson

FROM R. P. Anantatmula
E300A Group
MO-407/200E
3-2853

Subject Galvanic Corrosion of the Couple - AISI 316 Stainless Steel Well Screen Jacket and Mild Steel Pipe Base

Ref: a) Letter, October 14, 1983, R. P. Anantatmula to R. L. Jackson, Galvanic Corrosion of Type 316 Stainless Steel Well Screen Jacket Fitted Over Mild Steel Perforated Pipe Base.

b) Letter, April 24, 1985, R. L. Jackson to R. P. Anantatmula, Corrosion Resistance of Low-Carbon Steel.

Per our conversation, the following is my re-evaluation of the corrosion behavior of the galvanic couple, viz., carbon steel pipe base and AISI type 316 stainless steel (316) well screen jacket of the piezometer.

Although the present assessment is still conservative, similar to the previous evaluation (Reference a), I feel that the present estimate is a little more realistic compared to the previous estimate. The conservatism in the present calculations is retained by the assumptions that the temperature of the groundwater contacting the galvanic couple is at its maximum of 55°C (Reference b) and the 316 well screen jacket will be in a passive state throughout the life of the low-carbon steel pipe base. As discussed before (Reference a), the coupling of low-carbon steel to 316 raises the corrosion rate of low-carbon steel. Using the same methodology as before, along with the assumption that the entire length of the low-carbon steel pipe is in electrical contact with the 316 well screen jacket, the operating life of the present low-carbon steel pipe is at least 30 years.

As mentioned before (Reference a), the 316 well screen jacket will operate for at least 1000 years (for 1mm thickness) without fail. Stress corrosion cracking of the 316 well screen jacket is not considered to be a problem under the present conditions.

I appreciate the opportunity to be of some help to you in this matter. Should you have any questions with regard to my evaluation, please feel free to contact me on 373-2853.

R. P. Anantatmula

R. P. Anantatmula
Staff Scientist

RPA:dac

cc: R. C. Edwards
L. R. Fitch
T. B. McCall
W. H. Price
P. F. Salter
M. J. Smith
S. R. Strait
M. D. Veatch
LB/File
BRMC (2) W300/3503-002

Internal Letter

Rockwell International

Date June 11, 1985

No. 10120-85-268

TO (Name, Organization, Internal Address)
Those Listed

FROM (Name, Organization, Internal Address, Phone)
R. Stone
Drilling and Testing Group
MO-408/600 Area
3-4542

Subject: Placement of Piezometers in Flow Interiors at Well RRL-2C for Use in Ratio Tests

A series of estimates of the hydraulic head response in the Rocky Coulee, Cohassett, and Grande Ronde No. 5 flow interiors to pumping from the Rocky Coulee and Grande Ronde No. 5 flow tops was made to guide the design of well RRL-2C and the ratio method hydraulic tests to be performed using well RRL-2C. The estimates of hydraulic head response in the flow interiors were based on the theory of flow in aquicludes adjacent to slightly leaky aquifers (Neuman and Witherspoon, 1968). Those in the flow tops were based on standard transient flow theory for confined units.

It is assumed that hydraulic head response in flow interiors of at least two feet in a period of 30 days or less is required for positive identification and measurement of the head transients in the flow interiors within a reasonable period of time. The transducers that will be used to measure the flow interior head changes are known to drift down by about one foot per month.

The theory used to estimate hydraulic response in the flow interiors was judged to be valid for at least 100 days of pumping. The spacing of well RRL-2B and RRL-2C was judged to be small enough for the ratio method to be valid (Neuman and Witherspoon, 1972).

The estimates show that: a piezometer should be located about ($\pm$ 5 feet) 60 feet below the Rocky Coulee flow top, in the Rocky Coulee flow interior (z = 60 feet $\pm$ 5 feet); a piezometer should be located about ($\pm$ 5 feet) 80 feet above the Grande Ronde No. 5 flow top, in the Cohassett flow interior (z = 80 feet $\pm$ 5 feet); and a piezometer should be located about ($\pm$ 5 feet) 45 feet below the Grande Ronde No. 5 flow top in the Grande Ronde No. 5 flow interior (z = 45 feet $\pm$ 5 feet).

Parameter values used in the estimate cited above are given in the attached table.

Drawdown in the flow interior of the Rocky Coulee, Cohassett and Grande Ronde No. 5 flows was calculated directly from the theory of flow in aquicludes adjacent to slightly leaky aquifers. Drawdown in the Rocky Coulee and Grande Ronde No. 5 flow tops was calculated using the Theis equation. The transmissivity used for the Rocky Coulee flow top is a

Rockwell International

Those Listed
Page 2
June 11, 1985

geometric mean value for the reference repository location area. That used for the Grande Ronde No. 5 flow top was derived from an informal pumping test of well RRL-2C during well cleanup operations. The success of a ratio test or the drawdown in flow interiors is not particularly sensitive to the transmissivity of the flow top as long as it is great enough to permit pumping and as long as the pumped discharge is adjusted to provide an adequately strong hydraulic sink.

When pumping the Rocky Coulee flow top at 4 gallons per minute (gpm), the drawdown in well RRL-2B is estimated to be about 840 feet at 30 days. Drawdown at z = 60 feet in the Rocky Coulee flow interior at well RRL-2C is estimated to be about 0.1 feet, 5.9 feet, and 9.8 feet at 20, 30, and 40 days, respectively. At z = 70 feet, the flow interior drawdowns are estimated to be about <0.001 feet, 0.5 feet, and 5.9 feet for the same elapsed times, respectively.

When pumping the Grande Ronde No. 5 flow top at 200 gpm, the drawdown in well RRL-2B is estimated to be about 340 feet at 30 days. Drawdown at z = 80 feet in the Cohassett flow interior at well RRL-2C is estimated to be about <0.03 feet, 2.4 feet, and 3.1 feet at 20, 30, and 40 days, respectively. Drawdown at z = 45 feet in the Grande Ronde No. 5 flow interior is estimated to be approximately 2.4 feet, 4.6 feet, and 6.1 feet at 20, 30, and 40 days, respectively. Wells RRL-2B and RRL-2C are assumed to be 250 feet apart.

Randolph Stone

R. Stone,
Staff Hydrologist

RS:cam

Distribution
S. M. Baker
W. R. Brown
R. W. Bryce
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R. E. Gephart
G. S. Hunt
R. L. Jackson
W. H. Price
F. A. Spane
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cc: BRMC (2) 3503
LB

	T_h ft^2/day	K_h ft/day	b, ft	S	K_v, ft/day
Rocky Coulee					
Flow Top	1.25	0.125	10	10^{-5}	
Flow Interior			140	10^{-5}	10^{-6}
Cohassett					
Flow Interior			220	10^{-5}	10^{-6}
Grande Ronde No. 5					
Flow Top	200	10	20	10^{-5}	
Flow Interior			100	10^{-5}	10^{-6}

Internal Letter

Rockwell International

Date: September 3, 1985

No. 10120-85-394

TO: (Name, Organization, Internal Address)
Those Listed

FROM: (Name, Organization, Internal Address, Phone)
R. Stone
Drilling and Testing
MO-408/600 Area
3-4542

Subject: Pulse Test of the Rocky Coulee Flow Top in Well RRL-2B

Recently the opportunity arose, during casing bond logging in well RRL-2B, to perform a controlled pulse test of the Rocky Coulee flow top between RRL-2B and borehole RRL-2A and well RRL-2C. In a 79 minute period, 3,277 gallons (78 barrels) of "system" water were injected into well RRL-2B, which is currently completed in the Rocky Coulee flow top. The response to this pulse injection was measured in the piezometer completed in the Rocky Coulee flow top in well RRL-2C and in borehole RRL-2A where the Rocky Coulee flow top is packed off with a straddle packer assembly.

The flow of water into well RRL-2B was measured using a standard water meter. Pressure response at well RRL-2C was measured with a submerged, 0-100 psi Sinco pressure transducer installed in the Rocky Coulee flow top piezometer at 250 foot depth. Pressure response in the Rocky Coulee flow top at borehole RRL-2A was measured with a Paroscientific 0-3000 psi pressure transducer in a carrier above the straddle packer. The pressure records for the period of response at both observation locations are attached. The response in borehole RRL-2A to injection of water into well RRL-2B is closely followed by a second pressure pulse believed to have been caused by placement of a large packer on tubing in well RRL-2B, subsequent to pulse injection of the water.

The pressure pulse responses at borehole RRL-2A and well RRL-2C were analyzed using the method of Johnson, Greenkorn, and Woods (1966). A water temperature of 40°C and a formation thickness of 5 feet were assumed in converting oil field transmissivity in md ft/cp to hydrologic transmissivity in ft^2/day. The results of the analysis provide what should be rather good estimates of the transmissivity and storativity of the Rocky Coulee flow top in the RRL-2 area. All aspects of this test were well controlled.

Rockwell
International

Those Listed
Page 2
September 3, 1985

The estimated hydraulic property values are listed as follows.

Estimated Transmissivity and Storativity of the Rocky Coulee Flow Top Based on Pulse Input at Well RRL-2B and Pressure Response at Borehole RRL-2A and Well RRL-2C.

	RRL-2B → RRL-2A	RRL-2B → RRL-2C
T, ft^2/day	6.5	1.5
S	2×10^{-4}	3×10^{-5}

The storativity estimated from analysis of the response at borehole RRL-2A is near the upper end of the range of storativity values generally associated with confined water-bearing units. The transmissivity estimates are about an order of magnitude greater than those reported in my letters of July 31 and August 21, 1985 on the analysis of pressure response at well RRL-2C and borehole RRL-2A during drilling of the Rocky Coulee flow top in well RRL-2B. The estimates given in this letter are considered to be more accurate. The ratio of the transmissivity calculated from the RRL-2C response to that calculated from the RRL-2A response is about the same for both sets of estimates, however. It is thought that the difference between the transmissivity values in the two directions from well RRL-2B are real. It is unknown whether the difference is caused by areal hydraulic anisotropy or inhomogeneity, or both.

Rockwell
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Those Listed
Page 3
September 3, 1985

The possibility that the pressure responses at well RRL-2C and borehole RRL-2A were influenced by wellbore storage effects was examined using the method of Prats and Scott (1975). The analysis revealed negligible wellbore storage effects at the responding well and borehole.

References: Johnson, C. R., R. A. Greenkorn, and E. G. Woods, 1966, Pulse-Testing: A New Method for Describing Reservoir Flow Properties Between Wells, SPE Transactions, Vol. 237, pp. 1599-1604.

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Randolph Stone

Randolph Stone, Staff Hydrologist
Drilling and Testing Group

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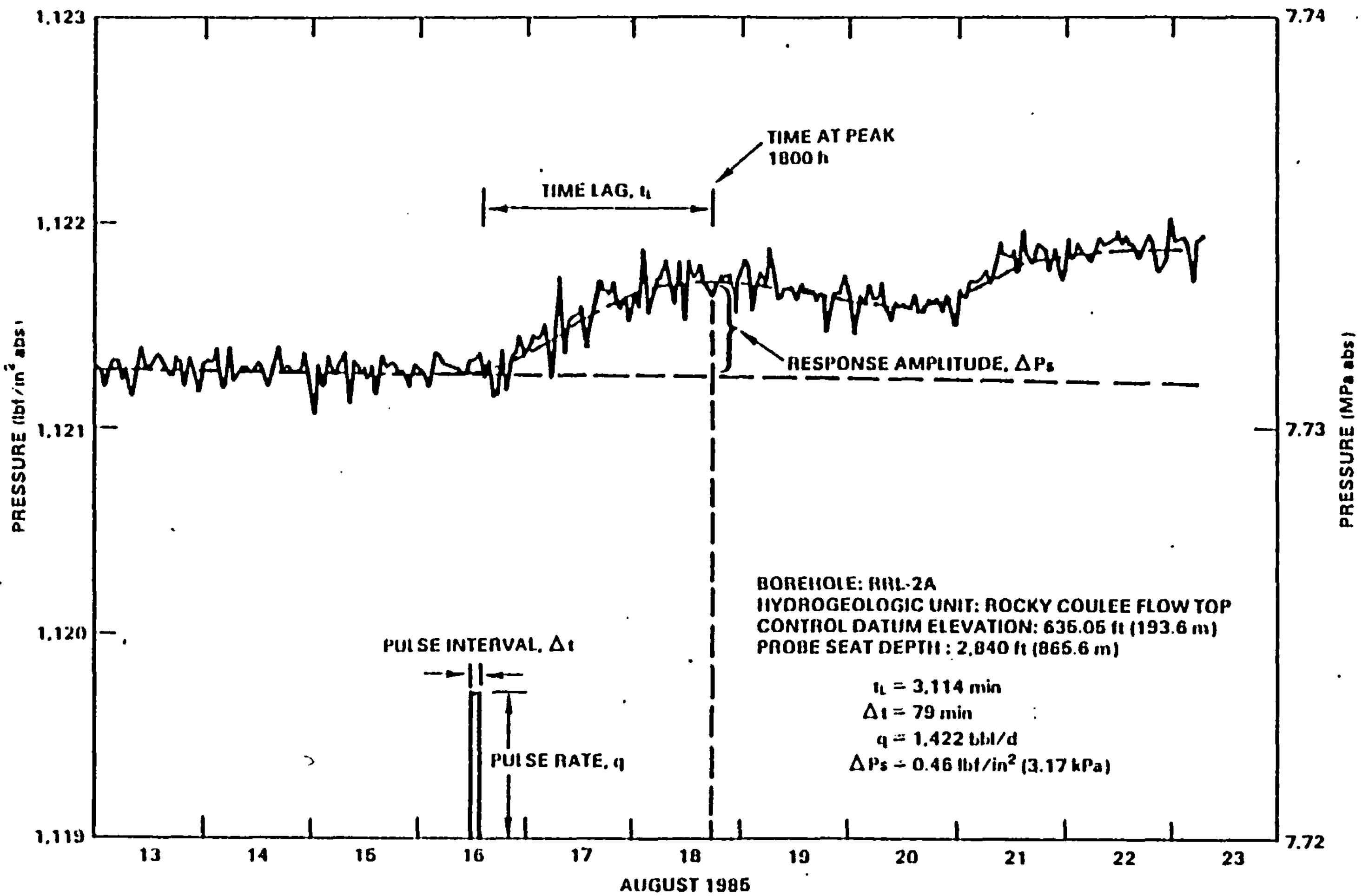
1,123
1,122
1,121
1,120
1,119
7.74
7.73
7.72
PRESSURE (lbf/in² abs)
PRESSURE (MPa abs)
TIME AT PEAK
1800 h
TIME LAG, t_L
RESPONSE AMPLITUDE, ΔP_s
PULSE INTERVAL, Δt
PULSE RATE, q
BOREHOLE: RRL-2A
HYDROGEOLOGIC UNIT: ROCKY COULEE FLOW TOP
CONTROL DATUM ELEVATION: 636.06 ft (193.6 m)
PROBE SEAT DEPTH: 2,840 ft (866.6 m)
t_L = 3,114 min
Δt = 79 min
q = 1,422 bbl/d
ΔP_s = 0.46 lbf/in² (3.17 kPa)
13
14
15
16
17
18
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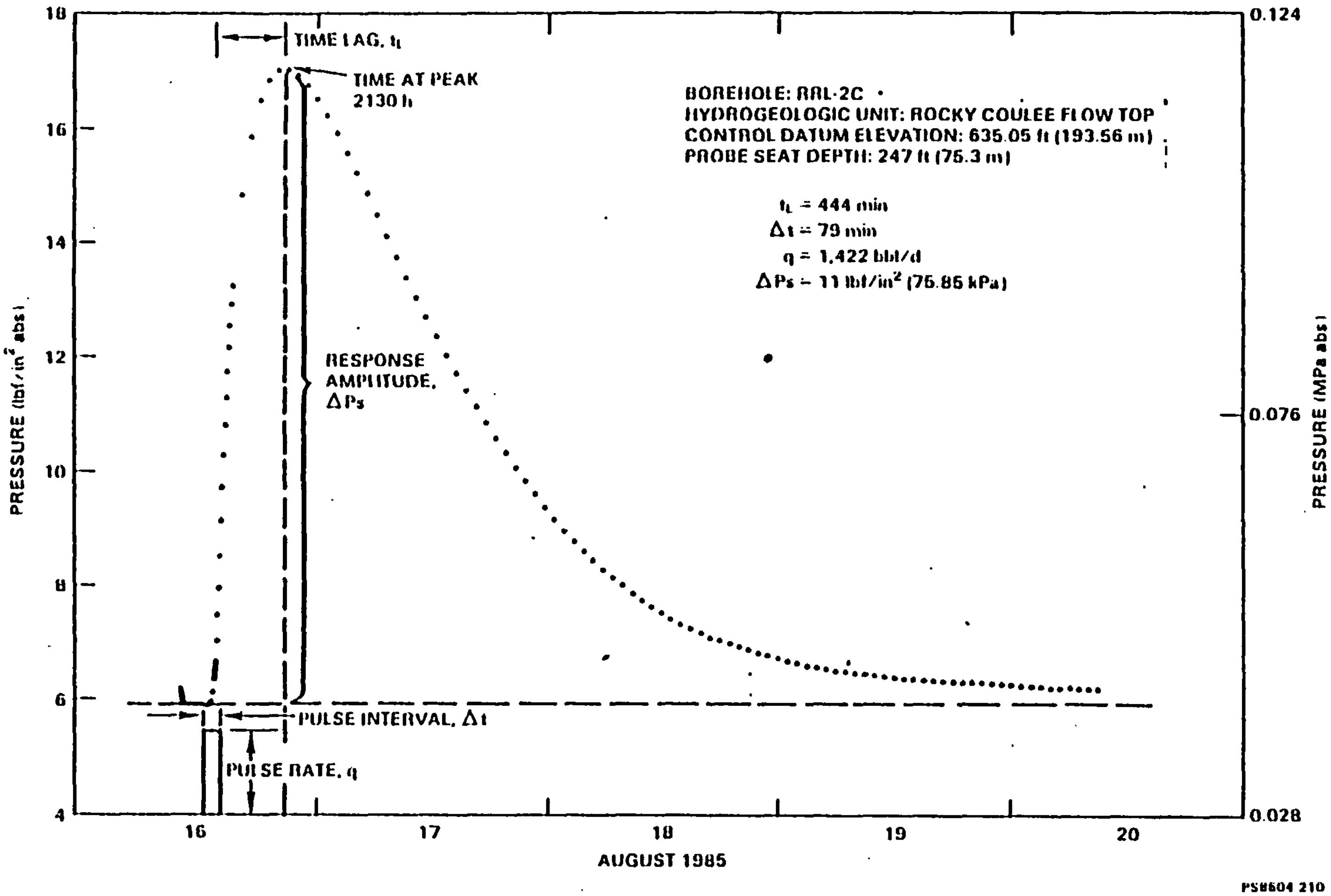
22
23
AUGUST 1985

PS8604 209


TIME LAG, t_L
TIME AT PEAK 2130 h
BOREHOLE: RRL-2C
HYDROGEOLOGIC UNIT: ROCKY COULEE FLOW TOP
CONTROL DATUM ELEVATION: 635.05 ft (193.56 m)
PROBE SEAT DEPTH: 247 ft (75.3 m)
t_L = 444 min
Δt = 79 min
q = 1,422 bbl/d
ΔPs = 11 lbf/in^2 (75.85 kPa)
RESPONSE AMPLITUDE, ΔPs
PULSE INTERVAL, Δt
PULSE RATE, q
PRESSURE (lbf/in^2 abs)
PRESSURE (MPa abs)
AUGUST 1985
PS8604 210

Rockwell Hanford Operations

BWIP SUPPORTING DOCUMENT		Number: SD- BWI-DP-051	Rev./Chg. No.: 2	Page 1 Of Total Pages
End Function Activity: Hydrologic Characterization	Project No.: N/A	CIN No.: Date:		
Document Title: Hydraulic Property Data from Selected Test Zones on the Hanford Site		Baseline Doc.: [ ] Yes [X] No Level:		
		WBS No. or Work Package No.: L3D2	CEI No.: 003	

Borehole No.:	Stratigraphic Formations:	Doc. Type	Subj. Code	Prepared by (type & sign name)	Date
N/A	Grande Ronde	2019	H700	S. R. Strait R. B. Mercer See reverse side for additional approvals	3/87

Abstract
(NOTE: Please limit the abstract to a total of 300 characters or less).

This data package contains a summary of hydraulic properties, as determined from analysis of hydrologic test data, of selected test zones within Saddle Mountains, Wanapum, and Grande Ronde Basalts. The information within this package includes: borehole, stratigraphic horizon, use code, isolated interval, effective test interval, transmissivity, equivalent hydraulic conductivity, hydraulic head, and the uncertainty of the hydraulic head value. The hydraulic properties are considered preliminary and subject to change with further analysis and subsequent documentation. The observed hydraulic head values are uncorrected, field-derived values.

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BWIP SUMMARY OF REVISION	Number SD- BWI-DP-051	Page of

Rev/Chg. No.	Date	Description Of Changes
1	2/6/86	This document was revised by adding the hydraulic properties from twenty-three test intervals to the forty-two test intervals that were included in the previous revision. The added zones include flow tops, flow interiors, and intraflow structures (fracture and vesicular zones) of the Grande Ronde Basalt. In addition, the equivalent hydraulic conductivity for each test interval has been added to the listing of hydraulic properties.
2	3/2/87	This document was revised by adding the hydraulic properties from 179 test intervals to the 65 test intervals that were included in the previous revision. The added zones include flow tops and interbedded sediments of the Saddle Mountains Basalt, flow tops, interbedded sediments, and flow interiors of the Wanapum Basalt, and the additional flow tops of the Grande Ronde Basalt. This revision represents an accumulation of all the hydraulic property data (244 test zones) from previous local-scale hydraulic testing.

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SD-BWI-DP-051
REV 2

Hydraulic Property Data from Selected Test Zones on the Hanford Site

S. R. Strait
R. B. Mercer

DRAFT

Hydrologic Testing Group
Basalt Waste Isolation Project

March 1987

Prepared for the United States
Department of Energy Under
Contract DE-AC06-77RL01030

Rockwell International
Rockwell Hanford Operations
North American Space Operations
Richland, Washington 99352

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CONTENTS

DRAFT

INTRODUCTION

Over the past eight years, hydrologists from the Basalt Waste Isolation Project (BWIP) have done extensive hydrologic testing in the Columbia River Basalts underlying the Hanford Site. The test intervals included within this report includes all tested flow tops, interbedded sediments, flow interiors, and intraflow structures within the Saddle Mountains, Wanapum, and Grande Ronde Basalts. The majority of the tests consisted of single borehole tests conducted in boreholes that were progressively drilled and tested (Strait and others, 1982). Other tests were in existing boreholes in which test zones were isolated using straddle packers. Hydrologic tests conducted prior to 1982 used surface based depth-to-water measurements and tests conducted after 1982 utilized downhole pressure sensing probes for monitoring hydrologic test response.

DATA SOURCE

Sources of information contained within this document include BWIP documents (see references) and BWIP raw data files. All raw hydrologic data used to calculate the hydraulic properties are stored in the Hydrologic Testing Group field file and BWIP's Basalt Records Management Center (BRMC). Raw data is available upon request from the BRMC.

Basalt Records Management Center
Basalt Waste Isolation Project
Rockwell Hanford Operations
P. O. Box 800
Richland, Washington 99352
Telephone: (509) 376-1102

DATA LIMITATIONS

The hydrologic test data that have been verified by internal and/or external technical review and issued in a Rockwell Hanford Operations document (see references) has no limitations on its use. In this case the transmissivity values, in units of feet squared per day, have been determined to be accurate to two significant figures. The values reported are considered the best estimate of transmissivity. The best estimate is obtained by examining the test results and associated analyses of the various hydrologic tests conducted (constant discharge, slug, pulse, constant drawdown, and constant head injection tests). Generally, results from long duration and/or high stress tests are given more weight in determining hydraulic properties which are considered more representative of the test horizon.

Equivalent hydraulic conductivity is calculated by dividing the transmissivity by the effective test interval. It is considered to be equally distributed over the effective test interval. The observed hydraulic head parameters, which were obtained from depth-to-water measurements, are recorded as elevation above mean sea level (MSL) to the nearest foot, with an assigned uncertainty (±) value. The uncertainty value results from nonequilibrium conditions at the time of measurement and instrument inaccuracies. The hydraulic head values have not been corrected for fluid-density effects, borehole deviation, and barometric or earth tide effects. Hydrologic test data that have not undergone verification by issuance of a document have not been validated by peer or technical review. In these cases, the transmissivities and equivalent hydraulic conductivities are presented in an order of magnitude range, with hydraulic head values assigned a larger uncertainty value. Hydrologic test data over the past six years was collected in accordance to Basalt Operation Procedure, C-2.8.

All raw data files and analyses of the raw data were examined by BWIP hydrologists. Based on the examination, the use of the data was established. The "use code" developed was based upon results of the data review and is presented in Table 1. Data (e.g., transmissivity) contained within this report are preliminary and subject to change with further analysis. Changes to the data will be documented in subsequent revisions to this data package.

DATA DESCRIPTION

This data package contains the borehole, stratigraphic horizons, use code, isolated interval, effective test interval, transmissivity, equivalent hydraulic conductivity, observed hydraulic head, and the uncertainty in the hydraulic head.

DRAFT

Table 1. "Use Code" for Hydraulic Property Data.

Use Code	Data Use
0	The data has been verified by internal and/or external peer or technical review and has unlimited use.
1	Hydrologic data and analyses appear to be of good quality, but the data has not been verified by any peer or technical review. The data use should be limited to conceptual modeling.
2	The data and analyses are of questionable quality and should not be used except in the most qualitative manner.

DRAFT

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APPENDIX A

Hydraulic Property Data

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SD-BWI-TI-175

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DC-3							
	Umtanum C/E	1	1092-1108	1092-1108	1.0E-12 to 1.0E-11	1.0E-14 to 1.0E-13	NA
DC-4							
	Rocky Coulee C/E	0	882-897	882-897	1.3E-12	8.8E-14	NA
	* Cohassett FT	1	899-915	904-909	1.0E-07 to 1.0E-06	1.0E-08 to 1.0E-07	128±?
DC-5							
	Cohassett FT	1	899-915	904-909	1.0E-07 to 1.0E-06	1.0E-08 to 1.0E-07	NA
	Cohassett C/E	1	964-976	964-975	1.0E-12 to 1.0E-11	1.0E-14 to 1.0E-13	NA
DC-6							
	* Grande Ronde Composite	1	689-1321	NA	1.0E-05 to 1.0E-04	NA	NA
	* Grande Ronde FT	1	730-822	733-746 748-756 761-765 776-783	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	130±?
	* Grande Ronde FT	1	822-882	821-851 853-872	1.0E-05 to 1.0E-04	1.0E-08 to 1.0E-07	130±?
	Umtanum FT	1	912-938	925-934	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	136±1.5
	* Umtanum C/E	1	938-989	938-989	1.0E-12 to 1.0E-10	1.0E-14 to 1.0E-12	NA
	* Umtanum FB	1	988-1076	993-1004 1015-1025 1030-1033	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	136±?

* Information new to DP-51 Rev. 2

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DC-6 cont							
*	Grande Ronde FT	1	1076-1166	1077-1082 1088-1092 1097-1098 1100-1102 1103-1113 1116-1120 1123-1159	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	137±?
*	Grande Ronde C/E	1	1166-1271	1166-1271	1.0E-12 to 1.0E-11	1.0E-15 to 1.0E-14	NA
	Grande Ronde FT	1	1271-1321	1275-1286	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	140±1.5
DC-7							
*	Grande Ronde Composite	1	1254-1526	NA	1.0E-06 to 1.0E-05	NA	>122
*	Grande Ronde Composite	1	1256-1298	1261-1263 1279-1283 1287-1293	1.0E-09 to 1.0E-08	1.0E-11 to 1.0E-10	NA
*	Grande Ronde 20 FT	1	1299-1351	1311-1317 1319-1344	1.0E-09 to 1.0E-08	1.0E-11 to 1.0E-10	NA
*	Grande Ronde Composite	1	1355-1407	1367-1370 1374-1384 1386-1389 1392-1396	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	>124
*	Grande Ronde 29 FT	1	1428-1471	1430-1433 1435-1466	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	123±.9
*	Grande Ronde Composite	1	1472-1526	1482-1482 1487-1493 1495-1508	<1.0E-07 to	<1.0E-09	>119
DC-7/8							
	McCoy Canyon FT	1	1039-1060	1053-1059	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	124±1.2
DC-12							
*	Rosalia FT	1	371-382	373-382	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	124±?

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* Information new to DP-51 Rev. 2

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
DC-12 cont							
*	Quincy IB/ Roza FT	1	405-416	405-406 408-413 413-416	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	123±?
*	Sentinel Gap FT	1	460-468	463-467	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-04	124±?
*	Sand Hollow II FT	1	514-521	515-519	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	124±?
*	Ginkgo II FT	1	582-605	584-585 586-605	1.0E-07 to 1.0E-06	1.0E-08 to 1.0E-07	124±?
*	Ginkgo I FT	1	625-634	627-630 632-634	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	124±?
*	Palouse Falls IB/ Grande Ronde 1 FT	1	676-689	677-684	1.0E-07 to 1.0E-06	1.0E-08 to 1.0E-07	123±?
	Grande Ronde 2 FT	1	691-701	694-696 698-701	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	124±.6
	Rocky Coulee FT	1	734-746	736-743	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	124±.6
*	Cohassett Composite	1	782-811	784-787 789-792 794-807	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	NA
	Grande Ronde 7 FT	1	859-867	862-865	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	124±.6
	Grande Ronde 8 FT	1	865-873	867-871	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	124±.6
*	Grande Ronde Composite	1	908-961	913-927 942-947 949-955	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	NA
	McCoy Canyon FT	1	935-961	942-947 949-955	1.0E-08 to 1.0E-07	1.0E-10 to 1.0E-09	NA
	Umtanum FT	1	975-1000	979-988 990-995	1.0E-10 to 1.0E-08	1.0E-12 to 1.0E-10	NA

* Information new to DP-51 Rev. 2

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalant Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DC-12 cont							
*	Grande Ronde Composite	1	1018-1241	NA	1.0E-04 to 1.0E-03	NA	124±?
*	Grande Ronde Composite	1	1226-1241	1227-1237	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	124±?
*	Grande Ronde Composite	1	1245-1358	NA	1.0E-04 to 1.0E-03	NA	124±?
*	Grande Ronde Composite	1	1324-1358	NA	1.0E-04 to 1.0E-03	NA	124±?
DC-14							
*	Elephant Mountain FT	1	112-145	120-126	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	115±?
*	Rattlesnake Ridge IB	1	145-164	150-162	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	122±?
*	Selah IB	1	206-234	214-231	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	124±?
*	Asotin FT	1	268-276	270-276	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	150±?
*	Asotin FT	1	277-281	279-281	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	150±?
*	Asotin FT	1	282-295	288-294	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	NA
*	Mabton IB	1	295-330	NA	1.0E-05 to 1.0E-04	NA	149±?
*	Priest Rapids FT	1	360-363	362-362	1.0E-04 to 1.0E-03	1.0E-04 to 1.0E-03	151±?
*	Priest Rapids FT	1	365-371	366-370	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	150±?
*	Priest Rapids FT	1	371-387	372-374	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	151±?
*	Roza FT	1	392-409	395-408	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	150±?

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
<u>DC-14 cont</u>							
*	Frenchman Springs FT	1	451-462	455-459	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	148±?
*	Frenchman Springs FT	1	480-497	488-496	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	149±?
*	Frenchman Springs FT	1	500-521	512-517	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	149±?
*	Frenchman Springs FT	1	524-555	529-532 536-539	1.0E-04 1.0E-03	1.0E-05 to 1.0E-04	149±?
*	Frenchman Springs FT	1	555-572	560-565	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	148±?
*	Frenchman Springs FT	1	572-604	575-581 587-597	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	134±?
*	Vantage IB/ Grande Ronde FT	1	646-681	653-661 668-671 672-675	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	143±?
	Grande Ronde FT	1	718-733	722-729	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	133±1.5
	Grande Ronde FT	1	735-766	747-755	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	135±.6
*	Grande Ronde FT	1	810-876	819-824 833-840 861-871	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	133±?
	Grande Ronde FT	1	841-876	861-871	1.0E-09 to 1.0E-08	1.0E-11 to 1.0E-10	133±1.5
	Grande Ronde FT	1	878-907	882-900	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	133±1.5
	Umtanum FT	1	933-958	936-956	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	134±.3
	Grande Ronde FT	1	969-983	975-980	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	134±.3
*	Grande Ronde FT	1	994-1017	999-1015	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	134±?

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DC-15							
*	Levey IB	1	84-105	87-95	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	112±.3
*	Rattlesnake Ridge IB	1	127-151	133-150	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	117±.3
*	Selah IB	1	183-192	183-188	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	109±:6
*	Esquatzel FT	1	192-201	193-198	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	109±.6
*	Cold Creek IB	0	217-240	220-239	3.1E-05	1.6E-06	109±.9 SD-BWI-TI-150
*	Mabton IB	0	306-327	310-324	6.1E-05	4.2E-06	117±.6 SD-BWI-TI-139
*	Priest Rapids	1	350-362	351-356	1.0E-07 to 1.0E-06	1.0E-08 to 1.0E-07	118±?
*	Priest Rapids/ Roza FT	1	372-394	378-392	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	118±.3
*	Roza FT	1	414-424	416-419	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	118±.3
*	Sentinel Gap FT	1	425-449	429-431	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	118±.6
*	Wallula Gap FT	1	451-459	453-458	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	118±.3
*	Sand Hollow III FT	1	459-473	463-468	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	118±.3
*	Sand Hollow II FT	1	469-486	475-481	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	118±.3
*	Ginkgo II FT	1	529-559	530-531 543-561	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	118±.6
*	Ginkgo I FT	1	559-575	561-573	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	118±.3

* Information new to DP-51 Rev. 2

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Borehole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
DC-15 cont							
	Vantage IB/ Grande Ronde I FT	1	640-670	645-661	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	119±.6
	Rocky Coulee FT	1	679-714	685-686 690-699	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	118±.6
	Grande Ronde 5 FT	1	723-758	744-747	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	119±.6
	Cohassett FT	1	760-777	768-775	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	119±.6
	Grande Ronde 7 FT	2	808-823	810-812	<1.0E-04	<1.0E-05	119±?
	* Grande Ronde 9 FT	1	821-842	832-834 840-842	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	119±.6
	Grande Ronde 11 FT	1	857-874	862-873	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	119±.6
	Umtanum FT	1	903-949	910-946	>1.0E-04	>1.0E-06	122±.3
	Grande Ronde 14 FT	1	989-1005	991-1003	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	112±?
	Very High Mg Flow FT	1	1006-1040	1016-1031	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	117±?
	Grande Ronde 17 FT	1	1101-1108	1102-1106	<1.0E-08	<1.0E-09	NA
	Grande Ronde 19 FT	1	1140-1172	1141-1168	1.0E-08 to 1.0E-07	1.0E-10 to 1.0E-09	NA
	* Grande Ronde 20, 21 & 22 FTS	1	1261-1293	1267-1277 1281-1286	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	123±.6
DC-16A							
	* Rattlesnake Ridge IB	1	204-255	208-246	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	137±?
	* Selah IB	1	283-311	287-306	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	134±?

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
<u>DC-16A cont</u>							
*	Cold Creek IB	1	329-369	337-312	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	127±?
*	Mabton IB	1	425-478	433-462	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	128±?
*	Priest Rapids FT	1	515-527	521-521	1.0E-06 to 1.0E-05	1.0E-06 to 1.0E-05	116±?
*	Roza FT	1	536-557	540-544	1.0E-02 to 1.0E-01	1.0E-03 to 1.0E-02	123±?
*	Frenchman Springs FT	1	577-610	593-596	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	123±?
*	Frenchman Springs FT	1	642-657	648-651	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	123±?
*	Frenchman Springs FT	1	682-689	682-684	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	122±?
*	Frenchman Springs FT	1	691-723	694-698 704-708 709-714 715-723	1.0E-05 to 1.0E-04	1.0E-07 to 1.0E-06	123±?
*	Frenchman Springs FT	1	755-780	762-780	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	123±?
*	Frenchman Springs FT	1	788-802	792-802	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	123±?
*	Vantage IB	1	814-832	825-828 828-524 829-829	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	123±?
	Grande Ronde FT	1	814-860	825-829	>1.0E-04	1.0E-05	122±.6
	Grande Ronde FT	1	864-898	869-885	1.0E-07 to 1.0E-04	1.0E-09 to 1.0E-06	122±.6
	Cohassett FT	1	905-941	909-919 922-929	1.0E-08 to 1.0E-04	1.0E-10 to 1.0E-06	122±.9
	Cohassett C/E (vesicular zone)	0	941-992	941-992	2.6E-07	4.9E-09	NA SD-BWI-TI-166

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DC-16A cont							
	Cohassett C/E	1	961-992	961-992	1.0E-12 to 1.0E-11	1.0E-13 to 1.0E-12	NA
	Cohassett FB	1	992-1024	1000-1019	1.0E-09 to 1.0E-08	1.0E-11 to 1.0E-10	122±.9
*	Grande Ronde FT	1	1031-1065	NA	1.0E-10 to 1.0E-09	NA	NA
*	McCoy Canyon FT	1	1070-1082	NA	NA	NA	123±?
	Umtanum FT	1	1104-1136	1105-1131	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	123±.9
	Umtanum C/E	1	1137-1178	1137-1178	1.0E-09 to 1.0E-08	1.0E-11 to 1.0E-10	NA
	Grande Ronde FT	1	1193-1231	1202-1209	1.0E-06 to 1.0E-06	1.0E-08 to 1.0E-07	123±.9
DC-19C							
*	Priest Rapids FT	1	503-595	507-516	1.0E-04 to 1.1E-03	1.0E-06 to 3.5E-05	NA SD-BWI-TI-226
*	Sentinel Gap FT	1	557-595	575-591	1.0E-05 to 1.1E-04	1.0E-07 to 3.5E-06	NA SD-BWI-TI-226
*	Ginkgo FT	1	738-752	738-739 744-750	>1.1E-04	>3.5E-06	NA SD-BWI-TI-226
*	Rocky Coulee FT	1	852-866	853-864	1.0E-07 to 1.1E-06	1.0E-09 to 3.5E-08	NA SD-BWI-TI-226
*	Cohassett C/E	1	951-980	959-973	1.0E-11 to 1.1E-10	1.0E-13 to 3.5E-12	NA SD-BWI-TI-226
*	Umtanum FT	1	1093-1118	1095-1116	1.0E-05 to 1.1E-04	1.0E-07 to 3.5E-06	NA SD-BWI-TI-226

* Information new to DP-51 Rev. 2

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DC-20C							
*	Sentinel Gap FT	1	563-615	567-574	1.0E-03 to 1.1E-02	1.0E-05 to 3.5E-04	NA SD-BWI-TI-226
*	Ginkgo FT	1	725-777	733-743	1.0E-05 to 1.1E-04	1.0E-07 to 3.5E-06	NA SD-BWI-TI-226
*	Cohassett FT	1	892-944	894-897	1.0E-07 to 1.1E-06	1.0E-08 to 3.5E-07	NA SD-BWI-TI-226
*	Umtanum FT	1	1080-1131	1083-1117	1.0E-07 to 1.1E-06	1.0E-09 to 3.5E-08	NA SD-BWI-TI-226
DC-22C							
*	Rocky Coulee FT	1	877-922	878-886	1.0E-09 to 1.1E-05	1.0E-11 to 3.5E-07	NA SD-BWI-TI-226
*	Umtanum FT	1	1126-1172	1127-1164	1.0E-05 to 1.1E-03	1.0E-07 to 3.5E-05	NA SD-BWI-TI-226
DC-23GR							
*	Rosalia FT	1	410-434	NA	1.0E-03 to 1.0E-02	NA	NA
*	Sentinel Gap FT	1	481-498	NA	1.0E-02 to 1.0E-01	NA	NA
*	Ginkgo FT	1	657-675	NA	1.0E-06 to 1.0E-04	NA to	NA
*	Rocky Coulee FT	1	742-757	NA	1.0E-08 to 1.0E-07	NA	NA
*	Cohassett FT	1	797-821	NA	1.0E-09 to 1.0E-08	NA	NA
*	Birkett FT	1	891-907	NA	1.0E-08 to 1.0E-06	NA	NA
*	Umtanum FT	1	1006-1027	NA	1.0E-08 to 1.0E-05	NA	NA

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DB-1							
*	Mabton IB	1	297-302	NA	1.0E-03 to 1.0E-02	NA	NA
*	Priest Rapids FT	1	329-347	NA	1.0E-04 to 1.0E-03	NA	NA
DB-2							
*	Mabton IB	1	274-282	274-282	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	NA
*	Roza FT	1	355-363	356-360	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	NA
*	Roza C/E	0	363-388	363-388	3.5E-10	1.4E-11	NA
*	Priest Rapids Composit	1	313-363	313-323 335-338	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	NA
DB-4							
*	Mabton IB	1	415-428	415-428	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	NA
DB-5							
*	Mabton IB	1	248-277	254-277	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	NA
DB-7							
*	Mabton IB	1	182-247	237-247	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	NA
DB-9							
*	Mabton IB	1	141-180	149-180	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	NA
DB-10							
*	Mabton IB	1	242-272	257628	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	NA

SD-BWI-TI-176

* Information new to DP-51 Rev. 2

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Borehole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
DB-11							
*	Mabton IB	1	216-316	264-307	1.0E-07 to 1.0E-06	1.0E-10 to 1.0E-09	207±?
*	Priest Rapids FT	1	311-319	319-319	NA	NA	288±?
*	Priest Rapids FT	1	316-369	365-369	NA	NA	292±?
DB-12							
*	Mabton IB	1	115-156	115-156	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	NA
*	Priest Rapids FT	1	160-199	179-180	1.0E-02 to 1.0E-01	1.0E-03 to 1.0E-02	NA
*	Priest Rapids FT	1	201-215	207-210	1.0E-02 to 1.0E-01	1.0E-03 to 1.0E-02	NA
DB-13							
*	Elephant Mountain FT	1	115-116	NA	1.0E-03 to 1.0E-02	NA	NA
*	Rattlesnake Ridge IB	1	141-163	NA	1.0E-04 to 1.0E-03	NA	NA
*	Selah IB	1	219-225	NA	1.0E-04 to 1.0E-03	NA	NA
*	Cold Creek IB	1	264-287	NA	1.0E-04 to 1.0E-03	NA	NA
*	Mabton IB	1	364-394	364-394	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	NA
DB-14							
*	Rattlesnake Ridge IB	0	64-88	64-88	1.0E-05	1.0E-07	136.5±? RHO-LD-57
*	Selah IB	1	137-150	138-150	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	NA
*	Cold Creek IB	1	188-202	188-202	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	NA

* Information new to DP-51 Rev. 2

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmis-sivity (m^2/sec)	Equivalent Hydraulic Conducti-vity (m/sec)	Observed Hydraulic Head (m) MSL
DB-14 cont							
*	Mabton IB	1	280-315	280110	1.0E-04 to 1.0E-03	1.0E-04 to 1.0E-03	128±?
DB-15							
*	Rattlesnake Ridge IB	0	46-68	51-68	5.1E-04 to	3.0E-05	125±? SD-BWI-TI-130
*	Selah IB	0	113-129	122-129	8.2E-06	1.2E-06	124±? SD-BWI-TI-131
*	Cold Creek IB	0	155-188	15864	1.8E-03	6.3E-05	124±? SD-BWI-TI-142
*	Asotin/ Umitilla FT	1	208-208	203-208	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	124±?
*	Umitilla FT	1	207-230	210-230	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	124±?
*	Mabton IB	1	230-257	230-257	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	124±?
*	Priest Rapids FT	1	262-295	280-291	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	125±?
*	Roza FT	1	319-337	323-337	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	125±?
*	Roza C/E	1	338-350	338-350	1.0E-11 to 1.0E-10	1.0E-12 to 1.0E-11	NA.
*	Squaw Creek IB	1	377-393	383-393	NA	NA	125±?
*	Frenchman Springs FT	1	396-409	399-409	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	124±?
*	Frenchman Springs FT	1	412-418	414-418	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	125±?
*	Frenchman Springs FT	1	425-440	431-440	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	125±?
*	Frenchman Springs FT	1	442-466	445-466	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	125±?

* Information new to DP-51 Rev. 2

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
<u>DB-15 cont</u>							
*	Frenchman Springs FT	1	479-513	481-484	1.0E-04 to 1.0E-03	1.0E-04 to 1.0E-03	125±?
*	Frenchman Springs FT	1	524-549	532-535	1.0E-08 to 1.0E-07	1.0E-09 to 1.0E-08	124±?
*	Frenchman Springs FT	1	549-589	568-574	1.0E-09 to 1.0E-08	1.0E-10 to 1.0E-09	123±?
	Vantage IB	1	589-601	597-601	1.0E-12 to 1.0E-10	1.0E-13 to 1.0E-11	NA
<u>RRL-2A</u>							
*	Mabton IB	1	416-471	426-442	1.0E-08 to 1.0E-07	1.0E-10 to 1.0E-09	127±?
*	Priest Rapids FT	1	480-522	515-522	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	122±?
*	Roza FT	1	529-540	533-536	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	123±?
*	Upper Frenchman Springs FTS	1	581-677	586-593 641-644 676-677	1.0E-03 to 1.0E-02	1.0E-04 to 1.0E-03	123±?
*	Lower Frenchman Springs FTS	1	684-806	692-699 725-735 759-763 796-800	1.0E-03 to 1.0E-02	1.0E-05 to 1.0E-04	122±?
	Vantage IB	1	812-827	814-820	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	122±.6
*	Grande Ronde FT	1	829-888	829-841 860-866	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	121±?
	Rocky Coulee C/E	1	894-909	894-909	1.0E-11 to 1.0E-10	1.0E-13 to 1.0E-12	NA
	Cohassett FT	0	909-920	912-918	4.5E-08	7.7E-09	121.8±0.1 SD-BWI-TI-102
	Cohassett C/E (vesicular zone)	0	932-967	940-945	2.8E-10	5.6E-11	NA SD-BWI-TI-090

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
RRL-2A cont							
	Cohassett C/E	0	968-989	968-989	4.7E-12	2.2E-13	NA SD-BWI-TI-109
	Cohassett FB	0	990-1019	992-1016	8.2E-04	3.5E-05	123.5±0.5 SD-BWI-TI-095
*	Grande Ronde FT	1	1027-1055	1031-1035 1040-1047	1.0E-10 to 1.0E-09	1.0E-12 to 1.0E-11	NA
	McCoy Canyon FT	1	1056-1074	1059-1065	1.0E-10 to 1.0E-09	1.0E-11 to 1.0E-10	NA
	McCoy Canyon E	1	1088-1095	1088-1095	1.0E-11 to 1.0E-10	1.0E-13 to 1.0E-12	NA
	Umtanum Composite FTS	0	1088-1152	1096-1144	5.1E-04	1.1E-05	123.7±0.1 SD-BWI-TI-105
*	Umtanum FT	1	1135-1152	1140-1143	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	124±?
	Umtanum E	0	1147-1160	1147-1160	1.7E-11	1.3E-12	NA SD-BWI-TI-107
	Umtanum E (fracture zone)	0	1152-1166	1164-1166	9.4E-04	5.3E-04	NA SD-BWI-TI-089
	Umtanum FB	1	1170-1185	1170-1178	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	124±0.5
RRL-2B/A							
*	Rocky Coulee FT	0	846-871	860-866	7.0E-06	1.4E-06	NA SD-BWI-TI-329
RRL-2B/C							
*	Rocky Coulee FT	0	846-871	85822542	1.6E-06	2.8E-07	NA SD-BWI-TI-329
RRL-2C							
*	Rocky Coulee C/E	1	882-889	882-889	1.0E-10 to 1.1E-09	1.0E-12 to 3.5E-11	NA SD-BWI-TI-329

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
<u>RRL-2C cont</u>							
*	Cohassett FT	1	903-912	909-914	1.0E-10 to 1.1E-09	1.0E-12 to 3.5E-11	NA SD-BWI-TI-329
*	Cohassett C	1	959-966	959-966	1.0E-10 to 1.1E-09	1.0E-12 3.5E-11	NA SD-BWI-TI-329
*	Birkett FT	0	846-1038	985-997	1.0E-04 to 1.1E-03	1.0E-06 to 3.5E-05	NA SD-BWI-TI-329
*	Birkett C/E	1	1010-1017	1010-1017	1.0E-10 to 1.1E-09	1.0E-12 3.5E-11	NA SD-BWI-TI-329
<u>RRL-6</u>							
*	Frenchman Springs T3	1	641-653	647-651 654-655	1.0E-11 to 1.0E-10	1.0E-12 to 1.0E-11	NA
	Cohassett FT	1	940-951	943-948	1.0E-11 to 1.0E-10	1.0E-12 to 1.0E-11	NA
	Cohassett C/E	1	954-1016	954-1016	1.0E-14 to 1.0E-11	1.0E-16 to 1.0E-13	NA
	Birkett FT	1	1015-1041	1019-1039	1.0E-08 to 1.0E-07	1.0E-10 to 1.0E-09	NA
	McCoy Canyon C/E	1	1104-1126	1104-1125	1.0E-13 to 1.0E-10	1.0E-15 to 1.0E-12	NA
	Umtanum FT	1	1130-1165	3 2183247	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	NA
	Umtanum C/E	1	1166-1200	1166-1200	1.0E-12 to 1.0E-11	1.0E-14 to 1.0E-13	NA
	Grande Ronde 11 FT	1	1201-1231	1203-1206 1219-1221	1.0E-09 to 1.0E-08	1.0E-08 to 1.0E-07	NA
<u>RRL-14</u>							
	Cohassett FT	1	938-959	939-946 948-950	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	124±1.5

* Information new to DP-51 Rev. 2

Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
<u>RRL-14 cont</u>							
	Cohassett C/E	1	957-1010	957-1010	1.0E-12 to 1.0E-11	1.0E-14 to 1.0E-13	NA
	Birkett FT	1	1004-1037	1012-1036	1.0E-07 to 1.0E-04	1.0E-09 to 1.0E-06	125±1.5
	Umtanum FT	1	1132-1163	1135-1156	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	123±1.5
	Umtanum C/E	1	1164-1190	1164-1190	1.0E-13 to 1.0E-12	1.0E-15 to 1.0E-14	NA
	Very High Mg Flow FT	1	1181-1205	1194-1139	1.0E-08 to 1.0E-07	1.0E-10 to 1.0E-09	NA
<u>McGee</u>							
*	Rosalia FT	1	247-251	NA	1.0E-02 to 1.0E-01	NA	NA
*	Upper Roza FT	1	282-285	NA	1.0E-02 to 1.0E-01	NA	NA
*	Lower Roza FT	1	313-334	326-333	>1.0E-03	>1.0E-05	279±?
*	Sentinel Gap FT	1	335-356	339-350	>1.0E-03	>1.0E-05	277±?
*	Sand Hollow II FT	1	402-420	406-416	>1.0E-03	>1.0E-05	278±?
*	Sand Hollow I FT	1	428-439	429-433	>1.0E-03	>1.0E-04	278±?
*	Silver Falls FT	1	440-452	443-450	>1.0E-03	>1.0E-05	278±?
*	Ginkgo II FT	1	482-512	487-495	>1.0E-03	>1.0E-05	278±?
*	Ginkgo I FT	1	510-533	517-524	>1.0E-03	>1.0E-04	279±?
*	Frenchman Springs FTS	1	538-562	555-560	1.0E-06 to 1.0E-05	1.0E-07 to 1.0E-06	280±?
*	Vantage IB	1	563-575	567-570	1.0E-08 to 1.0E-07	1.0E-09 to 1.0E-08	282±1.5

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
McGee cont							
*	Vantage IB	1	566-592	567-570 581-585	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	187±1.5
*	Grande Ronde II FT	1	593-607	593-597	1.0E-04 to 1.0E-03	1.0E-05 to 1.0E-04	183±?
*	Rocky Coulee FT	1	607-638	607-615	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	183±?
*	Grande Ronde 4 FT	1	649-670	658-662	1.0E-07 to 1.0E-06	1.0E-08 to 1.0E-07	183±?
*	Cohassett FT	1	667-712	670-676 679-681	1.0E-04 to 1.0E-03	1.0E-06 to 1.0E-05	183±?
*	Grande Ronde 6 FT	1	729-769	738-747	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	180±1.5
*	McCoy Canoyn FT	1	799-841	799-802 805-813 815-819	1.0E-06 to 1.0E-05	1.0E-08 to 1.0E-07	183±?
*	Very High Mg Flow FT	1	900-952	922-927 929-936 941-943	1.0E-07 to 1.0E-06	1.0E-09 to 1.0E-08	183±1.5
OBRIAN							
*	Priest Rapids FT	1	183-213	209-212	1.0E-01 to 1.0E+00	1.0E-02 to 1.0E-01	NA
FORD							
*	Priest Rapids FT	1	228-237	226716	1.0E-02 to 1.0E-01	1.0E-03 to 1.0E-02	NA
ENYEART							
*	Priest Rapids FT	1	293-333	326-332	1.0E-02 to 1.0E-01	1.0E-03 to 1.0E-02	NA
699-52-48							
*	Rattlesnake Ridge IB	8	44-59	44-59	1.0E-05	1.0E-06	NA RHO-ST-38

* Information new to DP-51 Rev. 2

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Bore-hole	Strat. Horizon	Use Code	Isolated Interval (m)	Effective Test Interval (m)	Transmissivity (m^2/sec)	Equivalent Hydraulic Conductivity (m/sec)	Observed Hydraulic Head (m) MSL
669-53-50							
*	Rattlesnake Ridge IB	0	45-59	45-59	1.0E-04	1.0E-05	NA RHO-ST-38
669-51-46							
*	Rattlesnake Ridge IB	0	37-50	37-50	1.0E-05	1.0E-06	NA RHO-ST-38
669-52-46							
*	Rattlesnake Ridge IB	0	50-69	50-69	1.0E-04	1.0E-06	NA RHO-ST-38
669-50-45							
*	Rattlesnake Ridge IB	0	41-54	41-54	1.0E-04	1.0E-05	NA RHO-ST-38
669-50-48							
*	Rattlesnake Ridge IB	0	65-76	65215	1.0E-04	1.0E-05	NA RHO-ST-38
669-47-50							
*	Rattlesnake Ridge IB	0	79-90	79229	1.0E-04	1.0E-05	NA RHO-ST-38
699-S11-E12A							
*	Levy IB	0	69-86	73-81	1.0E-05	1.0E-06	NA RHO-BWI-LD-27
BH-16							
*	Selah IB	1	250-282	265-280	1.0E-05 to 1.0E-04	1.0E-06 to 1.0E-05	NA
BH-17							
*	Asotin FT	1	312-334	314-318	1.0E-07 to 1.0E-06	1.0E-08 to 1.0E-07	NA

* Information new to DP-51 Rev. 2

TECHNICAL MEMORANDUM

From: Fred Marinelli

To: Adrian Brown
Mike Galloway

December 20, 1985

Re: Time-Lag in Flow Interior Piezometers

INTRODUCTION

As discussed in the BWIP document entitled, "Test Plan for Multiple-Well Hydraulic Testing of Selected Hydrogeologic Units at the RRL-2 Site ....", Rockwell Hanford Operations (RHO) plans to conduct ratio tests (Neuman and Witherspoon, 1972) by pumping from a basalt flow top and measuring associated hydraulic responses within the flow top and also in adjacent flow interiors. An important aspect of ratio tests is to accurately measure the aquitard (flow interior) response using piezometers. It is well known that piezometers can experience time-lag when completed in low permeability materials. To reduce time-lag, RHO plans to use closed piezometer systems in which the riser pipe is sealed by a pneumatic packer and hydraulic responses are measured using a downhole electrical pressure transducer. While this design would be acceptable in most geologic situations, the extremely low permeability of dense basalt might still result in time-lag effects that could potentially affect ratio test monitoring.

The effects of time-lag are a major concern in interpreting ratio test data. Test analysis, as presented in Neuman and Witherspoon (1972), is highly sensitive to the time at which the initial aquitard response first arrives at the piezometer. If piezometer time-lag results in an overestimation of the actual response time, calculated hydraulic diffusivity will be less than that actually existing within the aquitard. For performance modeling at the BWIP site, underestimates in the diffusity of dense basalt will result in underestimates of vertical hydraulic conductivity, leading to nonconservative performance assessment calculations.

APPROACH

For calculations performed herein, it is assumed that the time required for recovery of a pulse test is comparable to the time-lag of the installation. In a pulse test, an instantaneous pressure differential is induced between the piezometer and the formation. Re-equilibriation of hydraulic head inside the piezometer is related to the time required for the pressure perturbation to dissipate into the formation. These conditions are mathematically analogous to a situation where an instantaneous pressure change occurs within the formation adjacent to the piezometer. Thus, equations describing pulse test recovery are directly applicable to piezometer response due to a change in formation pressure.

Hydraulic drawdown in a piezometer, experienced after an instantaneous decrease in formation pressure, is given by the following equation (adapted from Bredehoeft and Papadopulos, 1980):

$$s/so = F(a,B) \tag{1}$$

where:

$$a = \frac{PI\ rs^2\ Ss\ L}{Cb} \tag{2}$$

$$B = \frac{PI\ K\ L\ t}{Cb} \tag{3}$$

s = piezometer drawdown [L]
so = initial formation drawdown [L]
F = dimensionless drawdown function [ ]
PI = 3.14159
rs = borehole radius [L]
Ss = specific storage [1/L]
L = piezometer length [L]
Cb = wellbore compressibility [L^2]
K = horizontal hydraulic conductivity [L/T]
t = recovery time [T]

Wellbore compressibility (Cb) is defined as the volume of fluid added to the wellbore per unit increase in hydraulic head. For an open piezometer, Cb is equal to cross-sectional area of the riser pipe. In a closed system, wellbore compressibity is related to the compressibility of borehole fluids and the compliance of downhole equipment (such as expandible packers). For an ideal closed piezometer, a minimum value of Cb is obtained by assuming that wellbore compressibility is related solely to the compressibility of water. In this case:

$$Cb = Yw\ Vw\ Cw \tag{4}$$

where: Yw = specific weight of water [M/L^2/T^2]
Vw = volume of water in piezometer [L^3]
Cw = compressibility of water [LT^2/M]

As discussed by Neuzil (1982), effective wellbore compressibility of real piezometer installations is generally higher than what can be attributed solely to water compressibity. Based on studies reported by Neuzil (1982) and Marinelli and Rowe (1985), it is reasonable to assume that effective Cb is a factor of 2 to 10 times higher that given by the above equation. The actual factor depends on characteristics of the piezometer installation and the borehole fluids.

According to the solution given above, an infinite time is required to achieve complete recovery. For practical purposes, however, it can be assumed that piezometer time-lag is approximately equal to the time required for 90 percent recovery. This corresponds to:

$$s/so = F(a,B90) = 0.1$$

Values of a and B corresponding to a dimensionless drawdown of 0.1 were obtained by linear interpolation from tables provided in Cooper et al (1967), Papadopulos et al (1973), and Bredehoeft and Papadopulos (1980). These values (B90 vs. log[a]) are plotted in Figure 1. Linear regression of the data results in the following empirical relationship:

$$B90 = -1.57 \log(a) + 2.06 \qquad (5)$$

Given the value of a, B90 can be calculated. Time required for 90 percent recovery is then determined using the following equation:

$$t90 = \frac{B90\ Cb}{PI\ K\ L} \qquad (6)$$

where: t90 = time at 90 percent recovery [T]

APPLICATION TO THE ROCKY COULEE FLOW INTERIOR

Estimates of time-lag for the Rocky Coulee Flow Interior piezometer at RRL-2C were made using the equations given above. These calculations were based on the following parameter values obtained either from the RRL-2 test plan or other relevant technical literature:

rs = .156 m
Ss = 3.6 E-07 1/m
L = 7.01 m
Yw = 1000 N/m^3
Cw = 4.28 E-09 m^2/N

The following range of horizontal hydraulic conductivities were considered, corresponding to RHO's "best guess" value for the Rocky Coulee Flow Interior plus or minus one order of magnitude:

Kh = 3.0 E-08 m/d (lower bound)
= 3.0 E-07 m/d (RHO "best guess")

= 3.0 E-06 m/d (upper bound)

To obtain minimum (least conservative) values of piezometer time-lag, wellbore compressibility was calculated based on the compressibility of water. The volume of water inside the closed piezometer was calculated to be 0.148 m^3. This corresponds to the pore volume of a sand pack with 30% porosity and the internal volume of a 23 meter length of riser pipe, but excludes the volume taken up by other riser pipes within the monitoring installation. Using equation (4), the minimum value of wellbore compressibity was calculated to be:

Cb(min) = 6.30 E-07 m^2

and by equation (2), the corresponding value of a was:

a = .306

Using the empirical relationship in equation (5), B90 was estimated to be:

B90 = 2.87

Finally, based on an assumed value of horizontal hydraulic conductivity, the time required for 90 percent recovery (assumed equal to time-lag) was computed using equation (6). Figure 2 shows predicted piezometer time-lags, corresponding to a wellbore compressibility of 6.30 E-07 m^2, for the range of horizontal hydraulic conductivity considered.

As previously disscussed, wellbore compressibility based solely on the properties of water tends to underestimate the effective compressibility of the piezometer installation, leading to underestimates of time-lag. To perform more realistic time-lag calculations, wellbore compressibility was increased to 1.9 E-06 m^2. This is a factor of about 3 times greater than the value used in previous calcluations. Using the procedure previously described, B90 was estimated to be 3.62, and predicted time-lags were calculated by equation (6). Figure 2 shows calculated time-lag for the hydraulic conductivity range of interest. We feel these values are more realistic than those asciated with the lower value of wellbore compressibility. As shown in Figure 2, a time lag of one day is estimated for RHO's "best guess" horizontal hydraulic conductivity of 3.0 E-07 m/d. However, if the actual horizontal hydraulic conductivity of dense basalt were as low as 3.0 E-08 m/d, the predicted time-lag could approach 10 days. For an upper-bound horizontal hydraulic conductivity of 3.0 E-06 m/d, the time-lag is 0.1 day.

Pre-analyses conducted by RHO predict initial ratio test responses in the Rocky Coulee Flow Interior ranging from 2 to 50 days (NRC-DOE, 1985), and our analyses suggest that piezometer time-lag could range from 0.1 to 10 days. Thus, considering the range of conditions potentialy existing at the RRL-2 site, piezometer time-lag may or may not be significant factor in interpreting and anlayzing ratio test data. In cases where time-lag is significant, standard ratio test analyses may lead underestimates in vertical hydralulic conductivity, which are nonconservative from the standpoint of performance modeling.

FIELD MEASUREMENT OF TIME-LAG

Since time-lag can be thought of as the time required for recovery of a pulse test, actual field measurement of time-lag for a piezometer installation can be accomplished by performing a standard pulse test and directly measuring (or extrapolating) the time for 90 percent recovery. Piezometers at the RRL-2C site are constructed in such a way that pulse tests can be easily performed. A possible procedure for conducting pulse tests is as follows:

1. Install pressure transducer and pneumatic packer (within the riser pipe) just above the monitored interval.

2. Expand packer and monitor pressure until static conditions prevail or a background trend is well estabilihed.

3. Add a volume of water to the riser pipe, creating a hydraulic head differential between the piezometer and the column of water above the packer. The exact height of water column can be measured by steel tape.

4. Momentarily deflate and inflate the packer to create an instantaneous pressure change within the piezometer.

5. Monitior pressure within the piezometer installation and measure (or extrapolate) the time required for 90 percent recovery.

DISCUSSION

After a ratio test is performed, the time of the initial response in the piezometer can be compared to the measured or computed time-lag of the installation. If the facility time-lag is sufficiently less than the initial response time, it can be concluded that time-lag effects need not be considered in interpreting and analyzing ratio test data. If, however, time-lag is comparable to the initial response time, corrections to the data may be required in order to predict the true aquitard response. In extreme cases, piezometer response may be dominated by time-lag effects. This might occur in situations where vertical hydraulic conductivity is relatively high, but the associated (rapid) aquitard response can not be measured due to time-lag effects. In this case, it may only be possible to calculate a lower bound value of vertical hydraulic conductivity using the ratio method.

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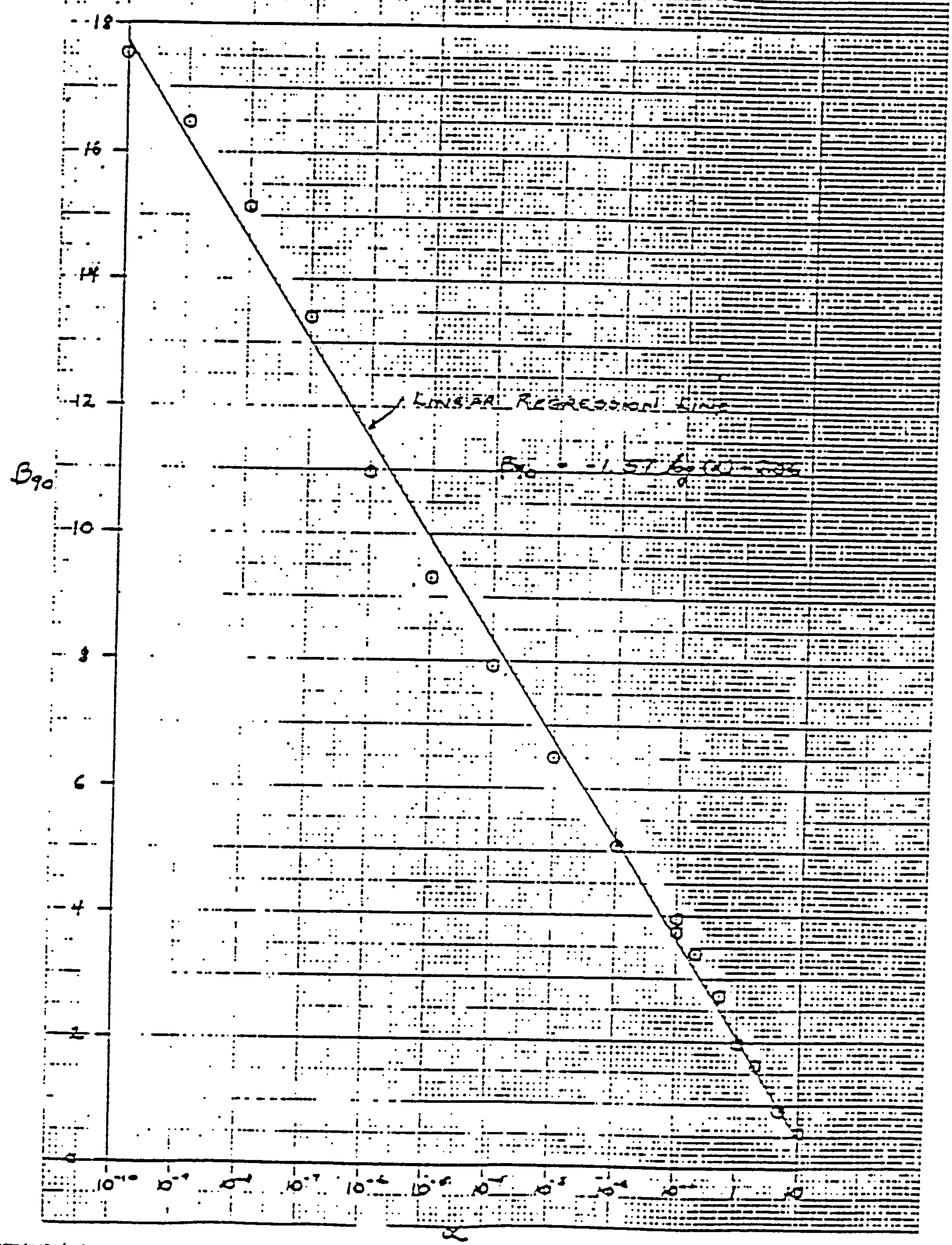
FIGURE 1 RELATIONSHIP BETWEEN β AND α FOR 90 PERCENT RECOVERY



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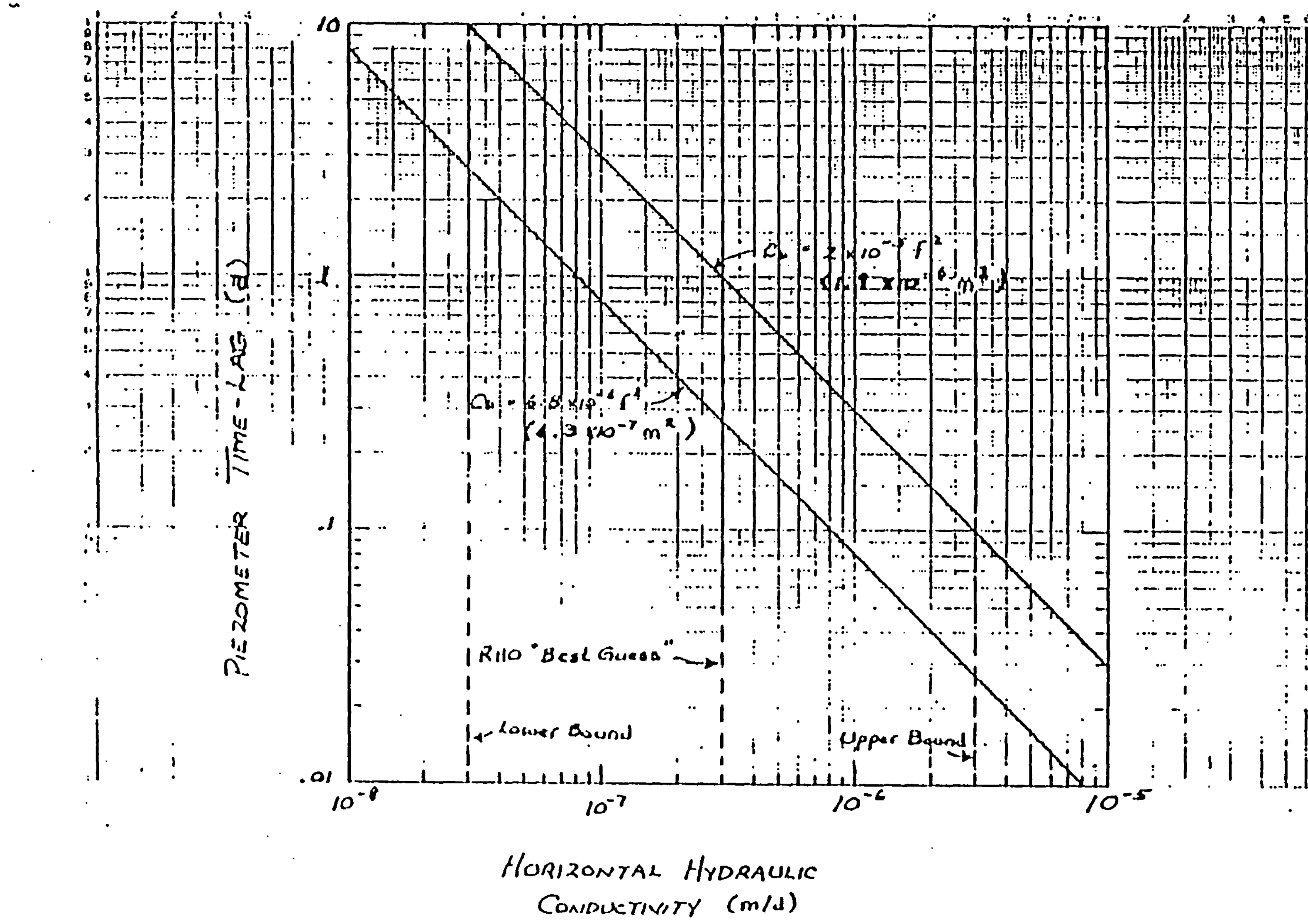

FIGURE 2 PREDICTED TIME-LAG IN ROCKY COULEE
FLOW NEAR PIEZOMETER AT RRL-2C

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BWIP SUPPORTING DOCUMENT				Number: SD- BWI-TP-040	Rev./Chg. No.: 0	Page 1 Of ___ / Total Pages
End Function Activity: Hydrologic Characterization			Project No.:	CIN No.: Date:		
Document Title: Plan for Multiple-Well Hydraulic Testing of Selected Hydrogeologic Units at the RRL-2 Site, Basalt Waste Isolation Project, Reference Repository Location				Baseline Doc.: Yes ☐ No ☒ Class: N/A		
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Borehole No.: RRL-2A, -2B and -2C	Stratigraphic Formations: Grande Ronde	Doc. Type: 2055	Subj. Code: E926	Prepared by (type & sign name): R. Stone, A. H. Lu, P. M. Rogers, R. W. Bryce. See reverse side for additional approvals	Date: 11/85	

Abstract

(NOTE: Please limit the abstract to a total of 300 characters or less).

A comprehensive plan for performing large-scale multiple-well hydraulic tests of units of the Grande Ronde Basalt within and near the Basalt Waste Isolation Project reference repository location on the Hanford Site has been developed. The purposes of the hydraulic testing are to evaluate the hydraulic characteristics of selected interflow zones and adjacent hydrogeologic units, and to characterize the chemical composition of groundwater collected from the interflow zones. Additional objectives of the tests include indentification and classification of hydraulic boundaries, assessment of the degree of leakage into the test interflow zones from adjacent flow interiors, and evaluation of the lateral hydraulic continuity of selected interflow zones. Most of the interflow zones can be tested using conventional pumped constant discharge well tests. One interflow zone and flow interior zones will likely be tested by an alternate method such as pressure pulse or constant head injection techniques because of their small estimated transmissivities. The planned sequence is to test the Rocky Coulee flow top, Cohasset flow top and interior zones, Grande Ronde No. 5 flow top, and Umtanum flow top, in that order. The staged construction of the pumping well will allow each zone to be tested individually. Water samples for field and laboratory analysis will be obtained from the interflow zones prior to, during, and after formal pumping tests of the units. Convergent pump tracer tests will be initiated during the pumping tests after quasi-steady flow has been established.

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Plan for Multiple-Well Hydraulic Testing of Selected Hydrogeologic Units at the RRL-2 Site, Basalt Waste Isolation Project, Reference Repository Location

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Basalt Waste Isolation Project

January 1986

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Rockwell International
Rockwell Hanford Operations
North American Space Operations
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CONTENTS

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EXECUTIVE SUMMARY

This document contains a plan for performing large-scale, multiple-well hydraulic tests of units of the Grande Ronde Basalt, within and near the Basalt Waste Isolation Project reference repository location on the Hanford Site. The purposes of the hydraulic testing are to evaluate the hydraulic characteristics of selected interflow zones and adjacent units, and to characterize the chemical composition of groundwater collected from the interflow zones. Additional objectives of the tests are to identify and classify hydraulic boundaries, to assess the degree of leakage into the test interflow zones from adjacent flow interiors, and to evaluate the lateral hydraulic continuity of selected interflow zones.

The test will be performed using a pumping well located at the RRL-2 site. Two observation wells near the pumping well will be utilized. Several wells and boreholes at greater distance will also be used in the tests. The pumping well will be advanced incrementally through the Grande Ronde Basalt so that each horizon to be tested can be investigated individually and then sealed before proceeding to the next horizon. One of the observation wells near the pumping well will provide the means to measure formation pressure in three flow interiors.

The Cohassett flow is the designated repository horizon, therefore knowledge of its hydraulic characteristics and those of adjacent and subjacent units is necessary for site characterization and repository performance assessment. With the likely exception of the Cohassett flow top and portions of the Cohassett flow interior that may be tested, the interflow zones of interest (Rocky Coulee, Grande Ronde No. 5, and Umtanum flow tops) can be tested using conventional pumped constant discharge well tests. It is assumed that the Cohassett flow top and Cohassett flow interior zones will be tested by an alternate method such as a pressure pulse or constant head injection technique because of their very small estimated transmissivity.

The planned sequence is to test the four horizons of interest in the pumping well, Rocky Coulee flow top, Cohasset flow top and interior zones, Grande Ronde No. 5 flow top, and Umtanum flow top, in that order. Water samples for field and laboratory analysis will be obtained from the flow tops in connection with pumping tests in the units. Convergent pulse tracer tests will be initiated during the pumping tests after quasi-steady flow has been established and after the ratio test is complete. Different tracers will be injected at the two observation wells to faciliate identification of the source of pulses that arrive at the pumping well.

The first test, of the Rocky Coulee flow top, will be performed by discharging groundwater from the flow top at a constant rate from a pumping well designated RRL-2B which is centrally located in the reference

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repository location on the Hanford Site. Water level and/or pressure measurements in the tested unit, adjacent flow interiors, and adjacent flow tops will be performed before, duing and after pumping. Nine observation wells and boreholes will be used during the Rocky Coulee test. These wells and boreholes are disposed about the pumping well at distances of from 76 m (250 ft) to 7,080 m (23,200 ft).

The Rocky Coulee flow top test was designed using estimates of transmissivity from single-well tests. A pumped discharge rate of 43.6 m^3/day (8 gpm) was selected based on numerical simulations which assumed homogeneous, isotropic aquifer conditions. A transmissivity value for the Rocky Coulee flow top equal to the geometric mean of transmissivity values obtained from single-well test analyses, was used in the simulations. The simulations predict about 263 m (863 ft) of drawdown at the pumped well after 50 days of pumping. Somewhat more than 0.6 m (2 ft) of drawdown in the Rocky Coulee flow top at 2,500 m (8,200 ft) from the pumping well is predicted for the same time after the onset of pumping. This amount of drawdown is judged to be measurable and interpretable.

A convergent pulse tracer test in the Rocky Coulee flow top will be initiated during the pumping test after quasi-steady flow has been established and after the ratio test is complete. Conservative tracer solutions of ammonium thiocyanate and lithium bromide will be injected into observation wells located at 76 m (250 ft) and 152 m (500 ft), respectively, from the pumping well. Mean tracer transit times from injection to arrival at the pumping well are expected to be about 1.3 and 5 days, respectively. Estimates of flow top effectively porosity and dispersivity will be derived, based on the measured tracer transit times and tracer breakthrough curve characteristics.

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INTRODUCTION

This report presents a plan for performing large-scale, multiple-well hydraulic tests of units of the Grande Ronde Basalt within and near the Basalt Waste Isolation Project (BWIP) reference repository location (RRL) on the Hanford Site. The tests will be performed using a pumping well located at the RRL-2 site (Figure 1). Testing will be achieved by withdrawing water from (or injecting water into) selected basalt interflow zones (commonly referred to as flow tops or flow bottoms) in the pumping well, or by applying pressure pulses to selected interflow zones. The changes in water level and/or pressure in the interflow zones and flow interiors that result from these actions will be measured at several locations in and near the RRL. The measured changes in water level and pressure will be used to calculate estimates of the hydraulic conductivity and storativity of the interflow zones and flow interiors and will assist in identifying hydraulic boundaries that may exist in and near the RRL.

While withdrawing water from the selected interflow zones in the pumping well, samples of the groundwater will be obtained to characterize its chemical composition. Also, tracers will be injected into selected interflow zones in observation wells and retrieved by pumping from the pumping well for the purpose of obtaining dispersion and travel time data that will be the basis for estimation of the effective porosity and dispersivity of the interflow zones.

The purposes of the hydraulic testing at the RRL-2 site are to evaluate the hydraulic characteristics of the selected interflow zones and adjacent hydrogeologic units, and to characterize the chemical composition of groundwater collected from the interflow zones. Estimates of the values of the hydraulic characteristics of interflow zones and flow interiors are needed to supplement and check information already available and to help form the basis for repository performance assessment. Characterization of the chemical composition of water from the Grande Ronde Basalt is a step toward understanding the origin and history of the water, and its pattern of flow.

OBJECTIVES OF THE TESTS

Several general objectives of the large-scale hydraulic testing at the RRL-2 site have been identified. These include:

- The facilitation of design of additional large-scale hydraulic tests of hydrogeologic units at other locations on the Hanford Site.

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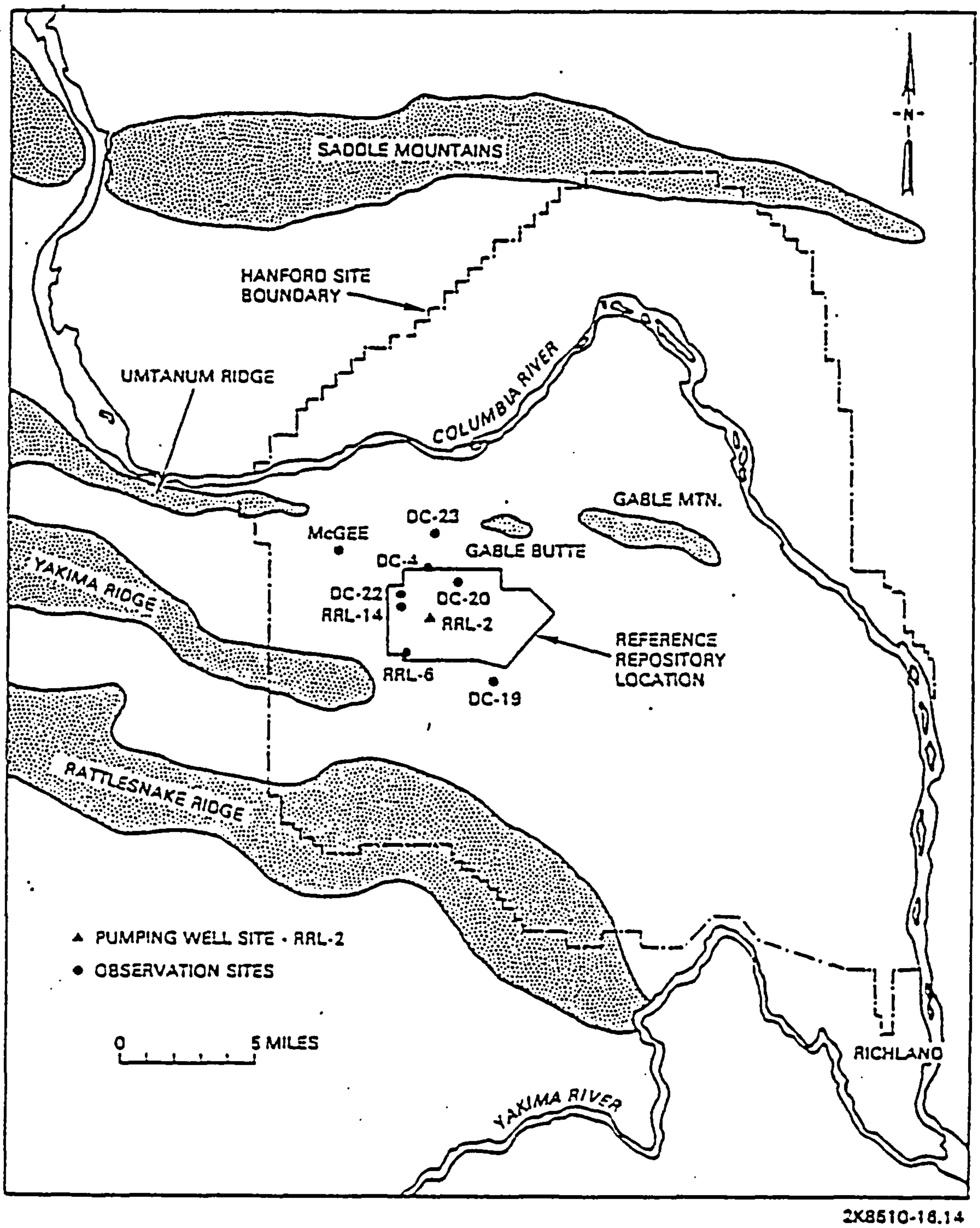

FIGURE 1. Location of RRL-2 site and principal observation sites for hydraulic testing of Grande Ronde Basalt units.

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- Identification and classification of hydraulic boundaries. (These boundaries may later be correlated with rock inhomogeneities and structures that influence groundwater flow in the RRL.)

- Characterization of the nature of dissolved substances in groundwater removed from selected Grande Ronde Basalt flow tops at the RRL-2 site.

- Assessment of the areal representativeness of hydraulic characteristic values obtained by previous single-well testing.

- Assessment of the degree of leakage into the test interflow zones from adjacent flow interiors.

- Evaluation of the lateral hydraulic continuity of selected interflow zones in the Grande Ronde Basalt in the RRL.

Specific requirements for evaluation of hydraulic characteristics of units of the Grande Ronde Basalt lead to a series of specific test objectives for the hydraulic testing at the RRL-2 site. These test objectives include:

1. Evaluation of lateral hydraulic conductivity, storativity, effective porosity, and longitudinal dispersivity of interflow zones.

2. Evaluation of vertical hydraulic conductivity of flow interiors using parameter variation and analytical techniques.

Details of how the test objectives will be fulfilled by the planned testing program at the RRL-2 site are found in the section on the test description. A synopsis of the methods to be used in fulfulling the general test objectives is presented here: 1) Identification of hydraulic boundaries will depend largely on the analysis of drawdown and recovery hydrographs and the recognition of hydrograph shapes diagnostic of a variety of possible hydraulic boundaries. 2) Water samples will be collected from the water pumped from the pumping well (well RRL-2B). These samples will be analyzed to provide a characterization of their dissolved chemical and gas content. 3) The hydraulic characteristic values estimated from the results of pumping from well RRL-2B will be compared with single and mean values of the same hydraulic characteristics as determined in single-well tests to provide an assessment concerning the representativeness of the latter. 4) The degree of leakage into the interflow zones of the Grande Ronde Basalt will be qualitativity assessed by inspection of drawdown hydrographs. Departure of drawdown records from the theoretical confined aquifer drawdown (as in the case of a leaky aquifer) may be quite obvious and easy to recognize. 5) Hydraulic continuity of flow tops can be evaluated by observing water levels in wells other than the pumping well. Where drawdown occurs in an observation well in a particular unit that is being pumped, it can be inferred that some hydraulic connection exists between the pumped well and the observation well, in the pumped unit. 6) The specific test objectives will be fulfilled by fitting various flow models to the observed pressure and water level responses to pumping from or injecting into well RRL-2B and to the history of recovery of tracers from pumping well RRL-2B. The model comparisons with observed response will provide estimates of the values of lateral hydraulic conductivity, storativity, longitudinal dispersivity, and effective porosity of the interflow zones as well as estimates of the vertical hydraulic conductivity of flow interiors.

SCOPE AND RELATIONSHIP OF TESTS TO THE BASALT WASTE ISOLATION PROJECT TEST PROGRAM

The large-scale hydraulic tests planned in this document are designed to cause water level and pressure changes in selected interflow zones that can be measured as far as several miles away from the pumping well. The primary observation wells at distance from well RRL-2B are piezometer clusters DC-19C, DC-20C, and DC-22C (Figure 1), which are described in the section on facilities. Hydraulic test design has focused on attempting to ensure measurable hydraulic response at piezometer clusters DC-20C and DC-22C. Because of the greater distance from well RRL-2B to piezometer cluster DC-19C, it may be difficult to propagate measurable responses from the pumping well to piezometer cluster DC-19C within a reasonable period of time.

The planned large-scale, multiple-well hydraulic tests of selected hydrogeologic units above and below the Cohassett flow interior (the designated repository horizon) within the RRL are part of the overall strategy for hydraulic testing at the Hanford Site as given in the Interim Site Investigation Program Plan (Rockwell Hanford Operations, 1985). As shown in Figure 2, these tests are identified in stage 2 of the overall BWIP hydrologic test strategy which is one of the centerpieces of the BWIP site hydrologic characterization effort. Data collection for establishment of background hydraulic head time-series trends at various locations at the site, a major part of stage 1 of the site hydrologic test strategy, is currently in progress.

This plan is prepared only for the large-scale hydraulic testing identified in Stage 2. Implementation of stages 2, 3, and 4 will provide data from several long-term pumping tests using several pumping wells at different locations in and near the RRL. This will facilitate evaluation of hydraulic characteristics of units of interest, and will provide the opportunity to investigate and identify hydraulic boundaries in the groundwater systems that could not otherwise be studied. Testing using several pumping wells, pumped individually in separate tests may also provide insight into the character and mechanism of vertical flow across basalt flow interiors that could not be obtained in a single test.

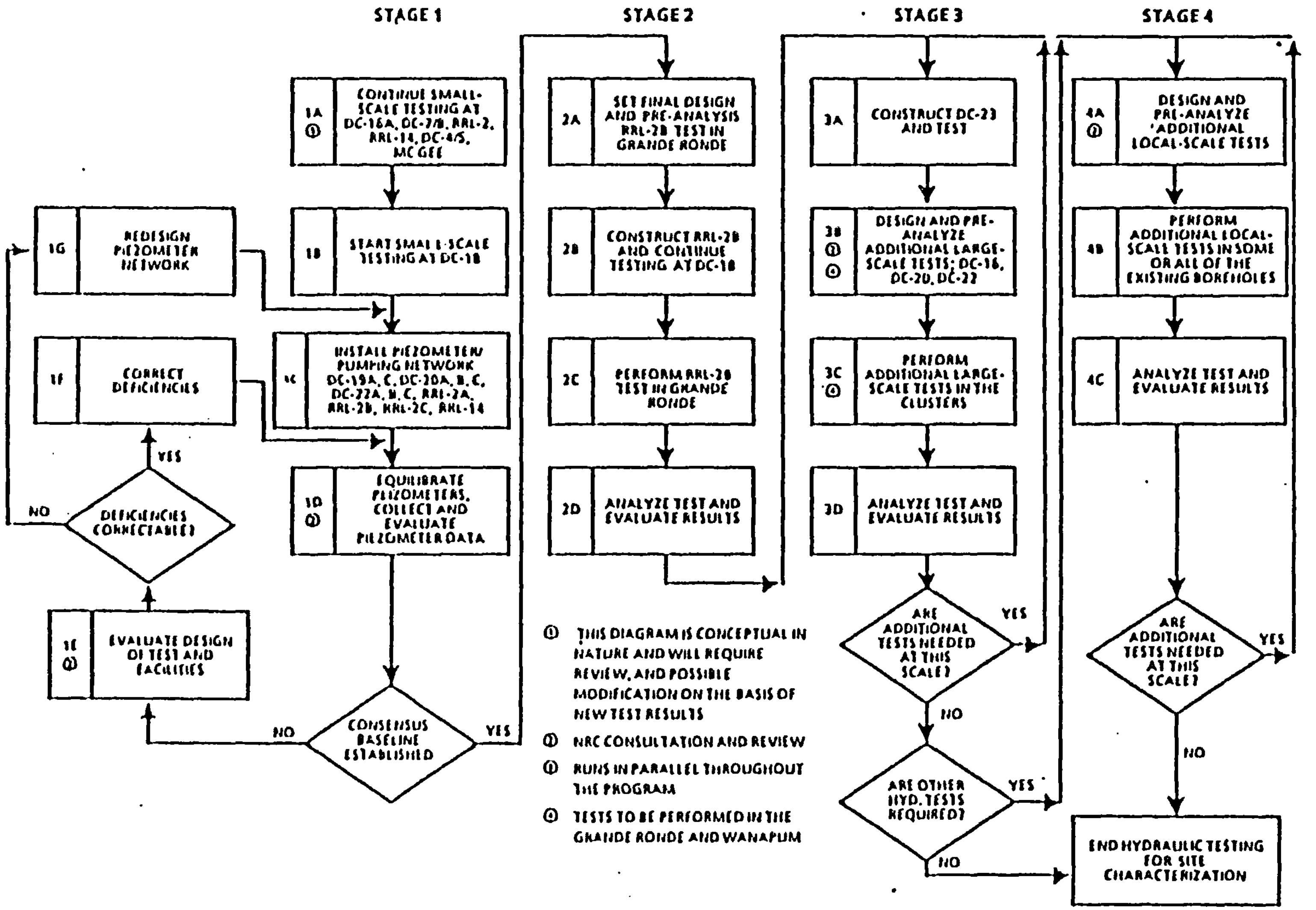

FIGURE 2. Logic diagram for BWIP hydrologic test strategy. (after Nuclear Regulatory Commission, 1983a)

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During the reconnaissance stage of hydrologic investigation at the Hanford Site, most hydraulic tests were performed in single boreholes (Strait and Mercer, 1984). These tests have provided good local estimates of hydraulic conductivity, however, the representativeness of these conductivity values on larger scales has been questioned and remains unknown (Nuclear Regulatory Commission, 1983). The long-term, large-scale, multiple-well hydraulic tests described in this plan represent an advance from the reconnaissance stage of the BWIP hydrologic testing program.

JUSTIFICATION OF NEED FOR TESTS

The information to be obtained from the planned tests is needed, first, to help firmly establish a conceptual model that adequately describes the pattern of groundwater flow in and near the RRL, and second, to provide hydraulic characteristic values that can be used with that model to provide accurate repository performance assessment as required by the Nuclear Regulatory Commission (1983b). Of particular importance is the estimation of hydraulic parameter values that can be used to estimate groundwater flow speed beneath the RRL.

The information to be obtained from the large-scale hydraulic testing at the RRL-2 site (and within the area of influence of the tests) will be useful to help establish boundary conditions to be used in groundwater flow models of the RRL and nearby areas, will provide estimates of hydraulic characteristic values to be used in the models, will provide additional chemical characterization of groundwater which may be useful in postulating patterns of groundwater flow, and will facilitate planning for further large-scale hydraulic testing.

Large-scale, multiple-well hydraulic tests are required to supplement the small-scale information collected previously. Some parameters such as aquifer storativity, porosity, and dispersivity are best estimated from multiple-well tests. Some of the predictive models employed in repository performance assessment and other models used to portray the features of groundwater flow on the scale of the RRL and the Hanford Site deal with the heterogeneous nature of hydrogeologic characteristics. It is important that the characteristic values used in the models be representative of the actual average site conditions on the scale of the models. Large-scale, multiple-well hydraulic tests will help assure that hydraulic parameter values used in performance assessment modeling will meet this requirement.

The designated repository horizon is contained within the Grande Ronde Basalt Formation. Representative hydraulic parameter values of this and adjacent horizons are necessary for repository isolation system performance assessment. Thus, large-scale, multiple-well hydraulic testing of selected hydrogeologic units in the Grande Ronde Basalt Formation is given high priority.

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Well RRL-2B is located within about 150 m (500 ft) of the Exploratory Shaft (ES) site which is fairly centrally located within the RRL. Testing at well RRL-2B would, therefore, provide the opportunity to evaluate hydraulic characteristics of units in the Grande Ronde for the central portion of the RRL and the ES site. The evaluation will be of value in predicting the amount of groundwater inflow to the mined region during construction of the underground test area after ES completion. It may also help detect any geologic structures that could have mine safety significance.

It is important to test units of the Grande Ronde Basalt at the ES site prior to construction of the shafts because of possible alteration of the groundwater regime in the vicinity of the shafts. For example, alteration of the units may occur when the shaft is grouted as a result of grout migration into relatively permeable interflow zones. Another possibility is incomplete sealing of the ES annulus, which might allow interconnection of interflow zones. Also, the observation wells, near the ES, prepared for the multiple-well testing may be monitored during ES construction to assess the hydraulic effects thereof. For these reasons and for those given in the proceeding two paragraphs, stage 2 of the hydrologic test strategy (Figure 2) specifies that the first large-scale hydraulic testing will be at the RRL-2 site and the tested information will be the Grande Ronde Basalt.

DESCRIPTION OF TESTS

SETTING AND FACILITIES

Site Hydrogeologic Description

Geology. The RRL lies within the central portion of the Cold Creek syncline (Figure 3). This syncline is located in the Pasco Basin, one of several structural and topographic basins within a subprovince of the Columbia Plateau termed the Yakima Fold Belt. Within the Pasco Basin were deposited many flows of the Miocene Columbia River Basalt Group (Figure 4). Because of their low viscosity and great volume, the lavas spread considerable distances from their source vents located mainly in the east and southeast portions of the Columbia Plateau.

The Hanford site is underlain by at least 50 basalt flows with a cumulative thickness greater than 3,000 m (9,800 ft) (Reidel et al., 1981). Basalt flows originally identified as candidate repository horizons lie between about 807 and 1,100 m (2,650 and 3,600 ft) below ground surface in the RRL in the Grande Ronde Basalt. The designated repository horizon (Cohasset flow) has an average thickness within the Cold Creek syncline of more than 60 m (200 ft).

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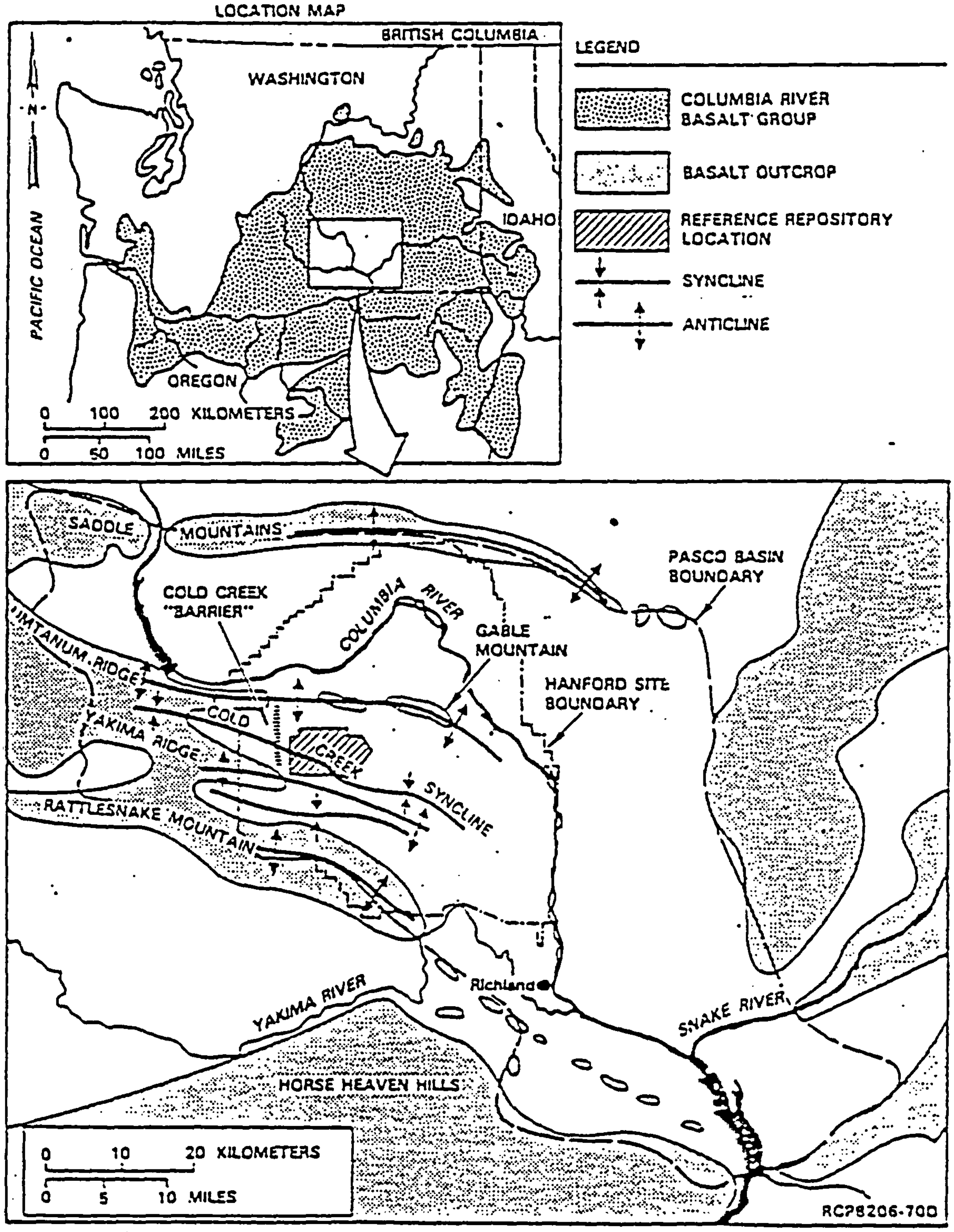

FIGURE 3. Extent of the Columbia River Basalt Group, Pasco Basin, and reference repository location.

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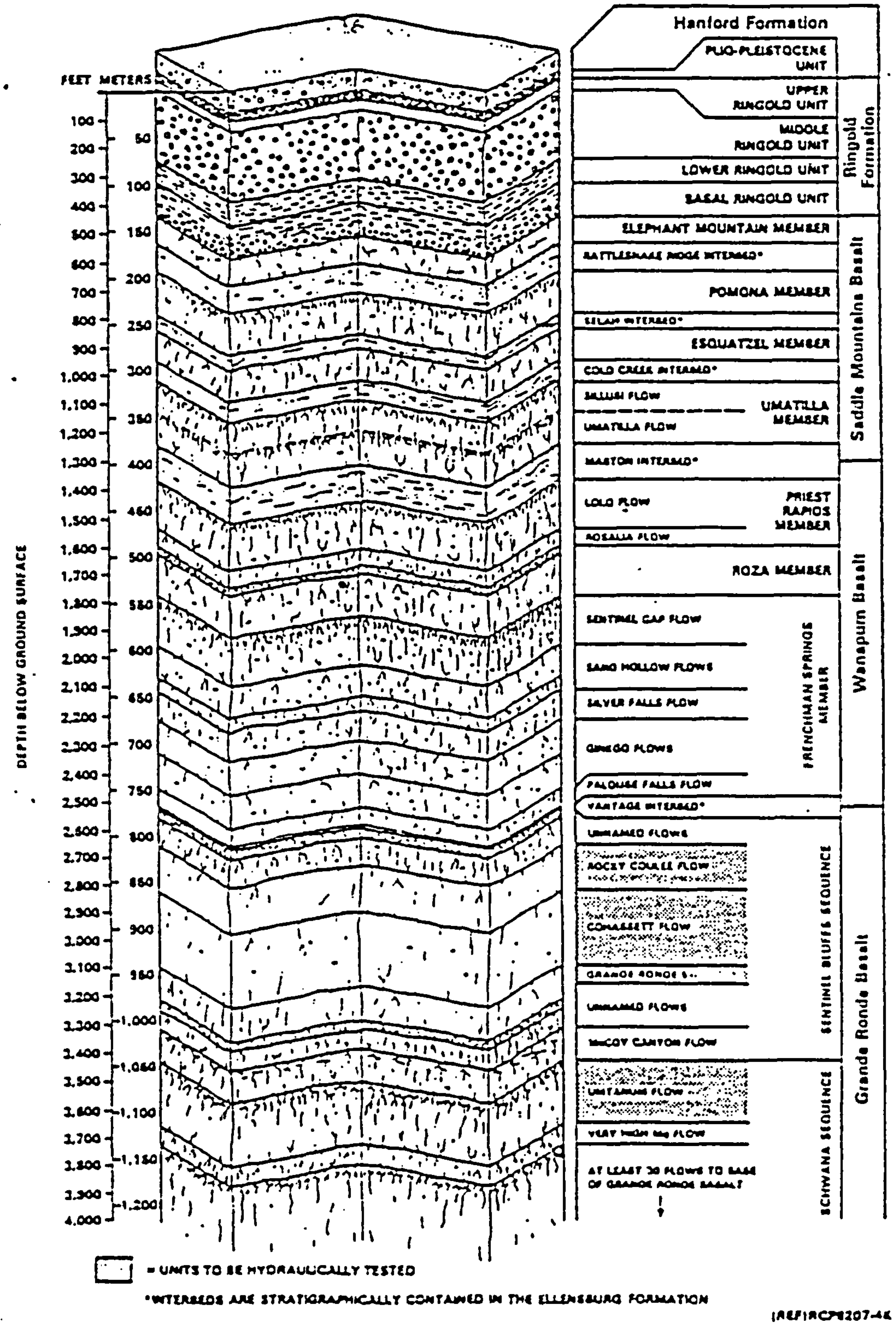

FIGURE 4. Stratigraphy of the Columbia River Basalt Group, from within the Grande Ronde to the surface, and sediments within the RRL.

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The Grande Ronde Basalt within the RRL is overlain by up to 20 flows of the Wanapum and Saddle Mountains Basalts. These two formations have a cumulative thickness of approximately 700 m (2,300 ft) and are interspersed with sediments of the Ellensburg Formation. In the Cold Creek syncline, the Saddle Mountains Basalt is overlain by approximately 200 m (650 ft) of Miocene-Pliocene fluvial and lacustrine sediments of the Ringold Formation and Pleistocene fluvial deposits of the Hanford Formation.

East-west trending anticlinal ridges of the Yakima Fold Belt border the Pasco Basin on the north and south and plunge into the Basin to the east. Many of the faults within the basin are associated with anticlinal folds and likely developed concurrently with folding (Price, 1982).

The Cold Creek syncline lies between the Umtanum Ridge-Gable Mountain anticline on the north and the Yakima Ridge anticline to the south (Figure 3). Beneath the RRL the basalt formations are nearly flat lying.

Individual basalt flows range in thickness from less than a meter to more than 100 m (300 ft). Average basalt flow thickness is between 30 to 40 m (100 to 130 ft) (Swanson and Wright, 1976). The basalt flows generally consist of an upper vesicular and/or brecciated flow top overlying a more dense jointed interior. The flow top typically accounts for about 15-percent of the total flow thickness.

Most fractures within flow interiors are joints created by contraction during original cooling of the flows (Long and Davidson, 1981). Individual fractures in the flow interiors range in length from a few centimeters to several meters. Post-emplacement tectonic fractures may be locally important in flow interiors and could transect several flows.

Well-developed basalt flow interiors consist of entablature and colonnade. The entablature is comprised of variably jointed rock with relatively small [0.2 to 0.9 m (0.7 to 3.0 ft) diameter] columns. Column orientation is commonly subvertical, but ranges from vertical to horizontal. The colonnade consists of relatively well-formed columns [0.5 to 2 m (1.6 to 6.5 ft) diameter] with fewer fractures than the entablature. Columns are normally upright but radiate locally and exhibit a variety of internal features. In some flows, the entablature overlies a single colonnade; in other flows, colonnade and entablature zones may be repeated in the flow interior (Department of Energy, 1982). The basal portion of basalt flows is usually a thin zone of fractured glassy basalt.

Groundwater Hydrology. Groundwater beneath the Hanford Site occurs in a shallow, unconfined aquifer consisting of fluvial and lacustrine sediments lying atop the basalts, and under confined conditions within flow tops and interbeds of the basalt sequence at greater depths.

The unconfined aquifer thickness varies between 0 and 75 m (0 to 250 ft). It is thickest along the eastern edge of the RRL, where 40

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years of local water disposal to surface ponds has raised the water table approximately 25 m (80 ft) (ERDA, 1975). Groundwater recharge to the unconfined aquifer is from both precipitation and intrabasin runoff from surrounding hills, and artificial recharge from water disposal into ponds. Discharge from the unconfined aquifer is to the Columbia River.

The main groundwater occurrence and horizontal movement in basalt formations is within the flow tops and sedimentary interbeds. The basalt flow interiors that separate individual flow tops appear to act as aquitards, with minimal storage capacity, through which some degree of vertical leakage occurs along fractures. The dominant pathways for groundwater movement in the basalt sequence may be:

- o The more permeable contact zones between basalt flows and in sedimentary interbeds.
- o Structural discontinuities such as tectonic fracture zones that may transect the basalt flows.
- o Stratigraphic discontinuities within the Basalt flows.
- o Cooling fractures within the basalt flows that allow distributed vertical flow (leakage) between them.

Local groundwater recharge to the shallow basalt units beneath the Hanford Site likely occurs where flow downward from the unconfined aquifer takes place and also results from precipitation and runoff on the basalt outcrops in the uplands at the margins of the Pasco Basin. Natural recharge to aquifers in the shallow basalt units from the overlying unconfined aquifer has been reported by Spane et al. (1980) and Gephart et al. (1976) to occur on the Hanford Site, where favorable potentiometric conditions and hydraulic communication exist. This is expected to take place, for example, in the Gable Mountain Pond area near the southwest corner of Gable Mountain.

The mechanism(s) of groundwater recharge to the deep basalt units is the subject of current investigation. Groundwater likely discharges from shallow basalt units to the overlying unconfined aquifer and, thence, to the Columbia River, near the river. Hydraulic head gradients directed upward from the shallow basalt units to the unconfined aquifer near the river support this concept (Department of Energy, 1982). The discharge pathways for deeper basalt units is still under investigation.

Wells, Piezometers, and Boreholes

Large-scale hydraulic tests conducted in the Grande Ronde Basalt at the RRL-2 site will utilize one pumping well and two observation wells close to the pumping well. These three wells are shown in plan in Figure 5. The

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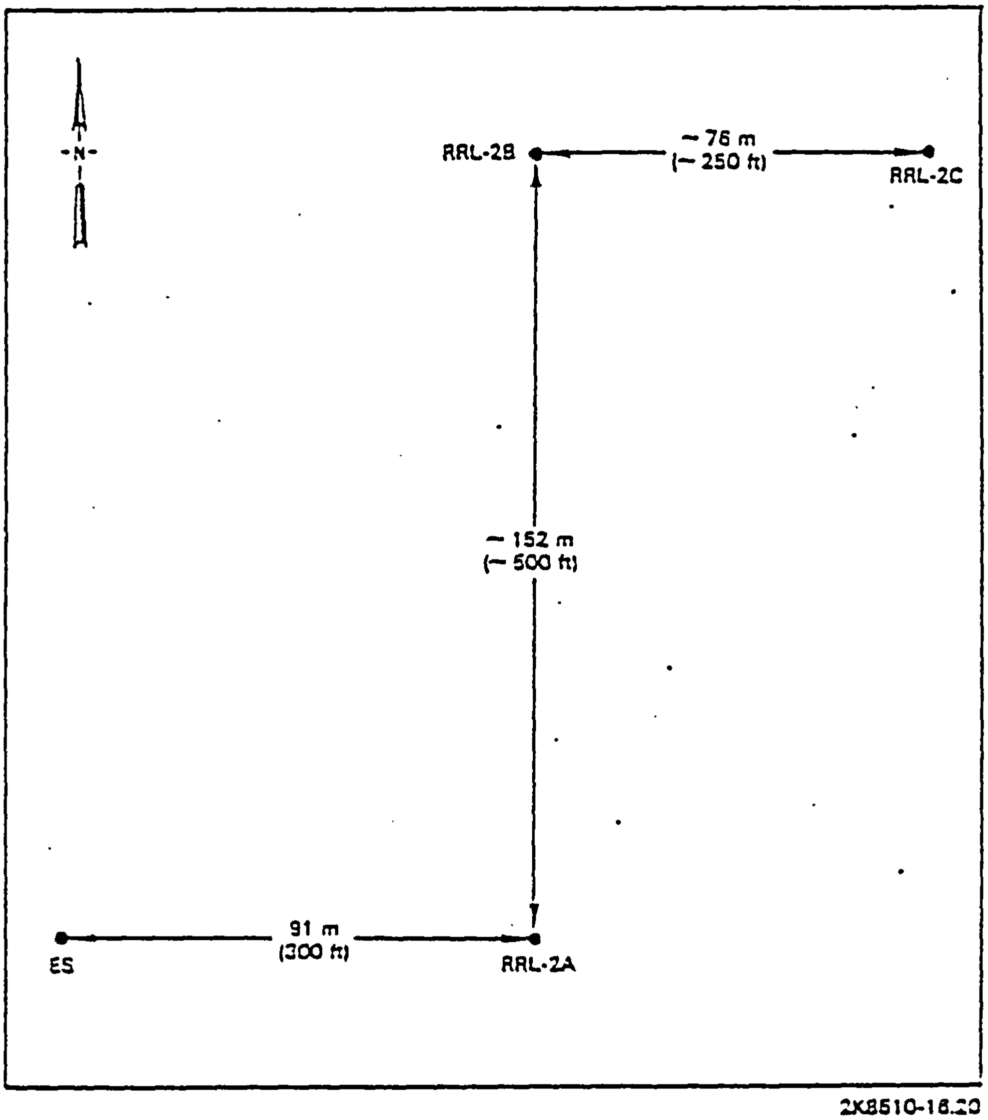

FIGURE 5. Plan view showing the approximate surface location of wells and boreholes at the RRL-2 site.

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facilities at the RRL-2 site consist of the small diameter borehole RRL-2A, the pumping well RRL-2B, and the piezometer nest RRL-2C. Both borehole RRL-2A and well RRL-2C will be used as multiple-level observation wells. Well RRL-2B will be advanced incrementally through the Grande Ronde Basalt so that each horizon to be tested can be investigated individually and then sealed before proceeding to the next horizon.

The other wells, piezometers, and boreholes completed in the Grande Ronde Basalt that will be used as primary observation points during the large-scale pumping tests appear on Figure 1 and include: piezometer clusters DC-19C, DC-20C, and DC-22C, boreholes RRL-6, RRL-14, and DC-4, and the McGee Well. The primary observation boreholes, wells, and piezometers for the Grande Ronde tests are summarized with their distances from the pumping well in Table 1.

Hydraulic head measurements will be made at all other observation points in the Hanford Site groundwater monitoring network (Swanson and Leventhal, 1984) during large-scale testing of the Grande Ronde. The measurements will include head measurements in wells and piezometers completed in the Wanapum and Saddle Mountains Basalt Formations above the Grande Ronde Basalt as well as in the unconfined system.

Well RRL-2B. Pumping well RRL-2B has been drilled and is presently completed in the Rocky Coulee flow top. The well is constructed so that selected hydrogeologic units (Rocky Coulee flow top, Cohassett flow top, Cohassett vesicular zone, Grande Ronde No. 5 flow top, and Umtanum flow top) within the Grande Ronde Basalt can be tested using a drill-test staged approached. (The flow immediately beneath the Cohassett flow in the lower Cold Creek Syncline is the fifth flow below the top of the Grande Ronde Basalt Formation. Hence, it is currently referred to as the Grande Ronde No. 5 flow. At the McGee Well, in the upper Cold Creek Syncline, an additional flow exists above the Cohassett. The flow immediately below the Cohassett flow is referred to as the Grande Ronde No. 6 flow, in that area. The flow beneath the Cohassett flow is correlative throughout the Cold Creek Syncline regardless of its numerical sequence from the top of the Grande Ronde Basalt). This approach allows for hydraulic testing of a horizon prior to deepening the well to test other horizons. Upon completion of hydraulic testing in each horizon, the well will be lined and cemented before drilling to the next test horizon. The lowermost test horizon will not be lined or cemented. A detailed description of the plans for construction of well RRL-2B is given by Jackson and Jones (1984). The general design for well RRL-2B is shown in Figure 6.

A positive displacement (sucker rod) pump, operating within 7.3 cm (2.875 in) tubing anchored in well RRL-2B by a packer, will be used to pump from the Rocky Coulee flow top. The general arrangement of the rod pumping system is shown in Figure 7. The rod pump fits into the seating nipple with a water tight seal. This arrangement eliminates wellbore storage in the pumping well, provides for rapid movement of water to the ground surface in the small (7.3 cm) tubing, and will allow pressure measurements

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TABLE 1. Primary Observation Wells, Piezometers, and Boreholes to be Used in Large-Scale Hydraulic Test of Grande Ronde Units.

Observation Facility	Approximate Distance From Well RRL-2B (m)	(ft)
Piezometer Nest RRL-2C	76	250
Borehole RRL-2A	152	500
Borehole RRL-6	2,250	7,400
Borehole RRL-14	2,250	7,400
Piezometer Nest DC-22C	2,410	7.900
Piezometer Nest DC-20C	2,570	8,450
Borehole DC-4	2,900	9,500
Piezometer Nest DC-19C	5,470	18,000
McGee Well	7,080	23,200

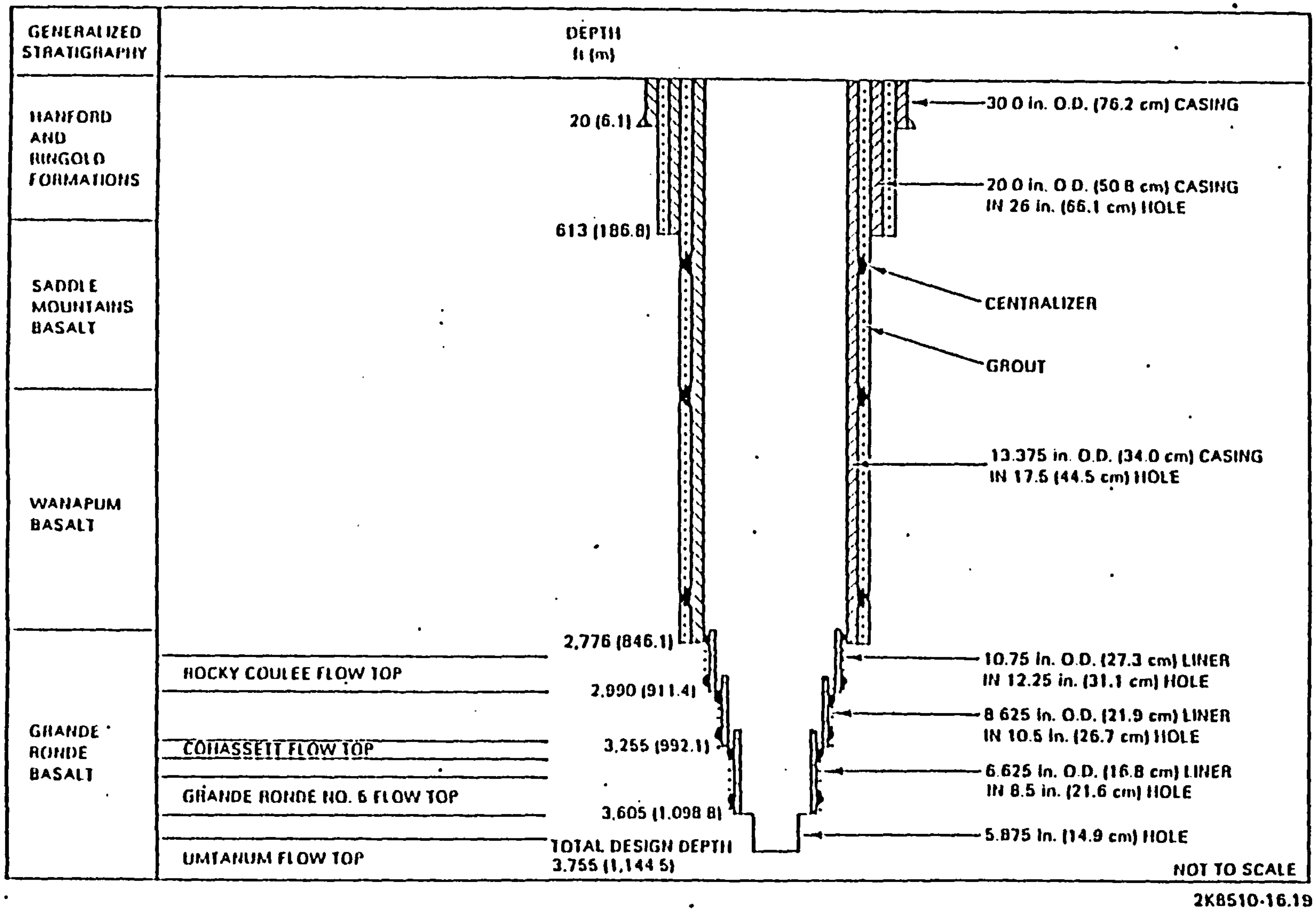

FIGURE 6. Proposed design of well RRL-2 B.

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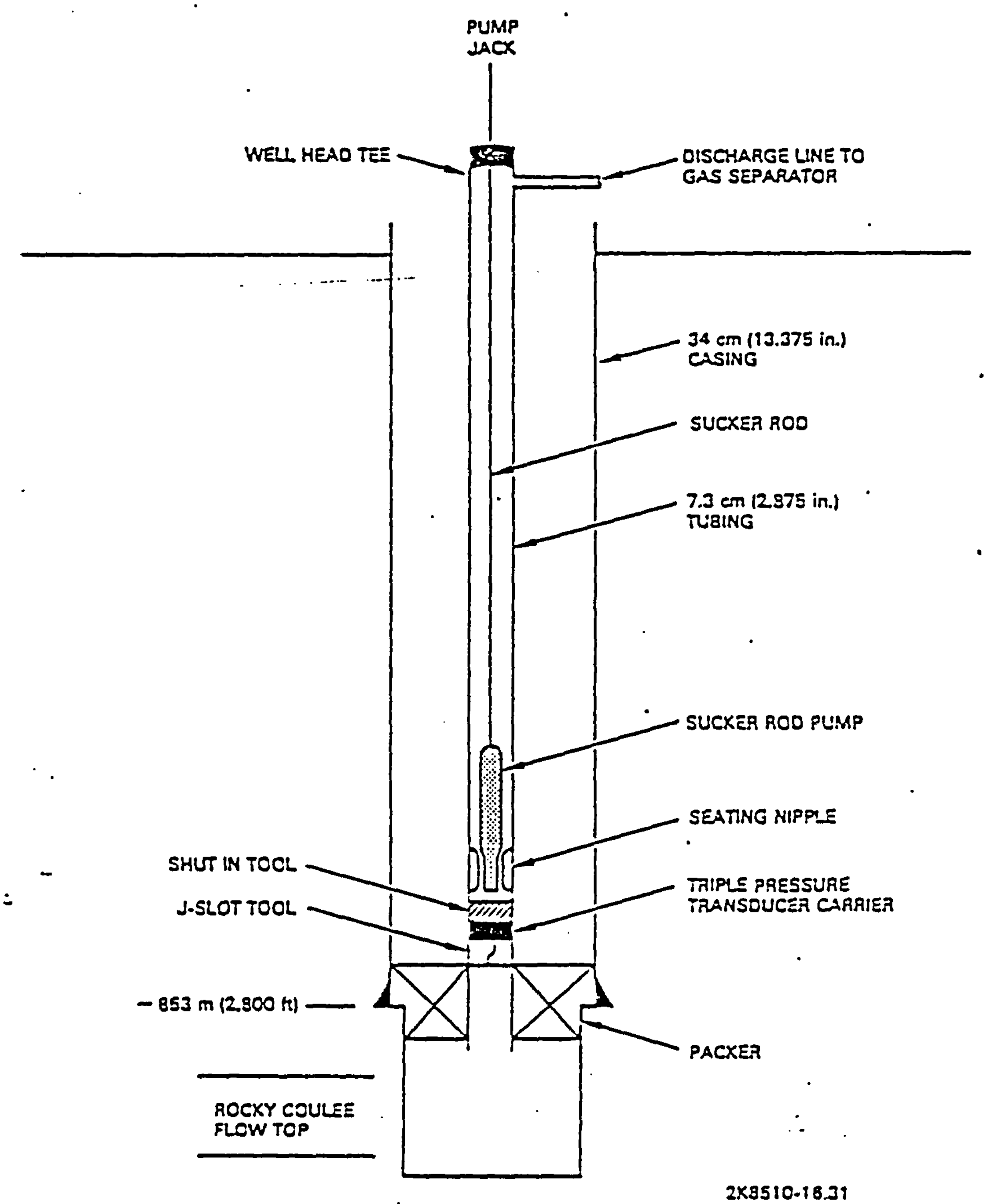

FIGURE 7. Configuration of well RRL-2B for testing the Rocky Coulee basalt flow top.

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at formation depth to be made using the Seling triple pressure probe, described in the section on instrumentation. Pumping tests of the Grande Ronde No. 5 flow top and Umtanum flow top will likely be accomplished using large capacity submersible pumps and a substantially different pump system configuration than that shown in Figure 7. The expected small hydraulic conductivity of the Cohassett flow top (Strait and Mercer, 1984) will likely make pumping from the unit impractical. If pulse tests in well RRL-2B indicate that the Cohassett flow top has substantial conductivity, it will be tested by pumping.

Piezometer Nest RRL-2C. Piezometer nest RRL-2C will provide the means to measure head and formation pressure in three flow tops in the Grande Ronde (Rocky Coulee, Cohassett, Grande Ronde No. 5) and formation pressure in three flow interiors (Rocky Coulee, Cohassett, Grande Ronde No. 5). This multiple-level piezometer differs from others in and near the RRL in that the RRL-2C design permits pressure monitoring of basalt flow interiors as well as flow tops. The general completion details of well RRL-2C are shown in Figure 8.

Pressure in the flow interiors will be measured using a transducer mounted below a wireline packer set just above the screen in the piezometers completed in the flow interiors (Figure 9). The shut-in pressure measurements in flow interior piezometers are required to avoid the unacceptably large response lag associated with open standpipes completed in material of very small hydraulic conductivity. Well RRL-2C, with its piezometers completed in flow interiors and flow tops, provides an opportunity to estimate vertical hydraulic conductivity of flow interiors using the ratio method described by Neuman and Witherspoon (1972), and numerial methods described in a subsequent section. Detailed description of the plans for construction of well RRL-2C can be found in Jackson and Jones (1984). The vertical position of the flow interior piezometers is considered in the section on hydraulic test design.

Borehole RRL-2A. Borehole RRL-2A was completed as a 7.5 cm (2.98-in.) diameter core hole to a total depth of 1211 m (3,973 ft). The configuration of the borehole as originally completed is shown in Figure 10. It was drilled in 1982 to acquire subsurface information to assess the suitability of the ES site and to aid in selection of ES porthole locations (Wintczak, 1984). The deepest string of casing in borehole RRL-2A was run to 827 m (2,713 ft) and cemented.

During hydraulic tests of the Rocky Coulee flow top, borehole RRL-2A will contain bridge plugs (packers) to isolate selected flow tops as shown in Figure 11. The flow tops are generally distinguished from flow interiors using borehole geophysical logging and coring techniques. The neutron-epithermal-neutron log of Figure 11 illustrates one of these techniques. The flow tops are distinguished by their reduced epithermal-neutron count. The hydrogen in water in the pores of the flow tops effectively moderates the fast neutrons from the source to less than epithermal energy levels. The bridge plugs, which are set in flow

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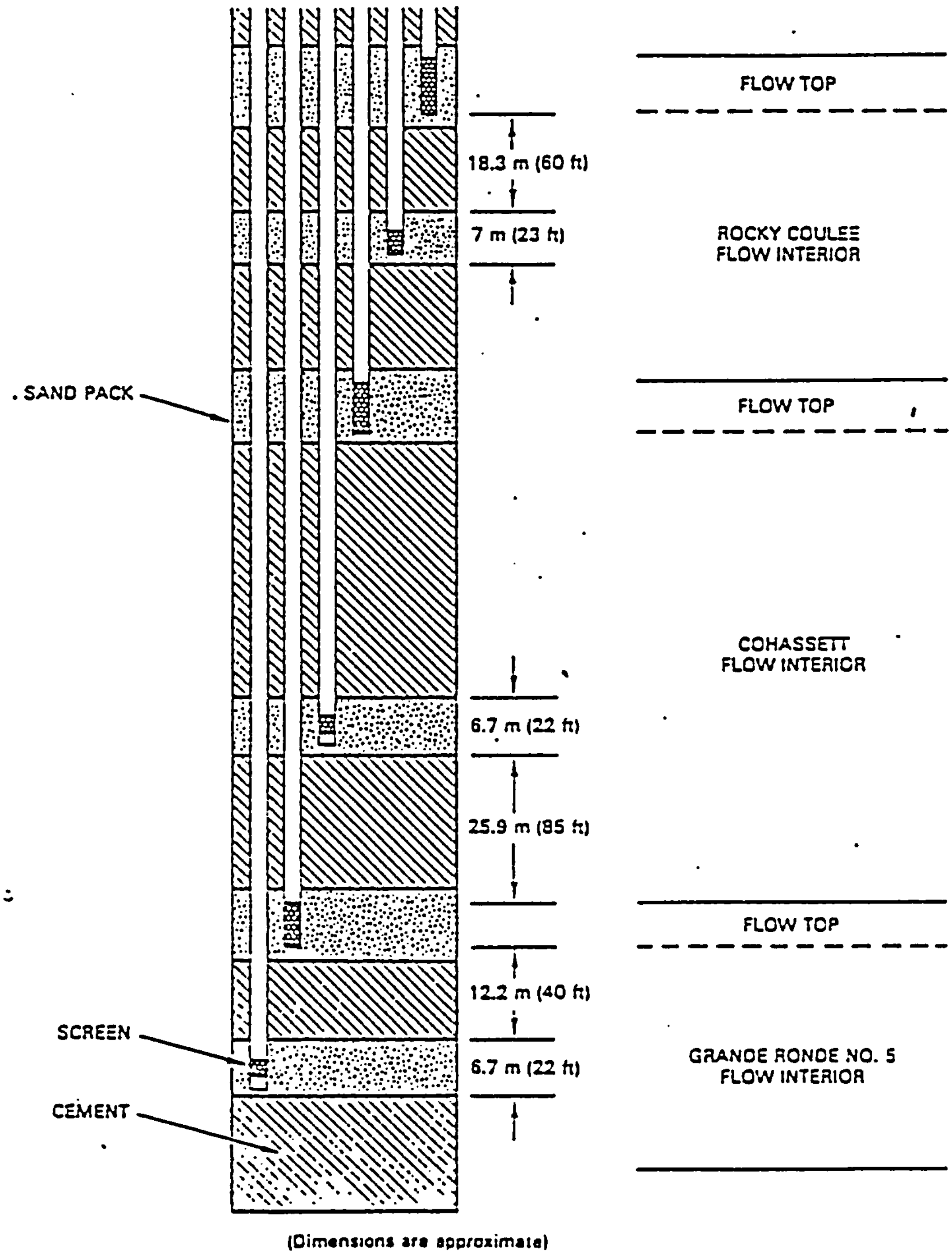

FIGURE 8. Schematic of Grande Ronde completions in piezometer nest RRL-2C.

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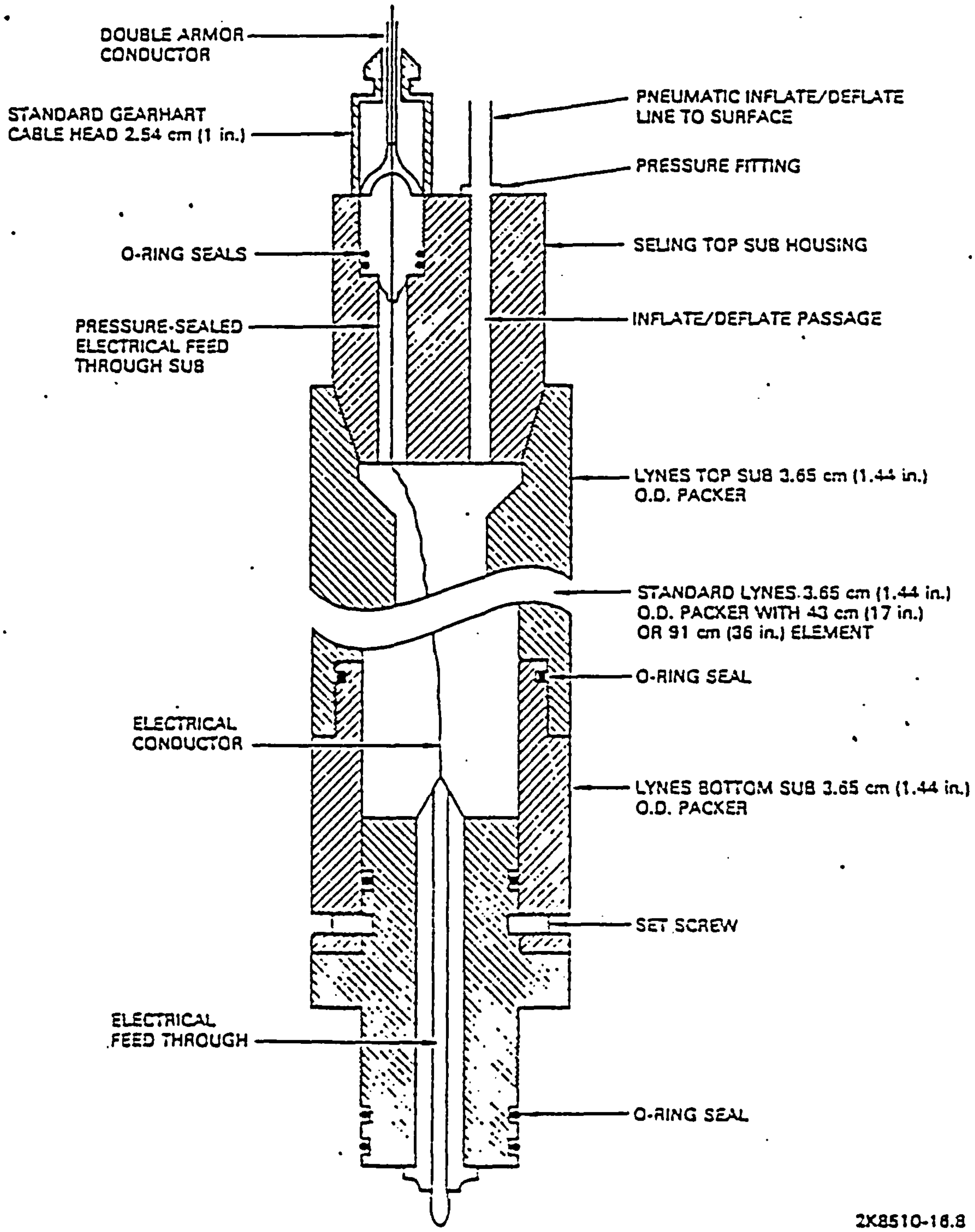

FIGURE 9. Wireline packer to be used in flow interior piezometers in well RRL-2C. (Transducer assembly will thread onto the pressure-sealed electrical feed through sub).

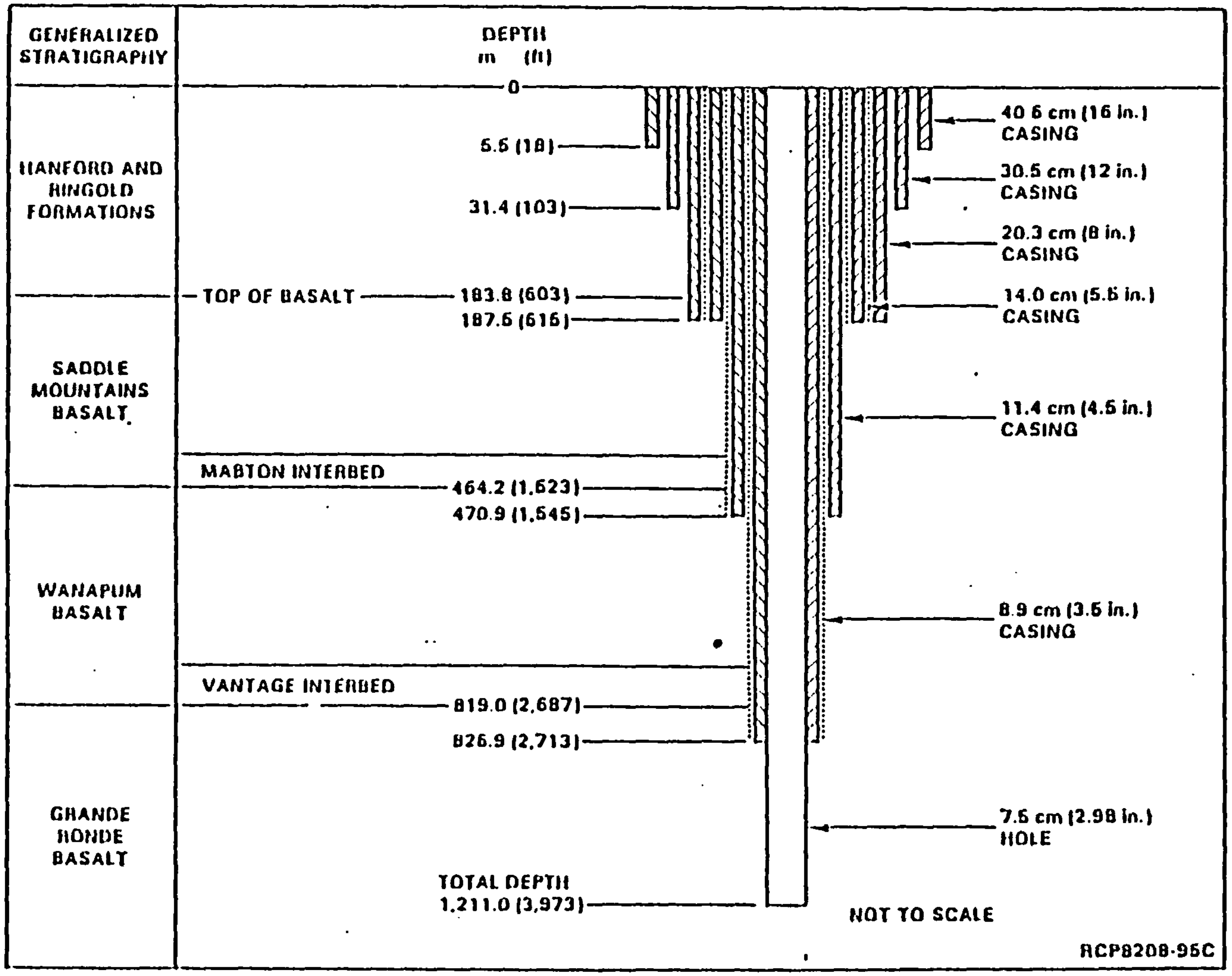

FIGURE 10. As-built configuration of borehole RRL-2A (from Wintczak, 1984).

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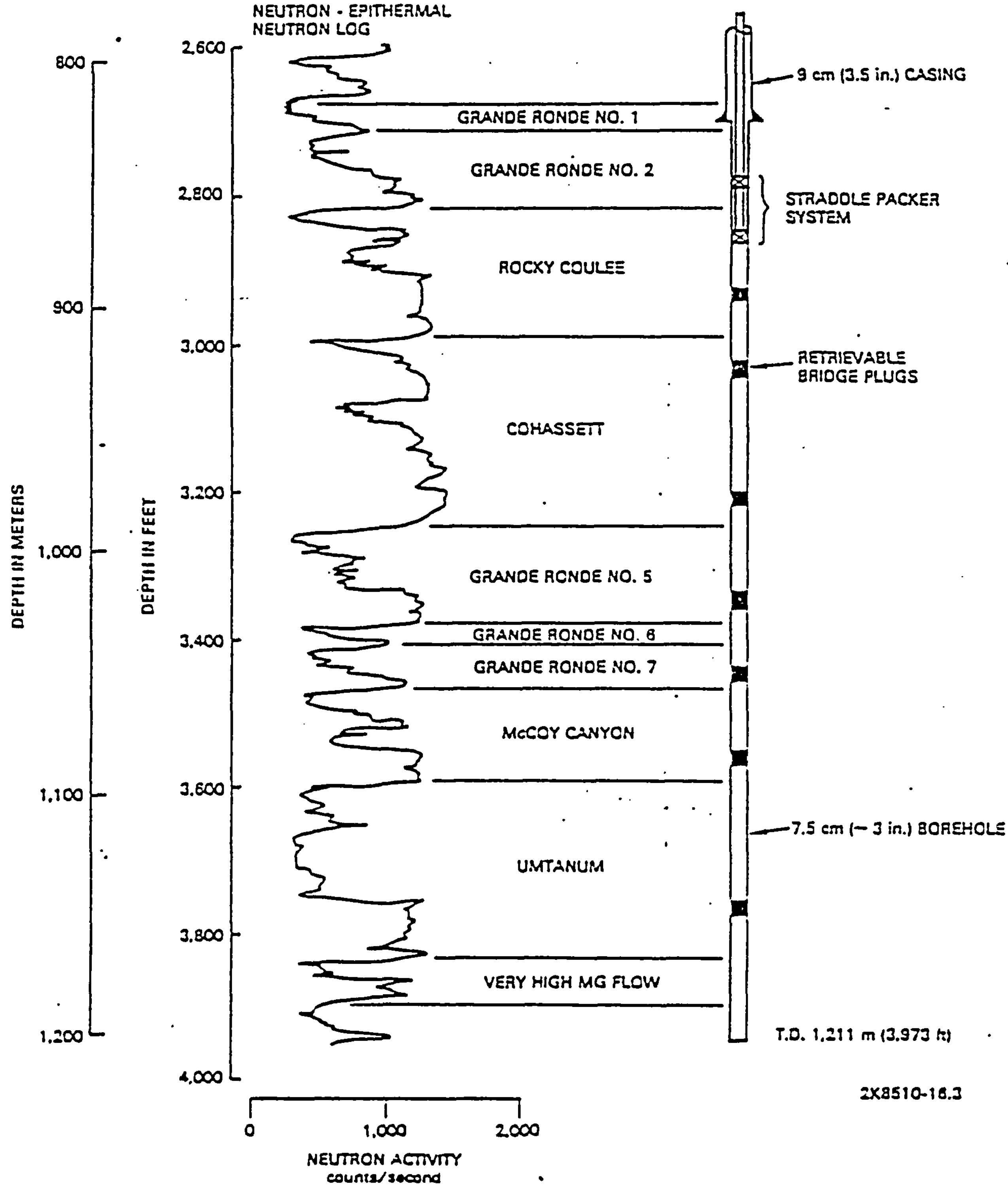

FIGURE 11. Configuration of borehole RRL-2A for hydraulic tests of the Rocky Coulee flow top. (Bridge plugs and packers not to vertical scale).

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interiors, prevent vertical hydraulic interconnection of various flow tops in the borehole. The flow tops so isolated in borehole RRL-2A are: Umtanum flow top, McCoy Canyon flow top, Grande Ronde No. 5 flow top, and Cohassett flow top. The Rocky Coulee flow top will be isolated within a straddle packed interval during its hydraulic test.

Some preparation and evaluation was carried out prior to installing the straddle packer pressure monitoring system below the 8.9 cm (3.5-in.) casing in borehole RRL-2A. These activities included:

- Dynamic fluid temperature logging of Cohasset and Rocky Coulee flow tops.
- Brief hydraulic tests of zones in the Cohassett flow interior that were previously hydraulically fractured in measurement of in situ stress. These tests were to determine if the hydraulic conductivity in the vicinity of the borehole was materially changed by the in situ stress measurements. The results indicate that no measureable change in hydraulic conductivity occurred.
- Placing bridge plugs to isolate flow tops from one another.
- Installing the straddle packer system to isolate the Rocky Coulee flow top.

During construction, the Rocky Coulee flow top was cemented in borehole RRL-2A to control drilling fluid loss. The Rocky Coulee flow top was, however, not completely sealed from the borehole as has been indicated by the dynamic fluid temperature logging mentioned above.

Pressure responses in the Cohassett flow top at borehole RRL-2A to pumping or pressure pulsing at well RRL-2B can be measured after removal of bridge plugs in the Rocky Coulee flow interior and the upper Cohassett flow interior and repositioning of the straddle packer assembly across the Cohassett flow top. Measurement of pressure response in the Grande Ronde No. 5 flow top will require at least the removal of the bridge plug in the lower Cohassett flow interior and repositioning of the straddle packer assembly. (Pressure can be sensed and measured above, within, and below the packed-off interval.)

Measurement of pressure response in borehole RRL-2A in the Umtanum flow top to pumping the flow top in well RRL-2B will require removal of all but the lowermost bridge plug and repositioning of the straddle packer assembly. This action will result in the interconnection of several flow tops above the upper packer of the straddle packer assembly. The benefits of measuring pressure transients in the Umtanum versus the effects of hydraulic interconnection of flow tops must be considered before such action. If the Umtanum flow top is tested by pumping well RRL-2B, the action may be justified because borehole RRL-2A will be the only nearby

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observation point in the Umtanum (well RRL-2C does not have a piezometer in the Umtanum flow top).

Piezometer Nests DC-19C, DC-20C, and DC-22C. Piezometer nests DC-19C, DC-20C, and DC-22C are located in and near the RRL and were recently constructed for the purpose of measuring time series hydraulic heads in flow tops in the Wanapum and upper Grande Ronde Basalts. The configuration of the piezometers in a typical C-series piezometer nest is shown in Figure 12. Details of construction of the piezometer nests are given in Jackson et al. (1984).

Borehole RRL-6. Borehole RRL-6 was completed as a 2.98-in. (7.6 cm) diameter core hole to a total depth of 1,231 m (4,040 ft) (Patterson, 1983). The configuration of the borehole as originally completed is shown in Figure 13. The deepest string of casing in borehole RRL-6 was run to 866 m (2,843 ft) and cemented. Bridge plugs have been set in flow interiors, as shown in Figure 14, to prevent vertical hydraulic interconnection of various flow tops in the borehole. The Rocky Coulee flow top will be isolated below a packer during its hydraulic test. The Rocky Coulee was cemented during the drilling of borehole RRL-6. It is hoped that complete sealing of the Rocky Coulee flow top did not occur. Testing of the Rocky Coulee flow top at borehole RRL-6 will investigate this possibility prior to the major test. Pressure monitoring in units below the Rocky Coulee flow top will require that bridge plugs be removed from borehole RRL-6 and that the packer be repositioned. This procedure would continue as with borehole RRL-2A, and with the same interconnection of flow tops above the packer assembly.

Borehole RRL-14. Borehole RRL-14 was completed as a 10.0 cm (3.9-in.) diameter core hole to a total depth of 1,219 m (4,000 ft) (Patterson, 1984). The configuration of the borehole as originally completed is shown in Figure 15. The deepest string of casing in borehole RRL-14 was run to 875 m (2,870 ft) and cemented. A Westbay multiple port monitoring system was installed in borehole RRL-14 as shown in Figure 16. Ports in the Westbay tubing, equipped with check valves, are located between double packers opposite the Rocky Coulee, Cohassett, Grande Ronde No. 5, and Umtanum flow tops. A port is also located opposite the vesicular zone in the Cohassett flow interior. A traveling pressure probe is suspended in the Westbay tubing on a wireline for pressure measurements. The probe is positioned opposite a port to measure pressure. Probe output travels to the surface via the wireline.

Borehole DC-4/DC-5. Borehole DC-4 was completed as a 7.7 cm (3.03-in.) diameter core hole to a total depth of 1,219 m (4,000 ft) (Fenix and Scisson, 1978). The configuration of the borehole as originally completed is shown in Figure 17. The deepest string of casing in borehole DC-4 was run to 804 m (2,639 ft) and cemented.

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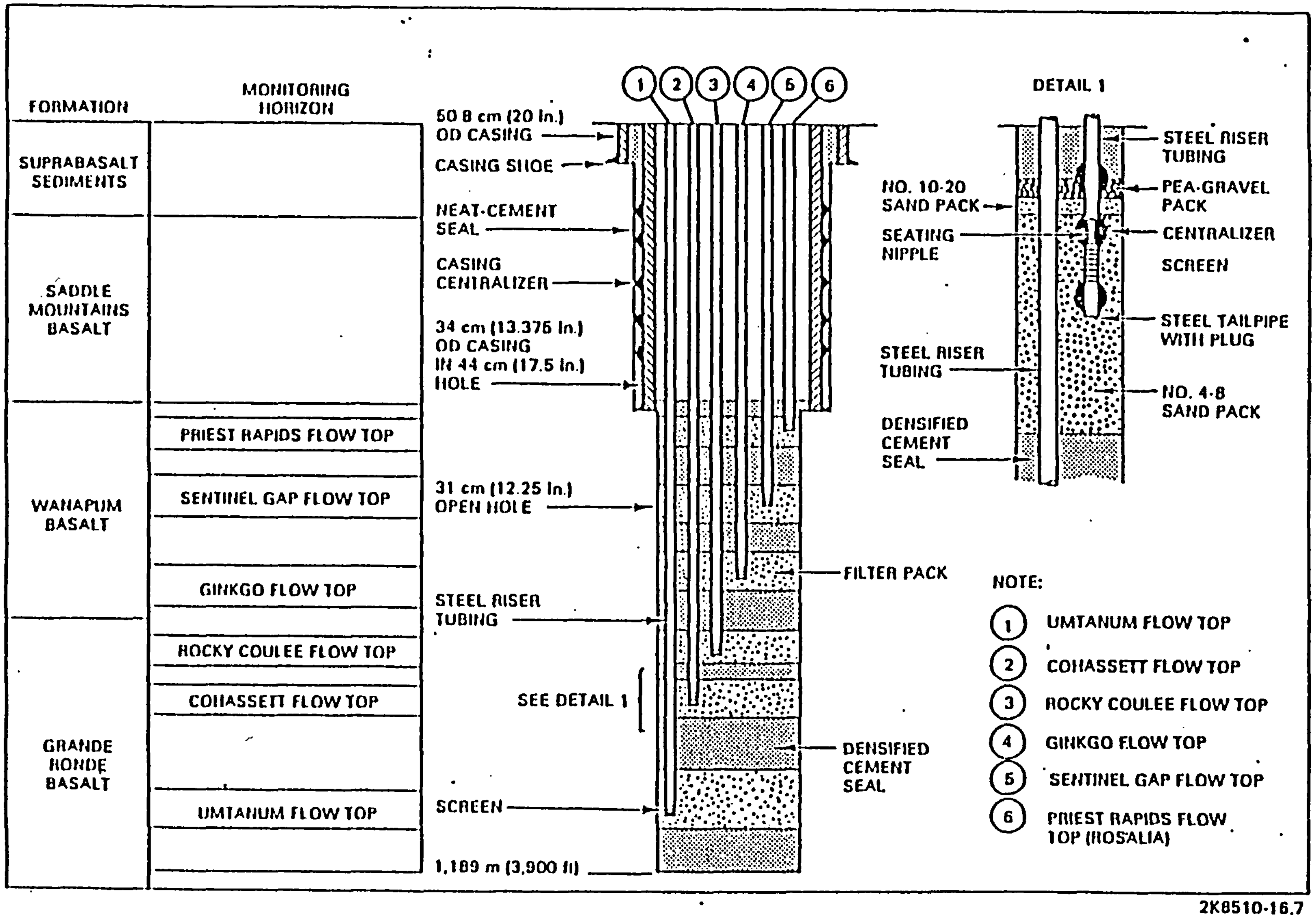

FIGURE 12. Schematic of C-Series of multilevel piezometer nest (from Jackson and Veatch, 1985).

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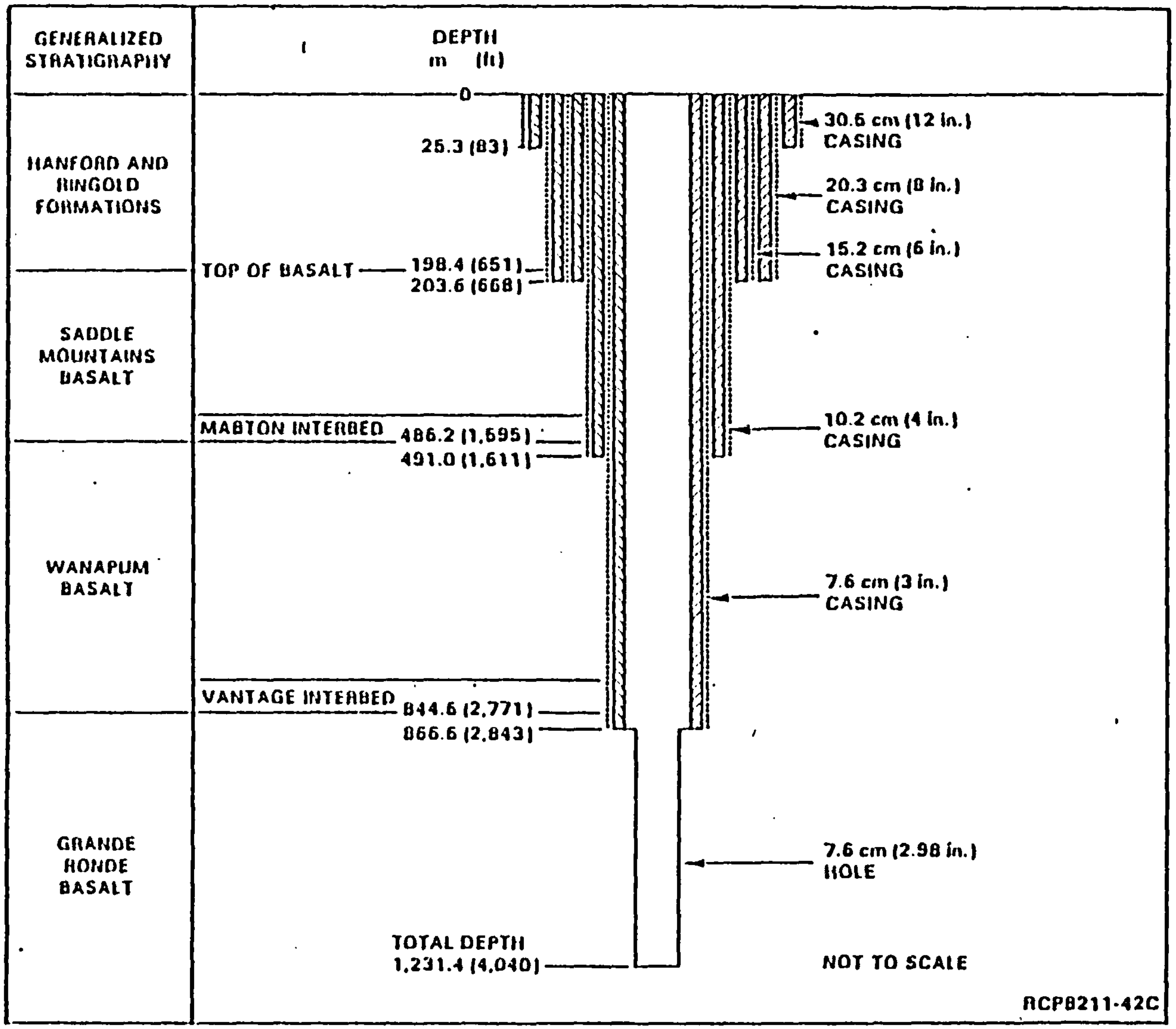

FIGURE 13. As-built drawing of borehole RRL-6 (from Patterson, 1983).

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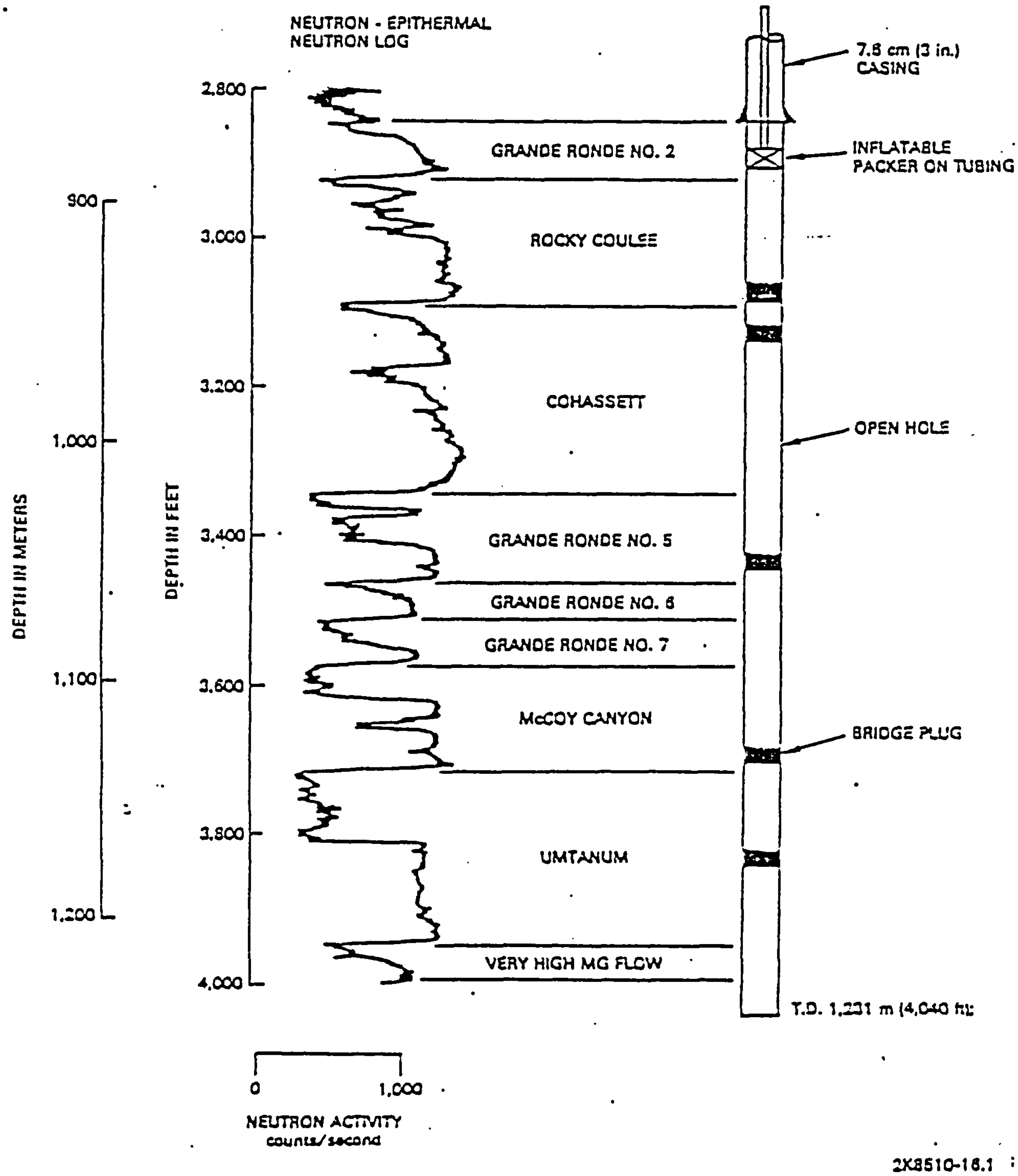

FIGURE 14. Configuration of borehole RRL-6 for hydraulic tests of the Rocky Coulee flow top. (Bridge plugs and packers not to vertical scale).

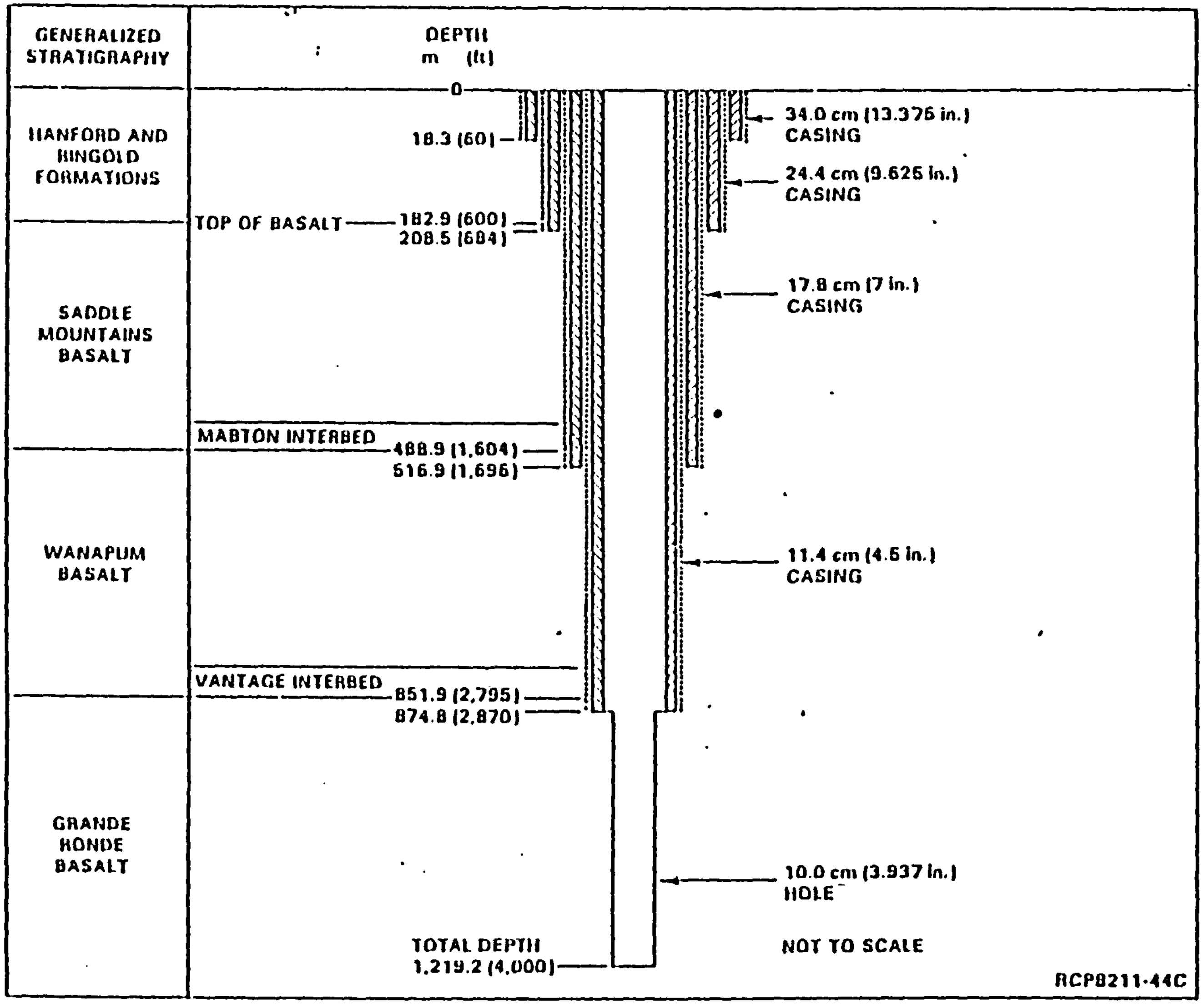

FIGURE 15. As-built drawing of borehole RRL-14 (from Patterson, 1984).

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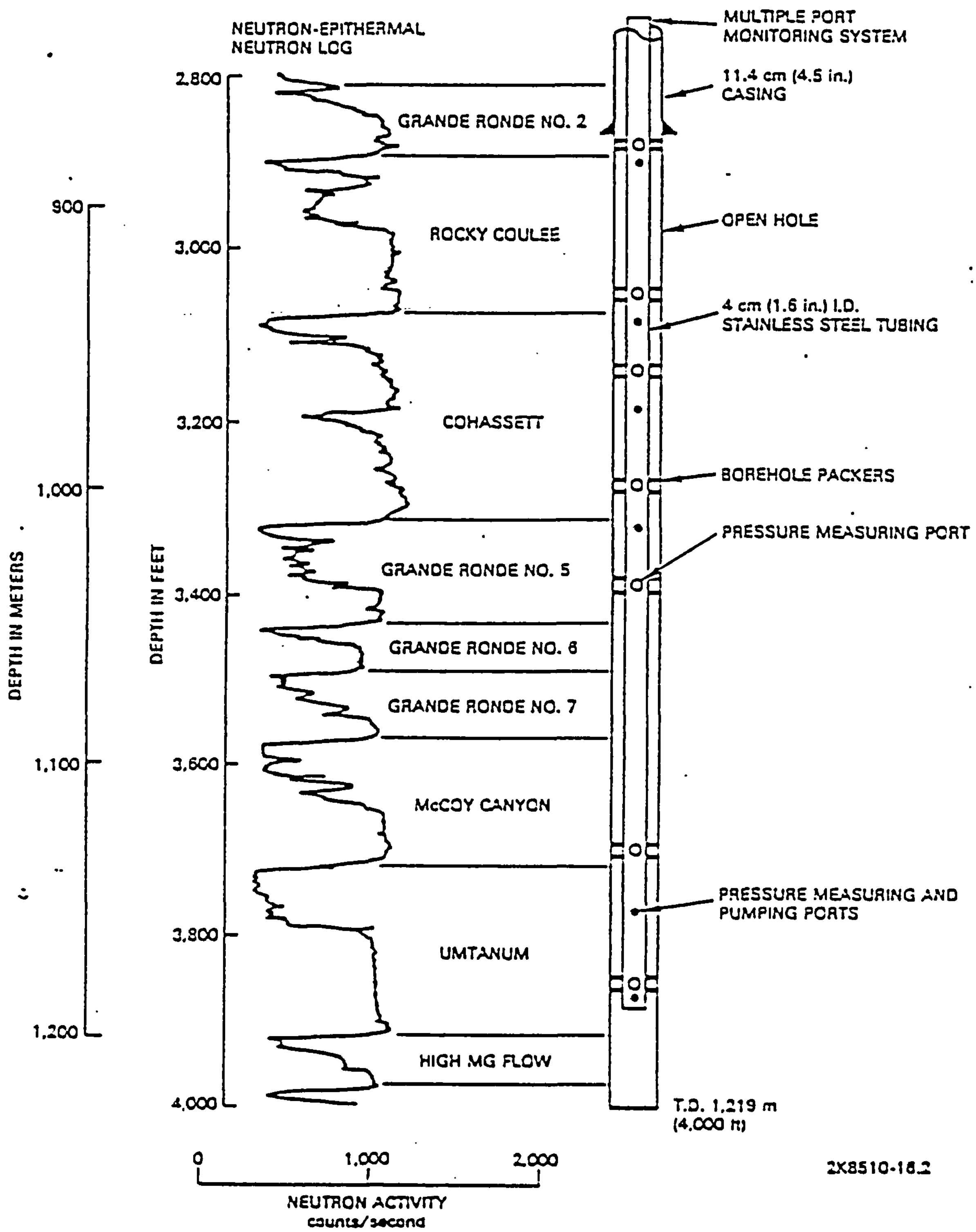

FIGURE 16. Schematic of Westbay multiple port monitoring system in borehole RRL-14.

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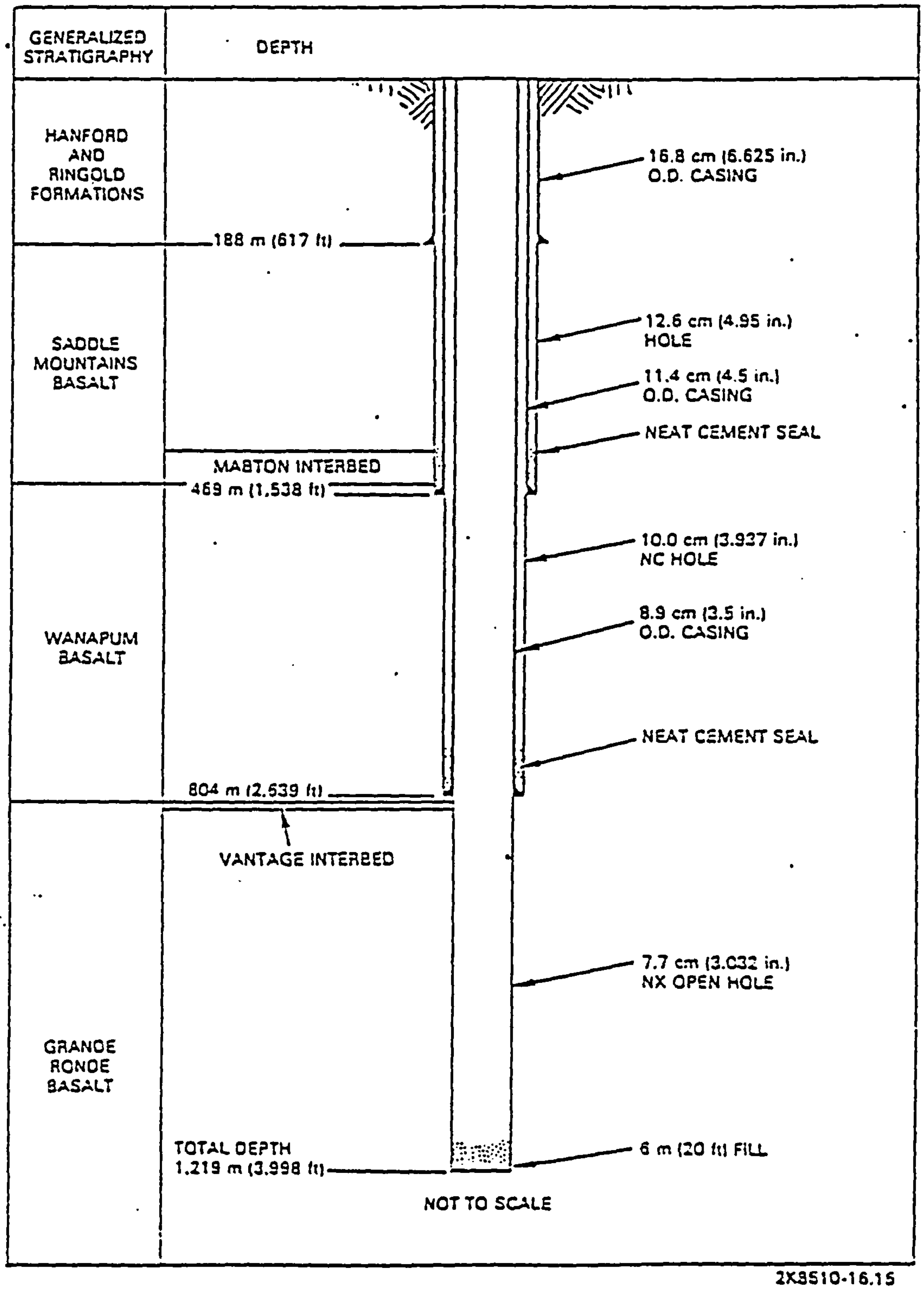

FIGURE 17. Original construction details of borehole DC-4 (from Fenix and Scisson, 1978).

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Bridge plugs have been set in flow interiors, as shown in Figure 18, to prevent vertical hydraulic interconnection of various flow tops in the borehole. The Rocky Coulee flow top is isolated by a straddle packer and will be so during the hydraulic testing of the Rocky Coulee flow top. The Cohassett flow top is isolated between a bridge plug and the lower packer of the straddle. Pressure monitoring in units below the Cohassett flow top will require that bridge plugs be removed from borehole DC-4 and that the straddle packer be repositioned. This procedure would continue as with borehole RRL-2A, and with the same interconnection of flow tops above the straddle packer assembly. Borehole DC-5, located very near to borehole DC-4, is cased and cemented to the top of the Grande Ronde Basalt. The borehole has a total depth of 1,216 m (3,990 ft) in the Grande Ronde and contains a series of bridge plugs in the open hole (below the casing) that separate the Umtanum, Grande Ronde No. 5, and Rocky Coulee flow tops.

McGee Well. The McGee Well was originally drilled in April 1927 for irrigation water supply. At that time, the well was completed in the Wanapum Basalt at a depth of 298 m (978 ft). Recently, the well was deepened (Wood et al., 1984) to a total depth of 952 m (3,123 ft) (Figure 19). Bridge plugs have been set in flow interiors as show in Figure 20, to prevent vertical hydraulic interconnection of various flow tops in the borehole. The Rocky Coulee flow top is isolated by a straddle packer assembly positioned as shown in Figure 20. Pressure monitoring in units below the Grande Ronde No. 4 flow top will require that bridge plugs be removed from the well and that the straddle packer be repositioned. This procedure would continue as with borehole RRL-2A, and with the same interconnection of flow tops above the straddle packer assembly. The McGee Well is located west of a roughly north-south trending groundwater flow impediment that separates it from the RRL (Figure 3).

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Boreholes DC-16A and DC-16C. Boreholes DC-16A and DC-16C contain bridge plugs that serve to prevent interconnection, in the boreholes, of the Wanapum and Grande Ronde horizons that are monitored at piezometer clusters DC-19C, DC-20C, and DC-22C.

NATURE OF TESTS AND THEIR SEQUENCE

The Umtanum and Grande Ronde No. 5 flow tops produce substantial quantities of water by pumping from wells and boreholes in the RRL-2 area as indicated by Figure 21. A more recent flow test in borehole RRL-2A shows that the Rocky Coulee flow top produces water also. In this test water was airlifted from the Rocky Coulee flow top at about 10.9m^3/day (2 gpm). These units are therefore of particular interest in the program of hydraulic testing at the RRL-2 site. The Cohassett flow top is also of interest because the Cohassett flow interior is the designated repository horizon.

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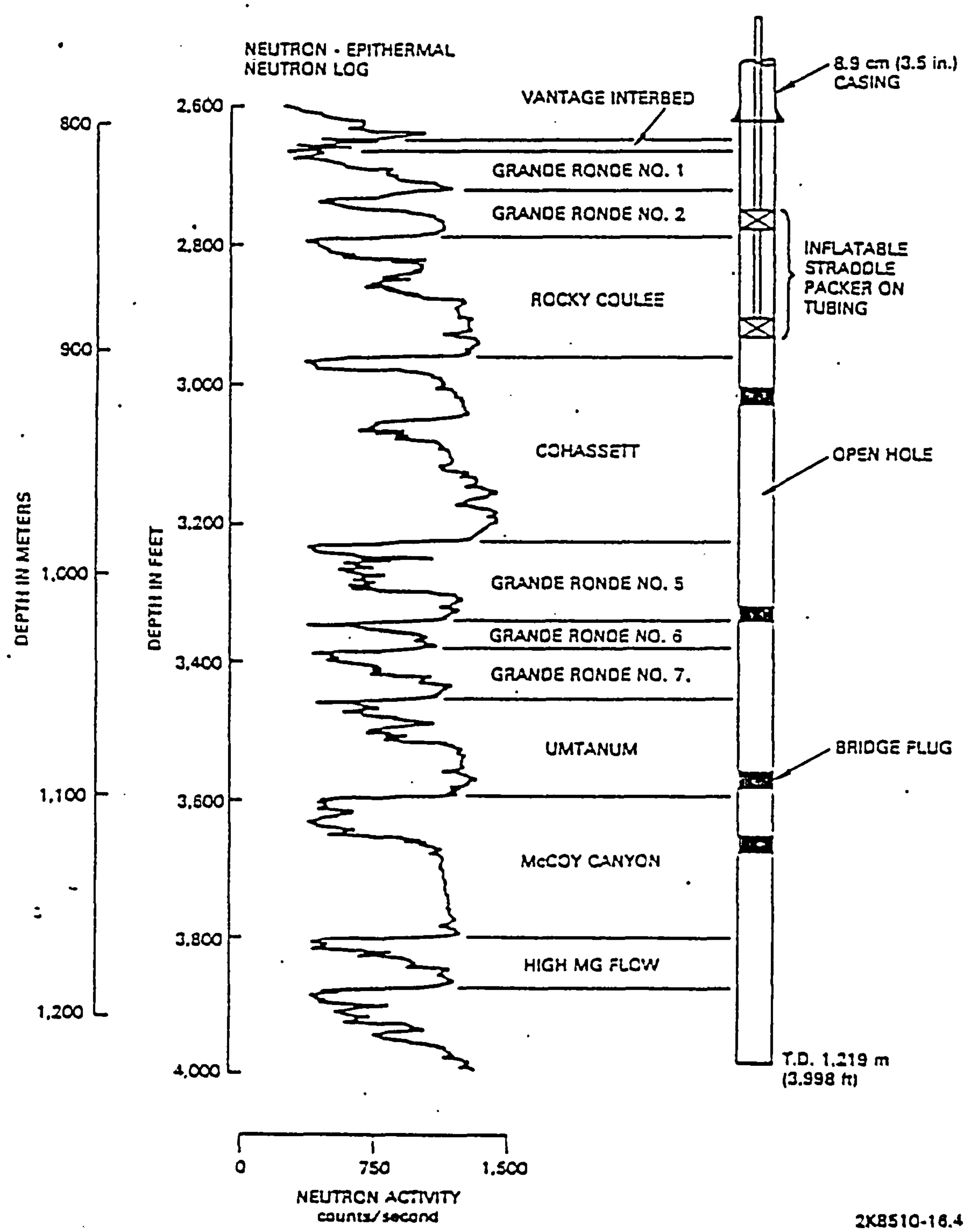

FIGURE 18. Configuration of borehole DC-4 for hydraulic tests of the Rocky Coulee flow top. (Bridge plugs and packers not to vertical scale).

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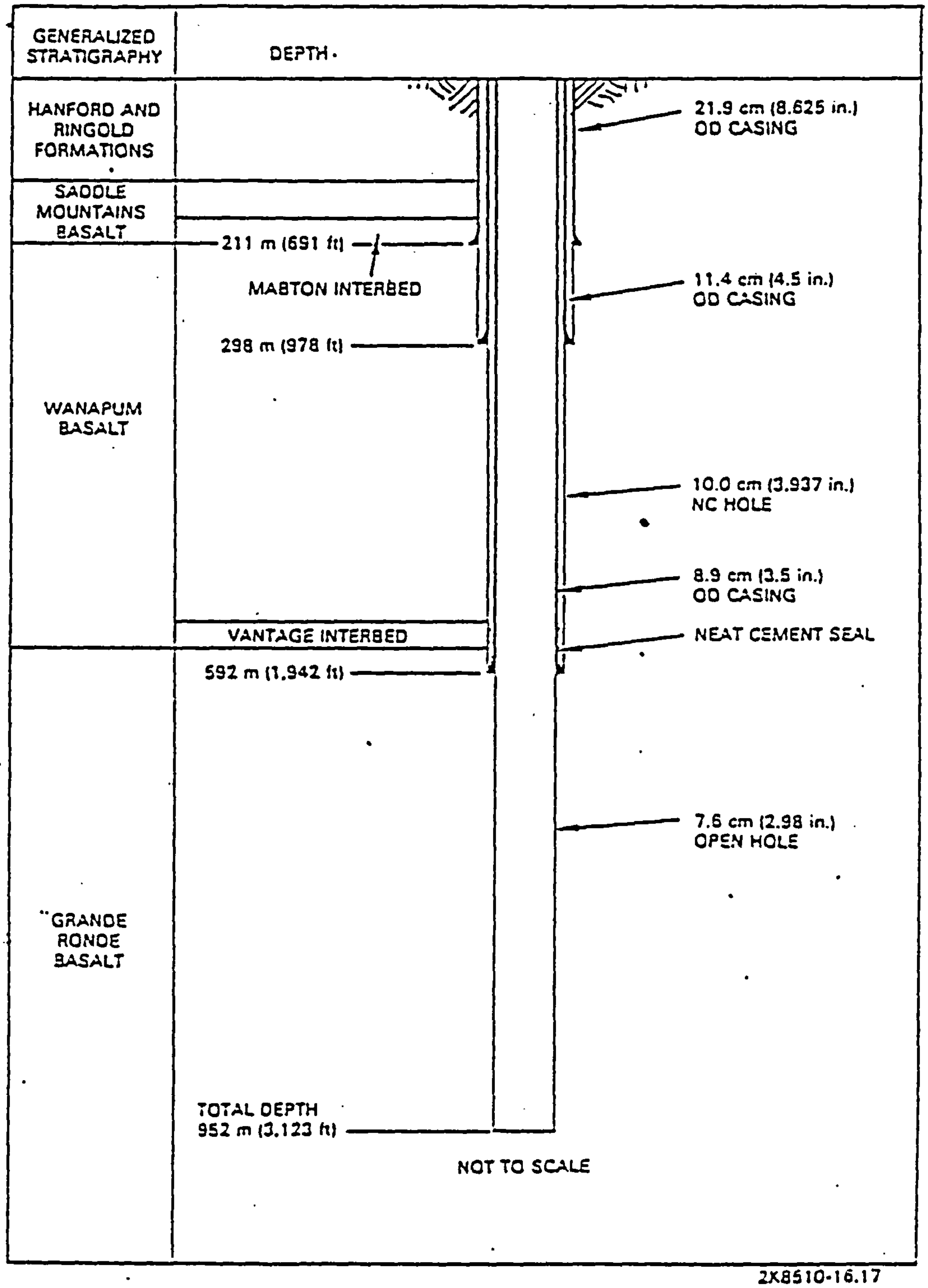

FIGURE 19. Construction Details of the McGee Well, (from Wood et al., 1984).

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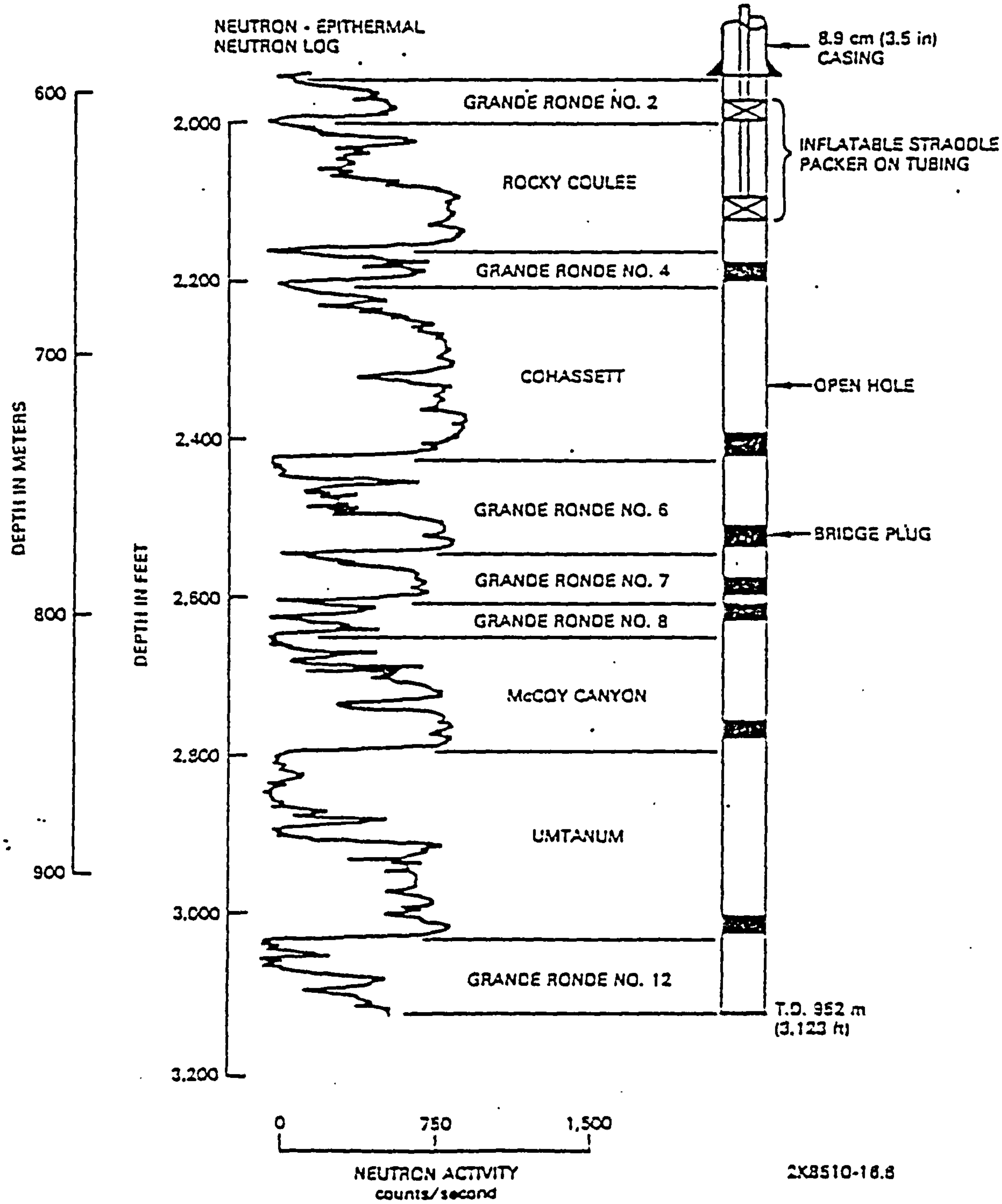

FIGURE 20. Configuration of the McGee well for hydraulic tests of the Rocky Coulee flow top. (Bridge plugs and packers are not to scale).

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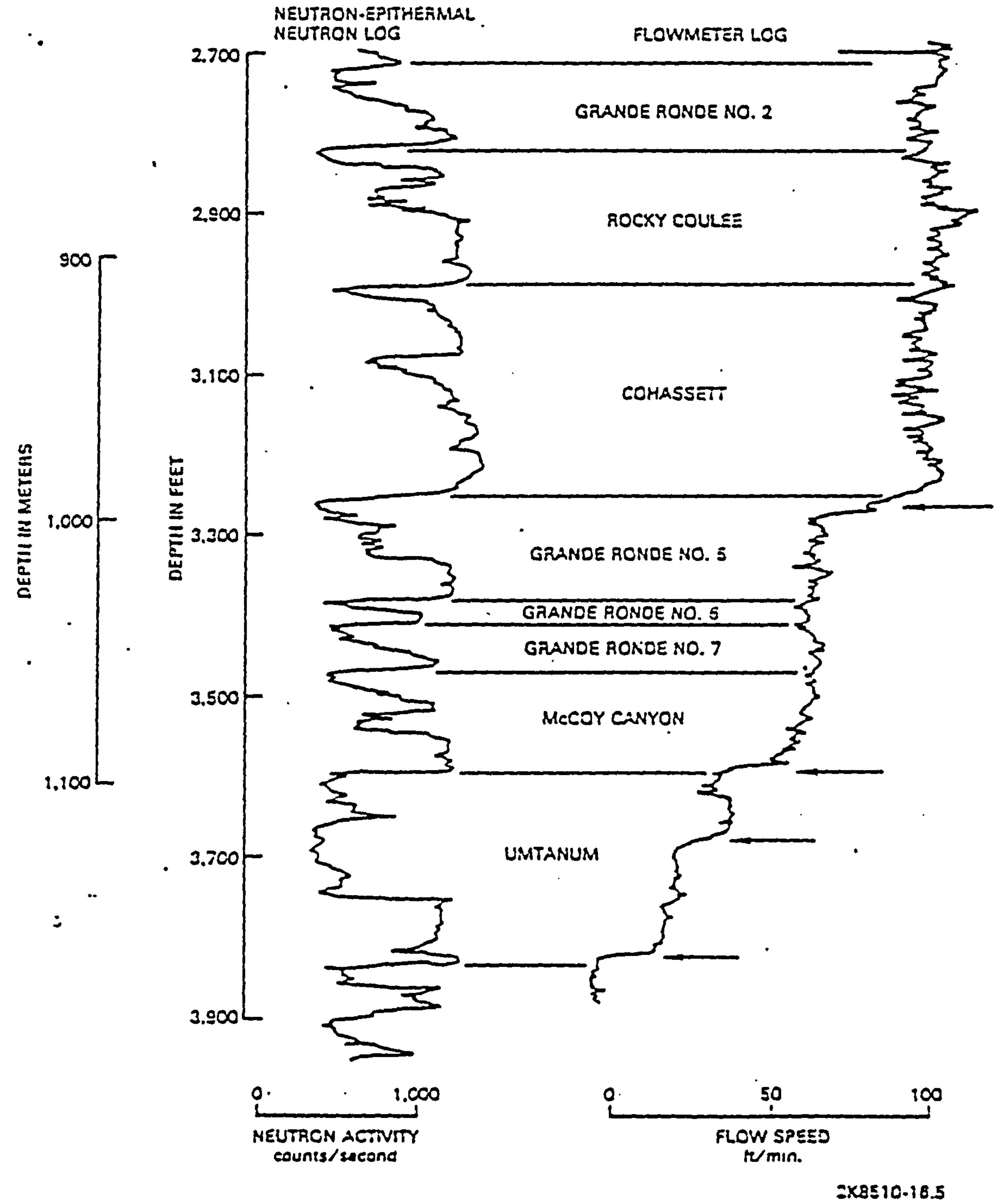

FIGURE 21. Flow meter log run in borehole RRL-2A during airlift pumping of water from the borehole. (Zones of substantial water production are noted by arrows).

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The primary focus of the hydraulic testing in the Grande Ronde Basalt at the RRL-2 site is the Cohassett flow interior. The Cohassett interior is the designated repository horizon, therefore, knowledge of its hydraulic characteristics and those of adjacent and subjacent units is necessary for repository performance assessment calculations.

Except for the Cohassett flow top, and portions of the Cohassett flow interior that may be tested, the interflow zones of interest (Rocky Coulee flow top, Grande Ronde No. 5 flow top, and Umtanum flow top) can be tested using conventional pumped constant discharge well tests. It is presently assumed that the Cohassett flow top and Cohassett flow interior zones will be tested by an alternate method such as a pressure pulse or constant head injection technique because of their very small estimated transmissivity (Strait and Spane, 1983).

The planned sequence is to test the four horizons of interest in well RRL-2B, Rocky Coulee flow top, Cohassett flow top and interior zones (Cohassett vesicular zone), Grande Ronde No. 5 flow top, and Umtanum flow top, in that order. The staged construction of well RRL-2B allows each interflow to be tested individually. This method of construction also requires that each interflow zone be sealed (using cement and steel liners) after it is tested, except for the last interflow tested. It will be difficult or impossible to regain hydraulic access to the sealed interflow zones in well RRL-2B after they have been tested. The alternative to the staged well construction proposed for well RRL-2B is to use a packer assembly to isolate the test intervals in the well. This alternative is less desirable for reasons that include the potential for leakage around the packer, under the influence of large pressure differentials induced by pumping from the well. Hydraulic interconnection of interflow zones in the open borehole above the packer is another shortcoming of this alternative. Single or straddle packer assemblies will be used, however, in pulse or constant head injection testing of the Cohassett flow top and interior zones.

Water samples for field and laboratory analysis will be obtained from the Rocky Coulee flow top, Grande Ronde No. 5 flow top, and the Umtanum flow top prior to, during, and after formal pumping tests in the units. If it is possible to pump water from the Cohassett flow top, water samples will be obtained from that unit. Convergent pulse tracer tests will be initiated during the pumping tests after quasi-steady flow has been established. A tracer pulse will be injected at both borehole RRL-2A and piezometer nest RRL-2C and the pumped discharge from well RRL-2B will be monitored to define the tracer pulse arrival. Different tracers will be injected at the two observation wells to facilitate identification of the source of pulses that arrive at well RRL-2B.

The large-scale hydraulic tests of units in the Grande Ronde Basalt using well RRL-2B as the pumping/pulse injection well can be initiated as soon as the time series head values from the observation wells and boreholes completed in the Grande Ronde units can be reliably projected beyond the planned test lengths. Means of satisfying this criterion

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are currently being investigated. Further discussion of this criterion is beyond the scope of this test plan.

TEST DESIGN

Hydraulic Test Design

Introduction. Four flow tops and possibly at least one flow interior zone will be tested at RRL-2, however, the emphasis of this plan is on the design of the first test in the Rocky Coulee flow top. The hydraulic test design for the Rocky Coulee flow top can be simply adapted to the other flow tops by scaling drawdowns using the transmissivity and discharge ratios between the Rocky Coulee flow top and the other flow tops. Two numerical models were used to facilitate hydraulic test design: a pseudo three-dimensional flow model (McDonald and Harbaugh, 1984) and an axisymmetrical flow model (Golder Associates, Inc., 1983). The three-dimensional flow model was used to estimate the areal response in the pumped and adjacent flow tops. The axisymmetrical model provided response estimates within dense flow interiors and for several flow tops including the pumped flow top. The pseudo three-dimensional flow model was only used to estimate response to pumping the Rocky Coulee flow top.

The axisymmetric model was used to simulate responses to three of the four planned hydraulic tests at RRL-2. These are the pumping tests of the Rocky Coulee flow top, the Cohassett flow top and the Grande Ronde No. 5 flow top. It was necessary to model the three tests with the axisymmetric model to assist in vertically locating the three dense flow interior piezometers that were installed in well RRL-2C.

The numerical model studies required the use of boundary conditions, which are based on the conceptualization of the groundwater flow system. They also required values of certain hydraulic parameters, which are based on single well hydraulic test results such as those provided by Strait and Mercer (1984), or are assumed if test results have not supplied estimates of parameter values. The hydraulic test results may be sensitive to heterogeneities such as variations in transmissivity or leakage. There is not enough information, however, to justify modeling a heterogeneous system on the scale anticipated for the multiple-well hydraulic tests at the RRL-2 site. If the horizontal transmissivity values are lognormally distributed in the areal sense, then their geometric mean value can be used to provide an effective value of transmissivity to use in numerical modeling (Neuman, 1982).

Based on the model studies described herein, it appears that hydraulic test design is relatively insensitive to the likely range of boundary conditions. In light of the discussion in the preceding paragraph, one homogeneous model was considered. Model simulations using ranges of input parameter values then provided insight into the various aspects of the

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hydraulic test design such as vertical location of piezometer completion interval (in dense flow interiors), discharge rates from the pumped well, and pumping test duration.

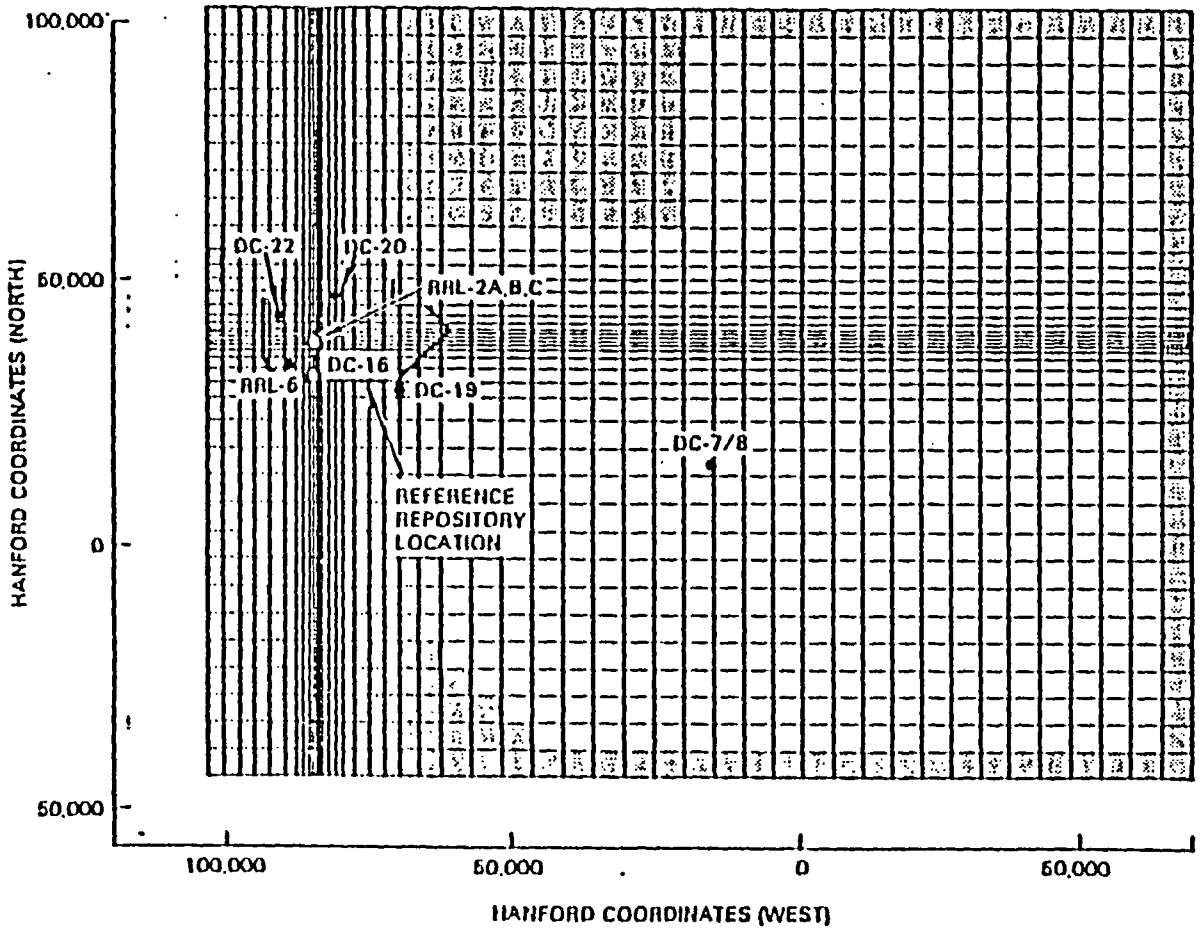
Conceptual Model. Several conceptual models were initially considered. The primary difference between these was their degree of complexity. The most complex conceptual model included heterogeneous distribution of aquifer and aquitard hydraulic properties, and boundary conditions based on geologic structure. Conceptual models that include areal heterogeneities are more complex than existing knowledge will support. Also, the more complex conceptual models preclude the use of many of the analytical solutions to groundwater flow problems.. Therefore, a simplified conceptual model was selected commensurate with the available data and consistent with many of the available analytical solutions.

A plan view of the pseudo three-dimensional model shows how boundary conditions are incorporated conforming to the simplified conceptual model of the groundwater flow system (Figure 22). As indicated in Figure 22, north, south, and west of the RRL-2 site, no-flow boundaries are specified. East from the RRL-2 site, the boundary is assumed to be at infinite distance. The effect of a boundary at infinite distance is created in the numerical model by setting the boundary a relatively great distance from the RRL-2 site as shown in Figure 22. The boundaries in Figure 22 that are east of the RRL-2 site are shown as no-flow boundaries, however, the effect of an infinite aquifer in the easterly direction is achieved because of the relatively great distance between the pumping site and the eastern boundaries, relative to the anticipated pumping duration of 60 days.

Hydraulic Parameter Values. Single-well hydraulic test results provide a basis for estimating hydraulic behavior on large scales, and were used in the planning and design of multiple-well hydraulic tests. Table 2 lists flow top transmissivity values and other derived parameter values. Column three contains best estimates of transmissivity values from single well tests in the Rocky Coulee flow top, Cohassett flow top, Grande Ronde No. 5 flow top, and the Umtanum flow top. The best estimates of the transmissivity values are based upon the professional opinion of the hydrologist who conducted the test.*

Because the transmissivity values are assumed to be lognormally distributed, we transform them using the transformation $X = \ln T$, where T is the transmissivity. The transformed values are listed in column four, Table 2. Columns five and six list the mean value of the transformed parameter, X_m, and its standard deviation, σ_X, for each of the flow

*These transmissivity value estimates are not being reported here for the record. Most of the analysis on which they are based have not been verified or peer-reviewed. The values are used simply as the basis for obtaining estimates of the geometric mean transmissivity of the four flow tops for multiple-well hydraulic test design.



IMPERMEABLE BOUNDARY

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FIGURE 22. Finite difference grid, well locations, and boundary conditions for hydraulic test simulation.

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TABLE 2. Transmissivity, Estimated from Single Well Tests, and Derived Parameter Values

Horizon	Well or Borehole	Transmissivity,* T, m^2/day	$x = \ln T$	Mean of $\ln T$, x_m	Std Dev of $\ln T$, σx	Geom. Mean T, $T_m = e^{x_m}$, m^2/day (ft^2/day)
Rocky Coulee Flow Top	RRL-2A	0.93	-0.07			
	DC-19C	0.05	-2.99	-1.41	3.0	0.24
	DC-22C	0.009	-4.71			(2.6)
	DC-12	8.4	2.12			
Cohassett Flow Top	DC-16A	0.26	-1.34			
	DC-4	0.011	-4.50			
	RRL-14	0.46	-0.77	-3.95	2.9	0.019
	RRL-2A	0.004	-5.52			(0.20)
	RRL-6	0.0005	-7.60			
Grande Ronde No. 5 Flow Top	DC-16A	0.005	-5.30			
	RRL-14	0.46	-0.78	-1.76	4.6	0.17
	RRL-2A	77.1	4.34			(1.8)
	RRL-6	0.005	-5.30			
Umtanum Flow Top	DC-19C	4.6	1.53			
	DC-6	0.93	-0.07			
	RRL-2A	44.6	3.80			
	DC-15	2.3	0.83	0.11	2.3	1.12
	DC-16A	4.6	1.53			(12.0)
	RRL-6	0.05	-2.99			
	RRL-14	0.46	-0.78			
	DC-20C	0.05	-2.99			
All of the Above	(n=21)			-1.50	3.3	0.22 (2.4)

* These transmissivity value estimates are not being reported here for the record. Most of the analyses on which they are based have not been verified or peer reviewed. The values are used simply as the basis for obtaining estimates of the geometric mean transmissivity of the four flow tops for multiple-well hydraulic test design.

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tops and for the combined flow top transmissivity data given in Table 2. The last column in the table gives the geometric mean transmissivity, T_m.

Table 3 lists parameter values used for the pseudo three-dimensional model runs. Six cases were evaluated. The first three cases simulated three layers, as shown in Figure 23, the Cohassett flow top (lower layer), the Rocky Coulee flow top (middle layer), and the Grande Ronde No. 2 flow top (upper layer), with pumped withdrawal from the Rocky Coulee flow top. The transmissivity of the Rocky Coulee layer was varied, in three cases, from the geometric mean value of the best estimates to a larger value ($T=\exp(X_m + \sigma_x)$) and then to a smaller value ($T=\exp(X_m - \sigma_x)$). The transmissivity of the Cohassett flow top was fixed at its geometric mean value. Because transmissivity values for the Grande Ronde No. 2 flow top were not available, the same values as used for the Cohassett flow top were used in the model study. A storativity of 10^{-5} was used for each layer in all cases. This value is appropriate if we assume each layer is a fully confined system. Leonhart et al. (1985) report a similar value for storativity of the McCoy Canyon flow top. A vertical conductivity value of 3×10^{-6} m/day (1×10^{-5} ft/day) was used for dense basalt flow interiors for all simulations. The work of Spane et al., (1983) provides support for assignment of this value.

Cases 4 through 6 are similar to cases 1 through 3 but with different upper and lower boundary conditions. In cases 1 through 3, an impermeable boundary condition was assumed above the Grande Ronde No. 2 and below the Cohassett flow top. In cases 4 through 6 a layer of large transmissivity and constant hydraulic head was placed above the Grande Ronde No. 2 and below the Cohassett flow top. The transfer coefficient (TCF) value (see next section) used between the uppermost layer and the Grande Ronde No. 2 flow top is the same as that used between the Grande Ronde No. 2 flow top and the Rocky Coulee flow top. Similarly, the TCF value used between the lowermost layer and the Cohassett flow top is the same as that used between the Cohassett flow top and the Rocky Coulee flow top.

Pseudo Three-Dimensional Model Study. A modular pseudo three-dimensional finite difference groundwater flow model, MODULAR, (McDonald and Harbaugh, 1984) was used to evaluate the sensitivity of drawdown to parameter variation. MODULAR is an updated version of a code by Trescott (1975). The code utilizes a block centered, finite difference grid in which variable grid spacing is permitted. Three dimensions are simulated by a series of two-dimensional models, using an interaquifer transfer coefficient (TCF) to determine the flow between the layers based on simple Darcian flow. The TCF is a quantity that, when multiplied by the vertical head difference and the area of the appropriate model block, yields the flow rate being transferred between the layers in the block. The TCF values for each confining bed are

TCF tos

$$TCF = K'/b \qquad (1)$$

Table 3. Parameter Values Used in Pseudo Three-Dimensional Groundwater Flow Simulations for Various Cases

Parameter	1 (3 layer)	2 (3 layer)	3 (3 layer)	4 (5 layer)	5 (5 layer)	6 (5 layer)
Transmissivity of Rocky Coulee Flow Top, T2, m^2/day(ft^2/day)	0.24 (2.6)	5.0 (54)	0.01 (0.124)	0.24 (2.6)	5.0 (54)	0.01 (0.124)
Transmissivity of Grande Ronde No. 2 and Cohassett Flow Top, T1, T3, m^2/day	0.02	0.02	0.02	0.02	0.02	0.02
Storativity, S1, S2, S3	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}
Flow Interior Vertical Hydraulic Conductivity, K', m/day	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}	3×10^{-6}
Inter Flow Top Transfer Coefficients,						
TCF01				8×10^{-8}	8×10^{-8}	8×10^{-8}
TCF12	8×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}	8×10^{-8}
TCF23	1.3×10^{-7}	1.3×10^{-7}	1.3×10^{-7}	1.3×10^{-7}	1.3×10^{-7}	1.3×10^{-7}
TCF34				1.3×10^{-7}	1.3×10^{-7}	1.3×10^{-7}

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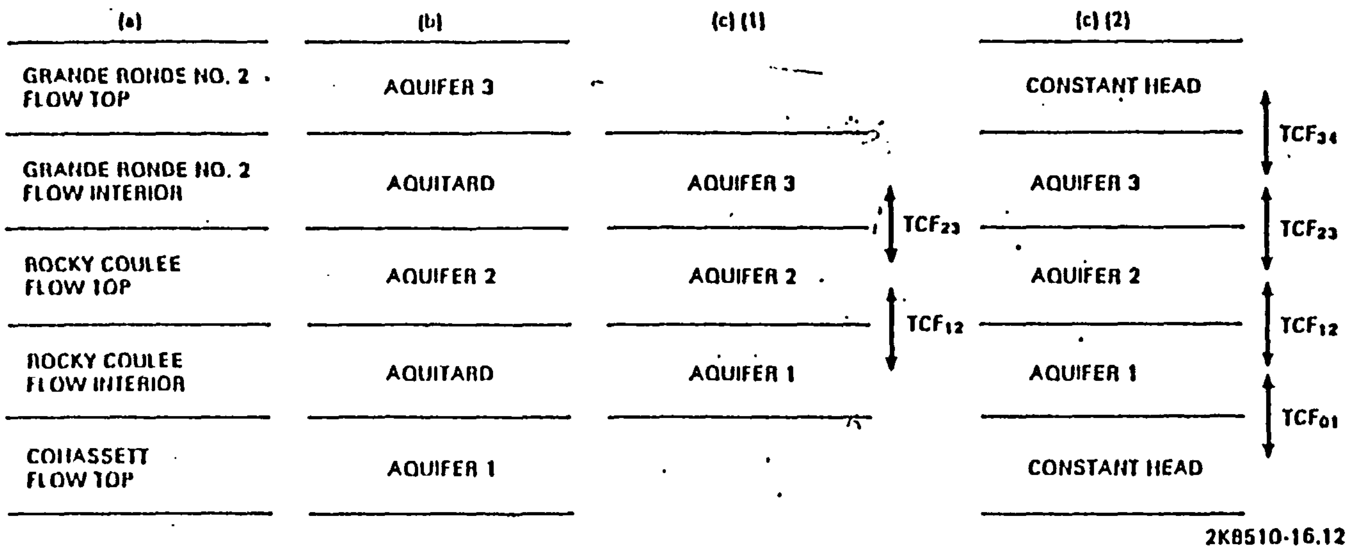

FIGURE 23. Conceptualization in vertical plane for pseudo three-dimensional model study. (a) Rocky Coulee flow top and adjacent units, (b) model geohydrologic classification of units, (c) model linkage of units for cases 1-3 (1) and for cases 4-6 (2).

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where k' = flow interior vertical hydraulic conductivity
b = dense flow interior thickness.

The equation governing flow in the flow top layers is

$$\frac{\partial}{\partial x}\left(T\frac{\partial h}{\partial x}\right) \frac{\partial}{\partial y}\left(T\frac{\partial h}{\partial y}\right) + (TCF)\ \Delta h_z = S\frac{\partial h}{\partial t} + Q \qquad (2)$$

where T = transmissivity of flow tops
S = storativity of flow tops
Δh_z = the hydraulic head difference between two flow tops
Q = the source (or sink) function.

The model was set up (See Figure 22) to perform a pre-test analysis to provide a basis for planning and designing of the multiple-well hydraulic tests at the RRL-2 site. Though the choice of model boundary conditions discussed previously does not represent a unique selection, the effect of slight variation of the geometry of the boundary structures on the test design is thought to be insignificant. The model grid consisted of 44 rows and 50 columns whose spacing varied from 56 m to 1,609 m (183 ft to 5,280 ft) and which represented an area 51.5 km long and 45 km wide. Figure 22 shows the grid, well and borehole locations, and boundary conditions.

Simulated response in the Rocky Coulee flow top to pumping from it, according to the six cases, is summarized in Tables 4 and 5. Drawdown in the Rocky Coulee flow top is similar for the corresponding three and five layer cases. Pumping rates were chosen to give maximum drawdown at well RRL-2B of less than 305 m (1,000 ft) except for cases 2 and 5 where a maximum pumping capacity of 0.15 m^3/ min (40 gpm) was used. Drawdown in the Grande Ronde No. 2 flow top and Cohassett flow top for the six cases is given in Table 6. Measurable drawdown in the Rocky Coulee flow top, as far away from well RRL-2B as well DC-19, is predicted only for cases 2 and 5. At the distance of wells DC-16, DC-20, and DC-22 (about 2.5 km), measurable drawdown in the Rocky Coulee flow top is predicted for cases 1, 2, 4, and 5. Only in the cases in which the Rocky Coulee flow top has its smallest transmissivity value are drawdowns at the distance of wells DC-20 and DC-22 predicted to be too small to measure.

The simulated pumping from well RRL-2B lasted 50 days for each case using one day time steps. Simulation was continued in all cases except case 1 for 60 days to observe the recovery. The recovery for case 1 was extended to 500 days.

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Table 4. Drawdown in Rocky Coulee Flow Top from Pseudo Three-Dimensional Model Study of Three Layer Cases

		Case 1	Case 2	Case 3
Well RRL-2B Pumping Rate, m^3/min (gal/min)		0.03 (8)	0.15 (40)	0.002 (0.5)
Total drawdown in Rocky Coulee flow top in well RRL-2B after pumping 50 days, m		263	74	285
Maximum drawdown in Rocky Coulee flow top in selected wells after pumping well RRL-2B for 50 days, m	RRL-2C	64	26	28
	DC-16	2.1	6.9	0.003
	DC-19	0.1	2.6	0.0006

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Table 5. Drawdown in Rocky Coulee Flow Top from Pseudo Three-Dimensional Model Study of Five Layer Cases

		Case 4	Case 5	Case 6
Well RRL-2B Pumping Rate, m^3 / min (gal/min)		0.03 (8)	0.15 (40)	0.002 (0.5)
Total Drawdown in Rocky Coulee flow top in well RRL-2B after pumping 50 days, m		263	74	285
Maximum Drawdown in Rocky Coulee flow top in selected wells after pumping well RRL-2B for 50 days, m	RRL-2C	63	26	27
	DC-16	2.0	6.8	0.004
	DC-19	0.1	2.5	0.001

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Table 6. Drawdown in Grande Ronde No. 2 (GR2) and Cohassett (C) Flow Tops from Pseudo Three-Dimensional Model Study*(m)

	Case 1		Case 2		Case 3		Case 4		Case 5		Case 6	
	GR2	C	GR2	C	GR2	C	GR2	C	GR2	C	GR2	C
RRL-2C	17	12	8.9	5.9	5.1	3.3	13.9	9.8	7.1	5.1	4.3	2.99
DC-16	1.3	0.97	2.9	2.1	0.005	0.004	0.85	0.7	2.2	1.6	0.006	0.004
DC-19	0.03	0.02	1.2	0.93	0.0006	0.007	0.05	0.03	0.87	0.67	0.002	0.001

*Assumes no storage in Grande Ronde No. 2 and Rocky Coulee flow interiors; after pumping well RRL-2B for 50 days.

Figure 24 illustrates the simulated drawdown in the Rocky Coulee flow top under the conditions of case 1 after 30 days of pumping. It is apparent that, at 30 days, the drawdown to be expected at wells DC-20C and DC-22C is less than 0.6 m (2 ft). Figure 25 illustrates the simulated drawdown for the same case (case 1) after 50 days of pumping. After 50 days, at least 0.6 m (2 ft) of drawdown is predicted at wells DC-20C and DC-22C and the other monitoring facilities except for borehole DC-4 and well DC-19C. It is apparent from figures 24 and 25 that the cone of depression at 30 and 50 days is not substantially influenced by the marginal boundary conditions of the model.

Figure 26 indicates that drawdown in excess of 0.6 (2 ft) will be present in the Rocky Coulee flow top during the recovery from pumping under case 1 conditions at all monitoring sites except at well DC-19C. Thus, the commonly observed phenomenon of depression cone expansion during recovery will work to increase the scale of hydraulic influence during the recovery, over that of the drawdown or pumping period.

Figure 27 provides a comprehensive picture of simulated drawdown in the Rocky Coulee flow top while pumping it at 0.03 m^3/min (8 gpm) from well RRL-2B under the conditions of case 1. Drawdown at all observation points whose drawdown hydrograph appears in Figure 27 should be measurable after thirty days of pumping, except at well DC-19C.

The pseudo three-dimensional modeling showed that measurable drawdown will occur in the Rocky Coulee flow top and in adjacent flow tops within a radius of about 2.4 km (1.5 mi) from the pumping well if the transmissivity of cases 1 and 4 is assumed. This transmissivity is considered the best estimate and should sustain a planned discharge rate from the pumping well of 0.03 m^3/min (8 gpm). If the transmissivity is substantially greater than that of cases 1 and 4, as in cases 2 and 5, substantial drawdown can

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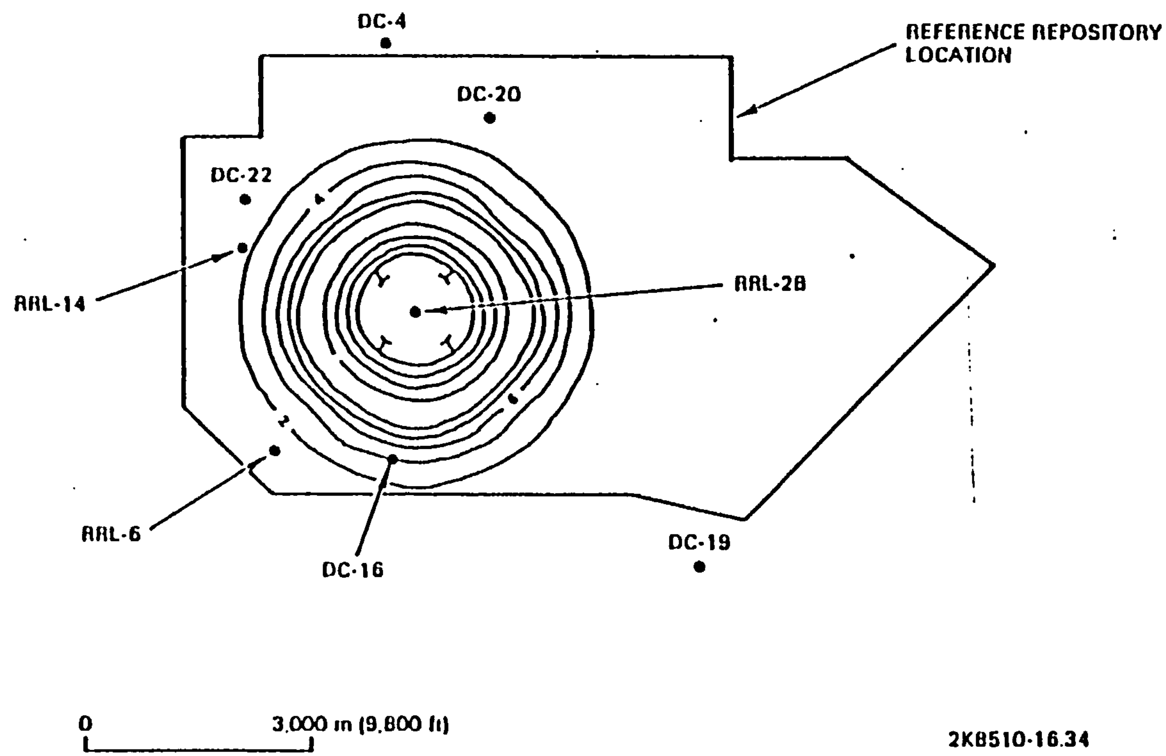

FIGURE 24. Simulated drawdown in Rocky Coulee flow top after 30 days of pumping at $0.03 m^3/min$ (8 gpm) from the Rocky Coulee flow top in well RRL-2B under conditions of case 1. Contour interval 2 ft (0.6m).

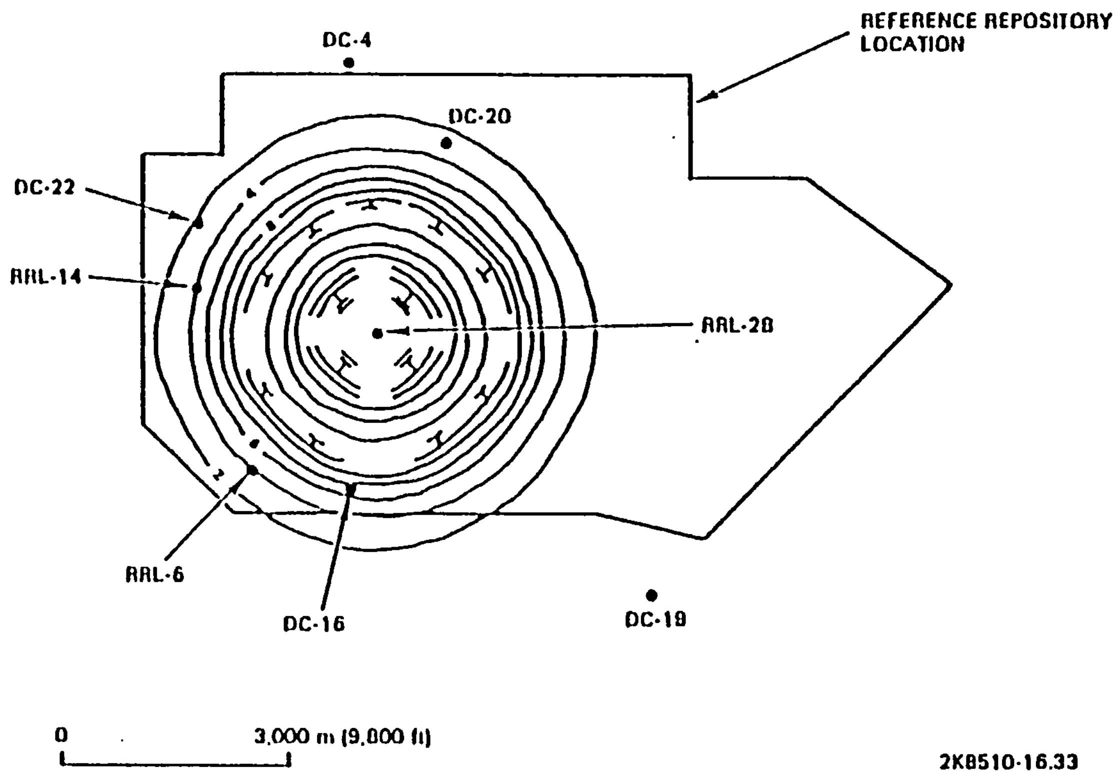

FIGURE 25. Simulated drawdown in Rocky Coulee flow top after 50 days of pumping at $0.03 m^3/min$ (8 gpm) from the Rocky Coulee flow top in well RRL-2B under conditions of case 1. Coutour interval 2 ft (0.6m).

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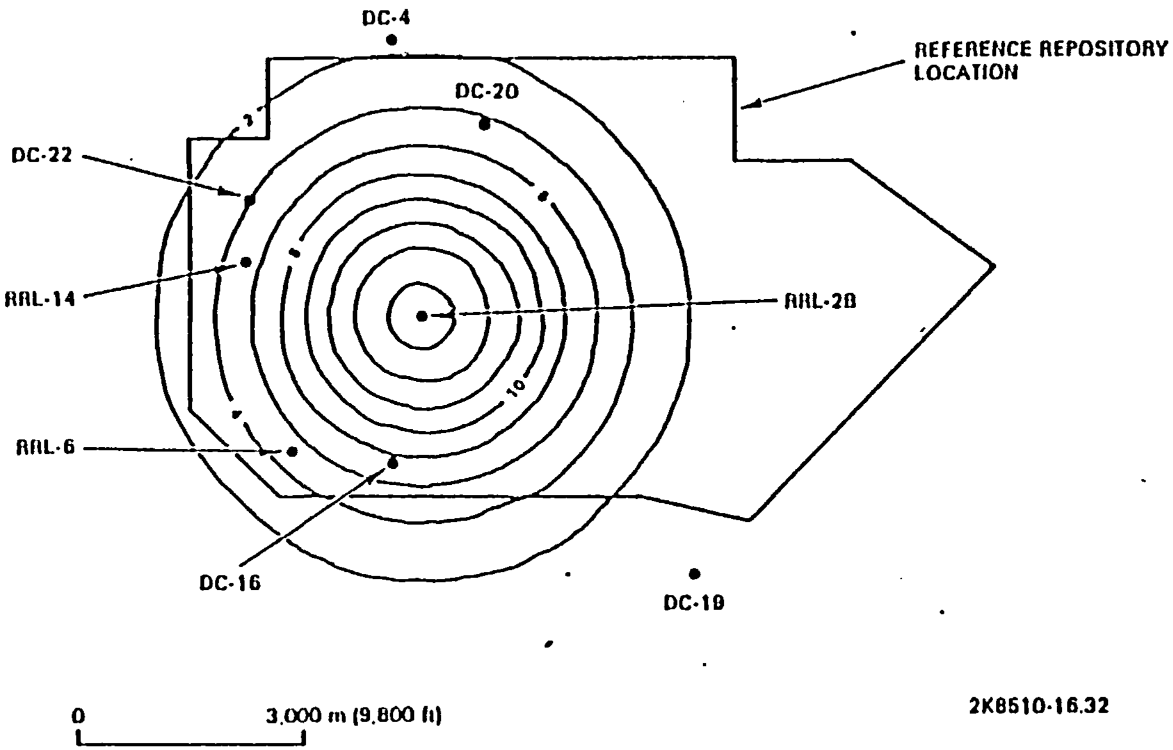

FIGURE 26. Simulated drawdown in Rocky Coulee flow top after 60 days of recovery following 50 days of pumping at $0.03 m^3/min$ (8 gpm) from the Rocky Coulee flow top in well RRL-2B under conditions of case 1. Contour interval 2 ft (0.6m).

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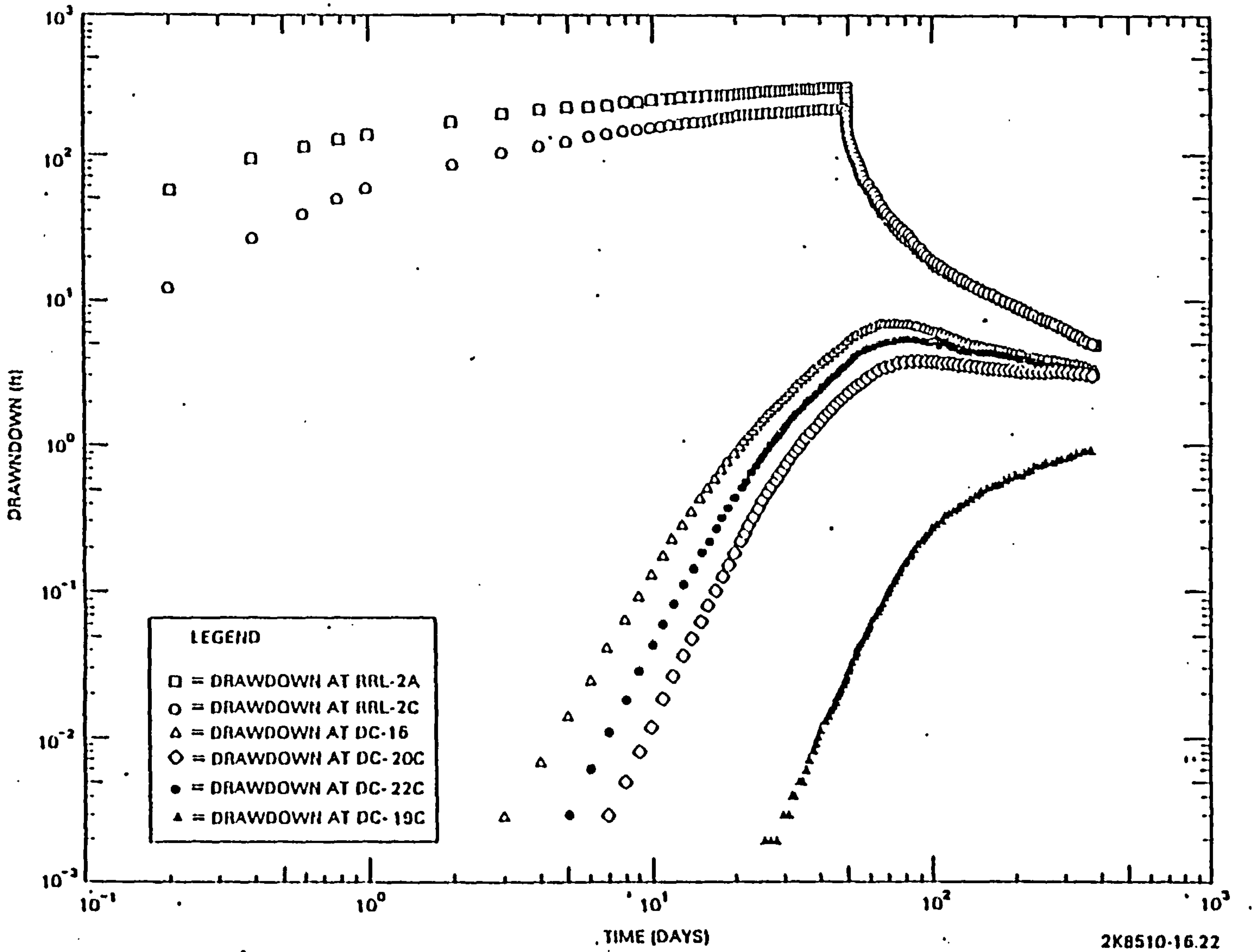

FIGURE 27. Simulated drawdown in Rocky Coulee flow top while pumping at $0.03 m^3/min$ (8 gpm) from the Rocky Coulee flow top in well RRL-2B under conditions of case 1. (Pumping ceased at 50 days. 1m=3.28 ft.)

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be propagated as far as well DC-19C (about 5 km (3.4 mi) from the pumping well). And finally, if the transmissivity of the Rocky Coulee flow top is substantially smaller than in cases 1 and 4, the radius of influence may not extend much beyond borehole RRL-2A and well RRL-2C. This result is predicted for cases 3 and 6.

Axisymmetric Model Study. Axisymmetric model simulations provided estimates of head drawdown in basalt flow interiors in response to pumping selected flow tops. The estimated responses allow the assessment of instrument adequacy and were helpful in deciding on the vertical placement of piezometer completion intervals in flow interiors.

Pumping test simulations were performed using the Golder Associates, Inc., transient, two-dimensional, axisymmetric, finite element code (Golder Associates, Inc., 1983). The work was performed by Golder Associates under Rockwell direction. Four cases were simulated. The first three cases used input parameter values based on single hole hydraulic tests performed in borehole RRL-2A (Wintczak, 1984). These values appear in Table 7 and are termed "base case" values. Sensitivity studies were conducted using these base case parameter values to determine head response in flow interiors to variation in the flow interior hydraulic diffusivity. The fourth simulation used flow top hydraulic conductivity values based on the geometric mean parameter values from single borehole testing (Table 8). These are termed "base case geometric mean values". Sensitivity studies were not conducted about these parameter values.

The vertical hydraulic conductivity of flow interiors for both base cases is assumed to be 3×10^{-6} m/day (1×10^{-5} ft/day). The ratio of K'/K is assumed to be 10 and 1 for the flow interiors and flow tops, respectively. The greater vertical conductivity in flow interiors is reasoned to be the consequence of less tortuous vertical flow pathways along mostly vertical cooling fractures. Values of specific storage were estimated to be 3.6×10^{-7} and 1×10^{-6} per metre (1.1×10^{-7} and 3.1×10^{-7} per ft) for flow interiors and flow tops, respectively.

Three simulations were calculated using the "base case" parameter values (Table 7). The flow interior vertical hydraulic conductivity was varied by one order of magnitude above and below the table value to yield a corresponding variation in the flow interior vertical hydraulic diffusivity, C_v ($=K'/S'_s$). The other parameters were held constant during the three simulations. The fourth simulation used the geometric mean hydraulic conductivity values for flow tops of the Grande Ronde Basalt equivalent to transmissivities given for use with the pseudo three-dimensional model (Table 2). The other parameter values remained the same as in the first three simulations.

The system modeled consists of areally extensive horizontal units of alternating basalt flow tops and basalt flow interiors. The modeled region is 236 m (773 ft) thick, extending from the top of the Grande Ronde No. 2

TABLE 7. Axisymmetric Model Geometry and Base Case Parameter Values

UNIT	DEPTH TO TOP OF UNIT,* m	THICKNESS OF UNIT,* m	HORIZONTAL CONDUCTIVITY, K,m/day	VERTICAL CONDUCTIVITY, K',m/day	SPECIFIC STORAGE S_s, m^{-1}	COMMENTS
Vantage	818	1.2				Not included in mesh
GR 1 FT	819	4.6	Upper boundary			Treat as Constant Head
GR 1 FI	823	5.8	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 2 FT	829	12.2	$7.6x10^{-4}$	$7.6x10^{-4}$	$1x10^{-6}$	
GR 2 FI	841	18.9	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 3 FT(Rocky Coulee)	860	24.9	$3.6x10^{-2}$	$3.6x10^{-2}$	$1x10^{-6}$	
GR 3 FI (Rocky Coulee)	885	26.8	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 4 FT (Cohassett)	912	5.2	$7.6x10^{-4}$	$7.6x10^{-4}$	$1x10^{-6}$	
GR 4 FI (Cohassett)	917	22.2	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 4 Vesicular Zone (Cohassett)	940	7.3	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 4 FI (Cohassett)	947	45.1	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 5 FT	992	24.4	$3x10^{0}$	$3x10^{0}$	$1x10^{-6}$	
GR 5 FI	1016	16.1	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 6 FT	1033	2.7	$3.6x10^{-2}$	$3.6x10^{-2}$	$1x10^{-6}$	
GR 6 FI	1035	6.4	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 7 FT	1042	7.3	$3.6x10^{-2}$	$3.6x10^{-2}$	$1x10^{-6}$	
GR 7 FI	1049	10.0	$3x10^{-7}$	$3x10^{-6}$	$3.6x10^{-7}$	
GR 8 FT	1059	6.4	Lower Boundary			Treat as Constant head

*Taken from results of drilling borehole RRL-2A.

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TABLE 8. Axisymmetric Model Geometry and Base Case Geometric Mean Parameter Values

UNIT	DEPTH TO TOP OF UNIT,* m	THICKNESS OF UNIT,* m	HORIZONTAL CONDUCTIVITY, K,m/day	VERTICAL CONDUCTIVITY, K',m/day	SPECIFIC STORAGE S_s, m^{-1}	COMMENTS
Vantage	818	1.2				Not included in mesh
GR 1 FT	819	4.6	Upper boundary			Treat as constant head
GR 1 FI	823	5.8	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 2 FT	829	12.2	3.9×10^{-3}	3.9×10^{-3}	1×10^{-6}	
GR 2 FI	841	18.9	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 3 FT (Rocky Coulee)	860	24.9	9.7×10^{-3}	9.7×10^{-3}	1×10^{-6}	
GR 3 FI (Rocky Coulee	885	26.8	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 4 FT (Cohassett)	912	5.2	3.9×10^{-3}	3.9×10^{-3}	1×10^{-6}	
GR 4 FI (Cohassett)	917	22.2	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 4 Vesicular Zone (Cohassett)	940	7.3	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 4 FI (Cohassett)	947	45.1	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 5 FT	992	24.4	7×10^{-3}	7×10^{-3}	1×10^{-6}	
GR 5 FI	1016	16.1	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 6 FT	1033	2.7	9.7×10^{-3}	9.7×10^{-3}	1×10^{-6}	
GR 6 FI	1035	6.4	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 7 FT	1042	7.3	9.7x10-3	9.7×10^{-3}	1×10^{-6}	
GR 7 FI	1049	10.0	3×10^{-7}	3×10^{-6}	3.6×10^{-7}	
GR 8 FT	1059	6.4	Lower Boundary			Treat as constant head

*Taken from results of drilling borehole RRL-2A.

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interior to the top of the Grande Ronde No. 8 flow top. The upper and lower boundaries were maintained as constant head boundaries in the finite element mesh. The mesh extends from the pumping well, RRL-2B, to a radial distance of 14,000 m (46,000 ft) where a constant head boundary is maintained. Mesh spacing is fine near well RRL-2C and becomes coarser towards the radial boundary. The finite element mesh incorporates 1,036 nodes and 972 elements.

The results of simulated pumping from the Rocky Coulee flow top for all four cases are illustrated in Figures 28, 29, 30, and 31. These results indicate that for all four cases measurable drawdown occurs at the radial distance of piezometer nest RRL-2C from the pumping well in about the upper one half of the Rocky Coulee flow interior after 10 days of pumping from the Rocky Coulee flow top. The RRL-2C piezometer nest is about 76 m (250 ft) from well RRL-2B. It is assumed that hydraulic head response in flow interiors of at least 0.6 m (2 ft) in a period of 30 days or less is required for positive identification and measurement of the head transients in the flow interiors within a reasonable period of time. The transducers that will be used to measure the flow interior head changes are known to drift down by about 0.3 m (1 ft) per month). Substantial drawdown also was calculated for the Cohassett flow top in all but case 3, the small C_v value case.

Pumping from the Grande Ronde No. 5 flow top was simulated and the results are summarized in Figures 32, 33, 34, and 35. A measurable drawdown response was calculated for the Grande Ronde No. 4 (Cohassett) flow interior up to the vesicular zone at about z = 46 m (z = 150 ft) within a pumping period of 20 days for all cases except the low C_v case. (z is the vertical distance from the upper or lower boundary of a flow top to a position in the overlying or underlying flow interior.) The low C_v case would require a pumping period in excess of 100 days to produce measurable drawdown as far into the Cohassett flow interior as the vesicular zone. Measurable drawdown response was calculated to at least the middle of the Grande Ronde No. 5 flow interior within a 10 day pumping period for all cases.

Limited check calculations were accomplished using the technique of Neuman and Witherspoon (1972). Some discussion on limitations of this technique is provided in a subsequent section. The flow interior drawdown responses calculated according to their method generally agree with those obtained using the axisymmetric model. Table 9 provides some of the flow top and flow interior responses estimated in the check calculations using the base case geometric mean parameter values. The table should be compared with responses shown in Figure 31.

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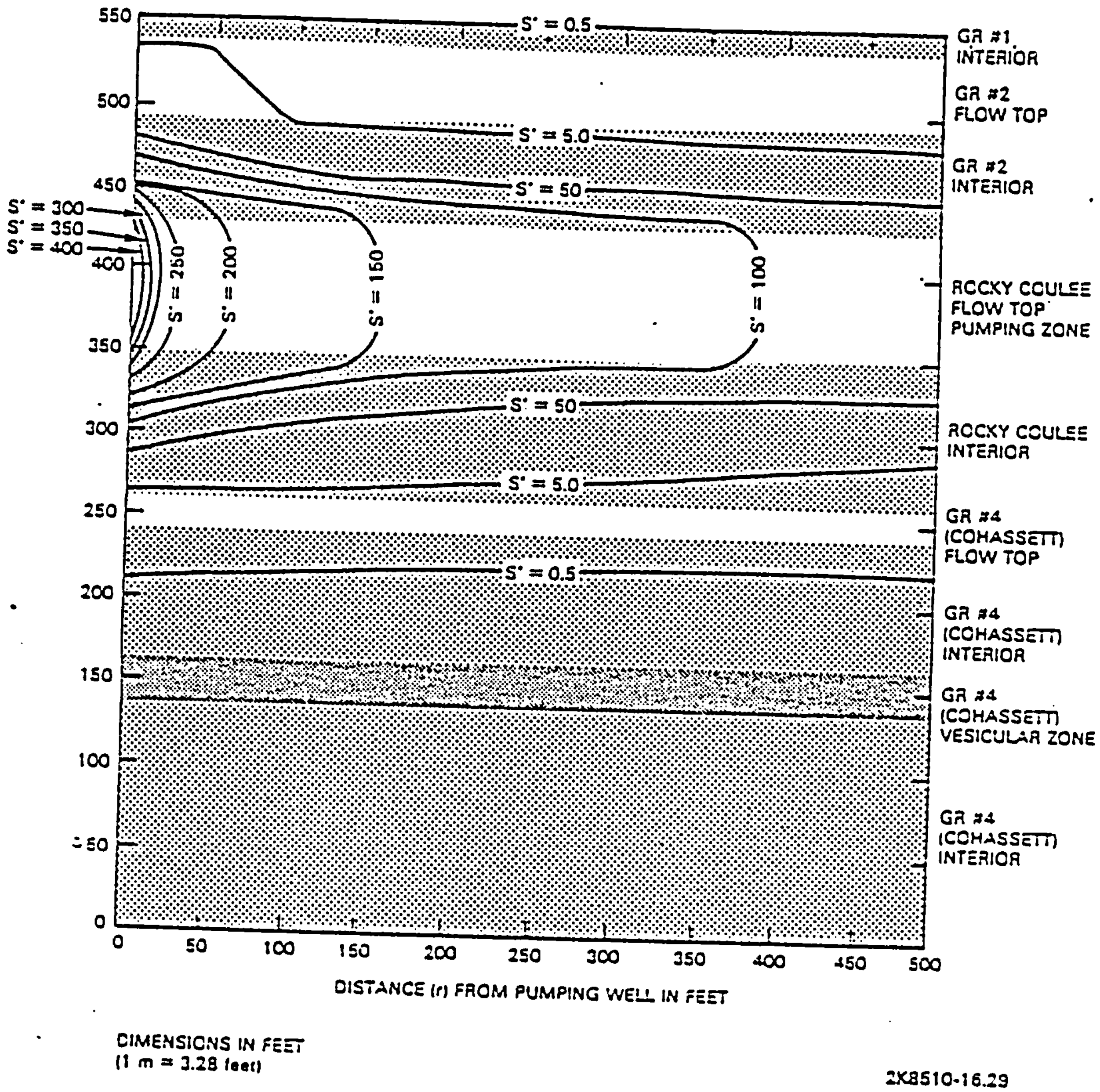

FIGURE 28. Vertical profile through pumping well RRL-2B while pumping from Rocky Coulee flow top at about 92.7 m^3/day (17 gpm). Drawdown contours for base case parameter values with C_v=91 after 10 days of pumping.

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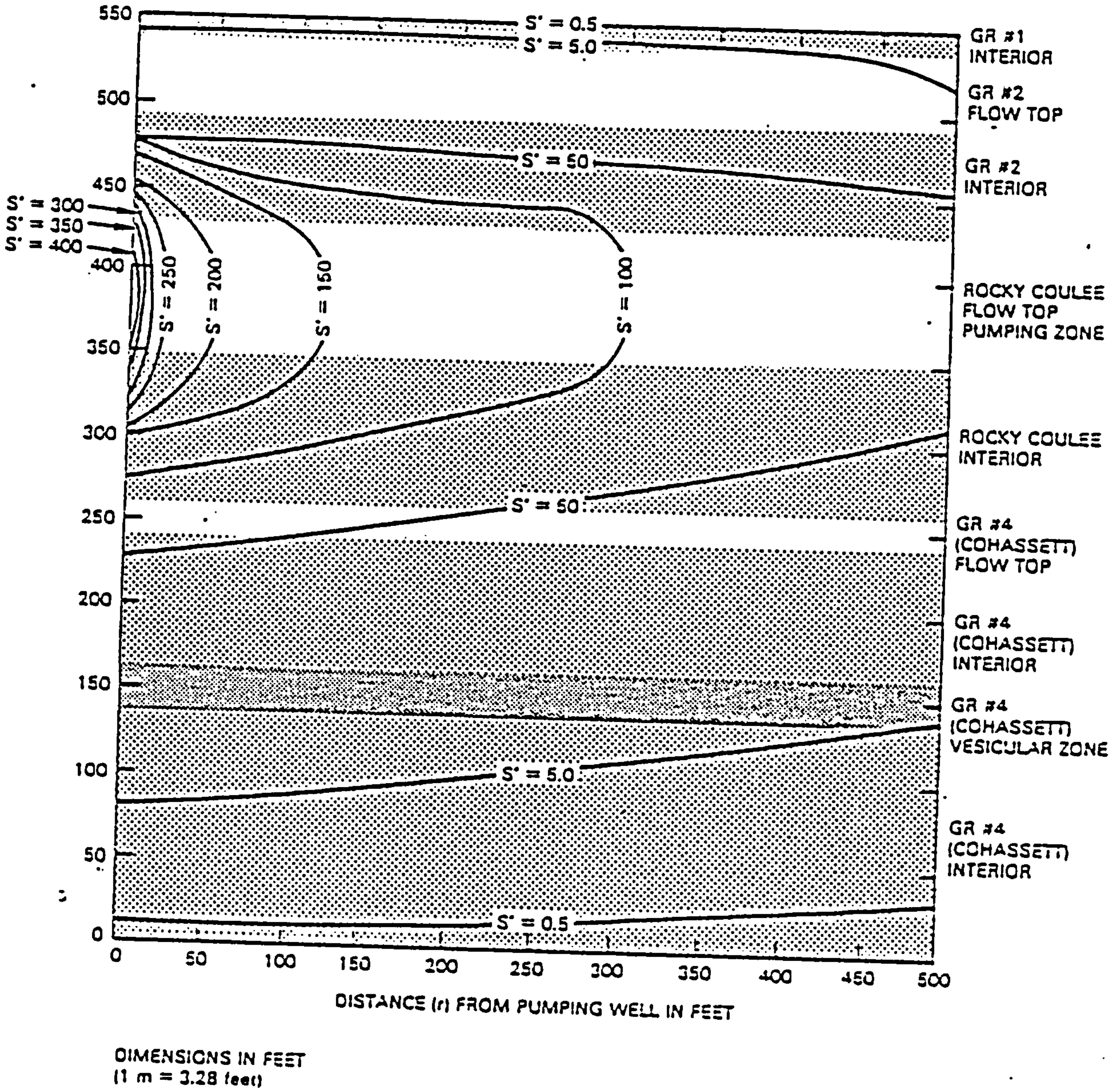

FIGURE 29. Vertical profile through pumping well RRL-2B while pumping from Rocky Coulee flow top at about 92.7 m^3/day (17 gpm). Drawdown contours for base case parameter values with C_v=910 after 10 days of pumping.

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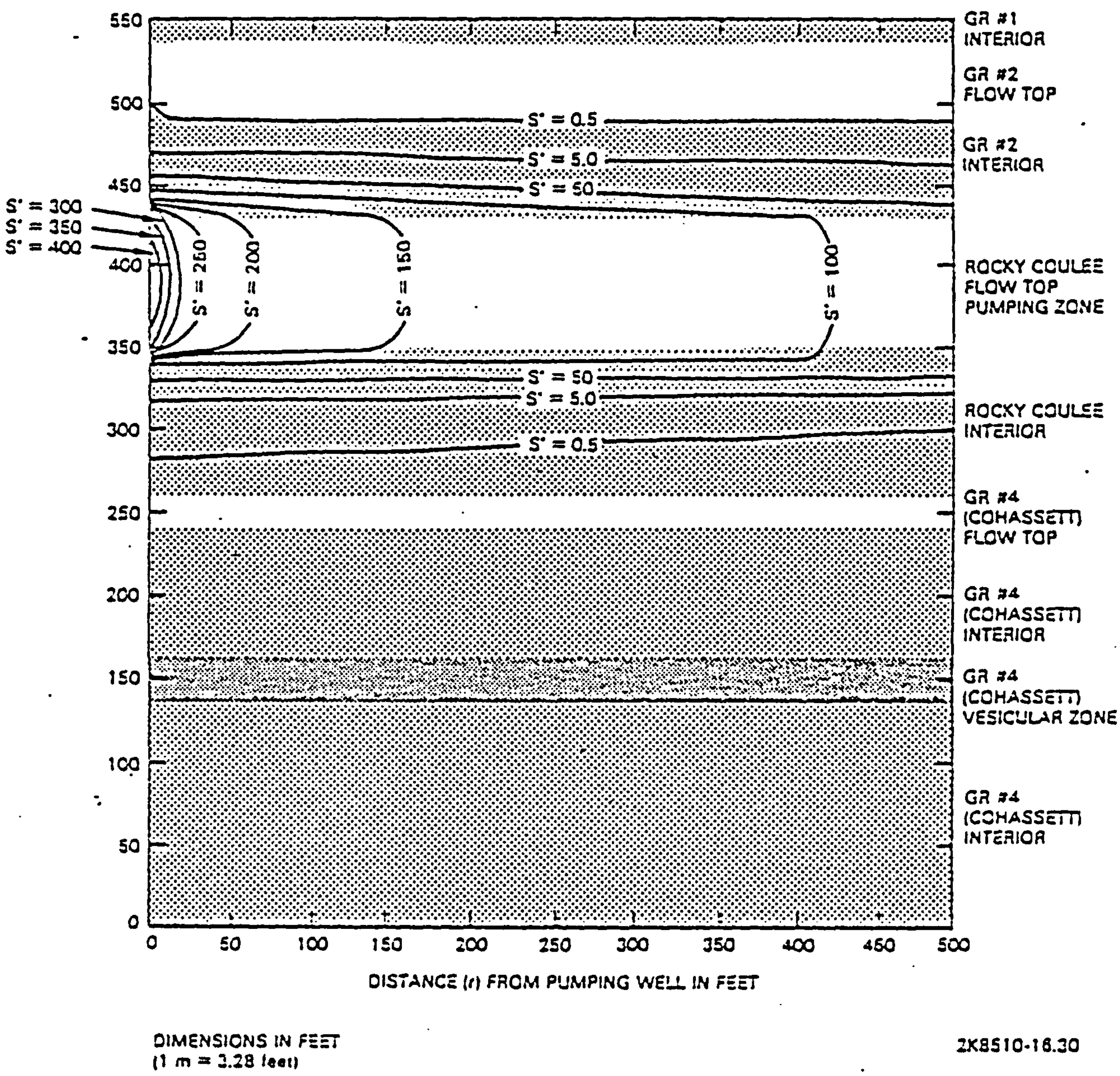

FIGURE 30. Vertical profile through pumping well RRL-2B while pumping from Rocky Coulee flow top at about 92.7 m^3/day (17 gpm). Drawdown contours for base case parameter values with C_v=9.1 after 10 days of pumping.

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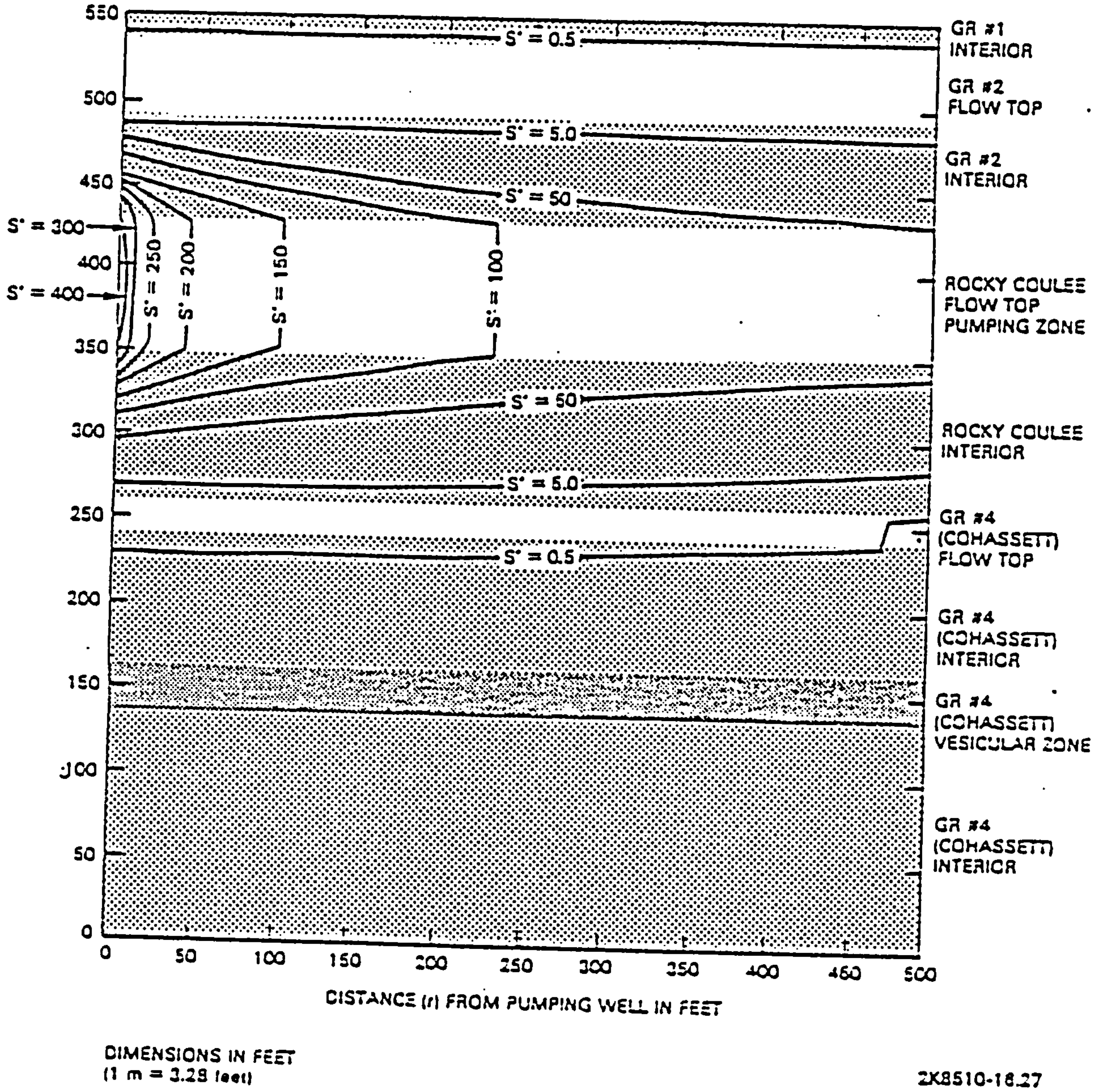

FIGURE 31. Vertical profile through pumping well RRL-2B while pumping from Rocky Coulee flow top at about 27.3 m^3/day (5 gpm). Drawdown contours for geometric mean parameter values with C_v=91 after 10 days of pumping.

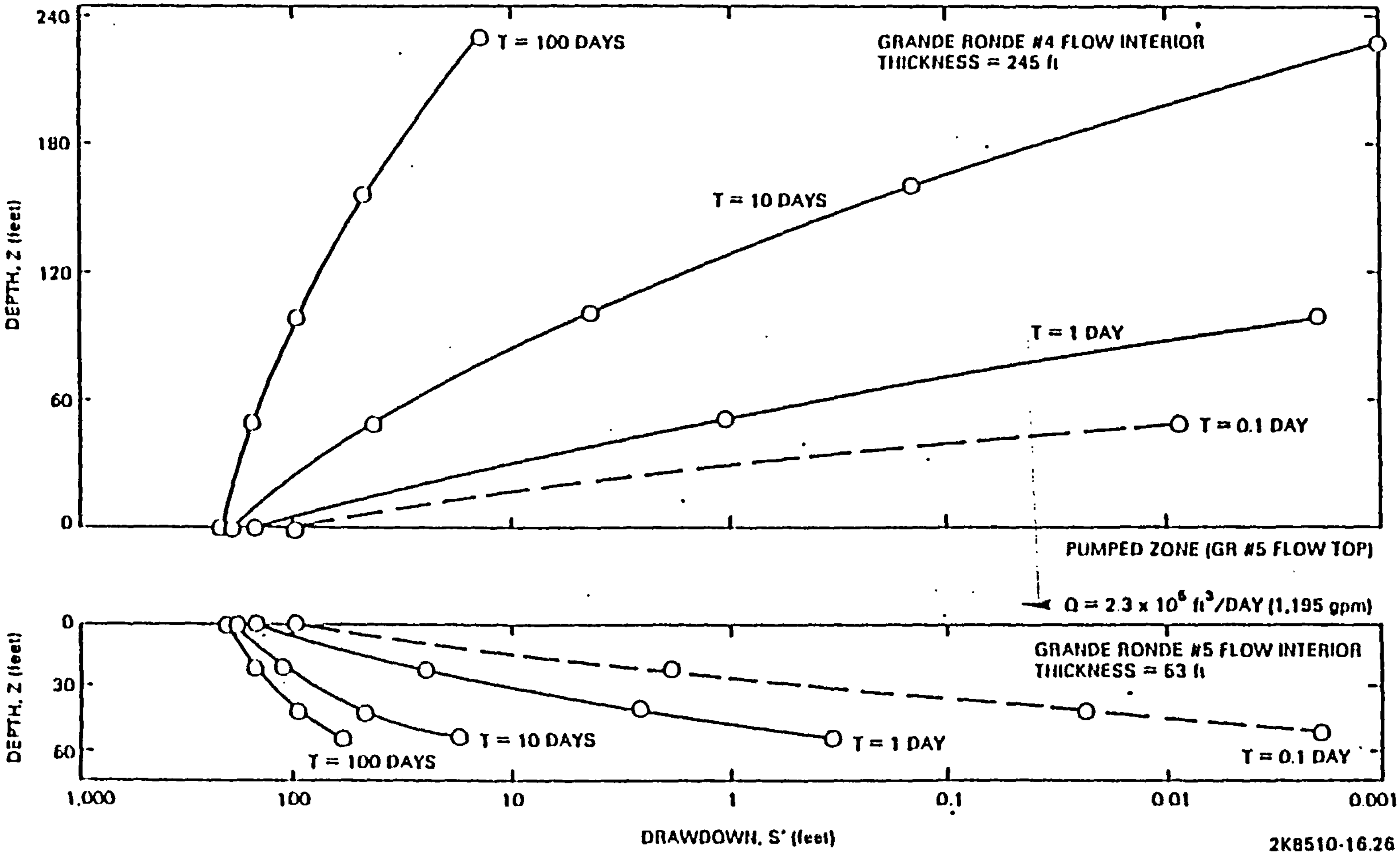

FIGURE 32. Drawdown at 76m (250 ft) from pumped well as a function of vertical distance from the pumped unit and time since pumping started. Pumping from the Grande Ronde No. 5 flow top. Base case with C_V=91.

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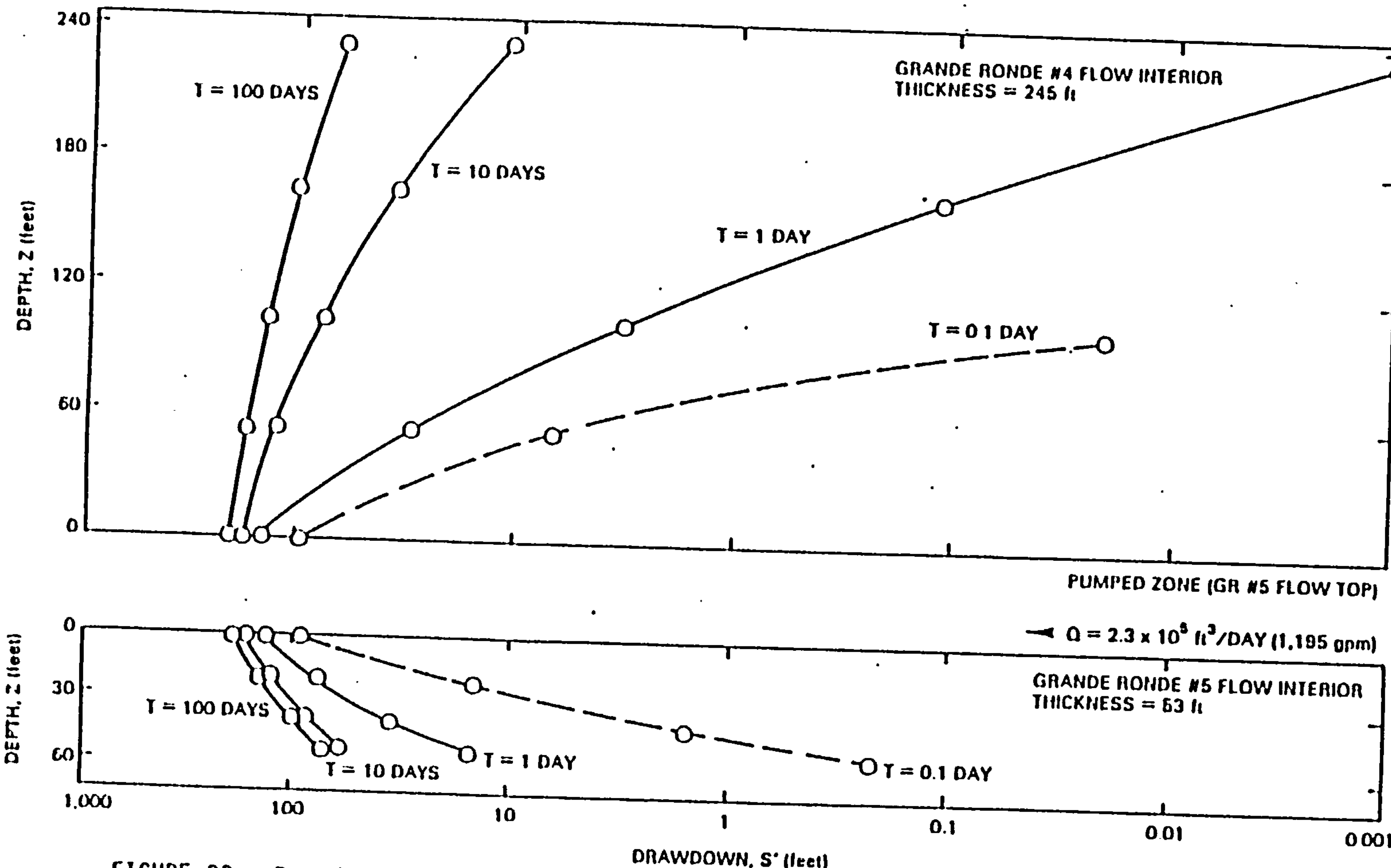

FIGURE 33. Drawdown at 76m (250 ft) radial distance from pumped well as a function of vertical distance from the pumped unit and time since pumping started. Pumping from the Grande Ronde No. 5 flow top. Base case with C_V=910.

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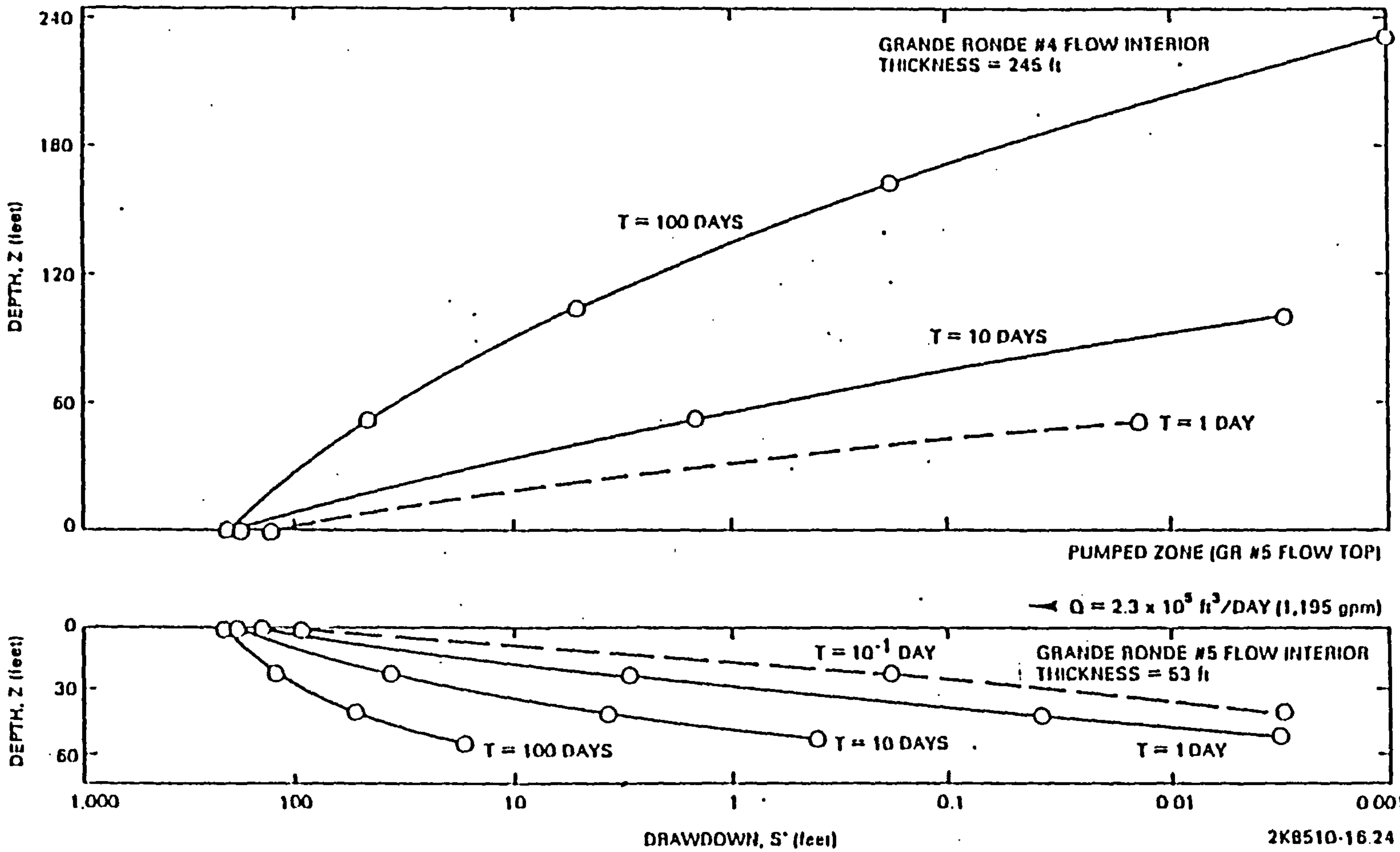

FIGURE 34. Drawdown at 76m (250 ft) radial distance from pumped well as a function of vertical distance from the pumped unit and time since pumping started. Pumping from the Grande Ronde No. 5 flow top. Base case with C_V=9.1.

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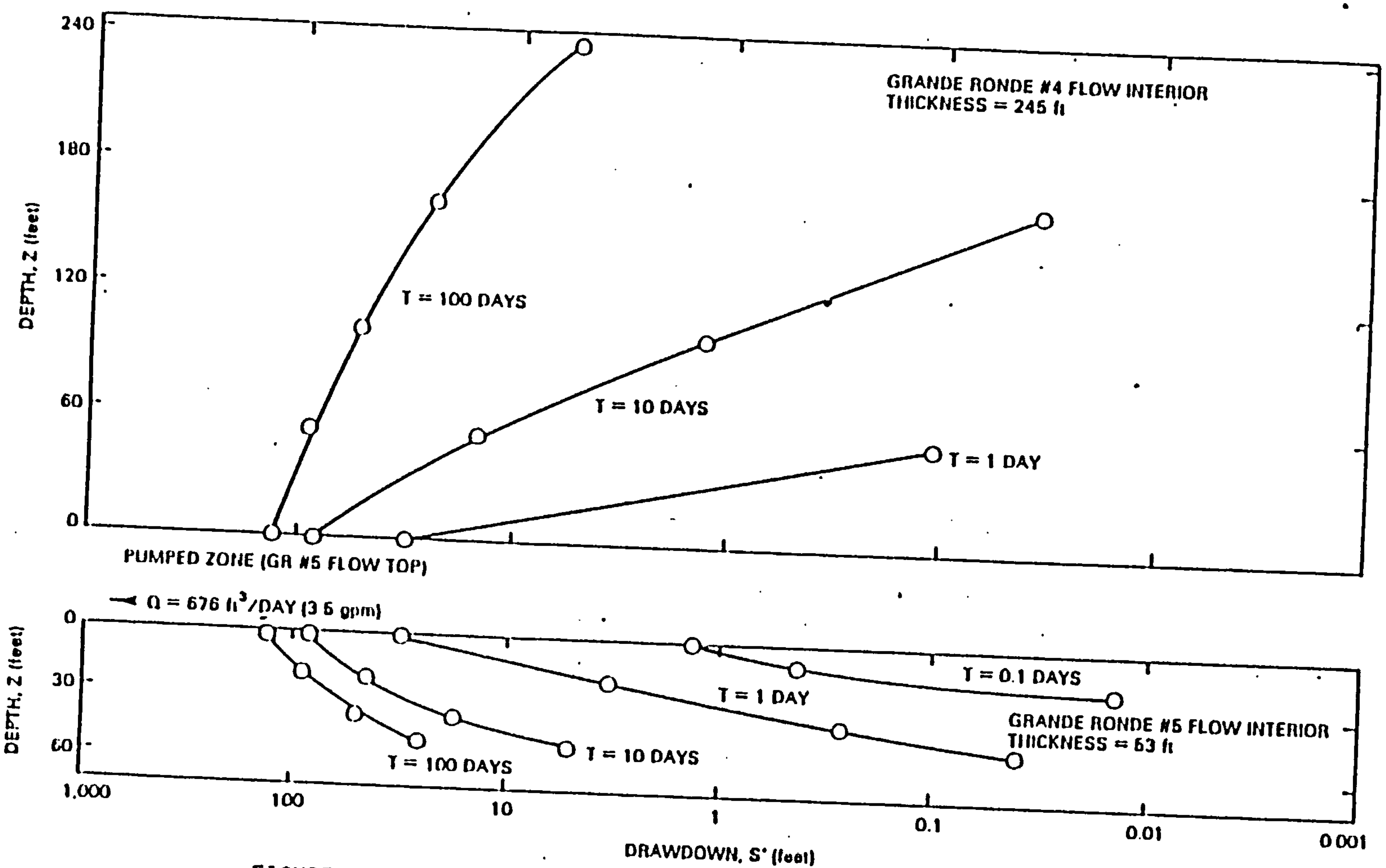

FIGURE 35. Drawdown at 76m (250 ft) radial distance from pumped well as a function of vertical distance from the pumped unit and time since pumping started. Pumping from the Grande Ronde No. 5 flow top. Base case using geometric mean parameter values and C_V=91.

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Table 9. Drawdown Response (ft) as Predicted by Theis and Ratio Method Analysis for Geometric Mean Base Case While Pumping from the Rocky Coulee Flow Top at 27.3m^3/day (5 gpm) after 10 Days.

Distance from Pumping well, r, ft	Rocky Coulee Flow Top Drawdown, ft	Rocky Coulee Flow Interior Drawdown, ft		
		z=5 ft	z=25 ft	z=50 ft
100	159	141	79	30.5
250	106	93	50	18
500	67		29	10

Measurable drawdown response should be observed in piezometers properly located in flow interiors overlying and underlying pumped flow tops at piezometer nest RRL-2C. The Rocky Coulee and Grande Ronde No. 5 flow tops are those to be pumped first and are respectively above and below the designated repository horizon (Cohassett flow). The Cohassett flow top will likely not be pumped because of its presumed small transmissivity. Flow interior piezometers in the Rocky Coulee flow, Cohassett flow, and Grande Ronde No. 5 flow have been installed in piezometer nest RRL-2C.

Placement of Piezometers in Flow Interiors. A series of estimates of the hydraulic head response in the Rocky Coulee, Cohassett, and Grande Ronde No. 5 flow interiors to pumping from the Rocky Coulee and Grande Ronde No. 5 flow tops was made to guide the design of well RRL-2C and the ratio method hydraulic tests to be performed using well RRL-2C. The estimates of hydraulic head response in the flow interiors were based on the theory of flow in aquicludes adjacent to slightly leaky aquifers (Neuman and Witherspoon, 1968). Those in the flow tops were based on standard transient flow theory for confined units.

It is assumed that hydraulic head response in flow interiors of at least two feet in a period of 30 days or less is required for positive identification and measurement of the head transients in the flow interiors. The transducers that will be used to measure the flow interior head changes have been found to drift down about one foot per month.

The theory (Neuman and Witherspoon, 1968) used to estimate hydraulic response in the flow interiors was judged to be valid for at least 100 days of pumping. The spacing of well RRL-2B and RRL-2C was judged to be small enough for the ratio method to be valid (Neuman and Witherspoon, 1972).

The estimates show that: a piezometer should be completed about 18 m (60 ft) below the Rocky Coulee flow top, in the Rocky Coulee flow interior; a piezometer should be completed about 24 m (80 ft) above the Grande Ronde No. 5 flow top, in the Cohassett flow interior; and a piezometer should be located about 14 m (45 ft) below the Grande Ronde No. 5 flow top, in the Grande Ronde No. 5 flow interior. The parameter values used to arrive at the above estimates are given in Table 10.

Drawdown in the flow interior of the Rocky Coulee, Cohassett and Grande Ronde No. 5 flows, was calculated directly from the theory of flow in aquicludes adjacent to slightly leaky aquifers. Drawdown in the Rocky Coulee and Grande Ronde No. 5 flow tops was calculated using the Theis equation. The conductivity used for the Rocky Coulee flow top is a geometric mean value for the reference repository location area. That used for the Grande Ronde No. 5 flow top was derived from an informal pumping test of well RRL-2C during well cleanup operations. The success of a ratio test and the drawdown in flow interiors is not particularly sensitive to the transmissivity of the flow tops as long as it is great enough to permit pumping and as long as the pumped discharge is adjusted to provide an adequately strong hydraulic sink.

When pumping from the Rocky Coulee flow top at 21.8 m^3/day (4 gpm), the drawdown in well RRL-2B (the discharging well) is estimated to be about 256 m (840 ft)at 30 days. Drawdown at z = 18 m (60 ft) in the Rocky Coulee flow interior at well RRL-2C resulting from the discharge from well RRL-2B is estimated to be about 3×10^{-2} m (0.1 ft), 1.8 m (5.9 ft), and 2.9 m (9.8 ft) at 20, 30, and 40 days, respectively. At z = 21 m (70 ft), the flow interior drawdowns are estimated to be about $< 3 \times 10^{-4}$ m (<0.001 ft), 0.152 m (0.5 ft), and 1.8 m (5.9 ft) for the same elapsed times, respectively.

When pumping from the Grande Ronde No. 5 flow top at 1,091 m^3/day (200 gpm), the drawdown in well RRL-2B is estimated to be about 104 m (340 ft) at 30 days. Drawdown at z = 24 m (80 ft) in the Cohassett flow interior at well RRL-2C resulting from the discharge from well RRL-2B is estimated to be about $<9 \times 10^{-3}$ m (0.03 ft), 0.7 m (2.4 ft), and 0.9 m (3.1 ft) at 20, 30 and 40 days, respectively. Drawdown at z = 14 m (45 ft) in the Grande Ronde No. 5 flow interior is estimated to be approximately 0.7 m (2.4 ft), 1.4 m (4.6 ft), and 1.8 m (6.1 ft) at 20, 30, and 40 days, respectively. Well RRL-2B and piezometer nest RRL-2C are assumed to be 76 m (250 ft) apart at the level of the Rocky Coulee flow top and Grande Ronde No. 5 flow top.

Tracer Test Design

Theoretical Basis for Design. The two-well convergent pulse technique will be applied to obtain estimates of the effective porosity and longitudinal dispersivity of the Rocky Coulee, Grande Ronde No. 5, and

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TABLE 10. Parameter Values Used in Determination of Vertical Position of Completion Interval in Well RRL-2C Flow Interior Piezometers*

UNIT	Horizontal Hydraulic Conductivity[1], K,m/day	Unit Thickness, b, m	Specific, Storage[2] S_s,m^{-1}	Vertical Hydraulic Conductivity[3], K, m/day
Rocky Coulee				
Flow Top	$3.8X10^{-2}$	3	$3X10^{-6}$	
Flow Interior		43	$2X10^{-7}$	$3X10^{-7}$
Cohassett				
Flow Interior		67	$1X10^{-7}$	$3X10^{-7}$
Grande Ronde No. 5				
Flow Top	$3.0X10^{0}$	6	$2X10^{-6}$	
Flow Interior		30	$3X10^{-7}$	$3X10^{-7}$

*These parameter values are not being reported here for the record. Some of the analyses on which they are based have not been verified or peer reviewed. The values are used simply as the basis for design of flow interior piezometers at at well RRL-2C.

[1]Geometric mean of conductivity values obtained from single well tests of the Rocky Coulee flow top in and near the RRL. A value obtained as an estimate of the Grande Ronde No. 5 flow top conductivity from testing at well RRL-2C.

[2]Based on Leonhart et al. (1985).

[3]Based on Spane et al. (1983).

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Umtanum flow tops. For the case in which steady withdrawal from the pumping well does not result in dewatering of the confined flow top, the volume of water pumped from the well during time t_0 is

$$V = Qt_0 = \pi x^2 hn \qquad (3)$$

where Q is the pump discharge rate, h is the thickness of the portion of the flow top that carries the flow, x is the distance from injection well to pumped well, n is the effective porosity of the portion of the flow top that carries the flow, and t_0 is the mean transit time of a tracer pulse from the injection well to the pumped well. Knowledge of the tracer pulse transit time between an injection well and a pumped well permits estimation of the flow top effective porosity using equation (3), provided the flow top is generally homogeneous and isotropic in its properties about the pumping well to the radius of the injection well.

An equation commonly used to describe the unidimensional transport of a non-reactive tracer in steady groundwater flow is (Fried, 1975)

$$\frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial x^2} - v\frac{\partial c}{\partial x} \qquad (4)$$

where c is the tracer concentration in the water, D is the coefficient of dispersion, v is the mean interstitial groundwater flow speed, and x and t are the space and time variables, respectively.

Lenda and Zuber (1970) solved equation (4) using appropriate initial and boundary conditions, for the tracer concentration in water from a pumping well resulting from an instantaneous tracer injection into the same horizon in another well. Their approximate solution to this problem is given by

$$\frac{cx^2hn}{m} = \frac{1}{\pi}\frac{1}{\sqrt{4\pi\frac{D}{vx}\left(\frac{t}{t_0}\right)^3}}\exp -\left[\frac{(1-{}^{t}/t_0)^2}{4\frac{D}{vx}\frac{t}{t_0}}\right] \qquad (5)$$

where m is the mass of the injected tracer. In radial flow v is not constant but the ratio of D/v is assumed to remain so ($D = \alpha v$; α = longitudinal dispersivity), in the range of pure hydrodynamic dispersion. Equation (5) has its limitations and should be considered only an approximate solution because its integral over the space coordinate does not yield the injected mass of tracer (Zuber, 1974).

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In radial flow, dispersion phenomena may often be treated unidimensionally. This is especially true with convergent pulse tracer tests where the flow lines converge on the pumped well, largely obliterating the effects of transverse dispersion.

Various theoretical tracer breakthrough curves calculated using equation (5) are given in Figure 36. The curves give dimensionless tracer concentration as a function of dimensionless time for various values of D/vx.

Using equation (5) and Figure 36 it is possible to estimate the quantity of tracer material that must be injected at the injection well for a measurable output at the pumping well. To do this one must have estimates of the dispersivity of the flow tops and of their effective thickness (hn product). In addition, the well spacing and pumped well discharge must be known or estimated.

Design Assumptions. The two-well recirculating tracer tests carried out at the DC-7/8 site in the McCoy Canyon flow top at Hanford provide the basis for estimates of flow top longitudinal dispersivity and effective thickness used here in the tracer test design. The McCoy Canyon tracer tests (Leonhart et al., 1985) provide estimates of longitudinal dispersivity that range from 0.46 to 0.84 m (1.5 to 2.8 ft) and of effective thickness that range from 0.002 to 0.003 m. The portion of the flow top that transmits the majority of the flow could be as thin as 1 m (3 ft). We used α = 0.84 m and n = 0.003 for design of the convergent tracer tests. Dynamic fluid temperature logging in well RRL-2C before piezometer installation provided information on the thickness of the portion of the Rocky Coulee and Grande Ronde No. 5 flow tops that carries the major portion of the flow.

Pumping rates from the Rocky Coulee flow top in well RRL-2B of 0.45, 0.9, and 1.8 m^3/hr (2, 4, and 8 gpm) are used in the tracer test design. Pumping rates from the Grande Ronde No. 5 flow top in the same well of 11.3, 22.7, and 45.4 m^3/hr (50, 100, and 200 gpm) are used in the tracer test design. (It is assumed that the Cohassett flow top is not transmissive enough to sustain pumped withdrawal at a useful rate). The two injection wells, borehole RRL-2A and piezometer nest RRL-2C, are located about 152 m (500 ft) and 76 m (250 ft) away from the pumping well, respectively. Design of tracer tests in the Umtanum flow top at the RRL-2 site is deferred until the Rocky Coulee and Grande Ronde No. 5 tracer tests have been completed.

In summary, the parameter values for tracer test design are:

- α = 0.84 m (2.8 ft)
- n = 0.003
- Q = 0.45, 0.9, 1.8, 11.3, 22.7, and 45.4 m^3/hr (2, 4, 8, 50, 100, 200 gpm)
- x = 76 m (250 ft), 152 m (500 ft)

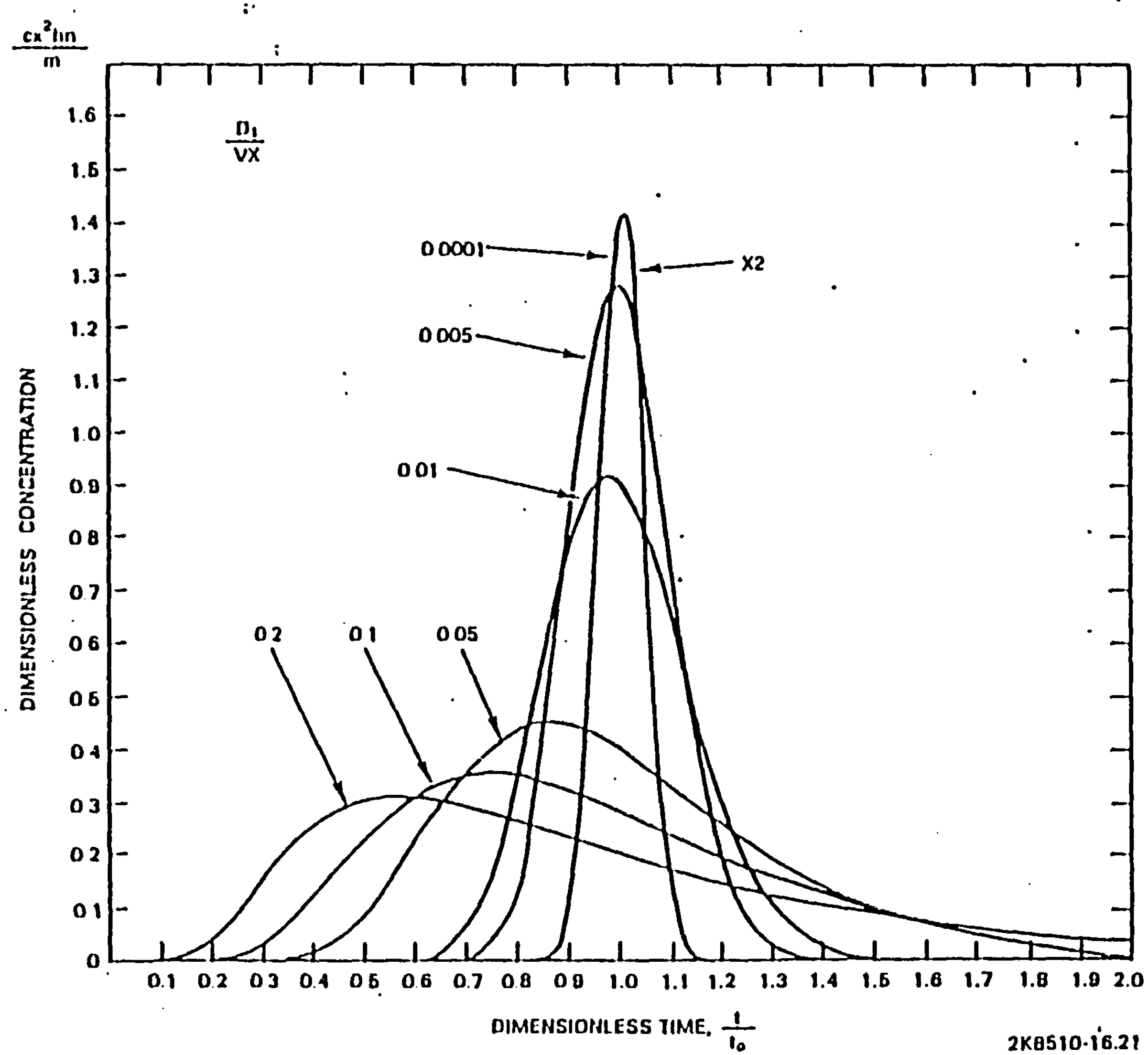

FIGURE 36. Normalized tracer breakthrough curves calculated using equation (5) (from Lenda and Zuber, 1970).

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- h = 1 m (3 ft) for Rocky Coulee flow top
- h = 9 m (30 ft) for Grande Ronde No 5 flow top

Results of Design Calculations. Mean tracer transit time from the two injection points (borehole RRL-2A and piezometer nest RRL-2C) to pumping well RRL-2B can be estimated using a rearrangement of equation (3):

$$t_0 = \frac{\pi x^2 hn}{Q} \qquad (6)$$

The estimated values of t_0 appear in Table 11.

Table 11. Mean Tracer Transit Time, Days

Q, m³/hr (gpm)	x=76 m (250 ft)	x=152 m (500 ft)
Rocky Coulee flow top		
0.45 (2)	5	20
0.9 (4)	2.5	10
1.8 (8)	1.3	5
Grande Ronde No. 5 flow top		
11.3 (50)	1.8	7.2
22.7 (100)	0.9	3.6
45.4 (200)	0.45	1.8

For the range of pumping well discharge rate assumed, mean tracer transit times from 0.45 days (10.8 hours) to about 7.2 days can be expected in the Grande Ronde No. 5 flow top. Mean tracer transit times from 1.3 to 20 days can be expected in the Rocky Coulee flow top. The total time required for complete tracer pulse recovery at the pumping well should be greater than the mean transit times given in Table 11. The mean transit times however, provide a fair general estimate of the time requirements for tracer test monitoring. Field measurement of the tracer concentration in water from the pumped well will provide information to guide its sampling for possible laboratory analysis of tracer content. Sampling should continue after pulse arrival until the tracer concentration drops to near the detection limit or to near the background concentration in the groundwater.

Because the purpose of this tracer test is fundamentally to trace the speed of movement and efficiency of mixing of groundwater in a controlled experiment, non-reactive (conservative) tracers were chosen. It was also required that the tracers have reasonably small background concentrations in the groundwater and low analytical detection limits. It is planned to inject an ammonium thiocyanate solution into the Rocky Coulee flow top in well RRL-2C and a lithium bromide solution and deuterium into the Rocky Coulee flow top in borehole RRL-2A. In discussion of results of the DC-7/8 tracer test, Leonhart et al. (1985) report minor declines in thiocyanate concentration with time in water samples from the pumped well, analyzed in the laboratory. Over the period of a short tracer test, where thiocyanate is determined in the field, this should not be a serious complication. In a later tracer test a pentafluorobenzoate (PFB) solution will be injected into the Grande Ronde No. 5 flow top in borehole RRL-2A and a metatrifluoromethylbenzoate (MTFMB) solution will be injected into the Grande Ronde No. 5 flow top in well RRL-2C. Deuterium may be used as a tracer in the Grande Ronde No. 5 tracer test depending on the nature of results obtained using deuterium in the Rocky Coulee flow top test. Bromide exists naturally in the Grande Ronde waters at concentrations of about 1 mg/l (1 ppm) and the practical detection limit for SCN^- is also about 1 mg/l. PFB and MTFMB are exotic synthetic organic compounds with no natural occurrence in deep groundwater. Their detection limit is about 0.1 mg/l.

A rearrangement of equation (5) was used to estimate the mass of tracer to be injected into Grande Ronde flow tops in borehole RRL-2A and piezometer nest RRL-2C.

$$m = \frac{cx^2hn}{\frac{1}{\pi}\frac{1}{\frac{4\pi D}{vx}\left(t/t_0\right)^3}\exp\left[\frac{-(1-t/t_0)^2}{\frac{4D}{vx}t/t_0}\right]} \qquad (7)$$

The peak Br^- and SCN^- concentration at the pumping well should be about 10 times the background or detection limit concentration so c in equation (7) was taken as 10 mg/l (10 ppm) for Br^- and SCN^-. It is believed that a deuterium concentration peak twice the natural concentration (about 15 mg/l) will be more than adequate to detect its breakthrough at the pumping well. Finally, c in equation (7) was taken as 2.5 mg/l (25 times the detection limit) for both PFB and MTFMB in calculating the appropriate mass of these tracers to be injected.

The values of x and hn used in calculating required tracer mass are as given under design assumptions. Values of D/vx were calculated using $v = x/t_0$ and $D = \alpha v$. The appropriate value of dimensionless time, t/t_0, for use in estimating required tracer mass was scaled from Figure

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SS at the dimensionless concentration peak of the breakthrough curve corresponding to the calculated value of D/vx.

The mass of tracer required, according to equation (7) is independent of the discharge rate of the pumped well (RRL-2B) because the mean interstitial groundwater flow speed, v, which varies with the pumped well discharge rate, appears in both the numerator and denominator of an expression equivalent to D/vx,

$$\frac{D}{vx} = \frac{\alpha v}{vx} = \frac{\alpha}{x} \qquad (8)$$

The value of α/x is invariant for a given flow-top-and injection well-pumping well spacing. Thus, the appropriate value of t/t_o for use in equation (7) does not vary with the discharge rate of the pumped well.

The parameters of the Rocky Coulee flow top tracer test design are given in Table 12. The tracer substances will be dissolved in appropriate volumes of Rocky Coulee water to provide a balance between the need to limit both total tracer solution concentration and volume of tracer solution and yet provide an initial tracer concentration great enough that the breakthrough will be detectable at well RRL-2B. It is desirable to limit tracer solution concentration to avoid large water density contrasts in and near the injection boreholes and well.

Table 12. Parameters of Rocky Coulee Flow Top Tracer Test Design

Injection Point, Tracer(s)	Tracer Mass to be Injected, kg	Volume, l; and Concentration of Tracer Solution, mg/l
RRL-2A		
LiBr	1.0[A]	130;7700
Deuterium	2.2[B]	130;1700
RRL-2C		
NH_4SCN	0.4[A]	60;7000

[A] Adequate to provide 10 times background or detection limit concentration at peak of pulse at well RRL-2B.

[B] Adequate to provide 2+ times background concentration at peak of pulse at well RRL-2B.

It is desirable to limit tracer solution volume to minimize the hydraulic disturbance caused by tracer solution injection and to provide an approximately instantaneous pulse tracer injection into the flow top. The tracer solution to be injected into borehole RRL-2A will contain 7,100 mg/l of bromide and that to be injected into well RRL-2C will contain 5,100 mg/l of thiocyanate. The bromide and thiocyanate content of water pumped from RRL-2B will be measured with a high performance liquid chromatograph. The thiocyanate content of water from well RRL-2B will be also measured with a double beam spectrophotometer. Samples of water pumped from well RRL-2B will be collected throughout the tracer test for subsequent deuterium analysis using mass spectrography.

The parameters of the Grande Ronde No. 5 flow top tracer test design are given in Table 13. The volume of Grande Ronde No. 5 flow top water used to dissolve the PFB and MTFMB was chosen using the same considerations applied to determination of the volume of tracer solution to be injected into the Rocky Coulee flow top. The PFB and MTFMB content of water pumped from well RRL-2B will be measured also with a high performance liquid chromatograph (HPLC).

Table 13. Parameters of Grande Ronde No. 5 Flow Top Tracer Test Design

Injection Point, Tracer(s)	Tracer Mass to be Injected, kg	Volume, l; and Concentration of Tracer Solution, mg/l
RRL-2A		
PFB	1.25	200;6250
RRL-2C		
MTFMB	0.5	100;5000

Note: Tracer mass adequate to provide 25 times detection limit concentration at peak of pulse at well RRL-2B.

The tracer solution injected into borehole RRL-2A and well RRL-2C will be followed by Rocky Coulee water to force the tracer solution out into the flow top and to flush it from the borehole and the sand pack in the well. The mechanics of actually injecting the tracer solution into the Rocky Coulee flow top at borehole RRL-2A and well RRL-2C are treated in the test procedures. Injection at both of the injection points will occur as quickly as reasonably possible. The tracer solution will be followed by Rocky Coulee water of at least two times the well or borehole dead volume.

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At borehole RRL-2A, the 130 liters of tracer solution will be followed by about 60 liters of Rocky Coulee water. Using results from pseudo-three dimensional modeling, the pressure required to inject the tracer solution and the approximate time to inject the solution can be derived. The tracer solution and the "chase" water will be injected into the Rocky Coulee flow top under 250 m of pressure head. The tracer solution is expected to flow into the Rocky Coulee flow top in about four minutes. At well RRL-2C, the 100 liters of tracer solution will be followed by about 400 liters of Rocky Coulee water. The tracer solution and the "chase" water will be injected into the Rocky Coulee flow top under 250 m of pressure head. The tracer solution is expected to flow into the Rocky Coulee flow top in about 3 minutes.

Estimates of "chase" water volumes required, injection pressures, and time to inject tracer solutions into the Grande Ronde No. 5 flow top will be derived prior to the tracer tests in the unit, based on experience gained in the Rocky Coulee tracer test.

Groundwater Sampling and Analysis

Field Facilities. A field laboratory installed in a small trailer will be the main field facility for groundwater sampling and field analysis of groundwater samples obtained from well RRL-2B. A small portion of the discharge stream from the pumped well will be piped into the field laboratory. Suitable valves will be installed to control flow and two sample spigots will be installed between the well head plumbing and the field laboratory. These spigots will be used for collection of samples to be analyzed for uranium/thorium decay series radionuclides.

Groundwater piped into the field laboratory from pumping well RRL-2B during the early stages of pumping will be monitored with daily measurements of pH, conductivity, turbidity, total alkalinity, oxidation-reduction potential, and temperature. These measurements, together with measurements of the major inorganic constituents, total organic carbon (TOC), and tritium* will provide the basis for determining when representative groundwater samples (clear water with consistent chemical composition) were obtained. Equipment to be used in groundwater sampling is listed in detail in Basalt Operating Procedures C-4.71 and C-4.82.

Sampling Activities. The sampling will include the collection of groundwater samples and gas samples. Groundwater samples will be collected throughout the pumping period for each horizon tested in well RRL-2B. Groundwater collected at the surface will be analyzed for major cations and anions, trace elements, stable and radioactive isotopes, pH, alkalinity, temperature, and oxidation-reduction potential. Groundwater collected at depth in the well, using subsurface sampling techniques, will be analyzed for dissolved gas content and for ^{14}C. Additional gas samples will be

*There is no real time advantage in measuring this parameter, but it will be useful as historical data.

collected from a gas-water separator at the surface. Table 14 summarizes the specific sample analyses planned, aside from tracer analysis. In addition to well-head sampling, a narrow diameter downhole sampling device will be used to collect a specimen for dissolved gas analysis by lowering the device to the formation level, after pumping ceases.

Samples of groundwater for field analysis and determination of total organic carbon (TOC), tritium, chloride, dissolved oxygen, and sodium will be taken at 24 hour intervals during pumping periods at well RRL-2B. Formal groundwater samples for the entire suite of determinations as shown in Table 14 will be collected every third day until the end of pumping. The last two samples before tracer breakthrough will be submitted for full-suite analysis. Groundwater samples will be analyzed in the field for tracer content at one-half hour intervals between tracer injection and tracer breakthrough. After the first appearance of tracer in water from well RRL-2B, samples will be analyzed in the field at least every 15 minutes for tracer content and groundwater samples will be taken every 15 minutes for possible laboratory tracer analysis.

EQUIPMENT REQUIREMENTS

Equipment for Hydraulic Testing

Aside from the wells, piezometers and boreholes discussed previously, several other items of equipment and systems will be used in the multiple-well hydraulic tests. These items and systems are described briefly as follows.

Submersible Pumps. Submersible, electric, turbine pumps will be used to pump water from some of the horizons to be tested by pumping, in well RRL-2B. The submersible pump to be used in pumping the Grande Ronde No. 5 flow top will be capable of pumping 22.7 to 45.4 m^3/hr (100 to 200 gpm) against 335 m (1,100 ft) to 244 m (800) of head. The pumps will be equipped with dynamic gas separators to remove most of the free gas from the pumped water. Requirements exist, of course, for pump power cable, drop pipe, and electrical controls. A positive displacement (rod) pump system will be used to pump from the Rocky Coulee flow top at about 44 m^3/day (8 gpm).

Emergency Power Supply. An emergency power supply will assure that pumping can continue uninterrupted during a short line power outage. A 100 Kw, three phase, diesel-powered generator equipped with an automatic start and switching system will provide uninterrupted power at the RRL-2 site. This generator will be capable of powering the pump, as well as the pressure measuring and recording systems at the RRL-2 site. It is assumed that line power outages will be a few minutes to a few hours in length, hence the primary concern in long-term (30-60 day) pumping tests is to keep the pump running; loss of a few minutes or a few hours of pressure

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Table 14. Summary of Measurements and Analyses to be Performed on Groundwater and Gas Samples from Well RRL-2B*

Field Analysis - Groundwater Samples Collected at Surface

- ph
- turbidity
- electrical conductivity
- alkalinity
- oxidation-reduction potential
- temperature

Laboratory Analysis - Groundwater Samples Collected at Surface

- Major cations - Na, Ca, K, Mg, Si
- Major anions - Cl, SO_4, F, S
- Total Organic Carbon (TOC)
- Trace Elements - Al, Ba, B, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, Pb, Sr, Zn
- Stable Isotopes - δ^2H, $\delta^{18}O$, $\delta^{13}C$, $\delta^{34}S$
- Radioisotopes - ^{14}C, ^3H, ^{36}Cl, ^{129}I, ^{99}Tc
- Uranium/Thorium Disequilibrium Series - ^{238}U, ^{234}Th, ^{234}U, ^{230}Th, ^{226}Ra, ^{222}Rn, ^{214}Pb, ^{214}Bi, ^{210}Pb, ^{210}Po, ^{235}U, ^{232}Th, ^{228}Ra, ^{228}Th, ^{224}Ra
- Dissolved Oxygen

Laboratory Analysis - Gas Samples Collected at Surface

- Major Gaseous Phases - CH_4, CO_2, O_2, N_2, H_2S, CO, Ar
- Stable Isotopes - $\delta^{13}C$

Laboratory Analysis - Groundwater Samples Collected with Subsurface Sampler

- Dissolved Gases - N_2, O_2, CO_2, CH_4, Ar, CO, H_2S
- Specific Dissolved Gas Isotopes - ^4He, ^{20}Ne, ^{22}Ne, ^{36}Ar, ^{40}Ar, ^{222}Rn
- Radioisotopes - ^{14}C, ^{226}Ra

* All samples subjected to field analysis as well as determination of TOC, tritium, chloride, dissolved oxygen, and sodium. Not all samples will be subjected to laboratory analysis, depending on the measured development ratio (water pumped/fluid lost in drilling and testing operations). If suitable development ratio is not reached, some determinations will be rendered meaningless, and will not be performed. Similarly, identified sources of bias or contamination may require that certain determinations be dropped from the list.

Straddle Packer Assembly and Production-Injection Packer. A standard straddle packer assembly and production-injection packer with shut-in tool, tubing, and downhole pressure transducers will be available for possible hydraulic tests of the Cohassett flow top in well RRL-2B and for possible hydraulic testing of Cohassett flow interior zones (Strait et al., 1982).

Pressure and Water Level Measuring Devices. Pressure measuring systems will be used to monitor hydraulic pressure in the observation wells, boreholes, and piezometers. These systems are described in more detail under Instrumentation and Data Collection. They are based largely on sensitive quartz pressure transducers. Steel tapes will be used to measure water levels periodically at observation points. The specially developed wireline packer, incorporating a quartz pressure transducer, will be used to measure shut-in pressure in the piezometers completed in basalt flow interiors. The wireline packer was discussed under wells, piezometers, and boreholes and is shown schematically in Figure 9.

Wellhead Plumbing, Flow Control and Measurement Devices. Water pumped to the surface from well RRL-2B will course through a system that will provide water temperature measurement, flow rate regulation (as needed) and flow volume measurement. Redundant flow regulators (Figure 37) and doubly redundant flow meters will be featured in the system. Suitably placed valves will allow the flow to be diverted from one flow regulator to the other and from one set of flow meters to the other, at will, in case of malfunction of the equipment. The flow regulation and measurement system diagrammed in Figure 37 will be fitted inside a weatherproof enclosure for year round use. A small centrifugal pump will provide a small flow, from down stream of the flow control and measurement system, to the field laboratory, for water sampling.

Pressure Pulse Generator and Tracer Pulse Pusher. A system consisting primarily of a water reservoir and positive displacement pump, with appropriate hoses, valves, flow meters and fittings, will be used to inject water into wells and tubing to provide for pulse tests between well RRL-2B and Well RRL-2C and borehole RRL-2A. Pulse tests will precede pumping tests in intervals that are pumped and will constitute one of the primary hydraulic tests in intervals that are not pumped. Results from pulse test analysis will be used to estimate the appropriate test well discharge rate. The same system will be used to pump in Grande Ronde water following the tracer solutions that will be injected at well RRL-2C and borehole RRL-2A.

Constant Head Injection Apparatus. A simple, manually regulated system consisting of an appropriate filtered water supply reservoir, valving for flow rate adjustment and a flow meter will be available for constant head injection into intervals of moderate to small hydraulic conductivity.

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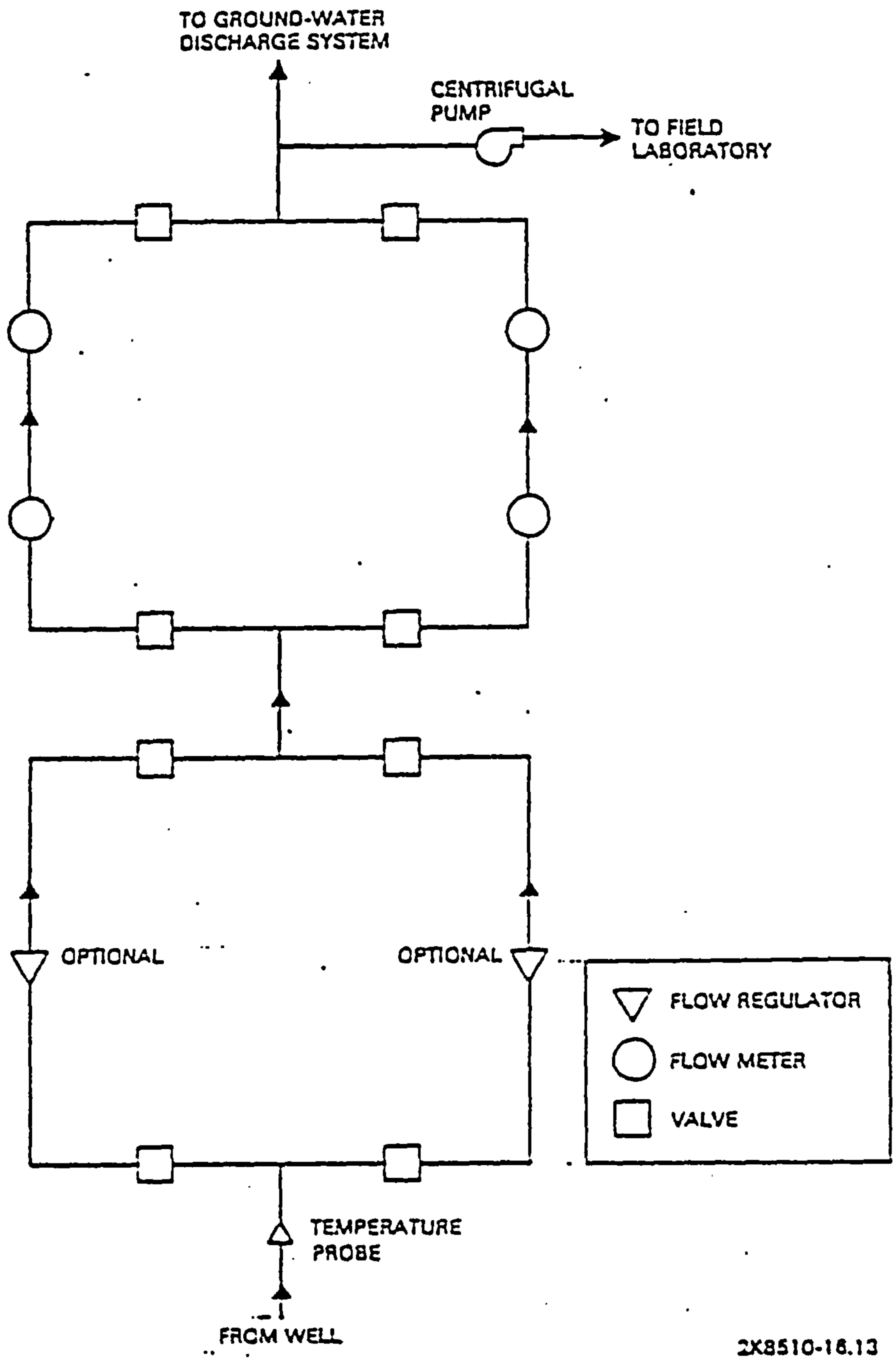

FIGURE 37. Flow regulation and measurement system for pumping well RRL-2B. (To be used during constant discharge testing).

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Equipment for Tracer Testing

Tracer Injection Tools. At borehole RRL-2A, the tracer solution will be placed in the packer tubing with 2.5 cm (1 in.) tubing prior to tracer injection. The water to follow the tracer solution will also be placed with the 2.5 cm tubing.

Tracer injection at well RRL-2C will involve the use of 2.5 cm tubing which will be run into the piezometer in the zone being tested. The lower end of the 2.5 cm tubing will be fitted with a plug retainer sub below three seal packing rings. The tubing will be stabbed into the seating nipple above the piezometer screen. The neoprene seal packing rings will provide a seal between the seating nipple and the tubing. Tracer injection will be accomplished by pressurizing the tubing to blow the plug out of the bottom of the plug retainer sub, allowing the tracer solution to be pumped into the piezometer below the seating nipple, opposite the screen. Water to flush the tracer solution into the flow top will also be injected through the 2.5 cm tubing.

Suitable and appropriate reservoirs and liquid handling apparatus will be available to transfer the tracer solutions and the flush water into the 2.5 cm injection tubing at the two injection points.

Field Analytical Apparatus. A high performance liquid chromatograph (HPLC) will be used in the field to detect and measure the bromide and thiocyanate tracers in the water pumped from well RRL-2B. This field analytical work will help in adequately sampling the pumped water for possible subsequent laboratory analysis for bromide and thiocyanate content. Thiocyanate will also be measured in the field using a method requiring a spectrophotometer. For subsequent tracer tests in the Grande Ronde No. 5 flow top using fluorinated benzoates as tracers, field HPLC equipment will also be used.

Equipment for Groundwater Sampling

Electrodes. The pH and oxidation-reduction potential of groundwater will be measured in the field with appropriate electrodes.

Thermometer. The temperature of groundwater will be measured with an immersion thermometer.

Apparatus for Alkalinity Titration. Burettes and pH meters will be available for alkalinity titration in the field.

Subsurface Sampling Device. A subsurface groundwater sampling device will be used to obtain water samples at prevailing formation temperature and pressure.

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Other equipment to be used in groundwater sampling is listed in Basalt Operating Procedures C-4.71 and C-4.82.

CONDUCT OF TESTS

The tests at the RRL-2 site, in the flow top zones to be investigated, will generally consist of a pressure pulse test followed by a constant-rate discharge pumping test. The constant-rate pumping test, a standard well test often used in hydrogeologic investigations, affords the opportunity to perform other tests or activities, concurrently. These will include radial convergent pulse tracer tests, ratio tests to obtain estimates of flow interior vertical hydraulic conductivity, and groundwater sampling.

The discharge rate for the pumping test of the Rocky Coulee flow top has been tentatively selected based on the results of hydraulic simulation studies. Using a geometric mean value of the transmissivity of the Rocky Coulee flow top of 0.24 m^2/day (2.6 ft^2/day), a discharge rate of 43.6 m^3/day (8gpm) will result in a head drawdown of about 260 m (850 ft) at the pumping well after 30 days.

As the test begins, a measurable response in the Rocky Coulee flow top in nearby well RRL-2C and borehole RRL-2A is expected to be manifest very quickly, followed by response somewhat later in the Rocky Coulee flow interior piezometer at well RRL-2C. This response will likely then be followed by response in the Rocky Coulee flow top piezometers at well DC-22C and DC-20C, and response in the adjacent flow top piezometers at well RRL-2C.

The tests will not begin until the time series head values from the observation wells and boreholes completed in the Grande Ronde units can be reliably projected beyond the planned test length. All pretest procedures must have been carried out. All wells, boreholes, and piezometers to be used in the tests must have been checked and tested for integrity and proper downhole configuration prior to the commencement of testing. All measuring devices must have been calibrated prior to the start of testing.

Tracer solution will be injected into the Rocky Coulee flow top first at borehole RRL-2A and then at well RRL-2C after the following conditions have been reached:

- Quasi-steady flow conditions have been reached in the vicinity of the RRL-2 site.
- Sufficient drawdown information has been obtained from well RRL-2C to support the ratio method analysis.

Quasi-steady flow can be assumed to exist at the RRL-2 site when the hydraulic gradients between borehole RRL-2A, well RRL-2C, and well RRL-2B become stable.

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Several criteria will guide termination of the hydraulic tests. Pumping will continue until the tracer concentration in samples of pumped discharge approaches the background or detection limit concentration. The test may continue beyond this point if there are indications that the head transients are reaching hydraulic boundaries or steady flow has not been reached. A fair chance exists that steady flow conditions (under the influence of distributed vertical leakage) may be reached, at which time the test could be terminated if the ratio and tracer tests are complete. A certain amount of consultation will take place at the time of completion of the tracer test to determine the course of the pumping test from there.

Surveillance and monitoring of the test will be a full-time responsibility during the time that water is being pumped from well RRL-2B. Twenty-four hour per day monitoring of the test will be accomplished by staff members. Monitoring of the performance of the pumping system, recording flow rates from the pumping well, checking the pressure measuring equipment, and measuring and recording water levels in wells and boreholes will be continuous requirements. Additional tasks in water sampling and analysis will accompany the tracer injection into well RRL-2C and borehole RRL-2A. Monitoring of pumped water quality will be necessary to obtain representative samples for detailed chemical characterization.

DATA

Instrumentation and Data Collection

Formation Pressure and Hydraulic Head. Formation pressure and hydraulic head will be monitored at numerous observation sites to detect responses to withdrawal of water from well RRL-2B. The frequency of long-term hydraulic head and pressure measurements at the principle observation sites, during hydraulic testing at well RRL-2B, is given in Table 15. The location of the observation sites is given in Figure 1. Pressure will be measured more frequently than once per hour at well RRL-2B, piezometer nest, RRL-2C, and borehole RRL-2A in the first 300 minutes of the tests.

Head and/or pressure will be measured at monitoring facilities in the Hanford Site Monitoring network. The facilities in the network are located in Figure 38. Table 16 gives the monitored horizon and frequency of long-term hydraulic head and pressure measurements during testing at well RRL-2B, at the sites in the network.

A variety of monitoring techniques will be utilized to obtain the required data under the variety of conditions that exist at the monitoring facilities. Formation pressures may be monitored using pressure sensors set at various depths or can be determined through water level measurements. The water level measurements can be converted to hydraulic head values using calculational routines developed by Spane and Mercer (1985).

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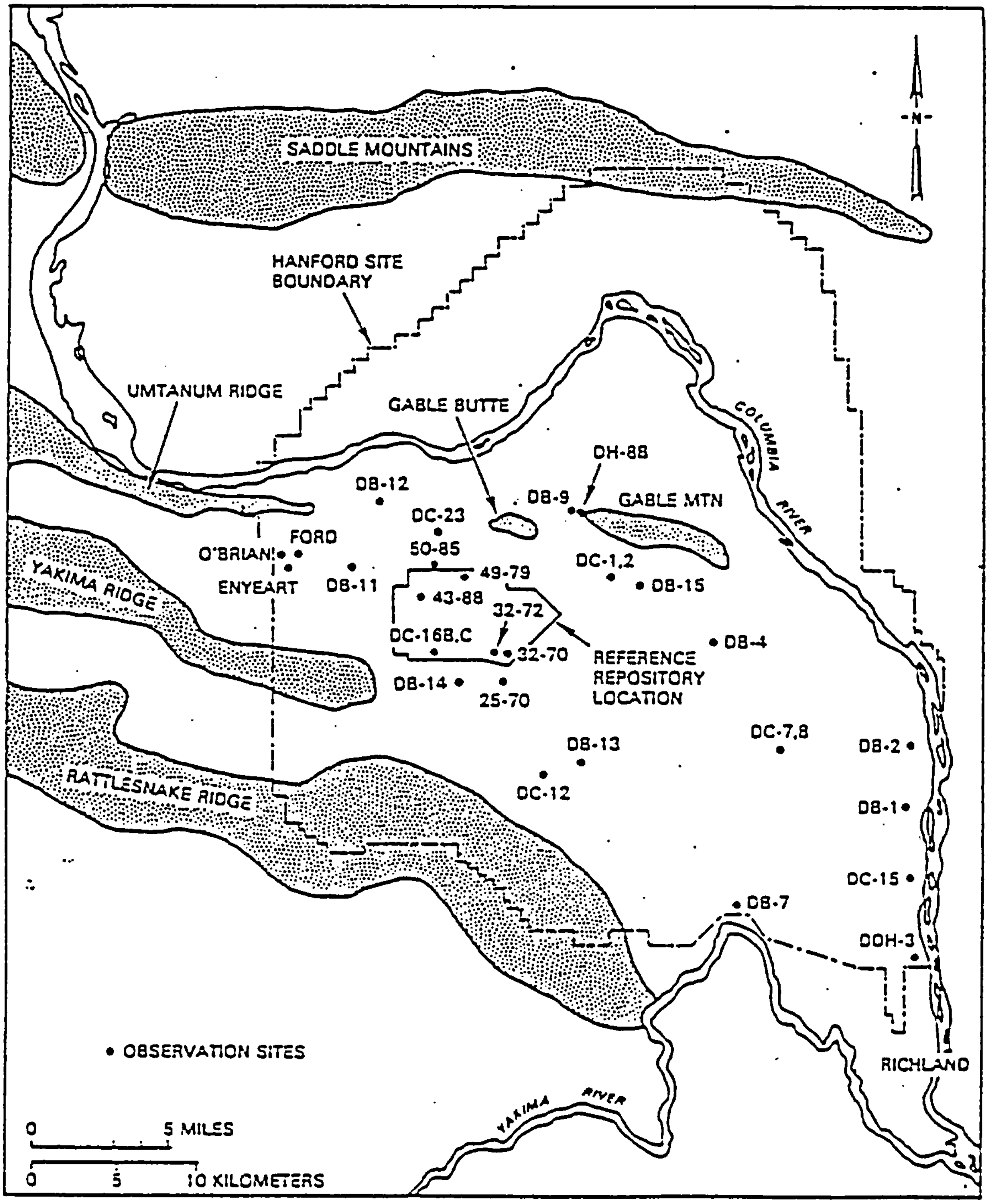

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FIGURE 38. Location of wells, boreholes, and piezometers of the Hanford Site Monitoring Network.

Table 15. Frequency of Head and Pressure Measurement at Principal Observation Facilities During Interference Testing Centered at Well RRL-2B.

Observation Facility (Wells, Piezometers, and Boreholes)	Head Measurement Frequency	Pressure Measurement Frequency
RRL-2A	daily	hourly
RRL-2C	daily	hourly
RRL-6	daily	hourly
RRL-14	NA[1]	daily[2]
DC-22C	daily	hourly
DC-20C	daily	hourly
DC-4	daily	hourly
DC-19C	daily	hourly
McGee Well	daily	hourly
RRL-2B	NA[3]	hourly

1 Head cannot be measured in borehole RRL-14 as it will be configured for the test.
2 A daily pressure profile of all the units monitored at borehole RRL-14 will be taken.
3 Head cannot be measured in well RRL-2B as it will be configured for the test.

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Table 16. Frequency of Head and Pressure measurement at Facilities in the Hanford Site Network During Interference Testing Centered at Well RRL-2B.

Observation Facility (Wells, Piezometers, Boreholes)	Horizon Monitored	Head Measurement Frequency	Pressure Measurement Frequency
25-70	Unconfined System	weekly	NM
32-70		weekly	NM
32-72		weekly	NM
43-88		weekly	NM
49-79		weekly	NM
50-85		weekly	NM
DC-16B	Mabton Interbed	continuous	NM
DB-9		continuous	NM
DH-8B		continuous	NM
DB-13		weekly	hourly
DB-7		weekly	NM
DB-4		weekly	hourly
O'Brian	Priest Rapids Interflow	continuous	NM
Ford		continuous	NM
Enyeart		weekly	weekly
DB-12		continuous	NM
DB-14		weekly	hourly
DB-16C		weekly	hourly
DB-1		weekly	NM
DB-11		weekly	hourly
DB-2	Composite Wanapum	continuous	NM
DB-15		weekly	NM
DB-1		weekly	hourly
McGee		weekly	hourly
DDH-3	Gingko Flow Top	weekly	NM
DC-7/8	Rocky Coulee Flow Top	weekly	hourly
DC-12		weekly	hourly
DC-15	Composite Grande Ronde	weekly	NM
DC-1		weekly	hourly
DC-2		weekly	NM

* NM - not measured

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The downhole pressure sensing system being used is based on a Seling, Inc., downhole pressure probe which houses a Paroscientific 4000 series quartz pressure transducer. The transducers have a range of 0 to 20.68 megapascals (0 to 3,000 lb/in^2 abs). The manufacturer's stated accuracy and resolution are 0.04 and 0.001 percent of full scale, respectively. The pressure measurements are temperature compensated using measurements made with a temperature transducer incorporated in the pressure transducer housing. The temperature transducer has an operational range of -55 degrees C to +150 degrees C and a stated accuracy of +/- 0.5 degrees C.

The Seling downhole probe is configured either as a single or triple pressure probe. The single pressure probe contains one pressure transducer for use when monitoring a single zone in a piezometer or borehole. The triple pressure probe contains three pressure transducers for monitoring up to three zones when used in conjunction with a multiple packer system.

The frequency signal produced by the downhole pressure transducer is passed through a Seling signal conditioner to a Hewlett-Packard frequency counter. If multiple pressure probes are used at one site, a multiplexer/signal conditioner is used to connect all the probes to a single control system. The system is controlled and the data is recorded using a Hewlett-Packard desktop computer. Pressure data is recorded on paper and floppy disk or magnetic tape. In addition, at selected sites, frequency counter output may be transmitted to the Basalt Technical Data Base System (BTDS) using FM transmission to trailer MO-408 and transmission over phone lines to BTDS. Various pressure recording frequencies can be selected.

Examination of the data will be carried out through the use of a Hewlett-Packard desktop computer or the BTDS. Management and control of records is described in Basalt Operating Procedure C-2.13.

Under appropriate conditions water levels will be monitored using chalked steel tapes, electrical water-level indicators or Stevens chart recorders. Measurements will be made following procedures described in Basalt Operating Procedure C-2.12, which were adopted from methods described by the U. S. Geological Survey (1977). Water-level measurements recorded on data sheets will also be stored on magnetic tape or disk for ease of manipulation.

Seling single downhole pressure probes will be installed just above the screen in each of the piezometers in well RRL-2C. The pressure probes monitoring the Grande Ronde No. 5, Cohassett, and Rocky Coulee flow interiors and the Cohassett flow top will be isolated from the overlying fluid column by inflatable packers. In addition, to the downhole pressure probes, the well house over well RRL-2C will contain a transducer to monitor atmospheric pressure. This transducer has a range of 0 to 10.3 kilopascals (0 to 15 lb/in^2 abs) and an accuracy of resolution of 0.04 and 0.001 percent of full scale, respectively. The six downhole pressure

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transducers and the atmospheric pressure transducer will be muliplexed to the surface recording equipment as discussed previously. Water levels will be monitored in the piezometers open to flow tops using an electrical water level indicator or a steel tape.

A TAM International straddle packer and a Seling single pressure probe will be set in borehole RRL-2A to monitor pressures in the various flow tops. In addition, water levels will be monitored in the flow tops, using an electrical water level indicator or steel tape.

A packer assembly and Seling triple probe will be set in well RRL-2B to allow downhole pressures in the various flow tops to be monitored during pumping and recovery.

Seling single downhole probes will be installed in each of the piezometers in the wells at the DC-19, DC-20, and DC-22 sites. Water levels will also be monitored in these piezometers using a steel tape.

A single packer and Seling triple probe will be set in borehole RRL-6 to allow downhole pressures in the various flow tops to be monitored. The water level will be monitored using a steel tape.

A Westbay multiple port monitoring system has been installed at borehole RRL-14. A paroscientific 0 to 13.8 megapascal (0 to 2,000 lb/in^2 abs) transducer mounted in a downhole traveling probe will be used to monitor pressure in various flow tops.

Pressure will be monitored in the flow tops at borehole DC-4 using a pressure transducer system, yet to be specified.

A TAM International straddle packer and Seling triple probe will be set in the McGee well to allow downhole pressures in the various flow tops to be monitored. Water levels will be monitored in the flow tops using a steel tape.

Well Discharge Rate. The discharge rate at well RRL-2B during pumping from the Rocky Coulee flow will be determined using readings of redundant flow totalizing water meters. The meters mechanically measure the volume of water that has passed through them. The periodic volume readings from the water meters will be recorded on data sheets and stored on disk for record. The volume readings will be transmitted to the BTDS.

During pumping from the Grande Ronde No. 5 flow top at well RRL-2B the discharge rate will be determined using flow-totalizing water meters as well as electronic flow rate meters. Data collection using the water meters will be the same as described for the Rocky Coulee test. The electronic flow meters will provide a voltage signal that can be interpreted and stored by desk top computer at the well site. The flow rate data can then be transmitted to the field test office and the BTDS.

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Tracer Concentration. The primary instrument for detecting and measuring tracer concentration in the water pumped from well RRL-2B is the high performance liquid chromatograph (HPLC). In addition, a double beam spectrophotometer will be used to measure thiocyanate concentration in the water. In practice, two HPLC units will be used in the field laboratory. One unit can be active while the other is undergoing periodic calibration with standard solutions.

Chromatograms will be produced by the computer integrator (a part of the HPLC system) and will become part of the permanent record of the tracer analysis. Other details of the tracer determinations will be recorded in controlled notebooks. The record of tracer concentrations as a function of time and/or volume of water pumped from well RRL-2B will be transmitted to the BTDS.

Water Quality. The indices of water quality to be measured in the field are pH, electrical conductivity, temperature, alkalinity, turbidity and oxidation-reduction potential. The pH and oxidation-reduction potential will be measured using specific electrodes. Temperature will be measured with an immersion thermometer. Electrical conductivity will be measured with a simple conductivity meter; alkalinity determination involves an acid titration; and turbidity is measured with a standard device for detecting suspended material in water. Discussion of the instrumentation to be used in laboratory analysis of the water from well RRL-2B is beyond the scope of this document.

The field and laboratory determinations of water quality will be recorded in controlled notebooks. The record of water quality, as measured in field, will be transmitted to the BTDS.

Data Storage and Display

Observed hydraulic head, formation pressure, well discharge rate, tracer concentration, and water quality data will be stored in the Basalt Records Management Center (BRMC), in the BTDS, and in the data base maintained by the Drilling and Testing Group. The BRMC holds an archival copy of the data while the BTDS and Drilling and Testing Group data bases serve as working data sources. The hydraulic head and formation pressure data may be displayed through the use of data loggers in the field and through access to the BTDS or the computer data base maintained by the Drilling and Testing Group.

Data Analysis and Evaluation

General Considerations. Analysis and interpretation of constant discharge pumping tests of long duration and of convergent tracer tests

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conducted in the deep basalt flows will likely be challenging. Some of the analysis will likely be fairly routine and simple, but there are enough unknown aspects of the hydrology and hydraulics of flow in the basalt sequence to ensure that considerable time and perhaps some rather unusual techniques will be employed in data analysis. A brief description of some of the standard methods for test analysis and interpretation is presented in this section and in the appendix. No attempt is made to cover the full range of possible conditions and applications because it is recognized that the pumping and tracer tests will involve a process of discovery requiring that appropriate methods of interpretation and analysis be applied as the need for them becomes apparent, as testing progresses.

Models having both analytical and numerical solutions are expected to be useful in test analysis. The standard analytical solutions to problems of radial groundwater flow to a pumping well may be quite useful in analysis of drawdown near the pumping well. As the responses to pumping from well RRL-2B suggest substantial departure from the conditions under which the closed form solutions apply, numerical models can be used for analysis.

Data compilation and graphical presentation are the first steps in conceptualizing the conditions of flow involved in the basalt hydraulic system involved in a pumping test. Areal patterns of drawdown in the units will be drawn for various times after pumping starts. Tracer breakthrough graphs will be prepared to show the history of tracer arrival at well RRL-2B. The hydrograph at each observation well or borehole will be prepared to portray the drawdown as a function of the logarithm of time and the logarithm of drawdown as a function of the logarithm of time. These graphical displays will be helpful in determining which model to fit observed data to in the analysis. The drawdown data will be modified by removing the effects of atmospheric pressure variation prior to its graphical display.

Evaluation Using Models with Analytical Solutions. The various models discussed in this section are based on certain assumptions and simplifications (idealizations). Where field conditions do not match the assumptions and idealizations of a model, errors will arise in the computation of the values of the hydraulic characteristics of the hydrogeologic unit tested. In practice, rather large deviations from the ideal conditions often occur. Most of the models are rather robust, and useful quantitative information can be obtained even in the face of such divergence. Actual field conditions will be a guide to help determine the best models with which to treat the observations. The problem of estimating the hydraulic characteristics of hydrogeologic units is often referred to as "parameter identification" or the "inverse problem". Application of models with closed form analytical solutions may be considered a special kind of inverse technique.

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Some of the most important methods of analysis of interference well tests using models with analytical solutions that have been considered for use include:

1) The Johnson, Greenkorn and Woods (1966) method for pulse test analysis.

2) The non-leaky type-curve method (Theis, 1935).

3) The Cooper-Jacob (1946) modified non-equilibrium method.

4) The Hantush and Jacob (1955) r/B method for leaky aquifers.

5) The method for leaky aquifers using the Hantush modified model (Hantush, 1960).

6) The ratio Method for analysis of leaky aquifer systems (Neuman and Witherspoon, 1972).

These methods are briefly described in the Appendix.

The analysis of the convergent tracer test results could follow the following steps as outlined by Lenda and Zuber (1970):

1. Estimate the value of t_o and D/vx by comparing the measured tracer breakthrough curve with those given in Figure 36.

2. Calculate n or hn from equation (3) using the known pumping well discharge rate, the injection well-pumping well separation distance and the estimated value of t_o.

3. Calculate the percent recovery of the injected tracer mass, R.

4. Calculate a series of tracer concentration values as a function of time using a rearrangement of equation (5) with mR as the mass term instead of simply m.

5. Compare the theoretical tracer breakthrough curve calculated in 4, above with the observed tracer breakthrough. If the agreement is not satisfactory, repeat the whole procedure for a different trial value of t_o and/or D/vx.

6. Finally, calculate dispersivity, α, from $\alpha = \frac{D}{V}$.

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Evaluation Using Models with Numerical Solutions. Though pumping tests are expected to integrate highly localized heterogeneity of the flow system to obtain an average value, the existence of areal heterogeneities resulting from geological features (e.g., faults, tectonic breccias, and other structures) would complicate the analysis of the tests. The assumptions on which most analytical solutions are based may be seriously violated. Thus, numerical modeling, coupled with a parameter identification program, may be necessary to provide an additional tool to perform analyses. The parameters, such as conductivity and storativity, are not directly measurable from a physical point of view, rather, they are identifiable by observing the dependent variable (hydraulic head or pressure) collected in the spatial domain. The number of observations is finite and limited in contrast to the infinite dimensions of the spatial domain. Therefore, optimization is generally used for parameter identification. The methods utilize the automatic process of iteration to adjust the estimated parameters in such a way that better agreement between the actual and the calculated heads is obtained. In some instances, however, the parameters identified are physically unreasonable but can reproduce hydraulic head data quite accurately. In order to constrain the estimated parameters to physically meaningful values, techniques have been developed by many researchers to use the physical plausibility of the results to optimize the predictive capabilities of the model. One of the techniques is to use a multi-objective decision framework. In this approach, both model error and physical plausibility criteria (based on prior measurements or statistical information) are considered simultaneously. This approach allows us to sequentially use the information gained from one test as information for other tests yet to be done.

Because the multiple-well hydraulic tests are expected to involve large areas, modeling on two scales is thought to be the most efficient means of designing and analyzing the test. Larger scale, far-field modeling, will provide efficient analysis of the effects of larger phenomena such as hydrologic responses. A smaller scale, near-field model, allows for detailed consideration of small-scale phenomena, such as wellbore storage, and effects of storage in the aquitards or basalt flow interiors. Furthermore, it will provide a flow field for tracer simulation.

Two finite difference codes, MODULAR (McDonald and Harbaugh, 1984) and TRESCOTT-INVERT (Lu and Yeh, 1985) will be used to estimate transmissivity distribution, storage coefficient, and interaquifer transfer coefficient, TCF. TCF is defined as the ratio of vertical conductivity to thickness of a dense interior. MODULAR is a modified version of TRESCOTT (Trescott, 1975) and is a well-documented code. TRESCOTT-INVERT is a modified TRESCOTT code incorporating an automatic parameter estimation technique. The applicability of the code has been preliminarily examined by Lu and Yeh (1985).

SEMTRAW is a two dimensional finite element code which can be used for axisymmetric as well as planar simulation of a flow system. The code is a

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modified version of SEMTRA and test cases have been documented by Kanehiro and Wilson (1984). The modified code is referred to as the SEMTRAW code to indicate its application to well test analysis. The code will be used for examination of near-field aspects (in the vicinity of a pumping well) to complement the TRESCOTT code which is more suitable for analyzing far-field behavior.

Flow in Porous Media (FPM) is an axisymmetric finite element code developed by Golder Associates. The code has been used in pre-test analysis of RRL-2 pumping, presented in other sections of this report. FPM has two apparent advantages over SEMTRAW: 1) There are four nodes per element in FPM against eight nodes in SEMTRAW, so that FPM can simulate more layers than SEMTRAW with only a slight reduction of accuracy. 2) FPM has been validated by test run in comparison with the ratio method, so that the model is more useful than SEMTRAW as a tool to estimate the vertical hydraulic conductivity.

A new method has been discussed for analyzing the diffusivity (K'/S'_s) in the dense flow interiors. The proposed method is to use a one-dimensional finite difference model (or analytical model) to simulate the transient pressure across the dense interior around well RRL-2C. As the drawdown at the boundaries will be recorded by the transducers located at the Rocky Coulee flow top and adjacent flow tops, the recorded data will be used as time dependent boundary conditions in the 1-D model. Assuming that the vertical flow will be dominant, the parameter, diffusivity, will be identified by adjusting the parameter such that the calculated pressures match the pressures recorded by the transducer located in the dense interior. In essence, the method decouples the solution in the dense interior from the coupled multiple-layer solution. By doing so we can get away from the requirement that the drawdown in the pumped flow top follow the Theis solution which is one of the assumptions used for the ratio method.

The tracer test may be analyzed by analytical models as well as a number of numerical transport models. The output of the near-field simulation can be used as input to a transport code to predict the distribution of the tracers to match the break-through curves. The available transport codes are: the "random-walk" particle transport code (Prickett et al, 1982), a finite element code used by Golder Associates, and a finite element code using an upstream weighted numerical method (Sun and Yeh, 1983).

TEST PROCEDURES

Test procedures are being written for multiple-well hydraulic testing and convergent tracer testing. The groundwater sampling and analysis activities will be carried out in accordance with the following:

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BOP C-2.14 Method of Collection of Pumping Test Samples

BOP C-2.4 Groundwater Sampling and Analysis

BOP C-4.71 Groundwater Sampling, Offsite Shipment, and Storage.

Hydraulic head monitoring will be conducted in accordance with BOP C-2.12. Data transmittal will follow BOP C-2.13.

SAFETY

All operations shall be in accordance with RHO-MA-221, Accident Prevention Standards and BOP C-1.2, paragraph 4.0, Safety. It will be the responsibility of the Rockwell Team Leader to ensure that all visitors, vendors, and operating personnel have appropriate protective equipment while at the test site.

Anticipated test conditions which may cause unusual safety hazards include:

* Methane that may evolve from discharge water from well RRL-2B,
* Belts connecting the motor and surface pumping unit at well RRL-2B, and the rotating and oscillating parts of the surface pumping unit,
* High pressure within packer inflation lines at well RRL-2C.

A pre-job Safety plan will be developed which addresses these and other anticipated hazards.

A closed system will be used to trap and dispose of any methane that evolves from the discharge water. If a hazardous volume of gas escapes, all personnel will clear the area and the Rockwell Hanford Operations Industrial Hygiene and Safety Department shall be notified. High pressure lines will be securely attached to prevent their whipping in the event of a leak. Also, access will be limited in the immediate area of the test to reduce exposure to hazards.

A safety inspection will be conducted after setting up the test equipment and prior to initiating the large-scale pumping test. Any deficiency shall be corrected before operations begin.

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ENVIRONMENTAL EFFECTS

The main potential environmental effects resulting from the discharge pumping tests at well RRL-2B will come about because of the land disposal of the pumped water. A furrowed surface disposal area west of the RRL-2 site has been prepared. The area has been fenced and the water from pumping will be continuously applied in the disposal area where it will infiltrate into the alluvial materials at the surface. The disposal of the pumped groundwater in this way should cause no significant hazard from the standpoint of human ingestion or plant growth. An environmental evaluation of the effects of land disposal of water from well RRL-2B will be issued prior to the initiation of testing.

QUALITY ASSURANCE

Quality assurance requirements applicable to the large-scale pumping and tracer tests to be conducted at the RRL-2 cluster site are found in the following documents:

* QAPP 12-101, Instrument Calibration
* QAPP 6-106, Controlled Notebooks
* QAPP 3-301, Technical Document Review
* QAPP 3-301.1, Peer Review
* QAPP 17-101, BWIP Records Management System
* QAPP 11-205, Data Acquisition Package
* QAPP 17-102, Recording Data for QA Records

Appropriate quality assurance requirements are imposed on subcontractors and suppliers. These requirements are documented in the statement of work or service contract. Reference:

* QAPP 4-402, Quality Assurance Review of Procurement Documents

BWIP Quality Assurance verifies implementation of quality requirements imposed on BWIP functions and subcontractors by surveillance, review or audit of activities. The procedures are documented in:

* QAPP 4-402, Quality Assurance Review of Procurement Documents
* QAPP 10-101, Surveillance Activities
* QAPP 18-101, Quality Assurance Audits
* QAPP 15-102, Nonconformance Control and Reporting

Testing activities are to be in accordance with the appropriate procedures, instructions, and specifications listed herein and with others which are currently being developed. These include:

* BOP C-2.8, Hydrologic Field Testing
* BOP C-2.4, Groundwater Sampling and Analysis
* BOP C-2.12, Hydraulic Head Monitoring
* BOP C-2.13, Transmittal of Piezometric Data

Prior to release, deliverable data will be reviewed and quality will be assessed. Any deficiencies or conditions which may affect the quality of test data will be explained in the test documentation.

The procedure for changing this test plan is documented in QAPP 6-104, Supporting Document Description. The page change method will be used to revise or replace existing pages and/or add additional pages covering new material.

All data shall be collected in accordance with procedures which provide detailed steps for the execution and documentation of the data collection activity, to the extent necessary to assure that the requirements and objectives of this plan are met within the identified constraints. These procedures shall be prepared, reviewed, approved, and controlled in accordance with QAPP 6-102, "Document Control of Field and Facility Procedures", and shall meet the requirements of RHO-QA-MA-3, "BWIP Quality Assurance Requirements Manual". Each procedure for data collection shall include, but not be limited to (as appropriate):

1. Statement of the requirements which are being implemented by the procedure.

2. Prerequisites such as borehole configurations and necessary initial conditions, with provisions for documenting that prerequisites have been met.

3. Descriptions of methods and instructions for performing the activities in sufficient detail to facilitate:

   (a) reasonable duplication of the results
   (b) understanding of data limitations and uncertainties.

4. Provisions for documentation of facilities, instrumentation, and equipment used to provide traceability to calibration records.

5. Provisions for reporting any unusual or unanticipated circumstances encountered during the testing.

6. Requirements for recording data and documentation of testing activities, including control of the records. Documentation shall meet

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the requirements of QAPP 17-102, "Recording Data for Quality Assurance Records and Records Correction". Control of data shall interface with QAPP 11-205, "Data Acquisition Package".

7. Qualification requirements for personnel, as applicable.

Data analyses shall be documented and verified in accordance with procedures which meet the requirements RHO-QA-MA-3, "BWIP Quality Assurance Requirements Manual", Criterion 3.

Measuring and test equipment shall be controlled in accordance with QAPP 12-101, "Calibration and Control of Measuring and Test Equipment".

Personnel shall be instructed as to the purpose, scope and implementation of quality assurance requirements and procedures, and this instruction shall be documented. Personnel performing activities affecting quality shall be qualified in the principles, techniques, and requirements of the activity being performed. Their experience shall be commensurate with the scope, complexity, or special nature of the activities. Formal training and qualification programs shall be documented to include the objective and content of the program, the attendees and dates of attendance.

Because of unforseen conditions that could be encountered during this activity, minor modifications/deviations to this test plan may be required. The cognizant team leader may initiate emergency field changes with the approval of management, to proceed without further delay. Methods of documenting the changes are described below:

- Controlled Notebooks. Minor modifications to this test plan will be accomplished by documenting the change in a controlled notebook. The controlled notebook shall denote the change, rationale, and effect of the change. The description documented in the controlled notebook shall include reference to the test plan, page number, and a signature and date of persons authorized to make changes. The cognizant team leader or his assigned representative shall brief all on-shift and on-coming shift personnel of the changes made to the plan. The test team leader is authorized to make minor changes to this plan with the approval of the manager monitoring the activity.

ORGANIZATIONAL AND FUNCTIONAL RESPONSIBILITIES

The Drilling and Testing Group is responsible for all aspects of equipment procurement and set-up for the test series. The decision to start each test in the series will be made by the Site Department Manager acting on recommendations of Department hydrologists. The Solution

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Chemistry Team is responsible for outfitting the field laboratory for water sampling and analysis. The Drilling and Testing Group will provide support in this endeavor. The decision to terminate each test in the series will be made by the Site Department Manager acting on recommendations of Site Department hydrologists. The results of decision meetings will be recorded in meeting minutes. Analysis and interpretation of test results will primarily be the responsibility of those Site Department hydrologists involved in planning and executing the test series. Others will become involved as necessary to ensure adequate interpretation of results.

The Site Department Manager will appoint a team consisting of qualified team leaders, hydrochemists, hydrologists, hydrologic technicians, technical advisors, and project assurance engineers. This team will be trained to conduct and analyze the multiple-well hydraulic testing at RRL-2 in accordance with this test plan and appropriate procedures.

SCHEDULE

The current schedule for large-scale hydraulic testing at the RRL-2 location (Figure 39) calls for testing of at least four horizons: the Rocky Coulee flow top, Cohassett flow top, the Grande Ronde No. 5 flow top and the Umtanum flow top.

Tests in the Cohassett interior may be carried out if favorable hole conditions are encountered. The scheduled length of testing for each horizon is primarily governed by its estimated transmissivity. The Rocky Coulee flow top will be pumped for about 60 days, followed by a 3 to 4 month period of recovery. Because of the anticipated small transmissivity of this flow top, the recovery period may be longer which would result in shifting the remainder of the scheduled tests. The Cohassett flow top at borehole RRL-2A has a small transmissivity of 1×10^{-3} m^2/day (4×10^{-2} ft^2/day) (Strait and Spane, 1983) and only a pulse test may be possible. Therefore, the testing of this zone should take no more than 2 months to complete. This time includes the pre-test monitoring as well as the pulse test. Drilling to each flow top is expected to take no longer than 2 to 3 weeks.

It is important to note that a schedule based on the dynamics of a natural system (i. e., the groundwater system) is continually subject to change relative to the response of that system. It is expected that the schedule presented here will be adjusted as testing progresses.

REPORTS

Each of the major test activities, hydraulic testing, tracer testing, and groundwater sampling and analysis will be documented in formal reports.

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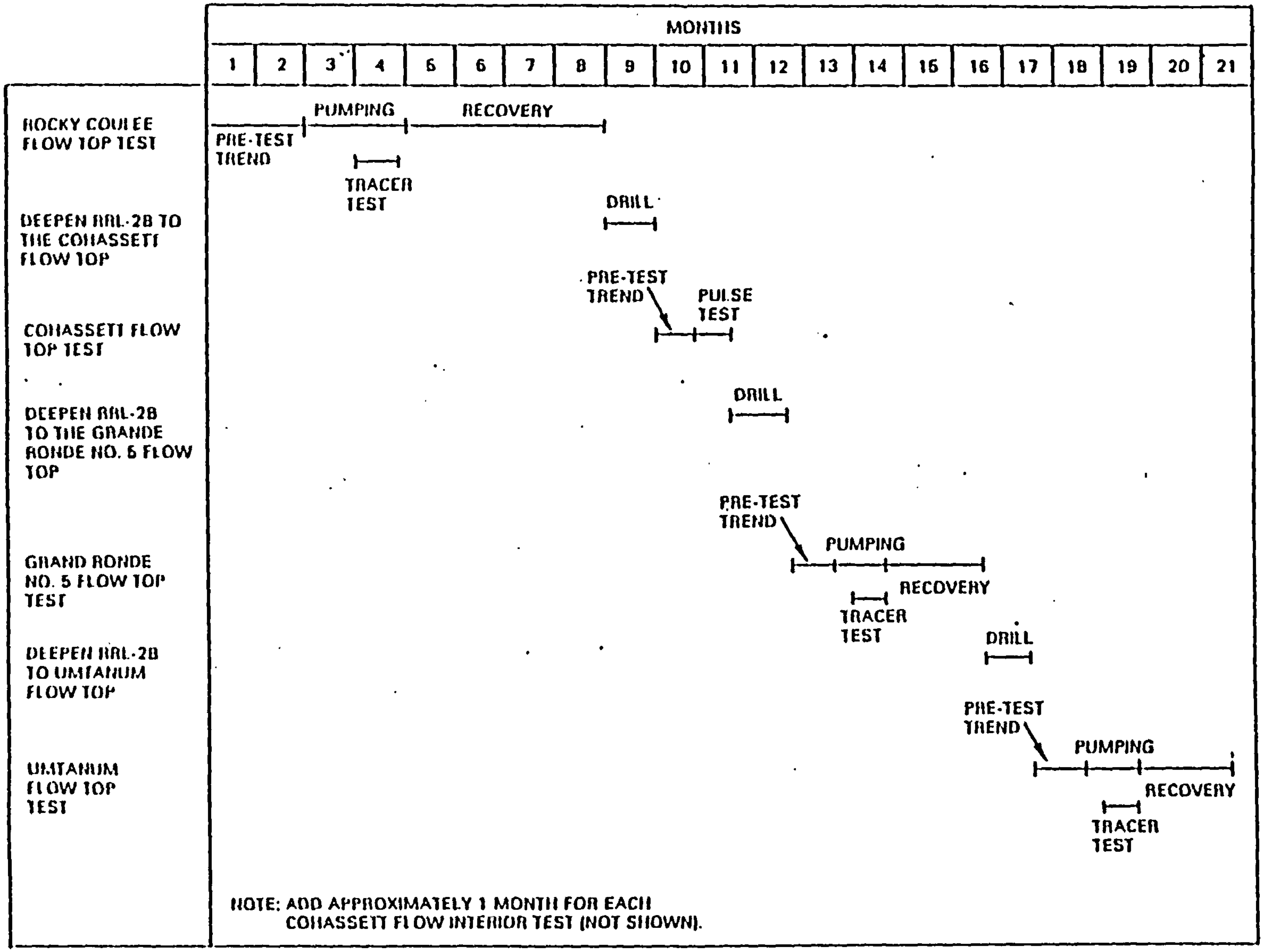

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FIGURE 39. Tentative schedule for large-scale hydraulic testing at the RRL-2 site.

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SUMMARY

A comprehensive plan for performing large-scale multiple-well hydraulic tests of units of the Grande Ronde Basalt within and near the reference repository location has been developed. The tests will be performed using a pumping well located at the RRL-2 site. Two observation wells near the pumping well will be utilized. Several wells and boreholes at greater distance will also be used in the tests. The pumping well will be advanced incrementally through the Grande Ronde Basalt so that each horizon to be tested can be investigated individually and then sealed before proceeding to the next horizon. One of the observation wells near the pumping well will provide the means to measure formation pressure in the three flow interiors.

The purposes of the hydraulic testing are to evaluate the hydraulic characteristics of selected interflow zones and adjacent units, and to characterize the chemical composition of groundwater collected from the interflow zones. Additional objectives of the tests are identify and classify hydraulic boundaries, to assess the degree of leakage into the test interflow zones from adjacent flow interiors, and to evaluate the lateral hydraulic continuity of selected interflow zones.

The Cohassett flow is the designated repository horizon, therefore knowledge of its hydraulic characteristics and those of adjacent and subjacent units is necessary for site characterization and repository performance assessment. With the likely exception of the Cohassett flow top and portions of the Cohassett flow interior that may be tested, the interflow zones of interest (Rocky Coulee, Grande Ronde No. 5, and Umtanum flow tops) can be tested using conventional pumped constant discharge well tests. It is assumed that the Cohassett flow top and Cohassett flow interior zones will be tested by an alternate method such as pressure pulse or constant head injection technique because of their very small estimate transmissivity.

The planned sequence is to test the four horizons of interest in the pumping well, Rocky Coulee flow top, Cohasset flow top and interior zones, Grande Ronde No. 5 flow top, and Umtanum flow top, in that order. Water samples for field and laboratory analysis will be obtained from the flow tops in connection with pumping tests in the units. If it is possible to pump water from the Cohassett flow top, water samples will be obtained from that unit. Convergent pulse tracer tests will be initiated during the pumping tests after quasi-steady flow has been established and after the ratio test is complete. Different tracers will be injected at the two observation wells to facilitate identification of the source of pulses that arrive at the pumping well.

The first multiple well test, of the Rocky Coulee flow top, was designed using estimates of transmissivity from single-well tests. A

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pumped discharge rate of 43.6 m^3/day (8 gpm) was selected based on numerical simulations which assumed homogeneous, isotropic aquifer conditions. A transmissivity value for the Rocky Coulee flow top equal to the geometric mean of transmissivity values obtained from single-well test analyses, was used in the simulations. The simulations predict about 263 m (863 ft) of drawdown at the pumped well after 50 days of pumping. Somewhat more than 0.6 m (2 ft) or drawdown in the Rocky Coulee flow top at 2,500 m (8,200 ft) from the pumping well is predicted for the same time after the onset of pumping. This amount of drawdown is judged to be measurable and interpretable.

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APPENDIX

The following is a brief description of some of the more important methods of analysis using models with analytical solutions. Common assumptions underlying all of the methods presented are:

- Hydrogeologic units are infinite in areal extent.
- In the area influenced by a particular test, the unit tested and overlying and underlying units are homogeneous, isotropic, and of uniform thickness.
- Prior to disturbance by pumping or pressurizing, the potentiometric surface(s) is (are) horizontal over the area influenced by the test.
- The test (pumping) well fully penetrates the tested unit.
- Water is removed from the tested unit (in a pumping test) at a constant rate (for constant discharge test, only).

PULSE TEST ANALYSIS

The pulse test is planned as a pre-pumping test diagnostic tool to obtain estimates of hydrogeologic unit characteristics to guide selection of pumping equipment and discharge rates from the test well. The response in an observation well to a pressure pulse input at a test well completed in a confined formation can be analyzed using a solution of the transient, radial flow equation presented by Johnson, Greenkorn, and Woods (1966). Their solution, with parameter values given in English units because of their petroleum industry affiliation, allows one first to estimate the formation lateral hydraulic diffusivity, η, using

$$(t_{DL}+1)t_{DL} \ln\left(1+\frac{1}{t_{DL}}\right) = \frac{r^2}{4\eta\Delta t} \qquad \text{(A1)}$$

where
Δt = input pressure pulse length (interval), min
r = distance between wells, ft
t_{DL} = dimensionless time lag, given by $t_{DL} = \frac{t_L}{\Delta t}$
t_L = time lag between end of pressure pulse input and peak of response at observation well, min
η = lateral hydraulic diffusivity, ft^2/min.

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Next, the formation transmissivity can be estimated using

$$T = \frac{70.6q}{\Delta p_s}\left[Ei\left(\frac{-r^2}{4\eta\Delta t\,(t_{DL}+1)}\right) - Ei\left(\frac{-r^2}{4\eta\Delta t\;\;t_{DL}}\right)\right] \quad \text{(A2)}$$

where T = transmissivity, md ft/cp
q = pulse flow rate, bbl/day
Δp_s= response amplitude, psi,

remembering that injection gives q a negative sign by convention.

Finally, the storage, S, (ft/psi) can be obtained from

$$\frac{56{,}900\ Sr^2}{T\Delta t} = \frac{r^2}{4\eta\Delta t}. \quad \text{(A3)}$$

Conversion from oil field transmissivity and storage to hydrologic transmissivity and storativity can be accomplished using conversions given by Earlougher (1977). The possible effects of wellbore storage on pulse test response can be examined using the method of Prats and Scott (1975).

NON-LEAKY TYPE CURVE ANALYSIS

Analysis of the results of pumping at a constant rate from a well completed in a confined (nonleaky) formation can often be accomplished using a solution of the equation describing radial flow to a well that was developed by Theis (1935). Application of the Theis solution requires that the water removed from storage in the formation be discharged instantaneously with decline in head, and that the pumped well appears to any observation wells as a line sink with infinitesimally small diameter. At least one observation well or piezometer is normally required. Because of the effects of pumped well bore storage and head losses on entry of water into the pumped well, drawdown observations in the pumped well are somewhat more difficult to interpret.

The Theis solution of the radial, confined groundwater flow equation can be written

$$s = \frac{Q}{4\pi T}\quad W(u) \quad \text{(A4)}$$

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where the argument u in the function W (u) is given by

$$u = \frac{r^2 S}{4Tt} \qquad (A5)$$

and r = distance between pumping and observation wells
s = drawdown at observation well
Q = discharge rate
T = formation transmissivity.

The function W(u) is termed the well function of u and is extensively tabulated in the geohydrologic literature.

Application of the Theis solution to the problem of evaluation of hydraulic characteristics of hydrogeologic units involves a type curve matching technique. Basically, the technique involves preparation of a type curve graph of the function W(u) as a function of 1/u on logarithmic paper. On a sheet of logarithmic paper of the same scale as the type curve, the drawdown at an observation well is plotted as a function of corresponding values of t/r^2. Superposing one graph on the other, keeping the coordinate axes of both parallel, a best fit of drawdown data to the type curve is chosen. A common "match point" is chosen and the corresponding values of s, t/r^2, W(u) and 1/u are determined. The formation transmissivity is then calculated from a rearrangement of equation (A4) and the storativity is calculated using a rearrangement of equation (A5).

MODIFIED NON-EQUILIBRIUM METHOD

The well function, W(u), is represented by an exponential integral that can be expanded as a convergent series so drawdown as expressed by equation (A4) can be given by

$$s = \frac{Q}{4\pi T}\left(-0.5772 - \ln u + u - \frac{u^2}{2\cdot 2!} + \frac{u^3}{3\cdot 3!} - \frac{u^4}{4\cdot 4!} + \cdots\cdots\right) \qquad (A6)$$

For small values of r, and at large values of t (u<0.02), the sum of the terms in the series beyond the first two becomes insignificantly small (Cooper and Jacob, 1946). With this approximation, equation (A6) can be written

$$s = \frac{Q}{4\pi T}\left(\ln \frac{1}{u} - 0.5772\right), \qquad (A7)$$

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which is the same as

$$s = \frac{Q}{4\pi T}\left(\ln \frac{4Tt}{r^2 S} - 0.5772\right). \tag{A8}$$

Converting to the common lagarithm gives

$$s = \frac{2.3Q}{4\pi T}\left(\log \frac{4Tt}{r^2 S} - 0.2509\right). \tag{A9}$$

Equation (A9) predicts that drawdown in an observation well at distance r from a pumped well will increase linearly with the logarithm of time. The slope of a graph of drawdown as a function of the logarithm of time for an observation well in a pumped formation, thus predicted, is given by $2.3Q/4\pi T$.

If drawdowns S_1 and S_2 at two different times t_1 and t_2 are considered, then

$$s_1 = \frac{2.3Q}{4\pi T}\left(\log \frac{4Tt_1}{r^2 S} - 0.2509\right)$$

and

$$s_2 = \frac{2.3Q}{4\pi T}\left(\log \frac{4Tt_2}{r^2 S} - 0.2509\right).$$

The drawdown difference reduces to

$$\Delta s = s_2 - s_1 = \frac{2.3Q}{4\pi T} \log \frac{t_2}{t_1}. \tag{A10}$$

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For one log cycle of time, $\log t_2/t_1 = 1$, and equation (A10) can be solved for T as follows:

$$T = \frac{2.30}{4\pi\Delta s} , \qquad \text{(A11)}$$

where Δs is the incremental drawdown per log cycle of time.

A graph of drawdown as a function of the logarithm of time is all that is required to solve equation (A11) for transmissivity. After the early effects of well-bore storage disappear and pumping time becomes greater, the graph should become linear. The constant pumping-well discharge and the drawdown per log cycle of time, in the linear portion of the drawdown data, are substituted into equation (A11).

Having obtained a value of T, it is possible to solve equation (A9) for S if the drawdown is made zero. The linear portion of the drawdown-log time graph is extrapolated to the zero drawdown axis where a value of t, termed t_0, is determined. The value of t_0 and the previously determined value of T and zero drawdown are substituted into equation (A9) to give

$$0 = \frac{2.30\ Tt_0}{4\pi T}\left(\log \frac{4Tt_0}{r^2 S} - 0.2509\right) ,$$

which can be rearranged with the result that

$$S = \frac{2.25\ Tt_0}{r^2} . \qquad \text{(A12)}$$

The condition imposed by the method just described, commonly referred to as the Cooper-Jacob method or modified nonequilibrium method, that u be less than 0.02 is a significant limitation. Assuming $S = 1 \times 10^{-5}$, T = 0.24 m^2/day, and r values of 76 m, 152 m, and 305 m, the time required for u to become equal to 0.02 is found to be 3, 12, and 48 days, respectively. Using the estimated geometric mean transmissivity (0.24 m^2/day) of the Rocky Coulee flow top, it is obvious that the Cooper-Jacob method can be applied to analysis of drawdown within 152 m of well RRL-2B over the period of a 60-day pumping test. Drawdown at distances greater than about 300 m cannot be analyzed using the Cooper-Jacob method. This means that any observed drawdown in piezometers at wells DC-20C and DC-22C will have to be analyzed by type curve methods rather than by the Cooper-Jacob technique.

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LEAKY AQUIFER ANALYSIS

A "leaky aquifer" is a unit that is over and/or underlain by less permeable layers that nonetheless provide a flow of water into the leaky aquifer when the pressure in the aquifer is reduced by pumping. Sometimes the leakage is so great that it can be detected in the aquifer being pumped. In this situation, the confining layers are termed aquitards and the aquifer or unit is said to be leaky. When the leakage is so little that it is not easily detected, the confining units are called aquicludes and the aquifer is referred to as being slightly leaky (Neuman and Witherspoon, 1968).

Several models of leaky aquifer flow have been developed. Three of them will be briefly described here. All of the leaky aquifer models assume that flow in the less permeable layers, above and below an aquifer, is essentially vertical. Hence these models provide for the estimation of the average vertical hydraulic conductivity of the confining layer.

r/B Method

Hantush and Jacob (1955) solve the problem of flow in a leaky, radially infinite aquifer. Figure A1 depicts a leaky aquifer system. An aquitard with thickness b' overlies an aquifer with a much greater hydraulic conductivity. The aquitard is overlain by another very conductive aquifer. The lower aquifer is pumped at a constant discharge rate, Q. Hantush and Jacob derived an expression that gives the distribution of drawdown in the pumped aquifer with time. Their solution is based on the assumptions that 1) flow is essentially horizontal in the aquifer and vertical in the aquitard, 2) no drawdown occurs in the upper aquifer as a result of pumping from the lower aquifer, and 3) leakage into the pumped aquifer is proportional to the head difference across the aquitard. The last assumption is equivalent to assigning a negligible storage capacity to the confining bed. Under this condition all the water leading into the pumped aquifer comes from the upper aquifer (source layer), with the aquitard serving simply as a conduit between the two aquifers.

The solution to this problem of leaky aquifer behavior with no storage in the aquitard is

$$s = \frac{Q}{4\pi Kb} W(u, {}^{r}/B) \qquad (A13)$$

where

$$u = \frac{r^2 S_s}{4tK} \qquad (A14)$$

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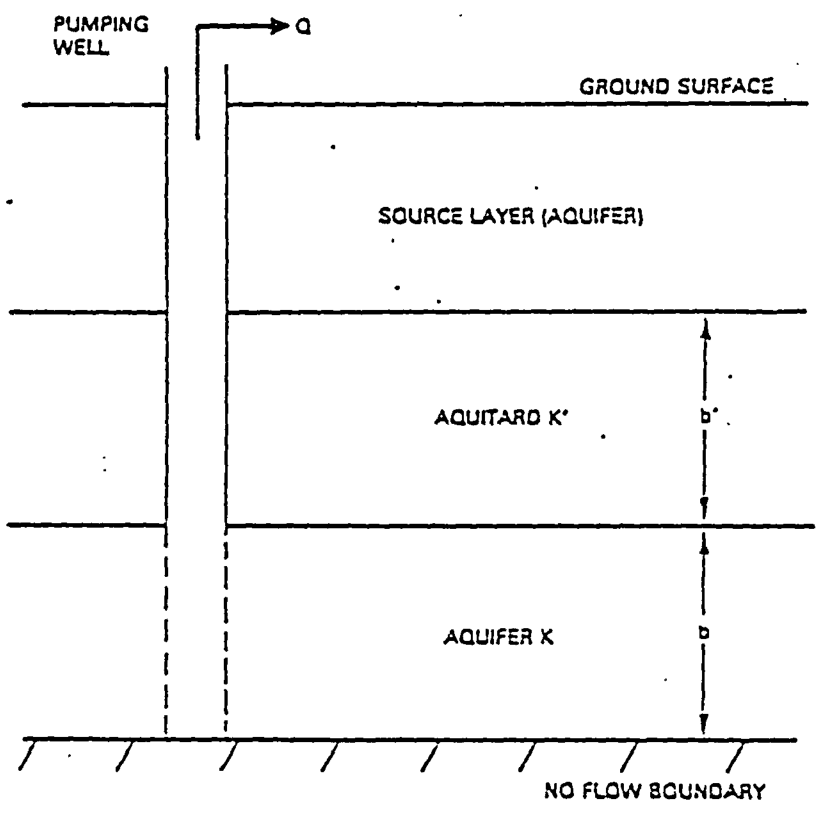

FIGURE A1. Leaky aquifer pumped by a fully penetrating well.

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$$r/B = \frac{r}{\sqrt{\frac{Kbb'}{K'}}} \qquad \text{(A15)}$$

K, K' = hydraulic conductivity of the aquifer and aquitard, respectively

S_s = specific storage of aquifer

b, b' = thickness of the aquifer and aquitard, respectively,

Values of the well function for leaky aquifers, $W(u,r/B)$, have been extensively tabulated (Hantush, 1956).

The procedure for analyzing a leaky aquifer test using the Hantush-Jacob model is similar to that of the Theis method for a confined aquifer. First, one must prepare a family of type curves on logarithmic paper of the function $W(u,r/B)$ as a function of $1/u$ for various values of r/B. The curve with $r/B = 0$ is the Theis curve. Next, the drawdown in an observation well completed in the aquifer is graphed as a function of time on logarithmic paper of the same scale as that used for the type curves. Match the drawdown record to a type curve and note the value of r/B and the values of s, t, $1/u$ and $W(u,r/B)$ at a match point.

The hydraulic conductivity of the pumped aquifer is calculated from a rearrangement of equation (A13). The specific storage of the pumped aquifer is calculated from a rearrangement of equation (A14). Finally the vertical conductivity of the aquitard is calculated from a rearrangement of equation (A15).

Neuman and Witherspoon (1969) found that the assumption that no water is released from storage in the aquitard tends to result in overestimating the value of aquifer conductivity and in underestimating the value of the conductivity of the aquitard. It is thought that water storage in basalt flow interiors may be quite limited, therefore the assumption of no aquitard storage, of the r/B model, may be valid for the Hanford basalt flow interiors. Another important uncertainty in the Hantush-Jacob model is that it does not distinguish between leakage from above or below the pumped aquifer. (Independent geologic and/or hydrologic knowledge of a situation must be available to assume that leakage is from only above or below the aquifer). This knowledge is crucial if one wishes to estimate the vertical hydraulic conductivity of the aquitard. The Hantush-Jacob model is viewed as one having potential usefulness in the RRL-2 tests as a tool to estimate flow top properties in the face of leakage. The model is not expected to be useful in evaluating, quantitatively, the vertical hydraulic conductivity of flow interiors.

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When the hydraulic conductivity of the confining bed is so small that the ratio K'/K tends to zero, the drawdown distribution in the aquifer becomes essentially the same as would be predicted by the Theis model for a confined aquifer (Javandel, 1983). As a result, techniques based on observation in the aquifer alone fail to give the properties of the confining bed.

Hantush Modified Model

In 1960, Hantush introduced a treatment of leaky aquifers that overcame some of the shortcomings of the Hantush and Jacob model (Hantush, 1960). In the Hantush modified model in which a storage capacity was assigned to the confining aquitard, the leaky aquifer problem was solved for 1) an infinite horizontal aquifer overlain by an aquitard whose upper boundary does not experience change in head from pumping the aquifer and 2) the same situation but with an impermeable bed overlying the aquitard. In this solution Hantush considered leakage into the aquifer from both above and below.

For t less than both b' S'/10K' and b'' S''/10K'', the solution for both cases 1) and 2) above is the same:

$$s = \frac{Q}{4 \pi K b} H(u, \beta) \qquad \text{(A16)}$$

where

$$\beta = (r\lambda)/4 \qquad \text{(A17)}$$

$$\lambda = \sqrt{\frac{K'}{Kbb'} \cdot \frac{S'}{S}} + \sqrt{\frac{K''}{Kbb''} \cdot \frac{S''}{S}} \qquad \text{(A18)}$$

$$u = \frac{r^2 S}{4tbK} \qquad \text{(A19)}$$

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The single prime denotes parameters of the upper aquitard; the double prime denotes those of the lower aquitard. A table of the function $H(u,\beta)$ appears in Hantush (1964).

Test data interpretation is much the same as for the Hantush-Jacob model. A type curve fit is obtained and values of the aquifer hydraulic conductivity and storativity are calculated from rearrangements of equations (A16) and (A19), using the match point parameter values. An estimate of the value of λ is obtained from a rearrangement of equation (A17). This leaves equation (A18) in four unknowns: K', K'', S, S''. If one of the aquitards can be considered impermeable, the hydraulic diffusivity of the other can be calculated. If the storativity of the aquitard can be independently estimated, its vertical hydraulic conductivity can then be calculated.

Except for very large values of β, the type curves have very similar shapes that are not much different from the Theis curve. It becomes difficult to decide which of the type curves to use in matching field data. The Hantush modified model provides no means to independently determine the properties of the aquitards. The Hantush modified model is viewed primarily as a diagnostic tool to estimate flow top properties in the face of leakage.

Ratio Method

The ratio method of aquitard evaluation is another tool for use in pumping test data analysis. Consider an aquifer confined above by an aquitard with a second aquifer above the aquitard as shown in Figure A2. For relatively short periods of pumping from aquifer A, no drawdown will occur in aquifer B, and the aquifer can be considered to be of effectively infinite thickness. This criterion can be expressed in terms of real time as (Neuman and Witherspoon, 1972).

$$t \leq \frac{0.1\, S_s'\, b'^2}{K'}$$

Near the pumped well the effects of vertical leakage down through the aquitard will be minimized and drawdowns in aquifer A can be approximated by the Theis equation, after pumped well-bore storage effects have diminished. The aquitard can then be treated as an aquiclude according to the theory of slightly leaky aquifers of Neuman and Witherspoon (1968).

The solution to the governing equation giving drawdown in the aquitard is

$$s'(r,z,t) = \frac{Q}{4\pi T} W(u,u'). \qquad \text{(A20)}$$

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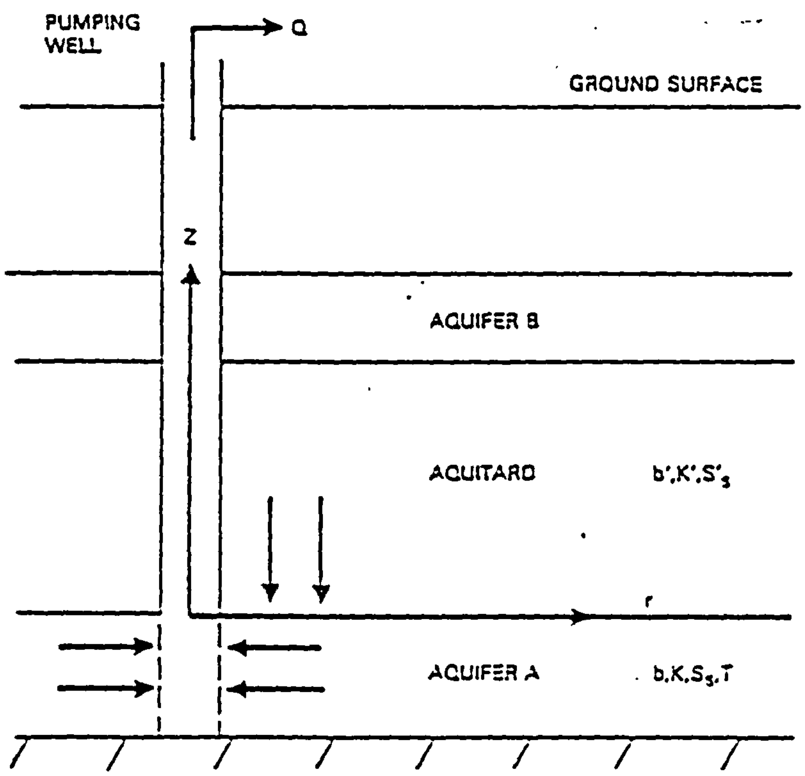

FIGURE A2. Aquifer confined above by an aquitard.

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The function $W(u,u')$ has been evaluated in terms of t_D and t'_D by numerical techniques. Dimensionless time for the pumped aquifer is $t_d = Kt/S_s r^2$ and that for the aquitard is $t'_D = K't/S_s z^2$.

It is required that the system remain saturated at all times and that the direction of flow be vertical in the aquitard and horizontal in the aquifer. The validity of the latter restriction for a system of two aquifers separated by an aquitard has been investigated by the finite-element method. It was found that when the conductivities of the aquifers are more than two orders of magnitude greater than that of the aquitard, the errors introduced by the assumption of vertical flow in the aquitard are usually less than 5% (California Department of Water Resources, 1971).

Neither equation (A20) nor the Theis equation can be used in itself to yield values of K' or S'_s. These values, however, can be determined by using the equations in combination. The usefulness of the two equations becomes evident when one considers s'/s, the ratio of drawdown in the aquitard to that in the pumped aquifer at the same elapsed time and the same radial distance from the pumping well.

Neuman and Witherspoon (1972) have shown that for practical values of t_D the ratio s'/s is independent of the dimensionless leakage parameter,

$$\beta = \frac{r}{4b(K'S'_s/KS_s)^{1/2}} ,$$

as long as β is about 1.0 or less. Because β is directly proportional to the radial distance from the pumping well, its magnitude can be kept within the limit imposed above by simply placing the observation wells close enough to the pumping well.

The ratio method relies on a family of curves of s'/s versus t'_D, each curve corresponding to a different value of t_D, as obtained from equation (A20) and the Theis equation. These curves are prepared from tables of values published by Witherspoon et al. (1967).

In the ratio method one first obtains the s'/s value at a given radial distance from the pumping well, r, and at a given time t. The next step is to determine the magnitude of t_D for the particular values of r and t at which s'/s has been measured and from measures of K and S_s derived from drawdown analysis of the observation well closest to the pumped well. Having determined which one of the curves of s'/s versus t_D should be

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used, one can read a value of t_D corresponding to the observed value of s'/s. Finally the vertical hydraulic diffusivity of the aquitard is determined from the relation.

$$\frac{K'}{S_s'} = \frac{t'_D z^2}{t} \qquad \text{(A21)}$$

When s'/s<0.1, the value of t'_D obtained by the ratio method is fairly insensitive to the magnitude of s'/s. As a result, the value of K'/S'_s calculated from equation (A21) depends little on the actual magnitude of the drawdown in the aquitard. Instead, the critical quantity determining the value of K'/S'_s, at a given elevation z is the time lag t between the start of the test and the time at which the aquitard observation well begins to respond.

To evaluate the vertical hydraulic conductivity and the specific storage of an aquitard from its hydraulic diffusivity, one of these quantities must first be determined by means other than the ratio method. Experience indicates that the hydraulic conductivity may vary by several orders of magnitude from one aquitard to another and from place to place in the same aquitard. A much more stable range of values is usually encountered in dealing with specific storage.

A relationship that may be useful in estimating values of S'_s is given by Domenico (1972) as

$$S_s' = \frac{\rho_w g}{E_c} \qquad \text{(A22)}$$

where ρ_w = water density
g = gravitational acceleration
E_c = bulk modulus of aquitard material.

With the aquitard (flow interior) specific storage estimated in this manner, the vertical hydraulic conductivity of the aquitard can be determined from its vertical hydraulic diffusivity.