Report No. SFIM-AEC-BC-CR-93120

AD-A280 331

FINAL

INTERMEDIATE AND ALLUVIAL WELL INSTALLATION REPORT

SITE 4, EXPLOSIVE WASHOUT LAGOONS

SUPPLEMENTARY REMEDIAL INVESTIGATION/ FEASIBILITY STUDY OF UMATILLA DEPOT ACTIVITY HERMISTON, OREGON

Contract No. DAAA15-90-D-0015
Delivery Order No.10

Prepared for:

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FEBRUARY 1994

AEC Form 45, 1 Feb 93 replaces THAMA Form 45 which is obsolete.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
Feb 94

3. REPORT TYPE AND DATES COVERED
Final (3 Jul 91 - Feb 94)

4. TITLE AND SUBTITLE
Intermediate and Alluvial Well Installation Report
Site 4, Explosive Washout Lagoons
Supplementary Remedial Investigation/Feasibility Study of
Umatilla Depot Activity, Hermiston, Oregon

5. FUNDING NUMBERS
C DAAA15-90-D-0015
TA 10

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland 21090

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
SFIM-AEC-BC-CR-93120

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Unlimited
Approved for Public Release

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The Intermediate and Alluvial Well Installation Report for Site 4, Explosive Washout Lagoons, Umatilla Depot Activity (UMDA), Hermiston, Oregon, has been prepared for the U.S. Army Environmental Center (USAEC) under the Base Realignment and Closure (BRAC) Program. The report documents the methods used to install four intermediate wells and two alluvial wells at Site 4 and the hydrogeologic conditions encountered. The wells were installed to 1) further assess the stratigraphy beneath Site 4; 2) assess the degree of interconnection between the basalt and the overlying alluvial sediments; 3) document water quality within the intermediate zone and further delineate explosives and nitrate/nitrite contamination within the alluvial aquifer; and 4) document horizontal and vertical groundwater flow patterns within the intermediate zone.

14. SUBJECT TERMS
Monitoring Well Installation, Hydrogeology Investigation, Remedial Investigation/Feasibility Study

15. NUMBER OF PAGES
106

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT

18. SECURITY CLASSIFICATION OF THIS PAGE

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

CONTENTS

TABLES

FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

bls	Below land surface
BRAC	Base Realignment and Closure
1,3-DNB	1,3-Dinitrobenzene
2,4-DNT	2,4-Dinitrotoluene
DOT	U.S. Department of Transportation
FSP	Field Sampling Plan
HMX	High Melting Explosive
ID	Inside diameter
NGVD	National Geodetic Vertical Datum
PVC	Polyvinyl chloride
RDX	Royal Demolition Explosive
RI	Remedial Investigation
1,3,5-TNB	1,3,5-Trinitrobenzene
2,4,6-TNT	2,4,6-Trinitrotoluene
UMDA	Umatilla Depot Activity
USAEC	U.S. Army Environmental Center, formerly USATHAMA
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
XRF	X-ray fluorescence

1.0 INTRODUCTION

This report presents the well installation methods and details for four intermediate wells and two alluvial wells installed at Site 4, Explosive Washout Lagoons, Umatilla Depot Activity (UMDA), Hermiston, Oregon. It has been prepared for the U.S. Army Environmental Center (USAEC) formerly the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), under the Base Realignment and Closure (BRAC) Program, Contract No. DAAA15-90-D-0015, Delivery Order No. 10. The purpose of the report is to document the methods used for the well installations and the hydrogeologic conditions encountered.

As discussed in detail in the Remedial Investigation (RI) report for UMDA (Dames & Moore, 1992b), during previous investigations at Site 4 contamination detected in the unconfined alluvial aquifer was attributed to historical activities at the Explosive Washout Lagoons. Contaminants consist primarily of Royal Demolition Explosive (RDX), High Melting Explosive (HMX), 1,3,5,-trinitrobenzene (TNB), 1,3-dinitrobenzene (DNB), 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), nitrobenzene, and nitrate/nitrite. Explosives (primarily RDX) and nitrate/nitrite were also detected in deep basalt wells installed into the Columbia River Basalts (4-8, 4-9, 4-10, and 4-17). The nature of the migration pathways for contaminant transport between the alluvial and basalt aquifers was unclear. It was surmised that the migration was facilitated by either natural fracturing within the basalt flows or manmade pathways created during the installation of the four deep wells.

To assist in further evaluating conditions at Site 4, four intermediate monitoring wells--4-19, 4-20, 4-21, and 4-22--were installed as part of the current investigation. The locations of these wells are shown in Figure 1-1. The objectives of the investigation were to:

- Further assess the stratigraphy beneath Site 4.
- Assess the degree of hydraulic interconnection between the basalt and the overlying alluvial sediments.

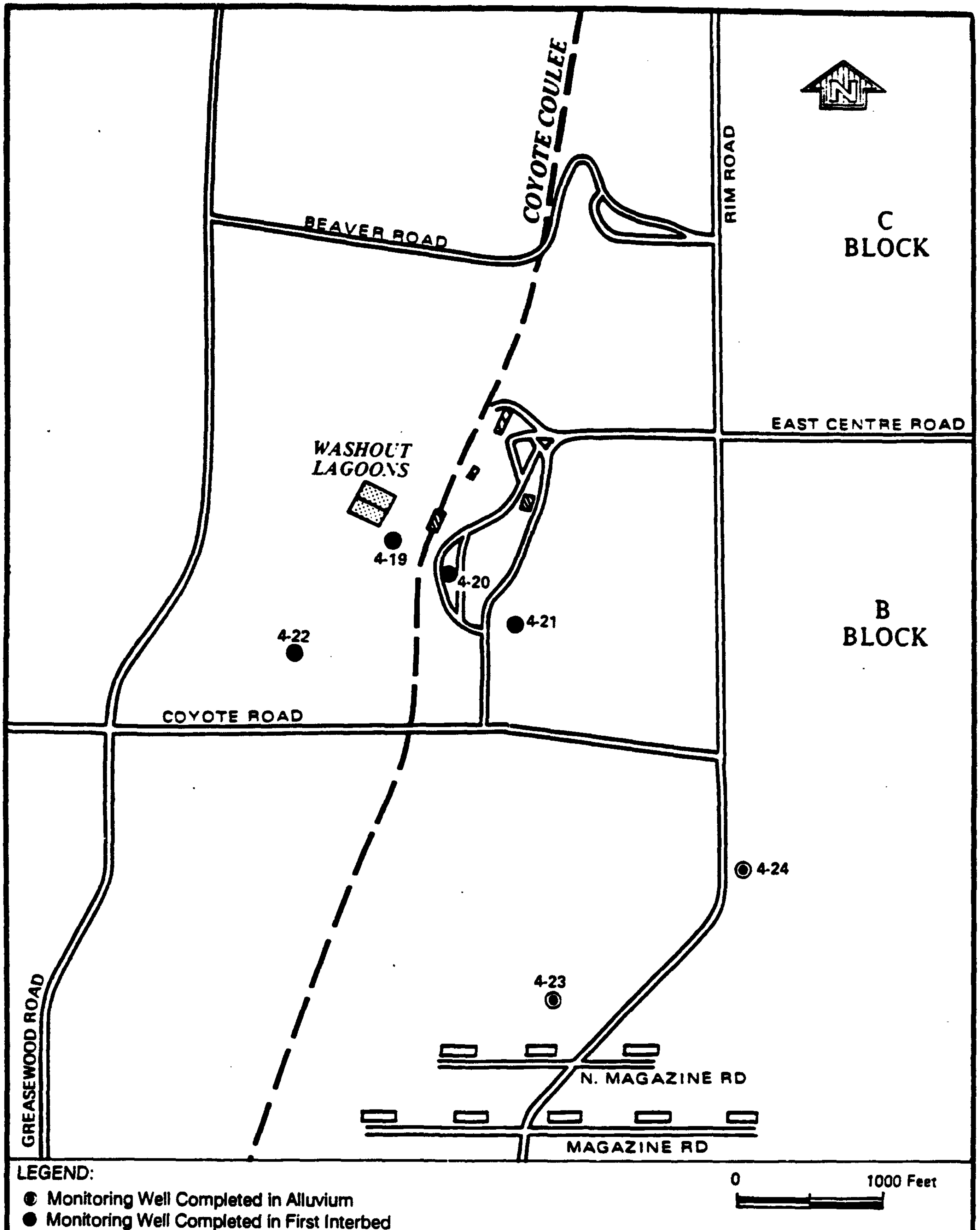

FIGURE 1-1
LOCATIONS OF NEW WELLS

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- Document water quality within the intermediate zone between the existing shallow alluvial and deep basalt wells.
- Document horizontal and vertical groundwater flow patterns within the intermediate zone.

In additior, two new alluvial wells--4-23 and 4-24--were installed to the south and southeast of the Explosive Washout Lagoons (see Figure 1-1) to further delineate the extent of explosives and nitrate/nitrite contamination within the alluvial aquifer. Note that the chemical analysis results for the alluvial (as well as intermediate) wells and contamination assessment are presented in an addendum to the RI report.

2.0 INTERMEDIATE WELL INSTALLATION METHODS

2.1 GENERAL WELL INSTALLATION METHODS

The four intermediate wells (4-19, 4-20, 4-21, and 4-22) were installed in accordance with the specifications of the Field Sampling Plan (FSP) Addendum (Dames & Moore, 1992a). The generalized intermediate well construction method is described below and is illustrated in Figure 2-1. Any deviations from the FSP Addendum are also discussed. Boring logs and well construction diagrams for each well are presented in Appendices A and B, respectively.

To minimize the potential of introducing contamination from the alluvial aquifer into the intermediate zone, the boreholes were telescoped at the bedrock contact. A Drill Systems AP-1000 reverse circulation percussion hammer rig was used to penetrate the upper alluvial deposits. An Ingersoll-Rand TH-60 air rotary rig was used to advance the hole in bedrock. In general, the following procedures were used during the drilling and well installation process:

- Triple wall drill casing was driven to refusal with the AP-1000 percussion hammer drill rig. The depth of refusal was between 54.5 and 155 feet below land surface (bls), depending on the well location. The inner dual-wall drill pipe was removed, leaving the 12-inch inside-diameter (ID) steel drill casing in place to prevent the borehole from collapsing. Split-spoon samples were collected at a 5-foot interval for the first well installed (4-19) and a 10-foot interval for the other three wells. As discussed with and agreed to by USAEC, the change from a 5-foot to a 10-foot interval was made primarily because of the homogenous subsurface conditions encountered in the first well and the difficulty in recovery of samples from the cobble-rich matrix of the alluvium.

- The TH-60 air rotary drill rig was moved onto the borehole to advance it into the basalt and to spot core the basalt to verify its nature and composition (see Section 4.3 for a description of this unit, the Elephant Mountain Basalt). An NW size core barrel (2.985 inches by 10 feet in length) was used for spot

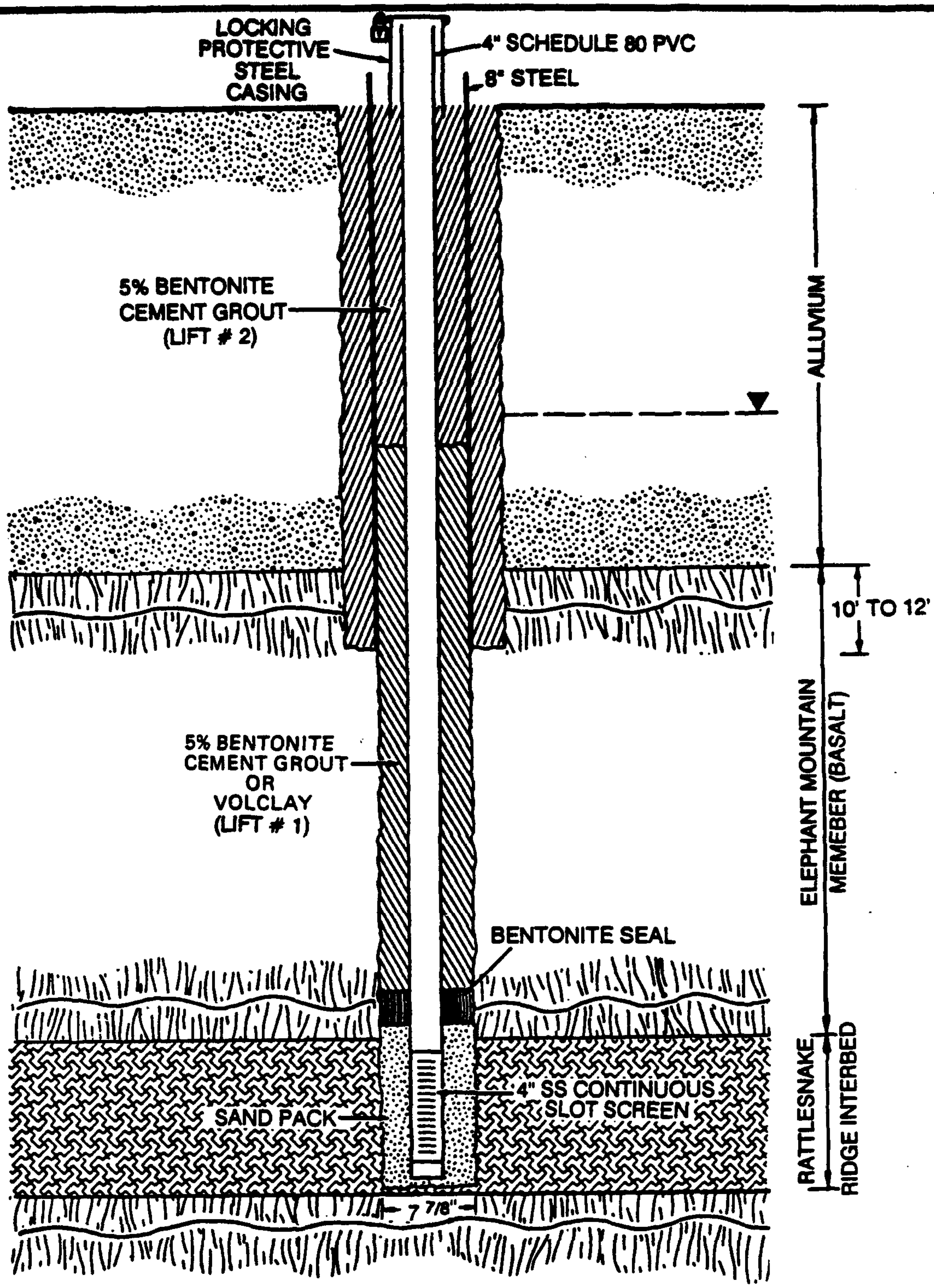

FIGURE 2-1
INTERMEDIATE WELL
CONSTRUCTION DIAGRAM

coring. When core samples were not being collected, a 5 1/2-inch downhole hammer drill bit with reverse air circulation was used to advance the borehole.

- The borehole into the upper basalt was advanced 10 to 12 feet into the unit and then reamed to 10 inches in diameter. An 8-inch steel casing was installed from the surface to 10 to 12 feet into the basalt. This casing was grouted in place using bentonite/cement grout tremied to the bottom of the borehole. The entire annulus was filled with bentonite/cement grout, and a substantial grout plug was tremied inside the 8-inch casing.

- The 12-inch triple wall casing was withdrawn, maintaining a head on the grout in the borehole to preclude collapse of the formation.

- The grout was allowed to cure for at least 12 hours.

- Following the curing period, the grout plug was drilled out and the borehole was advanced to the bottom of the first interbed by direct air rotary methods (see Section 4.3 for a description of this unit, the Rattlesnake Ridge Interbed). During advancement of the borehole, the basalt was spot cored with an NW size core barrel to verify its nature and composition.

- Packer tests were conducted during installation of two of the intermediate wells--4-20 and 4-22. Although not included in the FSP Addendum, as discussed with and agreed to by USAEC, the packer tests were conducted to assess the horizontal permeability of the upper basalt, for which no data were available from previous investigations. In both tests, a single packer was used to isolate a 6-foot interval of basalt within a borehole. Water loss at three pressures was recorded, and horizontal permeabilities were calculated. Data are presented in Appendix C.

- Following the packer test (if it was performed) and prior to installation of the monitoring well casing, the borehole was opened to 7 7/8-inch diameter with the TH-60 air rotary drill rig using a downhole hammer drill bit.

- At the completion of drilling, the drill rig was used to condition the borehole prior to well installation. Borehole conditioning is an important part of the drilling process, because it helps keep the borehole stable and free of obstructions. This was accomplished by slowly moving the drill bit up and down in the borehole while circulating air to remove any dislodged material.

- Monitoring well construction consisted of installing a 4-inch Schedule 80 polyvinyl chloride (PVC) well casing in the borehole. A 10-foot continuously wound stainless-steel well screen (slot size 0.02 inch) was set in the first interbed (150 to 200 feet bls). The continuous slot stainless-steel screen will allow use of any of the intermediate wells as recovery wells if remediation of this interbed is necessary, and if the well locations are consistent with remedial design objectives. A sand pack was placed to 3 to 5 feet above the top of the screen. The filter pack was a 10-20 Colorado Silica sand. A bentonite seal, 3- to 5-feet thick, was placed above the filter sand (Peltonite). Volclay was tremied (in one lift) to the water table in wells 4-19 and 4-21. A 5 percent bentonite/cement grout was tremied to the water table in wells 4-20 and 4-22. This first lift was then allowed to cure. Bentonite/cement grout was tremied from the top of the volclay or grout to the surface in a second lift. The use of volclay was discontinued after wells 4-19 and 4-21 because of the length of time required for it to cure. The long curing time necessitated a 4- to 6-day delay between the first and second grout lifts. While an adequate seal appeared to become established with the volclay, USAEC and Dames & Moore agreed that the 5 percent bentonite/cement grout would be used exclusively in the remaining two wells (4-20 and 4-22), because the faster curing time permitted the second grout lift to be conducted within 12 hours of the first.

Surface completions for all the wells consisted of a protective steel casing over the PVC well casing, four steel pickets, and a gravel blanket. The steel protective casing was 8 inches in diameter and extended approximately 2.5 feet below and 2.5 feet above the ground surface. It was fitted with a sliding steel cap that can be locked to the protective casing. The steel pickets are 3 inches in diameter and were placed approximately 4 feet from the protective casing. The pickets extend approximately 3 feet below and 3 feet above the ground surface. A 6-inch gravel blanket covered the area between the pickets and the protective casing. A mortar collar was placed inside the protective casing to approximately 6 inches above the ground surface, and a 1/4-inch drainage hole was drilled through the protective casing 1/8-inch above the mortar collar. The protective casing and pickets were painted orange, and the monitoring well's identifying number was painted in white on the protective casing.

All cuttings generated during the drilling activities were placed in new 17H U.S. Department of Transportation (DOT)-certified drums and labeled with well number, date, depth, and contents. Water generated during drilling was contained and transferred to the evaporation basins. The drums of cuttings are being stored in a central area warehouse at UMDA (Building 412) until the start of full-scale remediation of the contaminated soil at the Explosive Washout Lagoons. At that time, the remediation contractor will add the drummed cuttings from the Site 4 wells to the contaminated soil from the lagoons and the material will be composted.

The monitoring wells were developed for approximately 2 hours, between 2 to 7 days after emplacement of the internal mortar collar. Well development was performed using a 5-foot stainless-steel bailer and a submersible pump. The wells were first bailed to help remove any sediment that may have collected in the bottom of the casings. In addition, inserting and removing the bailer created a surging action that helped to clear the well screens. After bailing, the wells were pumped using a submersible pump to complete the development process. Temperature, pH, and conductivity were measured in the water removed from each well at least five times throughout development, always including the first and last water removed from the casings. Field readings collected during well development are provided in Appendix D. Development generally continued until five well volumes--including both the casing and saturated annulus--were removed, the physical parameters were reasonably stable, and the water appeared to be clear. The bailer and submersible pump were steam cleaned between wells; the pump discharge line for each well consisted of dedicated polyethylene tubing.

2.2 WELL-SPECIFIC CONSTRUCTION DETAILS

Table 2-1 summarizes the intermediate well construction. Appendices A and B provide the boring logs and well construction diagrams, respectively. Specific details on the construction history of each of the intermediate wells are as follows:

- Well 4-19 was initiated on 11/11/92. The well was installed on 11/16/92, including the first lift of the volclay. Final surface completion was conducted on 11/20/92. The well was developed on 12/15/92, slug tested on 12/19/92, and groundwater samples collected on 1/8/93.

- Well 4-20 was initiated on 11/30/92. The well was installed on 12/7/92, including the first lift of bentonite/cement grout. Final surface completion was conducted on 12/8/92. The well was developed on 12/18/92, slug tested on 12/19/92, and groundwater samples collected on 1/6/93.

- Well 4-21 was initiated on 11/15/92. The well was installed on 11/19/92, including the first lift of the volclay. Final surface completion was conducted on 11/21/92. The well was developed on 12/16/92, slug tested on 12/19/92, and groundwater samples collected on 1/7/93.

- Well 4-22 was initiated on 12/3/92. The well was installed on 12/9/92, including the first lift of bentonite/cement grout, with final surface completion on 12/10/92. The well was developed on 12/15/92, slug tested on 12/19/92, and groundwater samples collected on 1/9/93.

TABLE 2-1

INTERMEDIATE WELL CONSTRUCTION SUMMARY

Well No.	Surface Elevation (ft)	Measuring Point (msl)	Total Depth (ft)	Depth to Refusal (ft)	Depth of 8" Casing (ft)	Screened Interval (ft)	Screened Interval (msl)	Static Water Level [1,2] (ft)	Static Water Elevation [1] (msl)	Grout Type (first lift)
4-19	557.80	559.59	168.0	94.5	105.0	150-160	407.80--397.80	112.57	445.23	Volclay
4-20	616.40	617.45	218.0	151.0	162.0	198-208	418.40--408.40	145.50	470.90	Volclay
4-21	614.60	616.57	215.0	154.5	167.0	202-212	412.60--402.60	153.92	460.68	Bentonite/ Cement Grout
4-22	514.80	516.58	119.0	55.0	67.0	100-110	414.80--404.80	58.35	456.45	Bentonite/ Cement Grout

[1] Measured December 16, 1992.
[2] Depth below measuring point (top of casing)

3.0 ALLUVIAL WELL INSTALLATION METHODS

3.1 GENERAL WELL INSTALLATION METHODS

Two alluvial wells (4-23 and 4-24) were installed in accordance with the specifications of the FSP Addendum (Dames & Moore, 1992a). Boring logs and well constructic diagrams are presented in Appendices A and B, respectively. A Drill Systems AP-100 reverse circulation percussion hammer rig was used to penetrate the upper alluvial deposits. The following procedures were employed during the drilling and well installation process:

- Dual-wall drill casing was driven at least 10 feet into the unconfined alluvial aquifer with the AP-1000 percussion hammer drill rig. The depth to the unconfined aquifer was approximately 100 to 103 feet bls, depending on the well locations. Split-spoon samples were collected at selected intervals to verify subsurface lithology.

- Monitoring well construction consisted of installing a 4-inch Schedule 40 PVC well casing in the borehole. A 15-foot cut slot screen (slot size 0.01 inch) was set approximately 10 feet into the water table. A 15-foot screen was used to accommodate seasonal fluctuations of 3 to 5 feet in water table elevations in the unconfined aquifer. The filter pack--a 10-20 CSSI grade Colorado Silica sand--was placed to 5 feet above the top of the screen. A 5-foot-thick bentonite seal was placed above the filter sand (Peltonite). A bentonite/cement grout was tremied from the top of the bentonite grout to the surface.

Surface completions, cuttings disposal, and well development for the two alluvial wells were performed according to the methods described for the intermediate wells in Section 2.1. Figure 3-1 shows the general alluvial well construction details.

3.2 WELL-SPECIFIC CONSTRUCTION DETAILS

Table 3-1 summarizes the alluvial well construction. Appendices A and B provide the well logs and well construction diagrams, respectively. Specific details regarding the construction history of each of the alluvial wells are as follows:

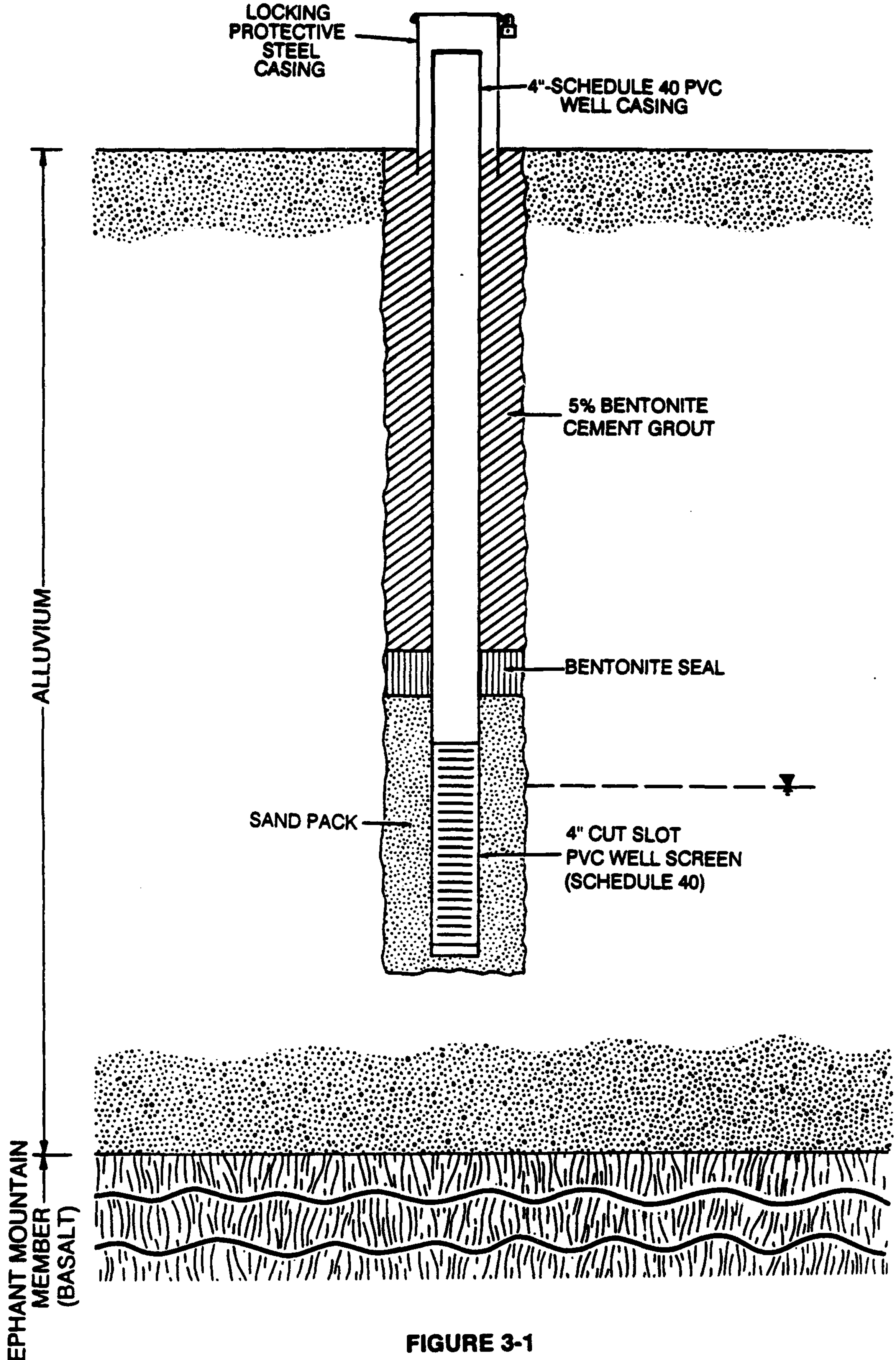

FIGURE 3-1
ALLUVIAL WELL CONSTRUCTION

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TABLE 3-1

ALLUVIAL WELL CONSTRUCTION SUMMARY

Well No.	Surface Elevation (ft)	Measuring Point (msl)	Total Depth (ft)	Screened Interval (ft)	Screened Interval (msl)	Static Water Level [1,2] (ft)	Static Water Elevation [1] (msl)
4-23	593.4	595.34	111	94--109	499.4--484.4	100.45	492.95
4-24	596.5	598.15	113.5	96.5--111.5	500.0--485.0	103.45	493.05

[1] Measured December 16, 1992.
[2] Depth below measuring point (top of casing).

- Well 4-23 was initiated on 11/14/92. The well was installed and completed on 11/15/92. The well was developed on 11/19/92 for a period of 1 hour. Slug testing was conducted on 11/23/92, and groundwater samples were collected on 12/15/92.

- Well 4-24 was initiated on 11/14/92. The well was installed and completed on 11/15/92. The well was developed on 11/19/92 for a period of 1 to 2 hours. Slug testing was conducted on 11/23/92, and groundwater samples were collected on 12/15/92.

4.0 HYDROGEOLOGIC SETTING

This section describes of the hydrogeologic conditions encountered beneath Site 4 during installation of the four new intermediate wells (4-19, 4-20, 4-21, and 4-22) and the two new alluvial wells (4-23 and 4-24). Also discussed are the hydrogeologic conditions encountered during previous installation of existing wells. Based on the additional data collected during this phase of work, the interpretation of Site 4 geology presented in the 1992 RI report (Dames & Moore, 1992b) has been somewhat revised. Generally, the geologic conditions encountered beneath Site 4 consist of a relatively thin aolean mantle at the surface, Pleistocene alluvial flood deposits, and Miocene basalt flows of the Columbia River Basalts. Figure 4-1 presents a northwest/southeast-trending geologic cross-section through Site 4, based on information from the new and existing wells.

4.1 AOLEAN DEPOSITS

The aolean deposits (windblown sediments) encountered in all new wells varied in thickness from approximately 2 feet (east of Coyote Coulee; see below for description) to 15 feet (west of the Coulee). The aolean mantle consists of a well sorted, fine-to-medium angular sand, tan-to-grey in color. These deposits are similar to those recorded in the boring logs of other Site 4 wells previously installed.

4.2 ALLUVIAL DEPOSITS

The Pleistocene alluvial flood deposits beneath the aolean deposits at Site 4 were deposited by a series of catastrophic flood events, which were precipitated by the cyclic failure and re-building of the ice dams that impounded Glacial Lake Missoula, in western Montana, approximately 17,200 to 11,000 years ago (Breckenridge et al., 1989). Each of these ice dam failures caused extremely high energy flows down the Columbia River. In the area of UMDA, these floodwaters expanded across the Umatilla Basin. Partial constriction of the Columbia River downstream of the Umatilla Basin caused hydrodynamic damming of the floodwaters; formation of glacial Lake Condon; and deposition of significant thicknesses of rounded-to-subrounded sand-, gravel-, and cobble-sized clasts in the Umatilla Basin (Breckenridge et al., 1989). Coyote Coulee, which runs through Site 4 on an approximate northeast/southwest trend, is a 50-foot escarpment interpreted to be formed

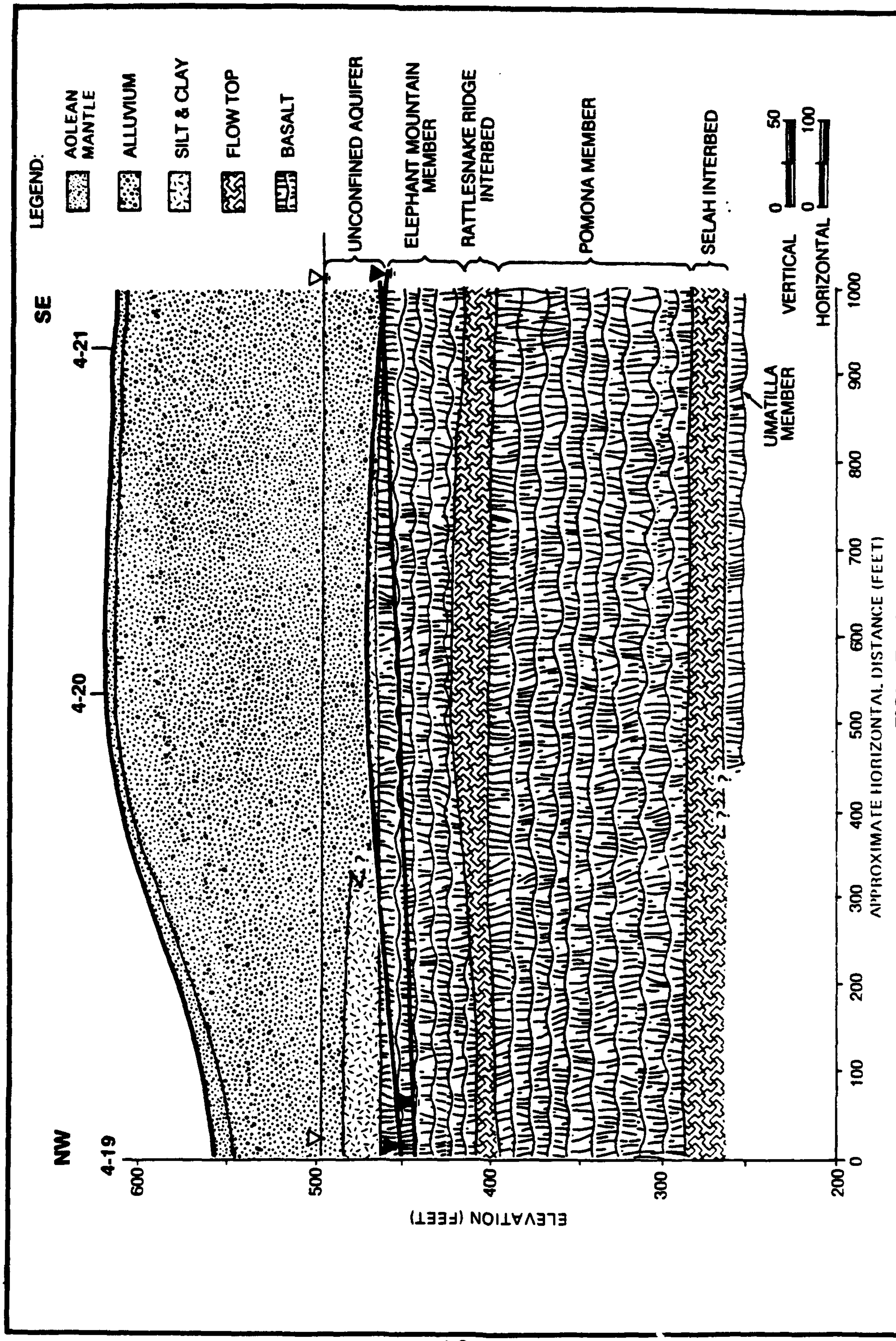

FIGURE 4-1
STRATIGRAPHIC CROSS-SECTION BENEATH SITE 4

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by standing waves in the floodwaters. Numerous smaller (10- to 20-foot) bottom ripples are present to the northwest of Site 4 and trend in the same direction.

Geologic samples collected from intermediate wells 4-20 and 4-21, and alluvial wells 4-23 and 4-24, suggest that--to the east of Coyote Coulee--the alluvial flood deposits consist of coarse sands, gravels, and cobbles composed primarily of basalt with lesser amounts of quartz, feldspar, and mica. These deposits extend from the surface (approximately 600 feet above National Geodetic Vertical Datum (NGVD) of 1929) to the basalt contact at approximately 460 feet above the NGVD. Directly above the basalt contact, the sediments are composed of slightly finer saturated silty sands.

Geologic samples from intermediate wells 4-19 and 4-22 suggest that the alluvial flood deposits west of the coulee are typically finer than those to the east, and consist of fine-to-coarse sand and gravel composed primarily of basalt with lesser amounts of quartz, feldspar, and mica. The alluvium extends from the base of the aolean mantle to an approximate elevation of 480 feet above the NGVD, where a sequence of fine sediments approximately 20-feet thick caps the basalt. Sediments are composed of silts, clays, and fine sand, and tend to be dry. At well 4-22, lake varves or rythmites were observed in these sediments, suggesting that they are lacustrine in origin. This unit may represent residual deposits associated with glacial Lake Condon. These lacustrine deposits--which extend to the top of the basalt--remained undisturbed in the lower energy environment on the downstream side of the standing wave associated with later flooding.

The alluvial flood deposits become saturated at approximately 495 feet above the NGVD. The saturated alluvium forms the uppermost aquifer beneath Site 4. It is unconfined, highly permeable, and ranges in saturated thickness from 35 feet (east of the coulee) to 10 to 15 feet (west of the coulee, where the lacustrine deposits thin the alluvium). Previous slug testing and permeability testing suggest a permeability range of 200 to 1,000 feet/day for the alluvium and 3 to 5 feet/day for the silt and clay of the lacustrine deposits (Dames & Moore, 1992b). Slug testing was conducted on the two new alluvial wells (4-23 and 4-24) and analyzed by methods proposed by Bouwer and Rice (1976). Permeability values of 1,571 and 1,944 feet/day, respectively, were obtained (Appendix E).

4.3 BASALT FLOWS

The uppermost basalt flows present beneath Site 4 are those of the Saddle Mountain Formation. Like all the Columbia River Basalts, they erupted during the Miocene Epoch. Flows and interbeds within the Saddle Mountain Formation consist of--from youngest to oldest-- the Elephant Mountain Member, the Rattlesnake Ridge Interbed, the Pomona Member, the Selah Interbed, the Umatilla Member, and the Mabton Interbed (Oberlander and Miller, 1981).

The uppermost basalt flow beneath Site 4 occurs at an approximate elevation of 460 feet above NGVD, or between 50 to 150 feet bls, depending on the location of the well. The topographic surface of the basalt at this area is relatively flat, with a variable depth to basalt due to the topographic expression of Coyote Coulee. Based on installation of the four new intermediate wells, this uppermost flow was found to be approximately 50 to 60 feet in thickness and composed of slightly-to-highly weathered aphanitic light grey basalt. Locally, alteration to kaolanitic clays was observed; however, overall, the rock was only slightly weathered and fractured. X-ray fluorescence (XRF) of core samples collected from this flow during the installation of the intermediate wells was used to evaluate the rock chemistry and identified the flow as the Elephant Mountain Member of the Saddle Mountain Basalts (Beeson, 1993). Results of this analysis are presented in Appendix F.

A flowtop interbed at an elevation of approximately 400 feet was encountered beneath the Elephant Mountain Member; this has been interpreted to be the Rattlesnake Ridge Interbed. The unit is approximately 20-feet thick and is composed of highly chloritized, highly vesicular basalt and interbed sediments. All four intermediate wells (4-19, 4-20, 4-21, and 4-22) were installed into this interbed.

Logs of the previously installed deep basalt wells (4-8, 4-9, 4-10, and 4-17) suggest that a second basalt flow, approximately 100-feet thick, is present beneath the Rattlesnake Ridge Interbed. This flow is interpreted to be the Pomona Member of the Saddle Mountain Basalts. A 20- to 30-foot-thick interbed present beneath this flow is interpreted to be the Selah Interbed. The deep basalt wells are all screened within this interbed.

The Rattlesnake Ridge and Selah Interbeds represent confined or leaky confined aquifers, with the Elephant Mountain and Pomona Members acting as the poorly permeable confining layers that separate them. Packer testing conducted at intermediate wells 4-20 and 4-22 suggest that the horizontal permeabilities in the Elephant Mountain Member range from 0.01 to 0.16 feet/day (Appendix C). Slug testing of the new intermediate wells was conducted and analyzed by methods proposed by Cooper et al. (1967). These data suggest that the permeability of the Rattlesnake Ridge Interbed is between 277 and 624 feet/day (Appendix E). Earlier slug testing suggests that the formation permeability of the Selah Interbed is between 2 and 16 feet/day (Dames & Moore, 1992b).

5.0 SUMMARY

Four intermediate and two alluvial wells were installed at Site 4, Explosive Washout Lagoons, at UMDA. Although the geologic conditions encountered were somewhat different from those anticipated, well construction methods were largely in accordance with those presented in the FSP Addendum (Dames & Moore, 1992a). As discussed with and agreed to by USAEC, deviations from this plan included the addition of two packer tests at intermediate wells 4-20 and 4-22; collection of split-spoon samples at 10-foot (rather than 5-foot) intervals at intermediate wells 4-20, 4-21, and 4-22; and use of a bentonite/cement grout mix in place of volclay to seal the borehole annulus beneath the water table at intermediate wells 4-20 and 4-22. Based on information from the installation of the new wells and existing wells, the geology encountered beneath Site 4 consists of an aolean mantle, alluvial flood deposits, lacustrine sediments in some areas, and basalt flows with associated interbeds. The alluvial flood deposits form a highly permeable but relatively thin unconfined aquifer. The basalt interbeds form a sequence of confined or leaky confined aquifers separated by the basalt flows. The intermediate wells were installed into the uppermost interbed aquifer (Rattlesnake Ridge Interbed).

As discussed in Section 1.0, data were also collected to assess the degree of hydraulic connection between the aquifers, to document water quality within the unconfined alluvial aquifer and Rattlesnake Ridge Interbed, and to document horizontal and vertical groundwater flow patterns. These data are included in an addendum to the RI report.

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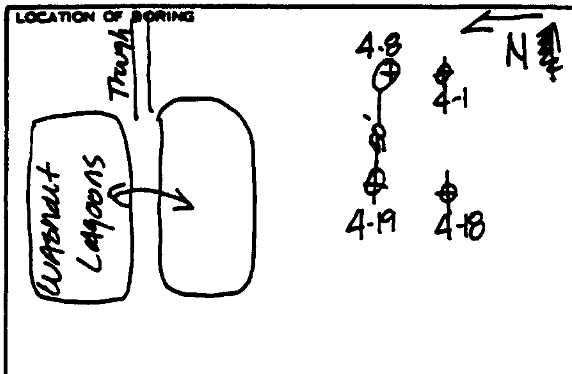
APPENDIX A

Boring Logs

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD:	Becker Hammer Reverse Circ.	BORING NO. 4-19
SAMPLING METHOD:	Calif. Split Spoon 18" x 3" 140# ext. hammer 30" drop	SHEET 1 OF 9
WATER LEVEL	62-64	DRILLING START TIME 1000 / FINISH TIME
TIME		
DATE		START DATE 11/11/92 / FINISH DATE
CASING DEPTH		

DATUM ELEVATION

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING (Time)	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS (OVM)	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS: Gently sloping west, sparse vegetation Pred. sand.
						0		
						1		
						2		-Cuttings 0-10': Pinkish-gray f-c sand
						3		dry, poorly graded. (Loess deposit?) Micaceous - (Pleist sand)
						4		↓
						5		
						6		
						7		
						8		
						9		
						10	SP	SAND: Pinkish-Gray (7.5YR 6/2), little or no fines, poorly graded sand, damp, Pred. quartz,
U	18/16	1030	1 / 10.0	8/10/13	0.0	1		basalt - fine grained, loess deposit?, med dense
						2		-Cuttings As Above 10.5-15'
						3		
						4		
						15	SM	SILTY SAND: Light-Brown (7.5YR 6/3) <20-25% fines, 75-80% v. fine sand, poorly graded,
U	18/6	1050	2 / 15.0	13/21/21	0.0	6		damp, micaceous, felsic, Pleist. sand. med dense -Occassional 2" basalt clasts.
						7		
						8		
						9		
						20		

DRILLING CONTR. Layne Env.

No.162879

BY Mark Ochsner DATE 11/11/92 CHK'D BY

928 1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-161	USATHAMA	Umatilla, OR

BORING NO. 4-19
SHEET 2 OF 9

DRILLING METHOD: See page 1

SAMPLING METHOD:

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING: START TIME / FINISH TIME; DATE / DATE

DATUM ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	~~NUMBER OF RINGS~~ OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						20	ML	SILT: Brown (7.5YR 5/3), <10% v. fine Sand, >90% fines, slight Plasticity, damp, med stiff,
U	18 / 18	1100	3 / 20.0	21/31/35	0.0	1	SP	SAND: Pinkish-Gray (7.5YR 6/2), <10% fines, >90% fine Sand, poorly graded, damp, loose. Angul Pred quartz & basalt, med dense to dense, micaceous Pleist. Sand. Occassional fine gravels. (basalt)
						2		
						3		
						4		
U	18 / 16	1120	4 / 25.0	5/8/13	0.0	25	SP	SAND: Pinkish-Gray (7.5YR 6/2), <10% fines, Pred. fine grained SAND, poorly graded, damp, loose to med dense, SAND is Angular, Pred basalt, & quartz (Salt: Pepper appearance), micaceous Pleist. Sand. Occassional layering in Sands.
						6		
						7		
						8		
						9		
						30		
U	18 / 18	1130	5 / 30.0	13/15/22	0.0	1	SM	SILTY SAND: Brown (7.5YR 5/3), 20-25% fines, (non plastic), 75-80% v. fine to fine Sand, poorly graded, damp, med. dense, occassional ½" color banding, bottom 2" shows oxidation Staining (Fe) Sand is angular, Pred. quartz, feldspar, some basalt, felsic, micaceous, Pleist Sand.
						2		
						3		
						4		-Occassional 2-3" Rounded gravels in Cuttings.
						35	GP	SANDY GRAVEL: Olive Brown (2.5Y 4/3), <5% fines, 40-45% fine-med. Sand, 50% gravel, poorly graded, dense, sand is As Above, gravel is rounded basaltic and angl. 1-2",
U	18/12 / 12	1155	6 / 35.0	8/50/5"	0.0	6		
						7		
						8		
						9		
						40		

DRILLING CONTR. Layne Env.

No.162867

BY Mark Ochsner DATE 11/11/92 CHK'D BY

28-1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD:	BORING NO.
See Page 1	4-19
SAMPLING METHOD:	**SHEET** 3 OF 9

WATER LEVEL					DRILLING START TIME	FINISH TIME
TIME						
DATE					DATE	DATE
CASING DEPTH						

DATUM

ELEVATION

DRILLING CONTR. Layne env.

No.162868

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS.
U	5 / 2"	1210	7 / 40.0	50-5"		40	GP	~~GRAVEL~~ SANDY GRAVEL: As Above
						1		
						2		
						3		
						4		-1-3" Rounded gravels (basalt) in Sand MATRIX in cuttings Rounded to Subrounded.
						45	SP/GP	SANDY GRAVEL: Brown (10YR 5/3), ~50% fine to med Sand, ~50% gravel, poorly graded, damp, little or no fines <5%, dense, Sand is rounded to Subrounded pred. quartz: basalt, felsic, gravel is subround basaltic are slightly weathered, micaceous
U	12 / 6	1230	8 / 45.0	40/50/6"		6		
						7		
						8		
						9		GRAVEL: Grayish Brown (10YR 5/2), 5-10% fine to coarse Sand, well graded, angular basalt fragments, fine pred. basalt, quartz, damp, med dense
						50	GW / SP / ML / GW	SAND: Brown (10YR 5/3), 5% fines, pred fine Sand, Poorly graded, damp.
U	18 / 18	1240	9 / 50.0	7/14/22		1		SILT: Brown (10YR 5/2) slightly plastic SILT, 5% v. fine Sand.
						2	GW	GRAVEL: Grayish Brown (10YR 5/2), 5-10% fine to coarse Sand, well graded, moist, med dense, gravel is angular, pred basalt & quartz, k-spar
						3		
						4		
						55	GP	GRAVEL: Dk Grayish Brown (10YR 4/2), < 5% fines, Pred. fine, angular to subrounded basalt, some quartz & volcanics, poorly graded, damp, med dense. < 10% fine to coarse Sand, gravel is slightly to mod. weathered.
U	18 / 18	1310	10 / 55.0	25/23/21		6		
						7		
						8		
						9		
						60		

BY Mark Ochsner

DATE 11/11/92 CHK'D BY

DSS 9 (2) (REV. 11-90)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-11	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD:

BORING NO. 4-19

SHEET 4 OF 9

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM ELEVATION

SURFACE CONDITIONS:

DRILLING CONTR. Layne Env.

No.162869

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	~~NUMBER OF RINGS~~ OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						60		GRAVEL: Dk Grayish Brown (10YR 4/2), <5% fines,
U	18/18	1320	11/60.0	2/35/21	0.0	1	GP	<10% fine to coarse sand, Pred. fine, Angular basalt gravels, with quartz, poorly graded,
						2		Slightly to mod. weathered, med dense - becomes finer gravels than above.
						3		- Drive casing at 2.5'/min.
						4		- Cuttings become moist-saturated at ~~62-65~~ 62-64' water table approx. 62-64'
						65		GRAVEL: Dk Grayish Brown (10YR 4/2), 5-10% fines,
U	18/18	1400	12/65.0	21/21/22	0.0	6	GP	< 10% coarse sand, > 85% fine to med gravel, Poorly graded, saturated, angular to rounded basalt
						7		Slightly weathered, med dense. 2" band of fine sand at 66.0' (tan)
						8		
						9		
						70		GRAVEL: Dk Gray (10YR 4/1), <5% fines, Pred.
U	18/12	1410	13/70.0	3/3/4	0.0	1	GP	fine angular basalt, with quartz & feldspars, poorly graded, saturated, loose. Some coarse angular sand, slightly weathered.
						2		
						3		- Cutting became SILTY Clay - saturated.
						4		1st Hydrogeologic contact at 73-74' bgs.
						75	~~MH~~ CL	CLAYEY SILT: Gray (10Y 5/1), <5% v-fine sand,
U	18/18	1435	14/75.0	9/16/10	0.0	6	ML	~~30%~~ 95% fines (Clay: Silt), moist, mod plastic, soft, liquid limit probably < 50, med stiff, cohesive
						7		possible Aquitard at 75'
						8		
						9		
						80		

BY Mark Ochsner DATE 11/11/92 CHK'D BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-086-14	USATHAMA	Umatilla, OR

DRILLING METHOD: Air Rotary TH-60 94.5' → See Page 1

SAMPLING METHOD: See Page 1

BORING NO. 4-19

SHEET 5 OF 9

DRILLING: START TIME / FINISH TIME / DATE / DATE

WATER LEVEL / TIME / DATE / CASING DEPTH

DATUM — ELEVATION

SURFACE CONDITIONS:

DRILLING CONTR. Layne Env.

No.162898

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						80	ML/SM	SANDY SILT: GRAY (5Y 5/1) 30-35% v.f. Sand, 65-70% fines, Slightly plastic, med. stiff to stiff, moist - not saturated.
U	18/14	1500	15/80	9/16/32	0.0	1		
						2		
						3		
						4		
						85	GM	SILTY SANDY GRAVEL: GRAY (5Y 5/1), 20-25% fines, 30% f-m, angular sand, 45% f-c gravel, poorly graded, saturated, v. dense, gravel is angular to subrounded basalt, slightly weathered, sand is pred. felsic, quartz, kspar basalt. Several pieces of cemented Ash-Tuff?
U	5"/5"	1530	16/85	50-5"	0.0	6		
						7		
						8		- harder drilling at 86.0'
						9		
						90	CL/ML	Clayey SILT: V. pale brown (10YR 7/2), <5% v. fine Sand, Pred. 100% fines, slight plasticity, med-stiff, damp - not saturated, cohesive
						1		
						2		End of day
						3		
						4		Refusal at 94.5' bgs w/Becker Hammer 08:55 Air rotary begins w/core (NW) 2.85" x 10' barrel.
						95	B	BASALT: (95-102.5' core): Dk GRAY (7.5YR 4/0), slightly weathered, vesicular basalt, weathered horizontal fracturing, traces of fine sand, rare secondary calcite filling, no phenocrysts, no pyrite, no vertical fracturing, chlorite in one vesicle, yellow-brown color in horiz. fractures - hematite. not saturated
			Core run #1	95-102.5'		6		
						7		
						8		RQD=29% Recovery=88%
						9		
						100		

BY Mark Ochsner DATE 11/11/92 CHK'D BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-006-111	USATHAMA	Umatilla OR

DRILLING METHOD: See Page 1

SAMPLING METHOD: See Page 1

BORING NO. 4-19

SHEET 6 of 9

DRILLING	
START	FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS.

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
				Core run #1	95-102.5'	100		BASALT: Core run #1 95-102.5' As Above
						1		
						2		
						3		
						4		
						105	B	- Cuttings are dry, Lt brown Sand - Probably rock flour - hard drilling 13 min/FT.
						6		- 8" casing set in cement from Surface to 105'
						7		
						8		- V. hard drilling - 15:16 min/FT
						9	B	
						110		
						1		- Cuttings dry - hard basalt,
						2		
						3		
						4		
				Core run #2	115-117.5'	115	B	BASALT: GRAY (7.5YR 4/0), moderately weathered vesicular basalt, Aphanitic, some Mafic minerals, with CA & Plag (40-50%), no phenocrysts, some vertical fracturing - closed Fe Staining, horizontal fracturing, occassional Secondary mineralization of vesicles & Fractures. RQD = 50%
						6		Recovery = 100%
						7		Core terminated at 117.5' due to slow penetration.
						8		
						9		
						120		

DRILLING CONTR. Layne env.

No.162900

BY Mark Ochsner DATE 11/14/92 CHK'D BY

028-1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06202-086	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD:

BORING NO. 419

SHEET 7 OF 9

DRILLING	START	FINISH
TIME		
DATE		

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM　　ELEVATION

DRILLING CONTR. Layne Env.

No.162886

BY Mark Ochsner　DATE 11/15/92　CHK'D BY

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
						120	B	V. Hard drilling - Blue gray dust coming from cyclone - basalt approx. 15 min./ft
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		-Begin core run #3 from 130-134'
						130		BASALT: GRAY (7.5YR 5/0), Highly vesicular, mod. weathered basalt. High Alteration of basalt in places to kaolinite. Top 1 foot of core has completely weathered basalt to clay (yellow brown), horizontal fracturing, vesicles completely filled with secondary minerals, no phenocrysts, secondary minerals are pred. chlorite, basalt is aphanitic, some Ca plag is visible in mafic matrix. RQD: 19% Recovery: 42%
				Core run #3	130-134'	1		
						2		
						3		
						4		
						5		V. hard drilling - blue gray cuttings, basalt
						6		
						7		Easier drilling and some H_2O at 138'. Probably weathered fracturing in basalt.
						8		
						9		
						140		

020.1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING: See Page 1

JOB NO.	CLIENT	LOCATION
06762-086-11	USATHAMA	Umatilla OR

DRILLING METHOD: See Page 1

SAMPLING METHOD: See Page 1

BORING NO. 4-19

SHEET 8 OF 9

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						140		
						1	B	V. Hard drilling - occassional water in Cyclone - from Above at ~135'-138' 13 min/FT.
						2		
						3		
						4		
						5		
						6		- Blue gray cuttings - basalt fragments.
						7		
						8		SANDY SILT: Blue Gray (5G 6/1), 25% v. fine Sand, 75% fines, slightly plastic, moist, stiff. Probably Completely weathered basalt.
						9	ML	
						150		BASALT: GRAY (7.5YR 5/0), Highly vesicular basalt, mod. to highly weathered, Several zones of Chlorite fillings, some Pyrite inclusions, Fractures and ~~fillings~~ vesicles are open, Color is Distinctly blue/greenish gray. Rock is Aphanitic mafic matrix, no phenocrysts. RQD = 72% Recovery = 90%
						1	B	
						2		
						3		
				Core run #4	150-160	4		-Probable flow top. Contact between Pomona and Umatilla members - Selah Interbed?
						5		
						6		
						7		
						8		
						9		
						160		

DRILLING CONTR. Layne Env.

No. 162887

BY Mark Ochsner DATE 11/15/92 CHK'D BY

02B.1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-11	USATHAMA	Umatilla OR

DRILLING METHOD:

SAMPLING METHOD: See page 1

BORING NO. 4-19

SHEET 9 OF 9

DRILLING	
START	FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM ELEVATION

SURFACE CONDITIONS.

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
				Core run #5	160-168'	160	B	BASALT: Lt Gray (7.5YR6/6), Relatively competent basalt, Aphanitic mafic matrix, Secondary minerals of chlorite & calcite in vesicles, no phenocrysts, occassional vesicles, fewer than above, Fractured zone at 162'
						1		
						2		
						3		
						4		-Basalt is more competent w/depth beneath flow top.
						5		
						6		
						7		
						8		Boring terminated at 168' bgs. on 11/15/92 G.W. encountered at 62-64' during drilling
						9		
						170		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						180		

DRILLING CONTR. Layne Env.

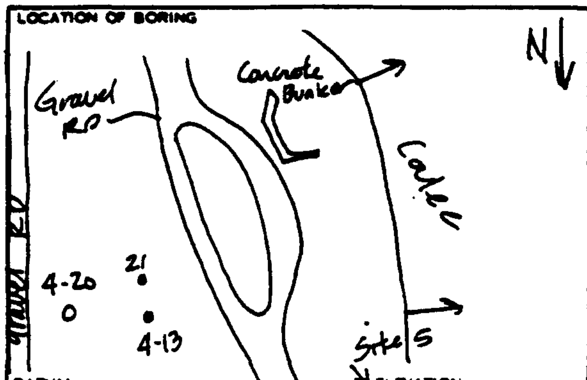
No.162873

BY Mark Ochsner DATE 11/15/92 CHK'D BY

028.5 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
	06702-086-N1	USATHAMA	Umatilla, OR



DRILLING METHOD: Becker Hammer
Percussion, reverse air
Triple wall csg 12" 9" 6"

SAMPLING METHOD:
Calif Split spoon 3" x 18"
140# ext. hammer 30" drop

BORING NO. 4-20

SHEET 1 OF 11

DRILLING	START	FINISH
TIME	1020	
DATE	11/30/92	

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING CONTR Layne Env

No.161972

SURFACE CONDITIONS: Relatively Flat Sand & Brush area

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	~~DEPTH OF CASING~~ Time	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	~~NUMBER OF BLOWS~~ OVM	DEPTH IN FEET	SOIL GRAPH	
						0		
						1		
						2		SAND: Reddish Brown (7.5YR 4/3), micaceous, angular quartz & basalt - cuttings - dry
						3	SP	
						4		
						5		
						6		
						7		-fine-med rounded gravels -basalt in sandy matrix -dry
						8		
						9		SANDY GRAVEL: Dk Brown (7.5YR 4/2), <5-10% fines, 30-35% m-c Sand - angular quartz & basalt, 65-70% f-m gravels, rounded, basalt clasts in sandy matrix, Poorly graded, dry, Grab Sample - no split spoon
						10	GP	
Grab	- / -	10:30	1 / 10.0	-	0.0	1		
						2		
						3		
						4		
						5		
						6	GP	- Sandy Gravel as above
						7		
						8		
						9		
						20		

BY Mark Ochsner DATE 11/30/92 CHK'D BY

028.5 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD:

BORING NO. 4-20

SHEET 2 OF 11

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL / TIME / DATE / CASING DEPTH

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	~~DEPTH OF CASING~~ TIME	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	~~NUMBER OF JUNKS~~ OVM	DEPTH IN FEET	SOIL GRAPH	
						20		SANDY GRAVEL: Dk Grayish-Brown (10YR 5/2), <5%
U	18 / 8	1045	2 / 20.0	17/36/41	0.0	1	GP	fines, 15-20% f-c Sand - angular basalt:
								quartz, mafic, 75-80% f-c gravels, subrounded
						2		to rounded basalt clasts, Fresh, poorly graded,
								dry, occassional mica in sands, dense
						3		
						4		
						5		- Sandy Gravel - as above
						6		
						7		
						8		- decrease in Sand at 28'
						9		
						30	GP	GRAVEL: Gray (7.5YR 6/0), little or no fines,
								100% angular basalt, fractured by split spoon
U	5" / 3"	1110	3 / 30.0	50/5"	0.0	1		dry basalt cobbles, v. dense
						2		
						3		
						4		
						5		
						6	GP	- increase in Sand (m-c), cuttings became
								Sandy Gravel.
						7		
						8		
						9		
						40		

DRILLING CONTR. Layne Env.

No.161973

BY Mark Ochsner DATE 11/30/92 CHK'D BY

080.1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06102-086-UW	USATHAMA	Umatilla OR

DRILLING METHOD: See Page 1

SAMPLING METHOD:

BORING NO. 4-20

SHEET 3 OF 11

DRILLING START TIME / FINISH TIME; DATE / DATE

WATER LEVEL / TIME / DATE / CASING DEPTH

DATUM | ELEVATION

SURFACE CONDITIONS:

DRILLING CONTR Layne Env.

No.162877

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						40	GP	SANDY GRAVEL: Dk Grayish Brown (10YR 5/2), <5% fines, 20-25% F-C Sand (angular basalt quartz)
U	4" / 4"	1130	34 / 40	50-4"		1		70-75% F-C gravels, poorly graded, dry, v. dense, gravel is angular to subrounded basalt clasts
						2		nose of sampler plugged w/basalt
						3		
						4		
						5		-Cuttings as Above
						6		
						7		
						8		
						9		
U	18 / 12	1200	5 / 50.0	37/44/48		50	GP	SANDY GRAVEL: GRAY (7.5YR 5/0), <5% fines, 10-15% f-c Sand, angular, pred basalt (mafic),
						1		85-90% f-c gravel, pred angular basalt, some rounded pieces, poorly graded, dry, v. dense.
						2		
						3		
						4		
						5		-drilling harder at 56' bgs. Coarse gravels to cobbles in cuttings.
						6		
						7		
						8		
						9		
						60		

BY Mark Ochsner DATE 11/30/92 CHK'D BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1.	0672-086-111	USATHAMA	Umatilla OR

DRILLING METHOD:

SAMPLING METHOD: See page 1

BORING NO. 4-20

SHEET 4 of 11

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

DRILLING CONTR. Layne Env.

No.162876

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						60	GP	SANDY GRAVEL: Gray (7.5YR 5/0), < 5% fines, 15-20% f-c angular sand, pred. basalt, quartz, 80-85% f-c gravels, angular basalt, poorly graded, dry, v. dense, occassional basalt cobbles in cuttings at 60'
U	6" / 6"	1300	6 / 60.0	50-6"		1		
						2		
						3		
						4		- occassional basalt cobbles in cyclone (4-6")
						5		
						6		
						7		
						8		
						9		
						70	GP	SANDY GRAVEL: Dk Grayish Brown (10YR 5/2), < 5-10% fines, 20-35% f-c sand (angular basalt, quartz), 60-65% gravel, poorly graded, dry, dense, gravel is subrounded to angular basalt clasts, some quartzite, limestone, f-c gravels.
U	18 / 16	1320	7 / 70.0	19/35/35		1		
						2		
						3		- gravels become finer, rounder
						4		
						5		- increase in sand - highly mafic. m-c sand in cuttings
						6		
						7		
						8		
						9		
						80		

BY Mark Ochsner DATE 11/30/92 CHK'D BY

02D.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	16702-026-11	USATHAMA	Umatilla OR

BORING NO. 4-20

SHEET 5 OF 11

DRILLING METHOD: See Page 1

SAMPLING METHOD:

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING: START TIME / DATE — FINISH TIME / DATE

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM ~~NUMBER OF RINGS~~	DEPTH IN FEET	SOIL GRAPH	
U	18 / 16	1350	8 / 80.0	8/31/50	0.0	80	GW	SANDY GRAVEL: Dk Grayish Brown (10YR 5/2), 5-10% fines, 25-30% f-c Sand (angular basalt mafic, some quartz & KSP), 70-75% gravels, angular to subrounded, basalt, some quartzite, fine to coarse, well graded, dry, dense.
						1		
						2		
						3		
						4		
						5		- Gravel becomes finer - well rounded
						6		
						7		
						8		
						9	GP	SANDY GRAVEL: Dk Grayish Brown (10YR 5/2), <5-10% fines, Recovered 2-4 basalt fragments, dry basalt. Casing returns at 90' indicate 25-30% m-c Sand angular basalt : Quartz, 70-75% f-c gravels, basalt, angular to sub rounded, poorly graded, damp, dense
U	18 / 6	1430	9 / 90.0	8/14/31	0.0	90		
						1		
						2		
						3		
						4		
						5		- cuttings are as above - Sandy Gravels dry
						6		
						7		
						8		
						9		
						100		

DRILLING CONTR. Layne Env.

No.162875

BY Mark Ochsner DATE 11/30/92 CHK'D BY

028.1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-111	USA Umatilla	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD:

BORING NO. 420

SHEET 6 OF 11

DRILLING	START	FINISH
TIME		
DATE		

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

DRILLING CONTR. Layne-Bowl.

No.161904

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	Time ~~DEPTH OF CASING~~	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVA ~~NUMBER OF WHACKS~~	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:
						100	GP	SANDY GRAVEL: Dk Grayish Brown (10YR 5/2), <5%
U	18 / 12	1515	10 / 100	23/41/48	0.0	1		fines, 20-25% f-c Sand, angular basalt: quartz (mafic), 75-80% f-c gravel, angular to subrounded
						2		basalt, fresh, poorly graded, damp, v. dense
						3		
						4		
						5		
						6		
						7		- Sandy Gravel as above - dry
						8		
						9		
U	0 / 0"	1600	11 / 110	50-0"		110	GP	No Recovery at 110' - Casing return at 110'
						1		exhibits Sandy Gravel as above, dry
						2		end of day
						3		
						4		
						5		
						6		
						7		- Cuttings are as above
						8		
						9		
						120		

BY Mark Ochsner DATE 11/30/92 CHK'D BY

GEN 1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	66762-086-111	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD: See page 1

BORING NO. 4-20

SHEET 7 OF 11

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM | ELEVATION

SURFACE CONDITIONS:

DRILLING CONTR. Layne Env.

No.161906

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	TIME (DEPTH OF CASING)	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	
Grab	– / –	0730	12 / 120	–	0.0	120	GP	SANDY GRAVEL: Dk Grayish Brown (10YR5/2), <5% fines, 25-30% f-m sand-angular quartz & basalt, some mica, 70-75% f-c gravel - angular to subrounded basalt clasts, dry, poorly graded, appears dense.
						1		
						2		
						3		
						4		
						5		
						6		
						▽7		- cuttings became saturated at 127'
						8		
						9		
U	0" / 0"	0900	13 / 130	50-0"	0.0	130	GP	No Recovery: casing returns are SANDY GRAVEL as above saturated.
						1		
						2		
						3		
						4		- occasional 4-6" cobbles in cyclone rounded, saturated.
						5		
						6		
						7		
						8		
						9		
						140		

BY Mark Ochsner DATE 12/1/92 CHK'D BY

DSB-1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086	USATHAMA	Umatilla OR

DRILLING METHOD: Air Rotary TH 60 from 151.0' 5 1/2 downhole hammer

BORING NO. 4-20

SHEET 8 OF 11

SAMPLING METHOD: NW core barrel 2.985" x 10'

DRILLING: START TIME / FINISH TIME / DATE / DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM — ELEVATION — SURFACE CONDITIONS.

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	TIME	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVA	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
U	0" / 0"	1000	14 / 140	50-0"	0.0	140	GP	No Recovery at 140': cuttings are sandy GRAVEL - As Above, Saturated
						1		
						2		
						3		- ~~sandy~~ Gravel cuttings - Saturated.
						4		
						5		
						6		
						7		
						8		- increase in silt at 148'. Brown SILTY Sand Saturated
						9		
						150	GM	SILTY, SANDY GRAVEL: Brown (7.5YR 4/2), 15-20% fines, 30-35% f-c Sand - angular quartz & basalt, 40-45% f-c gravels - subrounded basalt clasts; Poorly graded, non plastic, v. dense, Saturated
U	18 / 0"	1020	15 / 150	50/1", 50/2"	0.0	1	B	
						2		
						3		Casing Refusal on Basalt at 151.0'. cuttings at 150.5-151.0 have saprolitic texture at contact. Move in air Rotary rig.
						4		
						5		
						6		
			Core Run #1	157-162'		157	B	BASALT: Dk Gray (7.5YR 4/0), aphanitic, slightly weathered, slightly vesicular basalt, moderately horizontal fractured, competent basalt, no apparent secondary minerals, some Fe staining at 159-160'
						8		
						9		
						160		RQD = 33% Recovery = 100%

DRILLING CONTR. Layne Gull.

No.161908

BY Mark Ochsner DATE 12/1/92 CHK'D BY

058.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06762-086-111	USATHAMA	Umatilla OR

DRILLING METHOD:	BORING NO.
Air Rotary - TH60 5½" D.H. Hammer.	4-20
SAMPLING METHOD:	**SHEET**
NW core barrel 2.985" x 10'	9 of 11

WATER LEVEL					DRILLING START TIME	FINISH TIME
TIME						
DATE					DATE	DATE
CASING DEPTH						

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF HINGS	DEPTH IN FEET	SOIL GRAPH	
						160	B	Core run #1 157-162'
						1		
						2		Set 8" Steel casing to 162.0' end of day
						3		
						4		- 13' of heave in hole - Switch to Becker hammer and re-drive 12" csg., Flush-hole. Hole Cleaned to 160'. no heave in hole.
						5		
						6		
						7		
						8		
						9		
				Core run #2	170-176½'	170	B	BASALT: Lt Gray (10YR 6/0), highly fractured, slight to mod. weathered basalt, Fe staining upper 2-3' of core. Basalt becomes slightly vesicular, (weathered-out minerals), slightly weathered basalt, more competent rock at 175. RQD = 59% Recovery: 66%
						1		
						2		
						3		
						4		Good water return at 170'. Basalt becomes dry at 172-173'
						5		
						6		
				Core run #3	176½-180'	7	B	BASALT: Lt Gray (10YR 6/0), aphanitic, slightly vesicular, slightly weathered basalt, competent Rock, Some horizontal fracturing w/ Fe staining. Some secondary minerals of olivine present.
						8		
						9		RQD = 57% Recovery: 78%
						180		

DRILLING CONTR. Layne Env.

No.161909

BY Mark Oehsner DATE 12/6/92 CHK'D BY

ODE.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-026-111	USATHAMA	Umatilla OR

DRILLING METHOD: See page 9

SAMPLING METHOD:

BORING NO. 420

SHEET 10 OF 11

WATER LEVEL					DRILLING START	FINISH
TIME					TIME	TIME
DATE					DATE	DATE
CASING DEPTH						

DATUM

ELEVATION

DRILLING CONTR. Layne Env.

No.161842

BY Mark Ochsner

DATE 12/6/92 CHK'D BY

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:
						180		
						1		
						2		
						3		
						4		
						5	B	-hard drilling - blue-gray basalt fragments in cyclone - dry - dusty.
						6		
						7		
						8		
						9		
						190		
						1		
						2		
						3		
						4		-Softer drilling at 195'
						195	B	BASALT: Green, completely weathered residual basalt, Chloritized. Becomes brown highly weathered basalt at 196'; Basalt clasts at 196 exhibit completely altered matrix of Kaolinite clay, weathering rinds visible, Kaolinite Clay is brownish yellow, soft.
						6		
				Core run #4	195-205'	7		
						8		Recover only 2' of core impossible to tell exact contact elevations.
						9		Making water at 198-199'
						200		RQD = 6% Recovery: 19%

020.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD: See Page 1

SAMPLING METHOD:

BORING NO. 4-20

SHEET 11 OF 11

DRILLING	START	FINISH
TIME		1700
DATE		12/6/92

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS: See page 1

DRILLING CONTR. Layne Env.

No.161843

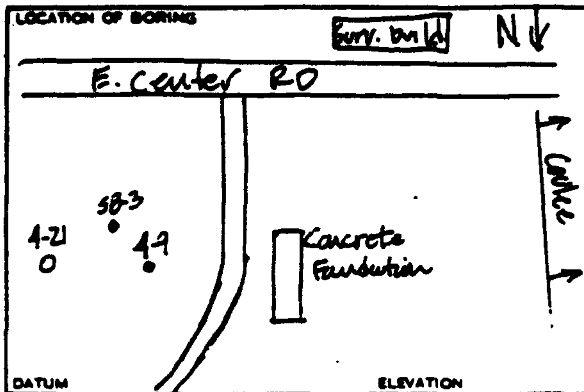
SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF MIN/5	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
					Core run #4 Cont'	200		Basalt Cont'
						1		
						2		
						3		
						4		
						5		
						6		
						7		- Drilling becomes harder at 207'. Dry basalt chips in cyclone
						8		- softer drilling at 209'.
						9		
				Core run #5 210-218'		210	B	BASALT: Gray-Green, completely weathered, Chloritized basalt appears to be residual Rock thru, becomes highly vesicular, Chloritized basalt at 213' - more competent Rock, ~~highly vesicular~~, Rock becomes gray, highly vesicular basalt at 216' competent basalt, Some secondary chlorite, Calcite, hard basalt. Probably hit interbed at 209'-213'.
						1		
						2		
						3		
						4		
						5		Recovery: 56% RQD: 28%
						6		
						7		
						218		Boring Terminated at 218.0' on 12/6/92. GW. encountered at 127 during drilling.
						9		
						0		

BY Mark Ochsner DATE 12/6/92 CHK'D BY

020.1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING



DATUM ELEVATION

JOB NO.	CLIENT	LOCATION
06762-086-111	USATHAMA	Umatilla OR

DRILLING METHOD: Becker Hammer
Triple wall Csg: 12" 9" 6"
Reverse circ.

SAMPLING METHOD:
Calif. Split spoon 3" x 18"
140# ext. hammer 30" drop

BORING NO. 4-21

SHEET 1 OF 11

DRILLING	START	FINISH
TIME	1600	
DATE	11/15/92	

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

SURFACE CONDITIONS: Flat, brush: Sand field (Sage Brush)

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	TIME	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM READINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						0		
						1		SAND: Brown (7.5YR 5/3), <5-10% fines, >90-95% f-M Sand - angular quartz: basalt, some esp. felsic, micaceous, poorly graded, dry, Pleist sand. -cuttings-
Grab	– / –	1605	– / –	–	0.0	2	SP	
						3		- increase in rounded f-m gravel, basalt clasts.
						4		
						5		
						6		
						7		
						8		
						9		GRAVEL: Grayish Brown (10YR 5/2), <5% fines, 5-10% f-c Sand (As Above), Pred. f-c gravels, basalt, rounded to subrounded, poorly graded, dry, v. dense.
U	5" / 5"	1615	1 / 10.0	50-5	0.0	10	GP	
						1		
						2		
						3		
						4		
						15		
						6		GRAVEL: As Above -cuttings- dry
						7		
						8		
						9		
						20		

DRILLING CONTR. Layne Env.

No.162888

BY Marla Ochsner DATE 11/15/92 CHK'D BY

020.0 (2) (REV. 11-00)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD:

BORING NO. 4-21

SHEET 2 OF 11

DRILLING	START	FINISH
TIME		
DATE		

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	TIME	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
cuttings	– / –	1625	– / –	—	0.0	20	GP	SANDY GRAVEL: Grayish-Brown (10YR 5/2), 30% f-c Sand, 70% m-c gravels, poorly graded, dry, dense, occassional cobble size basalt clasts. Sand is angular, pred. felsic, quartz, fsp, baslt, mic. gravels are angular basalt fragments. -cuttings-
						1		
						2		
						3		
						4		
						5		-cuttings are as Above - v. dry.
						6		
						7		
						8		
						9		SANDY GRAVEL: Grayish-Brown (10YR 5/2), 20% f-c Sand, < 5% fines, 75% c gravels, poorly graded, dry, dense to v. dense, Sand is pred. quartz, basalt, felsic, micaceous. gravels are angular, basalt fragments - fresh. End of day
						30	GP	
U	6" / 6"	1645	2 / 30	50/6"	0.0	1		
						2		
						3		
						4		
						5		- cuttings As Above Hard drilling
						6		
						7		
						8		
						9		
						40		

DRILLING CONTR. Layne Env.

No.162889

BY Mark Ochsner DATE 11/15/92 CHK'D BY

020.1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD:

BORING NO. 4-21

SHEET 3 of 11

DRILLING START TIME / FINISH TIME / DATE / DATE

WATER LEVEL / TIME / DATE / CASING DEPTH

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						40	GW	SANDY GRAVEL: Grayish Brown (10YR5/2), <5% fines, 25% f-c Sand, 75% m-c gravels, well graded, dry, dense, sand is angular, felsic, pred quartz & basalt - some feldspar. gravels are subrounded basalt, occassional angular basalt fragments. Alluvium
U	5" / 4"	1700	3 / 40.0	50/5"		1		
						2		
						3		End of day
						4		
						45		- becoming more mafic
						6		
						7		
						8		
						9		SANDY GRAVEL: Grayish Brown (10YR5/2) <5-10% fines, 35% F-C Sand, angular, pred basalt, mafic, >55% F-C gravels, angular to subrounded, basalt clasts and fragments, well graded, dense Alluvium
						50	GW	
U	12 / 10	0800	4 / 50.0	49/5.6"	0.0	1		
						2		
						3		
						4		
						5	GW	- Cuttings are pred. Sand & Gravel highly mafic - pred basalt.
						6		
						7		
						8		
						9		
						60		

DRILLING CONTR. Layne Env.

No.1 62878

BY Mark Ochsner DATE 11/16/92 CHK'D BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD:	BORING NO. 4-21
SAMPLING METHOD: See page 1	SHEET 4 OF 11
DATUM	ELEVATION

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING	
START TIME	FINISH TIME
DATE	DATE

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	~~NUMBER OF~~ PPMS OVM	DEPTH IN FEET	SOIL GRAPH	
						60	GW	SANDY GRAVEL: Gray (7.5YR 5/0), 35% F-c Sand, angular to subrounded, mafic, pred. basalt,
4	12/10	0830	5/60.0	50/5.05"	0.0	1		65% F-m gravel, subrounded basalt, dry well Gr
						2		
						3		Sand increasing w/depth - Cuttings ~~become~~
						4		
						5		
						6		
						7		
						8		
						9		
						70	SP	GRAVELLY SAND: Gray ~~7.5YR~~ Brown (10YR 5/2), <5% fines, 25% angular to subrounded basalt gravels,
4	18/15	0845	6/70.0	17/20/48	0.0	1		75% F-c Sand, angular to subrounded, Poorly graded, dry, dense
						2		
						3		
						4		increasing gravel w/depth
						5		
						6	GW	- Cuttings are Sandy Gravel, well graded
						7		
						8		
						9		
						80		

DRILLING CONTR. Layne West

No.162892

BY Mark Ochsner CHK'D BY

DATE 11/16/92

GEO.1 (2) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1			

DRILLING METHOD:

SAMPLING METHOD: See Page 1

BORING NO. 4-21

SHEET 5 OF 11

DRILLING	
START	FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	
U	5 / 5"	0930	7 / 80.0	50/5"	0.0	80	GP	GRAVEL: Gray (10YR 5/0), <5% fines, <10% f-m sand, Pred. angular to subrounded basalt gravels, poorly graded, dense, dry
						1		
						2		
						3		
						4		
						5		Gravel becomes rounded to well rounded
						6		
						7		
						8		
						9		
						90	GP	GRAVEL: Gray (10YR 5/0), 10% f-c sand, angular basalt, Pred. rounded f-m basalt gravel; poorly graded, dry, occassional 1-2" pieces of highly vesicular basalt
U	6" / 6"	1015	8 / 90.0	50-6"	0.0	1		
						2		
						3		
						4		
						5		- Drilling becomes V. HARD 4-6" cobbles in cuttings
						6		
						7		
						8		
						9		
						100		

DRILLING CONTR. Layne Env.

No.162893

BY Mark Ochsner DATE 11/16/92 CHK'D BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06702-086-11	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD: See page 1

BORING NO. 421

SHEET 6 OF 11

DRILLING	
START	FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
Cuttings		1045		Grab	–	100	GP	SANDY GRAVEL: Gray (10YR 5/6), <5% fines, 45% F-C angular Sand - Pred basalt, mafic, some 55% angular to Subround basalt gravels, poorly graded, dry, dense
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
Cuttings		1110		Grab	–	110	GP	GRAVEL: Gray (10YR 5/6) <5% fines, <10% f-c Sand, Pred. rounded to angular basalt, poorly graded, dry, v. dense
						1		
						2		
						3		
						4		
						5		-cuttings become moist at 115' - Sandy Gravel
						6		
						7		-cuttings become dry at 117'. HARD drilling at 118'
						8		
						9		
						120		

DRILLING CONTR. Layne NW

No.162894

BY Mark Juhsner DATE 11/16/92 CHK'D BY

028 I (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	06762-006-111	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD: See page 1

BORING NO. 4-21

SHEET 7 OF 11

WATER LEVEL					DRILLING	
TIME					START TIME	FINISH TIME
DATE					DATE	DATE
CASING DEPTH						

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	~~NUMBER OF RINGS~~	DEPTH IN FEET	SOIL GRAPH	
cuttings		1140	X	Grab	0.0	120	GP	GRAVEL: Gray (10YR 5/1), little or no fines, Pred subrounded to rounded basalt gravel, occassional angular fragments, dry, V. dense to hard, no spoon collected due to V. hard drilling, poorly graded.
						1		
						2		
						3		- cuttings become Saturated at 123' bgs
						4		
						5		- cuttings became finer w/depth.
						6		
						7		
						8		- cuttings become coarse sand to finegravel
						9		
						130		GRAVELLY SAND: Grayish Brown (10YR 5/2), <5% fines, 20-25% F-M angular basalt gravels, 75-80% F-C Sand, Pred coarse angular, basaltic, highly mafic, Saturated, dense.
U	18/15	1200	9/130	16/20/33	0.0	1	SP	
						2		
						3		
						4		
						135		cuttings became fine gravels. saturated. GRAVEL: Gray to Dk Gray (7.5YR 4/0), <5% fines, <10% vc Sand, Pred F-m rounded to Subrounded basalt, Saturated, dense, highly mafic
U		1220	10/135	17/20/19		6	GP	
						7		
						8		
						9		
						140		

DRILLING CONTR. Cascade [illegible]

No.162895

BY Mark [illegible] DATE 11/16/92 CHK'D BY

025.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING: See page 1

JOB NO.: 06702-086-141 | CLIENT: USATHAMA | LOCATION: Umatilla OR

DRILLING METHOD: See Page 1

SAMPLING METHOD:

BORING NO.: 4-21

SHEET 8 of 11

DRILLING: START TIME / FINISH TIME / DATE / DATE

WATER LEVEL / TIME / DATE / CASING DEPTH

DATUM | ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						140	GP	GRAVEL: Gray (7.5YR 4/0), <5% fines, 5-10%
U	18 / 6	1295	10 / 140	16/22/37	0.0	1		m-c sand, Subrounded basaltic, >90% f-m gravels subrounded basalt, slightly weathered
						2		Saturated, dense
						3		
						4		
U	18 / 0	1310	X	17/33/35	0.0	145	GP	no recovery -cuttings indicate f-m gravels (basalt)
						6		
						7		increasing fines w/depth
						8		
						9		
						150	SM/ML	SANDY SILT: Dk Grayish Brown (2.5Y 4/2), 60% fines, 40% v.fine to fine angular sand, felsic, Saturated,
U	18 / 12	1320	11 / 150	16/10/10	0.0	1		nonplastic, soft-med stiff, occassional fine basalt gravels.
						2		Fragments of Lt Tan cemented ash (tuff) at 11.3'
						3		-Harder drilling at 154'
						4		-Refusal at 154.5' bgs w/Becker rig
						155	B	Basalt: Dk Gray (7.5YR 4/0), slight to moderate weathering, vesicular, weathered horizontal fracturing, recovering chips from cyclone, dry.
						6		
						7		
						8		
						9		
						160		

DRILLING CONTR. Layne Env.

No.162897

BY Mark Adams DATE 11/16/92 CHK'D BY

080.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD:

BORING NO. 4-21

SAMPLING METHOD: See Page 1

SHEET 9 OF 11

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL / TIME / DATE / CASING DEPTH

DATUM — ELEVATION — SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						160		-Basalt chips discharging from cyclone.
						1		
						2	B	BASALT: Lt Gray (2.5Y 6/0), vesicular basalt, fine grained, occassional ca plag in mafic matrix, horizontal fracturing with some Fe staining at 166.5 no phenocrysts, no pyrite, chlorite, calcite minerals. -Similar to top flow encountered at 4-19. Competent Rock. Recovery = 100% RQD = 38%
				Core run #1 162-167'		3		
						4		
						5		
						6		
						7		- Set 8" casing from surface to 167' - cemented in place.
						8		- Some H_2O return at 168-169'
						9	B	-Cuttings are fresh basalt chips - some water
						170		
						1		
						2		
						3		
						4		
						5		- Cuttings are fresh basalt chips less water Continue drilling w/ 5½" hammer
						6		
						7		
						8		- becomes v. dry at 175-180' - blue gray basalt dust from cyclone
						9		
						180		

DRILLING CONTR. Layne Env.

No. 198198

BY Mark A. Ochsner DATE 11/18/92 CHK'D BY

028 1 13) (REV 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-086-11	USATHAMA	Umatilla OR

DRILLING METHOD: See Page 1

SAMPLING METHOD:

BORING NO. 4-21

SHEET 10 OF 11

DRILLING: START TIME / DATE; FINISH TIME / DATE

WATER LEVEL / TIME / DATE / CASING DEPTH

DATUM — ELEVATION

DRILLING CONTR. Layne Env.

№ 198199

BY Mark Ochsner DATE 11/19/92 CHK'D BY

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS
				core run #2 180-185'		180	B	BASALT: Lt. Gray (2.5Y 6/0), fractured basalt, Aphanitic, becomes fractured & weathered at 182-183', occassional vertical fracturing, Significant Chlorite filling @ 184', blue-green color. Dry
						1–4		Basalt is fresh at 180-181. Becomes more fractured with depth. Recovery: 100% RQD=66%
						5		- V. hard drilling at 185' - Fresh basalt Chips discharging - Basalt dust (blue gray) V. dry
						9		- Tool drop from 189-191' - Fracture zone?
						190		
						1		- Drilling Becomes hard again at 191'
						5	B	- V. hard: dry - Fresh basalt Chips as Above.
						9		- Drilling becomes Softer at 199' will core at 200'
						200		

(REV 11-80)

Dames & Moore

LOCATION OF BORING: See Page 1

JOB NO.: 06702-086-11

CLIENT: USATHAMA

LOCATION: Umatilla OR

BORING NO.: 4-21

SHEET 11 OF 11

DRILLING METHOD:

SAMPLING METHOD: See Page 1

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING — START: TIME / DATE; FINISH: TIME 1230, DATE 11/19/92

DATUM — ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
				Core run #3	200-208'	200	B	BASALT: Green Gray (5G 6/1). Poor Recovery, highly weathered, chloritized seams. Rock was obviously Rolled around in core barrel, Becomes Vesicular at 202'. No Recovery from 202-208'. dry. Selah Interbed?
						1		
						2		
						3		Recovery: 25% RQD: 8%
						4		
						5		
						6		
						7		-Clean hole w/ 5½" hammer to 210'. cuttings are greenish basalt (Chlorite)
						208		
						9		
				Core run #4	210-215'	210	B	BASALT: Green Gray (5G 6/1). highly weathered vesicular basalt, chloritized, to 213'. Becomes Lt Gray (5YR 6/0) aphanitic basalt, fresh, minor vesicles filled with secondary calcite - competent Rock.
						1		
						2		
						3		no Recovery from 214-215'
						4		Recovery = 80% RQD = 33%
						5		Coring terminated at 215'. Ream hole to 215'. 11/19/92
						6		G.W. encountered at 125 during drilling. Shallow Aquifer
						7		
						8		
						9		
						0		

DRILLING CONTR. Layne Env.

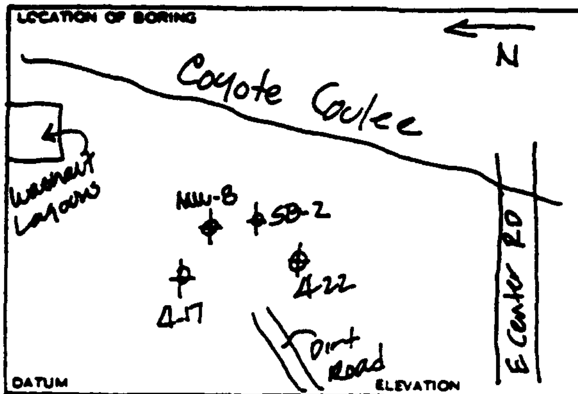
No.161961

BY Mark Ocksner DATE 11/19/92 CHK'D BY

D20.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING



DATUM

ELEVATION

JOB NO.	06762-096-111
CLIENT	USATHAMA
LOCATION	Umatilla OR
DRILLING METHOD:	Becker Hammer reverse circulation Triple wall Casing: 12"-9"-6"
BORING NO.	4-22
SHEET	1 of 6
SAMPLING METHOD:	Calif Split Spoon 3" x 18" 140# ext. hammer 30" Drop
DRILLING START TIME	1045
DRILLING START DATE	12/3/92
FINISH TIME	
FINISH DATE	

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

SURFACE CONDITIONS: Relatively flat, Sand & Brush field

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						0		
						1		
						2		
						3		
						4		
						5	SP	SAND - angular, poorly graded, micaceous, - cuttings - Pleist. Sands
						6		
						7		
						8		
						9		
						10	SP	SAND: Brown (7.5YR 5/3), 5-10% fines, >90% fine sand, angular quartz, feldspar, felsic, poorly graded, damp, medium dense, micaceous Pleist. Sand
U	18/18	1055	1/10.0	6/9/10	0.0	1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		- increase in silt
						9		
						20	SM	

DRILLING CONTR Layne Env.

No. 198192

BY Mark A. Ochsner DATE 12/3/92 CHK D BY

030 (12) (REV 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	6702-086	USATHAMA	Umatilla OR

DRILLING METHOD: See page 1

SAMPLING METHOD:

BORING NO. 4-22

SHEET 2 of 6

DRILLING	START	FINISH
TIME		
DATE		

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	TIME	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
4	18/18	1115	2/20.0	10/10/11	0.0	20	SM	SILTY SAND: Brown (7.5YR 5/3), 25-30% fines, 70-75% v. fine to fine sand, poorly graded, non-plas., damp, med. dense. Sand is angular quartz, feldspar & some basalt, felsic, micaceous. Pleist. Sand
						1		
						2		
						3		
						4		
						5		
						6		- cuttings became saturated at 27.0'
						7		
						8		
						9		
						30		SAND: Dk Brown (7.5YR 4/2), < 5% fines, 10-15% fine gravels, well rounded, basalt, mafic, 70-75% m-c sand, highly mafic, subrounded, basalt, saturated, well graded, loose, less mica
4	18/14	1130	3/30.0	6/5/9	0.0	1	SW	
						2		
						3		
						4		- increase in silt w/ depth
						5	ML	Cuttings became Sandy Silt. - Saturated -
						6		
						7		
						8		
						9		
						40		

DRILLING CONTR Layne Env.

No 198193

BY Mark Ochsner DATE 12/3/92 CHK'D BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-066	USATHAMA	Umatilla OR

DRILLING METHOD: Air Rotary from 55' / NW core

BORING NO. 4-22

SHEET 3 of 6

SAMPLING METHOD: NW Core barrel 2.985" Dia. x 10'.

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING: START TIME / FINISH TIME; DATE / DATE

DATUM ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	TIME	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM READINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
U	18/18	12:15	4 / 40.0	19/26/38	0.0	40	ML	SILT: Lt Brown (10YR 6/3) to olive Gray (5Y4/1), <5-10% v. fine Sand, thin 0.5-1.0mm color reddish alternates Lt Brown to olive Gray, well compacted pieces of silt, appears to be low energy lake deposit "Varves", moist, not saturated, very stiff
						1		
						2		
						3		
						4		
						5		
						6		Cuttings - Silt, dry-moist, micaceous
						7		
						8		
						9		
						50	ML	SANDY SILT: Brown (7.5YR 5/2), 25-30% v. fine-fine Sand, angular, quartz, felsic, 70-75% fines, nonplastic, occasional Fe Staining, well compacted silt, some mica present
U	18/18	12:45	5 / 50.0	10/16/18	0.0	1		
						2		
						3		
						4		
						5	B	Casing Refusal at 55.0' w/ Becker Hammer move-in air rotary rig
			Core run #1	55-57.5'		56		BASALT: Gray (7.5YR 4/0) (Core run 55-57.5') highly weathered, highly fractured basalt, vesicular, horizontal fracturing, some Fe Staining at fractures, no apparent secondary minerals RQD = 9% Recovery = 100%
						7		
						8		
						9		
						60		

DRILLING CONTR. Layne Env.

No. 161964

BY Mark Oelsner DATE 12/4/92 CHK'D BY

Dames & Moore

LOCATION OF BORING: See Page 1

JOB NO.: 06702-086-11(
CLIENT: USATHAMA
LOCATION: Umatilla OR
DRILLING METHOD: Air Rotary TH 60
BORING NO.: 4-22
SHEET: 4 of 6
SAMPLING METHOD: NW Core Barrel 2.985" x 10' See Page 1
DRILLING: START TIME / FINISH TIME / DATE / DATE
WATER LEVEL / TIME / DATE / CASING DEPTH
DATUM
ELEVATION
SURFACE CONDITIONS: See Page 1

DRILLING CONTR. Layne Env.

No.161965

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
						60	B	- Cuttings are ~~dr~~ basalt chips
						1		
						2		
						3		
						4		
						5		
						6		
						7		- Bottom of 8" CSG cemented at 67' bgs. to surface.
						8	B	- Drilling becomes hard at 67' - Dry - blue gray dust; basalt chips in cyclone. Drilling Rates: (5½") 12 min/FT.
						9		
						70		
						1		
						2		
						3		
						4		
				Core run #2	75-84.5'	75	B	BASALT: Lt Gray (7.5YR 6/0), highly fractured, aphanitic basalt, becomes less fractured at 77-84.5', Rock becomes competent basalt, no visual secondary minerals, slightly vesicular, dry, hard.
						6		
						7		
						8		Recovery: 100% RQD: 79%
						9		
						80		

BY Mark Ochsner DATE 12/4/92 CHK'D BY

080.1 (3) (REV 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See page 1	16202 8,-11	USATHAMA	Umatilla OR

DRILLING METHOD: Air Rotary TH 60

BORING NO. 4-22

SHEET 5 OF 6

SAMPLING METHOD: NW core Barrel 2.985" X 10'

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL | TIME | DATE | CASING DEPTH

DATUM | ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
				Core run #2	75-84.5'	80	B	Continue Core run #2 to 84.5'
						1		
						2		
						3		
						4		
						5		- V. hard drilling - blue gray basalt dust and fragments in cyclone
						6		
						7		
						8		
						9		
						90		- Continued hard drilling - dry
						1		
						2		
						3		
						4		
						5		Continued HARD drilling - dry basalt
						6		
						7		
						8		- Softer drilling at 99' will run core at 100'
						9		
						100		

DRILLING CONTR Cayneau

No.161966

BY Mark Ochsner DATE 12/2/92 CHK'D BY

020 1 (3) (REV 11-00)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	06702-086-111	USATHAMA	Umatilla OR

DRILLING METHOD: See Page 1

SAMPLING METHOD: See Page 1

BORING NO. 4-22

SHEET 6 of 6

DRILLING

	START	FINISH
TIME		1200
DATE		12/9/92

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS: See Page 1

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF HINKS	DEPTH IN FEET	SOIL GRAPH	
						100	B	BASALT: Dk Blue-green, highly weathered, Chloritized basalt - upper 2' sharp contact
				Core run #3	100-105'	1		at 102' to Lt brown (10YR 8/3) SILT, ash,
						2		Sandy gravel, probably Selah Interbed
							GM	material? not saturated, moist
						3		RQD = 17% Recovery: 80%
						4		Probable Selah Interbed 102-109'
						5		
						6		Drilled w/ 5½" hammer: harder drilling at
						7		109'. Blue-gray basalt chips and dust in cuttings, Dry.
						8		
						9	B	
						110		
						1		-Continued hard drilling at 112'. Basalt Chips in cyclone - Fresh blue-gray basalt.
						2		Dry.
						3		
						114	B	BASALT: Gray (7.5YR 6/0), aphanitic basalt, vesicular, some secondary olivine in
				Core run #4	114-119'	5		vesicles, larger vesicles with lt blue staining on rim, could be Chlorite, competent
						6		Rock from 109'. Dry.
						7		RQD = 43% Recovery = 100%
						8		
						9		Boring Terminated at 119' on 12/9/92. G.W. encountered at 27.0' during drilling
						120		

DRILLING CONTR. Layne Env.

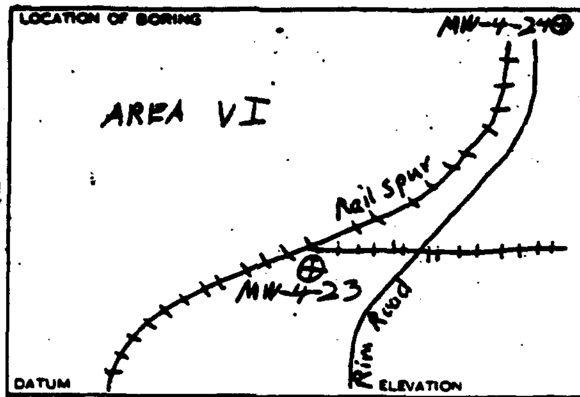
No.161967

BY Mark Ochsner DATE 12/9/92 CHK'D BY

020.1 (2) (REV 11-90)

Dames & Moore

LOCATION OF BORING



DATUM | ELEVATION

JOB NO.	06737-0??
CLIENT	USATHAMA
LOCATION	OR
DRILLING METHOD	Becker hammer Dual wall casing reverse Circulation 9"OD 6"ID
BORING NO.	~~MW~~-4-23
SAMPLING METHOD	Calif mod. Split spoon 3"OD x 18" 140# 30" drop external hammer
SHEET	1 OF 6
WATER LEVEL	
TIME	
DATE	
CASING DEPTH	

DRILLING	START	FINISH
TIME	0745	17:00
DATE	11/15/92	11/15/9[illegible]

SURFACE CONDITIONS: Flat gravelly Sandy Field, Sage brush.

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS (OVM)	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
Ctg					0.0	0	SP	SAND Reddish brown (5YR 4/3) 90-95% fine-med gr. poorly graded, Subrnd-rnd basaltic + qtz sand, occas gravel, fine-medgrained, subrnded <10% Silt dry loose No odor
						1		
						2		
						3		
						4		
Ctg					0.0	5	GM	SILTY SANDY GRAVEL Brown 7.5YR 5/2 60-70% med-crse, rnded-subrnded gravel 25-30% fine gr poorly ~~sort~~ graded subrnded Sand 10-15% Silt loose dry Basalt Cobbles up to 5" dia gravel is 1-2" dia, w/ Feldspars, qtzite
						6		
						7		
						8		
						9		
??				37/4/23	0.0	10		A/A Numerous fractured basalt cobbles
						1		
						2		
						3		
						4		
3/2 Ctg				1	0.0	5		A/A, w/ qtzite
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR Layne

No.162901

BY Ulysses Cooley DATE ____ CHK'D BY ____

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1			

DRILLING METHOD: See Page 1

BORING NO. 4-23

SHEET 2 OF 6

SAMPLING METHOD:

DRILLING	
START	FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

NM ELEVATION

DRILLING CONTR. ______

No.162902

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	SURFACE CONDITIONS:
	6"			15/14/8	0.0	20	GP	SANDY GRAVEL Brown 7.5YR 5/2 65-70% med-crse subrnded poorly graded gravel, 25-30% med-fine gr. Sand <10% Silt dry-moist, loose, w/ basalt cobbles up to 5" dia., qtzite, wtd Feldspar. Sand is 60% Basaltic, 40% Qtzite.
						1		
						2		
						3		
						4		
				—	0.0	5		A/A Abundant Basalt cobbles up to 4" dia.
						6		
						7		
						8		
						9		
935	18/12"			7/14/24	0.0	30	GP	SANDY GRAVEL Brown (7.5YR 4/2) 70-80% med-coarse gravel, 15-25% Sand (A/A) <10% Silt. dry loose wtd feldspar qtzite. w/ cobbles, fractured + subrounded
						1		
						2		
						3		
						4		SANDY GRAVEL Brown (7.5YR 4/2) 70-80% fine-coarse well graded gravel, 15-25% Sand A/A, <10% Silt Cobbles A/A Gravel: subrounded-rounded.
						Ctg 5	GW	
940	Ctg				0.0	6		
						7		
						8		
						39		
						0		

BY ______ DATE ______ CHK'D BY ______

DB.1 (3) (REV. 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION

DRILLING METHOD: SEE PAGE 1

SAMPLING METHOD:

BORING NO. 4-23

SHEET 3 OF [illegible]

DRILLING: START TIME / FINISH TIME; DATE / DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

OJM ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	
855	14 / 4"			11/19/ 50	0.0	40		Recovered only basalt fragments
						1		-will log Ctgs.
						Ctg 2	GW	SANDY GRAVEL (7.5 YR 4/2) DK. brown. 70-80% fine-coarse well graded rounded - subrounded gravel, 20-25% fine-coarse subrounded-sub
						3		
						4		angular, well graded Qtz+basalt sand ≤10% silt. [illegible]tzite. wtd feldspar
						45		Slightly moist. Basalt Cobbl Frags A/A
					0.0	6		
						7		Abundant basalt cobble Frags
						8		
						49		A/A
922	Ctgs				0.0	50		SANDY GRAVEL A/A
						51		wtd reddish feldspar
						2		
						3		
						4		
						5		SANDY GRAVEL A/A
	Ctg				0.0	6		
						7		
						8		
						59		
						60		

DRILLING CONTR.

No.162903

BY ______ DATE ______ CHK'D BY ______

028.1 (3) (REV 11-80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION

DRILLING METHOD: See page 1

BORING NO. 4-23

SHEET 4 OF 6

SAMPLING METHOD:

DRILLING: START TIME / FINISH TIME / DATE / DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

OVM ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM RANGE	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
Ctgs					0.0	60	GW	SANDY GRAVEL Dark brown (7.5 YR 4/2) 70-80% Basaltic med-coarse subrounded-rounded well graded Gravel 20-25% fine-coarse subrounded-subangular, well graded Qtz + basalt Sand <10% Silt. Quartzite present, weathered Feldspar. Abundant Basalt cobbles + boulder Frags. slightly moist.
						1		
						2		
						3		
						4		
Ctgs					0.0	5		A/A
						6		
						7		
						8		
						9		
Ctgs					0.0	70	GW	SANDY GRAVEL A/A
						1		
						2		
						3		
						4		
Ctgs					0.0	5	GW	Sandy GRAVEL A/A no Rec.
						6		
						7		
						8		
						79		
						0		

DRILLING CONTR. ____

No.162846

BY ____ DATE ____ CHK'D BY ____

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
	DRILLING METHOD: See page 1		BORING NO. 4-23
	SAMPLING METHOD:		SHEET 5 of 6
	WATER LEVEL / TIME / DATE / CASING DEPTH		DRILLING START TIME / FINISH TIME / DATE / DATE

DATUM | ELEVATION | SURFACE CONDITIONS

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	NUMBER OF RINGS	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
Ctgs					0.0	80	GW	SANDY GRAVEL (7.5 YR 3/0) Very Dark Gray 70-80% Fine-Coarse, Subrounded-subangular well graded Basaltic Gravel 20-25% Fine-Coarse, subrounded-subangular, well graded Sand (60% basaltic, 40% Quartzitic) <10% Silt with Abundant Basalt Cobbles + ~~Fractured~~ boulder Fragments moist no odor.
						1		
						2		
						3		
						4		
Ctgs					0.0	5		SANDY GRAVEL A/A
						6		
						7		
						8		
						9		
Ctgs					0.0	90		SANDY GRAVEL A/A
						1		
						2		
						3		
						4		
Ctgs					0.0	5		SANDY GRAVELL A/A
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR. ____

No.162843

BY ____ DATE ____ CHK'D BY ____

028 1 13) (REV 11/80)

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION

DRILLING METHOD: See Page I

BORING NO. 4-23

SHEET 6 OF 6

SAMPLING METHOD:

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DRILLING	
START TIME	FINISH TIME
DATE	DATE

DATUM

ELEVATION

SURFACE CONDITIONS:

TIME	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	
Ctgs					0.0	100		SANDY GRAVEL moist A/A
						1		
						2		
						3		
						4		
Ctgs					0.0	5		becoming moister
						6		
						7		
						108	∇	Wtr @ 108'
						9		
Ctgs					0.0	0		Drld to 110, pulld csg
						111		back 2' + let sit.
						2		Boring terminated @ 111.0 on 11/15/92. GW encountered @ 108' during drilling
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR. ______

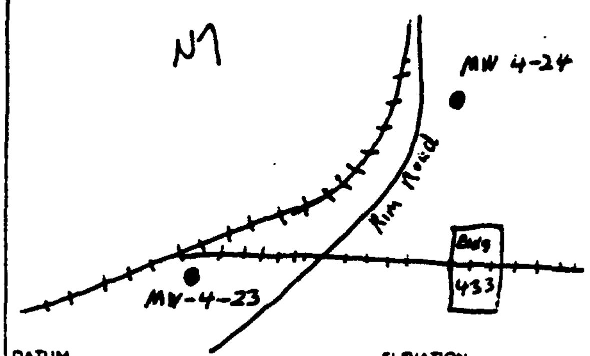
No.162880

BY ______ DATE ______ CHK'D BY ______

020 1 (3) (REV. 11-90)

Dames & Moore

LOCATION OF BORING



DATUM ELEVATION

JOB NO.	06732-036
CLIENT	USATHAMA
LOCATION	Umatilla C...
DRILLING METHOD:	Becker Hammer Dual wall casing reverse circulation, 9" OD, 6" ID
BORING NO.	MW-4-2[illegible]
SHEET	1 OF 6
SAMPLING METHOD:	Calif mod split spoon 3" OD x 18" 140# 30" drop external hammer

WATER LEVEL	101.8	101.8	101.6	101.6
TIME	11:45	13:02	13:30	14:00
DATE	11/14/92	11/14	11/14	11/14
CASING DEPTH	110'			

DRILLING	START	FINISH
TIME	10:10	1300
DATE	11/14/92	11/1[illegible]

SURFACE CONDITIONS: Gravelly, Sandy Field

TIME	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
					0.0	0	SP	SAND Reddish Brown (5YR 4/3) 90-95% fine-med. gr., poorly graded, subrnd-rnded, basaltic + qtz sand, occas. gravel (fine-med. gr.) subrnded) <10% Silt dry loose, no odor
						1		
						2 ctg	GM	SILTY SANDY GRAVEL (7.5YR 5/2) 50-55% Fine to med gravel, 25-30% med. to crse sand, subrounded - subangular, poorly-mod graded, Gravel is rounded - angular. Silt is non plastic, loose, dry - moist
						3		
						4		
						5		
						6		
						7		
						8		
						9		W/ Basalt Cobble up to 5" Black Massive.
10:25	4" / 2"		1 / 10'	50/4"	0.0	10	GM	SILTY SANDY GRAVEL (7.5Y 5/2) Brown 60-70% med-coarse gr gravel 10% Silt, 25-30% Fine gr Sand, poorly graded. Gravel m'al is subrounded, basaltic. Sand is subrounded rounded, Silt is non plastic. dry loose
						1		
						2		
						3		
						4		
						5 ctg		SILTY SANDY GRAVEL A/A w/ <10% fine basalt cobbles (10%) angular, fractured Some subrounded, dry loose.
						6		
						7		
					0.0	8 ctg		A/A w/ basalt Cobbles.
						9		
						0		

DRILLING CONTR Layne

No. 162880

BY Ulysses Conley DATE CHK'D BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1	DRILLING METHOD:		BORING NO. 4-24
	SAMPLING METHOD: See Page 1		SHEET 2 OF 6
	WATER LEVEL / TIME / DATE / CASING DEPTH		DRILLING START TIME / DATE, FINISH TIME / DATE
DATUM	ELEVATION		

SURFACE CONDITIONS:

TIME	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	
1043	2" / 2"		2 / 20	50 for 2"	0.0	20	GP	SANDY GRAVEL Brown (7.5YR 5/4) 65-70% Subrounded, med-crse Gravel, 28-30% fine grained subrounded, poorly graded Sand, <10% Silt, non plastic, dry loose.
1052						5 ctg		A/A Numerous Fractured Basalt Cobbles. Recovery is spoon is very low. Will not drive spoon at 30' interval Log ctgs.
10:57					0.0	ctg 30	GP	SANDY GRAVEL Dark brown (7.5YR 4/2) 70-80% med-coarse grained gravel, subrounded-subangular, poorly graded, 18-28% fine-med. gr. poorly graded, subrounded Sand, <10% Silt nonplastic loose moist.
Ctgs					0.0	5		A/A

DRILLING CONTR ______ No. 162880

CHK'D BY ______ DATE ______ BY ______

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Pag 1	DRILLING METHOD:		BORING NO. 4-24
	SAMPLING METHOD: See Pag 1		SHEET 3 OF 6
	WATER LEVEL / TIME / DATE / CASING DEPTH		DRILLING START TIME / FINISH TIME / DATE / DATE
DATUM	ELEVATION		

SURFACE CONDITIONS:

TIME	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	
11:10	0 / 0				0.0	40	GW	SANDY GRAVEL Dark brown (7.5 YR 4/2) 70-80% Basalt gravel + cobbles. Cobbles are highly fractured. Coarse-med grained gravel. 15-25% poorly graded, subrounded, predominately basalt w/ qtz, fine-med grained Sand. 5-10% Silt.
						1		
						2		
						3		
11:20	0 / 0				0.0	4		A/A
						5		
						6		
						7		
						8		
						9		
11:30	Cuttings				0.0	50	GW	SANDY GRAVEL A/A @ 40' Some wtd quartzite, frags of cemented qtz + basalt S.S.
						1		
						2		
						3		
					0.0	4		A/A
11:40	Cuttings					5		
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR. ____ CHK'D BY ____ DATE ____ BY ____

No.162880

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1			

DRILLING METHOD:

SAMPLING METHOD: See Page 1

BORING NO. 4-24

SHEET 4 OF 6

DRILLING	
START	FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

TIME	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH		OVM	DEPTH IN FEET	SOIL GRAPH	
1145 Ctgs					0.0	60		A/A @ 50'
						1		
						2		
						3		
						4		
1150 Ctgs					0.0	5	GW	SANDY GRAVEL A/A @ 60' moist
						6		
						7		
						8		
						9		
1155 Ctgs					0.0	70		
						1		
						3		
						3		
						4		
1210 Ctgs					0.0	5		Sandy Gravel, As Above [redacted] A/A
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR.

No. 162880

CHK'D BY

BY

DATE

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1			

DRILLING METHOD:

SAMPLING METHOD: See Page (

BORING NO. 4-24

SHEET 5 OF 6

DRILLING	START	FINISH
TIME		
DATE		

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

TIME	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
1220 Ctgs					—	80		SANDY GRAVEL 7.5YR 3/0 Very Dark Gray. 70-75% med-coarse grained, ~~[illegible]~~-mal graded subangular to subrounded Gravel, 20-25% med-coarse subangular-angular Sand (60% Basaltic, 40% Qtz) <10% silt moist loose. W/ fractured Basalt cobbles.
						1		
						2		
						3		
						4		
Ctgs					0.0	5		A/A
						6		
						7		
						8		
						9		
11:30				50-D	0.0	90 Ctg	GW	Basalt Cobble fragments not as numerous.
						1		
						2		
						3		
						4		
1255 Ctgs					0.0	5	GW	A/A @ 80' numerous cobble and/or boulder frags. Harder Drilling below 95'
						6		
						7		
12?? Ctgs						8	GW	A/A. Basalt frags contain Chlorite. ~~[illegible]~~ Metamorphics (Gneiss) present.
						9		
						0		

DRILLING CONTR.

No.162880

CHK'D BY

DATE

BY

Dames & Moore

LOCATION OF BORING	JOB NO.	CLIENT	LOCATION
See Page 1			

DRILLING METHOD:

SAMPLING METHOD: See Page 1

BORING NO. 4-24

SHEET 6 OF 6

DRILLING	START	FINISH
TIME		
DATE		

WATER LEVEL				
TIME				
DATE				
CASING DEPTH				

DATUM

ELEVATION

SURFACE CONDITIONS:

TIME	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT SAMPLER	OVM	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
						100	GW	SANDY GRAVEL Very Dark Gray (7.5YR 3/0, 70-75% med-crse well [redacted] graded
1245	0 / 0			50-0"	0.0	1		gravel, subrounded-rounded, 20-25% well graded, med-coarse grained, subrounded-subang.
						2	TS	60% Basaltic 40% Quartzitic Sand, <10% Silt dry, no odor.
						3		moist [redacted], SANDY GRAVEL A/A
						4		
1250	8 / 6				0.0	5		105 drilling a bit easier,
						106		
						7		107 Free Water SANDY GRAVEL Very Dark Gray
						8	V026	7.5YR 3/0 A/A well graded gravel, well graded sand.
						9		Let sit 1hr. 4.2' Stick up
						110		106 / 4.2 — 13:40 105.8 / 4.2 — 101.6
						111.2		
						2	BS	101.8 WL @ 13:02
						113		Hole better 107.6 @ 13:30 — 107.6 / 101.8 / 5.8 @ 13:02 — 6.0 @ 13:40
						4	TD	105.8 @ 14:00
						5		Boring terminated @ 113.5 on 11/14/02 GW encountered at 107.0 during Drilling.
						6		
						7		
						8		
						9		
						0		

DRILLING CONTR.

No. 162880

CHK'D BY

BY DATE

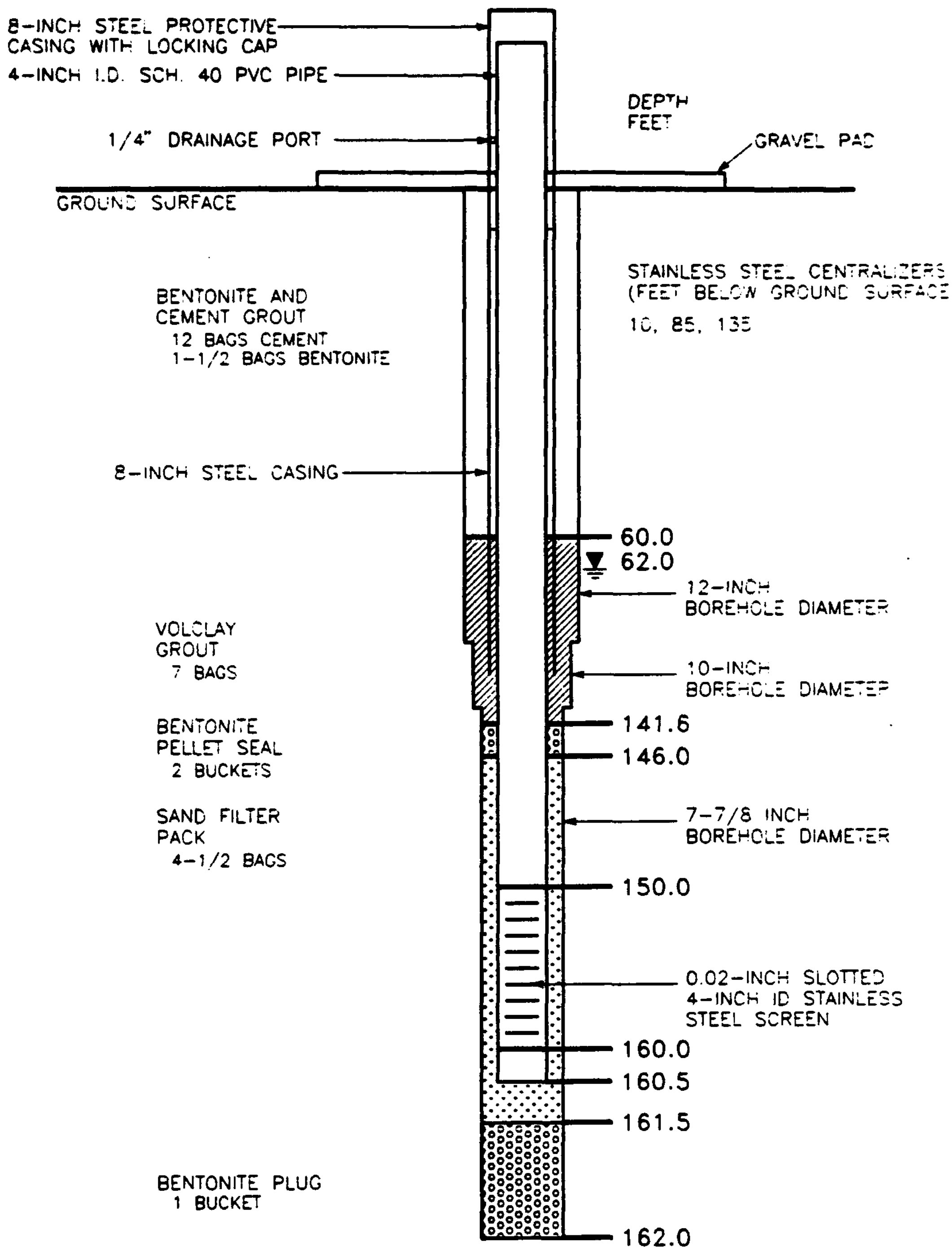
020 1 13 (REV 11-80)

APPENDIX B

Well Construction Diagrams

Well Installation Diagram
Explosive Washout Lagoons
Supplementary Remedial Investigation
UMATILLA, OREGON

Location: **4-19**
Installation Date: **11/17/92**
Surface Elevation: **557.80 Feet MSL**
Top of PVC Elevation: **559.59 Feet MSL**

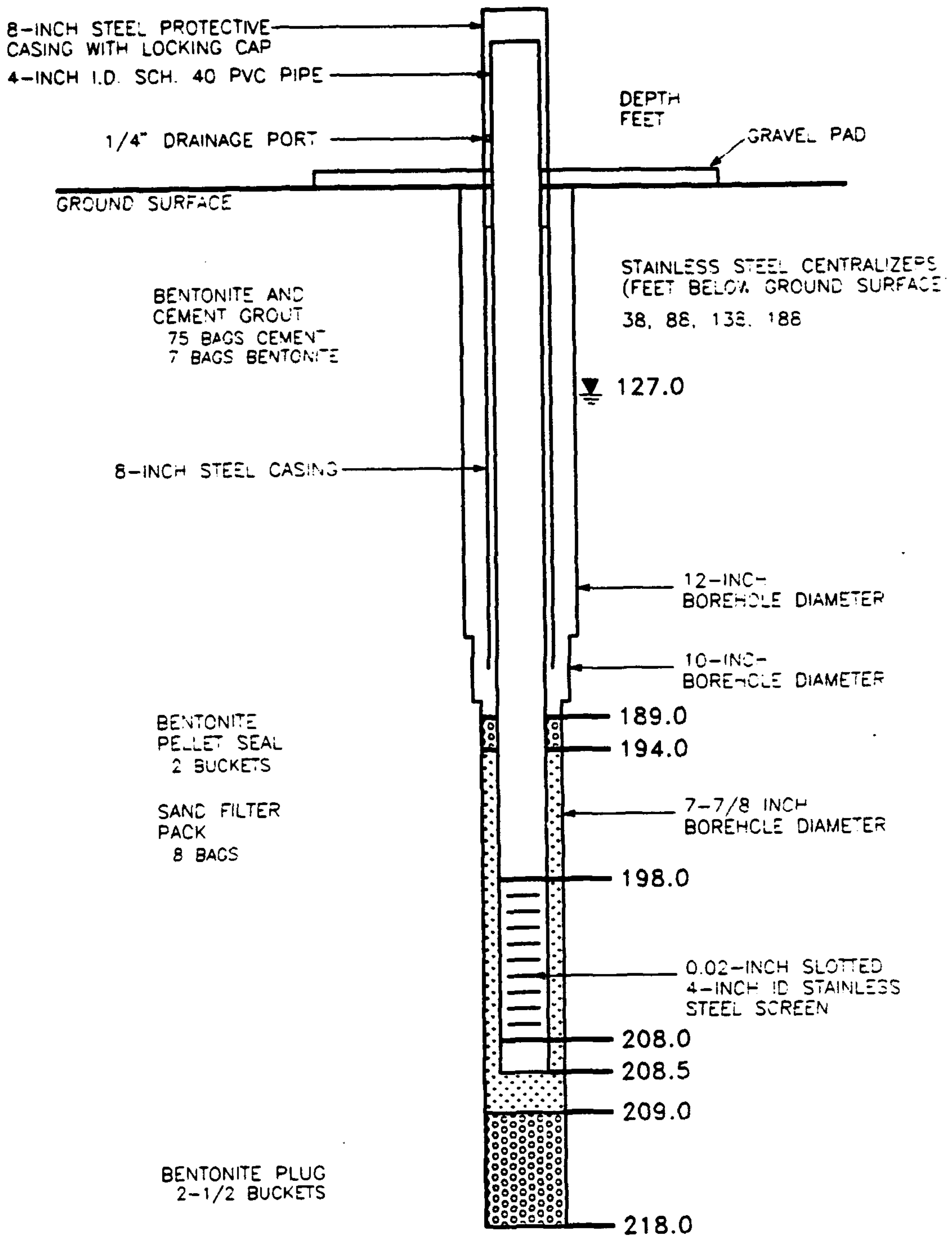


▼ GROUNDWATER ENCOUNTERED DURING DRILLING

NOT TO SCALE

Well Installation Diagram
Explosive Washout Lagoons
Supplementary Remedial Investigation
UMATILLA, OREGON

Location: 4-20
Installation Date: 12/09/92
Surface Elevation: 616.40 Feet MSL
Top of PVC Elevation: 617.45 Feet MSL



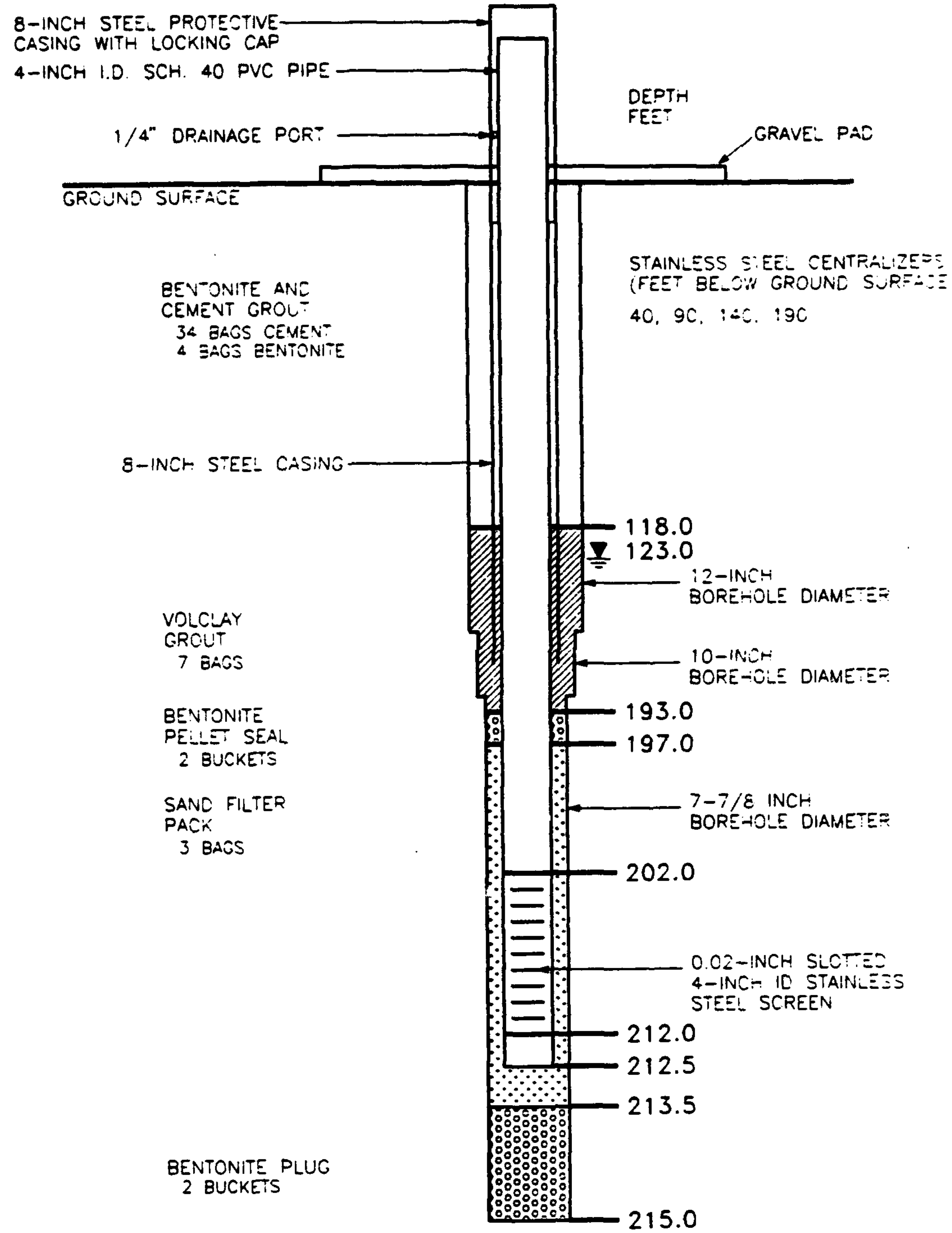
▼ GROUNDWATER ENCOUNTERED DURING DRILLING

NOT TO SCALE

DAMES & MOORE

Well Installation Diagram
Explosive Washout Lagoons
Supplementary Remedial Investigation
UMATILLA, OREGON

Location: **4-21**
Installation Date: **11/21/92**
Surface Elevation: **614.60 Feet MSL**
Top of PVC Elevation: **616.57 Feet MSL**



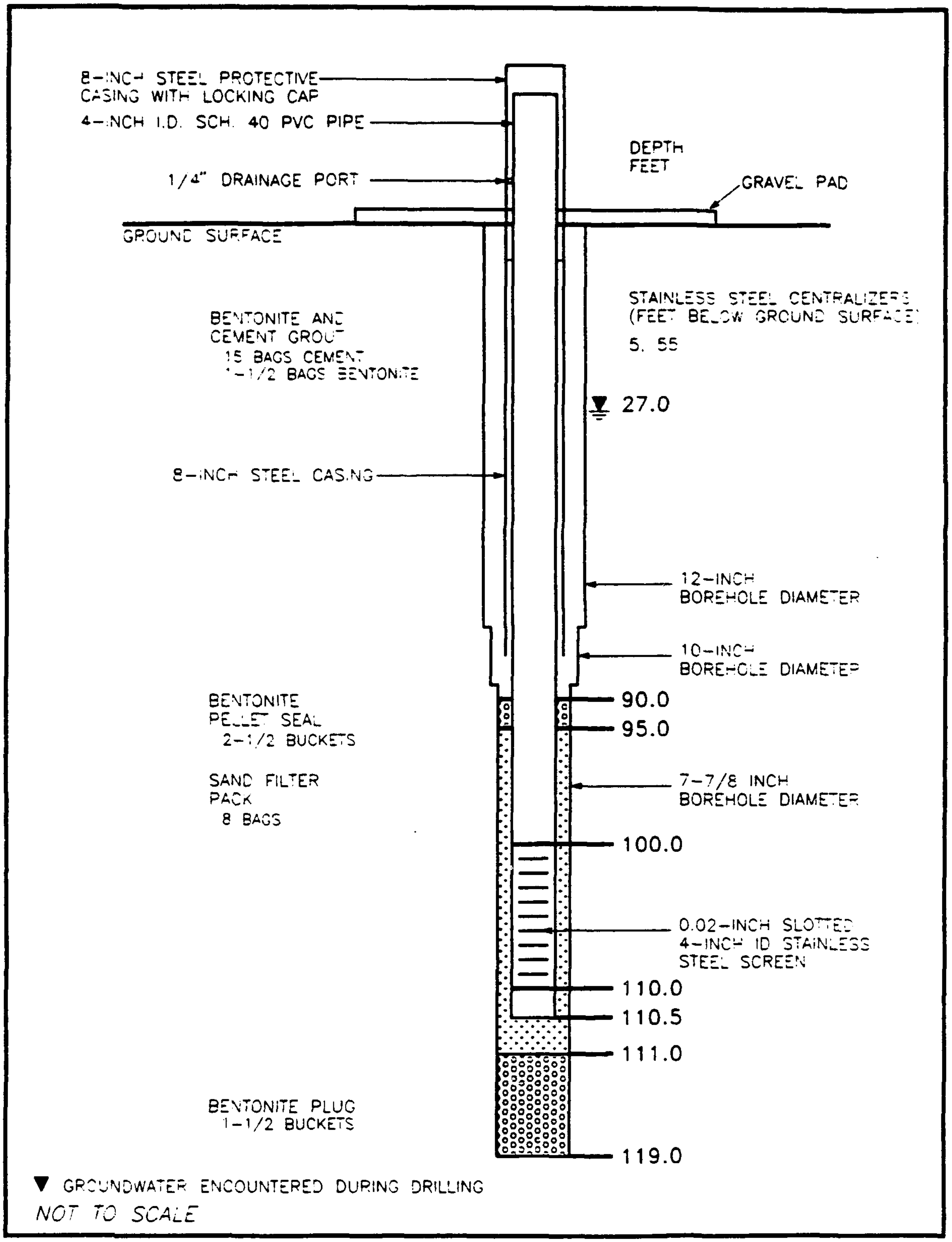
▼ GROUNDWATER ENCOUNTERED DURING DRILLING

NOT TO SCALE

DAMES & MOORE

Well Installation Diagram
Explosive Washout Lagoons
Supplementary Remedial Investigation
UMATILLA, OREGON

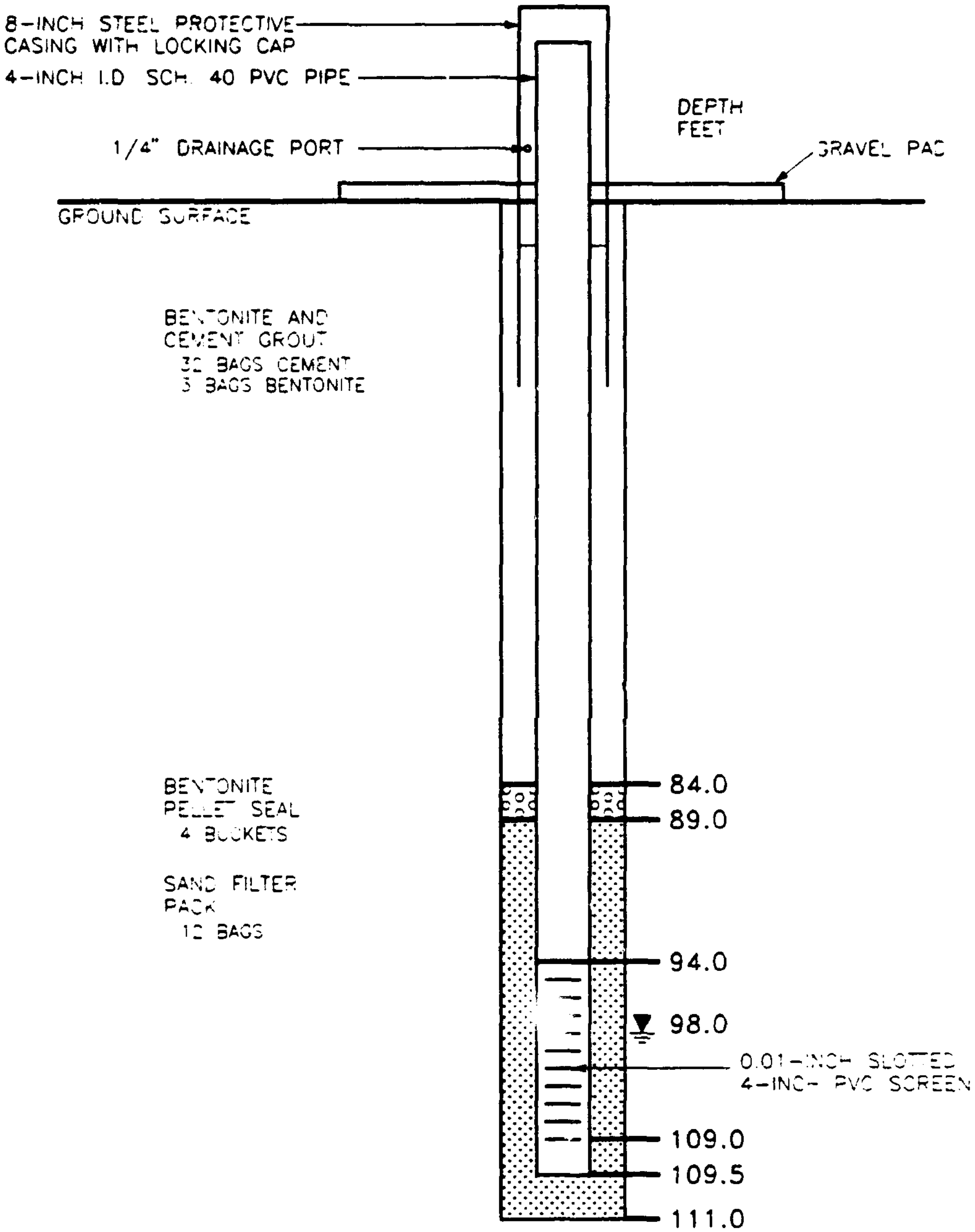
Location: 4-22
Installation Date: 12/09/92
Surface Elevation: 514.80 Feet MSL
Top of PVC Elevation: 516.58 Feet MSL



DAMES & MOORE

Well Installation Diagram
Explosive Washout Lagoons
Supplementary Remedial Investigation
UMATILLA, OREGON

Location: 4-23
Installation Date: 11/15/92
Surface Elevation: 593.40 Feet MSL
Top of PVC Elevation: 595.34 Feet MSL



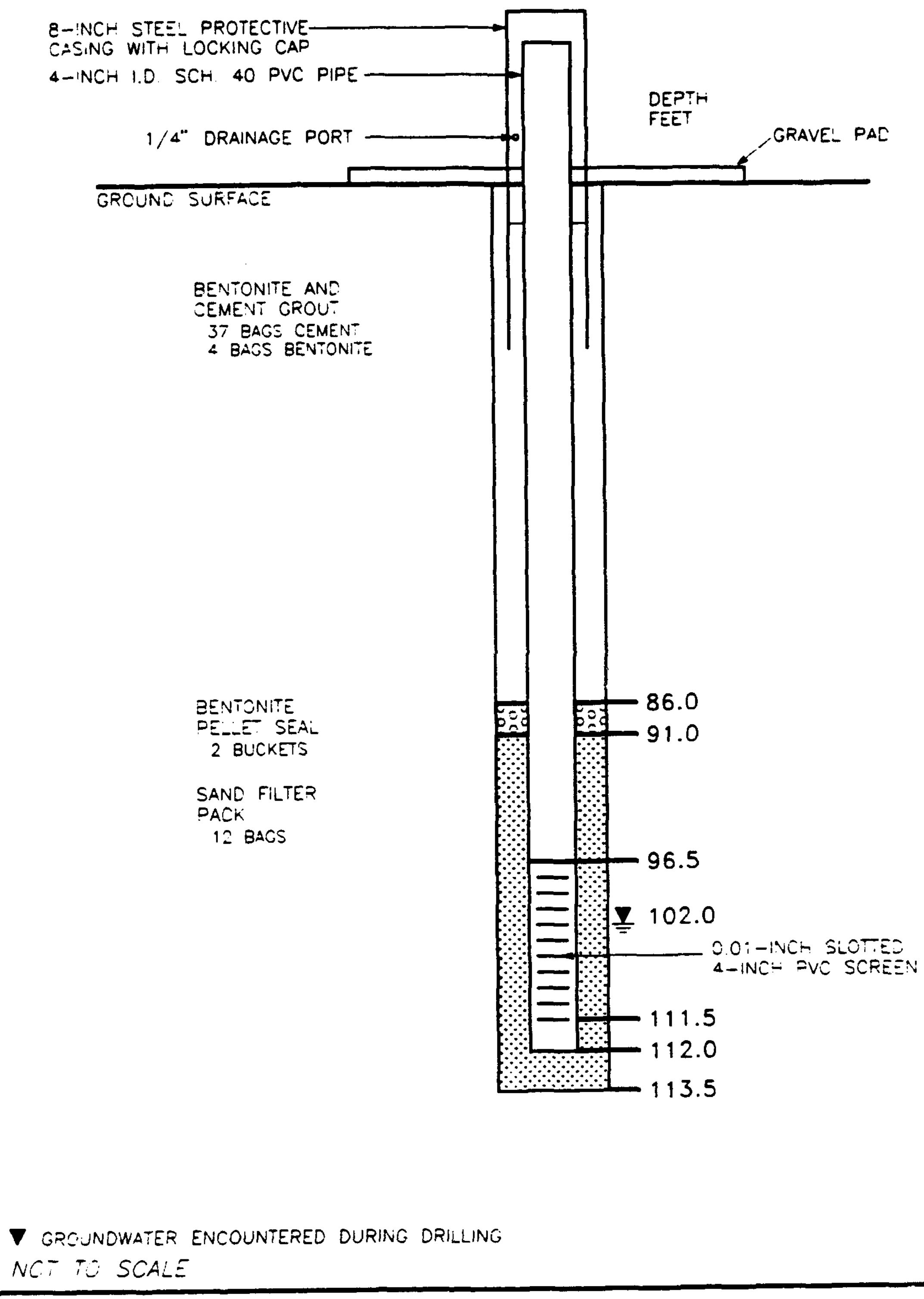
▼ GROUNDWATER ENCOUNTERED DURING DRILLING

NOT TO SCALE

DAMES & MOORE

Well Installation Diagram
Explosive Washout Lagoons
Supplementary Remedial Investigation
UMATILLA, OREGON

Location: 4-24
Installation Date: 11/15/92
Surface Elevation: 596.50 Feet MSL
Top of PVC Elevation: 598.15 Feet MSL



DAMES & MOORE

APPENDIX C

Packer Test Data

REPORT OF WATER PRESSURE TESTING

Max permissible psi = 80 psi

Boring No. 4-20
Page 1 of 1
† psi meter stickup = 3'

Location UMDA
Coordinates: N
E

Angle 90°
Bearing
Date Started 12/6/92
Date Completed

Ground Elevation
Rock Elevation 151
Groundwater Elevation 136.5
Logged By TML / MO

Test No.	Depth In Feet From	Depth In Feet To	Length of Interval Tested	Meter Start (inches in a dewar)	Meter End (of h_2o 1.875' dia)	Water Loss _cu.ft. _gal.	Elapsed Time (min.)	Rate of Loss _cfm _gpm	Pressure: Gage in psi	Pressure: psi (+) *Column (136.5+3' ×.433 = 60.4)	Pressure: psi (-) Friction (from calibration curve)	Net (psi)	~~K (ft/day)~~ H (feet) (psi ÷ .433)	K ft/day
1	174	180	6	0	1"	.23/1.72	1	.23/1.72	20	60.4	2.7	77.7	179.4	0.19
				1	1.75	.17/1.29	2	.17/1.29	20	60.4	2.3	78.1	180.4	0.14
				1.75	2.30	.12/.96	3	.12/.95	20	60.4	1.0	79.4	183.4	0.10
				2.30	3.00	.16/1.20	4	.16/1.20	20	60.4	2.0	78.4	181.1	0.13
				3.00	3.60	.14/1.03	5	.14/1.03	20	60.4	1.5	78.9	182.2	0.11
													K_{AV} =	0.13
2	174	180	6	4.00	5.10	.25/1.89	1	.25/1.89	40	60.4	2.8	97.6	225.4	0.17
				5.10	6.20	.25/1.89	2	.25/1.89	40	60.4	2.8	97.6	225.4	0.17
				6.20	7.40	.28/2.06	3	.28/2.06	40	60.4	3.2	97.2	224.5	0.19
				7.40	8.50	.25/1.89	4	.25/1.89	40	60.4	2.8	97.6	225.4	0.17
				8.50	9.40	.21/1.55	5	.21/1.55	40	60.4	2.5	97.9	226.1	0.14
													K_{AV} =	0.17
3	174	180	6	11.10	12.60	.34/2.58	1	.34/2.58	60	60.4	4.1	116.3	268.6	0.19
				12.60	14.0	.32/2.41	2	.32/2.41	60	60.4	3.8	116.6	269.3	0.18
				14.00	15.60	.37/2.75	3	.37/2.75	60	60.4	4.2	116.2	268.4	0.21
				15.60	17.00	.32/2.41	4	.32/2.41	60	60.4	3.7	116.7	269.5	0.18
				17.00	18.30	.30/2.24	5	.30/2.24	60	60.4	3.3	117.1	270.4	0.17
													K_{AV} =	0.19
												ΣK_{AV} =		0.16 ft/day
			Total gals used		~ 28 gals									

Depth to groundwater 139.5 feet × 0.433 = 60.4 psi

Gage + Column - Friction Loss = Net Pressure

* Column pressure = (depth to upper packer or depth to groundwater, whichever is smaller + height of gage above ground) × (0.433)

Conversion factors:
cu.ft × 7.48 gallons

Q = flow (ft³/min)
L = Length = 6'
H = Head =
r = hole radius = .119'

$$K = \frac{G}{2\pi LH} \ln \frac{L}{r} \quad (L > 10r) \quad \left(\times \frac{1440 \text{ min}}{1 \text{ day}}\right)$$

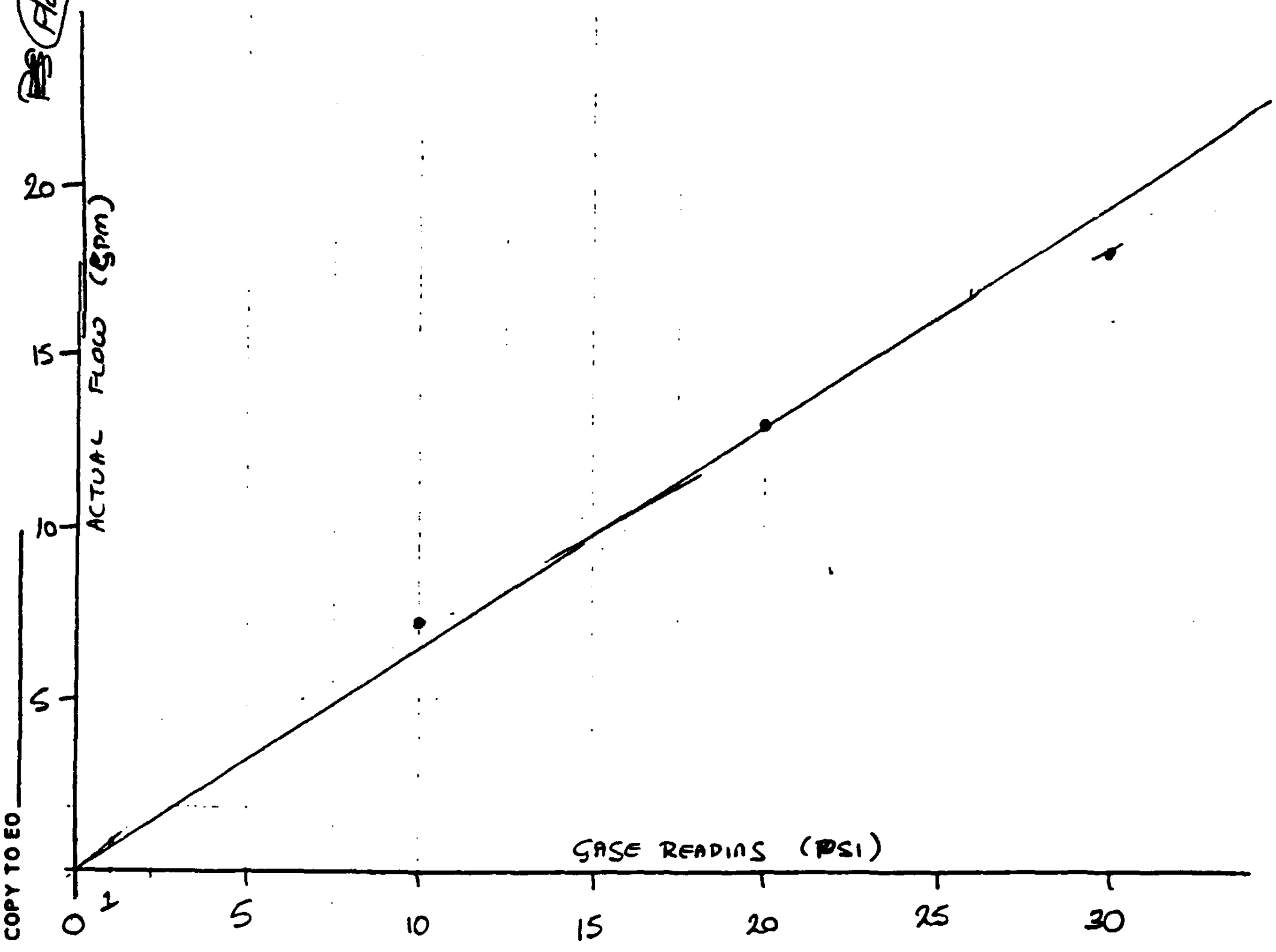
FILE
SUBJECT
SHEET OF

REVISIONS BY DATE TO EO
BY DATE TO EO

Packer Calibration (~178' String)

Totalizer Reading	Actual Flow	PSI
16 gpm	18.3 gpm	30
9.7 gpm	13.2 gpm	20
3.6 gpm	7.3 gpm	10

Flow (actual)



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REPORT OF WATER PRESSURE TESTING

Boring No. 4-22
Page 1 of

PSI gage 5.5' above ground

Location ____ Angle 90° Ground Elevation –
Coordinates: N ____ Bearing ____ Rock Elevation 55'
E ____ Date Started 12/8/92 Groundwater Elevation 48'
Date Completed ____ Logged By TML / MAO

Test No.	Depth in Feet From	Depth in Feet To	Length of Interval Tested	Meter Start (inches of h_2o in a 1.875' diam)	Meter End	Water Loss _cu.ft. _gal.	Elapsed Time (min.)	Rate of Loss _cfm _gpm	Pressure: Gage in psi	Psi (+) *Column	Psi (-) Friction	Net (psi)	H (feet) (psi ÷ .433)	K ft/min
1	79	85	6'	0.06	.1	0.04	1	0.04	10	23.2	0	33.2	76.7	0.08
				.1	.15	0.05	2	0.05	10	23.2	0	33.2		
				.15	.17	0.02	3	0.02	10	23.2	0	33.2		
				.17	.18	0.01	4	0.01	10	23.2	0	33.2		
				.18	.19	0.01	5	0.01	10	23.2	0	33.2		
2	79	85	6'	.20	.20	0	1	0	20	23.2	0	43.2	99.8	0
				.20	.20	0	2	0	20	23.2	0	43.2		0
				.20	.20	0	3	0	20	23.2	0	43.2		0
3	79	85	6'	.25	.26	0.01	1	0.01	40	23.2	0	63.2	145.9	0.01
				.26	.30	0.04	2	0.04	40	23.2	0	63.2		
				.30	.32	0.02	3	0.02	40	23.2	0	63.2		
				.32	.33	0.01	4	0.01	40	23.2	0	63.2		0.01
				.33	.35	0.02	5	0.02	40	23.2	0	63.2		

Depth to groundwater 48' feet X 0.433 = 20.78 psi

Gage + Column - Friction Loss = Net Pressure + gage height

* Column pressure = (depth to upper packer or depth to groundwater, whichever is smaller) X (0.433)

Conversion factors:
cu.ft X 7.48 gallons

Q = flow (ft^3/min)
L = Length
H = Head
r = hole radius (.119')

$$K = \frac{Q}{2\pi LH} \ln \frac{L}{r} \quad (L > 10r)$$

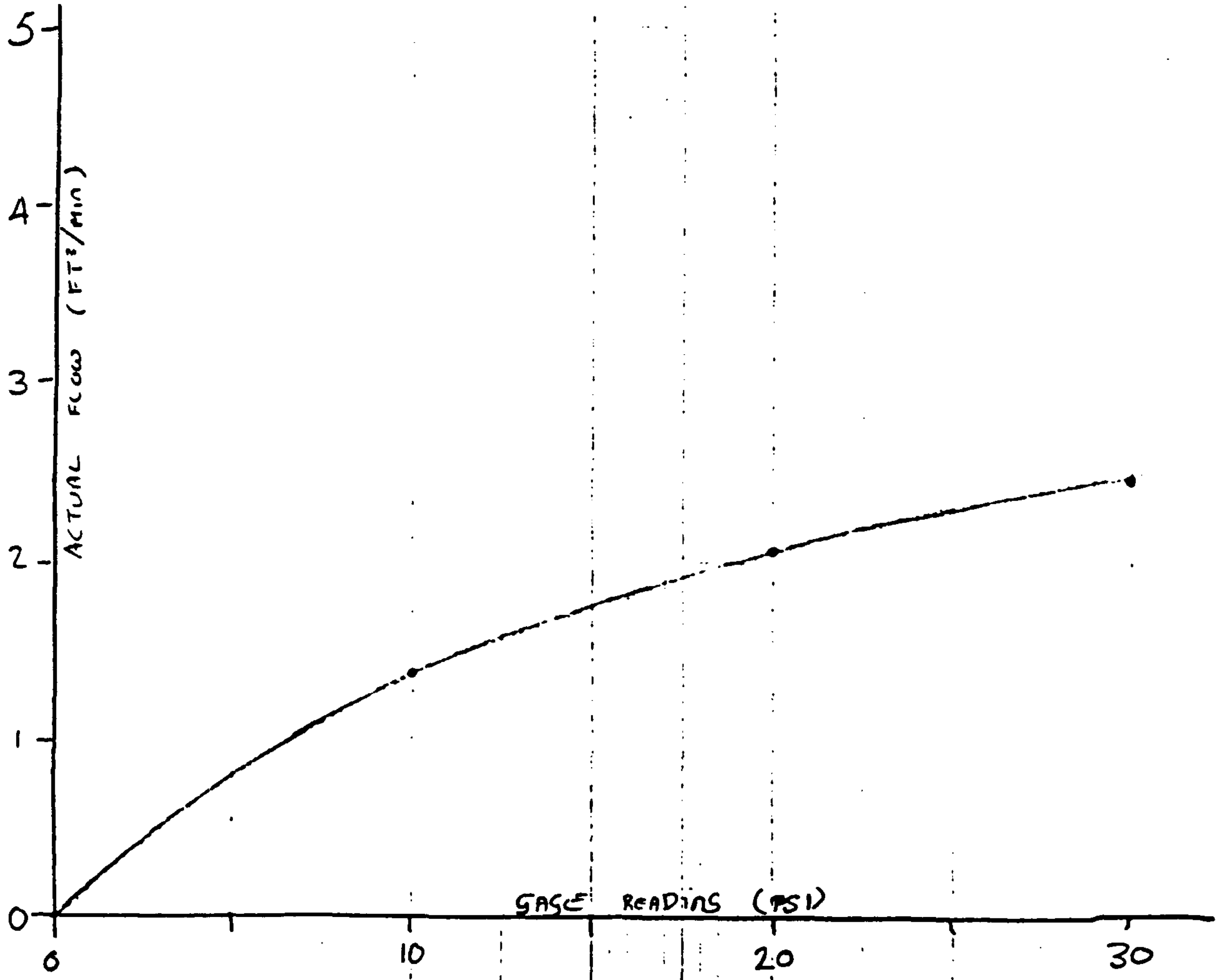
Boring No.

FILE Villard
SUBJECT Packer Test @ 4-22
SHEET ___ OF ___

REVISIONS
BY ___ DATE ___ TO EO ___
BY ___ DATE ___ TO EO ___

Packer String Calibration — 82' Packer String

Flow (ft) Start	End	ft × πr² ft × 2.76 (ft³)	Elapsed Time (min)	ft³/min	Psi gage
0.30	1.05	0.75×2.76 = 2.07	1	2.07	20
1.30	1.80	0.5 × 2.76 = 1.38	1	1.38	10
0.25	1.15	0.9 × 2.76 = 2.48	1	2.48	30



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APPENDIX D

Field Parameters (Temperature, Specific Conductance, pH)

WELL DEVELOPMENT RECORDS FOR SITE 4 WELLS

Well Number	Development Date	Water Level Prior to Development (feet T.O.C.)	Actual Total Purge Volume (gal) (Target Purge Volume – gal) (a)	Field Parameters: Measure No. (b)	pH	Temp. (C)	Conductivity (uMHOS)
4-19	12-15-92	112.57	325	T1	7.76	17.2	420
			(252.40)	T2	7.43	17.8	400
				T3	7.57	17.8	440
				T4	7.53	17.2	400
				T5	7.49	17.2	380
				T6	7.46	16.7	370
4-20	12-18-92	145.50	350	T1	8.27	18.9	495
			(332.85)	T2	8.96	17.2	375
				T3	7.87	16.1	320
				T4	7.66	16.7	300
				T5	7.55	16.7	300
				T6	7.54	16.7	300
				T7	7.56	16.7	310
4-21	12-16-92	153.92	290	T1	7.92	18.9	440
			(283.90)	T2	7.71	16.7	400
				T3	7.30	16.1	340
				T4	7.29	16.7	330
				T5	7.31	16.7	330
4-22	12-15-92	58.35	260	T1	7.79	17.2	240
			(253.80)	T2	7.40	16.7	300
				T3	7.12	16.7	320
				T4	7.56	16.7	300
				T5	7.55	16.7	310
4-23	11-19-92	100.62	160	T1	7.37	13.4	412
			(102.35)	T2	7.14	12.9	342
				T3	7.20	12.9	312
				T4	7.17	13.1	332
				T5	7.20	13.1	330
				T6	7.21	13.2	327
4-24	11-19-92	103.60	125	T1	7.72	12.9	439
			(84)	T2	7.57	12.8	366
				T3	7.50	12.6	327
				T4	7.51	12.7	333
				T5	7.52	12.6	332

(a) Target purge volume calculated is five pore volumes.

(b) Measurement T1 was taken from the first water that was removed from the well. The last measurement listed was taken within approximately fifteen minutes of the end of purging (i.e., from some of the last water removed from the well).

APPENDIX E

Slug Test Data

SLUG TEST CALCULATIONS
INTERMEDIATE WELLS 4-19, 4-20, 4-21, AND 4-22

Cooper Slug Test Calculations**

Well No.	K (ft/day)	D (ft)	rw (ft)	rc (ft)	t (sec)	B	A
4-19	277	10	0.33	0.17	0.9	1.0	0.1
4-20	416	10	0.33	0.17	0.6	1.0	0.1
4-21	624	10	0.33	0.17	0.4	1.0	0.001
4-22	357	10	0.33	0.17	0.7	1.0	0.1

** Input quantities are as follows:
D = Length of screen
rw = Radius from center of well to undisturbed aquifer material
rc = Casing diameter
t = Time from plot of drawdown vs. time corresponding to B=1 on type curve
B = Type curve value for KDt/r^2c
A = Type curve value for r^2wS/r^2c

REVISIONS BY ____ DATE ____ TO EO ____ BY ____ DATE ____ TO EO ____

Cooper Method Calculations

$KD = \frac{r_c^2 \beta}{t}$ $S = \frac{r_c^2 \alpha}{r_{ew}^2}$

4-19

$r_c = 0.17$ $D = 10.0$

$\beta = 1.0$ $r_{ew} = 0.33$

$t = 0.9$ $\alpha = 0.1$

$K = \frac{(0.17)^2 \cdot 1}{0.9 \cdot 10} = 3.21 \times 10^{-3}$ ft/sec

277.44 ft/day

$S = \frac{(0.17)^2 \cdot 0.1}{(0.33)^2} = 2.65 \times 10^{-2}$ ft

4-20

$r_c = 0.17$ $D = 10.0$

$\beta = 1.0$ $r_{ew} = 0.33$

$t = 0.6$ $\alpha = 0.1$

$K = \frac{(0.17)^2 \cdot 1}{0.6 \cdot 10} = 4.82 \times 10^{-3}$ ft/sec

416.16 ft/day

$S = \frac{(0.17)^2 \cdot 0.1}{(0.33)^2} = 2.65 \times 10^{-2}$ ft.

4-21

$r_c = 0.17$ $D = 10.0$

$\beta = 1.0$ $r_{ew} = 0.33$

$t = 0.4$ $\alpha = 0.001$

$K = \frac{(0.17)^2 \cdot 1}{0.4 \cdot 10} = 7.23 \times 10^{-3}$ ft/sec

624.24 ft/day

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FILE UMATILLA DEPOT ACTIVITY

SUBJECT Slug Test Calculations - Intermediate Wk

SHEET 2 OF 2

REVISIONS
BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

4-22

$r_c = 0.17$ $D = 10.0$

$\beta = 1.0$ $r_{ew} = 0.33$

$t = 0.7$ $\alpha = 0.1$

$$K = \frac{(0.17)^2 \cdot 1}{0.7 \cdot 10} = 4.13 \times 10^{-3} \text{ ft/sec}$$

356.71 ft/day

$$S = \frac{(0.17)^2 \cdot 0.1}{(0.33)^2} = 2.65 \times 10^{-2} \text{ ft}$$

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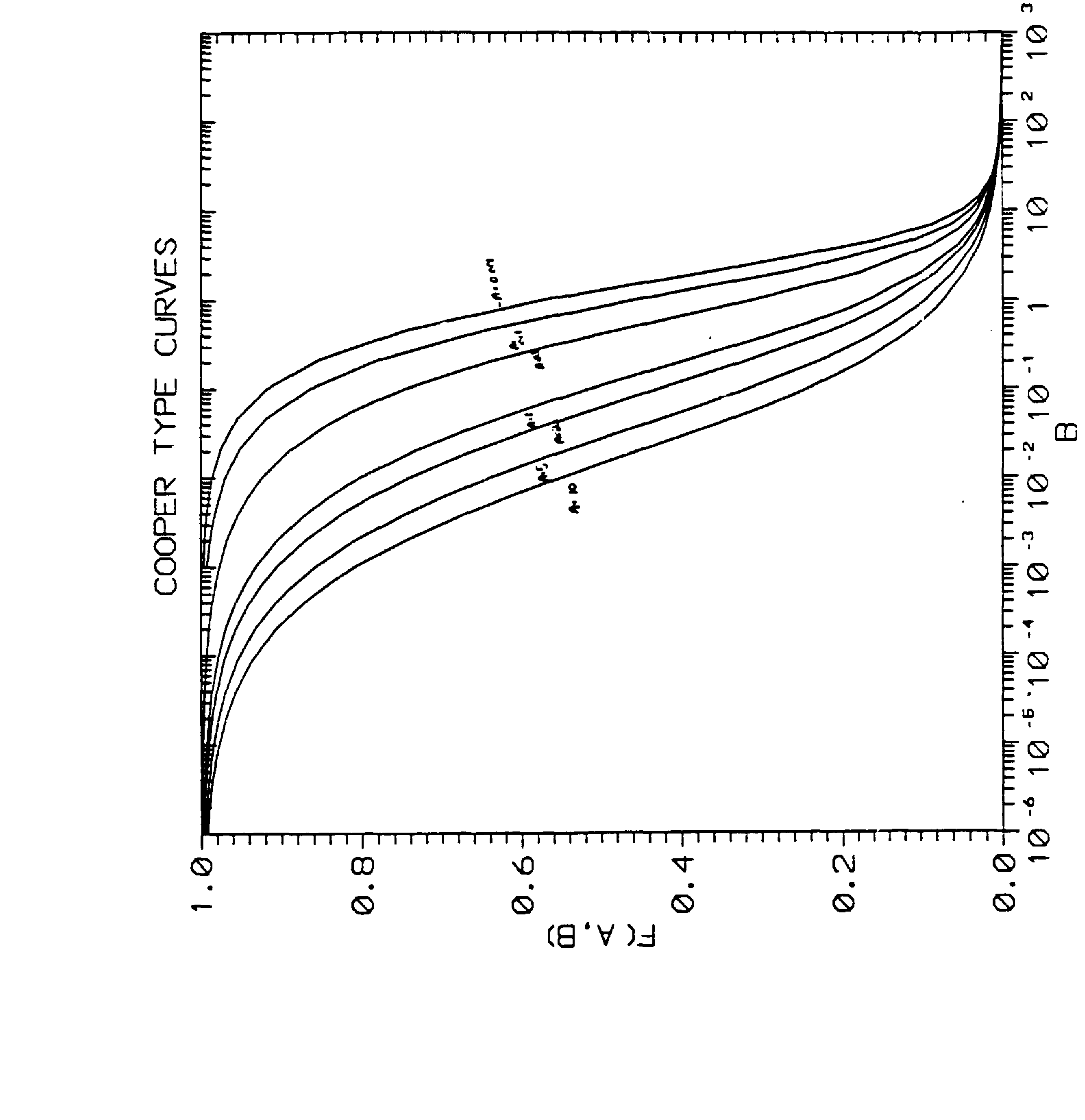
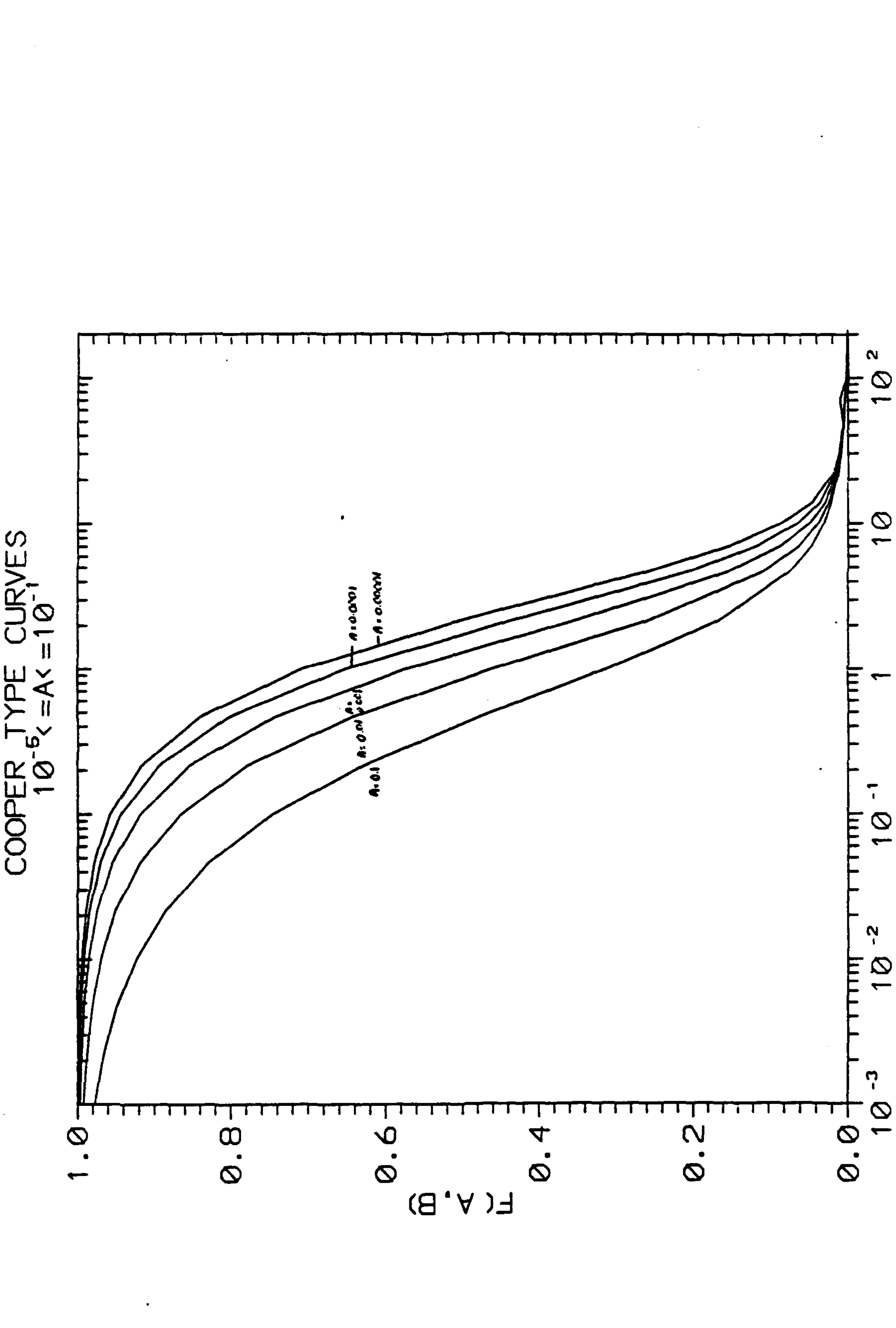
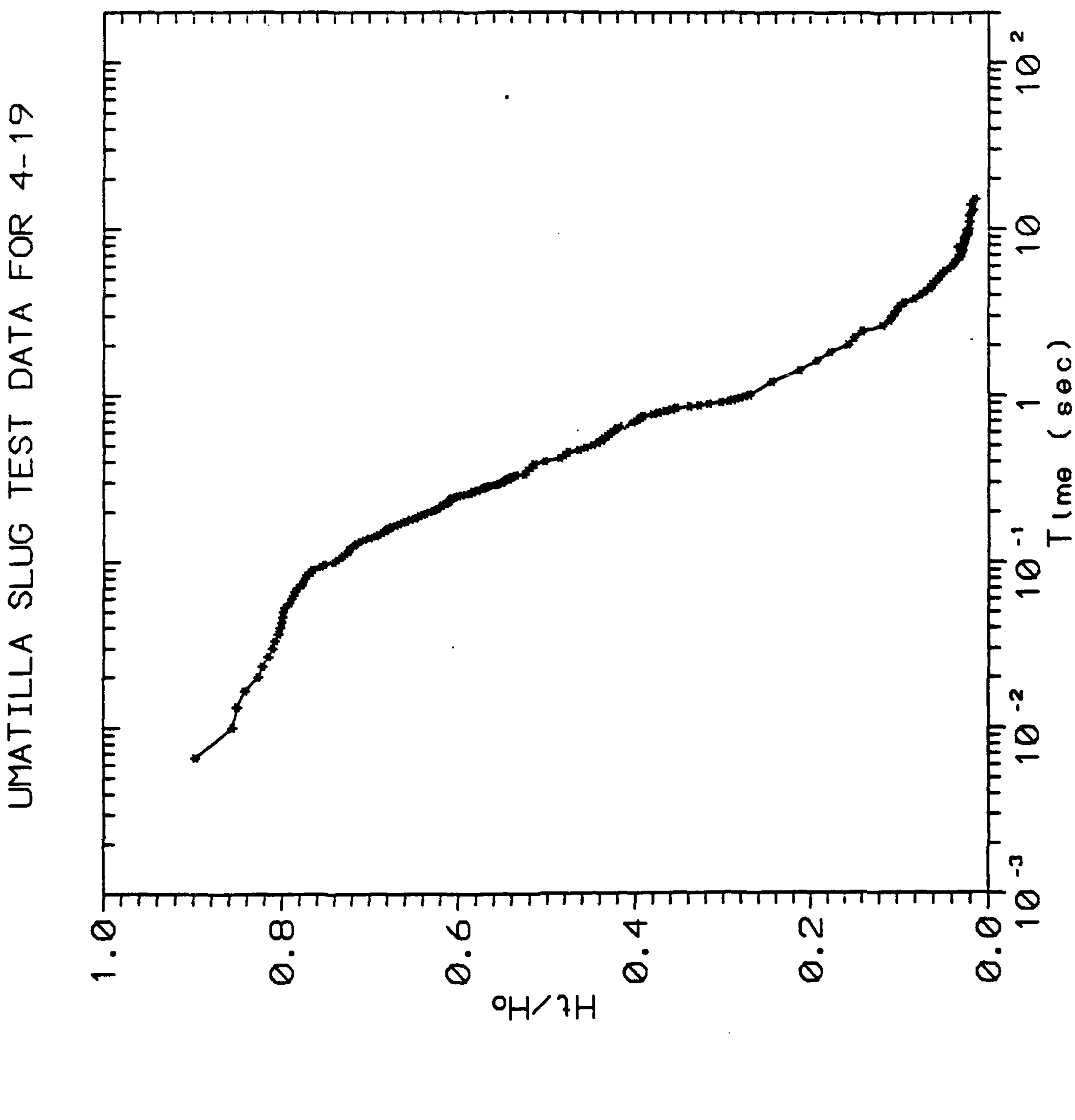
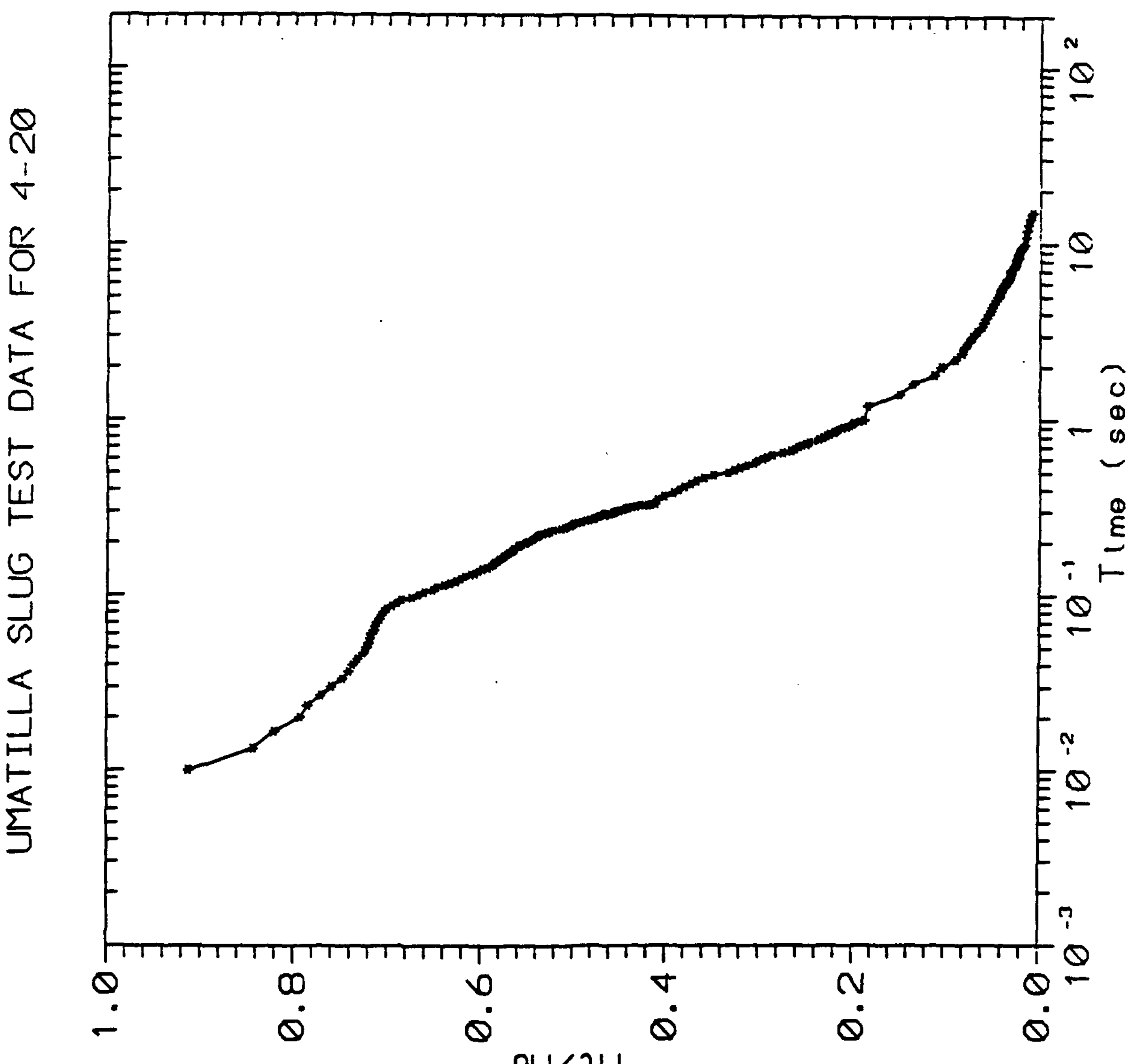

COOPER TYPE CURVES
F(A, B)
B
1.0
0.8
0.6
0.4
0.2
0.0
10 -6
10 -5
10 -4
10 -3
10 -2
10 -1
1
10
10 2
10 3

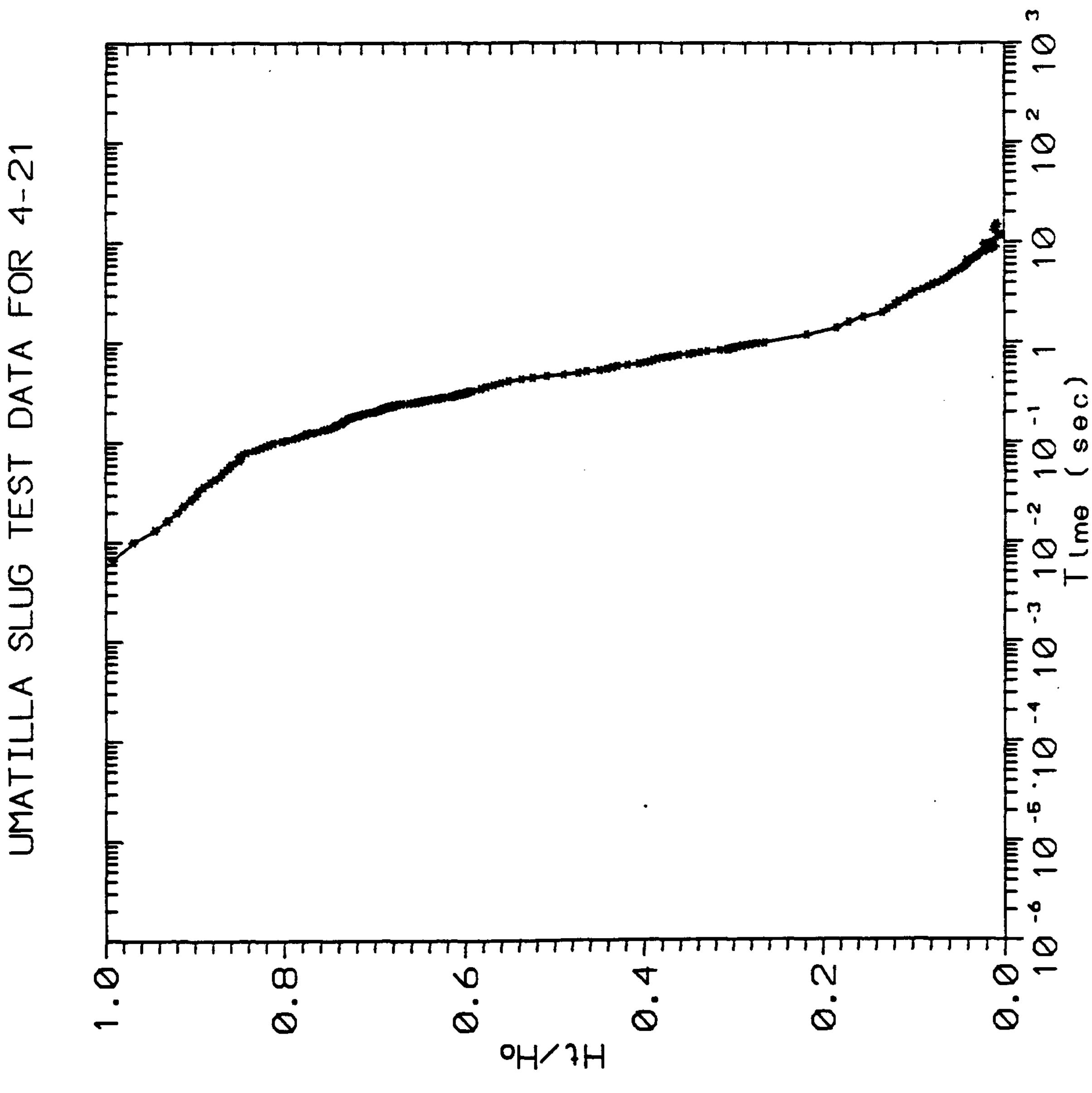

COOPER TYPE CURVES
$10^{-5} <= A <= 10^{-1}$
F(A, B)
B
1.0
0.8
0.6
0.4
0.2
0.0
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
A=0.1
A=0.01

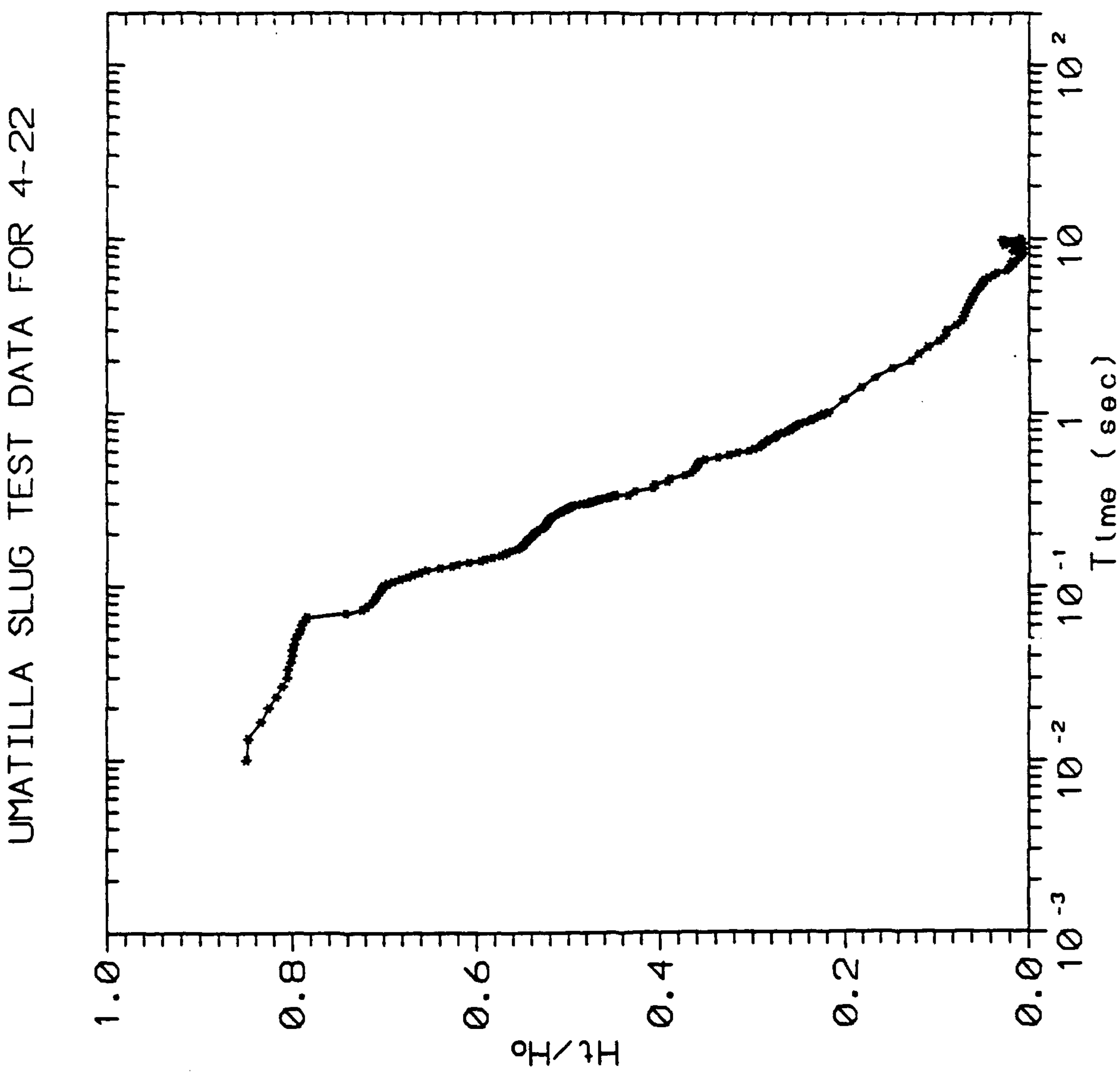


UMATILLA SLUG TEST DATA FOR 4-19
Ht/Ho
1.0
0.8
0.6
0.4
0.2
0.0
10 -3
10 -2
10 -1
1
10
10 2
Time (sec)



UMATILLA SLUG TEST DATA FOR 4-20
Ht/Ho
1.0
0.8
0.6
0.4
0.2
0.0
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
Time (sec)


UMATILLA SLUG TEST DATA FOR 4-21
Ht/Ho
1.0
0.8
0.6
0.4
0.2
0.0
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
1
10
10^2
10^3
Time (sec)


UMATILLA SLUG TEST DATA FOR 4-22
Ht/Ho
1.0
0.8
0.6
0.4
0.2
0.0
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
Time (sec)

SLUG TEST CALCULATIONS
ALLUVIAL WELLS 4–23 AND 4–24

Bouwer and Rice Slug Test Model Calculations*

Well No.	K (ft/day)	D (ft)	H (ft)	L (ft)	rw (ft)	rc (ft)	t (sec)	y0 (ft)	yt (ft)
4–23	1571	8.55	8.55	15	0.38	0.24	0.2	0.07	0.032
4–24	1944	8.05	8.05	15	0.38	0.24	0.45	0.055	0.006

* Input quantities are as follows:

D = Depth from water table to base of aquifer (saturated thickness)
H = Depth from water table to bottom of screen
L = Length of screen
rw = Radius from center of well to undisturbed aquifer material
rc = Casing diameter plus a correction for the presence of a gravel or sand pack
t = Arbitrary time selected to pick value of yt from straight–line portion of plot of drawdown vs. time
y0 = Drawdown at point where the extended straight–line portion of the graph intersects the y–axis at zero time
yt = Drawdown at time t on the straight–line portion of the graph

Bouwer and Rice Method Calculations

$$K = \frac{r_c^2 \ln(r_e/r_w)}{2L} \cdot \frac{1}{t} \cdot \ln\left(\frac{y_o}{y_t}\right) \qquad \ln r_e/r_w = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right]^{-1}$$

Correction for $r_c = \left[r_a^2 + n(r_w^2 - r_a^2)\right]^{1/2}$

4-23

$H = 8.55$ $\quad t = 0.2$ $\quad r_a = 0.17$

$L = 15.0$ $\quad y_o = 0.07$ $\quad n = 25\%$

$r_w = 0.38$ $\quad y_t = 0.032$

$r_c = 0.24$ $\quad C = 2.39$

$$r_c = \left[0.17^2 + 0.25(0.38^2 - 0.17^2)\right]^{1/2} = 0.24$$

$$\ln r_e/r_w = \left[\frac{1.1}{\ln\left(\frac{8.55}{0.38}\right)} + \frac{2.39}{15/0.38}\right]^{-1} = 2.42$$

$$K = \frac{0.24^2 \cdot 2.42}{2 \cdot 15.0} \cdot \frac{1}{0.2} \cdot \ln\left(\frac{0.07}{0.032}\right) = 1.82 \times 10^{-2} \text{ ft/sec}$$

1571.19 ft/day

4-24

$H = 8.05$ $\quad t = 0.45$ $\quad r_a = 0.17$

$L = 15.0$ $\quad y_o = 0.055$ $\quad n = 25\%$

$r_w = 0.38$ $\quad y_t = 0.006$

$r_c = 0.24$ $\quad C = 2.39$

$$r_c = \left[0.17^2 + 0.25(0.38^2 - 0.17^2)\right]^{1/2} = 0.24$$

$$\ln r_e/r_w = \left[\frac{1.1}{\ln\left(\frac{8.05}{0.38}\right)} + \frac{2.39}{15/0.38}\right]^{-1} = 2.38$$

$$K = \frac{0.24^2 \cdot 2.38}{2 \cdot 15} \cdot \frac{1}{0.45} \cdot \ln\left(\frac{0.055}{0.006}\right) = 2.25 \times 10^{-2} \text{ ft/sec}$$

1943.86 ft/day

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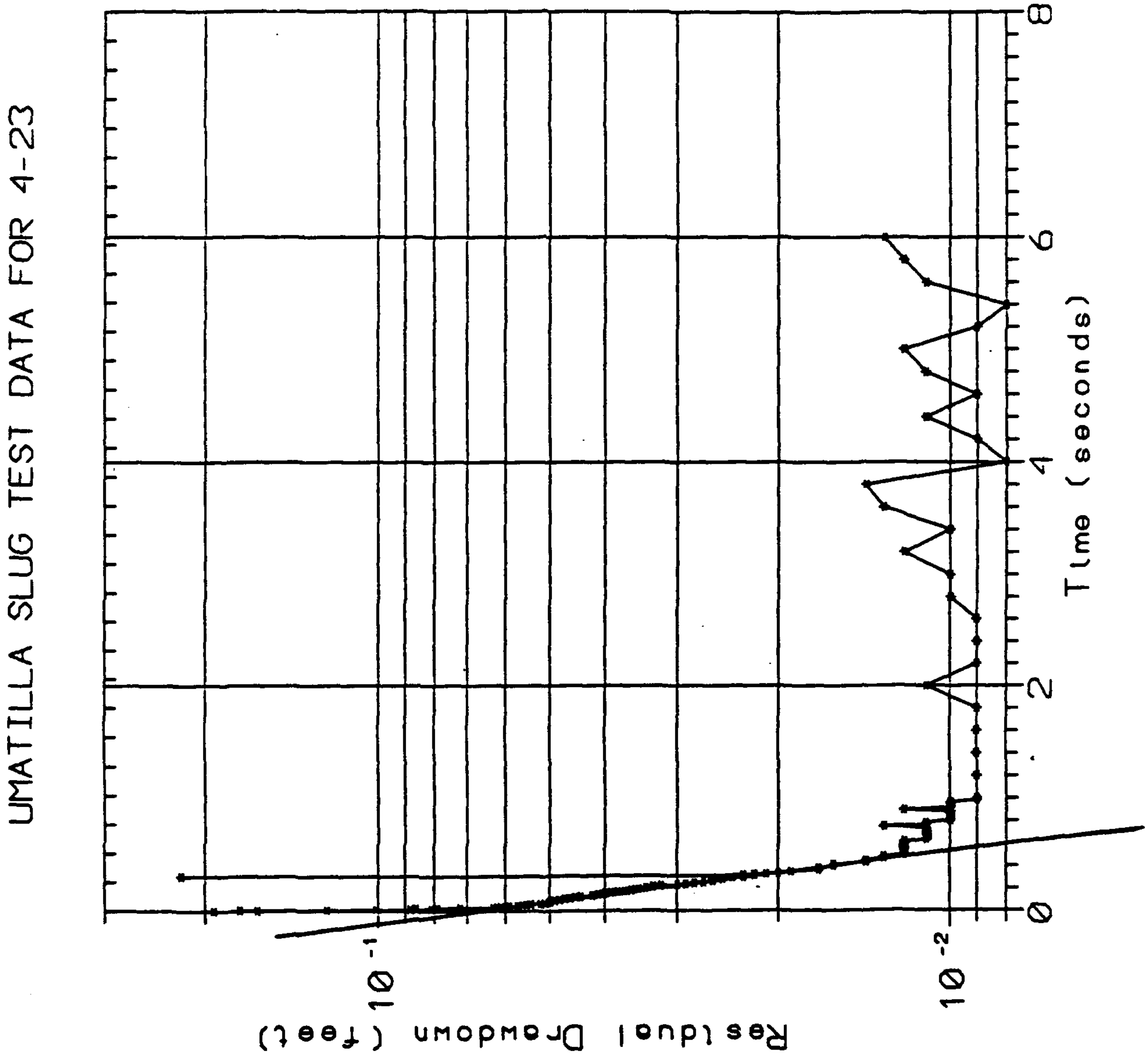
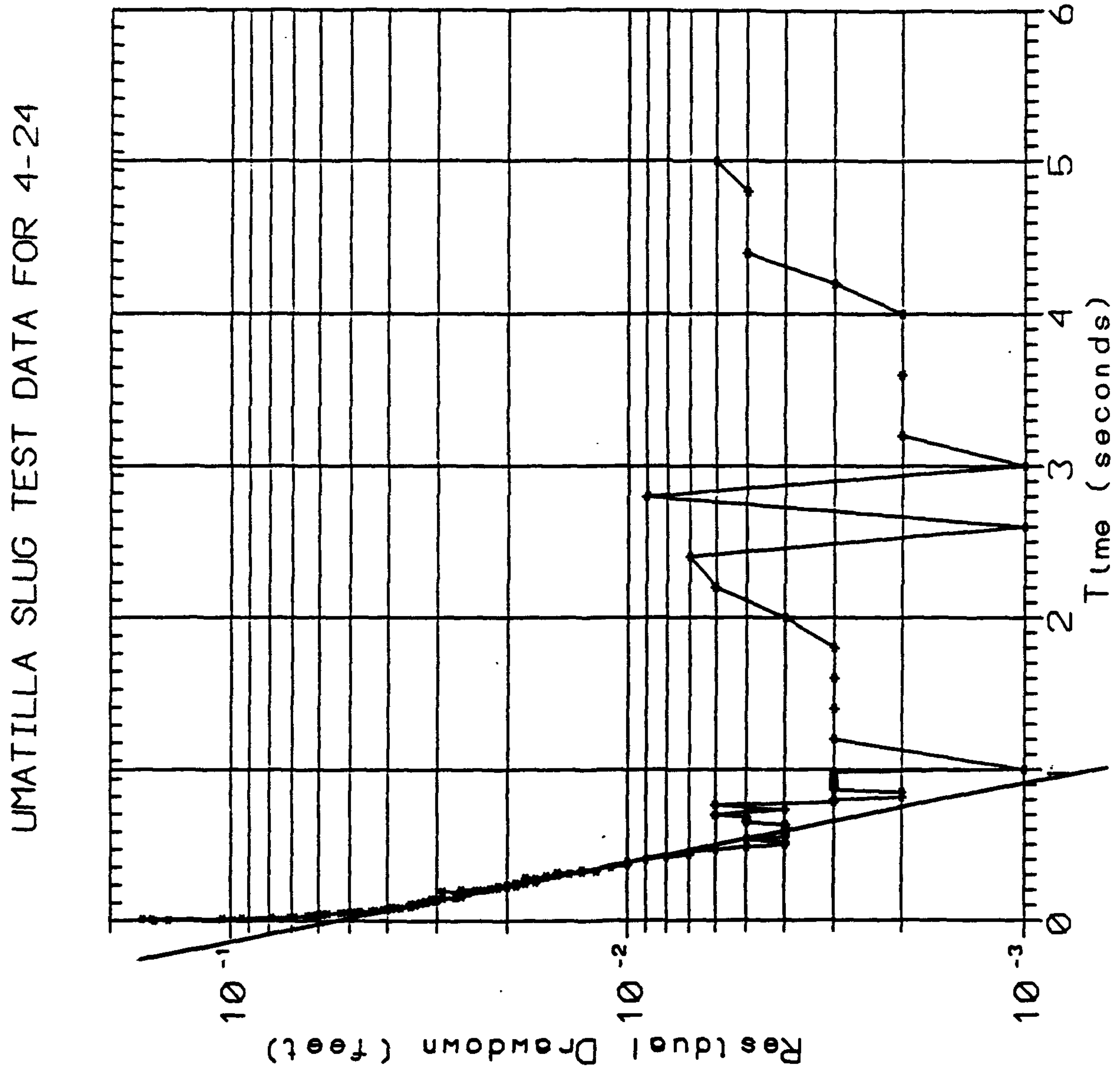

UMATILLA SLUG TEST DATA FOR 4-23
Residual Drawdown (feet)
10 -1
10 -2
Time (seconds)
0
2
4
6
8


UMATILLA SLUG TEST DATA FOR 4-24
Residual Drawdown (feet)
10^{-1}
10^{-2}
10^{-3}
Time (seconds)
0
2
3
4
5
6

APPENDIX F

XRF Analytical Results of Basalt Core Samples

Mark Ochsner
Dames and Moore
1750 S.W. Harbor Way, Suite 400
Portland, OR 97201

February 22, 1993

Dear Mark:

The X-ray fluorescence (XRF) analyses for the Umatilla-Ordinance Depot samples 4-20 (170-176.5') and 4-22 (75-80') just received from Washington State University's GeoAnalytical Laboratory are enclosed. Both of these samples are Elephant Mountain Member of the Saddle Mountains Basalt. The chemistry is an excellent match for Elephant Mountain and the lithology is also consistent, being abundantly microphyric with larger phenocrysts rare. Chemically the lower SiO_2, intermediate P_2O_5, and higher TiO_2 abundances are distinctive. This unit is usually underlain by the Rattlesnake Ridge interbed.

I checked the magnetic polarity using top and bottom of the core samples with a flux-gate magnetometer and found the sample from 4-22 to read "reversed" while the sample from 4-20 read "normal". Perhaps one of the cores had been inverted in handling, but Elephant Mountain is considered to be "reversed" to "transitional" paleomagnetic polarity.

Elephant Mountain Member comprises two flows in some of its distributional area, but the Umatilla location is very near to the mapped edge of this unit. The other reversed polarity unit that also pinches out in this locality is the Pomona Member, but these chemical analyses are nothing like the Pomona composition. Therefore, I can confidently conclude that these two core samples are from the Elephant Mountain Member of the Saddle Mountains Basalt.

Thank you for the opportunity to consult with you on this project! If you have and questions or need further consultation, please give me a call.

Sincerely,

Marvin H. Beeson

Marvin H. Beeson, Ph.D.
Geologist (OR G493)

Table of XRF Data

UMATILLA-ORDINANCE DEPOT

Drill Hole	4-20	4-22
Depth	170-175'	75-80'
XRF Date	17-Feb-93	17-Feb-93
	Normalized Results (Weight %)	
SiO2	51.16	50.33
Al2O3	12.86	12.75
TiO2	3.55	3.49
FeO*	14.91	14.34
MnO	0.215	0.30
CaO	8.60	9.95
MgO	4.41	4.37
K2O	1.15	1.14
Na2O	2.60	2.79
P2O5	0.538	0.538
	Trace Elements (ppm)	
Ni	4	6
Cr	23	20
Sc	39	35
V	412	424
Ba	467	459
Rb	28	28
Sr	235	240
Zr	239	236
Y	51	50
Nb	26.4	27.3
Ga	22	19
Cu	15	11
Zn	148	144
Pb	6	3
La	29	34
Ce	78	72
Th	6	8
CRBG UNIT	Elephant Mountain	Elephant Mountain

Major elements are normalized on a volatile-free basis
*Total Fe is expressed as FeO

XRF Analyses by WSU GeoAnalytical Laboratory