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Summary of Field Operations Powerline Wells PL-1, PL-2, PL-3

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SUMMARY OF FIELD OPERATIONS POWERLINE WELLS PL-1, PL-2, PL-3

Site-Wide Hydrogeologic Characterization Project

W.L. Foutz
Lamb Associates, Inc.
Sandia Contract No. AG-0178B

Environmental Restoration Project
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ABSTRACT

This report is a basic data report for field operations associated with the drilling, logging, completion, and development of Powerline Wells PL-1, PL-2, and PL-3. These test/monitoring wells were installed as part of the Sandia National Laboratories, New Mexico, Environmental Restoration Project.

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1.0 EXECUTIVE SUMMARY

This report summarizes field operations and hydrogeologic data obtained during installation of the Powerline monitoring/test wells near the western boundary of Kirtland Air Force Base. These wells were installed in 1994 as part of the Site-Wide Hydrogeologic Characterization Project saturated zone investigation. The Site-Wide Hydrogeologic Characterization Project is part of Sandia National Laboratories, New Mexico, Environmental Restoration Project. Interpretation of the data in this report will be presented in the Site-Wide Hydrogeologic Characterization Project 1995 Annual Report.

Three wells were drilled and completed at this location, and named PL-1, PL-2, and PL-3. They are located northwest of Tech Area III, and are named after a high-voltage powerline located just south of the wells. The objectives of the Powerline wells were to determine the depth to water, complete 2 water table wells and a deeper Santa Fe Group well, to determine the geologic provenance of Santa Fe Group sediments at this location, and to obtain background core samples for radiological analysis.

PL-1 is a 2-inch diameter Schedule 80 PVC observation well completed at the water table. The borehole was drilled to 750 ft and plugged back to 485 ft. PL-2 was drilled to 629 ft and is a 5-inch stainless steel monitoring/aquifer test well completed approximately 130 ft below the top of the saturated zone. PL-3 is a 4-inch Schedule 80 PVC monitoring/aquifer test well completed at the water table, and intended primarily to be used in conjunction with the other water table well, PL-1, located 40 ft east. The static water level at the Powerline location is about 448 ft below ground surface, or approximately 4885 feet above sea level.

During these field operations, important subsurface hydrogeologic data were obtained. These data include drill cuttings and lithologic descriptions, core samples with background analytical data, geophysical logs, water quality parameters, and water levels. Preliminary evaluation of the lithologic and geophysical logs indicate that poorly sorted, coarse grained lithofacies present from 220 ft to at least 750 ft below ground surface are fluvial in origin and were deposited by the ancestral Rio Grande. These fluvial deposits are overlain by a massive homogenous clayey silt of eolian and/or distal alluvial fan origin.

Aquifer tests at the Powerline location will generate data that may yield information on anisotropy in the Santa Fe Group and constrain numerical modeling results that indicate that there is a major northward component of groundwater flow from McCormick Ranch and Tech Area III test sites toward City of Albuquerque and KAFB well fields. Results from these tests may be presented in the Site-Wide Hydrogeologic Characterization Project 1995 Annual Report.

2.0 INTRODUCTION

The Environmental Restoration (ER) Project at Sandia National Laboratories, New Mexico (SNL/NM), is managing the project to assess and remediate sites on Kirtland Air Force Base (KAFB) that were potentially contaminated by SNL/NM operations. Within the ER Project, the Site-Wide Hydrogeologic Characterization (SWHC) task is responsible for the area-wide hydrogeologic investigation. The purpose of this project is to reduce uncertainty about the rate and direction of groundwater flow beneath KAFB and across its boundaries. The Powerline drilling project is part of the SWHC task.

2.1 Background

Three wells were drilled and completed at the Powerline location, located approximately 0.5 mile north and slightly west of the northwest corner of Tech Area III (Figure 1). This location is approximately 100 yards north of a high-voltage powerline that runs east-west. The nearest subsurface data point is monitoring well NWT-A-3, located about 0.8 mile southeast of the Powerline location. Test sites near the Powerline wells include SNL's Long Sled Track, McCormick Ranch, the Chemical Waste Landfill (CWL), the Mixed Waste Landfill (MWL), and the Liquid Waste Disposal Site (LWDS). Groundwater modeling based on wells at these test sites indicates that flow is northward toward KAFB and City of Albuquerque well fields.

2.2 Objective

This location was chosen because of the lack of wells and aquifer test data in this area, to determine whether ancestral Rio Grande deposits are present at this location, and to provide data in support of modeling results that indicate that groundwater flows northward at this location. The objectives of the Powerline wells were to determine the depth to water, complete two water table wells and a deeper Santa Fe Group well, to determine the geologic provenance of Santa Fe Group sediments at this location, and to obtain background core samples for radiological analysis.

3.0 GEOLOGIC SETTING

This section provides background information on surface geologic features, geologic structure, and subsurface geology including the stratigraphy of the upper Santa Fe Group. Detailed information on geologic findings from the Powerline wells is presented in Section 5.

3.1 Surface Geology

The Powerline wells are located in the Llano de Manzano geomorphic province (see Figure 2). This province is a moderately dissected piedmont, containing coalescent alluvial fans derived from tributaries draining the western escarpment of the Sandia Mountains. Surficial deposits in this subprovince contain primarily granitic lithologies from the Sandia Mountains. The

Figure 1. Location Map of Powerline Wells PL-1, PL-2, and PL-3

Figure 2. Geomorphic Provinces in the SNL/KAFB Area

province is divided into the Tijeras Arroyo and El Dorado subprovinces, which are differentiated based on principal drainage basins. The Tijeras Arroyo subprovince includes the Powerline wells and the area of the present-day arroyo, as well as Pleistocene alluvial fans derived from Tijeras Canyon. Surficial deposits derived from the Tijeras Canyon drainage contain granitic and sedimentary lithologies from the Sandia Mountains and sedimentary and metamorphic lithologies from the Manzanita Mountains (SNL/NM, 1995).

Fluvial sediments deposited by the ancestral Rio Grande flowing into the basin from the north typically are texturally and mineralogically more mature than fan materials. However, it can be difficult, if not impossible to distinguish these sediments from those deposited by sheet flows on the distal portions of fans. A crucial indicator of Rio Grande lithofacies is the occurrence of clasts of volcanic material, especially pumice. The Manzanita Mountains to the east of SNL/KAFB contain no volcanics, and the presence of volcanics is diagnostic of ancestral Rio Grande fluvial transport from volcanic source terrain to the north. However, the absence of volcanics is not necessarily a negation of Rio Grande origin (SNL/NM, 1995). Geologic findings at the Powerline wells are discussed in Section 5.

3.2 Stratigraphy

The upper Santa Fe Group (Hawley and Haase, 1992) was deposited from approximately 5 to 1 million years ago. About 5 million years ago, a through-flowing ancestral Rio Grande system developed (Lozinsky, et al., 1991), forming a large aggradational plain in the central basin area. It is characterized by intertonguing piedmont-slope deposits derived from the mountains to the east, and cross-stratified ancestral river deposits (thick clean sand and pebble gravel). Fine- to medium-grained overbank sediments were deposited in areas where major river systems merged, and in basin-floor and piedmont-slope transition zones (SNL/NM, 1995).

The region west of the Sandia/Tijeras fault complex is a smooth piedmont alluvial surface sloping gently to the west. The northern part is characterized by the entrenched valleys of Tijeras Arroyo and Arroyo del Coyote. The region is characterized by a thick basin-fill sequence of Santa Fe Group clastic sediments. The basin-fill sequence is generally unconsolidated, but tends to become consolidated with depth. Texturally, the strata range from very coarse cobbly gravels to clays. Genetically, they consist of: (1) alluvial fans with their characteristic proximal, medial, and distal sediments delivered to the subsiding basin from uplifted, eroding upland source areas to the east; and (2) fluvial sediments delivered to the axial part of the basin in Plio-Pleistocene time by the ancestral Rio Grande flowing through the basin from north to south (SNL/NM, 1995). The Powerline site is located at the eastern margin of ancestral Rio Grande sediments and the distal(western) margin of alluvial fan sediments. This results in intertonguing of ancestral Rio Grande and alluvial fan deposits, discussed in detail in Section 5.

3.3 Structure

The Powerline wells are located between the West Sandia Fault and the playa basin north of McCormick Ranch. It is an area of very little surface relief with the exception of Tijeras Arroyo, located about 1/2 mile north.

SNL/KAFB is located in a structurally complex area. A number of major regional faults intersect within the area resulting in a diverse pattern of fault trends and displacements. Because of these faults, the SNL/KAFB region can be subdivided into three regions: (1) an eastern area of bedrock outcrops, representing uplifted terrain that exhibits fault displacements and fracture lineaments (Hydrogeologic Region 1); (2) a middle area dominated by north-south trending, west-dipping normal faults interconnected in some cases by subdued graben features characterized by relatively shallow depth to bedrock (Hydrogeologic Region 2); and (3) a western area dominated by thick alluvial fill and evidence of additional north-south trending, west-dipping faults that have produced a series of down-to-the-west bedrock steps (Hydrogeologic Region 3) (SNL/NM, 1995). The Powerline wells are located in Hydrogeologic Region 3 (see Figure 3). Based on the driller's log from the deepest well in Tech Area III, (KAFB-10, 1041 ft deep) depth to bedrock is at least 1000 feet, and possibly several thousand feet.

4.0 BOREHOLE/WELL CONSTRUCTION INFORMATION

Drilling operations at the Powerline site were conducted by United States Geological Survey (USGS) personnel and supervised by SNL/NM personnel. Drilling techniques included air rotary, mud rotary, and mud rotary coring. The following sections summarize the drilling, well installation, and well development operations carried out at the Powerline site.

A summary of drilling chronology for well PL-1, PL-2, and PL-3 is shown in Figure 4. All drilling, well completion and well development were performed by USGS personnel and equipment. Typically, drilling operations were conducted in 10-day work cycles.

Three wells were drilled at this site and named PL-1, PL-2, and PL-3. These wells are 20 ft apart in an east-west line with PL-1 on the east and PL-3 on the west. PL-1 is a 2-inch diameter PVC water table piezometer designed for use as an observation well. PL-2 is a 5-inch diameter stainless steel well completed about 130 ft below the water table for use as a deep monitoring and aquifer test well. PL-3 is a 4-inch diameter PVC well screened across the water table for use as a monitoring and aquifer test well. Well completion relationships are shown in Figure 5.

Figure 4. Summary of Drilling Chronology for Wells PL-1, PL-2, and PL-3

Figure 5. Well Completion Schematic for Wells PL-1, PL-2, and PL-3

4.1 Drilling Operations

Drilling began at the Powerline location on October 15, 1994 and was completed on December 6, 1994. PL-1 is a 6 1/4-inch borehole that was drilled to a total depth of 750 ft. PL-1 was the pilot hole at this drill site and was drilled to evaluate the entire stratigraphic section from ground surface to 750 ft. Lithologic cuttings samples were collected and described at 10-ft intervals. In addition to the lithologic samples, seven 10-ft cores were taken at 100-ft intervals, beginning at 100 to 110 ft below surface. These core samples were taken to provide in-situ background geochemical data to assist the ER assessment of the MWL, and also the SNL Groundwater Protection Project. Core samples were analyzed for the following:

- Target Analyte List (TAL) metals
- Tritium
- Isotopic U, Th, Pu, Sr90
- Total alpha counts, total beta counts
- Gamma spectroscopy

Analytical results will provide radiological background concentration data that will be useful to future environmental investigations at any site on KAFB. Background geochemical data, and especially subsurface isotopic data from non-ER sites at SNL/KAFB are quite sparse, and will be used as a baseline to compare to samples from contaminated sites.

PL-2 was drilled with a 9 7/8-inch bit to a total depth of 629 ft. PL-3 was drilled with a 7 7/8-inch bit to a total depth of 480 ft. No core samples were taken from PL-2 or PL-3, but cuttings samples were collected at 10-ft intervals, lightly rinsed, and saved in chip boxes.

4.2 Well Completion

PL-1 is a 2-inch diameter Schedule 80 PVC observation well completed at the water table. The borehole was drilled to 750 ft and plugged back to 485 ft with a bentonite slurry (Volclay). The completion interval consists of 30 ft of 0.010-inch slotted PVC from 440 to 470 ft, surrounded by a 10-20 silica sand pack from 416 to 485 ft. A bentonite pellet seal separates the sand pack from the grout column. A 10-ft PVC sump was placed below the well screen.

PL-2 is a 5-inch stainless steel monitoring/aquifer test well completed approximately 130 ft below the top of the saturated zone. A 0.020-inch stainless steel screen was placed from 577 to 597 ft, surrounded by a 10-20 silica sand pack from 561 to 629 ft. The seal consists of 100 pounds of 1/4 inch bentonite pellets placed between layers of fine 16/40 sand on top of the sand pack and below the grout column. Since this well will be vigorously pumped, extra precautions were taken to ensure that a strong seal separates the grout column from the sand pack.

PL-3 is a 4-inch Schedule 80 PVC monitoring/aquifer test well completed at the water table, and intended primarily to be used in conjunction with the other water table well, PL-1, located 40 ft east. PL-3 has a 0.020-inch slotted PVC screen from 445 to 465 ft, with a 10-ft sump below the screen. The sand pack extends from 419 to 480 ft and is composed of 10-20 silica sand. A 10-ft thick bentonite pellet seal and 7 ft of additional 10-20 sand separates the grout column from the well screen.

4.3 Well Development

Well development was performed on each well after the grout was allowed to set for a minimum of 24 hours. Each well was developed using the air-lift method with an occasional water surge to help clean the screen. PL-1 developed poorly due to a low recharge rate and the presence of a small amount of grout in the screen. The grout probably leaked into the sand pack from the grout plug below the screen. The well was initially developed for three days, then re-developed four weeks later. After the second effort, the well water was turbid but much clearer, water production increased to about 1 gpm, and the water level appears to be representative of the formation.

PL-2 was developed on November 19, 1994. At the completion of well development, PL-2 was producing >100 gpm. The static water level is 449.2 ft below ground surface, and final water quality parameters were as follows:

Temperature - 18.9 degrees Celsius
Specific Conductivity - 421 microSiemens
pH - 8.2
Turbidity - 5.9 NTU

PL-3 was completed 5 ft deeper than PL-1. PL-3 was developed for 1 1/2 days using the air-lift and water surge method. This well produces less than 1 gpm, which is not enough to allow proper well development. Well water remained too cloudy to take turbidity readings or other water quality parameters. Well development on PL-1 and PL-3 will continue at a later date using a bailer.

5.0 BOREHOLE GEOLOGY

The geologic objectives of the Powerline wells were to characterize lithology and to determine whether the depositional provenance is ancestral Rio Grande or alluvium derived from the Sandia/Manzanita Mountains.

Cuttings samples were collected at 10-ft intervals from all three Powerline wells. Cuttings were lightly rinsed, bagged in cotton sample bags, and saved in 20-compartment chip boxes. Approximately 70 feet of core from PL-1 was also saved in core boxes. Core was taken in the intervals 100-110, 200-210, 300-310, 400-410, 500-510, 600-610, and 700-710 ft. The core was used for background geochemical and radiological analysis, and lithologic description. The

lithologic log for PL-1 is shown in Figure 6. Lithology from the surface to 220 ft is dominated by massive clayey silt with minor amounts of fine sand. Color ranges from light brown, yellowish and reddish brown to pink. Coarser lithologies are rare except for a 2-ft gravel bed at 138-140 ft and a few minor silty sand stringers.

At 220 ft there is an abrupt change to coarse, well graded (equivalent to poorly sorted) sand and gravel. These clean coarse sands and gravels persist to at least 750 ft, with very little interbedded silt. The only silt/clay layers between 220-750 ft are as follows:

260-280 ft

330-370 ft

420-430 ft

540-550 ft

The clayey silt unit from the surface to 220 ft is thought to be a distal alluvial fan deposit or eolian, or both, due to its fine homogeneous texture. There is no evidence of volcanic material. The coarse sediments below 220 ft are thought to be fluvial in origin, deposited by the ancestral Rio Grande (VanHart, 1995). Evidence for fluvial deposition includes the high degree of rounding and the abundance of interbedded coarse sand, gravel, and cobbles. Black sand and gravel is common, as well as thin white clay layers. Black pebbles may be basaltic and the white clays may be ash deposits, indicating a volcanic origin. Thin-section optical mineralogy will be used to determine the composition of these deposits.

6.0 BOREHOLE HYDROLOGY

The upper completion wells, PL-1 and PL-3, are screened across the water table in well-graded sand with 10% to 30% gravel and minor silt. PL-2 is completed in a deeper well-graded, silt-free sand unit. There does not appear to be a low-permeability zone separating PL-3 from the upper completions. The deepest well, PL-2 has 140 ft of head in the center of the well screen and was producing >100 gpm at the completion of well development. PL-1 and PL-3 have about 15 ft of head at the bottom of the screen and both these wells produce less than 1 gpm. Aquifer tests will be conducted on all three wells in 1995. Important depths and elevations are summarized in Table 1.

WELL NAME: PL-1		PAGE 1 of 1
LOCATION: POWERLINE ROAD	TOTAL DEPTH: 750 ft	
PROJECT: SWHC	CASING DEPTH: 480 ft	GROUND ELEVATION: 5330.304
DRILLING METHOD: MUD ROTARY	HOLE DIAMETERS: 6 1/4"	TOP OF CASING: 5332.316
DRILLING CONTRACTOR: USGS	REMARKS: 2" PIEZOMETER	
DATE DRILLED: 10-1-94	LOGGED BY: WALT FOUTZ	
DATE COMPLETED: 10-26-94	REVIEWED BY: JOHN McCORD	

	WELL CONSTRUCTION	LITHOLOGY	LITHOLOGIC DESCRIPTION AND REMARKS
0			CL Sandy to silty clay, dark yellowish brown (10YR 5/4) unconsolidated, very soft, medium to coarse grained sand.
50
100
150			CL Silty clay, moderate brown, 5 YR 4/4
200			ML Gravelly and sandy silt, pale yellowish brown, (10YR 6/2), angular sand and gravel.
250			CL Sandy clay, mostly moderate yellowish brown (10YR 5/4), w/coarse grained sand, angular.
300			GP Sandy gravel, well rounded to subrounded black and red granite wash
350			GC Clayey to sandy gravel, grayish orange to yellowish gray (5 YR 7/2), varying amounts of silt and clay matrix, stiff to soft texture varies w/clay content.
400			GP Sandy gravel, moderate yellowish brown (10YR 5/4), minor soft clay, gravel and coarse grained sand, subrounded to subangular.
450			SW Sand, fine to very coarse grained, graded, well graded, 20% gravel, minor silt.
500			GP Sandy gravel, very coarse sand to fine gravel, mod well sorted, no fines, 80% > coarse sand, clean.
550			SW Gravelly sand, fine to very coarse grained, well graded, clean, 20-60% gravel, little or no fines.
600			GM Sandy and silty gravel, moderately well graded, well cemented to unconsolidated, minor clay.
650			SW Sand, yellowish brown (10YR 5/4), very fine to very coarse grained, with minor clay. Some clay is light gray to white, possible ash(?). Minor gravel.
700			SP Silty and gravelly sand, very fine to very coarse sand 20% gravel w/minor clay but enough to coagulate sand
750			SP Sand, fine to medium grained, poorly graded, mostly unconsolidated. Almost no silt in core @700-710'. SM Silty sand, f-v fine grained, white clay ash(?)

Figure 6. Lithologic Log of PL-1

Table 1. Significant Depths and Elevations at the Powerline Wells

Well Name	Depth to Water ¹	Water Level Elevation ²	Top of Casing Elevation ²	Casing Depth ³	Borehole Depth ³
PL-1	447.00	4885.32	5332.32	480	750
PL-2	452.22	4881.12	5333.34	617	629
PL-3	453.40	4878.57	5331.97	475	480

¹ feet below top of casing

² feet above mean sea level

³ feet below ground surface

7.0 BOREHOLE GEOPHYSICS

The open borehole at PL-1 was logged on October 26, 1994 by USGS equipment and personnel. The log suite included long-short normal resistivity, dual density, natural gamma, neutron, and caliper logs. The logs were referenced to ground level and the hole depth was measured by logging equipment to be 752.7 ft. Geophysical logs and lithologic interpretations are attached in Appendix D. The same geophysical logs were run on PL-1 and PL-2.

Logging proceeded without problems and the log quality is excellent. The old logging probes were run in addition to the new probes in order to document the sensitivity difference, allowing correlation of old and new logs. All the wells at SNL/KAFB that were logged with USGS logging tools prior to 1994 used the old probes. The difference should be a linear offset, making log correlation relatively easy, if the difference is known (Appendix D). Results of the old and new tool correlation are available from USGS.

The logs indicate that the formation is basically composed of three distinctly different depositional series. There are sub-series within each of the three units. These depositional units are (Appendix D):

- 0-40 ft Top soil, mostly silt and sand with a layer of gravel at 14 and 20 ft. The gravel layers are only about 18-in thick.
- 40-280 ft This section is mostly sandy, silty clay. The sub-units include a section from 40 to 140 ft where the matrix gradually becomes finer grained, bottoming with a thick sand and gravel layer. Below the sand and gravel section the unit becomes very clayey. The clay unit is broken up by a very significant layer of sand and gravel from about 223 to 250 ft. This gravel section contains some cobble-size rocks and is a likely representative of the ancestral Rio Grande channel. Another less significant sand and gravel section exists at 260 to 268 ft.

280-750 ft This unit is primarily sand with sub-series sections of silty sand, sand and gravel, various amounts of clay in some sections and a wide variety of sand grain sizes. The logs indicate very high moisture content, hinting perched conditions near 340 ft and 358 ft. However, the fine grained material usually associated with an aquiclude is not present. There is a conglomerate-like section that is poorly cemented just below 510 ft, and the matrix is very clayey to 550 ft. The static water level appears to be 448 ft, where there is a shift to lower resistivity due to water saturation. There are several minor gravel beds in the unit below the water level.

The most notable feature of the logs is the excellent neutron response to water saturation that occurs at 448 ft. A sandy gravel at 138-140 ft produced a high resistivity spike on the geophysical logs that was identified as caliche. This caliche zone is correlative on geophysical logs from McCormick Ranch to KAFB-0215, located near the east runway (VanHart, 1995).

8.0 SUMMARY

The wells at the Powerline location are positioned to provide a subsurface data collection point in an area that previously had none. Geologic data consist of a detailed lithologic log, approximately 200 cuttings samples representing 10-ft intervals from the surface to 750 ft, nearly 70 ft of core, and two geophysical log suites. Preliminary evaluation of the lithologic and geophysical logs indicate that poorly sorted, coarse grained lithofacies are present from 220 ft to at least 750 ft below ground surface. These deposits are fluvial in origin and were deposited by the ancestral Rio Grande. The coarse fluvial deposits are overlain by a massive homogenous clayey silt of eolian and/or distal alluvial fan origin. There is a caliche zone at 138-140 ft that represents a long period of surface exposure.

Core samples were analyzed for metals, total alpha/beta, gamma spectrometry, and isotopic plutonium, thorium, uranium, strontium, and tritium. Background geochemical data obtained from the PL-1 core will provide a radiological baseline that will be useful to the Mixed Waste Landfill RCRA Facility Investigation (RFI), and the Site-Wide Groundwater Protection Program which is tasked with groundwater surveillance at non-ER sites. This knowledge can also be used to update risk assessments for other Tech Area III ER sites. This analytical data will be incorporated into the background study as a baseline for the Mixed Waste Landfill, and is available in project files.

Three test/monitoring wells were completed and developed. Two PVC wells, PL-1 and PL-3, were completed across the water table at 448 feet below the surface. PL-2 is a 5-inch stainless steel well completed deeper in the Santa Fe Group, screened at 577-597 feet. These wells will be used for water quality sampling and aquifer tests that will be conducted in 1995.

Hydrogeologic data to be obtained from aquifer tests will be used to constrain numerical models of groundwater flow from Tech Area III toward KAFB and City of Albuquerque well fields. Results of sampling and aquifer testing will be presented in the 1995 SWHC Annual Report.

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APPENDIX A
SNL/NM WELL DATABASE SUMMARIES

SNL/NM WELL DATA SHEET

Project Name:	SWHC	Geo Location:	KAFB WEST BOUNDARY
ER ADS #:	1330	Well Completion Date:	28-OCT-94
Well Name:	PL-1	Completion Zone:	SANDY GRAVEL
Owner Name:	SNL/NM	Formation of Completion:	SANTA FE GROUP
Date Drilling Started:	15-OCT-94	Well Comment:	PIEZOMETER
Drilling Contractor:	USGS		
Drilling Method:	MUD ROTARY		
Borehole Depth:	750		
Casing Depth:	480		

Survey Data

Survey Date: 22-DEC-94
 Surveyed By: GREINER, INC.

State Plane Coordinates

(X) Easting: 405991.551
 (Y) Northing: 145963.074

Surveyed Elevations (FAMSL)

Protective Casing:
 Top of Inner Well Casing: 5332.316
 Concrete Pad:
 Ground Surface: 5330.304

Calculated Depths and Elevations

Initial Water Elevation: 4885.32
 (FAMSL)
 Initial Depth To Water: 447
 (FBGS)

Completion Data Measured Depths (FBGS)

Casing Stickup:	1.9		
Interval	Start	Stop	
GROUT/BACKFILL	0'	399'	
PURE GOLD VOLCLAY			
Interval	Start	Stop	
CASING	0'	480'	
SCH 80 PVC		O.D. 2"	
Interval	Start	Stop	
BOREHOLE	0'	750'	
		O.D. 6.25"	
Interval	Start	Stop	
SEAL	399'	416'	
1/4" BENTONITE PELL.			
Interval	Start	Stop	
PRIMARY PACK	416'	485'	
10/20			
Interval	Start	Stop	
SCREEN	440'	470'	
SLOTTED PVC SCH 80			
Interval	Start	Stop	
SUMP	470'	480'	
Interval	Start	Stop	
PLUG BACK	485'	750'	

SNL/NM WELL DATA SHEET

Project Name:	SWHC	Geo Location:	KAFB WEST BOUNDARY
ER ADS #:	1330	Well Completion Date:	18-NOV-94
Well Name:	PL-2	Completion Zone:	COARSE SAND 500-600 FEET
Owner Name:	SNL/NM	Formation of Completion:	SANTA FE GROUP
Date Drilling Started:	01-NOV-94	Well Comment:	DEEP PUMPING WELL
Drilling Contractor:	USGS		
Drilling Method:	MUD ROTARY		
Borehole Depth:	629		
Casing Depth:	617		

Survey Data

Survey Date: 22-DEC-94
 Surveyed By: GREINER, INC.

State Plane Coordinates

(X) Easting: 405971.601
 (Y) Northing: 1459639.113

Surveyed Elevations (FAMSL)

Protective Casing:
 Top of Inner Well Casing: 5333.342
 Concrete Pad:
 Ground Surface: 5330.318

Calculated Depths and Elevations

Initial Water Elevation: 4881.122
 (FAMSL)
 Initial Depth To Water: 452.22
 (FBGS)

Completion Data Measured Depths (FBGS)

Casing Stickup:	3		
Interval	Start	Stop	
GROUT/BACKFILL	0'	549'	
VOLCLAY			
Interval	Start	Stop	
CASING	0'	617'	
304 STAINLESS STEEL	I.D 4.75"	O.D. 5.5"	
Interval	Start	Stop	
BOREHOLE	0'	629'	
		O.D. 10"	
Interval	Start	Stop	
SEAL	549.5'	561.5'	
16-40 SAND/BENT PELL			
Interval	Start	Stop	
PRIMARY PACK	561.5'	629'	
10/20			
Interval	Start	Stop	
SCREEN	577'	597'	
STAINLESS STEEL			
	Slot Size	.02"	
Interval	Start	Stop	
SUMP	597'	617'	
Interval	Start	Stop	
PLUG BACK	617'	629'	
10/20 SAND			

SNL/NM WELL DATA SHEET

Project Name:	SWHC	Geo Location:	KAFB WEST POWERLINE
ER ADS #:	1330	Well Completion Date:	04-DEC-94
Well Name:	PL-3	Completion Zone:	COARSE SAND
Owner Name:	SNL/NM	Formation of Completion:	SANTA FE GROUP
Date Drilling Started:	29-NOV-94	Well Comment:	4" WATER TABLE PUMPING WELL
Drilling Contractor:	USGS		
Drilling Method:	MUD ROTARY		
Borehole Depth:	480		
Casing Depth:	475		

Survey Data

Survey Date: 22-DEC-94
 Surveyed By: GREINER, INC.

State Plane Coordinates

(X) Easting: 405951.73
 (Y) Northing: 1459644.61

Surveyed Elevations (FAMSL)

Protective Casing:
 Top of Inner Well Casing: 5331.972
 Concrete Pad:
 Ground Surface: 5329.904

Calculated Depths and Elevations

Initial Water Elevation:
 (FAMSL)
 Initial Depth To Water:
 (FBGS)

Completion Data Measured Depths (FBGS)

Casing Stickup:

Interval	Start	Stop
GROUT/BACKFILL	0'	402'
VOLCLAY 10/20 SAND		

Interval	Start	Stop
CASING	0'	475'
SCH 80 PVC	I.D. 3.8" O.D. 4.5"	

Interval	Start	Stop
BOREHOLE	0'	480'
		O.D. 7.875"

Interval	Start	Stop
SEAL	409'	419'
1/4" BENTONITE PELL.		

Interval	Start	Stop
PRIMARY PACK	419'	480'
10/20		

Interval	Start	Stop
SCREEN	445'	465'
SCH 80 PVC		

Interval	Start	Stop
SUMP	465'	475'

Interval	Start	Stop
PLUG BACK	475'	480'
10/20 SAND		

APPENDIX B

SNL/NM GEOLOGIST LOGBOOK

10-15-94 Saturday
Cloudy, windy, cool
(Snow in Sandias & Matanzas)

0700 - Mob to lower
line #1 well location

0730-1300 Rig up, set surface
casing.

1300 Begin drilling
Cutting samples to be
taken every 10' below
30'. Note: Auger cores
to 28' were previously
obtained at this location

1430 Depth = 65'
Change screen on shale
shaker.

1500 Begin drilling at 65'.

1545 Depth = 100'. Begin
tripping out to put on
core barrel.

10-15-94

1615 - On bottom with core barrel. Begin coring 100' - 110'.

1640 - Coring completed. Begin tripping out.

1655 - Core to surface.

Samples taken from

100' - 102'

Core recovery = 9.65'

Core Lithology - silty clay, moderate brown (5 YR 4/4)

1710 Sampling completed

1720 Begin coring drilling

1800 Depth = 140'. Call it a cold day.

~~WNC~~

10-16-94 Sunday

Clouds, rain, cold

0800 - Arrive on location. Drillers mixing mud.

0820 - Begin Drilling

0845 - Depth = 150'

0915 - Depth = 160'

0930 - Leave site to pick up awning and other supplies from trailer at the TRS #1 drilling location

1000 Back with awning.

Depth = 190'

1030 Depth = 200'. Begin tripping out to put on core barrel

1045 Core barrel on. Begin tripping in.

10-16-94

1100 Begin coring 200'-210'.

1130 End coring. Begin tripping out.

1150 Core to surface

1200 Background concentration samples taken 200'-202'.

Core recovery = 10'

Core lithology - silty

sand sm

moderate yellowish brown

10 YR 6 1/2

1220 Back on bottom. Begin drilling.

1250 Depth = 220'

1330 Depth = 260'

1355 Depth = 280'

1420 Depth = 300'. Begin tripping out to put on core barrel.

10-16-94

1445 Core barrel attached. Begin tripping in.

1510 Core barrel on bottom. Begin coring.

1515 Begin coring 300'-310'

1530 Coring - ~~spine~~ completed. Begin tripping out.

1555 Core to surface

1610 Background concentration samples taken from 302'-304'.

Core recovery = 8.25'

Core lithology - Sand, well

graded, coarse to very

coarse grained, light

olive gray (5 Y 5/2).

Sand moist, possibly wet.

1630

1630 On bottom. Begin drilling.

10-16-94

1650 Depth = 320'

1715 Depth = 340'

1750 Depth = 360'

1820 Depth = 380'

1850 Depth = 400'

1900 - Leave Location

~~Mr. Long~~

10-17-94

Monday

Cloudy, breezy, cool

1130 - Arrive on location

1145 - Drillers arrive on location. Morning spent getting rig parts and drilling supplies.

1200 Begin rig maintenance

1330 Shut down for the day - Need to overhaul shale shaker.

1340 LV Location

~~Mr. Long~~

10-18-94 Tuesday PL-1

1200 - Joe & Deb arrive at site, Clear and coal.

Drillers not here. The trailer was delivered to PL-1 this morning -

Cleaned up and prepared for drilling.

1320 - Dan called - part wait to be in till 2 1430.

Went to 6540

1430 - At site - no driller

1515 - Driller arrive with shaker parts

1650 - Driller finishing work on shaker. No core well

So up today - 1600

10-19-94 Wed. well PL-1

0820 - Went on location. Driller gets equipment warmed up. Drill repairs on shake shaker. I was called. We

need to make decisions next week on:

- deep & shallow completion intervals

- whether to make 2" well deep or shallow.

1020 - back on bottom, circulate &

drill to 410 w/care barrel

1120 - Core barrel to surface - recovery 4.3' from 400-910.

Core description:

400-402.3 m - sandy to clayey silt,

tight, stiff, thin bedded,

light colors, cobbles (grs) at 400.

- 400.5 from 6m. of hole, gravel at 400.

400.5-410 - sm - sandy to clayey silt.

402.3-403.1 sm - sandy, well sorted

med. eg, med. sand, no silt or clay,

no gravel.

403.1-403.6 - large cobble

403.6-404.3 - sm - silty sand, fine,

well sorted, firm damp.

1132 - trapping in hole w/ 6 1/4" bit.

10-19-94 Wed. PL-1

1200 - Deb gone til next Tue. Finished taking background samples at 400-410'.

1520 - Kelly down at 500'.
1700 - still coming at 500'. Finished boxing core from PL-1 (3 boxes) that was taken over last Tuesday. When we had no boxes.

1710 - Start tripping core bbl. out of hole.
1800 - Lay down core 500-510'.
1865 recovery - lost 500-504.4
lost 508.45-510

1900 - finished logging car, sampling for bkgd samples, boxed up core. Tidy up location for

play's off
log out

W Foote

10-24-94 Monday PL-1

1500 - Walt on location. Drilling ahead at 500'.

1545 - connection at 540'.
1605 - Dan noticed ash layers a few inches thick in the zone 520-540.

One zone Dan thinks is nearly a ft thick is between 535-537'. We discussed core. Since ash layers

are generally so thin, we will hope to see some in 600-610 zone. Then sample core ash in next hole based on the logs from PL-1.

1700 - Dlg at 580'. Observed some pea-size volcanic clasts in 570-580' zone.

1735 - Kelly down at 1730. Won't make core run til tomorrow. 1st thing. Clean up, repair work, trip out of hole.

1800 - log out

1830 - off site (PGS-1)

W Foote

10-25-94 Tue PL-1

0815 Walk on location Driller
at warned up rig, start tripping
in hole w/ core barrel.
1015 - Core to surface w/ core 600-660'
Recovered 8.0 feet - lost bottom
part - Core 600-608! All SP sand -
well sorted - mg, vlg 600-601,
SS lense 600-602.4' SP sand
1110 - Finished boxing core & sampling.
Sample interval 606.8-608.1 -
went to labs for analysis.
Sample # SNL/NM 019452 (1-4)
1125 + back on bottom w/ roller bit,
drilling ahead.
1410 Drlg at 650' Jim Hudson
and D Byrnes on location
1423 Kelly down at 660'
1535 Dlg at ~~690~~ 690
1800 Coring out of hole w/ core barrel
1820 Core to surface - 800-710'
recovery 5.0' Went ss
1840 - Finish sampling background.
1900 - Log out

W. Early

Wed 10-26-94 PL-1

0830 - Walk on location
0836 - USGS logging truck on
location. Rig is tripping in hole at 710'.
0925 - Jim Hudson on location
0945 - Reaming 700-710.
1015 - called Grace Hagan re:
water levels & completion for NW7A-3:
sand pack 427-461
screen 435-460
WL el. 4892.81 ms1
top elev. 5333.81
DTW 441.00 (top)

1018 - Kelly down at 720'
1120 - total depth, 750'. Circ?
condition hole for logs
1140 - set Kelly back, start tripping
out for logs. Lots of folks on
location for logs: J. Hudson, R.K. DeVries,
J. Basler
11730 - hoisted over logs w/ J. W. Gandy, J. Hudson
completion core PL-1 - 440-470'
60' samp.
1900 - Log out

Thur 10-27-94

PL-1

4000 - Waitt & Dels on location.
We will pump Volclay, plug hole
back from 750' - 450'.
Set the screen 440-470'
w/ 10' sump to 400'. Need hole
TD ~ 985'.

0.10-slot PVC

Thur 10-27-94 PL-1

1400 - D. H. H. & D. H. H. plugged back
hole from 750' - 450'. They are
gone for the day.

1600 - worked on well file verification
2 hrs.

1630 - Log out

Fri 10-28-94 PL-1

0835 - Waitt & Dels on location.
Inventory of well construction materials
on location.

2" sch 80 PVC - 23' 15" x 20' =
400' blank clay + 10' sump
Screen 40' x 2" sch 80 0.10' slot PVC
w/o rings

54 SXS 10' 20' Columbia silica sand (50#)
15 SXS Pure Solid bentonite grout
4x 50# 1/4" bentonite pellets (Cetco)

Tag grout plug @ - couldn't tell

1 Fri 10-20-94 P2-1

0940 - running to 6 ft. W. W. L.
drill out Volclay plug to
approx 485'.

1030 - Start tripping out of hole
to run casing.

1115 - Start running 2" PVC casing
in hole.

1200 - run 500' total casing
460' block, 30' screen, 10' sump.
cut off 18.12' feet = 481.88
feet pipe in hole. Stickup #2'.

50' casing depth = 480

Screen interval: 440 - 470

10' sump

1210 - start tripping intrinsic pipe

1250 - start tripping 10/20 sand
intrinsic pipe at.

1255 - sand needed to fill 485 - 420'.

485 - 420 7" hole: 29 ft³ x 5 ft x 2.5 ft

420 - 400: 26 ft sand / linear ft = 60 x 26 =

(2" casing in 7" hole) = 1560 lbs sand

= 315 ft

1430 - tag sand at 416' after

28 5X sand - probably

native backfill (sand packs)

brought sand up.

1500 - finished tripping 2 buckets -
100 # 1/4" bentonite pellets.

1515 - Tag bentonite at 399'. Jan
said sand may have come a little
shorter we tagged it at 416.

1600 - pumped 1st batch of grout
to hydrate till 4:00

1615 - mix batch #2 - this one

should finish it off.

1700 - log out

W. F. G. G.

Sun 10-30-94 PL-1

0830 - Wait on location. On 10/28 already on train in the city to start well development. Start 5 min air on 5 min air off. Valley front was pumped to surface on Fri 10/28. Let set ± 36 hrs before well development. 1230 - Blowing well let recovery on 5-10-15 min intervals. Clearing slowly, water is still very muddy. Turbidity not measurable yet. 1500 - water clearing up with air off to let well fully recover. Calibrate YSF - standard 4 10 7 1000 pH - cord. 1068 1512 - YSF - OK 1620 - Let well recover 1 hr, then blow on it again. Poor recovery 1625 Will add water, then surge some more

1630 - Filled casing, now surging well to bottom still. 1 well cake, clean well screen slots (0.010)

1730 - turn off air after evacuating well.

1735 - off location

1800 - Log out

Fort

Mon 10-31-94 PL-1 Halliwell

0700- Well: Del at PL-1

0730- Well and Del on location

Del measured water level -

415.5' Started blowing,

unloaded fairly clean water

then drilling mud, then cleaner.

Well is making better more

water than yesterday, but still

too muddy to measure water

quality parameters.

0945- We've been using about a

15 min air on 15 min off cycle -

well is recharging better every

time. Dan thinks that the

whole screened interval isn't pay yet,

but should hopefully improve

through the day. Talked to

J.M. Cord about well placement

for PL-2 and PL-3. The easiest

configuration for the drillers is

is an E-W line, 20 ft apart.

J.M.C. concurred!

PL-3 PL-2 PL-1

W.

Mon 10-31-94 PL-1

1000-

1200- left well 51 ft 1 hr measured

DTW - 448.5 ft bgl. -

probably very close to static w.

Dan says well takes probably about

12 hr to recharge. We will

add some water now, giving

up 15 hrs or so to make sure

added water is evacuated from well

1540- We have been alternating between

blowing well dry and letting well

recover receiver, occasionally

adding water through hose (twice)

At 1500, Dan turned air on, no

returns. After about 30 mins

he pumped water through tremie,

pipe. Grout came up the

hole, gradually thickening, then

gradually thinning.

1600- We added more water after letting

well recover about 10 minutes. Started

blowing again, thin grout colored

water, then gets thicker

1605- Added water again, blew it out.

Water gets thicker is grout colored, then

thins.

1620- stop air, break open ventric
pipe to measure recovery w/
WL indication

1625	- WL - 450
1627	- WL - 449
1637	- 453.7 - 5.5 = 448.2
1648	- 453.5 - 5.5 = 448
1650	453.3 - 5.5 = 447.8
1650	453.0 - 5.5 = 447.5
1705	452.8 - 5.5 = 447.3
1725	452.5 - 2447.0

1800- log out - back at PGS-1

W. G. Gault

Tue 11-1-94 PL-1

0630- leave PGS-1

measure

0650- measure DTW through
framic pipe - 445.0. Only
came up 2 ft. overite. We

will blow on the well again,
see what happens. Apparently the
grout column - the annulus is
not draining into the casing. We
have a grout leak some where, either
above or below the sand pack.

If we continue to produce thick
grout up the casing, I am proposed
to send framic pipe down annulus
and try to remove most of the
grout column, then reseat the
packed seal above the sand pack.

0825- We've been alternating flushing
well w/ water, then evacuating
by air lift to determine how the
well is acting. The flush water
definitely has some grout in it,
but it seems to get less every
time. We will continue to test
well recover 15 min, then evacuate

Tue 11-1-a4 PL-1

to see what comes up. We will do this for another hour or so, then maybe quit well development for now. We probably have a slow leak in the seal, and which may heal itself or improve if left alone. We also tried to find the great level in the annulus - could not see it with a mirror. Sanding tape was inaccurate due to sticking to backhoe wall, but great level seemed to be about 120'.

0846 - air off to let well recover
0900 - air on - blowing fair amount of water, mud, greenish volcanic colored but this water, and the best flow so far.

0905 - air off will let recovery 20 min, evacuate gas, then stop development by air lift. Will resume w/ water at a later date.

Tue 11-1-a4 PL-1

0925 - air on. Water muddy and slightly greenish gray, but as good as before. Great appeared yesterday. Water volume better than ever. Well seal has apparently healed itself, if that was the problem. Whatever the case, we will stop development, resume with a bailer at a later date.

0930 - pull tremie pipe out of casing.

1110 - rig is moved to next hole, PL-2 located 20' 6" W. of PL-1.

1120 - start dig surface to set casing for PL-2

1200 - Start dig PL-2

1440 - Dig ahead of 100' 50'

1442 - ~~But measurement PL-2 = 4~~
WL measurement PL-1: 449.2' (6th casing stickup 1.9')

PL-1 W.L. (PM) = 447.3' Lg1

1510 - Kelly down at 80'

1705 - Dig ahead at 120'

1715 - done for the day at 120'

1745 - back to PG5-1

Logout -

W. Fawcett

Wed 11-2-94 PL-2

0715 - 1v. PGS-1

0745 - on location Drillers mixing mud.

0820 - measure DTW in PL-1. Fluid

level is 446.0', but there is

very little water: mostly very

wet grout. We still have a

problem in the annulus that

may have to be repaired.

Grout is coming in from above or

below the screen. If the seal

above the screen was leaking,

the fluid level in the casing should

rise until it reaches equilibrium

with the grout level in the

Casing. This is not happening,

indicating that the sand pack

may have sunk into the U-tube

plug below the screen.

0840 - Drtg at 160'

1135 - Drtg at 200'

1215 - Drilled to 220'. Trip out of

hole, end of cycle til Wed 11/9.

1300 - off base

W. Foutz

Thurs Wed 11-10-94

PL-2

1100 - Wait on location

1130 - Drillers arrive - Crew

this cycle is Steve Grant, Todd Hester,

Todd will be driller.

1250 - measure DTW in PL-1 - 437.9'

end of sounding tape was water-wet,

very slight evidence of grout.

1410 - T.D. for day at 260'

Mixing mud for tomorrow,

(need new roll-off bin for

used mud.

1800 - Log out.

Bldg 760

844-9530

- Laser range in Tijeras Arroyo

W. Foutz

Fri 11-11-94 PL-2

0700 - Meet Debie at PG8-1

0730 - on location. Driller tripping in hole.

1620 - leave location, T.D. to day at 340' 400'

1700 - log out

CP. Four

Sat 11-12-94 PL-2

0700 - Meet Debie at PG8-1

0730 - on location. No drillers

0830 - Drillers here. It has been raining all night and the roads and location are in bad shape. Drillers got service truck stuck on location. pulled free w/bruce.

1005 - Drillers tripping in hole after making more mud.

1100 - on bottom, started purging mud, drill pipe is plugged. Pull wet string of drill pipe to outside sand in pipe.

1105 - Weather getting worse again - windy, cold, raining.

1130 - drill pipe plugged with sand again. tripping out of hole.

1230 - Discussed possibilities w/ Steve's odd. If we continue drilling, will probably use all of remaining mud for another 20-40'. Will stop today.

T.D. 400'

CP. Four

1300 - log out

Sun 11-13-94 PL-2

0900 - on location. Washing to bottom.

1130 - on bottom, dig at 400'.

1330 - broke mud pump - motors off location for parts & repairs.

Hole depth 440'.

1600 - trapping end of hole to repair pump that is plugged with junk. T.D. for day at 440' 440

1630 - bit to surface. Steve and

Todd are working on pump.

1730 - log out

W. Point

Mon 11-14-94 PL-2

0800 - meet at PGS-

0830 - on location. Drillers are

working on mud pump.

0900 - W.P. - PL-1 - 444.2

Todd is trapping drill pipe in hole. Steve is off location.

running for parts.

1100 - ~~repaired~~ at 440'

KUMSGC - 846 - 7706

~~846 - 147~~

846 - 1478

1530 Mike Hall and

from SNL came and told us

we are in the line of fire

of their laser testing in Tjones

Arroyo. They will call us

every time we need to take cover.

We will also turn off all exhaust

sources (motors), which are what

the laser aims at.

1645 - laser off - back to work

will drain pumps, tip out of hole.

1830 - log out. T.D. 420'

W. Point

Tues 11-15-94 PL-2

0700 Meet @ Pgs-1

0730 On location. Driller

changed bit.

0800 Driller's tripping in hole.

Drilled to 500'.

0945 working on mud system -

thawing frozen pipes on

mud hopper

1005 Drilling at 500'. Laser

test will start 10:15-10:20

They will notify us when

test is over. We have gas laser

goggles for all 4 people on

location.

1015 notified R.K. Dewees that

we will need to log PL-2

tomorrow. Will call him

back this PM.

1145 Laser range hot

1230 Connection at 500'. Alexed

R.K. Dewees that we may want

to log hole tonight.

1425-connection at 580'.

1700- R.D. at 629' - core is available

for logs.

Tue 11-15-94 PL-2

1700- Loggers on location -

R.K. Dewees, Fred Getchallit

- start tripping out of hole

1800- bit to surface

1845- logging tools to bottom -

(Nash and doblers off site

1955 Gamma-Neutron Finished

running.

2045 Density finished. Going to run

3-arm caliper.

2200 Caliper completed.

2230 Log out.

D. Byrnes

Wed 11-16-94

PL-2

0900 on location. Drifters cleaning out hole. T.D. at 621' - will run casing so that screen is at 580' - 600' with sump below.

1025 - connection at 620' - washing and reaming to bottom. Caliper log shows tight hole 584-70. Todd said that is probably because we drilled it fast to get logs down.

1130 - on bottom 629' ~~blasts~~ Circ and circulation hole for completion.

1105 - Casing on location:
304 SS - 5' ID, 5 5/8" OD
30 jts x 20' blank = 600'
10 1/2 jts .020 ss screen = 20'
total casing 620'

1225 start out of hole to lay down pipe & run casing.

1400 - got new roll off delivered. Hoist play for SS casing doesn't fit casing. We are done for the day til tomorrow AM.
1500 - went to BDM. Log out WF 11/16/94

Thur 11-17-94

1230 - Wash on location. Drifters got here @ 10:30 to prime pumps and get ready to run casing when hoist play gets here.

1350 - still messing around waiting on hoist play.

1410 - hole has been cleaned and washed, ready to complete. Waiting on hoist play. Bailer volume: 23.4' x 0.25' ID = 8.6 gal.

1440 - hoist play is here - we'll start running casing.

1500 - run in 20' 304 SS sump, 20' .020 slot - SS screen.

1615 - Fred Hulse brought us 2 halogen light stands & ext. ends. Laser test folks called - testing is completed. I returned the laser goggles to them.

PL-2 Completion Schematic:

1630 - Total casing on location - 620'
when run, will leave 3' stick up
= casing T.O. 617' ~~screen 2~~
sum 617-597
screen 577-597

Sand calculation:

$$629 - 617 = 12 \text{ ft} \times 10'' = 6.5 \text{ ft}^3$$

$$617' - 560' = 57'$$

$$\text{casing vol} = 11 \text{ ft}^3$$

$$\text{hole vol} = 30 \text{ ft}^3$$

$$\text{annulus vol} = 19 \text{ ft}^3$$

$$\text{rat hole} = 6.5 \text{ ft}^3$$

$$\text{annulus} = 19 \text{ ft}^3$$

$$25.5 \text{ ft}^3 = 50 \text{ SK sand}$$

to bring sand to 560'

1730 - casing set at 617' - 64m ft
sum - John Mc (617) arrives on location

1745 - short run in - 7 remie pipe

Walt leaves location

1817 - 7 remie pipe on bottom

1825 - Begin Tremie in
sand pack

2030 - Sand pack placed.
Begin bailing to set
sand pack.

2250 - Sand pack set.
Depth to top 561.5'
Total bails = 25
(bailer volume ~ 8.6 gal)

set up to tremie in
2 sacks of 6-40 sand
to top of sand pack

2345 Begin to tremie in
2 bags 16-40 sand
3 buckets bentonite pellets
2 bags 16-40 sand

Friday Nov 18 1994
0100 End tremie Rig up
to circulate.

0115 Begin circulating
0120 End circulating

0145 - Top of bentonite
sand plug @ 549.5

0150 - Rig up to pump grout

W

Friday Nov 18, 1994

0000 In process of setting
bentonite plug

0145 Plug set,
included - 2 bags 16-40
sand

- 3 bucket of bentonite
pellets

- 2 bags of 16-40
sand

Top of plug @ 549.5 ft.

0150 Rig up to pump grant

0300 Begin pumping grant

0310 Shut down pump, pull
4 joints of tremie line -
~~Rig up to pump~~ Mix grant

0400 Begin pumping second batch
of grant.

0410 Shut pump down, pull
4 joints of tremie line.

Mix grant

0450 - Begin pumping third
batch of grant.

0500 - Shut down pump.
Pull 2 joints of Tremie
line. Mix grant.

0545 - Begin pumping fourth
batch of grant.

0555 - Shut down pump.
Pull 4 joints of Tremie
line. Mix grant.

0630 Begin pumping # fifth
batch.

0640 - Shut down pump.
Pull 4 joints of Tremie pipe.
Mix grant.

0730 - Begin pumping sixth
batch.

0740 Stop pumping. Pull & joints of tremie pipe. Mix grout.

0810 Begin pumping seventh batch.

0815 Grout to surface stop pumping. Trip out remaining tremie pipe.

Rig down. Will begin development Saturday 11/19/41.

~~0830~~ McCord leaves location

~~Done~~

SATURDAY Nov 19, 1944

0700 - Drillers Arrive on location.

- Begin Bailing for well development
- Water level @ beginning ~ 100'
0900 - John McCord arrives on location.

Bailing in progress
20 bails

1 bail = 8 gal
 $4 \frac{3}{4}$ ' ID casing = 1.1 ft/gal
∴ 1 bail should = 8 ft.

1240 - Bailing completed.
Total of 50 bails run.
Attempted water-level -
Probe "muddied up" @ ~ 430'
No water level

Dan indicated that the water level was probably below 500'.

1255 Rig up to run tremie to air develop.

Begin running tremie line.

1350 Begin air-developmental Bottom of air-line @ 614'.

1405 Begin water parameter check

$T = 18^{\circ}\text{C}$

$\text{SPC} = 471$

$\text{pH} = 8.1$

Turb = 873

Estimate flow rate = 35 gpm

- Cleaning up fast

02-1415 $T = 18.2$
 $\text{SPC} = 450$
 $\text{pH} = 8.2$

Turb 254

1420 $T = 18.3$
 $\text{SPC} = 439$
 $\text{pH} = 8.1$

Turb 129

1430 $T = 18.7$
 $\text{SPC} = 428$
 $\text{pH} = 8.2$

Turb 60.4

Flow ~ 70 gpm

1445 $T = 18.7$
 $\text{SPC} = 420$
 $\text{pH} = 8.1$

Turb 45.2

1500 $T = 18.8$
 $\text{SPC} = 421$
 $\text{pH} = 8.1$

Turb = 37.2

1500 - Shut off compressor
to let well recover

1510 - Fire up compressor
Begin air development

1530 $T = 18.8$

$SPC = 41.6$

$PH = 8.2$

$Turb = 20.7$

Flow rate $\sim 100 +$
gpm

1545

$T = 19.0$

$SPC = 41.7$

$PH = 8.1$

$Turb = 10.4$

1600

$T = 18.8$

$SPC = 41.4$

$PH = 8.1$

$Turb = 5.52$

Measured flow rate
5 gal/4 sec

1610

$T = 18.9$

$SPC = 41.7$

$PH = 8.1$

$Turb = 6.8$

1615

$T = 18.9$

$SPC = 42.1$

$PH = 8.2$

$Turb = 5.9$

Development completed

Shut-down air compressor

1620 - Pull tremie

line and

shut-down for

Thanksgiving

~~Jan~~

Mon 11-29-94 PL-1

1100 - Drillers on location. Have rig to PL-1 and rig up to re-develop well.

1400 - Walt on location. Dan has blown well dry twice. Let recover 15 min, then flushed w/ water, blow dry. Let recover 25 min, blow dry, flush w/ water again.

1440 Recovery very slow but fluid is fairly thin - grout was thick at beginning, but not now. Well seems to be O.K. for a piecometer.

Will continue development today, then start drill PL-3 tomorrow. Will finish development of PL-1 w/ bailer.

1545 DTD in PL-2 452.22' (b-to-c)

1700 - PL-1 is cleaning up nicely. Air on 5 min / air off 10 - recharges pretty well.

1740 - Air off - thin, brown mud.
(745 - log out definite
1800 10' PGS-1 w/ fount

Tue 11-29-94

PL-2

0800 - Walton location. Water level in ~~PL-1~~ PL-1 = 449' bgl. Same as PL-2. Dan has been blowing on well - water is

grout-colored but thin. Well makes < 1 GPM, but will probably be adequate for a piecometer.

0900 - Stopped well development w/ rig. Will continue at a later date w/ bailer.

0905 Generator out at fuel this AM. USGS personnel taking 8 hr. rehab.

Art Clark, John Palmer, Steve Grant

On location: Brian _____, Dan.

1105 - tremie pipe tripped out moved rig to new location PL-3, 20' west of PL-2

1300 Drillers run for bits & mud supplies.

Tue 11-29-94 PL-3

1500 - Drillers back w/ 7 7/8" bit,
other stuff

1400 - Start air drilling PL-3

1550 - Start mud rotary below
surface casing

1730 T.O. for day @ 20'

drain down,
log out

W. Fournier

Wed 11-30-94 PL-3

0800 Walk on location
mixing mud, thawing hoses,
priming mud system

0900 - Art Clark & Steve Grant
arrive. Working on shake shaker.

1100 - cleaned up trailer, took
lights back to G540

1330 - Drillers (Don & Art) still
working on shaker.

1445 - still fixing shaker.

1710 - finished working on shaker putting
it back together now.

1800 - Log out

HL 62-1-94 PL-3

Still fine shaker.

1035 - Shaker ~~fixed~~, hole, reamed and washed to 40. - 1

1340-1341 ahead of 1300.

1345-	Water levels:
-------	---------------

DTW	clean
488.80	no grant

PL-1	450.60	1.8'	488.80
------	--------	------	--------

PL-7	452.44	3.0	449.44
------	--------	-----	--------

1997 - connection to 160'

water level in PL-1 was clear, sharp tone, different than before this last development effort.

1535 - connection @ 200

115	7	4	3	2	22
-----	---	---	---	---	----

lenses and pumps, or being
dominated in day light to spend
up things for tomorrow AM.

1700-1900

W. Fort

Fr 12-2-24 PL-3

0800 - getting rig put back together
(drained hoses etc.)

0825 - ready to drill. Lots of clay
in this hole - will have to ream
all the way back to bottom.

10/10 - Connection at 240' Drilling ahead

1035 - connection at 260'

1120 - Connection of 280

1210 - connection at 320

locally swivel leading - is being fixed.

1330	to	M
------	----	---

1400 - connection at 360°

1430	- connection	to	380!
------	--------------	----	------

1575	-	connection	+ 400
------	---	------------	-------

1605-connection at 420"

127 1030

10

200

Sect 12-3-94 PL-3

0730 - Deb. on site
 0940 - connection at 440'
 1130 - reached total depth of 480'.
 Circulate and condition hole
 to run casing...
 1245 Start tripping drill pipe
 out of hole.
 Casing on location
 20' x 25' 500 #4 sch. 80 blank cs. PVC
 10' x 2' = 20 #4 .020 slot sch. 80 PVC screen
 5L 80 PVC - 4.5" OD, 375 ID
 2-10' joints screen = 20'
 checked O-rings, condition of screen - O.K.
 1330 10' dump below screen w/ 4" inch
 Sch. 80 PVC slip cap screwed
 on w/ sheet metal screws (9 screws)
 3 pairs 1/4" bentonite pellets
 1 pallet 10/20 Colorado silica sand
 ran casing to 475'

Sect 12-3-94 PL-3

Well Completion:

screen 445-465 = 165
 Sand pack: 480-475 = 2.5 ft = 3.5X
 475-430 = 11.7 ft = 23.55X
 total sand (calc) = 27.5X

Sat 12-3-94 PL-3

1545 - tremie run into annulus. Pumping water through tremie to this mud for sand seal installation.

Tremie pipe is at 472

1555 - start shooting sand. Will

aim for top of sand at 425'

1620 - 2pc tremie annular tremie at 425'

13 SX in hole so far.

1650 - tremied in 27 SX. Will

circ & tag sand next. Def gone.

1710 - tag sand at 419. Will seal

well a little to endorse sand

pack

1730 - Bailer is lost in well - top

box broke. Will have to fish

out bailer

1800 - tremie plugging pellets. Bottom

of tremie at 409. 1 bucket

pellets brought seal up 10 feet.

1830 - finished tremieing pellets.

Will tag in AM

Log out -

W. Fort 2

Sun 12-4-94

0800 - Wait on location. Tremie

pipe is slightly plugged - could not tag ^{pellets} ~~grout~~. Will

circulate to clean out pipe.

0840 - Tagged top of pellet seal 409.5

0915 - Tremied in 2 SX 10/20 sand

above pellet seal. Top of sand

should be at 402. Will

purp grout now.

1230 - finish grout to surface.

1300 - pulled tremie pipe. Drifters

will mix another batch to

top at PL-2 and PL-1 today.

1330 - Wait at site - Log out

W. Fort

M. 12-594 PL-3

Dr. Alex of side (Don only)
getting equal to thick batter
0.5 + 0.5 + PL-3.

John Palmer and Brian Bretz
watched SNC safety videos!

$RAO \cdot WZ, E \cdot MG$

1000 fished better out of well.
on first try.

1100 running termie pipe in to
start well develop next. Termie
at 468' (in sump below screen)

1200 Evacuated well, ran 3
times - not making much
water. Added about gal.

we ~~for~~ to help flush screen.

1443 - Jet well recover 45 min,
then blow dry. Making a
little more water with
blow air on /air out alternating
every few minutes.

1640 - hourly making water < 1.5 gpm.
This well will have to improve

1800s - Lay out, -
dramatically to work as a pump.
Well.

Tue 12/6/94 PL-3

0730 WL = 453.4 (ground surface)

1200 Debbie on-site

Don on-site, Todd + Brian
are moving equipment to staging
area.

Dan said well not making much water and is very turbid.

1245
Aiv
on

1250 Air off to let well recover

1320 Air on - Not much recovery and very turbid.

1335 A-20ff.

1400	Atv on	Same
------	--------	------

1420 A₂ Δff

1445
AW
8
S

1455 Air off

1520 Air on - not much recovery - still too low

1535 Air off - Dan will wait 12 hrs to
let well recover.

1605 Air on - not much recovery, slightly better?
Parameters: $T = 15.30^\circ\text{C}$

Parameters: $T = 15.3^{\circ}\text{C}$

$$H_c = 8.0$$

345

Turbidity - still too turbid
getting error msg on
HACH.

1615 Aiv off.

APPENDIX C
USGS DRILLERS LOGBOOK

Drillers Log for Oct. 14th 1994

7:00 L.v. motel
7:15 arrv. Staging area get some fuel
7:40 arrv. Site
7:40 - 8:05 get equip. running measure water level in Well at 81.8'
8:05 - 8:12 Warm up Rig Compressor
8:12 - 8:53 air on - Clean Water
8:53 - 9:18 Shut down Compressor, trip out trimie
9:18 - 10:20 move rest of equip. back to Staging area + Start Washing. get equip. cleaned
+ partially loaded
10:20 - 11:20 Run to Rodgers + get a 20' pc 8" ~~sch~~ Sch. 40 pc for Surface Casing
11:20 Drillers L.v. Staging area
11:30 arrv. motel

Drillers Log for Oct. 15th 1994

7:00 Lu. motel
7:15 arrv. Staging area
7:15-12:00 fuel up equip. & finish loading at Staging area then mobilize to next Site.
get equip. Set up & mud mixed. Set 8" Surface Casing to 4'
12:00-13:00 run back to last Site (TRD-1) & raid trailer for some plastic liners
& line Cuttings tank with plastic
13:06-13:18 Start mud Rotary w/ 6 1/4" #3 roller - Rotary 4'-20' - Sandy Silt.
13:18-13:26 Ream, Circ., add pc.
13:26-13:35 Tighten Shaker Screens
13:35-14:02 Rotary 20'-40'
(20'-30') fine & coarse Sand, silt
(30'-40') Same
14:02-14:10 Ream, Circ., add pc.
14:10-14:34 Rotary 40'-60' Mud Visc. 50 Mud Wt. 8.9 lbs/gal.
(40'-50') coarse Sand & Silt
(50'-60') coarse Sand, Silt, gravel
14:34-14:41 Ream, Circ., add pc.
14:41-15:17 Rotary 60'-80'
14:50-15:03 Stop & change 1 ~~size~~ Shaker Screen to larger mesh
(60'-70') Silty coarse Sand
(70'-80') Same w/ some clay

15:03-15:25 Ream, Circ., add pc.
15:25-15:44 Rotary 80'-99' - Core pt.
(80'-90') Sandy Silty Clay w/ some gravel
(90'-99') Same
15:25-16:00 Ream, Circ., & trip out bit for core run
16:00-16:12 Trip Core barrel to 99'
16:12-16:40 Core 99'-109'
16:40-17:00 Trip out barrel, lay out Core, [10' run, recover 9.65' silt & clay]
17:00-17:16 Lay out Core barrel & Trip 6 1/4" bit to 99'
17:16-17:34 Ream 99'-109' Rotary 109'-120'
(110'-120') Sandy Silty Clay
17:34-17:41 Ream, Circ., add pc.
17:41-17:56 Rotary 120'-140' - Silty coarse Sand & gravel
17:56-18:08 Circ. & pull bit up to 60'
18:08-18:12 pick up tools
18:12 Drillers ho. Site
19:00 arrv. motel

used 16 bags mud today

Drillers Log for Oct. 16th 1994

7:00 Lv. motel
7:15 arrv. Staging area
7:52 arrv. Site
7:52-8:00 get equip. running
8:00-8:08 Trip 6 1/4" bit from 60' - 120'
8:08-8:29 mix mud - 5 bags
8:29-8:41 Circ. to bottom & add pc.
8:41-9:11 Rotary 140'-160' mud visc. 45 mud wt. 8.9 lbs/gal.
(140'-150') Silty Course Sand & gravel w/ some clay
(150'-160') Clay, Course Sand & gravel
9:11-9:20 Ream, Circ., add pc.
9:20-9:52 Rotary 160'-180'
(160'-170') Silty Course Sand & gravel
(170'-180') Silty Clay, gravel
9:52-10:05 Ream, Circ., add pc.
10:05-10:24 Rotary 180'-200'
(180'-190') Silty Course Sand & gravel
(190'-200') Same
10:24-10:38 Ream, Circ., & trip out bit for Core run
10:38-11:08 Trip in Core barrel & Circ. to bottom
11:08-11:31 Core 200'-210'
11:33-12:00 Trip out Barrel, lay out Core, [10' run - recover 9.9' Silty Sand]
12:00-12:20 Lay out Core barrel & Trip 6 1/4" bit to 200'
12:20-12:43 Ream 200'-210' - Rotary 210'-220'
~~12:43-12:53~~ (210'-220') Silty Sand, Some gravel
12:43-12:53 Ream, Circ., add pc.
12:53-13:06 Rotary 220'-240' mud visc. 40 mud wt. 9.0 lbs/gal.
(220'-230') Course Sand & gravel
(230'-240') Same
13:06-13:13 Ream, Circ., add pc.
13:13-13:27 Rotary 240'-260'
(240'-250') Course Sand & gravel
(250'-260') Course Sand & gravel, w/ some clay
13:27-13:35 Ream, Circ., add pc.

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Drillers log for Oct. 16th 1994

13:35 - 13:53	Rotary 260' - 280'	(260' - 270') Sand, coarse sand + gravel (270' - 280') clay, coarse sand + gravel	Ream, Circ, add pc.	Rotary 280' - 300'	14:02 - 14:23
14:23 - 15:11	Ream, Circ, trip out bit for core run, trip core barrel in to 293'	(280' - 290') Silty clay, coarse sand + gravel (290' - 300') coarse sand + gravel			
15:11 - 15:17	Circ. to bottom				
15:17 - 15:31	Core 300' - 310'				
15:31 - 16:00	Trip out barrel, lay out core [10' run - recover 8.25' sand w/ 1' gravel on bottom]				
16:00 - 16:34	Lay out core barrel, Trip 6 1/4" bit to bottom				
16:34 - 16:47	Ream 300' - 310' Rotary 310' - 320'	(300' - 310') Sand (310' - 320') Silty gravel + small cobble	Ream, Circ, add pc.	Rotary 320' - 346'	16:47 - 16:54
16:54 - 17:12	Ream, Circ, add pc.	(320' - 330') Sand, Silty gravel (330' - 340') Silty coarse sand + gravel w/ some clay			
17:12 - 17:30	Ream, Circ, add pc. Lighter Shaker Screens				
17:30 - 17:50	Rotary 340' - 360'	(340' - 350') coarse sand + gravel w/ some clay (350' - 360') clayey gravel w/ conglomerates	Ream, Circ, add pc.	Rotary 360' - 380'	17:50 - 18:00
18:00 - 18:19	Rotary 360' - 380'	(360' - 370') clayey gravel w/ conglomerates (370' - 380') coarse sand + gravel w/ conglomerates			
18:19 - 18:30	Ream, Circ, add pc.				
18:30 - 18:50	Rotary 380' - 400' - coarse sand + gravel w/ conglomerates				
18:50 - 19:20	Ream, Circ, Trip bit out of hole for core run tomorrow				
19:25	Drillers to Site				
20:00	Arrv. Motel				

used 5 bags mud today

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Drillers Log for Oct. 17th 1994

7:00 Lu. motel, run to Imasco 1st thing + get 2" chucks for rig +
Some other misc. around town.
12:00 arru. Site, put new chucks on rig, discover shaker unit on shale
shaker is cracked. Whole side of unit is worn out. Decide to take
it off for repair. Take shaker unit to Troy's welding
16:00 arru. motel

Drillers Log for Oct. 19th 1994

- 7:00 L.V. motel, get fuel at Staging area
- 8:02-8:50 Arrv. site, fuel up equip., put screens on shaker
- 8:50-9:33 Trip Core barrel to 373' + Circ. to 393' Have to replace Swivel Seal
- 9:33-10:15 Replace Kelly Swivel Seal
- 10:15-10:20 add pc. + Circ. to bottom
- 10:20-10:43 Core 400'-410'
- 10:44-11:27 Trip out barrel, lay out Core [10' run - Recover 4.3' Silty Sand w/couple gravel layers]
- 11:27-11:54 Lay out barrel, Trip 6 1/4" roller to 400'
- 11:54-12:32 Ream 400'-410' Rotary 410'-420'
(410'-420') Course gravel, Conglomerates, Silty Sand
- 12:32-12:41 Ream, Circ., add pc.
- 12:41-12:58 Rotary 420'-440' mud visc. 50 mud wt. 9.0 lbs/gal.
(420'-430') Silty Sand, gravel
(430'-440') Same
- 12:58-13:06 Ream, Circ., add pc.
- 13:06-13:26 Rotary 440'-460'
(440'-450') Silty Sand, gravel
(450'-460') Same
- 13:26-13:41 Ream, Circ., add pc.
- 13:41-14:05 Rotary 460'-480'
(460'-470') Course Sand + gravel, Small Cobble
(470'-480') Silty Sand, Course Sand + gravel, Cobble
- 14:05-14:18 Ream, Circ., add pc.
- 14:18-14:45 mix mud - 6 1/2 bags
- 14:45-15:20 Rotary 480'-500'
(480'-490') Silty Sand, Course Sand + gravel
(490'-500') Same
- 15:20-16:44 Ream, Circ. Trip out bit, Trip in Core barrel + Circ. to bottom
- 16:44-17:09 Core 500'-510'
- 17:09-17:54 Trip out barrel, lay out Core [10' run, recover 8.65' Course Sand w/1' Conglomerate]
- 17:54-18:40 Drain down pumps, pick up tools
- 18:40 Drillers L.V. Site - End Cycle #10
- 19:00 arrv. motel

Used 6 1/2 bags mud today

Drillers log for Oct. 25th 1994

- 7:00 L.V. Motel
- 7:15 arrv. staging area, get fuel + mud
- 8:07-8:23 arrv. site, fuel up equip. + get running
- 8:23-9:10 Trip Core barrel to 600'
- 9:10-9:37 Core 600'-610'
- 9:38-10:25 Trip out Core barrel, lay out Core, [10' run, recover 8' ~~s~~ - 2' silt, 1' conglomerate, 5' sand]
- 10:25-11:16 Lay out Core barrel + put on new 6 1/4" roller trip bit to 500'
bit hangs up.
- 11:16-12:32 Ream 500'-600'
- 12:32-12:54 Ream 600'-610' Rotary 610'-620'
(610'-620') Course Sand + gravel w/ small cobble
- 12:54-13:06 Ream, Circ., add pc.
- 13:06-13:37 Rotary 620'-640' Mud visc. 40 mud wt. 9.1 lbs./gal.
(620'-630') Silty Course Sand + gravel w/ cobble + conglomerates
(630'-640') Silty Course Sand + gravel
- 13:37-13:44 Ream, Circ., add pc.
- 13:44-14:24 Rotary 640'-660'
(640'-650') Course Sand, very Course gravel
(650'-660') Same w/ cobble + conglomerate
-
- 14:24-14:31 Ream, Circ., add pc.
- 14:31-15:08 Rotary 660'-680'
(660'-670') Sandy clay, Course Sand, very Course gravel, conglomerates
(670'-680') same
- 15:08-15:17 Ream, Circ., add pc.
- 15:17-15:43 Rotary 680'-700'
(680'-690') Clayey Sand, possible Cinder + ash
(690'-700') Clayey Course Sand, some gravel, couple conglomerates
- 15:43-16:30 Ream, Circ., Trip out bit for Core run
- 16:30-17:14 Trip Core barrel in + Circ. to bottom
- 17:14-17:36 Core 700'-710'
- 17:36-18:30 Trip out barrel, lay out Core [10' run, recover 5' - .4' rock, 4' sand
.6' conglomerate]
- 18:35 Drillers. Lv. Site
- 19:00 arrv. motel

Drillers Log for Oct. 26th 1994

7:00 Lv. motel
7:42 arrv. Site
7:42-8:15 get equip. running, Change Rod packings in mud pump.
8:15-9:08 Lay out Core barrel & Trip 6 1/4" roller to 680'
9:08-9:21 Circ. to 700'
9:21-10:16 Ream 700'-710' Rotary 710'-720'
9:22-9:45 Stop & replace drive belt on Shaker
(710'-720') Silty Course Sand & gravel w/ conglomerates
10:16-10:22 Ream, Circ., add pc.
10:22-10:52 Rotary 720'-740'
(720'-730') Silty Course Sand & gravel
(730'-740') Same
10:52-11:01 Ream, Circ., add pc.
11:01-11:19 Rotary 740'-750' T.D.
(740'-750') Silty Course Sand & gravel
11:19-12:30 Ream, Circ., & trip out of hole RK Standing by to log
12:30-17:30 Standby for loggers, go to Hopper Incl. & buy 2-2" hoses & get one repaired,
Pay bill at Graves oil for fuel delivered 10/19, Order 12" PVC & casing
& grant from Pumps Inc, order Hoist Plug bearings, & get new drive belt
for Shale Shaker

11:30-18:44 RK had just finished, discuss plans for 2" well, do some misc.
around Site, bring Coaseneck back to Staging area.
18:44 Drillers lv. Staging area
19:00 arrv. motel

Drillers log for Oct. 27th 1994

- 7:00 Lv. Motel, Go to Pumps Inc to get grout & welding Supply to exchange gas bottles
- 9:40 - 11:00 arvu. site, get equip. running, Set up to mix Volclay, Trip Drill Steel to 745' decided it was best to backfill hole with grout rather than Gravel.
- 11:00 - 12:06 Mix 1st tank & pump 260 gal. Volclay
- 12:06 - 12:23 Transfer some mud out of Shaker & pull 70' of Steel
- 12:23 - 12:50 Mix 2nd tank & pump 220 gal. Volclay grout should be to 450' according to Calculations
- 12:50 - 13:46 pull Steel out of hole
- 13:46 - 16:25 Standby for Volclay, Repair Hoist Plug, load Trimie, 2" casing, Sand & grout on trailer at Staging area.
- 16:30 Arru. Motel

used 27 bags Volclay

Drillers Log for Oct. 28th 1994

7:00 Lu. motel
7:15-7:40 arru. staging area, discover Someone has Stolen Keys out of Van last night for work trucks, get our truck unlocked (have Spares) & get diesel.
8:10-8:45 arru. Site, get equip. fueled & running
8:45-9:26 Trip 6 1/4" roller to 420'
9:26-10:35 Ream 420'-485' Seen some volclay in mud return
10:35-11:10 Trip bit out of hole
11:10-11:28 Set up to run 2" casing
11:28-11:55 Set 2" sch. 80 Pvc to 480' (10' sump, 30'-10 slot Pvc screen, 440' Pvc to surface)
11:55-12:39 clamp off casing at Surface & set 1 1/4" trimic to 478'
12:39-13:05 Circ., & pour 10-50 lb. bags 10-20 Sand from 478'
13:05-13:11 pull 1 pc & pour 4 bags from 457'
13:11-13:35 pull 1 pc to 436', pump some mud out of Shaker & thin down mud in hole
13:35-13:48 Pour 10 bags Sand from 436'
13:48-13:55 pull 1 pc & pour 4 bags Sand from 415'
13:55-14:30 Circ. & tag Sand at 415' (haul some casing in hole wanted Sand at 420')
14:30-15:00 pull 1 pc & pour 2 buckets 1/4" pellets from 393'
15:00-15:35 let pellets settle & hydrate then tag pellets at 399'. pull 1 pc & add 10' pc. trimic at 383'

15:55-16:22 mix 1st tank volclay & pump 247 gal. pull 8 pc's.
16:22-17:10 mix 2nd tank volclay & pump 247 gal. to Surface
17:10-17:45 pull rest of trimic & flush, Clean up Site a little
17:45 Drillers Lu. Site
18:00 arru. motel

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Drillers Log for Oct. 29th 1994

8 hrs Standby for Volclay

Drillers Log for Oct. 30th 1994

6:00	Lo. motel
6:15	arrv. Staging area, load 3/4" triline on truck, get fuel
6:45-7:45	arrv. Site, get equip. fueled & running, prepare to Set 3/4" triline in well
7:45-8:28	Set 3/4" triline in well to 473' (7' from bottom)
8:28-8:48	Warm up rig compressor
8:48-8:55	evacuate well
8:55-9:00	air off
9:00-9:05	air on - muddy water
9:05-9:15	air off
9:15-9:30	air on - muddy water, little production
9:30-10:30	flush & Surge well with 80 gal. fresh water
10:30-10:40	air off
10:40-10:50	air on
10:50-11:00	air off
11:00-11:10	air on
11:10-11:20	air off
11:20-11:40	air on - mud colored water little production
11:40-12:10	air off
12:10-12:40	air on - almost blow dry
12:40-13:10	air off
13:10-13:15	air on - almost no recharge
13:15-14:42	flush & Surge well with 40 gal fresh water then evacuate
14:42-15:42	air off
15:42-16:10	air on, very little recharge, mud colored water
16:10-16:43	pump approx. 200 gal. fresh water in well & Surge again
16:43-17:33	air on - water starting to clear a little in the end, light mud colored water, looks like we might have opened formation a little close well producing a little
17:40	Drillers Lu. Site
18:00	arrv. motel

Drillers Log for Oct. 31st 1994

6:00	Lo. motel
6:15	arrv. Staging area, get load of fuel
6:38 - 7:00	arrv. Site, fuel up equip. + get running
7:00 - 7:14	measure water level in well at 415.5'
7:14 - 7:23	Warm up Rig Compressor
7:23 - 7:45	air on, blew some thick mud out of well then water thinned down to a light mud color
7:45 - 8:00	air off
8:00 - 8:15	air on - almost blow Dry
8:15 - 8:48	air off
8:48 - 9:08	air on - had good recharge, mud colored water, blow Dry
9:08 - 9:40	air off
9:40 - 9:50	air on
9:50 - 10:20	air off
10:20 - 10:40	air on
10:40 - 10:55	air off
10:55 - 11:00	air on - little recharge, water a light mud color
11:00 - 12:00	air off - measure water level at 458.5'
12:12 - 13:00	evacuate well then flush + Surge w/ approx 80 gal. fresh water + evacuate
13:00 - 13:20	air off
13:20 - 13:30	air on - little recharge
13:30 - 14:05	pump about 200 gal. fresh water in well + Surge then evacuate
14:05 - 14:15	air off
14:15 - 14:25	air on, well blows dry
14:25 - 15:00	air off
15:00 - 15:40	air on, no recharge, flush well a couple times with 10 gal. water started getting thick Volclay out of well
15:40 - 15:50	air off
15:50 - 16:23	air on Still have Volclay in well, flush couple more times with 10 gal. water
16:23 - 17:36	measure well recovery - fluid started at 449.5' came up to 447'
17:40	Drillers Lo. Site
18:00	arrv. motel

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Drillers Log for Nov. 1st 1994

6:00	Lo. motel
6:15	arrv. Staging area, get some fuel
6:45 - 7:10	arrv. Site, fuel up equip. & get running, measure fluid level at 445'
7:10 - 7:24	Warm up Compressor
7:25 - 7:41	Try to tag Volclay in annulus could be as far as 100'
7:41 - 8:15	air on thick grout in well, flush well a few times
8:15 - 8:35	air off
8:35 - 8:40	air on
8:40 - 9:00	air off
9:00 - 9:05	air on - light mud colored water, well seems to be recharging good
9:05 - 9:25	air off
9:25 - 9:30	air on - light mud colored water, decent recharge, wait calls that good
9:30 - 10:20	Trip out trimie
10:20 - 12:55	Move Rig ahead 20' & Set up site for next hole
12:55 - 13:13	Rotary w/ 9 7/8" roller from 4' - 20'
	(4' - 20') Silt & gravel
13:13 - 13:20	Ream, Circ., add pc.
13:20 - 13:51	Rotary 20' - 40'
	(20' - 40') Silty coarse sand & gravel
13:51 - 13:57	Ream, Circ., add pc.
13:57 - 14:30	Rotary 40' - 60'
	(40' - 60') Silty Sand
14:30 - 14:39	Ream, Circ., add pc.
14:39 - 15:13	Rotary 60' - 80'
	(60' - 80') Sandy Silt
15:13 - 15:43	Ream, Circ., add pc.
15:43 - 16:21	Rotary 80' - 100'
	(80' - 100') Sandy Silt, Sandy Clay, Some gravel
16:21 - 16:34	Ream, Circ., add pc.
16:34 - 17:06	Rotary 100' - 120'
	(100' - 120') Sandy Silt, Sandy Clay, gravel
17:06 - 17:22	Ream, Circ., pull bit up to 40'
17:22 - 17:40	Pack up tools
17:40	Drillers Lu. Site
18:00	arrv. motel

Used Shags much today

Drillers Log for Nov. 2nd 1994

6:00 Lu. Motel
6:15 arrv. Staging Area, get diesel & mud, drain water out of Steamer
7:13 - 7:30 Arrv. Site, fuel up equip. & get running
7:30 - 8:00 mix mud - 6 bags
8:00 - 8:15 Trip bit to 100' & circ. to bottom (120')
8:15 - 8:55 Rotary 120' - 140'
(120' - 140') Sandy Silt, Silty gravel
8:55 - 9:02 Ream, Circ., add pc.
9:02 - 9:39 Rotary 140' - 160'
(140' - 160') Sandy Silt, coarse sand & gravel
9:39 - 9:53 Ream, Circ., add pc.
9:53 - 10:30 Rotary 160' - 180'
(160' - 180') Sandy Silt, Silty coarse sand & gravel
10:30 - 10:41 Ream, Circ., add pc.
10:41 - 11:20 Rotary 180' - 200'
(180' - 200') Silty coarse sand & gravel
11:20 - 11:29 Ream, Circ., add pc.
11:29 - 12:07 Rotary 200' - 220'
(200' - 220') Sandy Silt, Silty gravel
12:07 - 12:41 Ream, Circ., Trip bit out of hole
12:41 - 18:18 Drain pump, Get sized drain plug out of 3x4 pump on Shucker, take water truck to staging area, Get pickup serviced, Stop by tire shop too late to get tires, Stop by other site & give guys a hand. arrv. Staging area
18:30 arrv. motel

end Cycle # 11

Drillers log for Oct. 24th 1994

8:44 Lv. Denver via United Air
10:00 arru. Alby.
10:00-12:00 Check into motel, grab lunch, arru. site
12:00-13:09 Get pumps primed + equip. running
13:09-13:47 Trip 6 1/4" roller to 486' + fill hole with mud
13:47-14:10 Mix mud - 5 bags
14:10-14:26 Circ. to 500'
14:26-14:58 Ream 500'-510' Rotary 510'-520'
(510'-520') Course Sand + gravel
14:58-15:09 Ream, Circ., add pc.
15:09-15:37 Rotary 520'-540' mud visc 50 mud wt. 9.1 lbs/gal.
(520'-530') Course Sand (Silty?)
(530'-540') Course Sand + Gravel
(535'-537') ash?
15:37-15:46 Ream, Circ., add pc.
15:46-16:12 Rotary 540'-560' mud visc. 45 mud wt. 9.1 lbs/gal.
(540'-560') Silty Course Sand + gravel
16:12-16:20 Ream, Circ., add pc.
16:20-16:50 Rotary 560'-580' mud visc 40 mud wt. 9.1 lbs/gal.
(561.5'-562') ash?
(560'-570') ash? Silty Course Sand + gravel
(570'-580') Silty Course Sand + gravel
16:50-16:58 Ream, Circ., add pc.
16:58-17:33 Rotary 580'-600'
(580'-590') Silty Course Sand + gravel
(590'-600') Same
17:33-18:16 Ream, Circ., Trip out bit for Core run tomorrow
18:20 Drillers Lv. Site
19:00 arru. motel

Drillers log for Nov. 10 1994 Thurs.

7:30 leave Denver via frontier air
 9:00 arrive Albuquerque
 9:00-10:15 check in to motel get parts shipped
 10:15-10:30 travel to staging area
 10:30-11:30 Switch trucks over Dan/Jeff get fueled up and travel to site
 11:30-16:40 Rig up prime pumps mix mud clean out 9 7/8 hole from 120 to 220 ft. and drill to 260 ft
 16:40-16:50 trip out of hole
 16:50-17:15 mix 9 bags mud and line waste container
 17:15-17:45 drain down pumps and pump waste mud over to other waste container
 17:45-18:00 travel to staging area
 18:00-18:15 travel to motel

mud 16:00 10.0 and 60 visc
 mix 9 bags total mud today

220-240

15:02-15:42

40 minutes

240-260

15:46-16:25

39 minutes

Drillers log for Nov. 11, 1994 fri.

6:00 - 6:15	leave motel travel to staging area
6:15 - 6:30	move mud and cover pallets supplies
6:30 - 6:50	travel to site
6:50 - 7:45	Rig up prime up and trip in 9 7/8
7:45 - 8:30	circulate & clean hole to 260 ft
8:30 - 12:15	drill to 340 ft.
12:15 - 12:45	repairs on shaker
12:45 - 16:15	drill to 400 ft and trip out of hole
16:15 - 17:00	travel to motel via staging area with stop for guards check aprox 10 minutes

Mud 15:30 9.4 and 75 visc.
mixed 15 bags total mud today

260 - 280	7:53 - 8:32	39 minutes
280 - 300	8:37 - 9:09	31 minutes
300 - 320	9:13 - 10:25	40 minutes
320 - 340	10:29 - 11:17	48 minutes
340 - 360	11:23 - 12:10	47 minutes
360 - 380	12:42 - 13:04 / 13:45 - 14:18	56 minutes
380 - 400	14:24 - 15:20	56 minutes

Drillers Log for Nov. 12, 1994 sat.

6:00-6:15	travel from motel to staging area
6:15-8:20	load up mud cover up pallets go off base to get fuel
8:20-8:45	arrive on site get pickup stuck and unstuck
8:45-10:00	mix 8 sacks mud rig up prime pumps etc.
10:00-12:30	trip 9 7/8" in to 360 ft go to circulate, plugged off trip up 100 ft still plugged off wet trip out clean out bit talk over scenario w/walt decide our time to get back in and drilling vs. production would be better spent next day. Continuous rain leaves water track in bad spot may not get out, drain down.
12:30-12:45	repairs on shaker
12:45-13:15	travel to motel via staging area

mixed 8 sacks total mud today

Drillers log for Nov. 13, 1994 sun

6:00-6:15 travel motel to staging area
6:15-6:45 load mud move equipment at area for fuel
travel to site
6:45-1330 rig up prime up to drill trip in and circulate
drill to 440 ft
1330-14:00 repair broken bolt on auto box mud pump ran
and found more broken bolts shut down
14:00-17:30 go to staging area get backup pump move onto
site prime up and find it wont pump volume.
break down, clean out, break down hoses and
pumps call it a day
17:30-18:00 travel to motel via staging area

mud 9.4 and 75 visc.
mixed 9 bags mud total today

400-420
420-440

10:51-12:11
12:18-13:24

80 minutes
66 minutes

Drillers log for Nov. 14, 1994 mon.

7:00-7:15 start at 7:00 to allow parts run into town travel
motel to staging area
7:15-7:30 locate propane torch and load truck
7:30-7:40 Steve goes for parts Todd travels to site
7:40-9:30 prime up rig up and trip in 200 ft
9:30-10:30 Steve arrives on site w/ parts shut rig down and
repair auto box rig mud pump
10:30-12:45 trip in rest of way and drill to 460 ft
12:45-13:20 repairs on shaker
13:20-15:30 drill to 490 ft
15:30-16:40 shut down standby wait on laser test
16:40-18:10 trip out of hole and drain down pumps etc.
18:10-18:45 travel home to motel via staging area

mud 9.3 and 69 visc.

no new mud today add water only

440-460

460-480

480-490

11:30-12:45

~~12:40~~ 13:20-14:36

14:41-15:26

75 minutes

76 minutes

45 minutes

Drillers log for Nov. 15, 1994 Tues.

6:00-6:05 Cold frost scrape windows
 6:05-6:20 travel motel to Staging area
 6:20-6:30 travel to site
 6:30-9:25 Rig up prime up and trip in
 9:25-10:00 mix 6 sacks mud
 10:00-12:50 drill to 560 ft
 12:50-13:30 mix 6 sacks mud
 13:30-15:15 drill to 600 ft
 15:15-15:30 repairs Shaker
 15:30-18:50 drill to 629 ft circulate on bottom, trip out
 of hole, break down bit and subs fill hole w/mud
 set up for logger stay on site till logger tags
 clean bottom w/ first tool
 18:50-19:30 travel to motel for van back to staging area
 out there and back to motel
 mix 12 bags mud total today
 mud 9.35 and 48 visc. 12:00 noon
 mud 9.40 and 48 visc. 16:30

490-500	9:04-9:25	21 minutes
500-520	10:02-11:12	70 minutes
520-540	11:17-12:06	43 minutes
540-560	12:07-12:48	41 minutes
560-580	13:30-14:20	50 minutes
580-600	14:25-15:08	43 minutes
600-620	15:20-16:32	72 minutes
620-629	16:37-16:55	18 minutes

Drillers Log for Nov. 16th 1994

- 6:00 Lu. motel
- 6:15 arvo. Staging area, Get Brian loaded & send him to El Paso. Load
trinic on trailer
- 7:00 - 8:05 arvo. Site, prime pumps & get equip. running
- 8:05 - 9:00 Trip 9 7/8" roller to 540'
- 9:00 - 10:28 Ream 540' - 629'
- 10:28 - 12:30 Circ. thin mud in hole to 290 disc.
- 12:30 - 13:13 Trip out bit
- 13:13 - 13:30 Set up to run 5" Casing
- 13:30 - 15:00 Make some phone calls, Drain pumps, Hoist plugs for 5" casing won't
fit, casing is different size made to adapt to PVC casing
- 15:00 - 17:00 run to Bernalillo to have a new Hoist plug made arvo. motel

Drillers Log for Nov. 17th & 18th 1994

8:00 lv. motel, pick up another pallet of Volclay at pumps Inc., Call Colorado engineering & wait
10:30 arrv. Site
10:30-11:00 get pumps ready to prime & equip. running, Steve lo's to go pickup new hoisting plug
11:00-12:58 Trip 9 7/8" roller in hole to make sure its open. Bottom at 626'. Trip Bit back out
12:58-14:00 finish Setting up to complete well
14:00-15:00 Standby for Steve to get back
15:00-16:40 Set 5" Stainless Steel Casing to 617' (20' Sump, 20'-20 slot screen, 580' riser)
16:40-17:51 Clamp casing off at surface
17:52-18:20 Set 1 1/4" trimix to 619'
18:20-19:00 Prime rig pump & circ.
19:00-19:13 Pour 7 1/2 bags 10-20 Sand from 619'
19:13-19:30 pull 1 pc & pour 9 bags 10-20 Sand from 604'
19:30-19:51 pull 1 pc & pour 12 bags 10-20 Sand from 583'
19:51-20:03 pull 1 pc. & pump some mud from Shaker
20:03-20:19 pour 12 bags 10-20 Sand from 562'
20:19-20:45 pull 1 pc & Circ. from 541' Tag Sand at 560.5'
20:45-21:30 Bail well with 8 gal bailer to draw down Sand, make 10 Runs
21:30-21:56 Tag Sand at 561.5'
21:56-22:42 Bail 15 more times
22:42-22:55 Tag Sand at 561.5'
22:55-01:19 Circ. & pour 2 bags 16-40 Sand, 3 buckets 1/4" pellets (wait til pellets are close to bottom) Chase pellets with 2 more bags 16-40 Sand.
01:19-01:55 let 16-40 Sand settle, then Circ. & tag top Sand at 549.5'
01:55-02:10 Set up to Volclay, Trimix still at 541'
02:10-03:35 mix 1st tank Volclay & pump 221 gal., pull 4 pc's.
03:35-04:27 mix 2nd tank Volclay & pump 221 gal., pull 4 pc's
04:27-05:16 mix 3rd tank Volclay & pump 221 gal., pull 2 pc's
05:16-06:15 mix 4th tank Volclay & pump 247 gal., pull 2 pc's
06:15-06:58 mix 5th tank Volclay & pump 247 gal., pull 4 pc's
06:58-08:02 mix 6th tank Volclay & pump 247 gal., pull 6 pc's
08:02-08:30 mix 7th tank Volclay & pump 120 gal., pull last 2 pc's Volclay to surface
08:30-9:00 Clean up tools, drain pumps
9:00 Drillers lv. Site Go pay fuel bill at Graves
10:00 arrv. motel

Drillers Log for Nov. 17th + 18th 1994

10-20 Sand from 625'-561.5' used 40.5 bags Sand

63.5' Sand ÷ 40.5 bags = 1.56' / bag Sand Calc. Vol. 1.3' / bag

16-40 Sand from 561.5'-558.5'

1/4" pellets from 558.5' - 553'

16-40 Sand from 553'-549.5'

Used 96 bags Volclay - Volclay grout from 549.5 - Surface

Drillers Log for NOV. 19th 1994

6:00 Lv. motel
6:15 arrv. Staging area. Help John & Brian load some stuff to take back to Denver, Get load of fuel
7:30 - 7:53 arrv. Site fuel up equip. & get running
7:53 - 12:44 Bail well with 8 gal. bailer, make 50 runs
2:44 - 12:57 John attempts to measure water level with no success, tape hangs up.
2:57 - 13:40 Set 1 1/4" trimie in well to 6 1/4' (3' from bottom)
3:40 - 13:51 Warm up rig compressor
3:51 - 13:56 air on, evacuate well, muddy waters
3:56 - 14:03 run discharge hoses out in the grass
4:03 - 15:03 air on, mud colored water, well making 30 gpm. Water clears to murky water in 10 min.
14:27 Turbidity 129 well production increased to 75 gpm
5:03 - 15:10 air off, attempt to measure water level again, tape won't go down
5:10 - 16:08 air on, water a little murky, well making 100+ gpm.
15:48 Turbidity 10.4, production - same
16:18 last 3 Turbidities below 10 John says that's good
6:20 - 17:11 pull trimie out of well - Warning! if pump is set in this well pull back out slowly as pump will ~~hang~~ hang on casing joints.
17:15 Drillers Lv. Site
17:30 arrv. motel

End Cycle #12

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7:30 Lu. Denver via Frontier Air
 9:00 arrv. Alby.
 9:00-10:00 Check into Motel
 10:00-11:20 arrv. Staging area, get fuel, head out to Site. Had to Jump Start
 equip. get equip. fueled up.
 11:20-12:20 move Rig off 5" well & Set up over 2" well, prepare to set 3/4" trimic
 12:20-12:50 Set 3/4" trimic to 473' in well. (7' from bottom)
 12:50-13:03 Warm up rig compressor
 13:03-13:33 air on, no return. Flush well with fresh water a couple times
 blow some thick w/d clay out of well, then blow continuous
 13:33-13:47 air off
 13:47-13:55 air on - had a little recharge, mud colored water, had just a mist
 coming out at the end.
 13:55-14:20 air off
 14:20-14:26 air on - mud colored water, little recharge
 14:26-15:00 Flush & Surge well with approx. 60 gal. fresh water
 15:00-15:15 evacuate well - air off
 15:15-15:25 air on - mud colored water, well doesn't seem to be producing
 15:25-15:40 air off
 15:40-15:53 air on
 15:53-16:10 air off
 16:10-16:20 air on - mud colored water, well seems to be recharging a little more
 16:20-16:30 air off
 16:30-16:35 air on - mud colored water
 16:35-16:45 air off
 16:45-16:50 air on - same, recharge is better, seems to be the same level
 16:50-17:00 air off
 17:00-17:05 air on
 17:05-17:15 air off
 17:15-17:26 air on - same
 17:20-17:30 air off
 17:30-17:35 air on - same
 17:35 - Shut down
 17:40 Drillers ho. Site
 18:00 arrv. Motel

Drillers Log for Nov. 29th 1994

6:00	Lv. motel
6:15	arrv. Staging area, get load of fuel
6:43-7:15	arrv. Site, fuel up equip. & get running. measure water level in well at 449'
7:15-7:30	Warm up rig Compressor
7:30-7:40	evacuate well, mud colored water, no vol clay
7:40-8:10	air off
8:10-8:20	air on - Same, good recharge
8:20-8:42	air off
8:42-8:50	air on - Same
8:50-10:45	Shut down Compressor, trip out trimic, unplug some frozen hoses
10:45-13:00	move rig 20' from S" well & set up for 3 rd hole this Site
13:00-15:05	run to Right bit for some 7 ^{7/8} " rollers, pick up 500 gal. tank & move fuel at Staging area
15:05-16:48	Continue Setting up. Mix mud - 12 bags, set 8" Surface Casing to 4'
16:48-17:00	Rotary with 7 ^{7/8} " roller 4'-20' (4'-20') Sandy Silt
17:00-17:08	Ream, Circ., add pc.
17:08-17:20	Rotary 20'-40' (20'-40') Sandy Silt
17:20-17:28	Ream, Circ., pull bit to Surface
17:20-17:28	Ream, Circ., pull bit to Surface
17:28-17:48	Drain pumps & hoses
17:50	Drillers Lv. Site
18:00	arrv. motel

Drillers Log for Nov. 30th 1994

6:00 Lv. motel
6:30 arri. Site
6:30-8:38 get pumps primed + equip. running, mix mud - 2 bags
8:38-17:35 discover shaker unit on shale shaker is trashed, repair shaker unit
17:35- Drillers Lv. Site
18:00 arri. motel

Drillers Log for Dec 1st 1994

6:00	lv. Motel
6:30	arrv. Site
6:30-9:00	finish rebuilding Shaker
9:00-10:30	get equip. running, pumps primed, mud manifold on Rig frozen, get it thawed out, start Rotary with 7 7/8" roller
10:30-10:38	Ream 20'-40' Circ., add pc.
10:38-10:56	Rotary 40'-60' mud visc. 40 mud wt. 9.1 lbs/gal. (40'-60') Sandy Silt
10:56-11:03	Ream, Circ., add pc.
11:03-11:22	Rotary 60'-80' (60'-80') Sandy Silt, Silty Course Sand
11:22-11:31	Ream, Circ., add pc.
11:31-11:51	Rotary 80'-100' (80'-100') Sandy Silt, Silty course sand + gravel
11:51-11:58	Ream, Circ., add pc.
11:58-12:49	Rotary 100'-120' (100'-120') Dense clay - 14.5 min. / ft. (100'-120') Clay, Silty Course Sand
12:49-12:57	Ream, Circ., add pc.
12:57-13:10	Rotary 120'-140' (120'-140') Course sand + gravel
13:10-13:18	Ream, Circ., add pc.
13:18-13:50	Rotary 140'-160' (140'-160') Clay, Silty Course Sand + gravel
13:50-14:02	Ream, Circ., add pc.
14:02-14:49	Rotary 160'-180' (160'-180') Silty Clay, some gravel
14:49-15:02	Ream, Circ., add pc.
15:02-15:25	Rotary 180'-200' (180'-200') Silty Course Sand + gravel, Clay
15:25-15:32	Ream, Circ., add pc.
15:32-15:51	Rotary 200'-220' (200'-220') Silty Course Sand + gravel, some clay
15:51-16:30	Ream, Circ., Trip out bit - Bit pulled Hard, have a lot of clay in hole yet.
16:30-17:30	Drain pumps & hoses
17:30	Drillers lv. Site, run & get another extension and cord + stop by airport to get hoist plug we ordered last cycle
19:00	arrv. Motel

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Drillers Log for Dec. 2nd 1994

6:00	lv. motel
6:15	arrv. staging area, get some fuel
6:38-8:23	arrv. site, fuel up equip. + get running, get pumps primed
8:23-9:48	Ream 40'-220'
9:48-10:04	Rotary 220'-240'
	(220'-240') Silty coarse sand + gravel
10:04-10:11	Ream, circ., add pc
10:11-10:32	Rotary 240'-260'
	(240'-260') coarse sand + gravel, silty gravel
10:32-10:39	Ream, circ., add pc.
10:39-11:14	Rotary 260'-280'
	(260'-280') Silty coarse sand + gravel, 6' clay, silty coarse sand + gravel
11:14-11:21	Ream, circ., add pc
11:21-11:38	Rotary 280'-300'
	(280'-300') coarse sand + gravel, some silt
11:38-11:45	Ream, circ., add pc.
11:45-12:04	Rotary 300'-320'
	(300'-320') coarse sand + gravel, some silt
12:04-12:08	circ.
12:08-12:50	replace Kelly Swivel Seal
12:50-12:57	Ream, circ., add pc.
12:57-13:21	Rotary 320'-340'
	(320'-340') coarse sand + gravel, some silt
13:21-13:28	Ream, circ., add pc
13:28-13:53	Rotary 340'-360'
	340' (340'-360') coarse sand + gravel, clay, silty coarse sand + gravel
13:53-14:01	Ream, circ., add pc
14:01-14:24	Rotary 360'-380'
	(360'-380') coarse sand + gravel w/ conglomerates
14:24-14:33	Ream, circ., add pc.
14:33-15:01	Rotary 380'-400'
	(380'-400') conglomerates, coarse sand + gravel
15:01-15:15	Ream, circ., add pc.
15:15-16:00	Rotary 400'-420'
	(400'-420') clay, tight silty coarse sand + gravel
16:00-16:26	Ream, circ., add pc.
16:26-17:00	Trip out bit
17:00-17:35	Break down pumps
17:35	Drillers lv. site
18:00	arrv. motel

Drillers log for Dec 3rd 1994

6:00 Lv. motel
6:15 arrv. Staging area, get load of fuel
6:38 - 8:00 arrv. Site, fuel up equip. & get running, get pumps primed
8:00 - 8:19 Trip 7 7/8" roller to 400'
8:19 - 8:34 Ream 400' - 420'
8:34 - 9:34 Rotary 420' - 440'
8:49 - 9:02 Stop & tighten Belt on Shaker
(420' - 440') Tight Silty coarse sand & gravel
9:34 - 9:40 Ream, Circ., add pc.
9:40 - 10:31 Rotary 440' - 460'
(440' - 460') Silty coarse sand (Tight) w/ some ~~coarse sand~~ gravel
10:31 - 10:39 Ream, Circ., add pc.
10:39 - 11:31 Rotary 460' - 480' T.D.
(460' - 480') Tight coarse sand, some silt
11:31 - 12:48 Ream, Circ., Thin mud in hole to 29 USC.
12:48 - 13:26 Trip out bit
13:26 - 14:45 Set 4" sch 80 pvc to 475' (10' sump, 20' - 20 slot pvc, ^{screen} 445' pvc to surface)
14:45 - 15:15 blow some grout out of trimie with air line
15:15 - 15:40 Set 1 1/4" trimie to 472'
15:40 - 15:55 Circ.
15:55 - 16:05 Pour 6 bags 10-20 sand from 472'
16:05 - 16:21 pull 1 pc. & pour 6 bags from 457' pull 1 pc.
16:21 - 16:32 pour 9 bags from 436'
16:32 - 16:45 pull 1 pc. & pour 6 bags from 415'
16:45 - 17:20 Circ. & tag sand at 419'
17:20 - 17:25 go to bail sand down & top of bailer snaps off on 1st run
17:25 - 17:45 pull 1 pc. add 15' & Circ. from 409'
17:45 - 18:00 pour 1 1/2 buckets 1/4" pellets, hose suction, pull 15'
18:00 - 18:23 Circ. & pour 1/2 bucket 1/4" pellets from 394' pull 1 pc.
18:23 - 18:30 Circ. from 373'
18:30 - 19:00 drain down pumps & hoses
19:00 Drillers hv. Site
19:30 arrv. motel

Drillers log for Dec. 4th 1994

7:00	Ku. motel
7:30	arrv. site
7:50 - 8:50	prime pumps + get equip. running, Tag pellets at 400.5' (12.5' plug)
8:50 - 9:30	add 1 pc. + pour 2 bags 16-20 sand from 394' sand should be at 402'
9:30 - 10:44	Mix 1 st tank volday + pump 221 gal. pull 4 pcs
10:44 - 11:56	Mix 2 nd tank volday + pump 234 gal. pull 5 pcs
11:56 - 13:20	Mix 3 rd tank volday + pump 234 gal. to surface, pull rest of mixture
13:20 - 14:00	out of hole + flush out
14:00 - 15:00	Mix 4 th tank + top off 5" well put the rest in 2" well
15:00	Break down pumps + hoses
15:00	Drillers ho. Site
15:30	arrv. motel

used 47 1/2 bags volday

Drillers Log for Dec. 5th 1994

7:00 Lv. motel, Drop off John & Brian at staging area so they can see a safety film out at site while I run to Rodgers to get a spear

9:00-11:00 arrv. site, put spear on trimie & fish bailer out of well, had to go to bottom to get it.

11:00-12:02 Trip 1 1/4" trimie in well to 228' & evacuate well, then trip trimie to 472' (3' from bottom)

12:02-12:33 evacuate well, flush well a couple times

12:33-13:00 air off

13:00-13:30 air on, not much recharge, surge well with 100 gal. fresh water

13:30-14:15 air off

14:15-14:25 air on, mud colored water, wells making less than 1 gpm

14:25-15:05 surge well with another 100 gal. fresh water

15:05-15:10 air on

15:10-15:20 air off

15:20-15:30 air on, not much recharge, mud colored water

15:30-15:45 air off

15:45-15:55 air on, very little recharge, mud colored water

15:55-16:15 air off

16:15-16:25 air on, almost no recharge, took 6 min. for mud colored water to get to surface

16:25-17:25 air off

17:25-17:35 air on - nothing

17:35-17:50 Drain pumps & hoses

17:50 Drillers hv. site

18:00 arrv. motel

Drillers log for Dec. 6th 1994

6:00	lv. motel, run to pumps Inc & drop off Broken pc's of bailer
7:10 - 7:47	arrv. site, get equip. running, measure water level at 453.4'
	Warm up rig Compressor
7:47 - 7:55	air on, mud colored water, almost blow dry
7:55 - 8:05	air off
8:05 - 8:10	air on - very little recharge
8:10 - 8:25	air off
8:25 - 9:50	flush well a couple times then surge well with 200 gal. fresh water
9:50 - 9:55	evacuate well
9:55 - 10:10	air off
10:10 - 10:15	air on - mud colored water
10:15 - 10:30	air off
10:30 - 10:35	air on - mud colored water, almost blow dry
10:35 - 10:55	air off
10:55 - 11:00	air on - same
11:00 - 11:20	air off
11:20 - 11:30	air on - little recharge
11:30 - 12:00	air off
12:00 - 12:10	air on - mud colored water recharge better after 1/2 hr. Still not a lot though
12:10 - 12:40	air off
12:40 - 12:50	air on - same
12:50 - 13:20	air off
13:20 - 13:30	air on - same, water light mud colored
13:30 - 14:00	air off
14:00 - 14:10	air on - well seems to be recharging the same after 1/2 hr, still
	light mud color
14:10 - 14:40	air off
14:40 - 14:50	air on - same
14:50 - 15:20	air off
15:20 - 15:30	air on - same
15:30 - 16:00	air off
16:00 - 16:10	air on - same, seems to be a little more recharge
16:10 - 16:40	air off
16:40 - 16:50	air on - same
16:50 - 17:20	air off
17:20 - 17:30	air on - same
17:40	Drillers lv. site
18:00	arrv. motel

Drillers Log for Dec. 7th 1994

6:00	Arrv. Motel
6:30	Arrv. Site
6:30 - 6:45	get rig running, measure water level in well at 448.5'
6:45 - 7:20	Pull + trim out of well
7:20 - 7:30	Went to move rig but sank in mud
7:30 - 14:00	Bring rest of stuff back to staging area. Get everything washed & loaded
14:00 - 16:45	Take goose-neck & some landing mats out to site & get rig out of mud
	Bring back to staging area & unload steel. Drain down steamer & blow
	water out
16:45	Drillers Av. Staging area
17:00	Arrv. Motel

end cycle # 13

APPENDIX D

EVALUATION AND INTERPRETATION OF GEOPHYSICAL LOGS FOR TEST WELL POWERLINE #1

EVALUATION AND INTERPRETATION OF GEOPHYSICAL LOGS FOR
TEST WELL POWER LINE # 1

Jim Hudson

Geophysical Logs

On October 26, 1994, drilling of test well, Power Line # 1, was completed to total depth of 750 feet and geophysical logging was called for after a period of mud circulation to condition the borehole. The U. S. Geological Survey commenced logging at approximately 0900 hours on October 26th.

The logging program included; long-short normal electric logs, gamma, neutron, dual-density, and caliper logs. The logs were referenced to ground-level and the hole depth was measured, with the logger, at 752.7 feet.

Logging proceeded without any problems and the log quality is excellent. Logging was completed about 1700 hours on the same day and the drill site was supplied with a copy of the logs. A short conference was held, at the drill site, where a well completion program was agreed upon.

I asked the logger operators to run the old logging probes against the new equipment in order to document the sensitivity difference, allowing correlation of old and new logs. The difference should be a linear offset, making log correlation relatively easy, if the difference is known.

LITHOLOGY AND INTERPRETATION OF GEOLOGS

The logs indicate that the formation is basically broken up into three distinctly different depositional series. There are sub series within each of the three units. These depositional units are:

0 to 40 feet-- Top soil, mostly silt and sand with a layer of gravel at 14 and 20 feet. The gravel layers are only about 18 inches thick.

40 to 280 feet-- This unit is mostly sandy, silty, clay. The sub-units includes a section from 40 to 140 feet where the matrix gradually becomes finer grained material, ending with a large sand and gravel layer. Below the sand and gravel section, the unit becomes very clayey. This primarily clay unit is broken up by a very significant layer of sand and gravel from about 223 to 250 feet. This gravel section contains some cobble size rocks and is a prime candidate in the search for the old river channel. There is another, less significant, sand and gravel section from about 260 to 268 feet.

280 to total depth-- This unit is primarily sand with sub-series sections of silty sand, sand and gravel, various amounts of clay in some sections and a wide variety sand grain sizes. The logs indicate very high moisture content, hinting perched conditions, near 340 ft. and around 358 feet. However, the fine grained material that is usually associated with an aquaclude, needed to contain percolation, is not present. There is a conglomerate like section that is poorly cemented, just below 510 feet and the matrix is very clayey to 550 feet. The static water-level appears to be at

448 feet and the shift in the electric log is due to saturation. There are several minor gravel beds in the unit below the water level.

The geolog lithology interpretation is as follows;	
DEPTH, IN FEET	DESCRIPTION
0-14	Silty sand
14-20	Fine grained sand with thin gravel layers at 14 and 20 feet.
20-22	Gravel, some to cobble size
22-32	Silty sand, few gravel
32-40	Gravel, sand with few cobbles at 36-38 ft.
40-50	Silt, fine grain sand, few large gravel
50-55	Clayey sand and silt
55-65	Sand, fine to med., very clayey near the top and the bottom
65-76	Silty sand with minor amt. of clay
76-80	Clay with small gravel
80-97	Clayey sand
97-110	Silty clay
110-118	Sandy clay
118-122	Silty clay
122-127	Sandy clay, thin sand layer at 124 ft.
127-132	Silty clay becoming sand at the bottom
132-137	Silty sand, increase sand with depth
137-141	Sand and gravel, fine grained sand with small gravel mostly at 138-140 ft.
141-147	Silty clay
147-151	Sandy clay, fine to med. grain sand
151-174	Clay, few streaks of fine grained silty sand
174-177	Silty sand, med. grained
177-179	Clay
179-182	Silty sand
182-189	Clay, small amt. sandy silt
189-193	Silty sand, med. to coarse grain sand
193-197	Clay, small amt. of sand
197-205	Silty sand
205-212	Clay
212-217	Sandy clay
217-221	Silty clay
221-228	Med. grained sand, few gravel
228-247	Sand, large gravel 238-241, deep invasion of drilling fluid
247-251	Silty sand
251-260	Silty clay
260-264	Large grain sand and gravel, deep invasion
264-268	Sand, fine to med. grained
268-278	Silty clay, grading to stiff clay at 276
278-296	Sandy gravel
296-300	Sand, small amt. sand
300-325	Sand, coarse to very coarse, few gravel streaks
325-336	Very coarse sand with gravel 325-329 grading to clayey sand

336-341	Sandy clay, very moist
341-343	Sandy silty gravel
343-354	Med. to coarse sand with small gravel, thin streaks of med. grain sand at 346 and at 348 ft.
354-359	Very fine grained sand becoming silty near the bottom, very moist
359-380	Sandy gravel becoming mostly gravel at 369 ft.
380-393	Gravel, some to pebble size
393-400	Sand, few small gravel, more silty and clayey with depth
400-402	Silty clay
402-404	Clay, less silt than above
404-412	Clay, becoming more sandy with depth
412-417	Sand with silt and few gravel
417-419	Fine grained sand
419-426	Silty sand
426-429	Sand, v. fine to fine grain
429-437	Silty sand, streak of gravel at 432 ft.
437-448	Silty sand, large grain size decreasing to med., static water level at 448 ft.
448-453	Silty sand, med. grained
453-462	Silty sand, fine to med.
462-470	Sand with only minor amt. of silt, med. grain grading to large with gravel
470-473	Silty, sandy clay
473-476	Clayey sand
476-485	Silty sand, mostly fine grain very silty
485-490	Silty sand, med. to coarse grain sand
490-494	Med. grain sand, w/ minor amt. of silt
494-501	Clayey sand with small gravel
501-509	Sand, med. grain becoming fine 506-509
509-514	Partially cemented sand and gravel, very fractured---good water zone
514-518	Sandstone, poorly cemented
518-524	Silty sand, mostly fine grain,
524-535	Sand, med. to coarse, few gravel, good permeability, clay streak at 533-534
535-540	Silty sand, poorly sorted, lower perm.
540-547	Clayey sand, grading to fine sand at 547
547-562	Sand, small gravel starting at 556, good permeability
562-564	Fine grained sand and silt, partly cemented
564-572	Sand, med. grain, few small gravel, good permeability
572-580	Sand, med. to fine grain,
580-592	Silty sand, small amt. of clay
592-602	Silty sand, med. to coarse, one ft. of gravel at 596 ft., fair perm.
602-606	Sand, very fine grain
606-609	Silty sand with small gravel
609-612	Fine sand, very silty
612-618	Silty sand, med. grain, incr. perm.
618-620	Fine grain sand and silt, lower perm.

620-625	Sand, med. grain, small amt. silt
625-629	Sand, fine to med., poorly sorted, lower permeability
629-633	Coarse sand and gravel, good perm.
633-637	Silty sand, fine to med.
637-648	Silty sand, fine grain, med. gr. 644-46
648-652	Clayey sand and silt
652-655	Sand, fine grain, some silt
655-659	Sand, med. to coarse, pebble size gravel, very high permeability
659-665	Silty sand, med. grain grading to fine
665-678	Silty sand, mostly fine grain
678-682	Sand, small gravel
682-688	Silty sand, fine to v. fine
688-698	Sand, med. grain, small amt. of silt
698-708	Silty sand
708-715	Sand, fine grain becoming med. at 713 ft.
715-717	Sand, v. fine, hard packed
717-732	Sand, med. to coarse, fair perm. some very thin streaks of clayey sand
732-735	Sand, v. fine grain, little silt
735-750	Sand, very silty to 740 ft., grading to med. sand, mostly high perm.

PL-1

PL-2

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