GW - 40

REPORTS

YEAR(S):

1990-1989

TECHNICAL APPROACH
FOR FURTHER OFF-SITE INVESTIGATION

May 23, 1990

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TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

Pursuant to the New Mexico Oil Conservation Division's (OCD) request to investigate the extent of dissolved phase hydrocarbon in the Lee Acres Community GCL proposes the following technical approach. The OCD has requested that three monitor wells be installed south of existing monitor wells SHS- 5, -6, -7. GCL recommends that the three new monitor wells be located along Circle Drive, south of Block Six, shown on the Suburban Heights Sub-division plat. Local ground water gradients are shown on Figure 1-1 which shows the direction of ground water flow. The first well will be installed directly downgradient of the existing plume, the second will be installed approximately 100 feet west of the first and the third will be installed 100 feet east of the first. Approximate locations for the proposed monitor wells are shown on Figure 1-1. Ground water samples will be collected from the three new monitor wells and analysis performed for halogenated, aromatic, and polynuclear aromatic hydrocarbons. The general chemistry of the groundwater will also be characterized. The results of the investigation will be reported to the OCD on August 24, 1990.

2.0 SOIL BORING

Prior to mobilizing the drill rig to the site, a utility survey will be conducted to ensure that borehole sites are not located over buried pipes or electric lines. Geoscience Consultants Ltd. personnel will review and approve or amend the proposed borehole locations based on their proximity to underground utilities.

Drilling will be performed using a large-diameter hollow-stem auger. All drilling equipment will be steam cleaned before initiation of drilling at each borehole. The continuous sampler will be steam cleaned prior to each use. All cuttings will be contained on plastic and disposed of in an appropriate manner.

Continuous core soil samples will be scanned using an H-Nu Photo-ionization Detector (H-Nu). A sample from each 5.0 - foot interval in the unsaturated zone from each borehole will be retained in a sealed sample container for headspace analysis using the H-Nu.

All boreholes will be logged on standard lithologic log forms, with H-Nu readings noted at the appropriate intervals. Other field notes will be made in a bound field notebook.

3.0 MONITOR-WELL INSTALLATION

The well casing will be composed of 4-inch, flush joint, polyvinyl chloride (PVC) screen and pipe (Figure 3-1), precleaned and prepackaged by the manufacturer. The casing will be installed by connecting individual sections while they are lowered into the borehole through the hollow center of the auger column. A 15-foot screen will be placed at the air/water interface, with 5 feet above the static water level and 10 feet below.

After the well casing has been installed, the auger flights will be retrieved in 5-foot intervals. Precleaned and prepackaged 10-20 grade silica sand will be poured down the auger annulus to fill the void left as each 5 foot flight is removed. This sand, combined with a small volume of formation sand that may slough into the borehole during retraction of the auger column, will provide the filter pack for the well screen. The sand will be placed to a level of 2 to 3 feet above the top of the screen.

A bentonite seal will be placed on top of the filter pack to form an impervious barrier and prevent downward migration of moisture. The remainder of the well annulus up to the ground surface will be grouted with a neat cement slurry containing 5% bentonite. The grout will be inserted from the surface after all remaining auger flights have been removed. The well head will be completed with a flush to grade water proof vault set in a 3-foot by 3-foot concrete slab. The locations and elevations of the monitor wells will be surveyed by a certified land surveyor.

4.0 WELL DEVELOPMENT

Well development will be conducted in 2 phases: bailing and pumping. In the first phase, water will be bailed from the wells in order to remove gross amounts of clay and silt. Bailing will also serve as a verification of proper well alignment. During the second phase of well development, a 2-inch air-ejector pump will be installed in the wells and operated from several different levels within the screened interval. The well will be determined to be fully developed when the indicator parameters of pH, temperature and electrical conductance of water sampled from the well have stabilized over three consecutive measurements.

5.0 SAMPLING

The wells will be sampled with a bottom-filling teflon bailer. The bailer will be steam cleaned prior to use on each well. If a steam cleaner is not available, the bailer will be washed with lab soap, rinsed with methanol, and triple-rinsed with distilled water prior to use on each well. The samples will be obtained according to guidelines cited in EPA's RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (OSWER-9950.1) and shipped to the laboratory in an ice chest following strict chain-of-custody procedures. Radian Analytical Services of Sacramento California will analyze the samples for halogenated and aromatic volatile organic compounds (EPA 601 and 602) and polynuclear aromatic hydrocarbons (EPA 610). Inter-Mountain Laboratories in Farmington, New Mexico, will analyze the ground-water samples to characterize the general chemistry including ionic balance, nitrates/nitrites and total dissolved solids.

6.0 REPORT

GCL will write a report presenting analytical results of the sampling program for the three new monitor wells. The report will contain a map of the ground water surface incorporating ground water elevation data from all wells installed by Giant south of the highway and any other wells where access can be obtained to without undue expenses. A review of the effectiveness of the recovery system will be included in the report. The extent of dissolved phase constituents will be reported and a map produced depicting benzene, toluene, ethylbenzene and xylene concentrations at the new wells.

7.0 SCHEDULE

The work will be scheduled to start June 18, 1990. A final report will be submitted to the OCD on August 24, 1990.

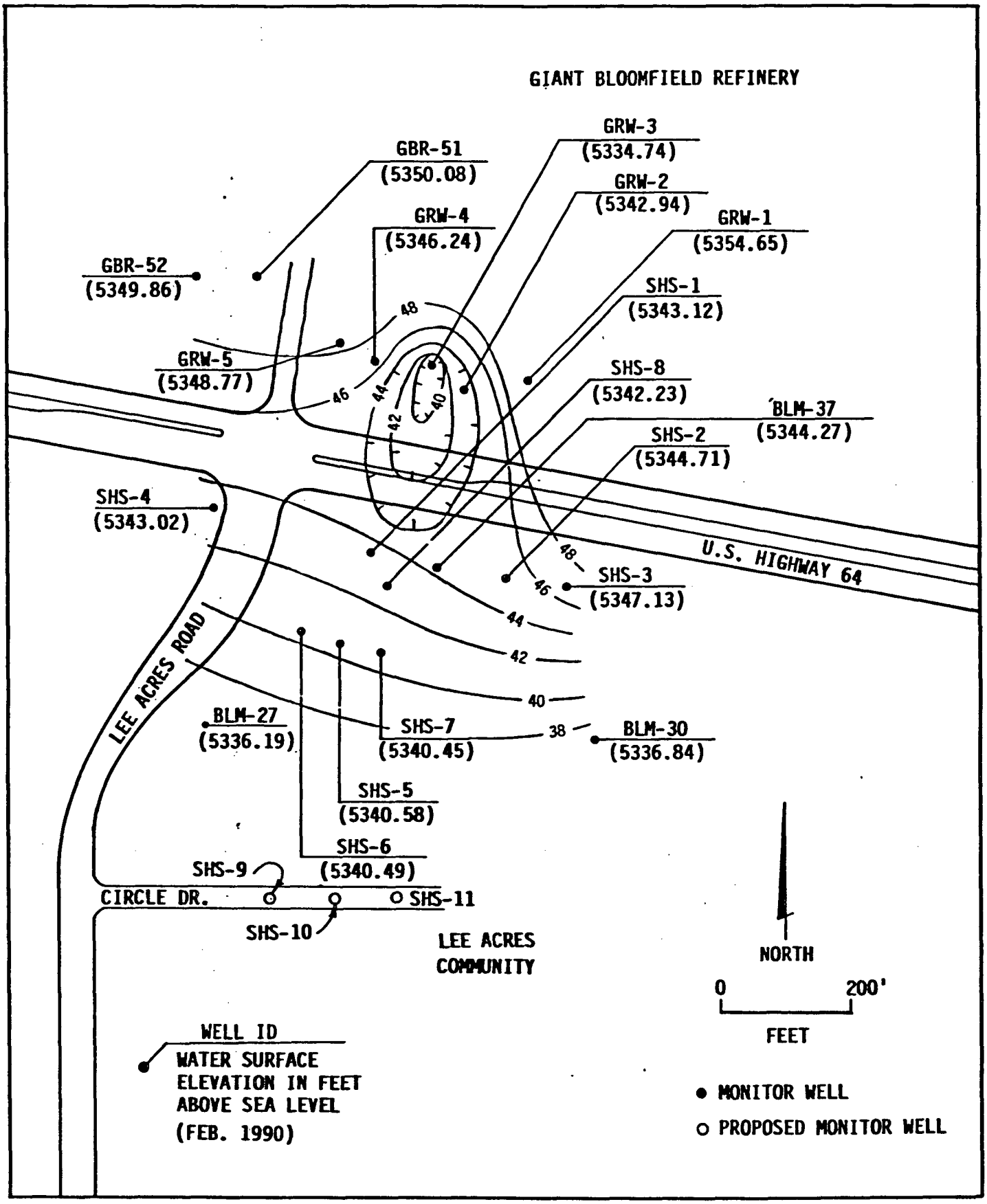

FIGURE 1-1
PROPOSED MONITOR WELL LOCATIONS

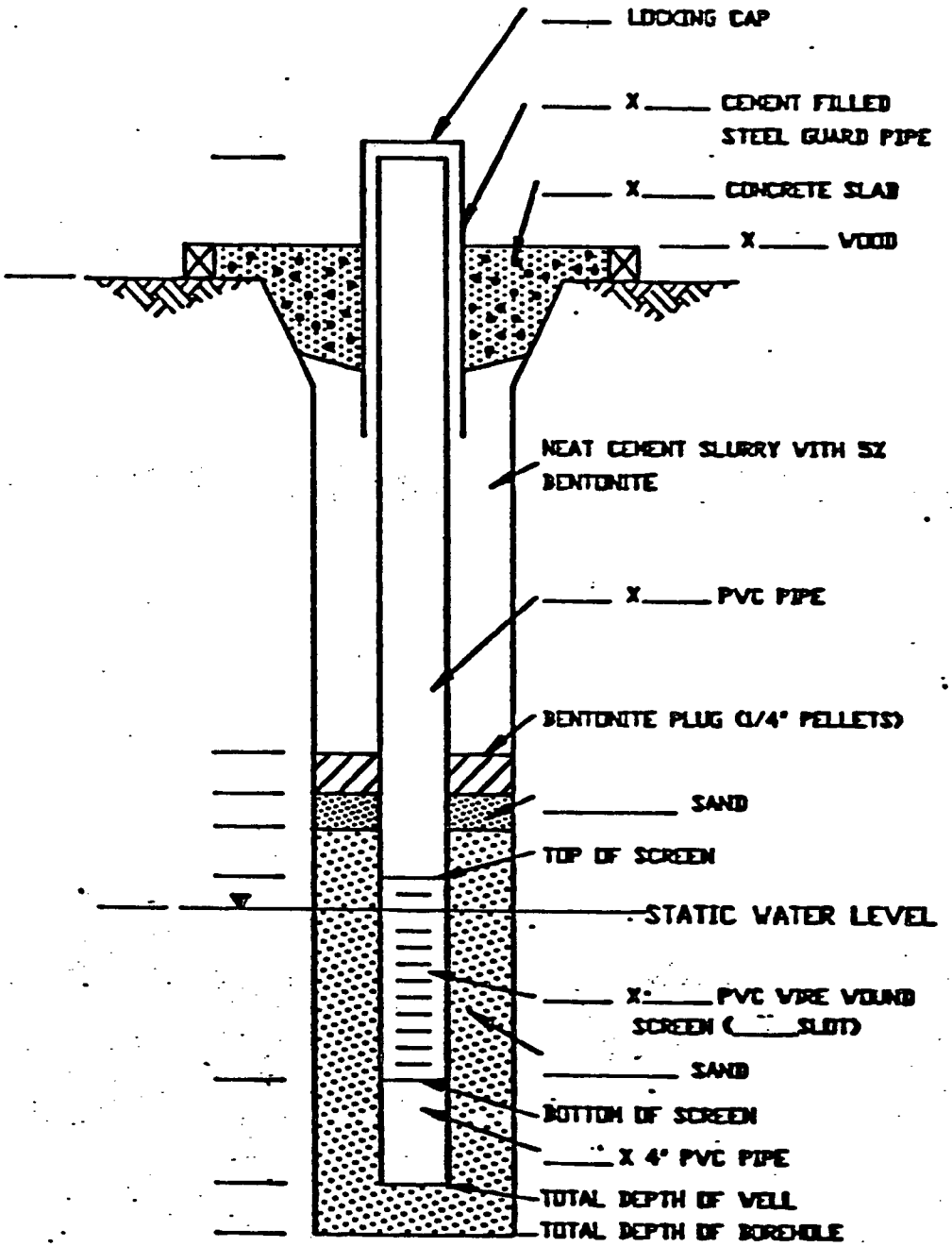

FIGURE 3-1

TYPICAL MONITOR WELL COMPLETION DIAGRAM

SECOND REPORT OF OFF-SITE INVESTIGATION

February 23, 1990

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GCL

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 EXECUTIVE SUMMARY

Geoscience consultants Limited (GCL) has installed six monitor wells and two piezometers south of State Highway 64 in the Lee Acres community. The six monitor wells and three BLM monitor wells have been sampled for total metals, halogenated volatile compounds, aromatic volatile compounds, major ions and total dissolved solids. The results indicate a free-phase hydrocarbon plume restricted to within 100 feet east and west of Bureau of Land Management monitor well BLM-37 and north of monitor well SHS-7. Installation of one recovery well in the free phase plume is proposed.

2.0 INTRODUCTION

In response to the Bureau of Land Management's (BLM) report of free-phase hydrocarbon in BLM's monitor well BLM-37 (Figure 1-1), the Oil Conservation Division (OCD) requested a subsurface investigation south of State Highway 64. GCL submitted a work plan to the OCD on July 7, 1989 titled Off-Site Hydrogeologic Investigation (GCL, 1989a). In accordance with the work plan, GCL installed two monitor wells, performed a soil vapor study, sampled and analyzed ground water and submitted the results to the OCD in the First Report of Off-Site Investigation on October 20, 1989 (GCL, 1989b). The First Report of Off-Site Investigation recommended monitor well installation, piezometer installation and ground water sampling and analysis to further characterize the subsurface South of State Highway 64.

On November 27-30, 1989, and January 2-9, 1990, Geoscience Consultants, Ltd. (GCL) continued the subsurface investigation. The investigation involved installation of two 2-inch piezometers and four 4-inch monitor wells. Installation of the 2-inch piezometers, one located west of County Road 5500 and the other located approximately 120 feet east of SHS-2, took place during November 27-30, 1989 (Figure 1-1). Installation of the 4-inch monitor wells took place during January 2-9, 1990 (Figure 1-1). Three BLM monitor wells and six GCL monitor wells were sampled to characterize the ground water chemistry south of the refinery.

Western Technologies Incorporated (WTI) of Farmington, New Mexico, was contracted to conduct the boring and monitor-well installation. Ground water samples were collected and submitted to Radian Analytical Services in Sacramento, California to be analyzed for halogenated and aromatic volatile organic compounds and metals. GCL also submitted ground water samples to Inter Mountain Laboratories in Farmington, New Mexico to be analyzed for major ions, total dissolved solids and to characterize the general chemistry.

3.0 METHODS OF INVESTIGATION

3.1 MONITOR WELL INSTALLATION

In accordance with the recommendations of the First Report of Off-Site Investigation (GCL, 1989b), GCL supervised the drilling and installation of the six monitor wells south of New Mexico Highway 64 (Figure 1-1).

The monitor wells and piezometers were installed by WTI using a CME-55 drill rig with 10-7/8" inside diameter hollow stem augers. The wells are screened through the water/air interface in order to observe any floating phase constituents. GCL's standard operating procedures were followed for well installation (Appendix A of the off-site investigation Plan; GCL, 1989a).

Borehole logs for SHS-1 through SHS-8 are included as Appendix A of this report. Locations for all boreholes are indicated on Figure 1-1 and on the borehole logs.

After the well casing had been installed, the auger flights were retrieved in 5-foot intervals. Precleaned and prepackaged 10/20 silica sand was poured down the auger annulus to fill the void left as each 5-foot flight was removed. The 10/20 sand was placed to a level of 5 feet above the top of the screen.

A bentonite seal was placed on top of the silica sand to form an impervious barrier and prevent downward migration of moisture. The remainder of the well annulus up to ground surface was grouted with a neat cement slurry containing 5% bentonite. The grout was introduced from the surface after all remaining auger flights had been removed. The well head was completed with the installation of a flush-to-grade concrete slab and waterproof steel vault. Well completion diagrams are included as Appendix A.

Well development and purging was conducted by bailing. The water was bailed from the well in order to remove gross amounts of clay and silt. The well was determined to be fully developed and/or purged when the indicator parameters of pH, temperature and electrical conductance of the ground water from three consecutive bailed samples from the well had stabilized.

3.2 GROUND WATER SAMPLING

Monitor wells BLM-37, BLM-27, BLM-30, SHS-1, SHS-2 and SHS-5 through SHS-8 were sampled to characterize the ground water chemistry. Samples were obtained using a bottom-filling teflon bailer. The bailer was washed with lab soap, rinsed with methanol, and triple-rinsed with distilled water prior to use on each well. The samples were obtained according to guidelines cited in EPA's RCRA Ground-water Monitoring Technical Enforcement Guidance Document (OSWER-9950.1) and shipped to the laboratory in an ice chest following strict chain-of-custody procedures.

Prior to sampling, the monitor wells were purged until three casing volumes of water were removed or indicator parameters of pH, temperature and electrical conductivity of the ground water from the well had stabilized.

Radian Analytical Services analyzed the ground water samples for halogenated volatile organic compounds using EPA method 601, aromatic volatile organic compounds using EPA method 602 and metals using the appropriate EPA method for each analyte. Inter Mountain Laboratories analyzed the ground water samples for major ions, total dissolved solids and performed a mass balance analysis.

4.0 RESULTS

No free-phase hydrocarbon was observed in any of the wells installed for the off-site investigation. Water surface elevations for surrounding wells are shown in Table 4-1. A potentiometric surface map south of State Highway 64 is shown on Figure 4-1. The results of the laboratory analyses are shown in Table 4-2 through 4-5.

5.0 RECOMMENDATIONS

Install one recovery well directly down gradient of monitor well BLM-37, in free phase hydrocarbon. If arrangements can be made with local property owners, a one day soil boring program is recommended to locate the southern edge of the free floating hydrocarbon plume. The recovery well ideally will be located one half of the distance between the southern edge of the plume and BLM-37, but its exact location will depend on landowner permission. If a boring program cannot be arranged with local land owners, the location of the southern edge of the plume will be estimated and the recovery well will be located accordingly. A recovery system will be designed to recover the free-phase hydrocarbon. An aquifer test should be performed to determine aquifer characteristics at the recovery well and to assist in recovery system design.

The product recovery and its affect on ground water gradients in the area will be documented by recording water levels at all Giant SHS monitor wells and measuring product thickness at the recovery well and at monitor well BLM-37 on a monthly schedule. Unrestricted access to BLM monitor well BLM-37 is required. Within three months after the recovery well operations begin, Giant will submit to the OCD in report form all data obtained.

6.0 REFERENCES CITED

GCLa, 1989, Off-site Hydrogeological Investigation, Geoscience Consultants, Ltd., Albuquerque, NM, 10 pp.

GCLb, 1989, First Report of Off-site Investigation, Geoscience Consultants, Ltd., Albuquerque, NM, 8 pp.

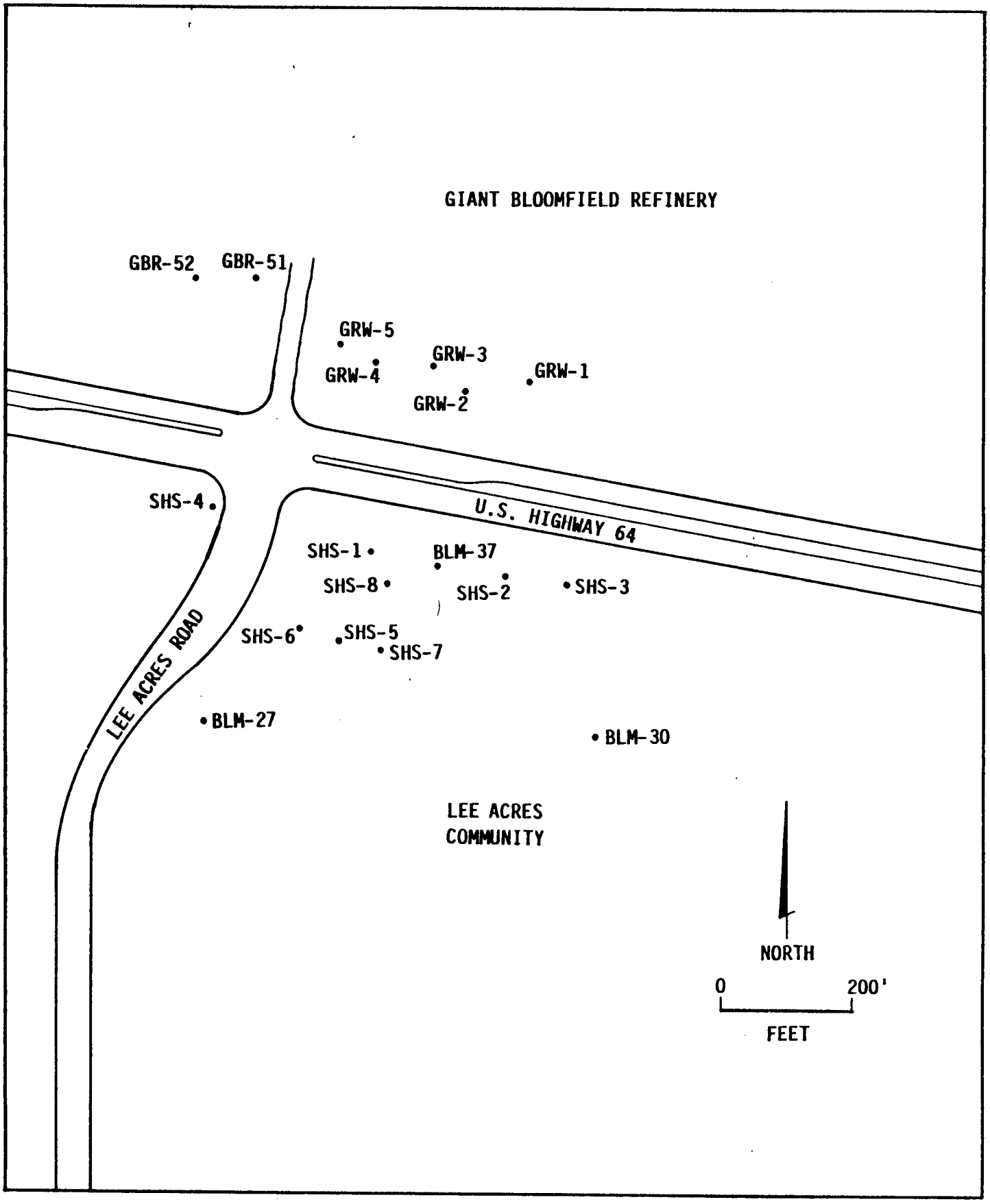


FIGURE 1-1
MONITOR WELL LOCATION MAP

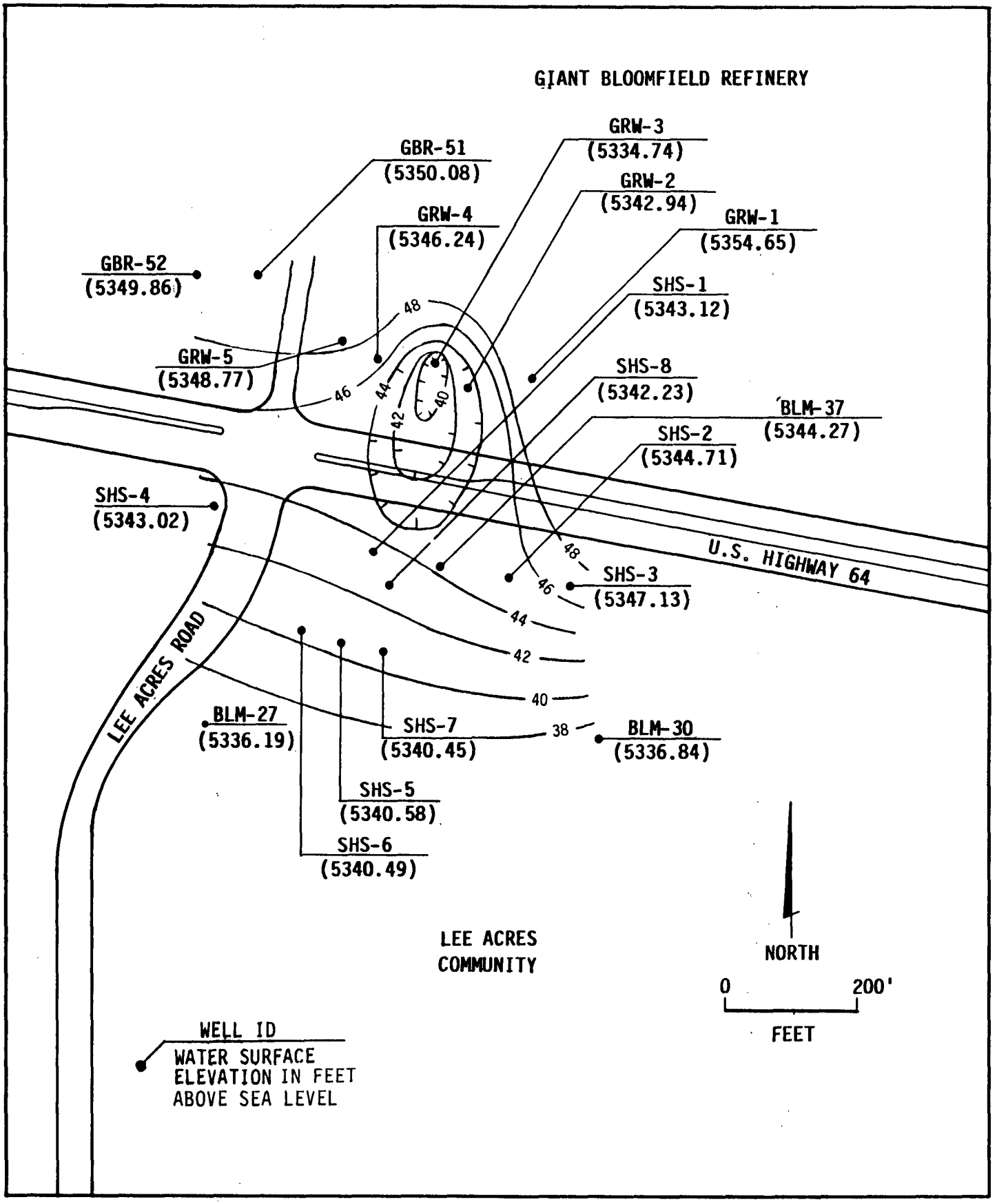


FIGURE 4-1
POTENTIOMETRIC SURFACE CONTOUR MAP
FEBUARY, 1990

TABLE 4-1

WATER LEVEL DATA

Well	Depth to Water	Casing Elevation	Water Surface Elevation
SHS-1	40.42	5383.54	5343.12
SHS-2	36.95	5381.66	5344.71
SHS-3	36.20	5383.33	5347.13
SHS-4	40.60	5383.62	5343.02
SHS-5	37.78	5378.36	5340.58
SHS-6	37.87	5378.17	5340.49
SHS-7	38.32	5378.77	5340.45
SHS-8	38.02	5380.25	5342.23
GRW-1	39.65	5394.30	5354.65
GRW-2	48.34	5391.28	5342.94
GRW-3	54.03	5388.77	5334.74
GRW-4	43.78	5390.02	5346.24
GRW-5	41.79	5390.56	5348.77
BLM-30	32.91	5369.75	5336.84
BLM-27	42.82	5379.01	5336.19
BLM-37*	39.19	5383.46	5344.27
BLM WATER LEVELS TAKEN		12/11/89	
SHS WATER LEVELS TAKEN		2/7/90	
GRW WATER LEVELS TAKEN		12/8/90	

*WATER LEVEL CORRECTED FOR 1.83' HC

ALL DATA ARE IN FEET

TABLE 4-2

RESULTS OF SAMPLING FOR AROMATIC VOLATILES

M&A Offsite Samples
Aromatic Volatiles (EPA 602)
Sampling Event 11/27/89 - 11/30/89;
01/02/90 - 01/10/90
Units: ug/L

	SHS-1	SHS-2	BLM-27	BLM-30	BLM-37
1,2-Dichlorobenzene	ND (100)	ND (4.0)	ND (0.40)	ND (0.40)	ND (800)
1,3-Dichlorobenzene	ND (100)	ND (4.0)	ND (0.40)	ND (0.40)	ND (800)
1,4-Dichlorobenzene	ND (75)	ND (3.0)	ND (0.30)	ND (0.30)	ND (600)
Benzene	ND (50)	10 (2.0)	ND (0.20)	ND (0.20)	16000 (400)
Chlorobenzene	ND (50)	ND (2.0)	ND (0.20)	ND (0.20)	ND (400)
Ethylbenzene	ND (50)	120 (2.0)	ND (0.20)	ND (0.20)	16000 (400)
Toluene	ND (50)	2.2 (2.0)	ND (0.20)	ND (0.20)	1800 (400)
Total Xylenes	330 (50)	37 (2.0)	ND (0.20)	ND (0.20)	75000 (400)

( ) = Detection Limit
ND = Not Detected at Detection Limit

TABLE 4-2

RESULTS OF SAMPLING FOR AROMATIC VOLATILES

M&A Offsite Samples
Aromatic Volatiles (EPA 602)
Sampling Event 11/27/89 - 11/30/89;
01/02/90 - 01/10/90
Units: ug/L

	SHS-5		SHS-6		SHS-7		SHS-8	
1,2-Dichlorobenzene	0.50	(0.40)	ND	(0.40)	ND	(40)	ND	(2.0)
1,3-Dichlorobenzene	ND	(0.40)	ND	(0.40)	ND	(40)	ND	(2.0)
1,4-Dichlorobenzene	ND	(0.30)	ND	(0.30)	ND	(30)	ND	(1.5)
Benzene	ND	(0.20)	ND	(0.20)	190	(20)	14	(1.0)
Chlorobenzene	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(1.0)
Ethylbenzene	ND	(0.20)	ND	(0.20)	ND	(20)	85	(1.0)
Toluene	ND	(0.20)	ND	(0.20)	290	(20)	ND	(1.0)
Total Xylenes	ND	(0.20)	ND	(0.20)	680	(20)	230	(1.0)

( ) = Detection Limit
ND = Not Detected at Detection Limit

TABLE 4-3

RESULTS OF SAMPLING FOR HALOGENATED VOLATILES

M&A Offsite Samples
Halogenated Volatiles (EPA 601)
Sampling Event: 11/27/89 - 11/30/89;
01/02/90 - 01/10/90
Units ug/L

	SHS-1	SHS-2	BLM-27	BLM-30	BLM-37
1,1,1-Trichloroethane	ND (1.0)	ND (0.20)	0.71 (0.20)	ND (0.20)	ND (1.0)
1,1,2,2-Tetrachloroethane	ND (0.75)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.75)
1,1,2-Trichloroethane	ND (1.0)	ND (0.20)	ND (0.20)	ND (0.20)	ND (1.0)
1,1-Dichloroethane	0.72 (2.5)	ND (0.50)	0.30 (0.50)	ND (0.50)	ND (2.5)
1,1-Dichloroethene	ND (1.0)	ND (0.20)	ND (0.50)	ND (0.50)	ND (1.0)
1,2-Dichlorobenzene	ND (2.5)	ND (0.50)	ND (0.50)	ND (0.50)	ND (2.5)
1,2-Dichloroethane	7.1 (0.50)	ND (0.10)	ND (0.10)	ND (0.10)	60 (0.50)
1,2-Dichloropropane	ND (0.50)	ND (0.10)	ND (0.10)	ND (0.10)	ND (0.50)
1,3-Dichlorobenzene	ND (1.6)	ND (0.32)	ND (0.32)	ND (0.32)	ND (1.6)
1,4-Dichlorobenzene	ND (1.2)	ND (0.24)	ND (0.24)	ND (0.24)	ND (1.2)
2-Chloroethylvinyl Ether	ND (2.5)	ND (0.50)	ND (0.50)	ND (0.50)	ND (2.5)
Bromodichloromethane	ND (0.50)	ND (0.10)	ND (0.10)	ND (0.10)	ND (0.50)
Bromoform	ND (2.5)	ND (0.50)	ND (0.50)	ND (0.50)	ND (2.5)
Bromomethane	ND (5.9)	ND (1.2)	ND (1.2)	ND (1.2)	ND (5.9)
Carbon Tetrachloride	ND (0.60)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.60)
Chlorobenzene	ND (1.3)	ND (0.25)	ND (0.25)	ND (0.25)	ND (1.3)
Chloroethane	ND (2.6)	ND (0.52)	ND (0.52)	ND (0.52)	6.0 (2.6)
Chloroform	5.7 (0.50)	ND (0.10)	ND (0.10)	ND (0.10)	ND (0.50)
Chloromethane	ND (1.5)	ND (0.30)	ND (0.30)	ND (0.30)	6.0 (1.5)
cis-1,3-Dichloropropene	N/A	N/A	N/A	N/A	N/A
Dibromochloromethane	ND (1.0)	ND (0.20)	ND (0.20)	ND (0.20)	ND (1.0)
Methylene Chloride	ND (2.0)	ND (0.40)	ND (0.40)	ND (0.40)	ND (2.0)
Tetrachloroethene	ND (0.50)	1.7 (0.10)	ND (0.10)	ND (0.10)	ND (0.50)
trans 1,2-Dichloroethene	21 (1.0)	ND (0.20)	ND (0.20)	ND (0.20)	8.0 (1.0)
trans-1,3-Dichloropropene	ND (1.5)	ND (0.30)	ND (0.30)	ND (0.30)	ND (1.5)
1,1,2-Trichloroethene	6.2 (1.0)	ND (0.10)	ND (0.10)	ND (0.10)	ND (1.0)
Trichlorofluoromethane	ND (1.0)	ND (0.20)	ND (0.20)	ND (0.20)	ND (1.0)
Vinyl Chloride	ND (1.0)	ND (0.20)	ND (0.20)	ND (0.20)	ND (1.0)

( ) = Detection Limit
ND = Not Detected at Detection Limit

TABLE 4-3

RESULTS OF SAMPLING FOR HALOGENATED VOLATILES

M&A Offsite Samples
Halogenated Volatiles (EPA 601)
Sampling Event: 11/27/89 - 11/30/89;
01/02/90 - 01/10/90
Units ug/L

	SHS-5	SHS-6	SHS-7	SHS-8
1,1,1-Trichloroethane	0.88 (0.20)	ND (0.20)	ND (20)	6.2 (1.0)
1,1,2,2-Tetrachloroethane	ND (0.15)	ND (0.15)	ND (15)	ND (0.75)
1,1,2-Trichloroethane	ND (0.20)	ND (0.20)	ND (20)	ND (1.0)
1,1-Dichloroethane	ND (0.50)	ND (0.50)	ND (50)	ND (2.5)
1,1-Dichloroethene	ND (0.20)	0.93 (0.20)	ND (20)	ND (1.0)
1,2-Dichlorobenzene	0.86 (0.50)	ND (0.50)	ND (50)	ND (2.5)
1,2-Dichloroethane	ND (0.10)	ND (0.10)	ND (10)	ND (0.50)
1,2-Dichloropropane	ND (0.10)	ND (0.10)	ND (10)	ND (0.50)
1,3-Dichlorobenzene	ND (0.32)	ND (0.32)	ND (32)	ND (1.6)
1,4-Dichlorobenzene	ND (0.24)	ND (0.24)	ND (24)	ND (1.2)
2-Chloroethylvinyl Ether	ND (0.50)	ND (0.50)	ND (50)	ND (2.5)
Bromodichloromethane	ND (0.10)	ND (0.10)	ND (10)	ND (0.50)
Bromoform	ND (0.50)	ND (0.50)	ND (50)	ND (2.5)
Bromomethane	ND (1.2)	ND (1.2)	ND (120)	ND (5.9)
Carbon Tetrachloride	ND (0.12)	ND (0.12)	ND (12)	ND (0.60)
Chlorobenzene	ND (0.25)	ND (0.25)	ND (25)	ND (1.3)
Chloroethane	ND (0.52)	ND (0.52)	ND (52)	ND (2.6)
Chloroform	ND (0.10)	ND (0.10)	ND (10)	ND (0.50)
Chloromethane	ND (0.30)	ND (0.30)	ND (30)	ND (1.5)
cis-1,3-Dichloropropene	ND (0.20)	ND (0.20)	ND (20)	ND (1.0)
Dibromochloromethane	ND (0.20)	ND (0.20)	ND (20)	ND (1.0)
Methylene Chloride	0.72 (0.40)	ND (0.40)	ND (40)	2.6 (2.0)
Tetrachloroethene	1.3 (0.10)	0.45 (0.10)	ND (10)	ND (0.50)
trans 1,2-Dichloroethene	12 (0.20)	ND (0.20)	ND (20)	24 (1.0)
trans-1,3-Dichloropropene	ND (0.34)	ND (0.34)	ND (34)	ND (1.7)
Trichloroethene	1.8 (0.20)	ND (0.20)	ND (20)	4.7 (1.0)
Trichlorofluoromethane	ND (0.20)	ND (0.20)	ND (20)	ND (1.0)
Vinyl Chloride	ND (0.20)	ND (0.20)	ND (20)	ND (1.0)

( ) = Detection Limit
ND = Not Detected at Detection Limit

TABLE 4-4

RESULTS OF SAMPLING FOR METALS

M&A Offsite Samples
Metals
Sampling Event 11/27/89 - 11/30/89;
01/02/90 - 01/10/90
Units mg/L

	SHS-1		SHS-2		BLM-27		BLM-30		BLM-37	
Antimony	NA		NA		NA		NA		NA	
Beryllium	NA		NA		NA		NA		NA	
Cadmium	ND	(0.0050)	ND	(0.0050)	ND	(0.0050)	ND	(0.0050)	ND	(0.0050)
Chromium	ND	(0.010)	ND	(0.010)	0.074	(0.010)	0.11	(0.010)	0.037	(0.010)
Copper	NA		NA		NA		NA		NA	
Nickel	NA		NA		NA		NA		NA	
Silver	ND	(0.010)	ND	(0.010)	ND	(0.010)	ND	(0.010)	ND	(0.010)
Zinc	NA		NA		NA		NA		NA	
Arsenic	0.024	(0.0020)	0.0048	(0.0020)	0.061	(0.0040)	0.048	(0.0020)	0.030	(0.0020)
Mercury	ND	(0.0002)	ND	(0.0002)	ND	(0.0002)	ND	(0.0002)	ND	(0.0002)
Lead	0.030	(0.0020)	0.0045	(0.0020)	0.082	(0.0020)	0.046	(0.0020)	3.10	(0.0020)
Selenium	ND	(0.0020)	ND	(0.0020)	0.0024	(0.0020)	0.020	(0.0020)	ND	(0.0020)
Thallium	NA		NA		NA		NA		NA	
Barium	0.24	(0.010)	0.40	(0.010)	1.2	(0.010)	0.75	(0.010)	0.22	(0.010)

( ) = Detection Limit
ND = Not Detected at Detection Limit

TABLE 4-4

RESULTS OF SAMPLING FOR METALS

M&A Offsite Samples
Metals
Sampling Event 11/27/89 - 11/30/89;
01/02/90 - 01/10/90
Units mg/L

	SHS-5		SHS-6		SHS-7		SHS-8	
Antimony	0.045	(0.034)	0.067	(0.034)	0.045	(0.034)	0.059	(0.034)
Beryllium	ND	(0.0010)	0.016	(0.0010)	0.003	(0.0010)	0.007	(0.0010)
Cadmium	ND	(0.0040)	0.005	(0.0040)	ND	(0.0040)	ND	(0.0040)
Chromium	0.009	(0.0070)	0.20	(0.0070)	0.024	(0.0070)	0.042	(0.0070)
Copper	0.036	(0.0060)	0.19	(0.0060)	0.075	(0.0060)	0.12	(0.0060)
Nickel	0.13	(0.015)	0.24	(0.015)	0.16	(0.015)	0.26	(0.0150)
Silver	ND	(0.0070)	ND	(0.0070)	ND	(0.0070)	ND	(0.0070)
Zinc	0.20	(0.0020)	0.75	(0.0020)	0.12	(0.0020)	0.24	(0.0020)
Arsenic	ND	(0.0040)	ND	(0.0020)	ND	(0.0040)	ND	(0.012)
Mercury	ND	(0.0002)	ND	(0.0002)	ND	(0.0002)	ND	(0.0002)
Lead	0.006	(0.0030)	0.058	(0.0030)	0.024	(0.0030)	0.039	(0.0030)
Selenium	ND	(0.0050)	ND	(0.0050)	ND	(0.0050)	ND	(0.0050)
Thallium	ND	(0.0050)	ND	(0.0050)	ND	(0.0050)	ND	(0.0050)
Barium	NA		NA		NA		NA	

( ) = Detection Limit
ND = Not Detected at Detection Limit

TABLE 4-5

RESULTS OF SAMPLING FOR MAJOR IONS AND TDS

M&A Offsite Samples
General Water Chemistry
Sampling Event 11/27/89 - 11/30/89;
01/02/90 - 01/10/90

		SHS-1	SHS-2	BLM-27	BLM-30	BLM-37
Bicarbonate as HCO3	mg/l	996.44	1193.31	330.94	171.51	483.66
Calcium	mg/l	444.26	309.51	467.42	553.75	623.23
Carbonate as CO3	mg/l	0.00	0.00	0.00	0.00	0.00
Cation/Anion Difference	%	0.78	0.32	0.59	0.19	0.49
Chloride	mg/l	749.41	401.47	165.94	256.94	457.68
Conductivity	umhos/cm @ 25C	4829	4239	2973	3735	5443
Magnesium	mg/l	39.67	123.99	3.09	58.22	36.54
Major Anions	meq/l	56.10	52.42	37.37	47.51	64.00
Major Cations	meq/l	55.23	52.09	36.93	47.32	64.62
Nitrate	mg/l	NA	NA	NA	NA	NA
pH		7.64	7.53	7.31	7.38	7.95
Potassium	mg/l	1.80	5.40	0.88	2.13	5.56
Resistivity	ohm-m	2.0708	2.3590	3.3636	2.6774	1.8372
Sodium	mg/l	684.00	604.80	306.40	341.40	698.40
Sodium Absorption Ratio		8.34	7.35	3.88	3.69	7.36
Sulfate	mg/l	893.78	1033.69	1308.57	1797.43	2071.49
Total Acidity as CaCO3	mg/l	0.00	0.00	0.00	0.00	0.00
Total Alkalinity as CaCO3	mg/l	816.75	978.12	271.26	140.58	396.44
Total Dissolved Solids (180)	mg/l	3304	3002	2434	3220	4606
Total Dissolved Solids (calc)	mg/l	3303	3066	2415	3094	4131
Total Hardness as CaCO3	mg/l	1271.54	1282.07	1178.91	1621.00	1705.21

NA = Not Analyzed

TABLE 4-5

RESULTS OF SAMPLING FOR MAJOR IONS AND TDS

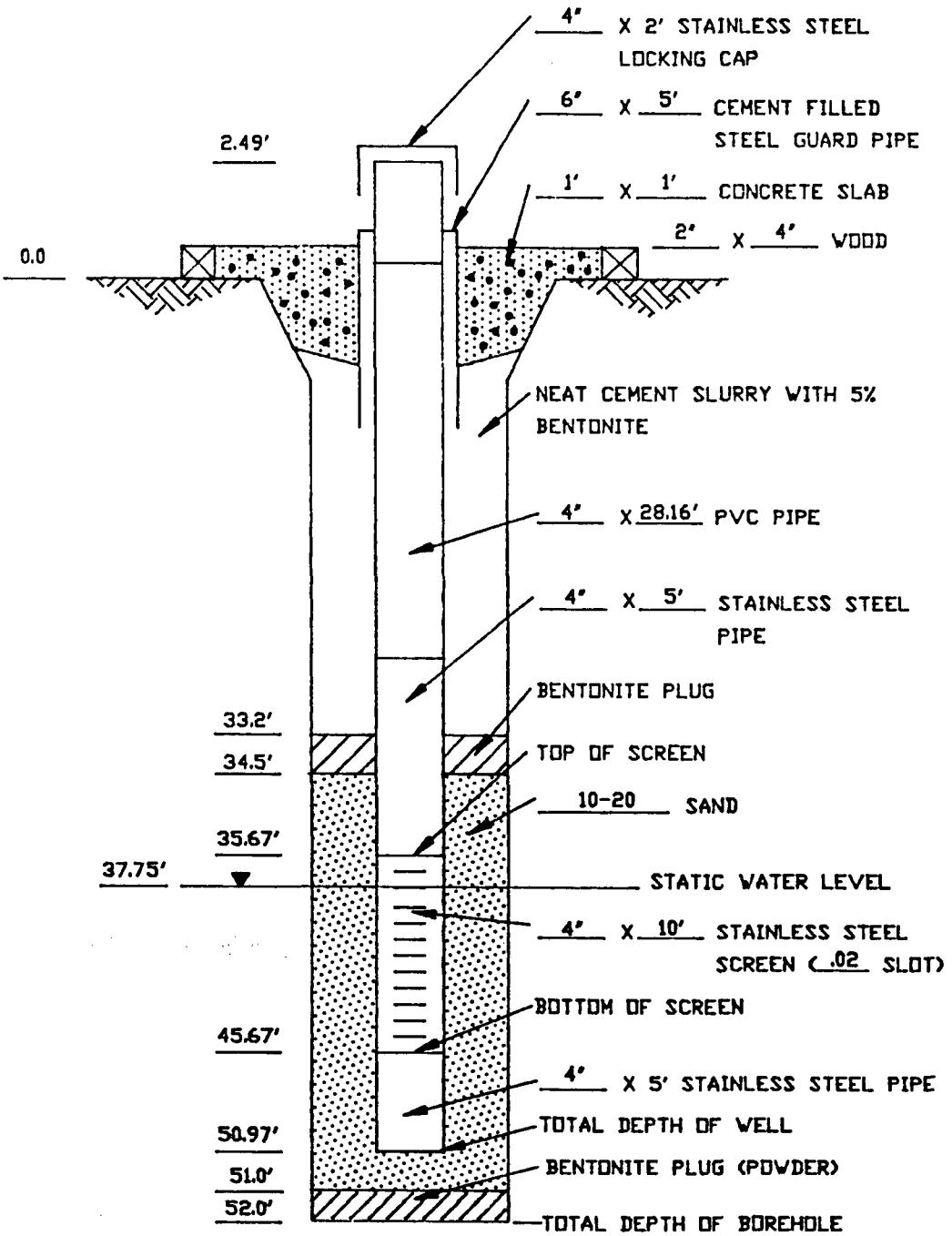
M&A Offsite Samples
General Water Chemistry
Sampling Event 11/27/89 - 11/30/89;
01/02/90 - 01/10/90

		SHS-5	SHS-6	SHS-7	SHS-8
Bicarbonate as HCO3	mg/l	517.88	326.24	1295.84	757.42
Calcium	mg/l	408.47	467.42	332.67	536.90
Carbonate as CO3	mg/l	0.00	0.00	0.00	0.00
Cation/Anion Difference	%	0.20	0.07	1.15	0.21
Chloride	mg/l	355.35	172.60	619.33	751.31
Conductivity	umhos/cm @ 25C	3623	3398	4438	5416
Magnesium	mg/l	8.14	14.35	46.45	50.01
Major Anions	meq/l	41.83	40.84	49.04	62.40
Major Cations	meq/l	41.67	40.90	50.18	62.14
Nitrate	mg/l	NA	NA	NA	NA
pH		7.51	6.97	7.37	7.45
Potassium	mg/l	3.90	13.38	5.40	5.52
Resistivity	ohm-m	2.7601	2.9429	2.2533	1.8464
Sodium	mg/l	471.60	369.00	681.00	714.80
Sodium Absorption Ratio		6.32	4.59	9.27	7.91
Sulfate	mg/l	1119.28	1469.88	495.45	1381.82
Total Acidity as CaCO3	mg/l	0.00	0.00	0.00	0.00
Total Alkalinity as CaCO3	mg/l	424.49	267.41	1062.16	620.84
Total Dissolved Solids (180)	mg/l	2634	2634	2838	3910
Total Dissolved Solids (calc)	mg/l	2621	2667	2818	3813
Total Hardness as CaCO3	mg/l	1052.60	1225.23	1021.02	1545.22

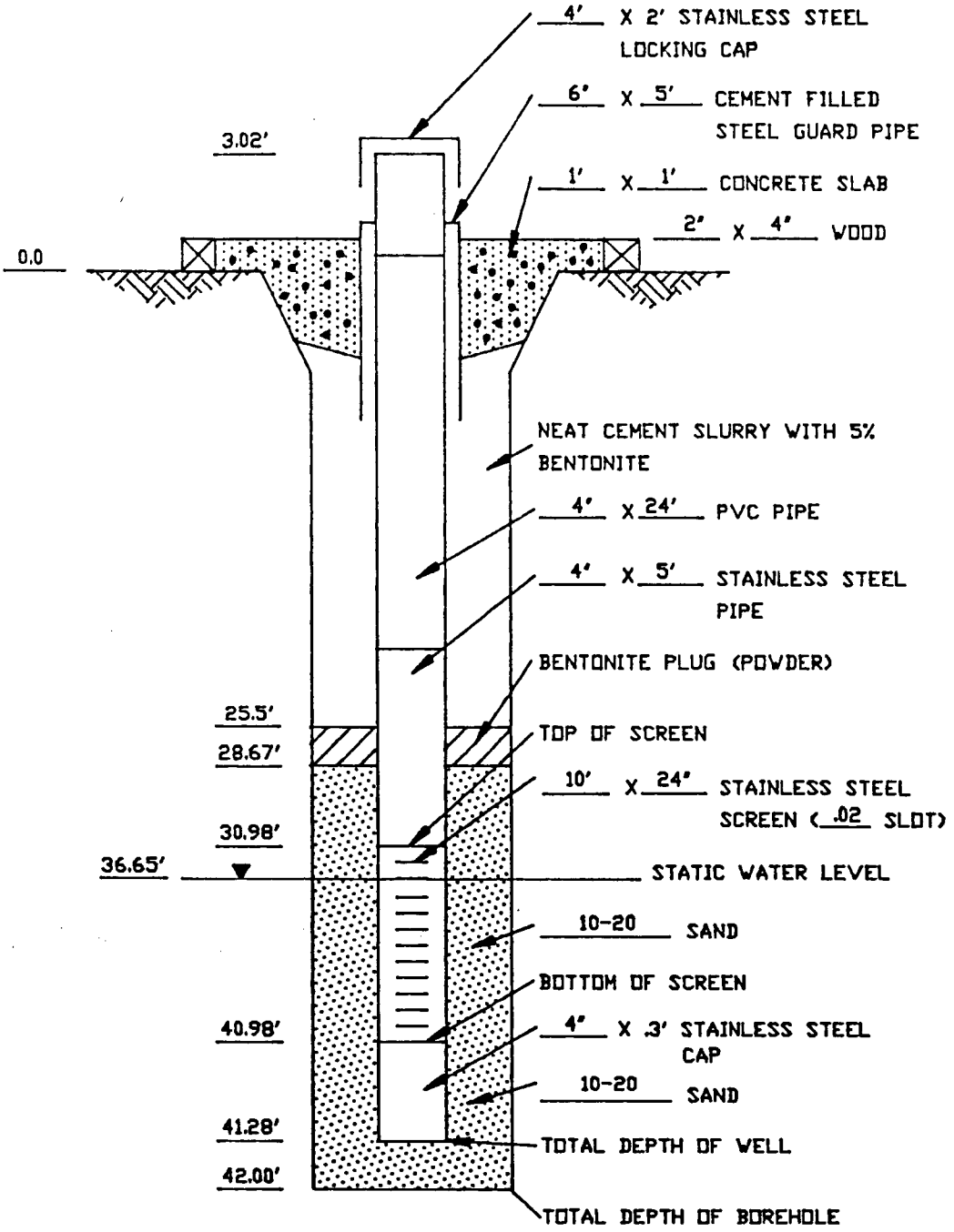
NA = Not Analyzed

APPENDIX A

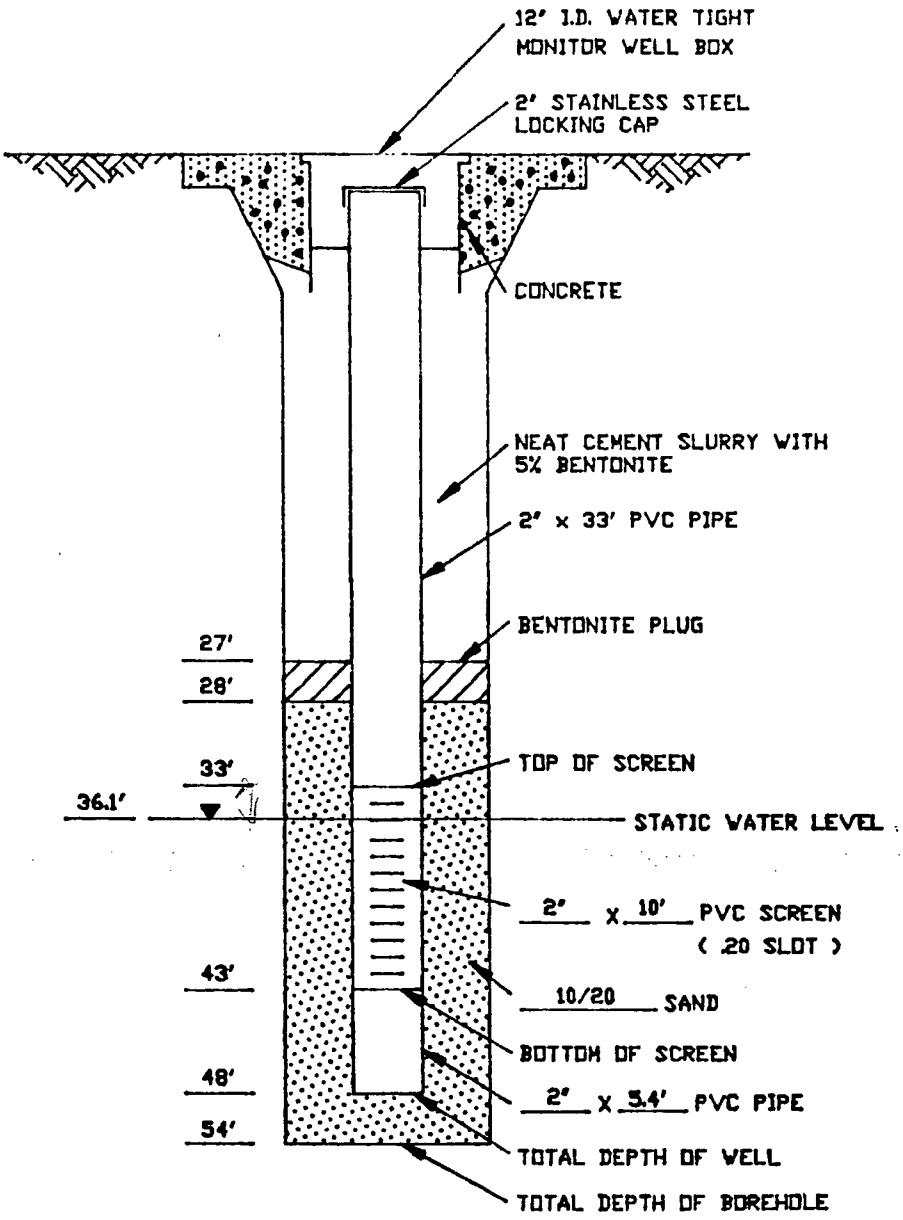
LITHOLOGS AND COMPLETION DIAGRAMS



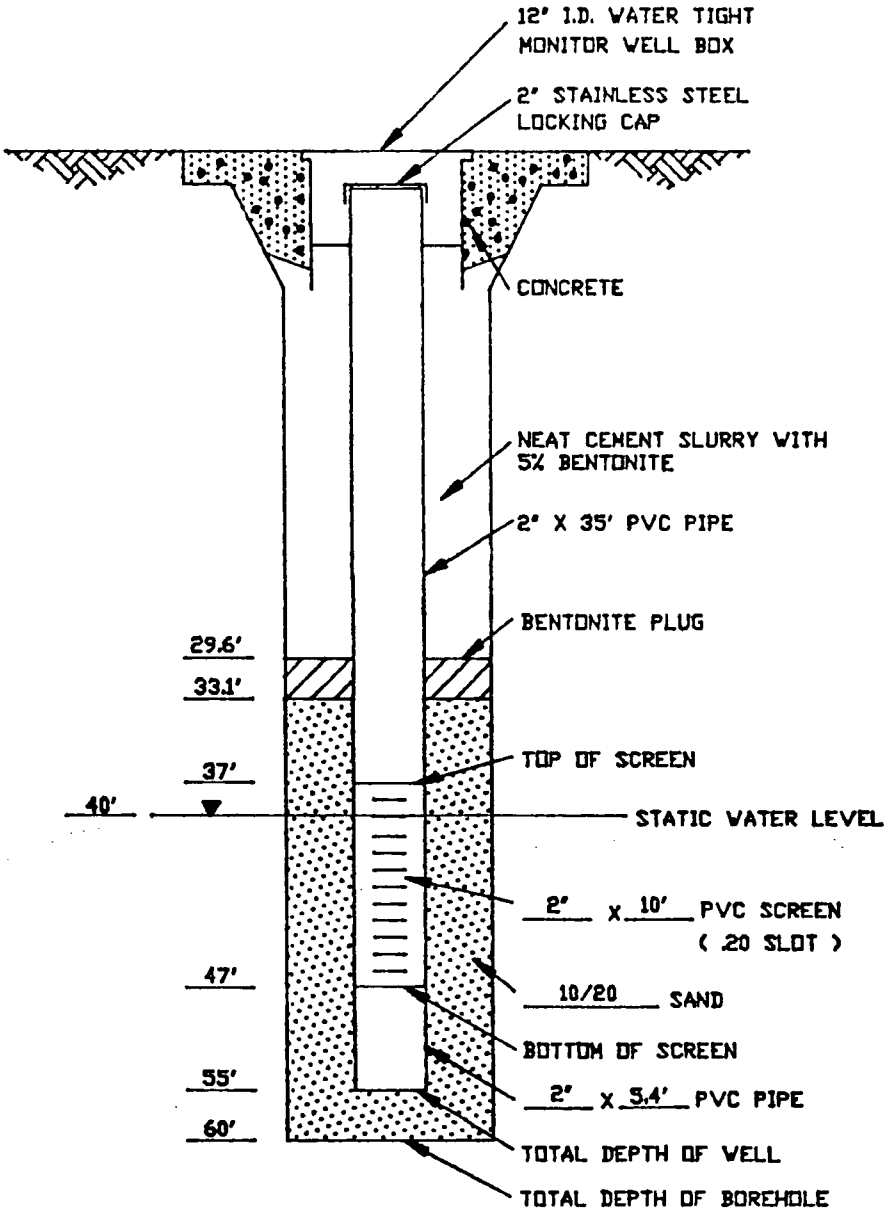
MONITOR WELL COMPLETION DIAGRAM SHS-1



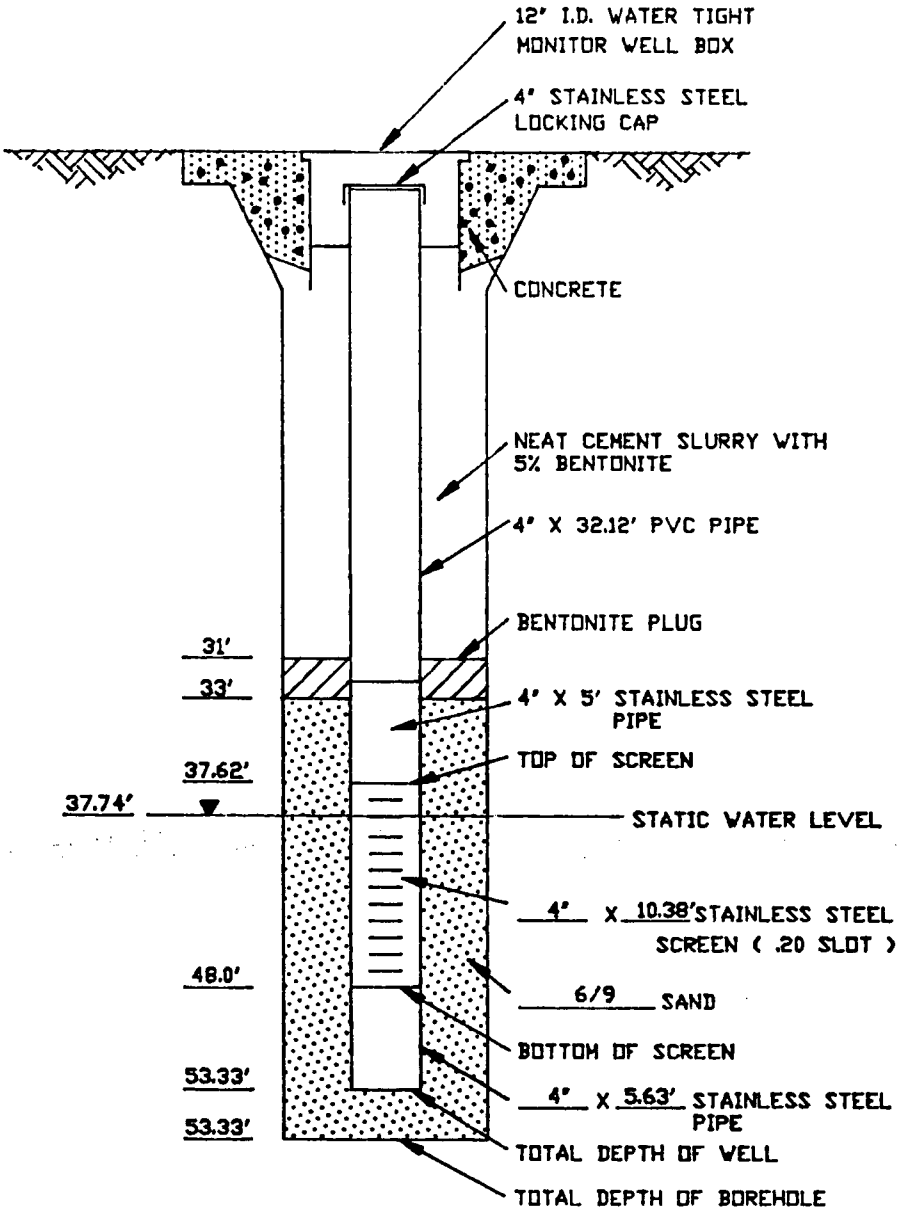
MONITOR WELL COMPLETION DIAGRAM SHS-2



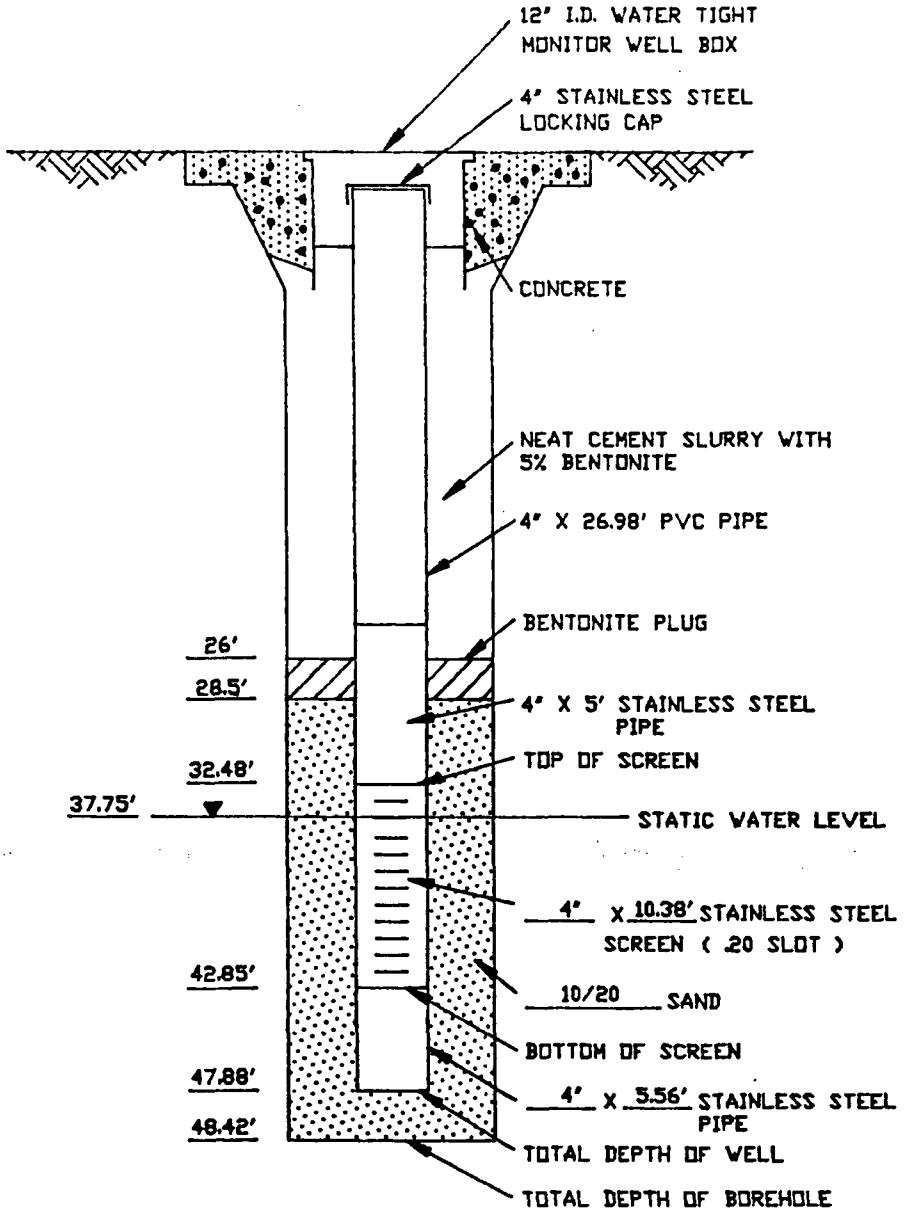
SUBGRADE COMPLETION DIAGRAM SHS-3



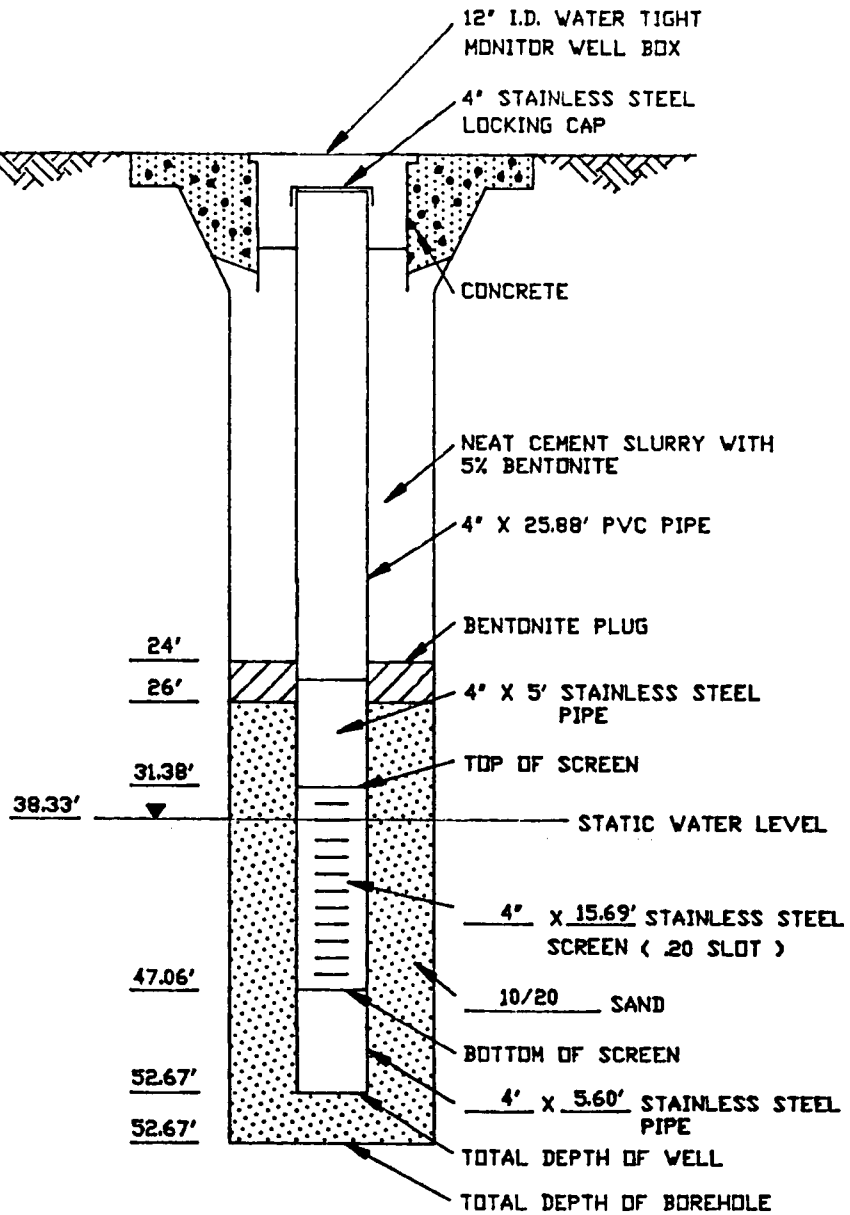
SUBGRADE COMPLETION DIAGRAM SHS-4



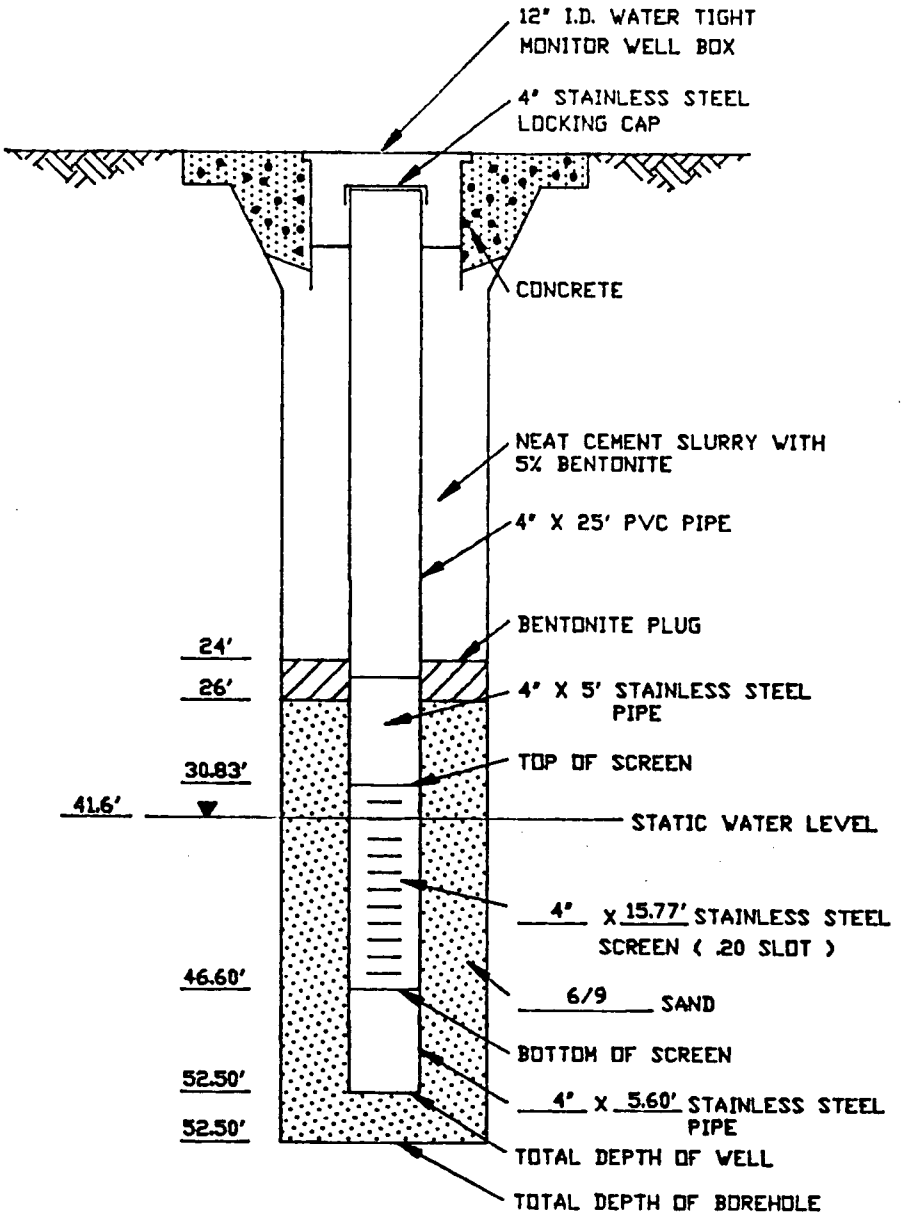
SUBGRADE COMPLETION DIAGRAM SHS-5



SUBGRADE COMPLETION DIAGRAM SHS-6

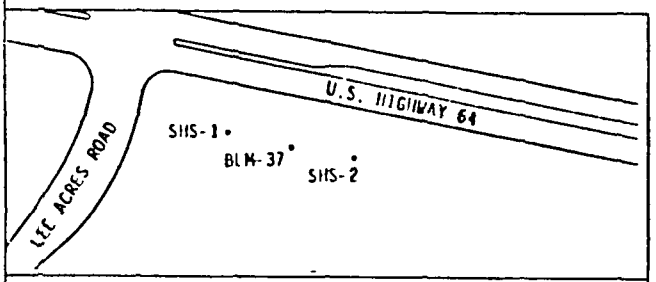


SUBGRADE COMPLETION DIAGRAM SHS-7



SUBGRADE COMPLETION DIAGRAM SHS-8

BOREHOLE LOG (SOIL)



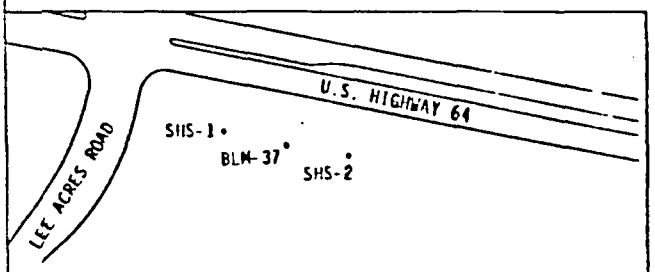
SE 1/4 SW 1/4 NW 1/4 NW 1/4 S 27 T29N R12W

SITE ID: Lee Acres Community LOCATION ID: SHS-1
SITE COORDINATES (ft.): Coordinates are local to GBR
N 9896-34 E 11406.67
GROUND ELEVATION (ft. MSL): Approximately 5381
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Hollow Stem Auger
DRILLING CONTR.: Western Tech
DATE STARTED: 7/31/89 DATE COMPLETED: 8/1/89
FIELD REP.: M. Nee
COMMENTS:

LOCATION DESCRIPTION: South of Giant's Bloomfield refinery on NMSR 64 right of way, 100 ft west of BLM-37

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0			2	1	0	3			SW	0-28' Sand Mod Brn, 10 YR 4/4, v fine to fine grained, well sorted, unconsol., slightly moist at approx. 13'. Minor pebble gravel at 11'-13'.
			5	2	3	8			CL	Silty clayey sand stringer, moderate brown, 10 YR 4/4, at approx. 15'-15.5'.
5									GP	Minor small pebble gravel 22-28'.
			3	3	8	13				28'-30' Clay, moderate olive brn, 5 Y 4/4, minor fine to coarse sand.
10									SW	30'-30.5' Sand as above (0'-28'), no gravel.
			3	4	13	18			CL	6" clay to 31' grading to v fine sand at 33' olive gray, 5 Y 3/2.
15									SC	33'-36' Silty Sandy Clay, moderate olive brn, 5 Y 4/4, approx. 33% clay, 33% sand, 33% silt.
			0	5	18	23				36'-37' as above only stained, olive gray, 5Y 3/2. Fine to coarse sand interval 37' to 37-1/2' then to silty clay olive gray, 5 Y 3/2.
20										
			3	6	23	28			CL	37'-1/2-39' Silty clay, olive gray 5 Y 3/2.
25									SM	39'-40' Silty sand, olive gray, 5 Y 3/2 unconsol., MW sorted.
			5	7	28	33			CL	40'-41.5' Clay, mottled, mod yllsh brn, 10 YR 5/4 - olive gray. 5 YR 3/2.
30									SW	41.5'-42.5' Sand. mod. olive brn 5 Y 4/4, f-m sand, unconsol., MW sorted.
			0	8	33	38			SC	42.5'-43.5' Sandy clay, mod brn, 5 YR 4/4.
35									SW	43'-50' Sand, mod yllsh brn, 10 YR 5/4, fine to med sand. unconsol. MW sorted, saturated
			2	9	38	43			NA	50'-51.5' mudstone/claystone, dusky yellow 5 Y 6/4 to light olive brn, 5 Y 5/6 mod well consolidated, carbonaceous shale present, weathered, shale present.
40										
			0	10	43	48			NA	51.5'-52' Sandstone, dusky yellow, 5 Y 6/4 to light olive brn, 5 Y 5/6, fine to med grained, well consolidated, well sorted.
45										
			3	11	48	52				
50										

BOREHOLE LOG (SOIL)



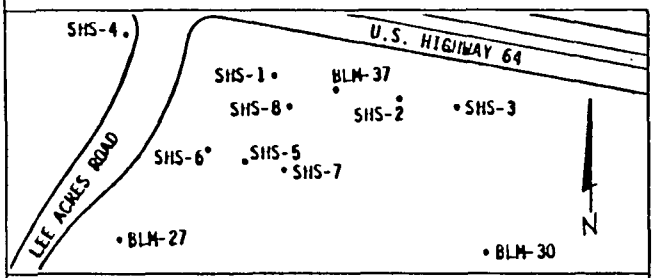
SE 1/4 SW 1/4 NW 1/4 NW 1/4 S27 T29N R12W

SITE ID: Lee Acres Community LOCATION ID: SHS-2
SITE COORDINATES (ft.): Coordinates are local to GBR
N 9854.92 E 11609.55
GROUND ELEVATION (ft. MSL): Approx. 5382
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Hollow Stem Auger
DRILLING CONTR.: Western Technology
DATE STARTED: 8/2/89 DATE COMPLETED: 8/2/89
FIELD REP.: M. Nee
COMMENTS:

LOCATION DESCRIPTION: South of Giants Bloomfield Refinery on NMSR 64 right of way, 100 ft east of BLM-37

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0				1	0	3.5				0-1' Soil, Silty sand w/organics, mod. yllsh, brn 10 YR 5/4, 40% silt, 60% f sand, unconsolidated, mod well sorted, sub angular to sub rounded.
			3.5	2	3.5	3.5				
			2							1'-26' Gravelly Sand, Dark yellowish orange, 10 YR 6/6, 90% v fine - fine pred. quartz, unconsol., well sorted, sub ang to sub rounded, 10% gravel is fine to coarse pebble gravel, rounded.
5				3	8.5	13.5				
										26'-30' Sandy gravel, Dark yllsh orange, 10 YR 6/6, unconsol., rounded, pebble gravel to cobbles.
10										
			3	4	13.5	18.5				30'-33.5' Clayey Silty Sand, mod yllsh brn, 10 YR 5/4. Clay to fine sand, unconsol. poorly sorted.
15										
										33.5'-36' Sand, mod yllsh brn, 10 YR 5/4, fine to mod sand, unconsol. sub ang to sub rounded, mod well.
			3	5	18.5	23.5				
20										36'-37' Clayey Silt, dark yllsh brn, 10 YR 4/4, unconsol. MW sorted.
			0	6	23.5	28.5				37'-39.5' Gravelly Sand, dark yllsh brn, 10 YR 4/2, to olive black, 5 Y 2/1, at 38.5'.
25										
										80% Fine sand, 20% small cobbles, ps, unconsol. sand is sub ang to sub rounded, cobbles are rounded.
			0	7	28.5	33.5				
30										39.5'-40.5' Sandstone, olive black 5 Y 2/1, MW consolidated, stained, appears to be Naciamento.
			2.5	8	33.5	38.5				40.5'-40.8' Claystone, olive gray, 5 Y 4/1, mod well consolidated.
35										
										40.8'-41.1' Sandstone, dark yllsh orange, 10 YR 6/6, med sand, MW sorted, unconsolidated.
			5	9	38.5	43.5				
40										41.1'-41.3' Claystone, olive gray, 5 Y 4/1. mod well consolidated.
										41.8'-42' Sandstone, grayish orange, 10 YR 7/4, med sand, mod consol., subang, calcium cement, moist.
			5	10	43.5	48.5				
45										
			5	11	48.5	53.5				
50										

BOREHOLE LOG (SOIL)



___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: OFFSITE GIANT LOCATION ID: SHS-3
SITE COORDINATES (ft.):
N E
GROUND ELEVATION (ft. MSL):
STATE: NEW MEXICO COUNTY: SAN JUAN
DRILLING METHOD: HOLLOW STEM AUGER
DRILLING CONTR.: WESTERN TECHNOLOGIES INC.
DATE STARTED: 11/29/89 DATE COMPLETED: 11/30/89
FIELD REP.: LINLEY
COMMENTS:

LOCATION DESCRIPTION:

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0									SW	0-6' SAND: Yelsh orange (10 YR 6/6) fn to med fn grained, uncons, mod poorly sorted, sbang to sbrndd, fill.
5									SM	6-8' CLAYEY SAND: Dark yelsh brn (10 YR 4/2) v fn to fn grained, uncons, mod poorly sorted, sbang to sbrndd.
10									SW	8-35' SAND: Dark yelsh orange (10 YR 6/6) fn to med grained, uncons, mod sorted, sbang to sbrndd. At 25' BGL cobbles (intbd w/depth). Clay fraction <10%, Grv fraction ≈15% to 25%.
15										
20										
25										
30										
35									SW	35-38' SAND: (Hily wthd Sst), mod redsh brn (10 R 4/6) to dk yelsh orange (10 YR 6/6), fn to med sand, mod sorting, semiconsol, fri sbang to sbrndd. (v dns) Clay fraction incr w/depth to ≈20%.
40									Pt	38-38.5' COAL: Blk (N1), flaky to leaf like layering, fri, consol.
45									GM	38.5-39.5' GRAVELLY SANDY CLAY: Gnsh gry (5 GY 6/1) to dk yelsh orange (10 YR 6/6) v fn to med grained, poorly sorted, semiconsol, sbang to sbrndd. Grv fraction ≈10-15% & up to 1/8" diam. Sand fraction ≈20-25%.
50									GM	39.5-44' GRAVELLY SAND: Dk yel orange (10 YR 6/6) med to crs grained, uncons, poorly sorted, sbang to sbrndd, wet.

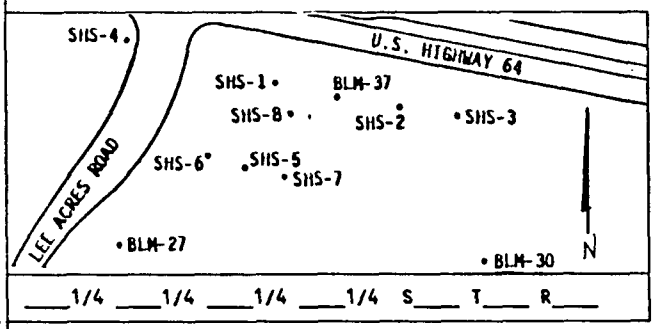
BOREHOLE LOG (SOIL)

(Continued)

LOCATION ID: SHS-3

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
50									ML	44-54' CLAY (SHALE): Lt olv gry (5 Y 6/1) v fn grained, consol, intbd med crs sand horizons (dk yelsh orange (10 YR 6/6) mod sorting, sbang to sbrndd, wet upper 4" of sample & becoming dry w/depth.
55										
60										
65										
70										
75										
80										
85										
90										
95										
100										
105										
110										
115										

BOREHOLE LOG (SOIL)



___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: OFFSITE GIANT LOCATION ID: SHS-4
SITE COORDINATES (ft.):
N E
GROUND ELEVATION (ft. MSL):
STATE: NEW MEXICO COUNTY: SAN JUAN
DRILLING METHOD: HOLLOW STEM AUGER
DRILLING CONTR.: WESTERN TECHNOLOGIES INC.
DATE STARTED: 11/27/89 DATE COMPLETED: 11/28/89
FIELD REP.: LINLEY
COMMENTS:

LOCATION DESCRIPTION:

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0									SW	0-27' SAND: Grysh orange (10 YR 7/4): v fn to med fn grained, sbang to sbrndd, uncons, mod sorted, moist at ≈15' BGL. 20-21' BGL Grv horizon, well rndd, ≈0.5" diam. Overall grain size incr w/depth to med-med crs sand. Grv fraction incr in Lith at ≈25' BGL.
5										
10										
15										
20										
25									GM	27-32' GRAVELLY CLAYEY SAND: Grysh orange (10 YR 7/4) v fn to crs grained, poorly sorted, sbang to sbrndd, semi to uncons, moist. Grv content ≈10-15%, clay fraction ≈25-30%.
30									GC	32-37' GRAVELLY SANDY CLAY: As above w/color change to grysh orange (10 YR 7/4) to mod yelsh brn (10 YR 5/4). Grv fraction decr w/depth to ≈5%, clay fraction ≈50% incr w/depth to ≈75%, Grv fraction 0% at 37' BGL.
35									SC	37-44' SANDY CLAY: Grysh orange (10 YR 7/4) v fn to med fn grained, poorly sorted, semiconsol, sbang to sbrndd, moist. Sand fraction ≈20-25% & decr w/depth to 15-20% & bcm fn grained.
40									SM	44-45' CLAYEY SAND: Grysh orange (10 YR 7/4) to mod yelsh brn (10 YR 5/4). V fn to med fn grained, uncons, sbang to sbrndd, poorly sorted, moist.
45									SC	45-50' SANDY CLAY: Grysh orange (10 YR 7/4) to mod yelsh brn (10 YR 5/4) v fn to med grained, poorly sorted, sbang to sbrndd, semiconsol, moist. Sand fraction ≈20% incr w/depth to ≈30-35% at 48' BGL, then decr to ≈15% & bcm fn grained. Grv horizon at 47-49' BGL.
50										

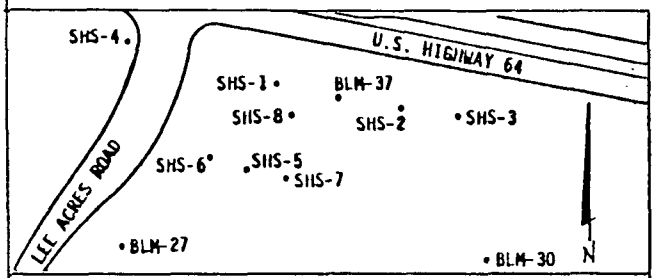
BOREHOLE LOG (SOIL)

(Continued)

LOCATION ID: SHS-4

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
50									ML	50-60' SHALE: Lt olv (10 Y 5/4) to dk gnsh yel (10 Y 6/6) v fn grained, consol, well sorted, sbrndd to rndd.
55										
60										
65										
70										
75										
80										
85										
90										
95										
100										
105										
110										
115										

BOREHOLE LOG (SOIL)



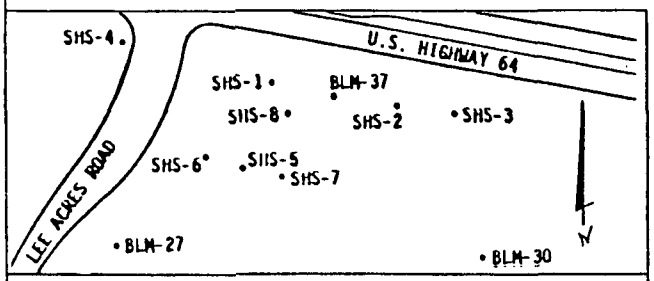
___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: OFFSITE GIANT LOCATION ID: SHS-5
SITE COORDINATES (ft.):
N E
GROUND ELEVATION (ft. MSL):
STATE: NEW MEXICO COUNTY: SAN JUAN
DRILLING METHOD: HOLLOW STEM AUGER
DRILLING CONTR.: WESTERN TECHNOLOGIES INC.
DATE STARTED: 1/7/90 DATE COMPLETED: 1/8/90
FIELD REP.: LINLEY
COMMENTS:

LOCATION DESCRIPTION:

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0		100%	1	1	0	3′			SW	0-31′ SAND: Grysh orange (10 YR 7/4), v fn to med fn sand, poorly sorted, uncons, sbang to sbrndd, abd rootlets. Cobbles at 10′ BGL -up to 4" diam, sbrndd ≈1′ thick at 13-14′ BGL -at ≈18′ BGL 6" thick lens of clayey silt -intbd Grv through depth up to 1" diam sbang to sbrndd.
		0%	2	2	3	8′				
5										
		4%	3	3	8	14′				
10										
		40%	4	4	14	18′				
15										
		0%	5	5	18	23′				
20										
		75%	6	6	23	27′				
25										
		100%	7	7	27	33′				
30										
									SC	31-32′ CLAYEY SILT: Mod yelsh brn (10 YR 5/4) v fn to fn med sorting uncons to semiconsol, sbang to sbrndd.
		100%	8	8	33	38′			SM	32-38′ SILTY SAND: Grysh orange (10 YR 7/4), fn to med fn grained semi to uncons sbang to sbrndd, mod poorly sorted incr grain size w/depth to med sand.
35										
		30%	9	9	38	42′				
40									SP	38-42′ SAND: Pale yelsh orange (10 YR 8/6) fn to med crs, poorly sorted, uncons sbang to sbrndd, v moist.
		20%	10	10	42	47′				
									SC	42-43′ CLAYEY SILT: Pale yelsh brn (10 YR 6/2) v fn to fn, mod sorted, semiconsol, sbang to sbrndd, sat.
45										
		20%	11	11	47	52′			SW	43-58′ SAND: Pale yelsh brn (10 YR 6/2) fn to med crs sand, poorly sorted, uncons, sbang to sbrndd, sat.
50										
		10%	12	12	52	57′				

BOREHOLE LOG (SOIL)



___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: OFFSITE GIANT LOCATION ID: SHS-6
SITE COORDINATES (ft.):
N_____ E_____
GROUND ELEVATION (ft. MSL):
STATE: NEW MEXICO COUNTY: SAN JUAN
DRILLING METHOD: HOLLOW STEM AUGER
DRILLING CONTR.: WESTERN TECHNOLOGIES INC.
DATE STARTED: 01/03/90 DATE COMPLETED: 01/03/90
FIELD REP.: LINLEY
COMMENTS:

LOCATION DESCRIPTION:

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0		75%	1	1	0	3'			SW	0-24' SAND: Dk yelsh orange (10 YR 6/6) med fn to med crs grained, sbang to sbrndd, uncons, poorly sorted minor rootlets, Grv fraction 1-3% up to 1.5" diam. Bcm med to fn grained w/depth, clay - silt fraction ≈15-20% intbd (cobbles @ ≈8' BGL) - at 20' BGL back to med crs to crs sand. 21' BGL cobbles - out by 22' BGL.
		50%	2	2	3	9'				
5										
		75%	3	3	9	17'				
10										
		40%	4	4	13	17'				
15										
		40%	5	5	17	22'				
20										
		75%	6	6	22	26'				
25		80%	7	7	26	31'			SM	24-26' SANDY CLAY: Lt olv gry (5 Y 5/2) v fn grained, mod sorted, sbang to sbrndd, semiconsol, moist. Sand fraction ≈15% med fn grained - Grv layer just at contact of sand - clay interface (24') clasts up to 1.5-2" diam, sbrndd, at 24.5' BGL 0.5' sand lens med crs as above.
30		60%	8	8	31	36'			SW	26-45' SAND: Dusky yel (15 Y 6/4) to yellsh gry (5 Y 7/2) med crs sand, sbang to sbrndd, uncons, poorly sorted grading into med fn sand at 28' BGL. ≈3" silt layer at 27.5" BGL. At 34' BGL Grv lens ≈0.5-1.5" diam sbrndd 3-4" thick. Intbd of silty sands at 44' BGL cobbles 0.5" diam in sample. Sat at ≈37-38' BGL. No trace of HC in sampler - intbd Grv up to 2" diam sbang to sbrndd.
35		60%	9	9	36	41'				
40		40%	10	10	41	46'			SW	45-48.5' BEDROCK-SANDSTONE: Mod yel (5 Y 7/6) to dusky yel (5 Y 6/4), med to fn grained, consol, mod sorting sbang to sbrndd, intbd silty clays. TD 48.5 auger refusal.
45		20%	11	11	46	48'				
50										

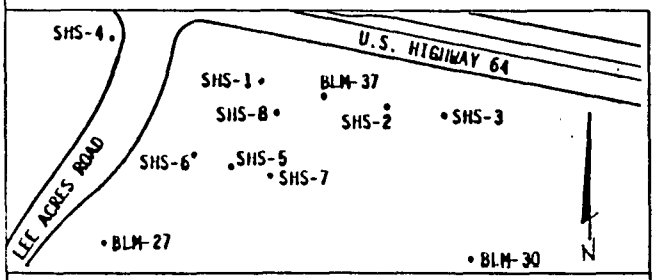
BOREHOLE LOG (SOIL)

(Continued)

LOCATION ID: SHS-7

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
50										41-54' SAND: Pale to lt olv (10Y 6/2-5/4) med crs, mod sorted uncons, sbang to sbrndd, v moist. No odor silt fraction ≈25% decr w/depth, noted dk HC stained horizon at ≈49' BGL ≈4 to 6" thick TD 54' BGL.
55										
60										
65										
70										
75										
80										
85										
90										
95										
100										
105										
110										
115										

BOREHOLE LOG (SOIL)



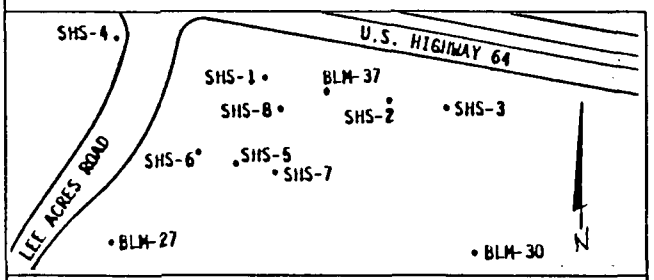
___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: OFFSITE GIANT LOCATION ID: SHS-7
SITE COORDINATES (ft.):
N_____ E_____
GROUND ELEVATION (ft. MSL):
STATE: NEW MEXICO COUNTY: SAN JUAN
DRILLING METHOD: HOLLOW STEM AUGER
DRILLING CONTR.: WESTERN TECHNOLOGIES INC.
DATE STARTED: 01/04/90 DATE COMPLETED: 01/06/90
FIELD REP.: LINLEY
COMMENTS:

LOCATION DESCRIPTION:

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0		100%	1	1	0	4'			SW	0-36' SAND: Dk yelsh orange (10 YR 6/6) fn to med fn grained, mod poorly sorted, uncons, sbang to sbrndd. Rootlets in upper 18", sand bcm more crs grained w/depth to a med to med crs grained,
5		100%	2	2	4	9'				rootlets at 10-12' BGL, encountered cobbles at ≈16' BGL, cobbles at 26' GBL, med crs to crs sand, cobbles up to 5" diam, rootlets at 27' BGL. Grv up to 2.5" diam w/med crs sand at 30-
10		50%	3	3	9	14'				35' BGL.
15		70%	4	4	14	18'				
20		0%	5	5	18	22'				
25		50%	6	6	22	27'				
30		60%	7	7	27	32'				
35		80%	8	8	32	37'				
40		30%	9	9	37	41'			SM	36-37' SAND SILT: Dk yelsh orange (10 YR 6/6) v fn to fn grained semiunconsol, sbang to sbrndd mod poorly sorted, clay fraction ≈15% sand fraction ≈30%, 37' BGL noted HC odor from drilling cuttings at 38' BGL noted (bottom of sampler) blk horizon w/HC odor noted H_2O at ≈42' BGL - cuttings have blk staining (?) w/HC odor. HC horizon _____.
45		40%	10	10	41	45'				
50		50%	11	11	45	50'			SC	37-40' CLAYEY SAND: Grysh olv, v fn to med crs, poorly sorted, semi to uncons sbang to sbrndd, sat. HC odor.
									SC	40-41' CLAYEY SILT: Grysh orange (10 YR 7/4) v fn to fn mod poorly sorted, semi to consol sbang to sbrndd, moist, no odor.

BOREHOLE LOG (SOIL)



____1/4 ____1/4 ____1/4 ____1/4 S____ T____ R____

SITE ID: OFFSITE GIANT LOCATION ID: SHS-8
SITE COORDINATES (ft.):
N E
GROUND ELEVATION (ft. MSL):
STATE: NEW MEXICO COUNTY: SAN JUAN
DRILLING METHOD: HOLLOW STEM AUGER
DRILLING CONTR.: WESTERN TECHNOLOGIES INC.
DATE STARTED: 01/09/90 DATE COMPLETED: 01/09/90
FIELD REP.: LINLEY
COMMENTS:

LOCATION DESCRIPTION:

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0		60%	1	1	0	4'			SM	0-6' SANDY SILT: Dk yelsh orange (10 YR 6/6) v fn to fn grained uncons, mod sorted, sbang to sbrndd, rootlets.
5		80%	2	2	4	9'			SW	6-15' SAND: Mod yelsh brn (10 YR 5/4) fn to med crs, poorly sorted, uncons sbang to sbrndd, Grv at ≈8' BGL and ≈1' thick, up to 1-2" diam, sbrndd to sbang, rootlets.
10		70%	3	3	9	14'				
15		30%	4	4	14	19'			SM	15-17' SANDY SILT: Pale yelsh brn (10 YR 6/2) v fn to med fn grained, poorly sorted semi to uncons, sbang to sbrndd.
20		60%	5	5	19	24'			SW	17-37' SAND: Mod yelsh brn (10 YR 5/4) fn to med crs, poorly sorted, uncons, sbang to sbrndd, moist, at ≈37' BGL noted blk stain in cuttings w/HC odor.
25		50%	6	6	24	29'				
30		70%	7	7	29	34'				
35		100%	8	8	34	39'				
40		70%	9	9	39	41'			SM	37-39' SILTY SAND: Dk gnsh gry (5 GY 4/1) to grysh blk (N 2) (HC staining ?) v fn to med fn sand, semi to uncons, mod poorly sorted, sbang to sbrndd, v moist, HC odor w/staining, HNu = 120, LEL = 74%.
		0%	10	10	41	45'			SW	39-41' SAND: Dk gnsh gry (5 GY 4/1) fn to med grained, poorly sorted, uncons, sbang to sbrndd, sat.
45		10%	11	11	45	50'			SM	41-45' SANDY SILT: Gnsh gry (5 GY 6/1) v fn to fn grained, mod poorly sorted, semi to uncons, sbang to sbrndd, sat.
50		20%	12	12	50	53'				

LOG OF BOREHOLE

Location: LEE ACRES LANDFILL
Coordinates: N3546 E5737
Total Depth: 34.70'

Borehole/Well No.: BLM-30
Ground Surface Elevation: 5367.77
Water Level Encountered:
Static:

Drilling Company: Stewart Brothers
Date Drilled: November 3, 1987
Drilling Method: Hollowstem Auger
Logged By: L. Gregory-Frost
Geologist

Driller: Danny White
Helper: Dave Clark, Walter Smith
Drilling Fluid: none

Comments:

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			0.0-20.0' SAMPLE. CUTTINGS: SAND: see BLM-31 for accurate description of 0.0-20.0'. 20.0-20.6' SAMPLE. Recovered 0.6/0.6' = 100%. SANDSTONE: moderate yellowish brown (10 YR 5/4) and yellowish gray (5 Y 7/2) matrix; coarse to very coarse-grained; subangular to angular; occasional pebbles; moderately sorted; 95% quartz grains with 5% black, pink, rust, and brick red grains; well cemented horizontally and poorly cemented vertically; overall moderately cemented; hard; dry to moist. 20.6-27.5' SAMPLE. Center bit. 27.0-27.5' SAMPLE. Recovered 0.5/0.5' = 100%. SANDSTONE: same as 20.0-20.6'; moderately cemented horizontally; poorly cemented vertically; moist. 27.5-32.0' SAMPLE. Center bit.	
5				
10				
15				
20				

LOG OF BOREHOLE

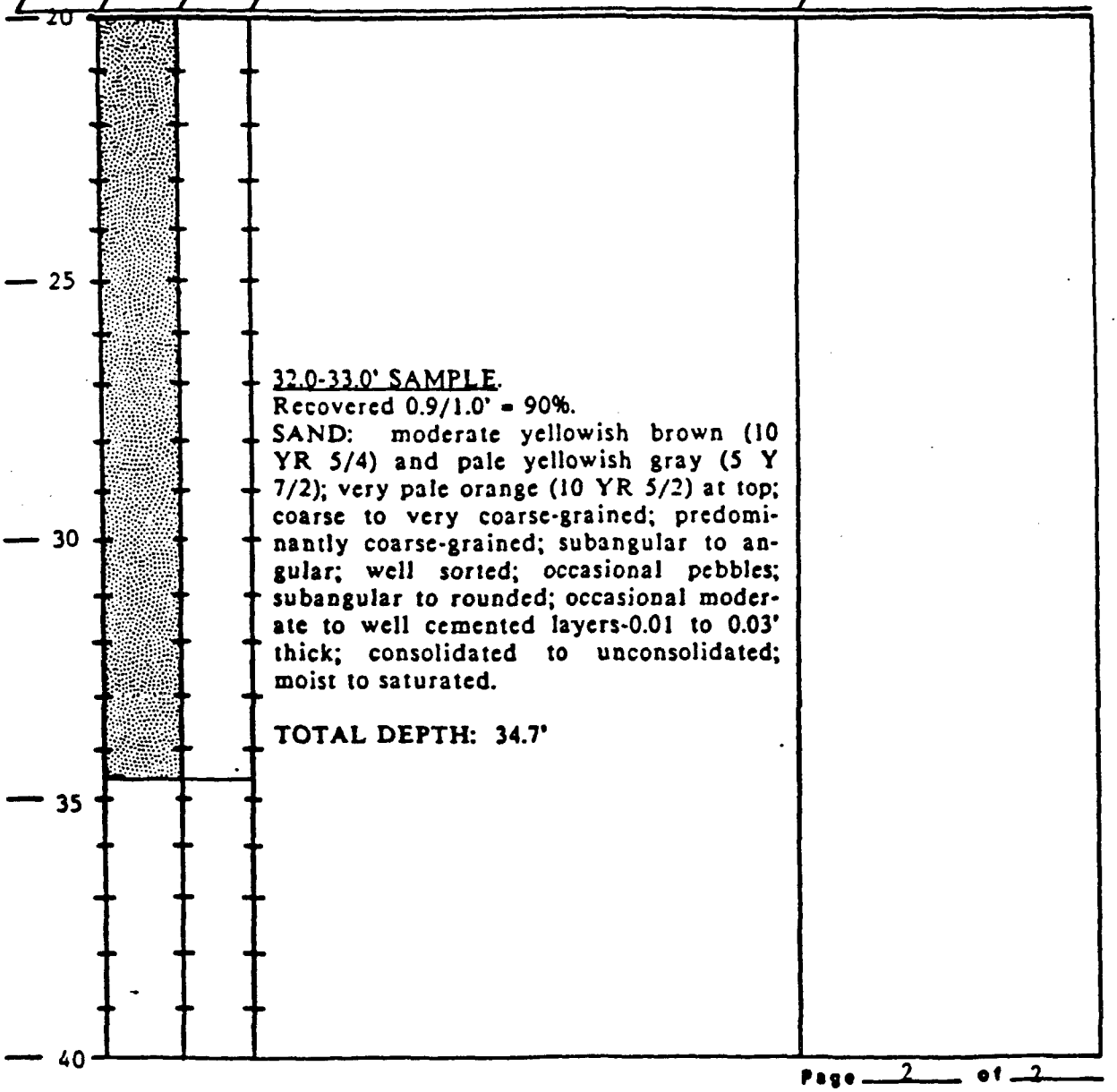
Location LEE ACRES LANDFILL
Coordinates
Total Depth

Borehole/Well No. BLM-30
Ground Surface Elevation
Water Level Encountered
Static

Drilling Company
Date Drilled
Drilling Method
Logged By
Geologist

Driller
Helper
Drilling Fluid

Comments



Well BLM-30

Well Construction Summary

Location or Coords: N 3546 E 5737

Elevation: Ground Level 5367.77

Top of Casing 5369.75

Drilling Summary:

Total Depth 34.70'

Borehole Diameter 7.25"

Driller Danny White
Stewart Bros. Drilling Co.
Grants, New Mexico

Rig Failing F-10

Bit(s) 7.25" auger blade bit

Drilling Fluid None

Surface Casing None

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C = Casing S = Screen

0.0	-	24.29	C_1		-		
24.29	-	34.60	S_1		-		
	-				-		
	-				-		
	-				-		
	-				-		
	-				-		
	-				-		

Casing: C1 2" I.D. 316 L Stainless Steel; flush-threaded

C2

Screen: S1 2" I.D. 316 L Stainless Steel, 0.010" slot

S2

Centralizers None

Filter Material 10/20 grit silica sand; 1.0 - 2.0 ϕ silica sand

Cement Portland Type I Cement/ Sodium Bentohite Grout

Other 2" 316 L Stainless Steel top cap, bottom cap
4" x 5' steel well covers with lockable cap

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
7.25" auger	11/3	0725	11/3	0906
Geophys. Logging:	NA			
Casing: Steel 2" Stainless	11/3	0906	11/3	0927
Filter Placement:	11/3	0927	11/3	1009
Cementing:	11/3	1020	11/3	1034
Development:				
Other: slurry Bentonite	11/3	1009	11/3	1020

Well Development:

See well development summary table.

Comments:

All "O" rings removed from screen/ casing.

WESTON

LOG OF BOREHOLE

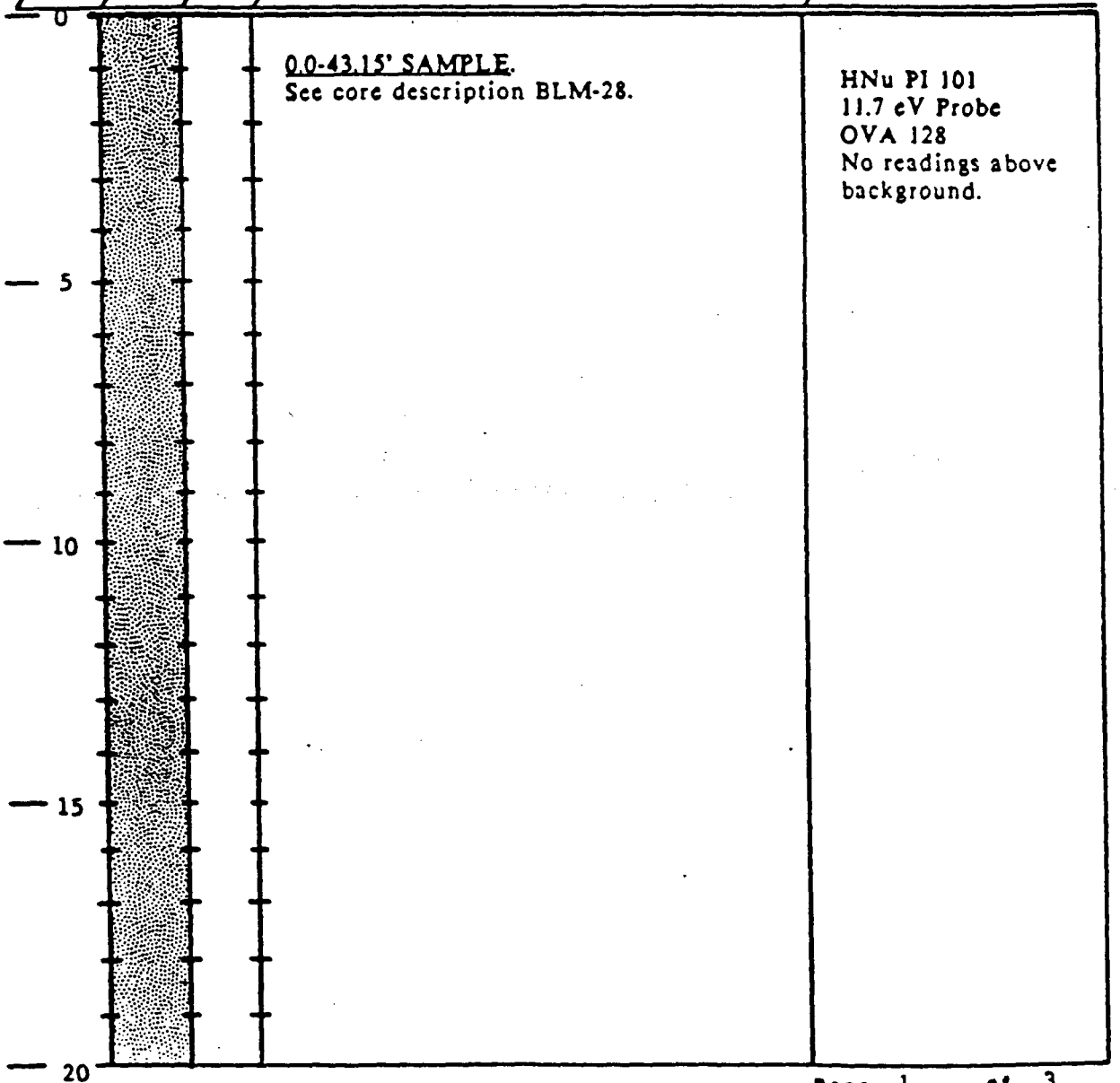
Location: LEE ACRES LANDFILL
Coordinates: N3584 E5143
Total Depth: 43.15'

Borehole/Well No.: BLM-27
Ground Surface Elevation: 5376.83
Water Level Encountered:
Static:

Drilling Company: Stewart Brothers
Date Drilled: December 4, 1987
Drilling Method: Rotary
Logged By: L. Gregory-Frost
Geologist

Driller: Danny White
Helper: D.Clark,W. Smith,M.Sanchez
Drilling Fluid: bentonite mud

Comments:



LOG OF BOREHOLE

Location: LEE ACRES LANDFILL
Coordinates: N3585 E5133
Total Depth: 73.0'

Borehole/Well No.: BLM-28
Ground Surface Elevation: 5376.83
Water Level Encountered:
Static:

Drilling Company: Stewart Brothers
Date Drilled: November 11-12, 1987
Drilling Method: Rotary
Logged By: L. Gregory-Frost, Geologist

Driller: Mike Sanchez
Helper: Rick Fronce, B. Ward
Drilling Fluid: bentonite mud

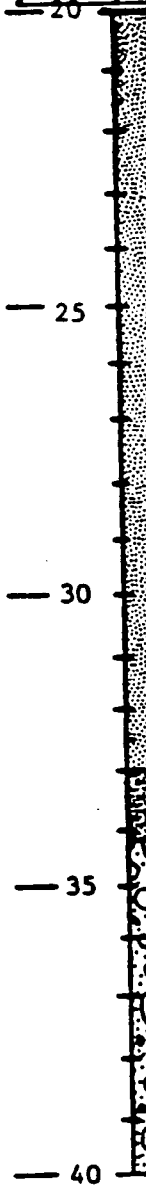
Comments:

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0			**ALLUVIUM**	
			0.0-5.0' SAMPLE. Recovered 4.4/5.0' = 88%. SAND: grayish orange (10 YR 7/4) to moderate yellowish brown (10 YR 5/4); very fine to coarse-grained; rounded to subangular; slightly silty; poorly sorted; at 0.55-0.65' intervals-0.10' thick silty very fine to fine-grained moderately consolidated zones; rooted to 2.5' depth; unconsolidated; dry.	HNu PI 101 11.7 eV Probe OVA 128 No readings above background.
5				
			5.0-9.0' SAMPLE. Recovered 3.8/4.0' = 95%. SAND: grayish orange (10 YR 7/4); fine to very coarse-grained; rounded to angular; slightly silty; poorly sorted; predominantly medium-grained at top, coarse-grained at base; fining upward; occasional rounded pebbles at base; unconsolidated; dry.	
10				
			9.0-12.5' SAMPLE. Recovered 3.9/4.5' = 87%. SAND: grayish orange (10 YR 7/4); very fine to very coarse-grained; predominantly medium to coarse-grained; rounded to angular; poorly sorted; unconsolidated; dry.	
15				
			12.5-17.5' SAMPLE. Recovered 4.5/5.0' = 90%. SAND: grayish orange (10 YR 7/4); very fine to medium-grained; predominantly fine-grained; rounded to subangular; slightly silty; poorly sorted; unconsolidated; dry.	
20				

LOG OF BOREHOLE

Location: LEE ACRES LANDFILL
Borehole/Well No.: BLM-28
Coordinates:
Ground Surface Elevation:
Total Depth:
Water Level Encountered:
Static:
Drilling Company:
Driller:
Date Drilled:
Helper:
Drilling Method:
Drilling Fluid:
Logged By:
Geologist

Comments:



Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
20–40			17.5-22.5' SAMPLE. Recovered 3.0/5.0' = 60%. SAND: same as 12.5-17.5'; dry. 22.5-27.5' SAMPLE. Recovered 3.5/5.0' = 70%. SAND: grayish orange (10 YR 7/4); very fine to upper coarse-grained; rounded to subangular; poorly sorted; occasional rounded to subangular pebbles and cobbles; occasional slightly silty moderately consolidated layers; unconsolidated; dry. 27.5-32.5' SAMPLE. Recovered 2.0/5.0' = 40%. SAND: grayish orange (10 YR 7/4); medium to very coarse-grained; subangular; poorly sorted; abundant pebbles and cobbles-up to 0.30' diameter; rounded to well rounded; base 0.05' very fine-grained silty, clayey, consolidated sand; unconsolidated; dry. 32.5-37.5' SAMPLE. Recovered 1.7/5.0' = 34%. 32.5-34.2': SAND TO CLAYEY SAND: moderate yellowish brown (10 YR 5/4); very fine to medium-grained; subangular silty; poorly sorted; unconsolidated; moist; grading into CLAYEY SAND; very fine to fine-grained; rounded to subangular; poorly sorted; consolidated; moist to saturated. REDRILL: gravel and boulders cannot be drilled and sampled with hollow stem auger; therefore redrill fifteen feet away.	

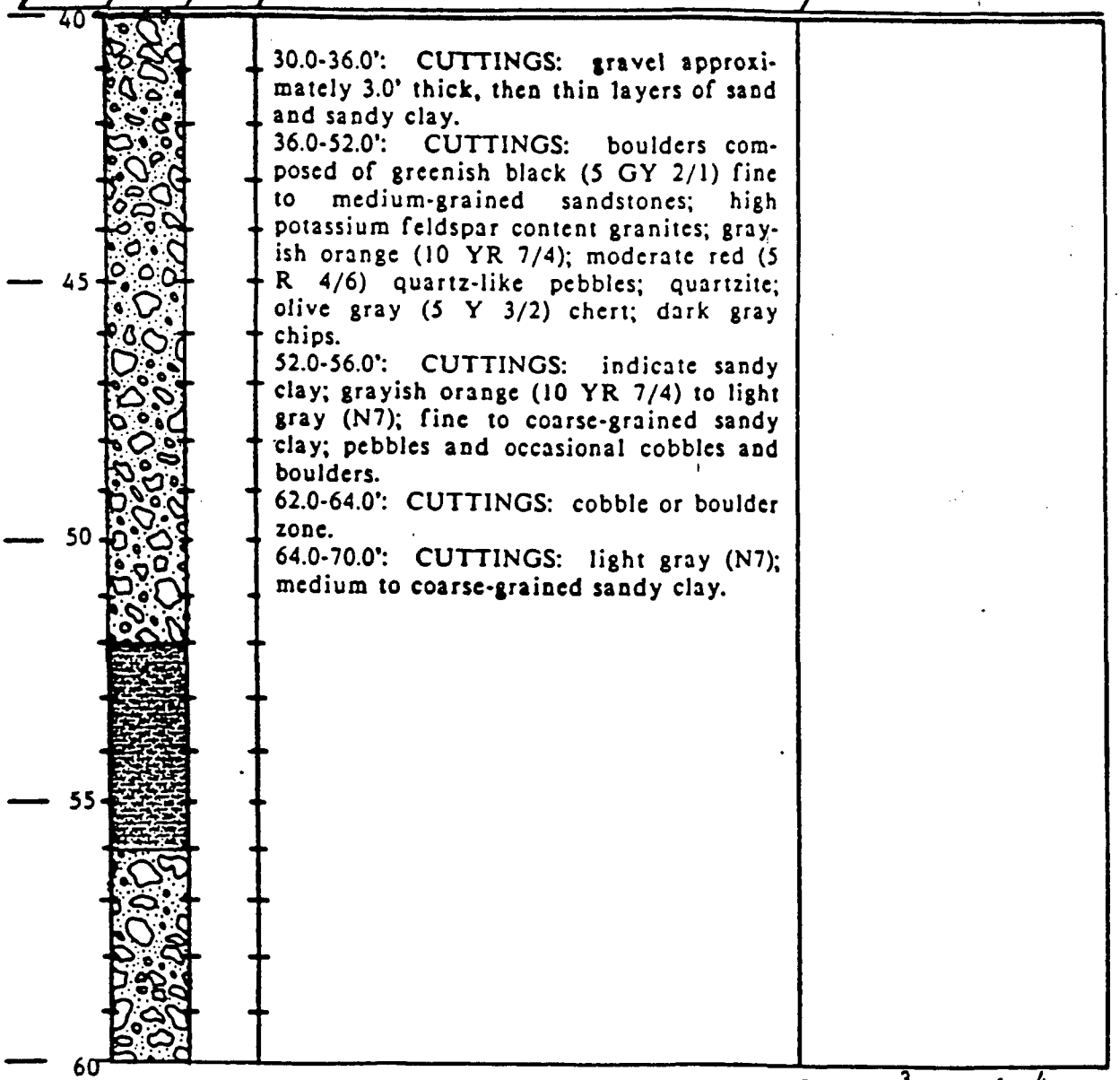
LOG OF BOREHOLE

Location: LEE ACRES LANDFILL
Coordinates:
Total Depth:

Drilling Company:
Date Drilled:
Drilling Method:
Logged By:
Geologist

Borehole/Well No.: BLM-28
Ground Surface Elevation:
Water Level Encountered:
Static:
Driller:
Helper:
Drilling Fluid:

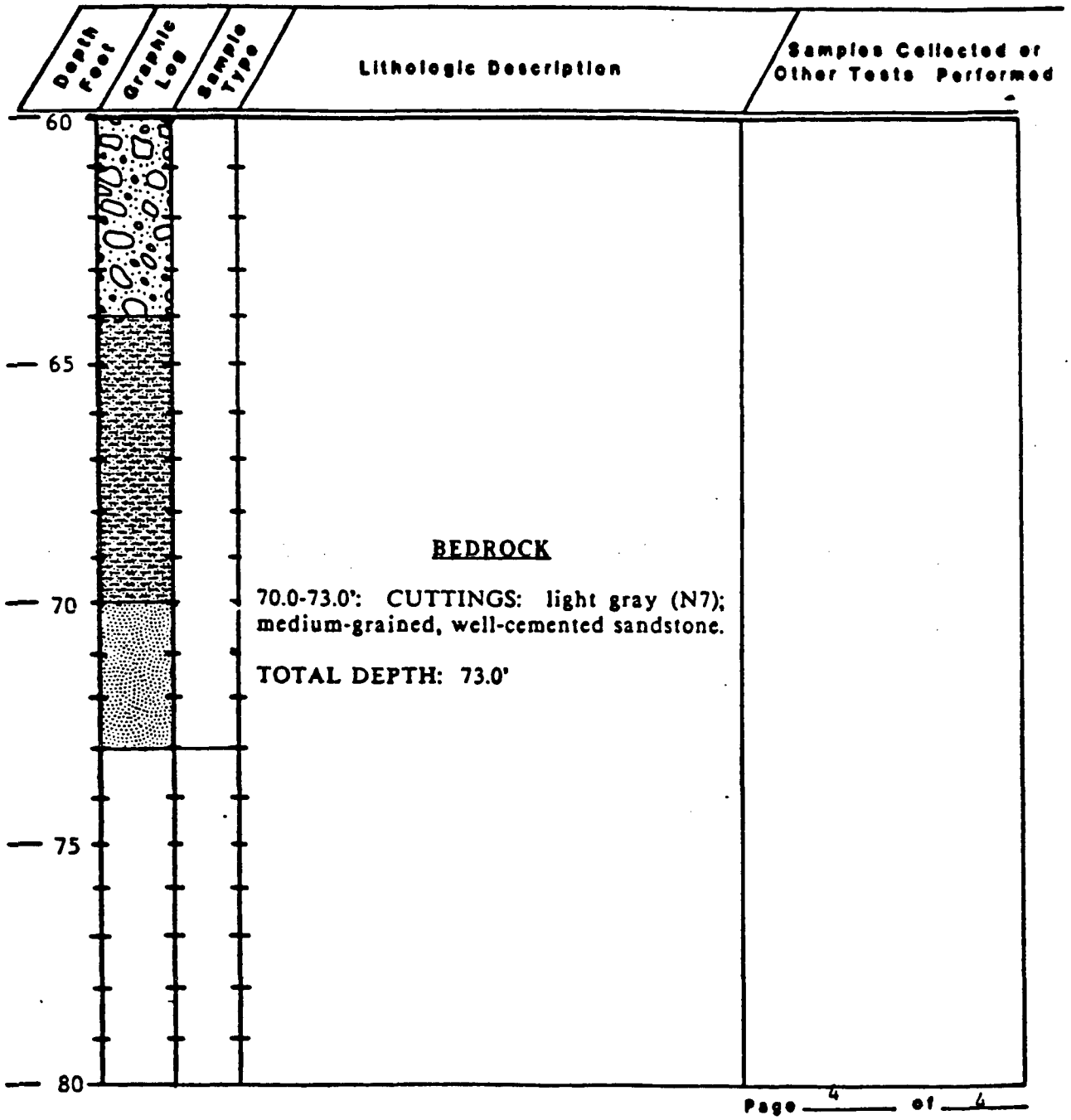
Comments:



LOG OF BOREHOLE

Location: LEE ACRES LANDFILL
Borehole/Well No.: BLM-28
Coordinates:
Ground Surface Elevation:
Total Depth:
Water Level Encountered:
Static:
Drilling Company:
Driller:
Date Drilled:
Helper:
Drilling Method:
Drilling Fluid:
Logged By: Geologist

Comments:



WELL COMPLETION SCHEMATIC

Location: LEE ACRES LANDFILL

Well No.: BIM-27

Coordinates: N 3584 E 5143

Elevation:

Ground Surface: 5376.83

Total Depth:

Well: 43.15' Borehole: 43.15'

Top of Casing: 5379.01

Formation of Completion: Alluvium

Surface Casing Material: N/A

Casing Material: 316 L Stainless Steel

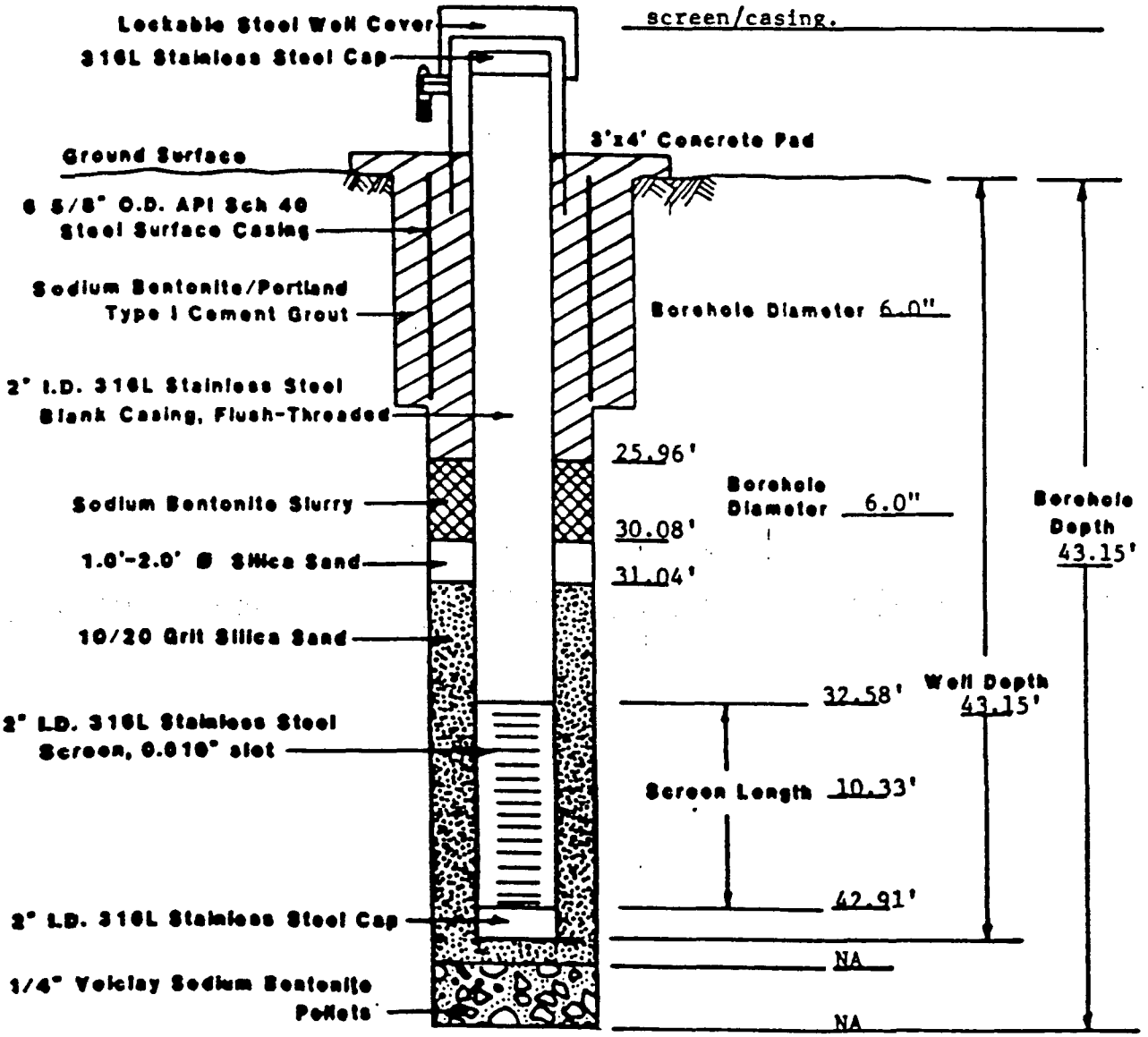
Surface Casing Diameter: N/A

Screen Material: 316 L Stainless Steel

Casing Diameter: 2" I.D.

Date Installed: 12/4/87 Installed By: LAG

Comments: "O" rings removed from screen/casing.



Not To Scale

Well BLM-27

Well Construction Summary

Location or Coords: N 3584 E 5143

Elevation: Ground Level 5376.83

Top of Casing 5379.01

Project Lee Acres Landfill Site

Location Farmington, New Mexico

Personnel Laurie Gregory-Frost

Drilling Summary:

Total Depth 43.15'

Borehole Diameter 6.0"

Driller Danny White
Stewart Bros. Drilling Co.
Grants, N.M.

Rig Gardner-Denver 1500

Bit(s) 6" tricone bit

Drilling Fluid bentonite mud

Surface Casing NA

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C = Casing S = Screen

0.0	-	32.58	C_1		-		
32.58	-	42.91	S_1		-		
	-				-		
	-				-		
	-				-		
	-				-		
	-				-		
	-				-		

Casing: C1 2" I.D. 316 L Stainless Steel; flush threaded

C2

Screen: S1 2" I.D. 316 L Stainless Steel, 0.010" slot

S2

Centralizers None

Filter Material 10/20 grit silica sand; 1.0 - 2.0 ∅ silica sand

Cement Portland Type I Cement/ Sodium Bentonite Grout

Other 2" 316 L Stainless Steel bottom cap, top cap
4" x 5' steel well cover with lockable cap

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
6" rotary	12/4	1045	12/4	1216
Geophys. Logging:	NA			
Casing: Steel 2" Stainless	12/4	1216	12/4	1224
Filter Placement:	12/4	1345	12/4	1504
Cementing:	12/4	1527	12/4	1544
Development:				
Other: slurry Bentonite	12/4	1514	12/4	1527

Well Development:

See well development table.

Comments:

All "O" rings removed from casing/ screen.

WESTON

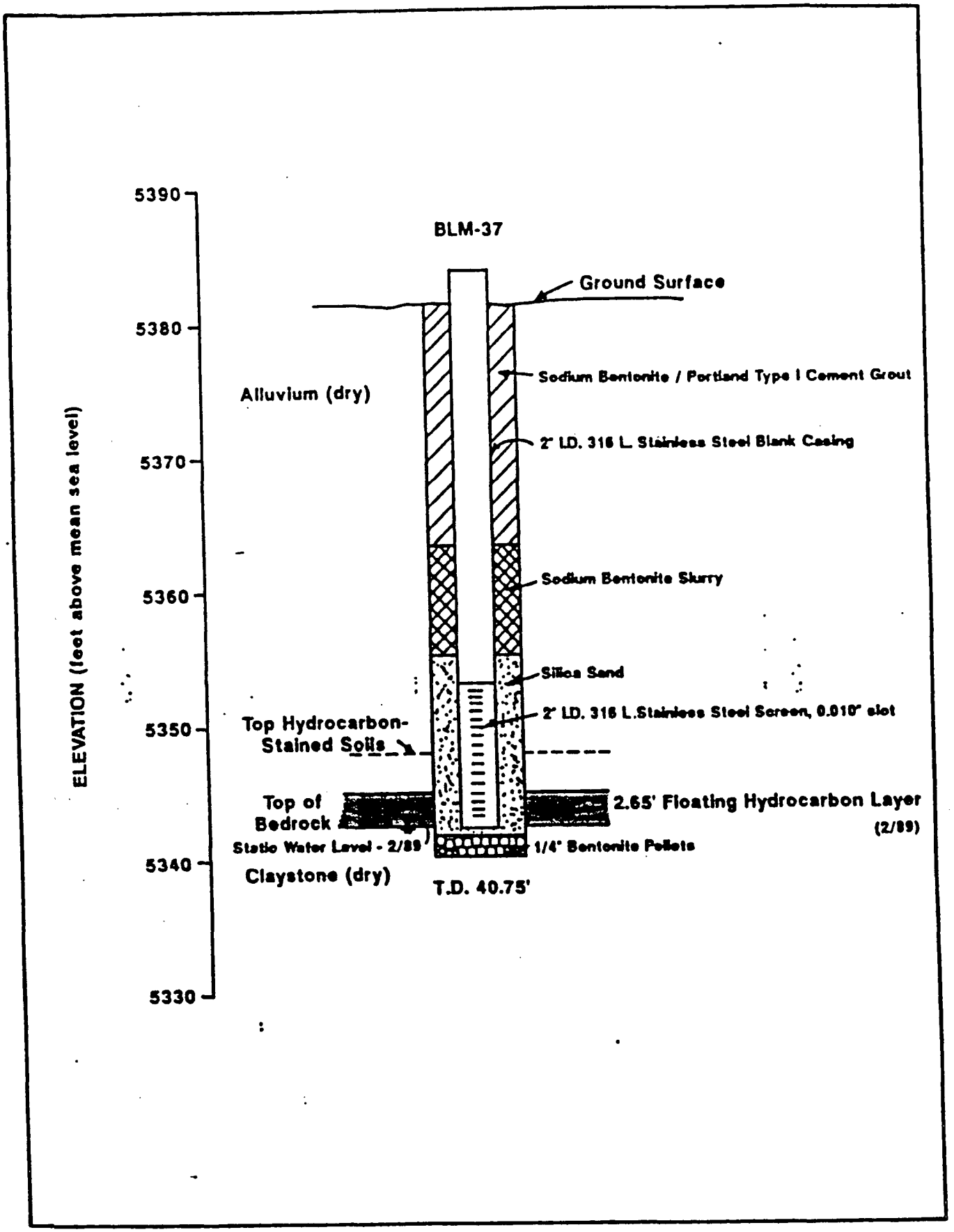


Figure 3: SCHEMATIC OF BLM-37 WELL CONSTRUCTION - Lee Acres Landfill, Farmington, N.M.

FIRST REPORT OF OFF-SITE INVESTIGATION

October 20, 1989

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF PLATES

1.0 EXECUTIVE SUMMARY

Geoscience Consultants, Ltd. (GCL) has examined the distribution of petroleum hydrocarbons in ground water and in soils near the water table in the Lee Acres community south of the Giant Industries, Inc. (Giant) refinery in Bloomfield, New Mexico. The study involved installation of two new monitor wells on the state right-of-way south of State Highway 64 (NM 64) and performance of a limited soil vapor survey in the Lee Acres community. Ground water was sampled at the new monitor wells and at seven pre-existing wells on and south of the refinery grounds. Analyses were performed for total metals, halogenated volatile compounds, aromatic compounds, major ions, total dissolved solids and nitrates/nitrites. The new monitor wells indicate that any free product plume south of NM 64 is restricted to a zone within 100 feet east and west of Bureau of Land Management well BLM-37. The soil vapor survey indicates that free product is restricted to a zone within 300 feet south of NM 64. Additional boreholes are recommended to conclusively determine the southern extent of the free-product plume and to better define ground water chemistry, hydraulic characteristic and flow patterns in this area.

2.0 INTRODUCTION

The Bureau of Land Management (BLM) has installed three shallow wells in the study area (Figure 2-1). Free-phase hydrocarbons were reported to be floating on the water table at one of these wells - BLM-37. This report prompted the New Mexico Oil Conservation Division to request that Giant conduct a hydrogeologic investigation of petroleum product contamination south of NM 64. In response to these events, GCL submitted an off-site investigation plan (GCL, 1989) for study of the area south of the refinery (see Figure 2-1).

The investigation involved installation of two four-inch monitor wells on the right of way south of NM 64. These wells were located approximately 100 feet to the east and west of BLM-37 (see Plate 1). These two new monitor wells, three BLM wells and four on-site wells were sampled to characterize ground water chemistry on and south of the refinery grounds.

A limited soil vapor survey was performed to determine the size and extent of the petroleum hydrocarbon plume south of NM 64. The results of the drilling, and the sampling and soil vapor investigations are presented below with conclusions and recommendations for further action at the site.

3.0 METHODS OF INVESTIGATION

In accordance with the off-site investigation plan (GCL, 1989), GCL drilled two 4-inch monitor wells on the right-of way for NM 64, south of the highway. The two wells, SHS-1 and SHS-2, are located 100 feet east and west of BLM-37, respectively (Figure 2-1).

The wells were installed using a CME-55 drill rig with 10 7/8 " (inside diameter) hollow stem augers by Western Technology, Inc. of Farmington, NM. The wells are screened through the water/air interface in order to observe any floating phase constituents. GCL's standard operating procedures were followed for well installation (Appendix A of the off-site investigation plan; GCL, 1989).

Lithologic logs and well completion diagrams for SHS-1 and SHS-2 are presented in Appendix A of this report.

As discussed in the off-site investigation plan for this project (GCL, 1989), nine wells were sampled to examine ground water chemistry in the southern portion of the refinery grounds and in the Lee Acres community south of NM 64. GCL's standard operating procedures for sampling (Appendix B of the off-site investigation plan; GCL, 1989) were followed during sample collection.

Three recovery wells (GRW-2, GRW-4 and GRW-6) and one monitor well (GBR-52) were sampled to characterize ground water chemistry in the southern portion of the refinery. Ground water from these wells was analyzed for halogenated volatile organic compounds, aromatic volatile organic compounds, major ions, total dissolved solids and nitrates/nitrites.

Five monitor wells south of NM 64 were sampled to determine concentrations of organic compounds in ground water. In addition, ground water samples from these wells (BLM-37, BLM-27, BLM-30, SHS-1 and SHS-2) were obtained by representatives of Giant and the BLM for independent analysis. These samples were analyzed for total metals, halogenated volatile organic compounds, aromatic volatile organic compounds, major ions, total dissolved solids and nitrates/nitrites.

As discussed in the off-site investigation plan, (GCL, 1989) a limited soil vapor survey was performed in the Lee Acres community. Soil vapor was analyzed at 39 stations on a grid south of NM 64. Vapor sampling stations were more closely spaced in the northern portion of the study area to facilitate delineation of petroleum hydrocarbons in the subsurface near existing monitor wells. Decisions to analyze soil vapor at a given station were based on evaluation of volatile aromatic hydrocarbon concentrations at nearby stations.

A portable gas chromatograph (Photovac Model 10S70) was used to detect hydrocarbons in soil vapor. The instrument provided semiquantitative data for several volatile aromatic hydrocarbons in the soil vapor phase. Sampling and analytical procedures are described briefly below and follow GCL's standard operating procedures for soil vapor surveys (Appendix C of the off-site investigation plan; GCL, 1989). Seven foot galvanized steel probes were used to collect vapor. Each probe was fitted with an evacuation line and adaptor and driven into the soil to a five foot depth or until refusal. After insertion, the probes were withdrawn until vapor flow was achieved. The probes were evacuated for 30 to 60 seconds using a small vacuum pump to eliminate atmospheric components prior to sampling. Five hundred microliter aliquots of vapor were drawn from the evacuation lines and analyzed for benzene, toluene, ethylbenzene and para-, meta- and orthoxylene.

4.0 ANALYTICAL RESULTS

Analytical results for the samples collected during this investigation are shown in Tables 4-1 through 4-4.

Toluene is common in soil vapor throughout the study area and was the sole aromatic hydrocarbon detected at many stations (Table 5-1 and Plate 1). Analytical data for benzene, ethylbenzene and the xylenes indicate a decline in concentration to zero values between 100 to 300 feet south of U.S. Route 64 (Plate 1). In addition ethylbenzene and the xylenes were detected in subsurface vapors at a series of stations located 600 feet south of the highway in the Lee Acres community.

5.0 CONCLUSIONS

The soil vapor survey and groundwater sampling indicate the presence of hydrocarbons in the subsurface south of NM 64. The work to date indicates that free phase product, on the water table at BLM-37, has east and west boundaries within the limits defined by monitor wells SHS-1 and SHS-2. The east-west dimension of the free-product plume, therefore, is less than 200 feet. Further investigation is necessary to define the southern extent of this plume.

The near ubiquity of toluene in soil vapors in this area strongly limits the usefulness of this constituent for delineating hydrocarbon contamination in the subsurface. Data for benzene, ethylbenzene and the xylenes suggest that any free-product plume is restricted to a zone within 300 feet south of NM 64 (Plate 1). The data do not permit interpretation of the zone of high ethylbenzene and xylenes concentrations in soil vapor further to the south.

6.0 RECOMMENDATIONS

Boreholes should be installed at the locations labeled B1 - B7 on Plate 1. The westernmost, hydrocarbon-free borehole of the pair B1 and B2 should be completed as a 2" piezometer. If both wells contain hydrocarbons, B1 should be completed as a piezometer and the soil vapor survey should be extended. Based on site evidence, hydrocarbons are not expected in these boreholes.

B3 should also be completed as a piezometer. The soil vapor survey and site evidence, do not suggest that hydrocarbon will be found at B3. If hydrocarbons are found at that location, another boring west of the arroyo (Plate 1) should be considered.

B4, B5 and B6 may be completed as 4" monitor wells. This decision is subject to conditions in the subsurface at these locations. If no hydrocarbons are found at B5 and B6, the borings will be completed as wells. If no hydrocarbon is found at B4, another boring will be drilled approximately half way between B4 and B7. It is intended that three wells be located on the downgradient edge of any hydrocarbon plume.

If B7 shows evidence of hydrocarbons in the ground water, it should be completed as a 4" recovery well. The location of B7 is subject to change based on findings at B4, B5 and B6. It is intended that B7 be located near the center of any plume.

7.0 REFERENCES CITED

GCL, 1989, Off-site hydrogeologic investigation, Geoscience Consultants, Ltd., Albuquerque, NM, 10.p.

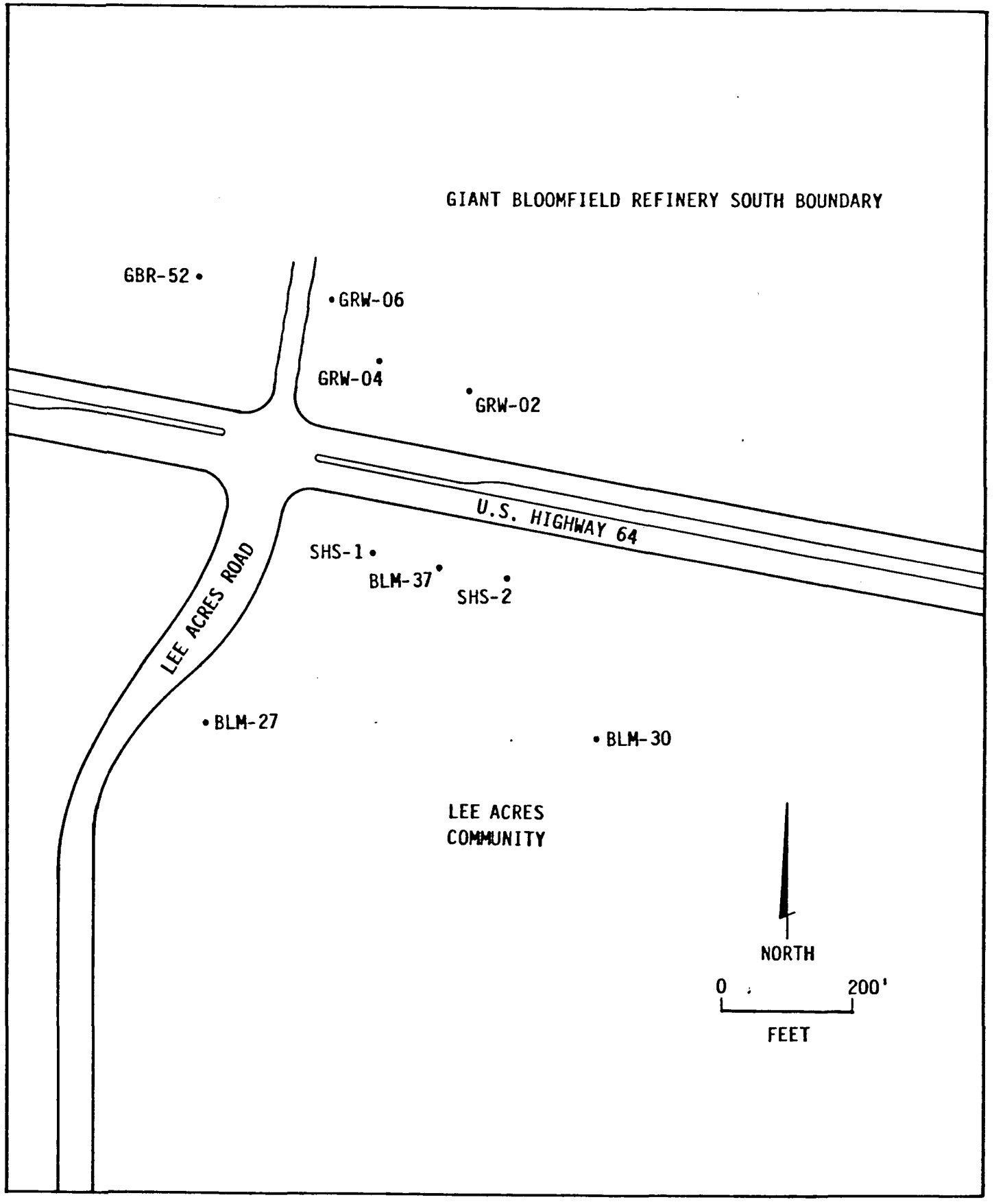


FIGURE 2-1

MONITOR WELL LOCATION MAP

TABLE 4-1

RESULTS OF SAMPLING FOR AROMATIC VOLATILES

M&A Offsite Samples
Aromatic Volatiles (EPA 602)
Sampling Event 09/06/89 - 09/07/89
Units: ug/l

	BLM-27		BLM-37		FIELD BLANK		GBR-52		GRW-2		GRW-4		GRW-6		SHS-1		SHS-2		BLM-30	
1,2-Dichlorobenzene	ND	(0.20)	ND	(100)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
1,3-Dichlorobenzene	ND	(0.40)	ND	(200)	ND	(0.40)	ND	(0.40)	ND	(0.40)	ND	(40)	ND	(0.40)	ND	(40)	ND	(40)	ND	(0.40)
1,4-Dichlorobenzene	ND	(0.20)	ND	(100)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
Benzene	ND	(0.10)	7600	(50)	ND	(0.10)	ND	(0.10)	0.26	(0.10)	950	(10)	1.8	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
Chlorobenzene	ND	(0.10)	ND	(50)	ND	(0.10)	ND	(0.10)	ND	(0.10)	ND	(10)	ND	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
Ethylbenzene	ND	(0.10)	ND	(50)	0.27	(0.10)	ND	(0.10)	1.6	(0.10)	200	(10)	16	(0.10)	140	(10)	120	(10)	ND	(0.10)
Toluene	ND	(0.30)	ND	(150)	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND	(30)	ND	(0.30)	ND	(30)	ND	(30)	ND	(0.30)
Total Xylenes	ND	(0.20)	7400	(100)	ND	(0.20)	ND	(0.20)	0.23	(0.20)	200	(20)	15	(0.20)	280	(20)	48	(20)	ND	(0.20)

( ) = detection limit
ND = not detected at detection limit

TABLE 4-2

RESULTS OF SAMPLING FOR HALOGENATED VOLATILES

M&A Offsite Samples
Halogenated Volatiles (EPA 601)
Sampling Event: 09/06/89 - 09/07/89
Units ug/L

	BLM-27		BLM-37		FIELD BLANK		GBR-52		GRW-2		GRW-4		GRW-6		SHS-1		SHS-2		BLM-30	
1,1,1-Trichloroethane	1.6	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	71	(20)	0.97	(0.20)	ND	(20)	ND	(20)	0.2	(0.20)
1,1,2,2-Tetrachloroethane (4)	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
1,1,2-Trichloroethane (3)	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
1,1-Dichloroethane	2.4	(0.10)	ND	(20)	ND	(0.10)	ND	(0.10)	ND	(0.10)	ND	(10)	1.4	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
1,1-Dichloroethene	ND	(0.10)	ND	(20)	ND	(0.10)	ND	(0.10)	ND	(0.10)	ND	(10)	ND	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
1,2-Dichlorobenzene	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
1,2-Dichloroethane	ND	(0.10)	78	(20)	ND	(0.10)	ND	(0.10)	0.36	(0.10)	ND	(10)	3.5	(0.10)	ND	(10)	68	(10)	ND	(0.10)
1,2-Dichloropropane	ND	(0.10)	ND	(20)	ND	(0.10)	ND	(0.10)	ND	(0.10)	ND	(10)	ND	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
1,3-Dichlorobenzene	ND	(0.50)	ND	(100)	ND	(0.50)	ND	(0.50)	ND	(0.50)	ND	(50)	ND	(0.50)	ND	(50)	ND	(50)	ND	(0.50)
1,4-Dichlorobenzene	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
2-Chloroethylvinyl Ether	ND	(2.0)	ND	(400)	ND	(2.0)	ND	(2.0)	ND	(2.0)	ND	(200)	ND	(2.0)	ND	(200)	ND	(200)	ND	(2.0)
Bromodichloromethane	ND	(0.10)	ND	(20)	ND	(0.10)	ND	(0.10)	ND	(0.10)	ND	(10)	ND	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
Bromoform	ND	(2.0)	ND	(400)	ND	(2.0)	ND	(2.0)	ND	(2.0)	ND	(200)	ND	(2.0)	ND	(200)	ND	(200)	ND	(2.0)
Bromomethane	ND	(1.0)	ND	(200)	ND	(1.0)	ND	(1.0)	ND	(1.0)	ND	(100)	ND	(1.0)	ND	(100)	ND	(100)	ND	(1.0)
Carbon Tetrachloride	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
Chlorobenzene	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
Chloroethane	ND	(0.50)	ND	(100)	ND	(0.50)	ND	(0.50)	ND	(0.50)	ND	(50)	ND	(0.50)	ND	(50)	ND	(50)	ND	(0.50)
Chloroform	ND	(0.10)	ND	(20)	ND	(0.10)	ND	(0.10)	ND	(0.10)	ND	(10)	ND	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
Chloromethane	ND	(0.50)	ND	(100)	ND	(0.50)	ND	(0.50)	ND	(0.50)	ND	(50)	ND	(0.50)	ND	(50)	ND	(50)	ND	(0.50)
cis-1,3-Dichloropropene	ND	(0.40)	ND	(80)	ND	(0.40)	ND	(0.40)	ND	(0.40)	ND	(40)	ND	(0.40)	ND	(40)	ND	(40)	ND	(0.40)
Dibromochloromethane (3)	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)
Methylene Chloride	ND	(0.40)	ND	(80)	ND	(0.40)	ND	(0.40)	ND	(0.40)	ND	(40)	1.1	(0.40)	ND	(40)	ND	(40)	ND	(0.40)
Tetrachloroethene (4)	1.3	(0.10)	ND	(20)	ND	(0.10)	ND	(0.10)	ND	(0.10)	ND	(10)	ND	(0.10)	ND	(10)	13	(10)	ND	(0.10)
Total 1,2-Dichloroethene (2)	ND	(0.10)	ND	(20)	ND	(0.10)	ND	(0.10)	ND	(0.10)	28	(10)	0.48	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
trans-1,3-Dichloropropene (3)	ND	(0.40)	ND	(80)	ND	(0.40)	ND	(0.40)	ND	(0.40)	ND	(40)	ND	(0.40)	ND	(40)	ND	(40)	ND	(0.40)
Trichloroethene	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	0.77	(0.20)	22	(20)	ND	(20)	ND	(0.20)
Trichlorofluoromethane	1.1	(0.10)	ND	(20)	ND	(0.10)	1.1	(0.10)	1.4	(0.10)	ND	(10)	ND	(0.10)	ND	(10)	ND	(10)	ND	(0.10)
Vinyl Chloride	ND	(0.20)	ND	(40)	ND	(0.20)	ND	(0.20)	ND	(0.20)	ND	(20)	ND	(0.20)	ND	(20)	ND	(20)	ND	(0.20)

( ) = detection limit
ND = not detected at detection limit

TABLE 4-3

RESULTS OF SAMPLING FOR METALS

M&A Offsite Samples
Metals
Sampling Event 09/06/89 - 09/07/89
Units mg/L

	BLM-27		BLM-30		BLM-37		FIELD BLANK		SHS-1		SHS-2	
Arsenic	<0.053	(0.053)	<0.053	(0.053)	<0.053	(0.053)	<0.053	(0.053)	<0.053	(0.053)	<0.053	(0.053)
Barium	1.4	(0.002)	0.57	(0.002)	0.36	(0.002)	<0.002	(0.002)	0.27	(0.002)	1.5	(0.002)
Cadmium	<0.004	(0.004)	<0.004	(0.004)	<0.004	(0.004)	<0.004	(0.004)	<0.004	(0.004)	<0.004	(0.004)
Chromium	0.074	(0.007)	0.043	(0.007)	0.043	(0.007)	<0.007	(0.007)	0.011*	(0.007)	0.029*	(0.007)
Lead	0.13*	(0.042)	0.056*	(<0.042)	8.7	(0.042)	<0.042	(0.042)	<0.042	(0.042)	0.062*	(0.042)
Mercury	<0.0002	(0.002)	<0.0002	(0.0002)	<0.0002	(0.0002)	<0.0002	(0.0002)	<0.0002	(0.0002)	<0.0002	(0.0002)
Selenium	<0.075	(0.075)	<0.075	(0.075)	<0.075	(0.075)	<0.075	(0.075)	<0.075	(0.075)	<0.075	(0.075)
Silver	<0.007	(0.007)	<0.007	(0.007)	<0.007	(0.007)	<0.007	(0.007)	<0.007	(0.007)	<0.007	(0.007)

( ) = detection limit
ND = not detected at detection limit
* = the laboratory has indicated that these values are within 5 times the detection limits and are estimates

TABLE 4-4

RESULTS OF SAMPLING FOR MAJOR IONS, TDS AND NITRATES

M&A Offsite Samples
General Water Chemistry
Sampling Event 09/06/89 - 09/07/89

		BLM-27	BLM-30	BLM-37	FIELD BLANK	GBR-52	GRW-2	GRW-4	GRW-6	SHS-1	SHS-2
Bicarbonate as HCO3	mg/l	372.69	186.34	692.13	1.16	252.89	585.65	1118.06	718.75	984.95	1091.44
Calcium	mg/l	167.73	545.13	66.12	0.42	487.87	467.71	346.75	379.01	289.50	201.60
Carbonate as CO3	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cation/Anion Difference	%	0.69	1.03	0.33	6.03	0.68	0.65	0.37	0.22	0.57	1.61
Chloride	mg/l	188.32	267.62	535.24	0.00	39.65	346.91	564.97	614.53	683.92	297.35
Conductivity	umhos/cm @ 25C	3191	3995	5847	6.21	3082	4860	5287	4690	5043	4446
Magnesium	mg/l	189.03	53.61	464.18	0.23	16.28	105.49	131.82	77.93	109.51	205.19
Major Anions	meq/l	37.07	47.50	69.46	0.05	38.05	56.34	60.94	50.29	53.31	51.95
Major Cations	meq/l	36.56	46.53	69.93	0.05	37.53	57.07	61.40	50.52	53.92	53.65
Nitrate	mg/l	3.49	8.09	124.4	0.08	3.91	18.3	0.02	0.17	0.02	0.31
pH		7.57	7.47	7.28	6.79	7.66	7.48	7.49	7.39	7.14	7.48
Potassium	mg/l	1.28	5.76	5.40	0.10	1.74	5.30	3.30	3.00	2.58	6.85
Resistivity	ohm-m	3.1338	2.5031	1.7103	NA	3.2446	2.0576	1.8914	2.1322	1.9829	2.2492
Sodium	mg/l	290.00	339.60	651.00	0.10	271.40	573.00	762.60	577.50	699.00	610.20
Sodium Absorption Ratio		3.65	3.72	6.22	0.03	3.29	6.23	8.84	7.06	8.88	7.23
Sulfate	mg/l	1231.21	1771.10	2064.91	1.65	1573.58	1773.57	1280.59	1016.40	857.57	1231.21
Total Acidity as CaCO3	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Alkalinity as CaCO3	mg/l	305.48	152.74	567.32	0.95	207.29	480.04	916.44	589.14	807.34	894.62
Total Dissolved Solids (180)	mg/l	2408	3222	4598	2	2572	3692	13732	3100	5326	3242
Total Dissolved Solids (calc)	mg/l	2251	3074	4127	3	2515	3560	3640	3022	3126	3089
Total Hardness as CaCO3	mg/l	1195.75	1580.54	2073.62	2.02	1284.19	1600.70	1407.17	1266.05	1172.60	1346.69

NA = not analyzed

TABLE 5-1

PORTABLE GAS CHROMATOGRAPHIC
ANALYTICAL RESULTS FOR AROMATIC HYDROCARBONS
LEE ACRES COMMUNITY AND
SURROUNDING AREA

POINT NO.	BENZENE	TOLUENE	ETHYLBENZENE	TOTAL XYLENES
1	N/D	N/D	N/D	N/D
2	1.5	123.0	20.0	N/D
3	N/D	204.4	59.3	N/D
4	2.0	181.0	N/D	74.0
5	0.9	189.5	13.0	N/D
6	1.7	239.0	N/D	217.0
7	N/D	169.0	N/D	353.0
8	16.2	188.0	15.5	847.0
9	18.0	208.0	N/D	604.0
10	N/D	344.8	N/D	N/D
11	N/D	293.0	N/D	N/D
12	N/D	412.0	N/D	58.0
13	N/D	402.6	N/D	985.4
14	N/D	305.8	N/D	N/D
15	N/D	315.0	N/D	74.4
16	N/D	312.0	N/D	N/D
17	N/D	1050.0	N/D	288.0
18	1.2	160.0	N/D	137.0
19	N/D	277.0	N/D	72.3
21	N/D	286.0	N/D	N/D
22	3.8	204.0	N/D	N/D
23	N/D	368.0	N/D	N/D
24	N/D	331.8	N/D	N/D
25	N/D	304.3	N/D	N/D
26	N/D	312.0	N/D	83.0
30	N/D	315.0	N/D	N/D
31	N/D	N/D	65.2	N/D
32	N/D	N/D	N/D	N/D
37	N/D	N/D	N/D	418.0
38	N/D	315.0	N/D	260.0
39	N/D	276.7	50.6	27.8
41	N/D	N/D	N/D	136.0
42	N/D	N/D	N/D	4.8
43	N/D	N/D	N/D	N/D
44	N/D	N/D	5.5	8.9
BLM	N/D	200.5	N/D	N/D
3N	N/D	N/D	N/D	N/D
6N	63.5	347.0	16.0	61.5
9N	34.7	68.2	199.0	365.6

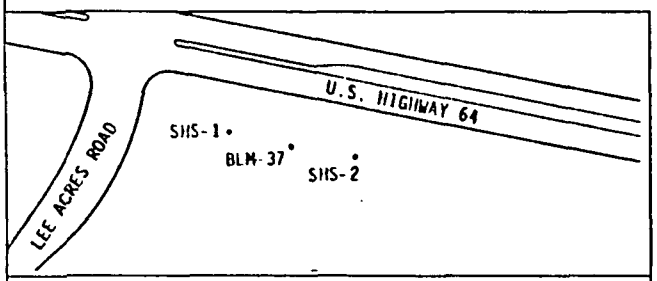
VALUES IN PPM
N/D = NOT DETECTED

0653/PORTGC.TAB

APPENDIX A

LITHOLOGIC LOGS AND MONITOR WELL COMPLETION DIAGRAMS

BOREHOLE LOG (SOIL)

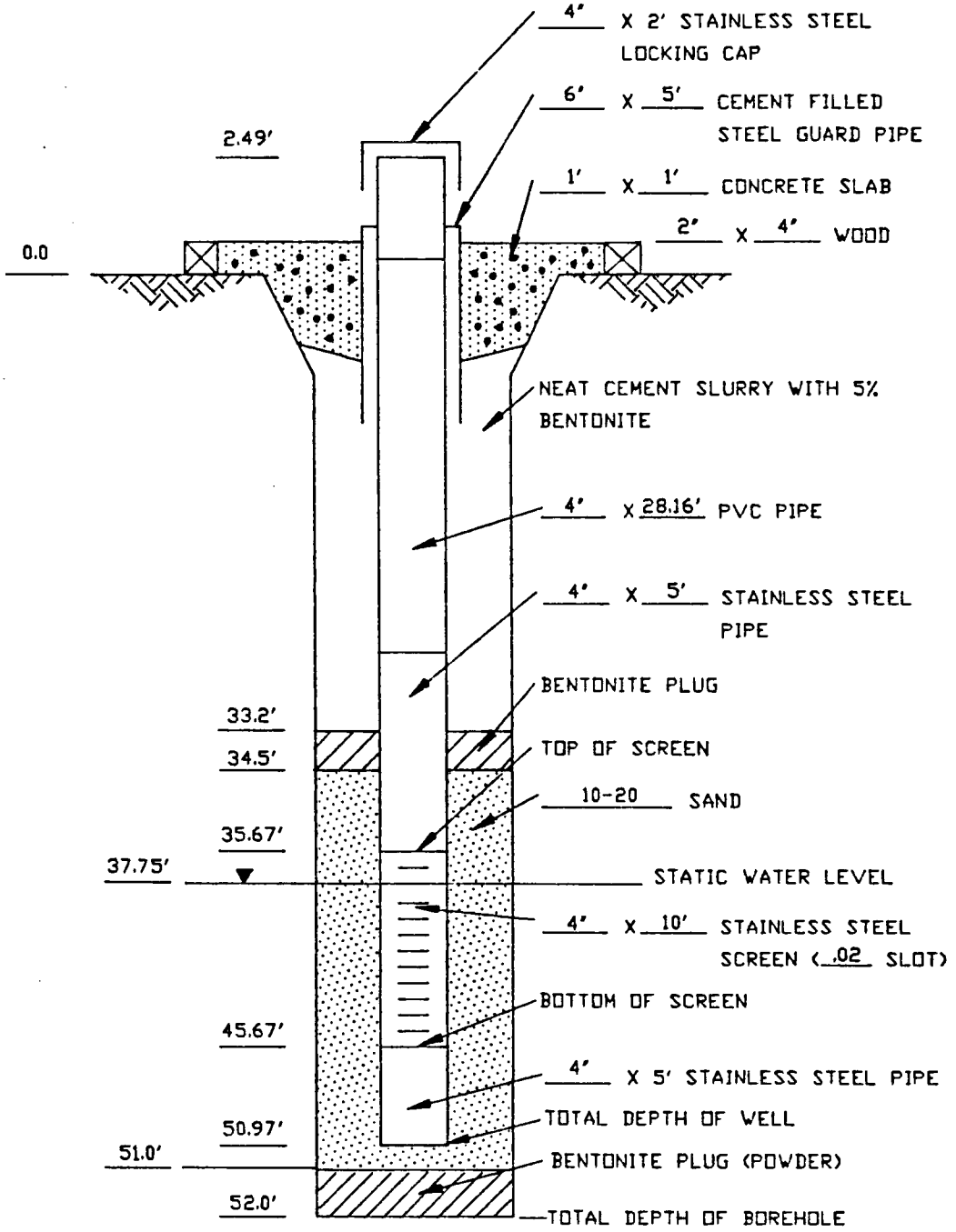


SE 1/4 SW 1/4 NW 1/4 NW 1/4 S 27 T29N R12W

SITE ID: Lee Acres Community LOCATION ID: SHS-1
SITE COORDINATES (ft.): Coordinates are local to GBR
N 9896-34 E 11406.67
GROUND ELEVATION (ft. MSL): Approximately 5381
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Hollow Stem Auger
DRILLING CONTR.: Western Tech
DATE STARTED: 7/31/89 DATE COMPLETED: 8/1/89
FIELD REP.: M. Nee
COMMENTS:

LOCATION DESCRIPTION: South of Giant's Bloomfield refinery on NMSR 64 right of way, 100 ft west of BLM-37

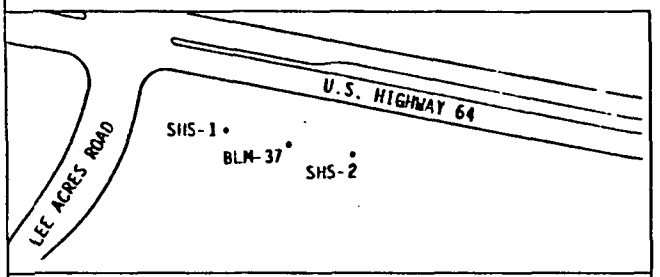
DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0			2	1	0	3			SW	0-28' Sand Mod Brn, 10 YR 4/4, v fine to fine grained, well sorted, unconsol., slightly moist at approx. 13'. Minor pebble gravel at 11'-13'.
			5	2	3	8			CL	Silty clayey sand stringer, moderate brown, 10 YR 4/4, at approx. 15'-15.5'.
5									GP	Minor small pebble gravel 22-28'.
			3	3	8	13				28'-30' Clay, moderate olive brn, 5 Y 4/4, minor fine to coarse sand.
10									SW	30'-30.5' Sand as above (0'-28'), no gravel.
			3	4	13	18			CL	6" clay to 31' grading to v fine sand at 33' olive gray, 5 Y 3/2.
15									SC	33'-36' Silty Sandy Clay, moderate olive brn, 5 Y 4/4, approx. 33% clay, 33% sand, 33% silt.
			0	5	18	23				36'-37' as above only stained, olive gray, 5Y 3/2. Fine to coarse sand interval 37' to 37-1/2' then to silty clay olive gray, 5 Y 3/2.
20										
			3	6	23	28			CL	37'-1/2-39' Silty clay, olive gray 5 Y 3/2.
25									SM	39'-40' Silty sand, olive gray, 5 Y 3/2 unconsol., MW sorted.
			5	7	28	33			CL	40'-41.5' Clay, mottled, mod yllsh brn, 10 YR 5/4 - olive gray. 5 YR 3/2.
30									SW	41.5'-42.5' Sand. mod. olive brn 5 Y 4/4, f-m sand, unconsol., MW sorted.
			0	8	33	38			SC	42.5'-43.5' Sandy clay, mod brn, 5 YR 4/4.
35									SW	43'-50' Sand, mod yllsh brn, 10 YR 5/4, fine to med sand. unconsol. MW sorted, saturated
			2	9	38	43			NA	50'-51.5' mudstone/claystone, dusky yellow 5 Y 6/4 to light olive brn, 5 Y 5/6 mod well consolidated, carbonaceous shale present, weathered, shale present.
40									NA	51.5'-52' Sandstone, dusky yellow, 5 Y 6/4 to light olive brn, 5 Y 5/6, fine to med grained, well consolidated, well sorted.
			0	10	43	48				
45										
			3	11	48	52				
50										



MONITOR WELL SHS-1

SOUTH OF GIANTS BLOOMFIELD REFINERY

BOREHOLE LOG (SOIL)

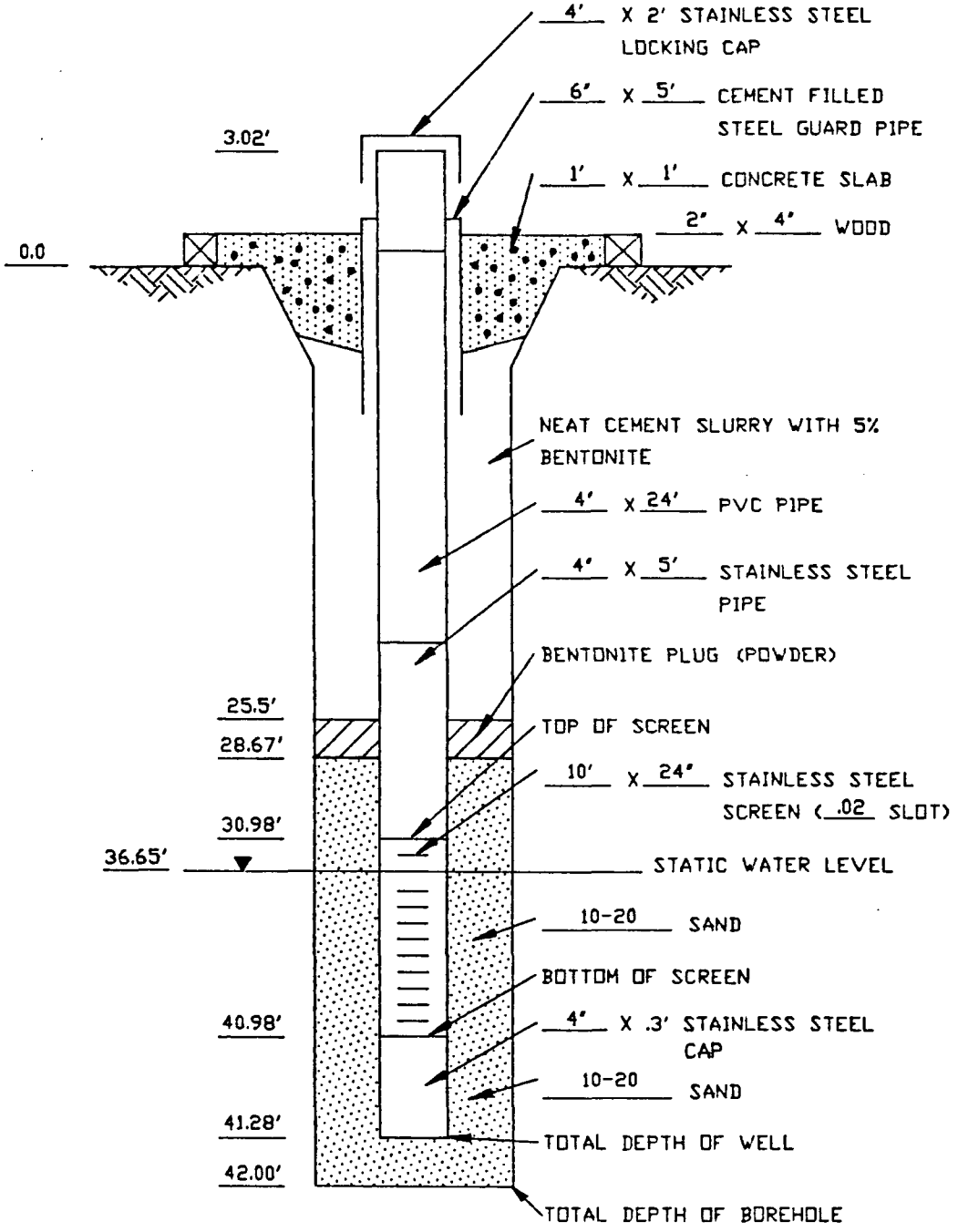


SE 1/4 SW 1/4 NW 1/4 NW 1/4 S27 T29N R12W

SITE ID: Lee Acres Community LOCATION ID: SHS-2
SITE COORDINATES (ft.): Coordinates are local to GBR
N 9854.92 E 11609.55
GROUND ELEVATION (ft. MSL): Approx. 5382
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Hollow Stem Auger
DRILLING CONTR.: Western Technology
DATE STARTED: 8/2/89 DATE COMPLETED: 8/2/89
FIELD REP.: M. Nee
COMMENTS:

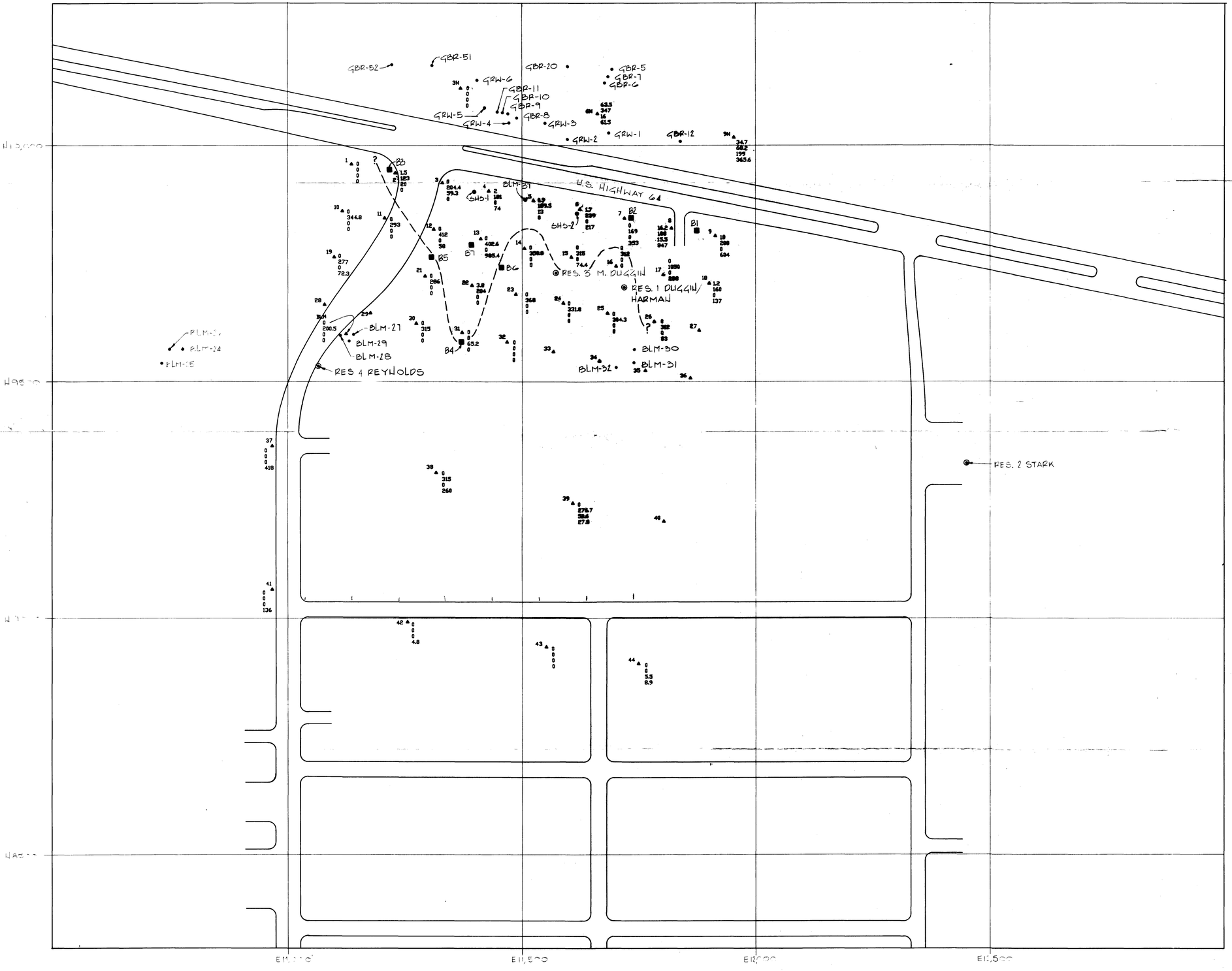
LOCATION DESCRIPTION: South of Giants Bloomfield Refinery on NMSR 64 right of way, 100 ft east of BLM-37

DEPTH	LITH.	REC	SAM	RUN #	RUN FROM	RUN TO	SAMPLE I.D.	SAMPLE TYPE	USCS	VISUAL CLASSIFICATION
0				1	0	3.5				0-1' Soil, Silty sand w/organics, mod. yllsh, brn 10 YR 5/4, 40% silt, 60% f sand, unconsolidated, mod well sorted, sub angular to sub rounded.
			3.5	2	3.5	3.5				
			2							1'-26' Gravelly Sand, Dark yellowish orange, 10 YR 6/6, 90% v fine - fine pred. quartz, unconsol., well sorted, sub ang to sub rounded, 10% gravel is fine to coarse pebble gravel, rounded.
5										
				3	8.5	13.5				26'-30' Sandy gravel, Dark yllsh orange, 10 YR 6/6, unconsol., rounded, pebble gravel to cobbles.
10										
			3	4	13.5	18.5				30'-33.5' Clayey Silty Sand, mod yllsh brn, 10 YR 5/4. Clay to fine sand, unconsol. poorly sorted.
15										
										33.5'-36' Sand, mod yllsh brn, 10 YR 5/4, fine to mod sand, unconsol. sub ang to sub rounded, mod well.
			3	5	18.5	23.5				
20										36'-37' Clayey Silt, dark yllsh brn, 10 YR 4/4, unconsol. MW sorted.
			0	6	23.5	28.5				37'-39.5' Gravelly Sand, dark yllsh brn, 10 YR 4/2, to olive black, 5 Y 2/1, at 38.5'.
25										
										80% Fine sand, 20% small cobbles, ps, unconsol. sand is sub ang to sub rounded, cobbles are rounded.
			0	7	28.5	33.5				
30										39.5'-40.5' Sandstone, olive black 5 Y 2/1, MW consolidated, stained, appears to be Naciamento.
			2.5	8	33.5	38.5				40.5'-40.8' Claystone, olive gray, 5 Y 4/1, mod well consolidated.
35										
										40.8'-41.1' Sandstone, dark yllsh orange, 10 YR 6/6, med sand, MW sorted, unconsolidated.
			5	9	38.5	43.5				
40										41.1'-41.3' Claystone, olive gray, 5 Y 4/1. mod well consolidated.
										41.8'-42' Sandstone, grayish orange, 10 YR 7/4, med sand, mod consol., subang, calcium cement, moist.
			5	10	43.5	48.5				
45										
			5	11	48.5	53.5				
50										



MONITOR WELL SHS-2

SOUTH OF GIANTS BLOOMFIELD REFINERY



LEGEND

- RESIDENTIAL WELL
- MONITOR WELL
- BENZENE CONCENTRATION (IN PARTS PER MILLION)
  TOLUENE CONCENTRATION (IN PARTS PER MILLION)
  ETHYLBENZENE CONCENTRATION (IN PARTS PER MILLION)
  TOTAL-XYLENE CONCENTRATION (IN PARTS PER MILLION)
- LIMIT OF POTENTIAL HYDROCARBON PLUME AS INDICATED BY SOIL VAPOR ANALYSES
- PROPOSED BORINGS

OCT 13 1989

PLATE 1

RESULTS OF SOIL VAPOR SURVEY AND BOREHOLE LOCATION MAP

LEE ACRES COMMUNITY

GCL

CLIENT	
DATE	8-24-89
DRAWN BY	K.K
CHECKED BY	P. EBERLY
REVISED	10-10-89
SCALE	1"=100'

N

0 100'

FEET

OFF-SITE HYDROGEOLOGIC INVESTIGATION

July 7, 1989

Prepared for:

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

1.0 PURPOSE AND SCOPE

The primary objective of the off-site hydrogeologic investigation is to define the extent of any free-phase hydrocarbons in the aquifer down-gradient from the Bloomfield Refinery. A secondary objective is to examine the ground water chemistry, hydraulic characteristics and flow patterns in the shallow aquifer in this area to determine if an active containment or reclamation program is required and to determine if past operations at the refinery are responsible for creating the need for any active remedial program.

If a containment or reclamation program is recommended and if past refinery activities created the need, a remedial plan to supplement the existing discharge plan will be presented to NMOCD.

2.0 BACKGROUND INFORMATION

Several sources of information were utilized to develop the technical approach presented herein. This section of this submission is not intended to be a review of previous data, but is simply a brief listing of the data sources used in preparation of this document.

GCL has drilled numerous monitor and recovery wells in the area immediately north of US Highway 64 (State Rt 17). The chemistry of the aquifer in this area has been characterized, the hydraulic parameters have been tested and the geology of this area has been described in previous reports. At present, a series of pumping wells is preventing any off-site migration of hydrocarbons.

In 1986, Tracer Research Corporation conducted a soil vapor survey which included five points along Highway 64, just north of the Suburban Heights Subdivision. The data from this report suggest that the portion of the southern refinery area which is known to have floating hydrocarbons may be defined by soil vapor values. A 10-fold increase in total petroleum hydrocarbon concentrations, relative to other areas where floating hydrocarbons do not exist, is shown in this report.

In cooperation with the US Bureau of Land Management (BLM), the USGS has prepared Water Resources Investigation 87-4246. Of special interest are two seismic cross-sections of the Southern Refinery area. Geologic information presented in these cross-sections is in good agreement with GCL data for this area.

Roy F. Weston, under contract with the BLM, installed nineteen wells during a preliminary investigation of the Lee Acres Landfill. Of the nineteen wells installed, there are three well cluster locations, each of which contain three wells, located south of highway 64 and downgradient of Giant's Bloomfield Refinery (Figure 2-1). In late 1988 or early 1989 Weston drilled an additional well in this area designated as BLM-37. Three feet of hydrocarbon stained cuttings and 2.65 feet of floating hydrocarbon were reported by Weston in BLM 37, downgradient of Giant's

property. Included in Weston's Preliminary Investigation Report are a cross-section and analytical results from sampling BLM wells South of Giant's Bloomfield Refinery.

The New Mexico Oil Conservation Division (NMOCD) and the New Mexico Environmental Improvement Division (NMEID) have sampled private wells in the Suburban Heights Subdivision between 1985 and 1986.

Based upon the data listed above, the following generalizations were used to develop an approach for the planned investigation south of Highway 64:

- Unconsolidated alluvial sediments are present to a depth of approximately 20 feet below land surface in the southern refinery area and a depth of 40 feet near BLM-37.

- Underlying the unconsolidated alluvium are consolidated permeable sandstones and low-permeability claystones of the Naciemento Formation.

- An irregular erosional surface marks the contact between bedrock and overlying alluvium.

- The uppermost aquifer in this area may be unconsolidated alluvium or sandstones of the Naciemento.

- Recovery operations have lowered the water table in the underlying aquifer near the recovery wells.

- The accuracy of laboratory analyses conducted on behalf of BLM are being questioned by the New Mexico Environmental Improvement Division (NMEID).

- The gradient of the potentiometric surface of the uppermost aquifer appears to be to the south towards the San Juan River,

except in the area of the pumping recovery wells where a cone of depression is maintained.

3.0 TECHNICAL APPROACH

3.1 TASK 1: EXISTING DATA COMPILATION

GCL will conduct a search for the location of and pertinent information for all existing wells south of the Giant Bloomfield Refinery and north of the San Juan River. The well locations will be plotted on a map and their locations will be field verified. Most of this data is available in previous GCL reports.

Analytical results for all samples collected from existing wells in the area of interest will be compiled. Organic and inorganic analytical results will be tabulated and entered into a data base.

Information collected by the BLM and the NMEID regarding the area south of the Giant Bloomfield Refinery will be requested from these agencies. GCL must have the cooperation of these agencies to expedite this investigation.

3.2 TASK 2: RECONNAISSANCE DRILLING AND SAMPLING

In order to confirm the results reported by Weston for BLM-37 and to better define the extent of any free phase hydrocarbons, GCL will drill two 4-inch monitor wells along Highway 64 right-of-way south of the highway and north of the Suburban Heights Subdivision. The first well, SHS-1, will be located approximately 100 feet east of BLM-37 and the second well, SHS-2 will be located approximately 100 feet west of BLM-37.

Each well will be installed using a hollow stem auger drill rig. It is anticipated that Western Technology Inc. will install the wells. The wells will be screened through the water/air interface. Well installation will follow GCL's standard operating procedures and can be found in Appendix A.

Due to uncertainties regarding the accuracy of the chemical data from Weston, resampling of existing well BLM-37 downgradient from the refinery is required. Other BLM wells may be sampled if necessary. In addition SHS-1 and SHS-2 will be sampled along with on-site recovery

wells GRW - 1, 3, 5 and monitor well GBR 52. Sampling will follow GCL's standard operating procedures and is described in Appendix B.

The samples obtained from the wells will be analyzed for halogenated and aromatic volatile organic compounds (EPA methods 601 and 602). Total dissolved solids as well as major ion concentrations will also be determined for each well. Water levels will be obtained from the wells scheduled for sampling along with other off-site BLM wells, provided the BLM cooperates with this effort, and on-site refinery wells. It must be emphasized that BLM cooperation in obtaining water level measurements is critical to the development of an accurate hydrologic characterization.

3.3 TASK 3: SOIL VAPOR SURVEY

The Tracer Research Corporation data of 1986 suggests that soil vapor hydrocarbon values differ by an order of magnitude between areas with free-phase hydrocarbons and areas which show no hydrocarbons. GCL anticipates that a soil vapor survey will be an effective tool to use in determining the edge of any plume and assisting in the location of necessary borings or wells. However, a soil vapor survey may have limitations due to the low volatility of any free-phase hydrocarbons released during refinery activities. Prior to attempting any soil vapor survey, ground water chemistry data will be obtained in accordance with tasks 1 and 2 for the area south of Highway 64.

After ground water chemical data has been compiled, a portable gas chromatograph and hand driven probes will be utilized to measure dissolved hydrocarbon concentrations (BTEX) in shallow soil gas at locations with well-defined ground water chemistry data. The methods employed for the soil vapor are described in Appendix C.

If a significant difference in vapor concentrations is observed between areas of known free phase hydrocarbons and areas which exhibit no floating product, a soil vapor sampling program south of Highway 64 will be initiated.

Because access to private property may be restricted, sample locations along roadways are anticipated. GCL will establish a grid to locate initial soil vapor survey sample locations. A 100-foot grid will be established south from US 64 for approximately 300 feet at which point a 300- foot grid will be established for an additional 600 feet to the south. The west boundary of the grid system will be the unnamed arroyo west of the Suburban Heights Subdivision and the east boundary will be approximately 800 feet east of the arroyo.

The 100-foot grid will be used to define the extent of suspected free floating hydrocarbon in the vicinity of BLM-37. Based on analytical results from sampling, the 100-foot grid will be broken down to a 50-foot grid to more precisely define the edges of a plume.

The 300-foot grid will be used to characterize the site and determine other possible sources which may influence the hydrochemistry in the vicinity of the Suburban Heights Subdivision. Based on the analytical results of the initial soil vapor survey, the survey will be expanded or determined complete.

3.4 TASK 4: LETTER REPORT

GCL will summarize the results of the preliminary reconnaissance (tasks 1,2 and 3) in a letter report to NMOCD. All field data will be presented. Recommendations for defining the downgradient edge of any free-phase hydrocarbons will be presented.

3.5 TASK 5: DEFINITION OF DOWNGRADIENT EDGE OF HYDROCARBON FLOATING PHASE PLUME

A soil boring and well installation program is also required to define hydrochemistry of the area south of Highway 64. The number of soil borings will depend upon the success of the soil vapor program. The edge of any plume will be defined through field examination of cores and samples obtained in the boring program. It is our objective to install one well inside the plume (SHS 3), but down gradient of BLM-37, and two

wells about 100 feet downgradient from the edge of the free-phase hydrocarbon plume (SHS 4 & 5).

After the installation of these three additional wells, a second sampling event will occur. SHS-1 through SHS-5, BLM-37, GRW-1,3,5 and GBR-52 will be sampled. The samples obtained will be analyzed for halogenated and aromatic volatile organic compounds using EPA method 601 and 602. Samples collected from SHS 3, 4, and 5 will also be analyzed for total dissolved solids and major cations and anions. Water levels will be measured for all wells. Instantaneous slug tests, to determine aquifer characteristics, may be performed to compare with Weston data.

3.6 TASK 6: LETTER REPORT

The new data will be presented in a second letter report to NMOCD. The extent of the free-phase hydrocarbon plume will be defined. Chemical data from wells will also be utilized to estimate the extent and nature of dissolved phase constituents. It is anticipated that a careful examination of the hydrochemical data will permit identification of the source(s) of contamination. Recommendations regarding further definition of any dissolved-phase element of the plume will also be presented.

With the extent of free-phase hydrocarbon constituents defined, the need for a containment and reclamation strategy will be addressed. If an active remedial action is recommended, a conceptual design and schedule for such an action will be presented. Forty five days after receipt of OCD's review of GCL's conceptual design, planned remedial action will commence.

4.0 SCHEDULE

The reconnaissance drilling program is scheduled to begin on July 24, and will require two weeks to drill, develop and sample the appropriate wells. It is anticipated that BLM-37 will require additional development pumping to obtain a representative ground water sample.

Analytical results for volatile hydrocarbons will be available in early August and the soil vapor survey will be conducted immediately after receipt of those data (mid-August). The remaining analytical results of sampling should be available in late-August. The first letter report is scheduled for submission on September 22, 1989.

After NMOCD review of the first progress report with the recommendations for further site characterization, the second phase of boring and well installation will commence. Considering 10 working days for NMOCD comment, the borehole and well installation program should begin in mid-October A 10-day field program is anticipated. In consideration of the time necessary for well development, sampling and waiting on final analytical results, the second progress report is scheduled for submission on December 15, 1989.

In the second letter report, a schedule for any further activities will be presented.

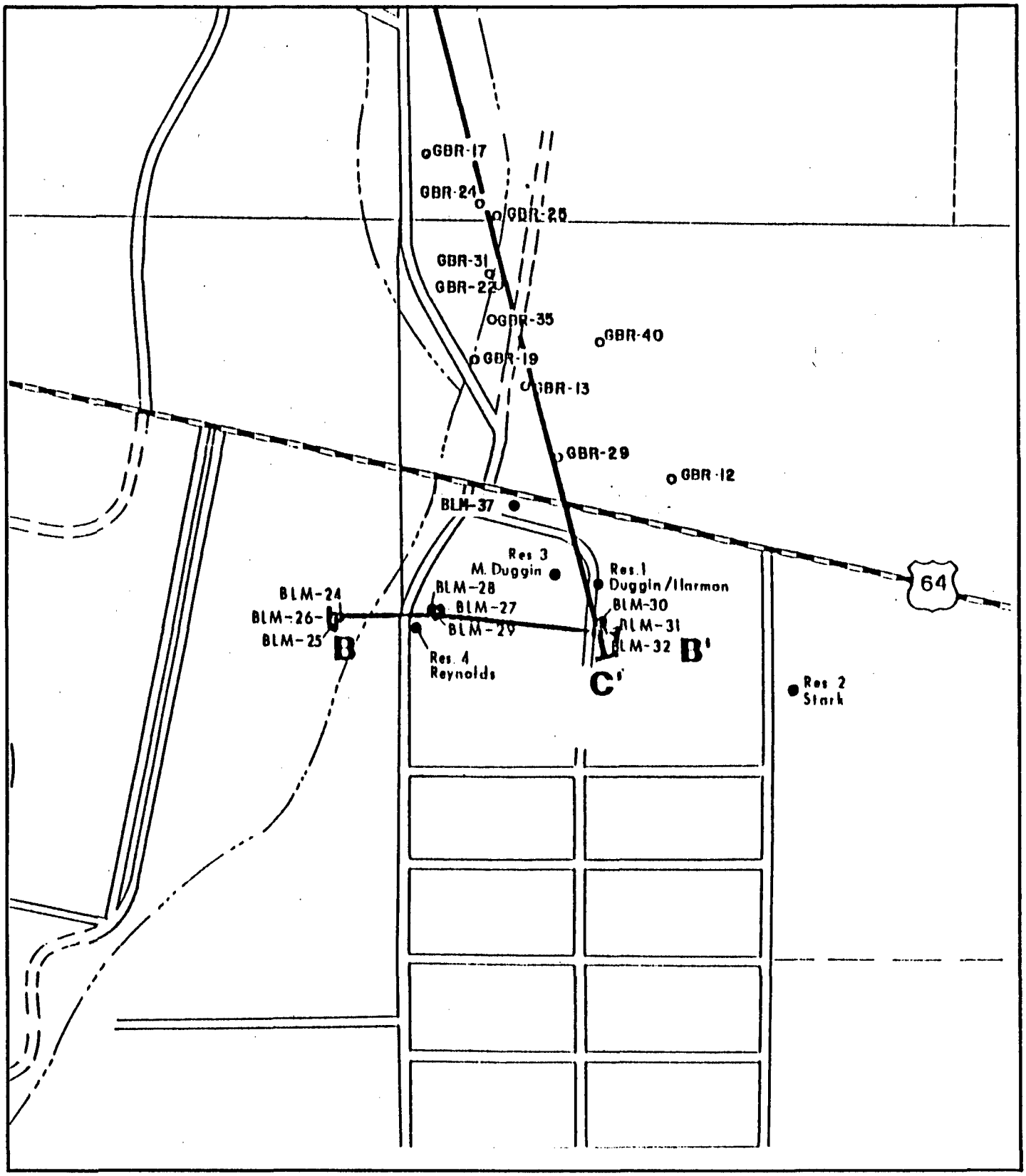

FIGURE 2-1

APPROXIMATE LOCATION OF BLM-37 AND OTHER WELLS SOUTH OF THE REFINERY

(From Weston, 1988)

APPENDIX A

PROCEDURES FOR MONITOR WELL INSTALLATION AND SAMPLING

PROCEDURES FOR MONITOR WELL INSTALLATION AND SAMPLING

1.0 INTRODUCTION

This plan describes the work to be performed during boring and monitor well installation programs. The work is expected to be completed within five days of initiation, or as soon thereafter as practicable. Lab results of all water sample analyses will be reported to the client in a letter report as soon as analytical results become available.

2.0 SOIL BORING

Prior to mobilizing the drill rig to the site, a utility survey will be conducted to ensure that borehole sites are not located over buried pipes or electric lines. Geoscience Consultants Ltd. personnel will review and approve or amend the proposed borehole locations based on their proximity to underground utilities.

Drilling will be performed using a large-diameter hollow-stem auger. All drilling equipment will be steam cleaned before initiation of drilling at each borehole. The continuous sampler will be steam cleaned prior to each use. The steam cleaner will be supplied by the drilling contractor. All cuttings will be drummed until a determination of the method of disposal can be made.

Continuous core soil samples will be scanned using GCL's H-Nu Photo-ionization Detector (H-Nu). A sample from each 2.5-foot interval in the unsaturated zone from each borehole will be retained in a sealed sample container for headspace analysis using the H-Nu.

All boreholes will be logged on standard GCL lithologic log forms, with H-Nu readings noted at the appropriate intervals. Other field notes will be made in a bound field notebook.

3.0 MONITOR-WELL INSTALLATION

The well casing for the wells will be composed of 4-inch, flush joint, polyvinal chloride (PVC) screen and pipe (Figure 3-1), precleaned and prepackaged by the manufacturer. The casing will be installed by

connecting individual sections while they are lowered into the borehole through the hollow center of the auger column. A 10-foot screen will be placed at the air/water interface, with 3 feet above the static water level and 7 feet below.

After the well casing has been installed, the auger flights will be retrieved in 5-foot intervals. Precleaned and prepackaged 20-40 grade silica sand will be poured down the auger annulus to fill the void left as each 5 foot flight is removed. This sand, combined with a small volume of formational sand that may slough into the borehole during retraction of the auger column, will provide the filter pack for the well screen. The sand will be placed to a level of 2 to 3 feet above the top of the screen.

A bentonite seal will be placed on top of the filter pack to form an impervious barrier and prevent downward migration of moisture. The remainder of the well annulus up to the ground surface will be grouted with a concrete slurry. The grout will be inserted from the surface after all remaining auger flights have been removed. The well head will be completed with a 3-foot stainless steel riser and stainless steel locking cap set in a 4-foot by 4-foot concrete slab. The locations and elevations of the monitor wells will be surveyed by a certified land surveyor.

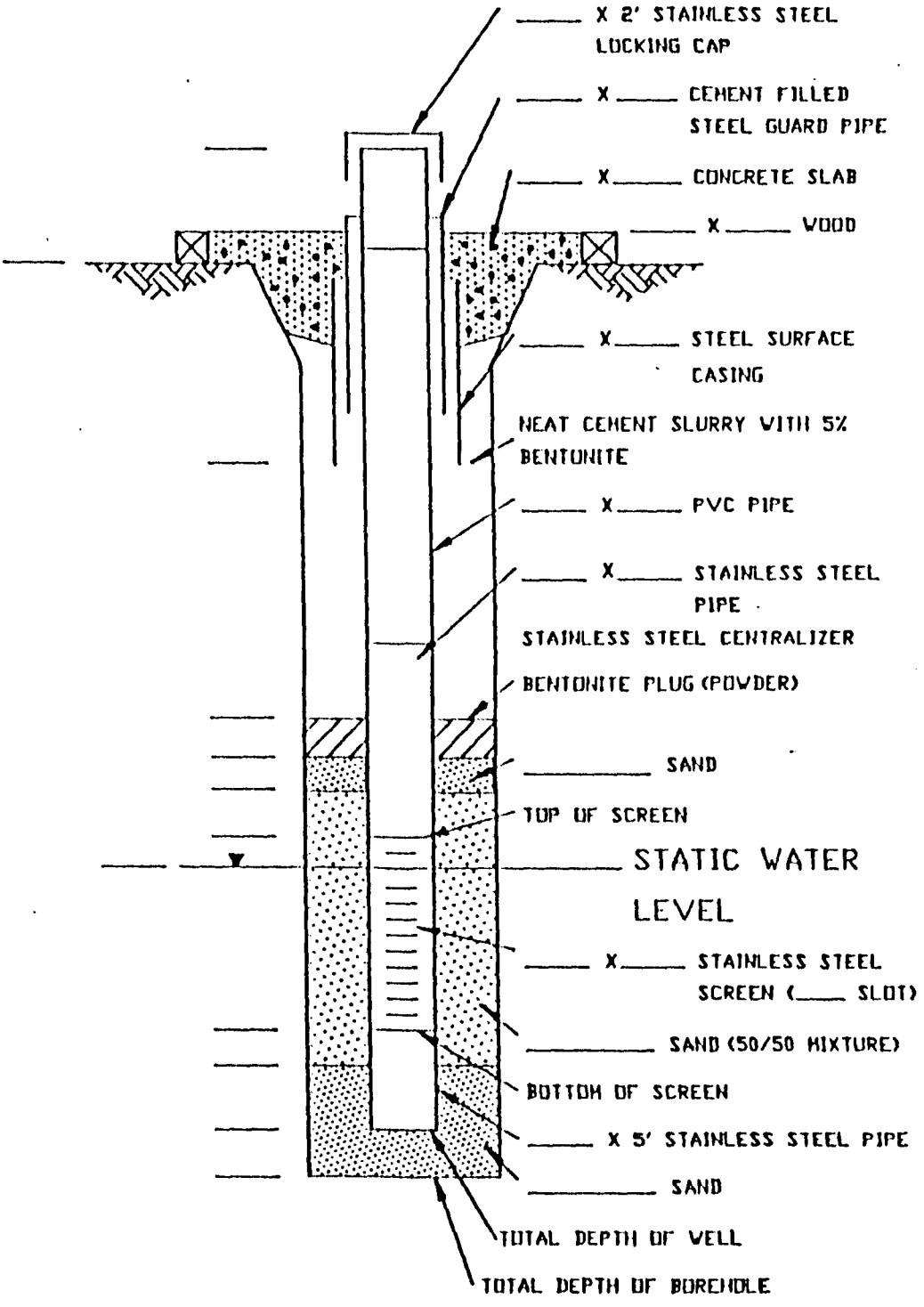

FIGURE 3-1

TYPICAL MONITOR WELL COMPLETION DIAGRAM

4.0 WELL DEVELOPMENT

Well development will be conducted in 2 phases: bailing and pumping. In the first phase, water will be bailed from the well in order to remove gross amounts of clay and silt. Bailing will also served as a verification of proper well alignment. During the second phase of well development, a 2-inch air-ejector pump will be installed in the well and operated from several different levels within the screened interval. The well will be determined to be fully developed when the indicator parameters of pH, temperature and electrical conductance of water sampled from the well have stabilized over three consecutive measurements.

5.0 SAMPLING

The wells will be sampled with a bottom-filling teflon bailer. The bailer will be steam cleaned prior to use on each well. If a steam cleaner is not available, the bailer will be washed with lab soap, rinsed with methanol, and triple-rinsed with distilled water prior to use on each well. The samples will be obtained according to guidelines cited in EPA's RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (OSWER-9950.1) and shipped to the laboratory in an ice chest following strict chain-of-custody procedures. Inter-Mountain Laboratories in Farmington, New Mexico, will analyze the ground-water samples for halogenated and aromatic volatile organic compounds using EPA methods 601 and 602. Samples will also be analyzed for major ion concentrations and total dissolved solids.

0653\GENWRK.PLN

GCL

APPENDIX B

STANDARD OPERATING PROCEDURES
PROCEDURES FOR PURGING AND SAMPLING WELLS

Procedures for Purging and Sampling Wells

1.0 PURPOSE

To describe the Standard Operating Procedures (SOP) for purging and sampling wells.

2.0 SCOPE

This document describes procedures to be used in purging and sampling wells for determination of water quality and potential contamination. The procedures described in this document are consistent with the requirements of all Federal regulations, and are specifically designed to comply with ground-water monitoring requirements under RCRA.

3.0 PROCEDURES

3.1 PREPARATIONS FOR SAMPLING

Before proceeding to the field area, be sure that all necessary equipment and supplies are on hand. To the extent possible, all equipment and supplies should be decontaminated in the laboratory before proceeding to the field area. Equipment decontamination procedures are described in a separate SOP.

Equipment and supplies needed for collecting representative ground-water samples include:

- An electronic water-level indicator or steel tape and chalk,
- Distilled water and wash bottles,
- Brushes and laboratory soap,
- Heavy plastic bags,
- Paper towels or clean rags,
- Zip-lock plastic bags,
- Rubber gloves,
- Several 500 ml beakers,
- A submersible pump (at some sites there is a dedicated pump or bailer for each well) with appropriate attachments to enable purging and sampling the well,
- A hose to direct any pump discharge several feet away from the well, and containers to receive the discharge if it is contaminated,
- Plastic sheet film,

- A graduated bucket,
- A bottom-filling teflon or stainless steel bailer with sufficient cord and/or cable,
- All necessary sample containers with the appropriate volume of preservatives added to the containers by the laboratory,
- pH meter,
- Thermometers,
- Specific conductance meter,
- Field log book and sample forms,
- Ice and ice chest for samples,
- Strapping tape and shipping labels,
- Waterproof marking pen,
- Chain-of-Custody labels,
- Watch or stopwatch for use in determining pumping rates.

A nearby location of a steam cleaner is desirable in order to avoid long delays for cleaning of equipment, if necessary, between sampling of individual wells.

3.2 DETERMINE WATER LEVEL
Using an electronic sounder ("water level probe") or other suitable device, measure the depth to water (DTW) in the well. If approximate total depth (TD) of the well is not known, it will also be necessary to measure total depth with the sounder. If approximate total depth is known, defer the measurement until after sampling has been completed. Use of the electronic sounder is described in a separate SOP.

3.3 DETERMINE THE VOLUME OF WATER TO BE PURGED FROM THE WELL
This normally is at least 3 casing volumes, determined as follows:

- Measure the true inside diameter of the casing, using a steel tape or ruler; convert to feet.
- Find the true inside radius (r) of the casing by dividing the diameter by 2.
- Determine 1 casing volume in cubic feet (V_{cf}) by calculating:

$$V_{cf} = 3.14 \times (r)^2 \times (TD - DTW).$$

- Determine 1 casing volume in gallons by multiplying V_{cf} x 7.48 gals/ft^3.

- Multiply by 3 to determine total volume of water to be pumped from the well.

The exception to this standard (other than program requirements) is in the case of low yield wells. When purging low yield wells, pump the well once to dryness. Samples should be collected as soon as the well recovers. When full recovery exceeds three hours, samples should be collected as soon as sufficient water volume is available.

3.4 PURGE THE WELL

Currently, standards allow for several options for purging wells. They are:

- Teflon or stainless steel bailers

- Existing dedicated equipment - Use of these devices must be approved by On-Site Representatives.

- Peristaltic pumps - Use of these devices, suitable for shallow wells only, must be approved by the On-Site Representative.

- Positive displacement bladder pump or air lift pump, capable of being completely disassembled and cleaned before use in each well. Air must not contact ground water.

At no time during purging should the evacuation rate be high enough to cause the ground water to cascade back into the well thus causing excessive aeration and potential stripping of volatile constituents.

The actual volume of purged water can be measured by several acceptable methods.

- When bailers are used to purge, the actual volume of each bailer's contents can be measured using a calibrated bucket.

- If a pump is used for purging, the pump rate can be determined by using a bucket and stopwatch, and the duration of pumping timed until the necessary volume is purged. A totalizing flow meter may be used, if available.

Monitor the pH, temperature, and specific conductance of the water purged to ensure that these parameters have stabilized by the time three casing volumes have been withdrawn. If stabilization has not been achieved at that time, continue purging until it is achieved.

3.5 DISPOSAL OF PURGED WATER

Dispose of pumped water in a manner which poses no threat of contamination to any surface or ground water in the vicinity. If the water is determined to be hazardous, it must be contained and disposed of accord-

ing to appropriate regulations.

3.6 INITIAL SAMPLING FOR FIELD PARAMETERS

Begin sampling by withdrawing water from the well in accordance with the procedures of Section 3.8. Place the first water withdrawn in a 500 ml or larger flask or beaker which has been properly cleaned, then rinsed three times with the well water being recovered. Use this sample for field measurement of temperature, specific conductance, and pH. Procedures for these field measurements are described in a separate SOP document.

3.7 SAMPLE COLLECTION

3.7.1 General Considerations

The technique used to withdraw a ground-water sample from a well should be selected based on a consideration of the parameters which will be analyzed. To ensure the ground-water samples' representativeness, it is important to avoid physically altering or chemically contaminating the samples during collection, withdrawal, and containerization.

The preferred sampling device for all parameters is a double check valve stainless steel or Teflon bailer.

To the extent possible, no sampling device constructed of or containing neoprene, PVC, Tygon, silicone, polyethylene, or Viton will be used to collect ground-water samples.

In some cases, it may be necessary to use equipment already in the well to collect samples. This is particularly true of high volume, deep wells (>150 feet) where purging pumps are ineffective, and bailing is impractical. If existing equipment must be used, determine the make and model of the pump and check with the manufacturer concerning component construction materials.

General sampling procedures include the following:

- Clean sampling equipment should not be placed directly on the ground. Use a drop cloth or feed line from clean reels. If reels are used, avoid placing contaminated lines back on reels.
- Lower sampling equipment slowly into the well to avoid degassing of the water and damage to the equipment.
- If bailer cable is to be decontaminated and reused, it must be Teflon-coated or made of stainless steel. Braided polypropylene is also acceptable.
- Check the operation of bailer check valve assemblies to confirm free operation.
- Bladder Pump flow rates should be adjusted to eliminate intermittent or pulsed flow. The settings should be determined during the purging operations. Flow rate should be less than

100 ml/minute when sampling for volatile organic compounds (VOC's). Air-lift pumps should not be used for sample collection.

- Samples should be collected and containerized in the order of the parameters volatilization sensitivity. Table 3-1 lists the preferred collection order for some common ground-water parameters.

3.7.2 Collection of Volatile Organics Samples (VOAs)
VOAs should be collected from the first bailer removed from the well after purging, immediately following collection of the sample for field analyses. The most effective means of controlled collection of the sample is by employing two people. One person should retrieve the bailer from the well and place the bottom over a VOA container (40-ml septum vial) held by the second person. The second person should insert the Teflon bottom-emptying device into the bailer, bring the vial to the tip of the bottom-emptying device, and tilt the vial to approximately 60° from the vertical.

Delivery of the sample from the bailer down the edge of the vial is accomplished when the person holding the bailer slowly opens the top check valve with a Teflon, glass, or stainless steel insert. As the vial is filled, the second person should return the sample vial to the vertical position.

Fill the septum vial until it is just overflowing. Cap the vial and invert. If a bubble exists, discard and repeat. Do not reopen the vial and add additional sample.

If an approved pump is used, reduce the flow to less than 100 ml per minute prior to sample collection.

3.8 CONTAINERS
Collect all samples using the standard methods described in the Sampling and Analysis Plan for the project, and preserve all samples in approved containers. The specific containers and preservatives used for each analyte may vary among laboratories. The standard methods of the laboratory selected for analysis will be followed in each project Sampling and Analysis Plan. Handle all samples in accordance with the procedures described in the SOP documents "Procedures for Packing and Shipping of Samples" and "Chain-of-Custody Procedures."

3.9 FINAL FIELD ANALYSES
Immediately after collection of all samples required in the Sampling and Analysis Plan, collect a final sample for field analyses, as described in Section 3.7 above. The purpose of these repeat analyses is to check for possible changes in water quality during the time of sampling. Samples

TABLE 3-1

PREFERRED ORDER OF SAMPLE COLLECTION

1. Volatile organics (VOA)
2. Total metals
3. Purgeable organic carbon (POC)
4. Purgeable organic halogens (POX)
5. Extractable organics
6. Dissolved metals
7. Total organic carbon (TOC)
8. Total organic halogens (TOX)
9. Phenols
10. Cyanide
11. Sulfate and chloride
12. Nitrate and ammonia
13. Radionuclides

used for field analyses should be discarded in an approved and safe manner when the analyses are complete.

3.10 MEASURE TOTAL DEPTH OF WELL
After collection and preservation of all samples and completion of final field analyses, measure the depth to bottom of the well, using the electronic sounder. Use of the sounder is described in a separate SOP.

4.0 REFERENCES

U.S. Code of Federal Regulations, 1983, 40 CFR 264.97.

U.S. Environmental Protection Agency, 1986a, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, p. 97-114.

U.S. Environmental Protection Agency, 1986b, Test Methods for Evaluating Solid Waste: EPA Report SW-846; Volume I: Physical/Chemical Methods.

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APPENDIX C

STANDARD OPERATING PROCEDURES
PROCEDURES FOR SOIL VAPOR SAMPLING AND ANALYSIS

PROCEDURES FOR SOIL VAPOR SAMPLING AND ANALYSIS

1.0 PURPOSE

To describe and illustrate the methods and procedures used in sampling and analyzing shallow subsurface soil vapor for various contamination evaluations.

2.0 SCOPE

A shallow soil-vapor survey is commonly a rapid and cost-effective method for roughly delineating the areal extent of a known spill involving hydrocarbons or other volatile constituents. Shallow soil-vapor investigations are also used to determine the presence or absence of specific constituents in the subsurface at sites where spills or leaks are possible but have not been identified.

3.0 PROCEDURES

3.1 EQUIPMENT AND SUPPLIES

A. Necessary equipment at all sites will include:

- Probes (3/4" I.D. steel pipe, schedule 20 or similar)
- Drive Points
- Adapters
- Floor jack (2-ton capacity)
- Pipe clamp
- Pipe wrenches
- Pipe cutter
- Pipe reamer
- Portable gas chromatograph (GC) (Photovac), syringes and other necessary GC supplies (kit)
- Calculator
- Internal tank filling adapter
- Vacuum pump (battery operated)
- Slide hammer
- Duct tape
- Teflon tubing
- Black inert rubber hose
- Battery pack for GC
- Zero-grade air cylinders

B. Optional equipment and supplies needed at some sites:

- Rotary hammer with bit
- Extension cords
- Generator
- Brunton compass and tape measure
- Steam cleaner
- Metal detector
- Sand and asphalt or concrete patching material

C. Safety Equipment for Persons Driving Probes:

- Hard Hats
- Coveralls
- Gloves
- Safety Glasses
- Steel-toed Boots

3.2 Define the area to be surveyed. This may include an entire gas station, a large area of property, or as small as the area around a single tank.

3.3 Divide the survey area into a grid or other appropriate pattern, and number each location on the grid. Grid spacing may vary depending on the size of the survey area, site conditions and the level of detail required. 20 to 50 foot grid spacing is generally used for a survey at a service station. Note: One may want to number points as field work progresses, so expansion of the grid will be consistently numbered.

3.4 Be sure all sampling equipment, including probes, vacuum adapters, points, and slide hammer (inside and outside) is thoroughly steam cleaned prior to use.

3.5 Prior to soil sampling, an "air sample" of the ambient air should be analyzed with the GC. Be sure the air sample is collected a distance away from or upwind from any running vehicle or other source of hydrocarbon emissions (20-30 feet is sufficient).

3.6 Next, collect a "system blank" to be analyzed prior to sampling. The vacuum pump should be attached to a clean probe with point attached, via an adapter, and a sample collected. This will provide background data of ambient air passing through a probe.

3.7 If it is necessary to drill through concrete or asphalt, start the generator (make sure it is positioned downwind of probes) or plug an extension cord into an available electrical outlet. Locate the rotary hammer over the hole and drill through the concrete or asphalt to underlying soil. Remove drill.

3.8 Insert the drive point into base of probe. Tape point loosely with duct tape to probe (so it won't fall out during insertion into hole).

3.9 Remove lift plate (white) from floor jack, and place hole in lifting arm of the jack over the drilled hole.

3.10 Insert the probe through the hole in the jack's lifting arm, and into the drilled hole or the soil surface.

3.11 Place slide hammer over the top of the probe and drive to the target depth. Generally, a target depth of 5 feet is used, except for vertical profiles. Remove the slide hammer.

3.12 Promptly after driving the probe, place an adapter over it and connect it to the vacuum pump.

3.13 Place pipe clamp around probe at the lifting arm of the jack. Tighten clamp. Turn jack handle clockwise to activate hydraulics. Use jack to retract probe 1-3 inches immediately before sampling.

3.14 When the chemist is ready to take the sample, activate the vacuum pump. It is necessary to evacuate approximately 5 probe volumes of soil vapor prior to sampling. This can be approximated by the vacuum reading on the pump.

VACUUM PUMP GAGE READING (Inches Hg)	EVACUATION TIME (Seconds)
2 - 5	30
5 - 10	45
10 - 15	60
15 - 17	90

Note: Vacuum pressures above 17 in. Hg. suggest either a clogged probe, a very tight formation, or water. If there is a possibility of shallow ground water, be sure water is not evacuated and passed into the vacuum pump. Above 17 in. Hg. the pump will not collect a good soil vapor sample and the problem should be investigated.

3.15 After the evacuation time is satisfied, insert a clean syringe (equipped with a mini-enert valve) through the flexible latex (self-sealing) tubing at the top of the adapter. Flush the syringe 3 times with the soil vapor while the evacuation pump is running. Turn the evacuation pump off and immediately withdraw a 2cc sample and close the mini-enert valve on the syringe.

3.16 Analyze the sample by gas chromatography. This task will be performed by a person experienced in GC operations.

3.17 With the pipe clamp still tightened around the probe, extract the probe. The jack can be reset by turning the handle counterclockwise. This will allow the lifting arm to drop, and the pipe clamp can be loosened and lowered.

3.18 After extraction, the used probe and adaptor should be set aside in a designated area so as to prevent confusion with clean probes or adapters.

3.19 For each soil vapor point, record in log book the following items:

SITE LOCATION
WEATHER JOB #

	TIME	POINT #	DEPTH	VACUUM	EVAC TIME	REMARKS
Example	10:00	# 5	5′	3" Hg	30 Sec.	
	10:30	# 7	5′	18" Hg	-	Probe clogged removed, cleaned redrove to 6′

3.20 Steam clean all probes and adapters prior to re-use.

3.21 After QA/QC of field data, results should be submitted to Data Management for processing and mapping.

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