B 10/17/02

REPORT OF GEOTECHNICAL SERVICES
SUBSURFACE CONTAMINATION STUDY
UNOCAL BULK PLANT 0082
CHELAN, WASHINGTON
FOR
UNOCAL

3/14/90

GeoEngineers

Consulting Geotechnical
Engineers and Geologists

March 14, 1990

Unocal
P.O. Box 76
Seattle, Washington 98111

Attention: Mr. Gary Gunderson

We are submitting five copies of our subsurface contamination study at the site of Unocal Bulk Plant 0082 in Chelan, Washington. Our services were authorized verbally by Mr. Gary Gunderson on October 27, 1989. Contractual terms for our services are included in blanket contract B1982A.

We appreciate the opportunity to be of continued service to Unocal. Please call if you have any questions regarding this report.

Yours very truly,

GeoEngineers, Inc.

James A. Miller, P.E.
Principal

DJK:JAM:db

cc: Mr. Dave George
Washington Dept. of Ecology
801 B Summit View Dr.
Yakima, WA 98902

File No. 0161-228-B04

GeoEngineers, Inc.
2405 140th Ave. NE, Suite 105
Bellevue, WA 98005
Telephone (206) 746-5200
Fax. (206) 746-5068

Geo Engineers

TABLE OF CONTENTS

List of Tables

List of Figures

APPENDIX A

List of Appendix A Figures

APPENDIX B

GeoEngineers

REPORT OF GEOTECHNICAL SERVICES
SUBSURFACE CONTAMINATION STUDY
UNOCAL BULK PLANT 0082
CHELAN, WASHINGTON
FOR
UNOCAL

INTRODUCTION AND SCOPE

The results of our explorations for subsurface petroleum-related contamination at the site of Bulk Plant 0082 are presented in this report. The site is located southeast of the intersection between Highway 97 and East Street in Chelan, Washington. The site location and surrounding features are shown in the Vicinity Map, Figure 1. The general layout of the site is shown in the Site Plan, Figure 2,

The purpose of our services is to explore and evaluate potential subsurface petroleum-related contamination at the site. The scope of services completed for this study includes:

1. Drill three exploration borings at the site using air-rotary drilling equipment.
2. Excavate three test pits using a rubber-tired backhoe.
3. Obtain soil core samples at 5-foot intervals from each boring and grab samples at 1- to 3-foot intervals from each test pit. Conduct field screening on each sample for evidence of contamination using visual, water sheen and headspace vapor screening methods.
4. Obtain one surface soil sample from beneath the warehouse and conduct field screening and analytical testing.
5. Test at least one soil sample from each boring and test pit excavation for the presence of benzene, ethylbenzene, toluene and xylenes (BETX) by EPA method 8020 and/or total petroleum hydrocarbons (TPH) by EPA Method 418.1. Test the surface soil sample obtained from beneath the warehouse for TPH.
6. Install a 2-inch-diameter PVC monitor well casing within a flush-grade, locking surface monument in the three power borings.
7. Develop the well screens by hand bailing with a stainless steel bailer.

8. Accurately determine the monitor well casing rim elevations and water table depths in each well for determination of water table elevations and shallow ground water flow direction.
9. Sample the water table interface for the potential presence of free (floating) product.
10. Obtain ground water samples from each monitor well for laboratory analysis of BETX by EPA Method 8020 and TPH by EPA Method 418.1.
11. Measure the air space in each well casing for hydrocarbon vapors using a properly calibrated Bacharach TLV Sniffer.
12. Evaluate the field and laboratory data with regard to current regulatory criteria.

SITE CONDITIONS

GENERAL

Unocal Bulk Plant 0082 is located approximately 200 feet east of Lake Chelan outside the Chelan city limits. The site slopes gently downward toward the west with a ground surface elevation of approximately 1120 feet above sea level.

The site is located within an area of residential and commercial development. Single-family residences are located to the east and west. A fuel bulk facility operated by Shell Oil is located north of the site across Highway 97. A water slide park is located south of the site.

The bulk plant is currently inactive. Facilities on the property include an office building, a wood-floored warehouse building, six vertical above-ground fuel storage tanks, a truck loading rack, truck unloaders, a barrel storage area, pumps and piping. The tank farm is approximately 5 feet above the loading rack and warehouse level. The truck loading area was previously located north of and adjacent to the warehouse building.

SITE HISTORY

The date of construction of Bulk Plant 0082 and the previous site use are unknown. According to information supplied to GeoEngineers by Unocal, the low tank numbers for this site indicate a construction date in the late 1920s. Tanks 2276, 2277 and 2278 were added in 1950. The current truck loading rack and the office building were constructed in 1968. The pumps and associated piping were updated in 1950, 1969 and 1985. Unocal indicated

that a loss of approximately 1900 gallons of unleaded gasoline occurred in the tank farm area in 1985 due to a tank overfill. A concrete floor was added to the tank farm following the spill incident.

SUBSURFACE SOIL CONDITIONS

Subsurface soil conditions beneath the bulk plant site were explored by drilling three test borings (MW-1 through MW-3) and excavating three test pits (TP-1 through TP-3) at the locations indicated in Figure 2. Details of the field exploration program, the boring logs and the test pit logs are presented in Appendix A.

The site is underlain by very dense deposits of sand and gravel. Boring MW-1 encountered fine to coarse gravel with sand from the base of the crushed rock surface covering to a depth of 12 feet. Fine to medium sand with occasional gravel was encountered from the base of the gravel to the completed depth of 30.3 feet in MW-1. Boring MW-2 encountered coarse gravel with silt and sand from beneath the crushed rock paving to approximately 9 feet. The coarse gravel was underlain by fine to medium sand to a depth of approximately 17 feet. Boring MW-2 encountered a second coarse gravel unit from 17 to 22 feet and fine to medium sand from 22 feet to the base of the exploration at 30.3 feet. Fine to medium sand with occasional gravel was encountered from beneath the crushed gravel paving to approximately 8 feet in MW-3, and was underlain by 10 feet of coarse gravel with sand. Fine to medium sand was encountered from the base of the gravel unit to the completed depth of 31 feet. The test pits encountered sand with gravel through their entire depths.

GROUND WATER CONDITIONS

Ground water conditions at the site were explored by constructing a monitor well in each boring. Construction details for the three monitor wells are included in Appendix A.

We determined the water table depth and elevation in MW-1 through MW-3 on December 4, 1989, three to four days after drilling. The water table at the site was between 19.2 and 19.8 feet below ground surface at the time of our measurements. Very little slope was observed on the water table at the time of our field measurements. Water table elevations for the monitor wells and water table elevation contours are included in Figure 2 for

measurements made on December 4. The ground water flow direction beneath the site appears to be eastward away from Lake Chelan.

SURFACE CONTAMINATION

Visual evidence of surface hydrocarbon contamination is present (1) around the current and former truck loading rack locations, (2) near the northeast corner of the site, (3) in the barrel storage area, (4) east of the warehouse platform, and (5) near the tank farm containment wall (Figure 2). One surface sample was obtained from TP-3 (located near the barrel storage area) and one shallow subsurface sample was obtained from TP-1 (located west of the loading rack) for analytical testing. The results of these analyses are discussed in the following of this text.

Visual evidence of hydrocarbon contamination was not observed beneath the warehouse floor. We obtained one surface soil sample (WH-1) from beneath the warehouse and tested the sample for TPH. The analytical results are included in Table 1. Laboratory analysis detected a concentration of 150 ppm TPH in the sample.

SUBSURFACE CONTAMINATION

Potential subsurface fuel-related contamination at the site was evaluated by:

1. Conducting field screening on each soil sample obtained from the borings and test pits for evidence of contamination using visual, water sheen and headspace vapor screening methods. These methods are described in Appendix A.
2. Measuring the air space in the monitor well casings for hydrocarbon vapors.
3. Sampling the water table interface in each monitor well for the presence of free (floating) product).
4. Testing selected soil samples obtained from the borings and test pits and ground water samples for TPH by EPA Method 418.1 and for BETX by EPA Method 8020.

Subsurface contamination data are summarized in Tables 1 and 2. Field screening results for the soil samples obtained from the borings and test

pits are presented in the monitor well and test pit logs included in Appendix A. Laboratory reports for the soil and water samples are included in Appendix B.

Petroleum-like odors were noted from 12 to 20 feet in MW-1 and from 26 to 28 feet in MW-3. Visual evidence of petroleum contamination was noted from the ground surface to a depth of 4 feet and again at 11 feet in TP-1, from the gravel surface to 10 feet in TP-2, and to a depth of approximately 3 inches in TP-3.

Moderate to low hydrocarbon vapor concentrations were detected by headspace field screening methods in at least one soil sample obtained from MW-1, TP-1 and TP-2. Headspace vapors were not detected at significant concentrations during field screening of the soil samples obtained from MW-2, MW-3 and TP-3.

Sheen testing involves immersion of soil in water and observing the water surface for signs of sheen. Moderate to heavy sheens were observed during the sheen screening tests on the soil samples obtained from 15 and 20 feet in MW-1, from 0 to 11 feet in TP-1 and TP-2, and from 0 to 1 foot in TP-3. Either no sheen or a slight sheen was observed while testing the soil samples obtained from MW-2, MW-3 and below a depth of 1 foot in TP-3.

The concentrations of hydrocarbon vapors in the monitor well casings were measured with a Bacharach TLV Sniffer calibrated to hexane. A vapor concentration of 420 ppm was measured in MW-1. Concentrations measured in MW-2 and MW-3 were less than 100 ppm.

Selected soil samples from each boring and test pit were analyzed for the presence of BETX and TPH. Benzene was not detected in the soil samples tested. A moderate concentration of xylenes (59 ppm) was detected in the sample obtained at 1 foot in TP-1. Low concentrations of ethylbenzene, toluene and/or xylenes were detected in the samples tested from MW-1 and TP-1, and in the sample obtained from 5 feet in TP-2.

A high concentration of TPH (69,000 ppm) was detected in the surface sample obtained from TP-3. The TPH concentration was 160 ppm for the soil sample obtained from a depth of 3 feet in TP-3. Moderate to high concentrations of TPH were also detected in the soil samples tested from MW-1, TP-1 and TP-2. Low concentrations of TPH were detected in the soil samples tested from MW-2 and MW-3.

Free (floating) hydrocarbons were not observed in the monitor wells. Sheens and petroleum-like odors were observed during well development in MW-1 and MW-3.

Benzene (270 ppb), ethylbenzene (95 ppb), toluene (150 ppb) and xylenes (700 ppb) were detected in the ground water sample from MW-1. A low concentration of xylenes (1.5 ppb) was detected in the ground water sample obtained from MW-3. BETX was not detected in MW-2. Low concentrations of TPH were detected in the ground water samples obtained from MW-1, MW-2 and MW-3 (3.8, 0.23 and 9.3 ppm, respectively).

CONCLUSIONS

The results of this study indicate the presence of surface and subsurface petroleum-related contamination at Bulk Plant 0082. Concentrations of TPH in subsurface soil samples obtained from the vicinity of the truck unloaders (MW-1) and the current (TP-1) and former (TP-2) truck loading locations exceed current Washington Department of Ecology (Ecology) soil cleanup guidelines (200 ppm). TPH concentrations greater than cleanup guidelines also were detected at ground surface in the barrel storage area (TP-3).

The concentration of benzene detected in the ground water sample obtained from MW-1 exceeds the current drinking water standard of 5 ppb. MW-1 is located adjacent to the truck unloaders. GeoEngineers informed Mr. Dave George of Ecology on January 16, 1990 about the presence of petroleum-related contamination at the bulk plant.

RECOMMENDATIONS

It is our opinion that the most practical method of soil remediation at this site is soil excavation and landfarming/aeration. Removal of the source of hydrocarbons in the soil facilitates the natural degradation of residual hydrocarbons in the ground water. We recommend that the warehouse, covered platform, truck unloaders, truck loading rack and associated product lines be demolished and removed from the property.

It is our understanding that Unocal would like the tank farm and containment wall to remain intact. Because soil contamination in the vicinity of the truck unloaders extends to a depth of at least 20 feet, deep excavation will be required and shoring may be necessary to preserve

the integrity of the tank farm. In addition, contamination may be found to extend beneath the tank farm. Remedial options for the tank farm area can be reviewed at that time.

We recommend treating the contaminated soils on site or on other Unocal property. The treatment process should consist of tilling the soil regularly to enhance aeration and adding nutrients and water as necessary to promote biodegradation of the residual hydrocarbons.

We recommend sampling ground water for laboratory analysis of BETX at the end of the cleanup program. Several wells may be destroyed during soil excavation operations. These wells should be replaced so that ground water can be sampled. Future sampling and analysis of ground water samples could necessitate additional remedial measures, such as ground water treatment.

LIMITATIONS

We have prepared this report for use by Unocal. This report may be made available to prospective buyers of the property and to regulatory agencies. The report is not intended for use by others and the information contained herein is not applicable to other sites.

Our interpretations of subsurface conditions are based on data from widely spaced boreholes at the site. It is always possible that areas with undetected contamination may exist in areas of the site that were not explored by drilling or by shallow explorations.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No other conditions, express or implied, should be understood.

- o O o -

GeoEngineers

Please call if you have questions concerning our report.

Respectfully submitted,

GeoEngineers, Inc.

Julia Fowler for
Deborah J. Kristof
Hydrogeologist

James A. Miller
Principal

DJK:JAM:sd

TABLE 1
SUMMARY OF HYDROCARBON VAPOR AND SOIL CHEMISTRY DATA

Boring/ Test Pit Number	Soil Odor During Drilling	Well Casing Vapor Concentrations		Sample Depth (feet)	Purgeable Aromatics(1) (EPA Method 8020) (ppm)				Total Petroleum Hydrocarbons (EPA Method 418.1) (ppm)
		ppm	%LEL		B	E	T	X	
MW-1	Yes	420	4	15	<0.025	0.22	0.046	2.6	4,600
	Yes	--	--	20	<0.025	0.079	0.029	0.83	1,300
MW-2	No	<100	<1	15	<0.025	<0.025	<0.025	<0.025	6.1
MW-3	Yes	<100	<1	15	<0.025	<0.025	<0.025	<0.025	19
TP-1	--	--	--	1	<0.13	<0.13	1.1	59	
	--	--	--	11	<0.025	<0.025	<0.025	1.8	1,900
TP-2	--	--	--	5	<0.025	0.15	0.066	0.72	6,000
	--	--	--	11	<0.05	<0.025	<0.025	<0.025	590
TP-3	--	--	--	0	<0.025	<0.025	<0.025	<0.025	69,000
	--	--	--	3	<0.025	<0.025	<0.025	<0.025	160
WH-1	--	--	--	0	--	--	--	--	150

Notes:
(1) B = benzene, E = ethylbenzene, T = toluene, X = total xylenes
"--" signifies "not tested"
"<" signifies "less than"
"ppm" signifies "parts per million"

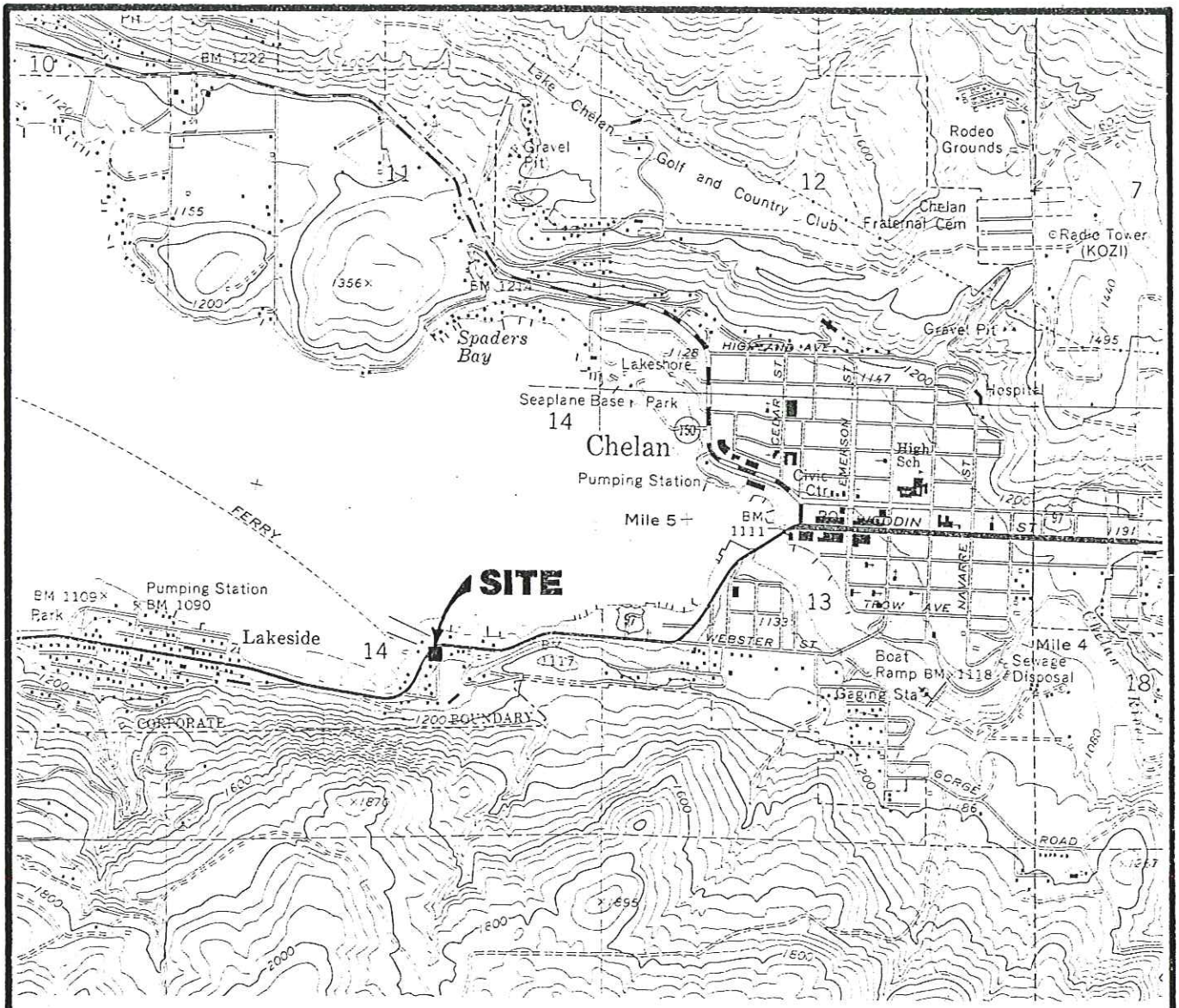
Geo Engineers

GeoEngineers

TABLE 2
SUMMARY OF GROUND WATER QUALITY DATA

Well Number	Water Table Conditions	BETX (ppb)(1) (EPA Method 602)				TPH (ppm)(2) (EPA Method 418.1)
		B	E	T	X	
MW-1	Moderate sheen	270	95	150	700	3.8
MW-2	No sheen	ND	ND	ND	ND	0.23
MW-3	Moderate sheen	ND	ND	ND	1.5	9.3

Notes:
(1) B = benzene, E = ethylbenzene, T = toluene, X = total of ortho, meta and para xylenes. BETX lower detection limit is 0.5 ppb.
(2) TPH = Total Petroleum Hydrocarbons. TPH lower detection limit is 0.05 ppm.
"ND" indicates "not detected"
"ppb" indicates "parts per billion"
"ppm" indicates "parts per million"



REFERENCE: USGS 7.5' TOPOGRAPHIC QUADRANGLE MAP "CHELAN, WASH."

Geo Engineers

VICINITY MAP

FIGURE 1

0161-228-804 DJK:KKT 1-12-90

0161-228-804 WSL:KKT 2-19-90

0 20 40
SCALE IN FEET

HIGHWAY 97

81.31 81.30 81.29 81.28

Crushed Rock Paving

MW-2
81.31

Underground Product Lines

Truck Loading Rack

Oil/Water Separator

Concrete Slab

Concrete Berm

TP-1

MW-1
81.28

Drain Line

Aboveground Product Lines

MW-3
81.31

Truck Unloaders

Former Truck Loading Area

TP-2

Concrete Curb

Pumps

WH-1

Concrete Dike

Covered Platform

2278 2277 2276

Concrete Floor

Warehouse

3192 1987 2227

Barrel Storage

TP-3

Vertical Aboveground Storage Tanks

Office

ALLEY

EAST STREET

Property Line

Chain Link Fence

EXPLANATION:

- MW-1 / 81.28 — MONITOR WELL LOCATION AND NUMBER; GROUND WATER TABLE ELEVATION ON 12/4/89
- TP-1 — TEST PIT LOCATION AND NUMBER
- WH-1 — SOIL SAMPLE LOCATION & NUMBER
- 81.30 — GROUND WATER ELEVATION CONTOUR BASED ON 12/4/89 MEASUREMENTS
- GENERAL DIRECTION OF GROUND WATER FLOW ON 12/4/89
- AREA OF SURFACE STAINING
- BENCHMARK AT SE CORNER OF OIL/WATER SEPARATOR, ASSUMED ELEVATION OF 100.00 FEET

REFERENCE: DRAWING ENTITLED "CHELAN, WASH., MARKETING BRANCH, GENERAL ARRANGEMENT", REVISION DATED 10/8/85, BY UNOCAL.

GeoEngineers

SITE PLAN

FIGURE 2

APPENDIX A

A P P E N D I X A

FIELD EXPLORATIONS

DRILLING AND SOIL SAMPLING PROGRAM

Subsurface conditions at Bulk Plant 0082 were explored by drilling three borings and by excavating three test pits at the locations indicated in Figure 1. The borings were drilled between November 30 and December 1, 1989 to depths of 30.3 to 31.0 feet using top-drive air rotary drilling equipment owned and operated by Soil Sampling Service, Inc. The test pits were excavated on December 4, 1989 to depths of 8 to 11 feet using a rubber-tired backhoe owned and operated by Stocker Excavation. The drilling and soil sampling equipment was cleaned with a hot-water pressure washer prior to each boring.

An engineer from our staff determined the boring and test pit locations, examined and classified the soils encountered, and prepared a detailed log of each boring and test pit. Soils encountered were classified visually in general accordance with ASTM D-2488-83, which is described in Figure A-1. An explanation of the boring log symbols is presented in Figure A-2. The boring logs are given in Figures A-3 through A-5. The test pit logs are given in Figure A-6.

Relatively undisturbed soil samples were obtained from each boring using a Dames & Moore split-barrel sampler (2.4-inch-ID). The sampler was driven 18 inches by a 300-pound weight falling a vertical distance of approximately 30 inches. The number of blows needed to advance the sampler the final 12 inches or other indicated distances is indicated to the left of the corresponding sample notations on the boring logs.

At least one soil sample from each boring and test pit was selected for chemical analysis of benzene, ethylbenzene, toluene and xylenes, and total petroleum hydrocarbons. One surface soil sample also was obtained from beneath the warehouse for analysis of total petroleum hydrocarbons.

Samples that were tested are denoted in the boring and test pit logs with a "CA." Chain-of-custody procedures were followed in transporting soil samples to the laboratory.

FIELD SCREENING OF SOIL SAMPLES

Soil samples obtained were split into two portions. One portion of each sample was retained for soil classification and analytical testing. A GeoEngineers representative conducted field screening on the second portion of each soil sample obtained from the exploratory borings and test pits. Field screening results are used as a general guideline to delineate areas of potential petroleum-related contamination in soils. In addition, screening results are used as a basis for selecting soil samples for chemical analysis. The field screening methods employed included (1) visual examination, (2) sheen testing, and (3) headspace vapor testing using a Bacharach TLV Sniffer calibrated to hexane. The results of headspace and sheen screening for soil samples from the borings are included on the boring logs. The field screening data for the test pit samples are included in Figure A-6.

Visual screening consists of inspecting the soil for the presence of stains indicative of residual petroleum hydrocarbons. Visual screening is generally more effective in detecting the presence of heavier petroleum hydrocarbons such as motor oil, or when hydrocarbon concentrations are high. Sheen testing and measuring headspace vapors are more sensitive screening methods which have been effective in detecting contamination at levels less than regulatory cleanup guidelines.

Sheen testing involves immersion of the soil sample in water and observing the water surface for signs of a sheen. Sheens are classified as follows:

No Sheen (NS)	No visible sheen.
Slight Sheen (SS)	Light colorless sheen, spotty to globular; spread is irregular, not rapid; areas of no sheen remain; film dissipates rapidly.

Moderate Sheen (MS)	Light to heavy film, may have some color or iridescence, globular to stringy; spread is irregular to flowing.
Heavy Sheen (HS)	Heavy colorful film with iridescence; stringy, spread is rapid; sheen flows off the sample; most of water surface is covered with sheen.

Headspace vapor screening involves placing a soil sample in a plastic sample bag. The sample bag is sealed and shaken slightly to expose the soil to the air trapped in the bag. The probe of a Bacharach TLV Sniffer is inserted into the bag and the TLV Sniffer withdraws air from the bag. The instrument measures the concentration of combustible vapors present within the sample bag headspace. The TLV Sniffer records concentrations in parts per million (ppm) and is calibrated to hexane. The instrument is designed to detect combustible hydrocarbons at concentration ranges between 100 ppm and 10,000 ppm.

Field screening results are site specific. The results vary with soil type, soil moisture and organic content, ambient air temperature, and type of contaminant.

MONITOR WELL CONSTRUCTION

Two-inch-diameter, Schedule 40 polyvinylchloride (PVC) casing was installed in each of the hollow-stem auger borings at the completion of drilling. The lower portion of the PVC casing consists of machine slotted (0.020-inch slot width) well screen, allowing entry of water, floating hydrocarbons and hydrocarbon vapors into the well casing. Medium sand was placed in the borehole annulus surrounding the well screen. The well casings are protected within flush-grade surface monuments. Monitor well construction details are indicated in Figures A-3 through A-5.

The monitor wells were developed by removing water from the wells with a stainless steel bailer. The elevations of the well casings were measured to the nearest 0.01 foot with an engineers level on December 4, 1989. An elevation datum of 100 feet was assumed on the southeast corner of a catch basin located north of MW-3 (Figure 2). Elevations referenced to this datum are included on the monitor well logs.

GROUND WATER SAMPLING PROGRAM

Ground water samples were collected from the monitor wells by GeoEngineers on December 4, 1989. The water samples were collected with a teflon bailer after at least three well volumes of water were removed from each well casing. The water samples were transferred to septum vials, which contained hydrochloric acid as a sample preservative, in the field and kept cool during transport to the testing laboratory. Chain-of-custody procedures were observed in transporting the samples to the analytical laboratory.

The bailer was cleaned prior to each sampling attempt with a fresh water rinse, a trisodium phosphate (TSP) wash, and a distilled water rinse.

GROUND WATER ELEVATIONS

The depth to the ground water table relative to the monitor well casing rims was measured on December 4, 1989. The site measurements were made using a weighted fiberglass tape and water-finding paste. The fiberglass tape was cleaned with a TSP wash and a distilled water rinse prior to use at each well. Ground water elevations were calculated by subtracting the water table depth from the casing rim elevations. Water table positions measured on December 4, 1989 are shown on the monitor well logs.

HYDROCARBON VAPOR CONCENTRATIONS

Hydrocarbon vapor concentrations were measured in each monitor well on December 4, 1989 using a Bacharach TLV Sniffer, which is calibrated to hexane. The lower threshold of significance for the TLV Sniffer in this application is 400 ppm, or 4 percent of the Lower Explosive Limit (LEL) of hexane.

CHEMICAL ANALYTICAL PROGRAM

Ground water and soil samples collected from the three monitor wells and soil samples collected from the three test pits were analyzed by the laboratory of Analytical Technologies, Inc. Gas chromatography was used to quantify benzene, ethylbenzene, toluene, and xylenes (BETX) in the water and soil samples (EPA Method 8020). Infrared spectrophotometry methods were used to analyze for total petroleum hydrocarbons (TPH) in the ground water and soil samples (EPA Method 418.1).

Laboratory data sheets and chain-of-custody forms are included in Appendix B.

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS MORE THAN 50% PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-83.
2. Soil classification using laboratory tests is based on ASTM D2487-83.
3. Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry – Absence of moisture, dusty, dry to the touch

Moist – Damp, but no visible water

Wet – Visible free water or saturated, usually soil is obtained from below water table

Geo Engineers

SOIL CLASSIFICATION SYSTEM

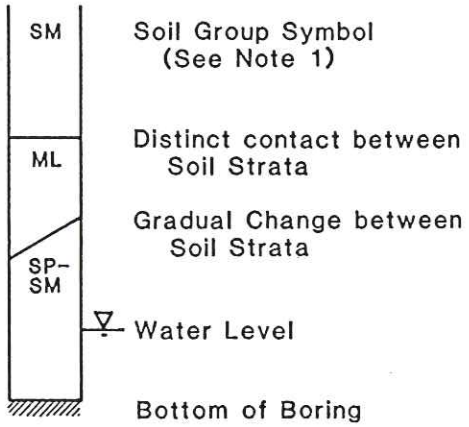
FIGURE A-1

GEI 85-88

LABORATORY TESTS:

AL	Atterberg limits
CP	Compaction
CS	Consolidation
DS	Direct shear
GS	Grain-size analysis
HA	Hydrometer analysis
K	Permeability
M	Moisture content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfined compression
CA	Chemical Analysis

SOIL GRAPH:



BLOW-COUNT/SAMPLE DATA:

Blows required to drive Dames & Moore sampler 12 inches or other indicated distances using 300 pound hammer falling 30 inches.

"P" indicates sampler pushed with weight of hammer or hydraulics of drill rig.

22 ■	Location of relatively undisturbed sample
12 ⊠	Location of disturbed sample
P □	Location of sampling attempt with no recovery
10 ◪	Location of sample attempt using Standard Penetration Test procedures

NOTES:

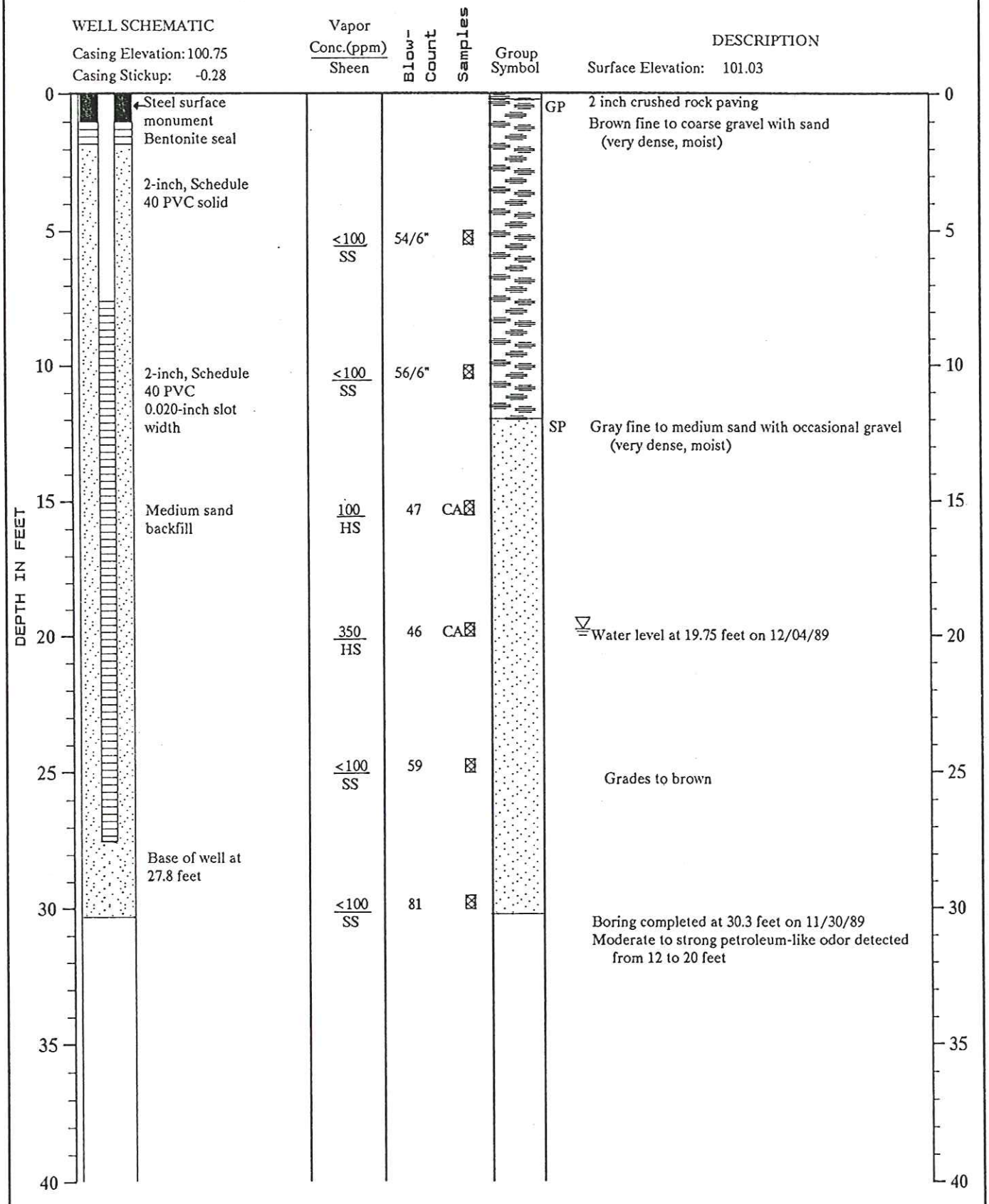
1. Soil classification system is summarized in Figure A-1.
2. The reader must refer to the discussion in the report text as well as the exploration logs for a proper understanding of subsurface conditions.

Geo Engineers

KEY TO BORING LOG SYMBOLS

FIGURE A-2

MONITOR WELL NO. MW-1



Note: See Figure A-2 for explanation of symbols

Geo Engineers

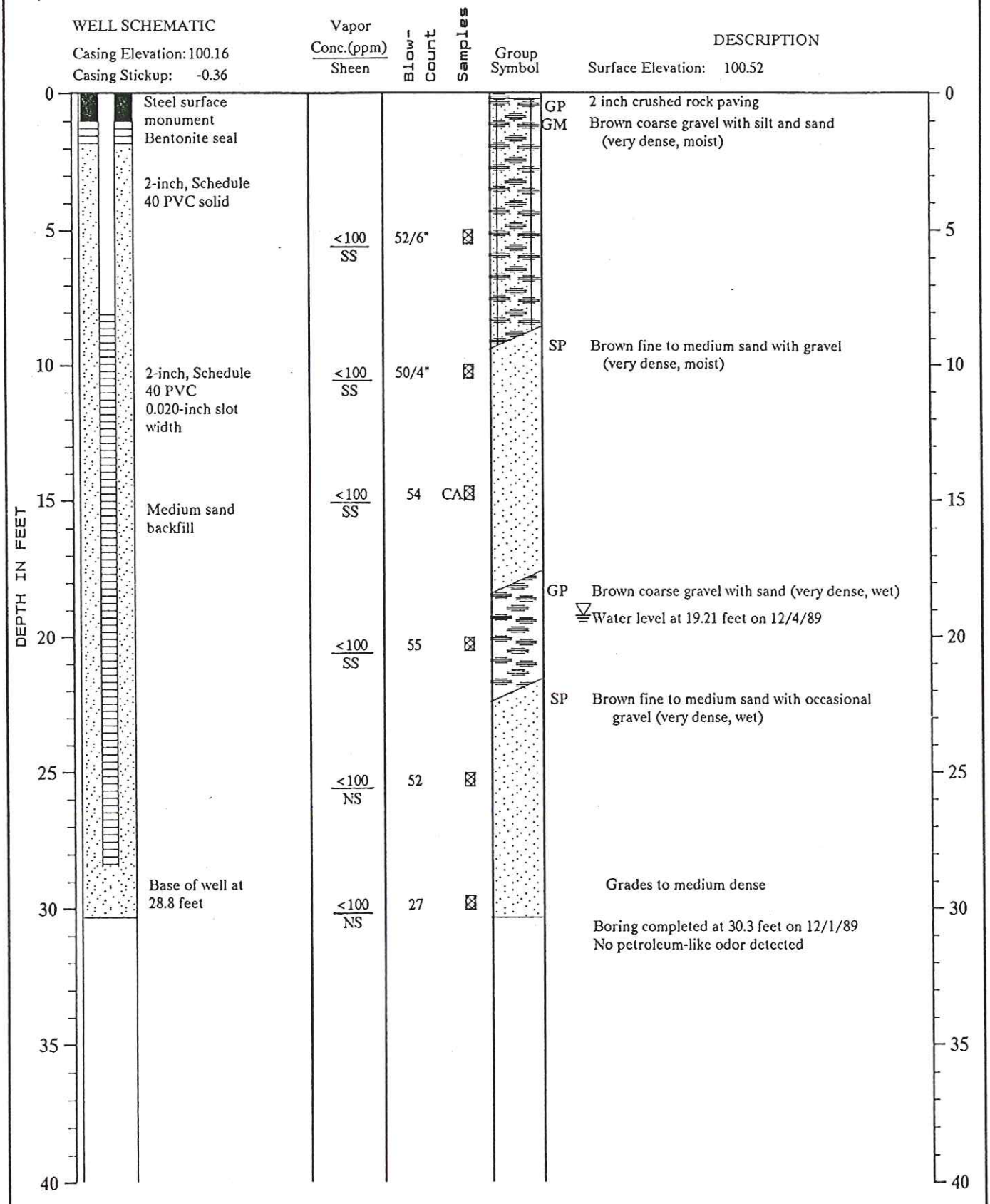
Log of Monitor Well

Figure A-3

:NLP:WSL:CDO 3/5/90

1-228-B04

MONITOR WELL NO. MW-2



Note: See Figure A-2 for explanation of symbols

Geo Engineers

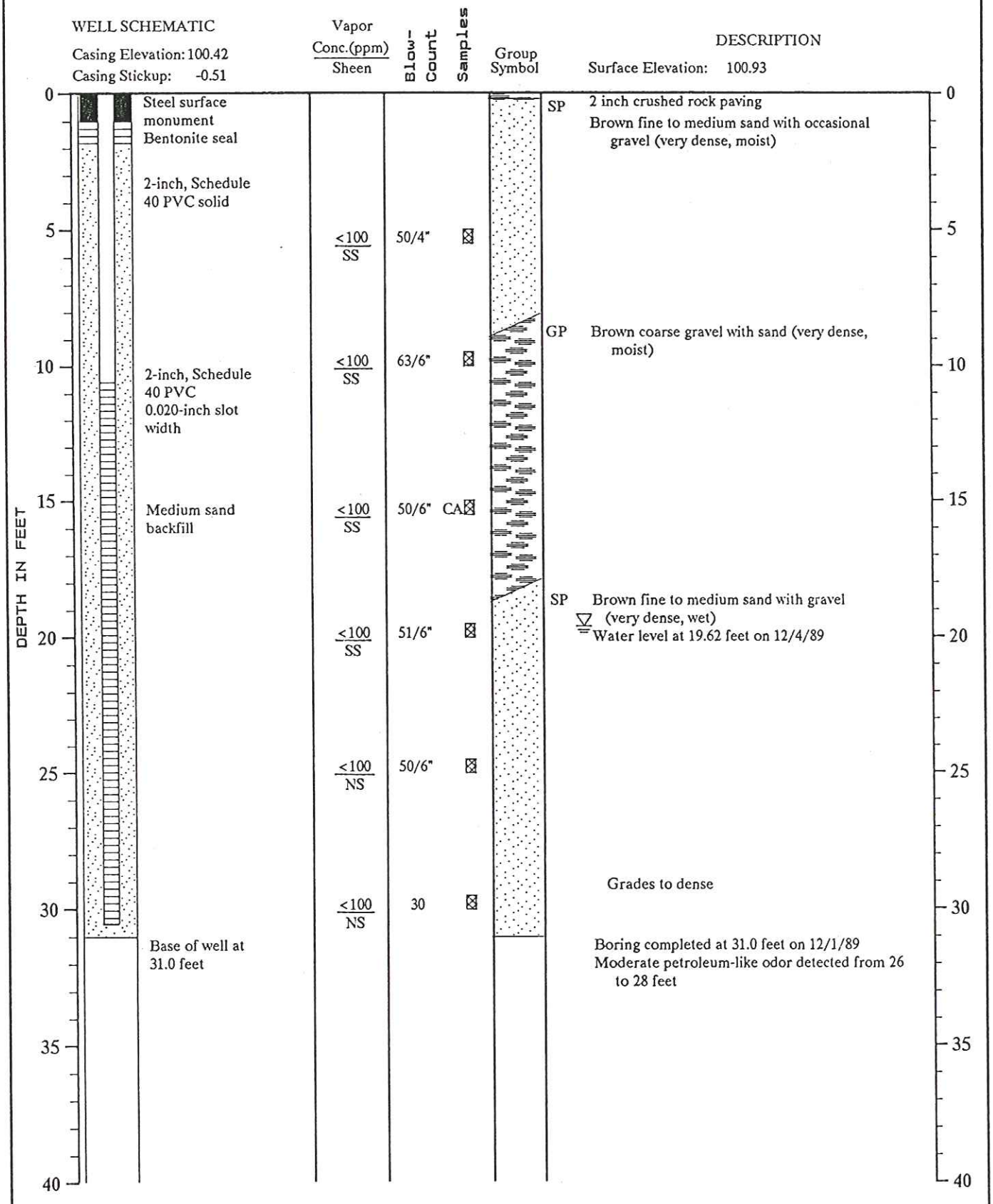
Log of Monitor Well

Figure A-4

:NLP:WSL:CDO 3/5/90

1-228-B04

MONITOR WELL NO. MW-3



Note: See Figure A-2 for explanation of symbols

Geo Engineers

Log of Monitor Well

Figure A-5

:NLP:WSL:CDO 3/5/90

:1-228-B04

Geo Engineers

LOG OF TEST PITS

FIGURE A-6

Test Pit Number	Sample Depth (feet)	Field Screening Results: Water Sheen Test	Field Screening Results: Headspace Vapors (ppm)	Classification Symbol	Soil Description	
TP-1	1.0 (CA)	HS	140	SP	0 - 11.6 feet	Brown fine to medium sand with
	3.0	MS	<100			gravel, cobbles and boulders
	4.0	MS	<100			(Dense, moist)
	6.0	MS	<100			Test pit base at 11.0 feet
	8.0	MS	<100			
	11.0 (CA)	HS	130			Note: Visual evidence of contamination noted from 0 to 4.0 feet and at 11.0 feet
TP-2	1.0	MS	<100	SP	0 - 5.0 feet	Brown fine to medium sand with
	3.0 (CA)	MS	<100			gravel, boulders and rubble
	5.0 (CA)	HS	320			(dense, moist) (fill)
	8.0	HS	220	SP	5.0 - 11.0 feet	Gray to brown fine to medium sand
	11.0 (CA)	HS	190			with gravel (dense, moist)
						Test pit base at 11.0 feet
						Note: Visual evidence of contamination noted from 0 to 10.0 feet
TP-3	0.0 (CA)	HS	--	SP-SM	0 - 5.0 feet	Brown fine to medium sand with silt
	1.0	MS	<100			and gravel (medium dense, moist)
	3.0	SS	<100	SP	5.0 - 8.0 feet	Brown medium to coarse sand with
	5.0	SS	<100			gravel (medium dense, moist)
	8.0	SS	<100			Test pit base at 8.0 feet
						Note: Visual evidence of contamination noted from 0 to 0.3 feet

Notes:

See Figure A-2 for explanation of soil classification symbols. An explanation of field screening procedures is presented in Appendix A.

The depths on the test pit logs, although shown to 0.1 foot, are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

APPENDIX B

AnalyticalTechnologies,Inc. 560 Naches Avenue, S.W., Suite 101, Renton, WA 98055, (206) 228-8335

GeoEngineers

ATI I.D. # 8912-003

JAN 8 1989

Routing GF

File 0161-228-4

January 5, 1990

GeoEngineers, Inc.
2405 140th Avenue N.E.
Suite 105
Bellevue, WA 98005

Attention : Julia Fowler

Project Number : 161-228-4

Project Name : Unocal

On December 5, 1989 Analytical Technologies, Inc. received four soil samples for analyses. The samples were analyzed with EPA methodology or equivalent methods as specified in the attached analytical schedule. The results, sample cross reference, and the quality control data are enclosed.

Karen L. Mixon
Project Manager

Frederick W. Grothkopp
Technical Manager

FWG/elf

SAMPLE CROSS REFERENCE SHEET

CLIENT : GEOENGINEERS, INC.
PROJECT # : 161-228-4
PROJECT NAME : UNOCAL

ATI #	CLIENT DESCRIPTION	DATE SAMPLED	MATRIX
8912-003-1	MW-1, #3 @ 15 FT.	11/29/89	SOIL
8912-003-2	MW-1, #4 @ 20 FT.	11/29/89	SOIL
8912-003-3	MW-2, #3 @ 15 FT.	11/29/89	SOIL
8912-003-4	MW-3, #3 @ 15 FT.	12/01/89	SOIL

----- TOTALS -----

MATRIX	# SAMPLES
SOIL	4

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

PURGEABLE AROMATICS ANALYSIS
DATA SUMMARY

CLIENT	: GEOENGINEERS, INC.	DATE SAMPLED	: 11/29/89
PROJECT #	: 161-228-4	DATE RECEIVED	: 12/05/89
PROJECT NAME	: UNOCAL	DATE EXTRACTED	: 12/08/89
CLIENT I.D.	: MW-1, #4 @ 20 FT.	DATE ANALYZED	: 12/11/89
SAMPLE MATRIX	: SOIL	UNITS	: mg/Kg
EPA METHOD	: 8020 (BETX)	DILUTION FACTOR	: 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
BENZENE	<0.025
ETHYLBENZENE	0.079
TOLUENE	0.029
TOTAL XYLENES	0.83

SURROGATE PERCENT RECOVERY

BROMOFLUOROBENZENE	96

AnalyticalTechnologies,Inc. 560 Naches Avenue, S.W., Suite 101, Renton, WA 98055, (206) 228-8335

ATI I.D. # 8912-007

GeoEngineers

JAN 5 1989

Routing

File

January 4, 1990

GeoEngineers, Inc.
2405 140th Avenue N.E.
Suite 105
Bellevue, WA 98005

Attention : Julia Fowler

Project Number : 161-228-4

Project Name : Unocal

On December 6, 1989 Analytical Technologies, Inc. received three water samples and seven soil samples for analyses. The samples were analyzed with EPA methodology or equivalent methods as specified in the attached analytical schedule. The results, sample cross reference, and the quality control data are enclosed.

Karen L. Mixon
Project Manager

Frederick W. Grothkopp
Technical Manager

FWG/pes

SAMPLE CROSS REFERENCE SHEET

CLIENT : GEOENGINEERS, INC.
PROJECT # : 161-228-4
PROJECT NAME : UNOCAL

ATI #	CLIENT DESCRIPTION	DATE SAMPLED	MATRIX
8912-007-1	MW-1	12/04/89	WATER
8912-007-2	MW-2	12/04/89	WATER
8912-007-3	MW-3	12/04/89	WATER
8912-007-4	TP-1 #1	12/04/89	SOIL
8912-007-5	TP-1 #6	12/04/89	SOIL
8912-007-6	TP-2 #9	12/04/89	SOIL
8912-007-7	TP-2 #11	12/04/89	SOIL
8912-007-8	TP-3 S	12/04/89	SOIL
8912-007-9	TP-3 #13	12/04/89	SOIL
8912-007-10	WH-1	12/05/89	SOIL

----- TOTALS -----

MATRIX	# SAMPLES
WATER	3
SOIL	7

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

PURGEABLE AROMATICS ANALYSIS
DATA SUMMARY

CLIENT	: GEOENGINEERS, INC.	DATE SAMPLED	: N/A
PROJECT #	: 161-228-4	DATE RECEIVED	: N/A
PROJECT NAME	: UNOCAL	DATE EXTRACTED	: N/A
CLIENT I.D.	: REAGENT BLANK	DATE ANALYZED	: 12/18/89
SAMPLE MATRIX	: WATER	UNITS	: ug/L
EPA METHOD	: 8020 (BETX)	DILUTION FACTOR	: 1

COMPOUND	RESULT
BENZENE	<0.5
ETHYLBENZENE	<0.5
TOLUENE	<0.5
TOTAL XYLENES	<0.5

SURROGATE PERCENT RECOVERY

TRIFLUOROTOLUENE	75

PURGEABLE AROMATICS ANALYSIS
DATA SUMMARY

CLIENT	: GEOENGINEERS, INC.	DATE SAMPLED	: 12/04/89
PROJECT #	: 161-228-4	DATE RECEIVED	: 12/06/89
PROJECT NAME	: UNOCAL	DATE EXTRACTED	: N/A
CLIENT I.D.	: MW-2	DATE ANALYZED	: 12/18/89
SAMPLE MATRIX	: WATER	UNITS	: ug/L
EPA METHOD	: 8020 (BETX)	DILUTION FACTOR	: 1

COMPOUND	RESULT
BENZENE	<0.5
ETHYLBENZENE	<0.5
TOLUENE	<0.5
TOTAL XYLENES	<0.5
SURROGATE PERCENT RECOVERY	
TRIFLUOROTOLUENE	87

PURGEABLE AROMATICS
QUALITY CONTROL DATA

CLIENT	: GEOENGINEERS, INC.	SAMPLE I.D.	: 91202601
PROJECT #	: 161-228-4	DATE ANALYZED	: 12/14/89
PROJECT NAME	: UNOCAL	SAMPLE MATRIX	: WATER
EPA METHOD	: 8020 (BETX)	UNITS	: ug/L

COMPOUND	SAMPLE RESULT	SPIKE ADDED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % REC	RPD
BENZENE	<0.5	5.00	4.4	88	4.3	86	2
TOLUENE	<0.5	5.00	4.6	92	4.1	82	11

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

PURGEABLE AROMATICS ANALYSIS
DATA SUMMARY

CLIENT	: GEOENGINEERS, INC.	DATE SAMPLED	: 12/04/89
PROJECT #	: 161-228-4	DATE RECEIVED	: 12/06/89
PROJECT NAME	: UNOCAL	DATE EXTRACTED	: 12/08/89
CLIENT I.D.	: TP-1 #1	DATE ANALYZED	: 12/17/89
SAMPLE MATRIX	: SOIL	UNITS	: mg/Kg
EPA METHOD	: 8020 (BETX)	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
BENZENE	<0.13
ETHYLBENZENE	<0.13
TOLUENE	1.1
TOTAL XYLENES	59

SURROGATE PERCENT RECOVERY

TRIFLUOROTOLUENE	130

PURGEABLE AROMATICS ANALYSIS
DATA SUMMARY

CLIENT	: GEOENGINEERS, INC.	DATE SAMPLED	: 12/04/89
PROJECT #	: 161-228-4	DATE RECEIVED	: 12/06/89
PROJECT NAME	: UNOCAL	DATE EXTRACTED	: 12/08/89
CLIENT I.D.	: TP-2 #9	DATE ANALYZED	: 12/18/89
SAMPLE MATRIX	: SOIL	UNITS	: mg/Kg
EPA METHOD	: 8020 (BETX)	DILUTION FACTOR	: 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
BENZENE	<0.025
ETHYLBENZENE	0.15
TOLUENE	0.066
TOTAL XYLENES	0.72

SURROGATE PERCENT RECOVERY

TRIFLUOROTOLUENE	115

PURGEABLE AROMATICS ANALYSIS
DATA SUMMARY

CLIENT	: GEOENGINEERS, INC.	DATE SAMPLED	: 12/04/89
PROJECT #	: 161-228-4	DATE RECEIVED	: 12/06/89
PROJECT NAME	: UNOCAL	DATE EXTRACTED	: 12/08/89
CLIENT I.D.	: TP-3 S	DATE ANALYZED	: 12/18/89
SAMPLE MATRIX	: SOIL	UNITS	: mg/Kg
EPA METHOD	: 8020 (BETX)	DILUTION FACTOR	: 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
BENZENE	<0.025
ETHYLBENZENE	<0.025
TOLUENE	<0.025
TOTAL XYLENES	<0.025

SURROGATE PERCENT RECOVERY

TRIFLUOROTOLUENE	103

PURGEABLE AROMATICS
QUALITY CONTROL DATA

CLIENT	: GEOENGINEERS, INC.	SAMPLE I.D.	: 91210003
PROJECT #	: 161-228-4	DATE EXTRACTED	: 12/08/89
PROJECT NAME	: UNOCAL	DATE ANALYZED	: 12/19/89
EPA METHOD	: 8020 (BETX)	MATRIX	: SOIL
		UNITS	: mg/Kg

COMPOUND	SAMPLE RESULT	SPIKE ADDED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % REC	RPD
BENZENE	<0.025	0.50	0.39	78	0.40	80	3
TOLUENE	<0.025	0.50	0.38	76	0.39	78	3

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GEOENGINEERS, INC. SAMPLE MATRIX : WATER
PROJECT # : 161-228-4
PROJECT NAME : UNOCAL UNITS : mg/L

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED CONC	SPIKE ADDED	% REC
PETROLEUM HYDROCARBONS	8912-002-1	0.78	0.43	58	N/A	N/A	N/A
PETROLEUM HYDROCARBONS	BLANK SPIKE	N/A	N/A	N/A	6.45	10.1	64

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GEOENGINEERS, INC. SAMPLE MATRIX : SOIL
PROJECT # : 161-228-4
PROJECT NAME : UNOCAL UNITS : mg/Kg

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED CONC	SPIKE ADDED	% REC
PETROLEUM HYDROCARBONS	8912-007-8	69,000	69,000	0	**	**	**

** Due to the necessary dilution of the sample, result was not attainable.

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GEOENGINEERS, INC. SAMPLE MATRIX : SOIL
PROJECT # : 161-228-4
PROJECT NAME : UNOCAL UNITS : %

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED CONC	SPIKE ADDED	% REC
MOISTURE	8912-007-4	8.0	8.4	5	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$