gettler — ryan inc.

90 DEC 28

December 21, 1990

Alameda County Health Agency
Department of Environmental Health
80 Swan Way, Room 200
Oakland, California 94621

Attention: Mr. Barney Chan

Reference: Unocal Service Station No. 5325
3220 Lakeshore Avenue
Oakland, California 94610

Mr. Chan:

As requested by Ron Bock of Unocal Corporation, we are forwarding a copy of the Monitoring Well Installation report dated November 19, 1990, prepared for the above referenced location.

If you should have any questions or comments, please call.

Sincerely,

Keith E. Bullock

KEB/me

enclosure

cc: Mr. Ron Bock, Unocal Corporation
Mr. Tom Callaghan, Regional Water Quality Control Board

2150 west winton avenue • hayward, california 94545-1210 • (415) 783-7500

GeoStrategies Inc.

MONITORING WELL INSTALLATION REPORT

UNOCAL Service Station No. 5325
3220 Lakeshore Avenue
Oakland, California

Report No. 7814-5

December 19, 1990

GeoStrategies Inc.
2140 WEST WINTON AVENUE
HAYWARD, CALIFORNIA 94545
(415) 352-4800

December 19, 1990

Gettler-Ryan Inc.
2150 West Winton Avenue
Hayward, California 94545

Re: MONITORING WELL INSTALLATION REPORT
UNOCAL Service Station No. 5325
3220 Lakeshore Avenue
Oakland, California

Gentlemen:

This Monitoring Well Installation Report has been prepared for the above referenced site.

If you have any questions, please call.

GeoStrategies Inc.

Douglas G. Wolfe
Geologist

David H. Peterson
Senior Geologist
C.E.G. 1186

REGISTERED GEOLOGIST
DAVID H. PETERSON
No. 1186
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

DGW/DHP/mlg

Report No. 7814-5

QC Review:

1.0 EXECUTIVE SUMMARY

This document summarizes the results of the field activities and chemical analyses for the UNOCAL Service Station No. 5325 in Oakland, California.

- Three soil borings U-1, U-2 and U-3 were drilled and completed as ground-water monitoring wells on September 24, 1990. Soil samples were collected and the lithology logged. Selected samples were chemically analyzed for TPH-Gasoline and BTEX. Ground-water levels were measured in the newly installed wells prior to collecting samples for chemical analyses on October 8, 1990. Ground-water level data indicates that shallow groundwater beneath the site flows to the south-southwest with an approximate hydraulic gradient of 0.005.

- Soil samples collected from Boring U-1 contained TPH-Gasoline concentrations ranging from 480 parts per million (ppm) (6.5 foot sample) to 1.4 ppm (11.5 foot sample). Benzene concentrations from this boring ranged from 4.5 ppm at 6.5 feet to 0.64 ppm at 11.5 feet. The soil samples from Boring U-2 contained 110 ppm TPH-Gasoline at 6.0 feet and 0.007 ppm Benzene at 11.5 feet. Chemical concentration levels were reported as ND (below the detection limit) elsewhere in the boring U2. Soil samples from boring U-3 did not contain detectable concentrations of TPH-Gasoline or BTEX.

- Groundwater analyses detected TPH-Gasoline concentrations of 690 parts per billion (ppb) in upgradient Well U-1 and 780 ppb in cross-gradient Well U-2. Benzene concentrations were 38 ppb in Well U-1 and 27 ppb in Well U-2. TPH-Gasoline and BTEX were not detected in down-gradient Well U-3.

- The site appears to be underlain primarily by low permeability clays and silts with interbedded more permeable silty sand. Depth to groundwater occurs between 9.30 and 12.23 feet below grade. The shallow groundwater appears to be unconfined to semi-confined.

- GSI recommends that water-level monitoring be conducted monthly. Ground-water sampling and chemical analyses should be conducted on a quarterly basis. Ground-water samples should be analyzed for TPH-Gasoline (EPA Method 8015 (Modified) and BTEX (EPA Method 8020).

2.0 INTRODUCTION

This report has been prepared by GeoStrategies Inc. (GSI) for UNOCAL Service Station No. 5325, at 3220 Lakeshore Avenue in Oakland, California (Plate 1).

Two 10,000 gallon underground storage tanks (UGSTs) and a 120 gallon waste oil tank, were replaced at the site during June 1990. Soil samples from the sidewalls of the UGST excavation contained TPH-Gasoline concentrations ranging from ND to 2800 ppm. The sidewalls were then over-excavated until ND results were obtained. TPH-Gasoline was detected in the piping trenches up to 60 ppm. The TPH-Gasoline was concluded to be limited to soils immediately adjacent to the tanks and piping, and these soils were excavated, treated and eventually removed from the site.

On September 24, 1990, three exploratory soil borings were drilled and completed as ground-water monitoring wells (Wells U-1, U-2 and U-3) at the locations shown on Plate 2. The wells were installed to evaluate whether gasoline had impacted groundwater beneath the site. The results of these monitoring well installation activities and chemical analyses are discussed in this report.

Field work was performed in accordance with current State of California Water Resources Control Board (SWRCB) guidelines. Field Methods and Procedures are presented in Appendix A.

3.0 SITE ACTIVITIES

3.1 Field Procedures

Three exploratory soil borings were drilled and completed as ground-water monitoring wells (Wells U-1, U-2 and U-3). Drilling was performed using a truck-mounted hollow-stem auger rig. Soil samples were collected at approximately 5-foot intervals with a modified California split-spoon sampler. Soil samples were described and exploratory boring logs prepared (Appendix B) by a GSI geologist using the Unified Soil Classification System (ASTM D2488-84) and Munsell Soil Color Charts.

Soil samples retained for chemical analyses were collected in precleaned brass liners, sealed on both ends with aluminum foil and plastic end caps, entered onto a Chain-of-Custody form, and transported in a cooler with blue ice to International Technology (IT) Analytical Services, a State-certified environmental laboratory located in San Jose, California.

A tube of soil from each sampled interval was used to perform head-space analysis in the field to screen for the presence of volatile organic compounds (VOCs). Head-space analysis involved transferring soil from the sample tube into a clean jar and immediately covering the jar with aluminum foil secured with a ring-type threaded lid. After approximately 20 minutes, the foil was pierced and the head-space air within the jar was tested for VOCs, measured in parts per million (ppm), using an Organic Vapor Meter (OVM) photoionization detector. Head-space analysis results are presented on each boring log in Appendix B.

3.2 Soil Analyses

Soil samples collected in the field were analyzed in the analytical laboratory for Total Petroleum Hydrocarbons calculated as Gasoline (TPH-Gasoline) according to EPA Method 8015 (Modified) and Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) according to EPA Method 8020.

3.3 Well Installation and Ground-water Analyses

Monitoring wells were installed in the borings to depths of 21.5 (U-2 and U-3) and 26.5 (U-1) feet. The wells were constructed using 3-inch-diameter Schedule 40 PVC casing and 0.020-inch factory slotted well screen. Well screen intervals extend at least 4 feet above the first encountered water bearing zone. Lonestar #2/12 graded sand was placed in the annular space across the entire screen interval and one foot above the top of the screen. A one-foot bentonite seal, followed by a concrete grout seal was placed above the sand to just below grade. The wells were completed at ground surface using a water-proof well cap, lock and traffic-rated vault. Well construction details are presented in Appendix B.

Ground-water samples were collected on October 8, 1990, by G-R and analyzed for TPH-Gasoline according to EPA Method 8015 (Modified) and BTEX according to EPA Method 8020. Analyses were performed at IT Analytical Services in San Jose, California. A copy of the G-R sampling procedures is presented in Appendix A.

3.4 Potentiometric Measurements

Prior to ground-water sampling, depth to groundwater was measured in each well using an electronic interface probe. Water-level data were collected on October 8, 1990, by G-R. Static groundwater levels were measured from the surveyed top of the well box and recorded to the nearest $\pm$0.01 foot.

3.5 Floating Product Measurements

Each well was monitored for the presence of separate-phase hydrocarbons (floating product) using a portable oil-water interface probe. The wells were visually inspected with a clean, clear acrylic bailer for the presence of a separate-phase sheen and to confirm the interface probe results. No floating product or product sheens were detected in any of the monitoring wells during this sampling event.

4.0 HYDROGEOLOGIC CONDITIONS AND SITE GEOLOGY

Three exploratory borings were drilled to a maximum depth of 26.5 feet. Silty sand with minor gravel was observed from approximately 14 to 21 feet in Well U-1, and 6 to 10 feet in Well U-2. In Well U-3 a silty sand occurs from a depth of 10 and 14 feet.

The shallow water-bearing strata consist of sand with gravel, clayey silt, clay and silt with sand. Groundwater was encountered at depths between 10.0 to 10.5 feet below ground surface. Equilibrated water levels were measured in newly installed well U-1 (10 feet), U-2 (16 feet) and U-3 (14 feet). These water levels indicate that the aquifer is most likely unconfined. Clay and silt strata underlie this uppermost water-bearing strata, and appear to be areally continuous beneath the site.

5.0 RESULTS

5.1 Soil Chemical Analytical Results

Boring U-1 contained TPH-Gasoline concentrations of 480 ppm (6.5 foot sample) and 1.4 ppm (11.5 foot sample). Benzene concentrations were detected at 4.5 ppm at 6.5 feet and 0.64 ppm at 11.5 feet. The soil samples from Boring U-2 contained 110 ppm TPH-Gasoline at 6.0 feet and 0.007 ppm Benzene at 11.5 feet. These chemical concentration levels were at or below detectable limits elsewhere in Boring U-2. Soil samples collected from Boring U-3 did not contain detectable concentrations of TPH-Gasoline, or BTEX. Soil chemical analytical data are summarized in Table 1.

5.2 Potentiometric Data

Groundwater was encountered between 8.76 to 12.23 feet below grade, which corresponds to an elevation range of -3.55 to -4.09 feet above mean sea level (MSL). Groundwater elevation data for this sampling round have been plotted and contoured and are presented on Plate 3 as a potentiometric map. Water level data indicate an approximate hydraulic gradient beneath the site of .005. Shallow ground-water flows toward the south-southwest. Potentiometric data are summarized on Table 2.

5.3 Ground-water Chemical Analytical Results

TPH-Gasoline was detected at 690 ppb in Well U-1 and at 780 ppb in Well U-2. Benzene concentrations were 38 ppb in Well U-1 and 27 ppb in Well U-2. TPH-Gasoline and Benzene were not detected in Well U-3. A chemical concentration map (Plate 4) was prepared using TPH-Gasoline and Benzene concentrations from this round of sampling. Chemical analytical data are also summarized on Table 2. A copy of the G-R groundwater sampling report, which includes IT Analytical Services certified analytical report and Chain-of-Custody Forms is presented in Appendix D.

5.4 Physical Testing

A sample of clay from a possible basal confining layer (aquitard) from exploratory boring U-1 was tested for permeability by a falling head test. The calculated permeability of this clay unit was 1.5×10^{-8} centimeters per second (cm/s) or 4.25×10^{-5} ft/day. Physical testing results are presented in Appendix E.

6.0 CONCLUSIONS

- Soil and ground-water chemical data indicate that petroleum hydrocarbons exist in the vicinity of Wells U-1 and U-2. Hydrocarbons were not detected in soils and shallow groundwater near downgradient Well U-3.

- Stratigraphy beneath site is predominated by fine grained (ie, silt and clay) deposits; coarser grained strata (silty sand) vary in depth and thickness and may not represent a single continuous unit.

- The clays at the bottom of boring U-1 have low permeability that may limit downward migration of gasoline components.

- Because gasoline components were not detected in the downgradient soil or groundwater (Boring U-3), it is possible that lateral migration in a downgradient direction is retarded by the impermeable nature of the soils. However, the direction of groundwater flow was determined from only three wells installed in varying lithologies and may only be approximate. Additionally, the direction of ground-water flow may vary seasonally, as water levels in the wells equilibrate, or with long-term changes in precipitation rates.

- Additional subsurface investigation and monitoring will be needed to further assess site hydrogeologic conditions.

7.0 RECOMMENDATIONS

The following recommendations are based on available data and our current understanding of the distribution of petroleum hydrocarbons detected in the shallow groundwater:

- Water-level and floating-product measurements (if present) should be obtained monthly. These data should be continually reviewed to evaluate potential seasonal changes in the hydraulic gradient and ground-water flow direction.

- A quarterly ground-water sampling program should be instituted for the present monitoring network to monitor dissolved hydrocarbon concentrations in the shallow groundwater.

LIST OF ATTACHMENTS

TABLE 1

SOIL ANALYSIS DATA

WELL/BORING NO	SAMPLE DATE	ANALYZED DATE	TPH-G (PPM)	BENZENE (PPM)	TOLUENE (PPM)	ETHYLBENZENE (PPM)	XYLENES (PPM)
U1-6.5	24-Sep-90	08-Oct-90	480.	4.5	29.	14.	74.
U1-11.5	24-Sep-90	04-Oct-90	1.4	0.64	0.019	0.015	0.051
U2-6.0	24-Sep-90	04-Oct-90	110.	<0.2	1.6	2.4	12.
U2-11.5	24-Sep-90	04-Oct-90	<1.0	0.007	<0.005	<0.005	0.005
U2-21.5	24-Sep-90	04-Oct-90	<1.0	<0.007	<0.007	<0.007	<0.007
U3-6.5	24-Sep-90	04-Oct-90	<1.0	<0.005	<0.005	<0.005	<0.005
U3-11.5	24-Sep-90	04-Oct-90	<1.0	<0.006	<0.006	<0.006	<0.006

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TABLE 2

GROUND-WATER ANALYSES DATA

WELL NO	SAMPLE DATE	ANALYZED DATE	TPH-G (PPB)	BENZENE (PPB)	TOLUENE (PPB)	ETHYLBENZENE (PPB)	XYLENES (PPB)	WELL ELEV (FT)	STATIC WATER ELEV (FT)	PRODUCT THICKNESS (FT)	DEPTH TO WATER (FT)
U-1	08-Oct-90	15-Oct-90	690	38	75	8.6	130	5.75	-3.55	----	9.30
U-2	08-Oct-90	18-Oct-90	780	27	46	15	130.	4.94	-3.82	----	8.76
U-3	08-Oct-90	17-Oct-90	<50	<0.5	<0.5	<0.5	<0.5	8.14	-4.09	----	12.23
TB	08-Oct-90	15-Oct-90	<50	<0.5	<0.5	<0.5	<0.5	----	----	----	----

CURRENT REGIONAL WATER QUALITY CONTROL BOARD MAXIMUM CONTAMINANAT LEVELS
Benzene 1.0 ppb Xylenes 1,750 ppb Ethylbenzene 680 ppb

CURRENT DHS ACTION LEVELS
Toluene 100 ppb

TPH-G = Total Petroleum Hydrocarbons calculated as Gasoline
PPB = Parts Per Billion TB = Trip Blank

Note: 1. All data shown as <x are reported as ND (none detected).
2. Static Water elevations referenced to mean sea level (MSL). Elevations are corrected for free product using a corretion factor of 0.8.

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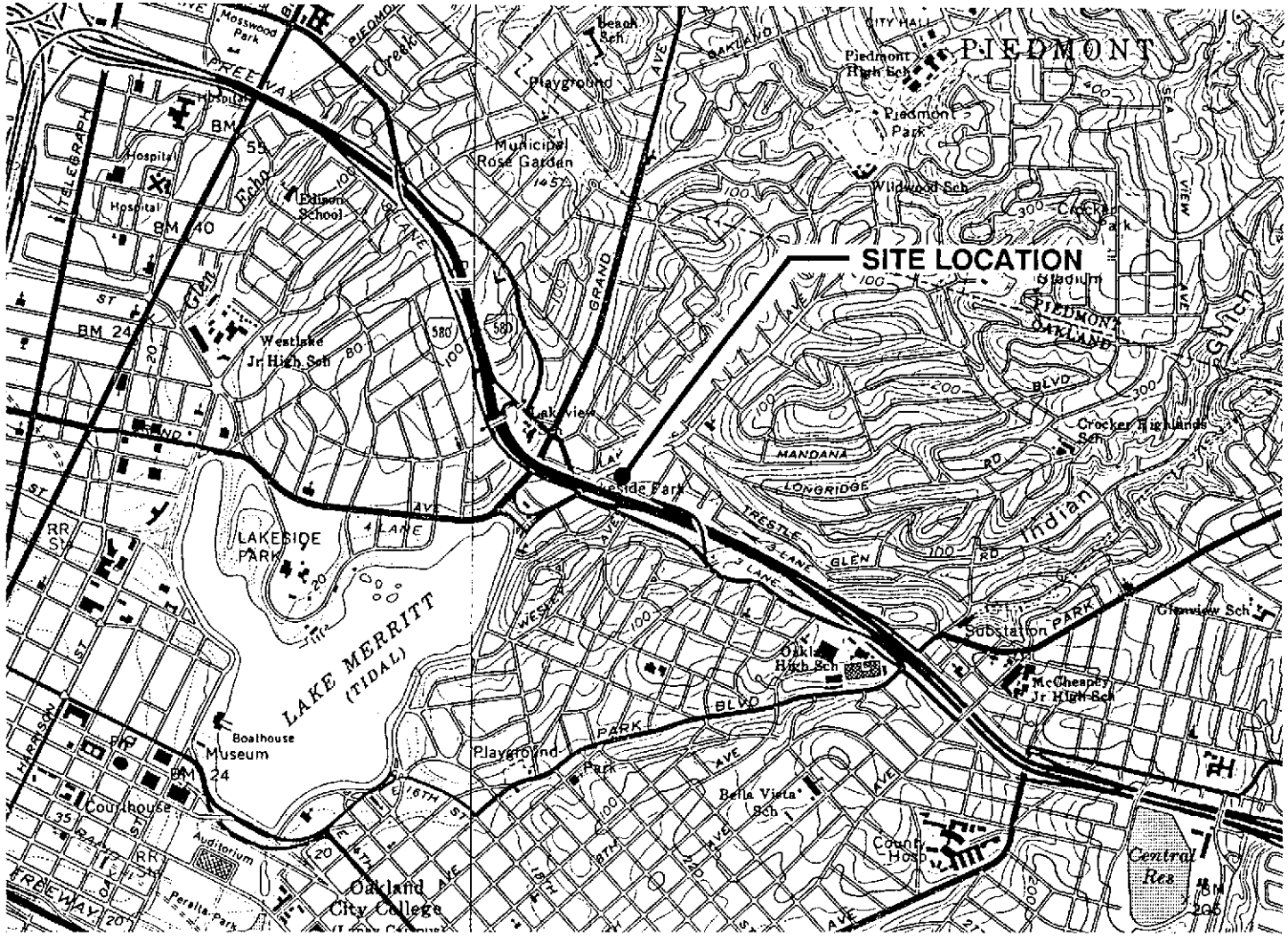

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Base Map: USGS Topographic Map

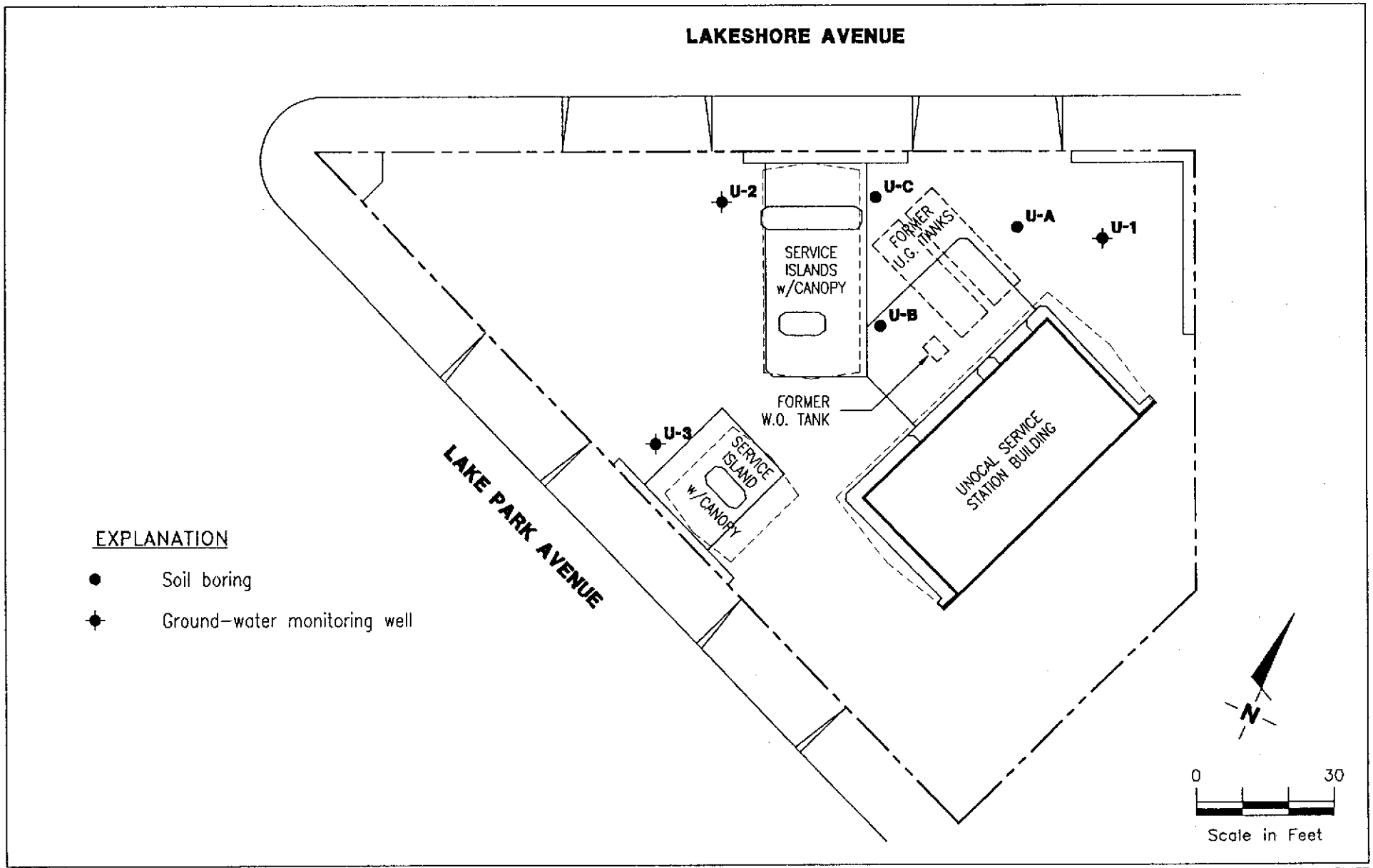
Approximate Scale: 1" = 2000'

GeoStrategies Inc.

Vicinity Map
UNOCAL Service Station #5325
3220 Lakeshore Avenue
Oakland, California

PLATE
1

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
7814	RG/CEG	6/90	

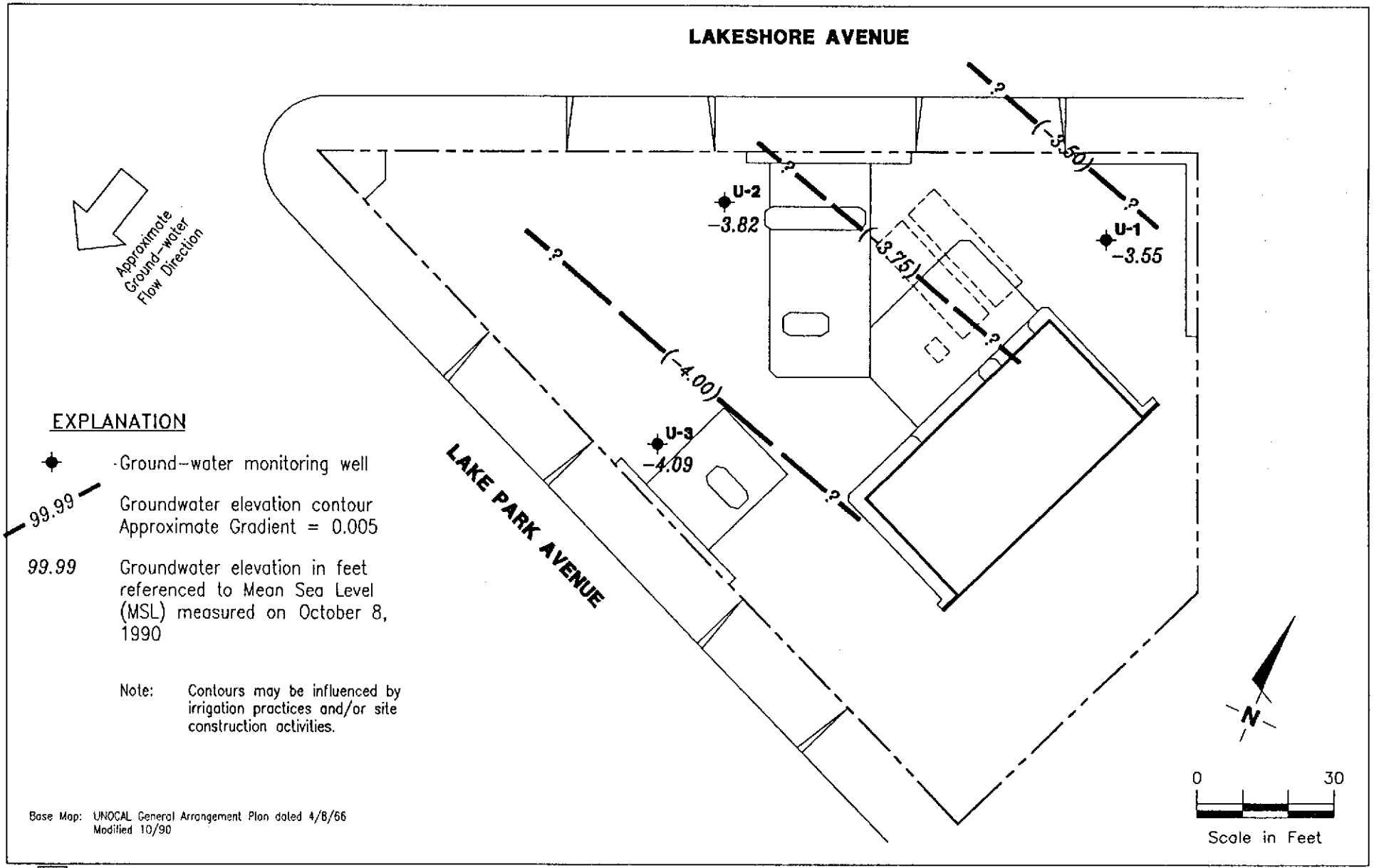


GeoStrategies Inc.

SITE PLAN
UNOCAL Service Station #5325
3220 Lakeshore Avenue
Oakland, California

PLATE 2

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE
7814	CWP CEG 12-92	10/90	

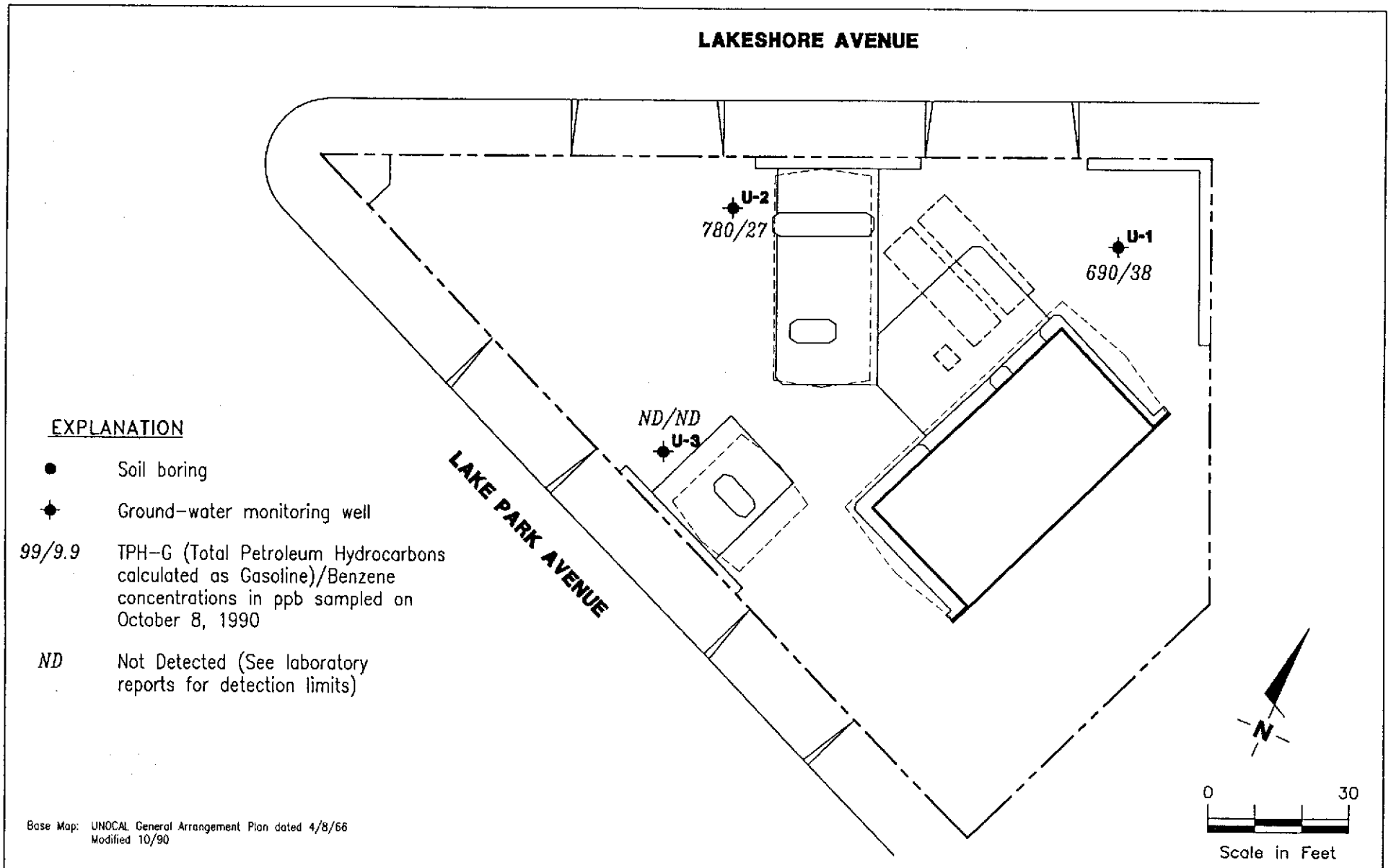


GeoStrategies Inc.

POTENTIOMETRIC MAP
UNOCAL Service Station #5325
3220 Lakeshore Avenue
Oakland, California

PLATE
3

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
7814-5	RC/CEG	10/90	



GeoStrategies Inc.

TPH-G/BENZENE CONCENTRATION MAP
UNOCAL Service Station #5325
3220 Lakeshore Avenue
Oakland, California

PLATE
4

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE
7814-5	DTP/CEG 1186	10/90	

FIELD METHODS AND PROCEDURES

EXPLORATION DRILLING

Mobilization

Prior to any drilling activities, GeoStrategies Inc. (GSI) will verify that necessary drilling permits have been secured.

Utility locations will be located and drilling will be conducted so as not to disrupt activities at a project site. GSI will obtain and review available public data on subsurface geology and if warranted, the location of wells within a half-mile of the project site will be identified. Drillers will be notified in advance so that drilling equipment can be inspected prior to performing work.

Drilling

The subsurface investigations are typically performed to assess the lateral and vertical extent of petroleum hydrocarbons present in soils and groundwater. Drilling methods will be selected to optimize field data requirements as well as be compatible with known or suspected subsurface geologic conditions.

Monitoring wells are installed using a truck-mounted hollow-stem auger drill rig or mud-rotary drill rig. Typically, the hollow-stem rig is used for wells up to 100 feet, if subsurface conditions are favorable. Wells greater than 100-feet deep are typically drilled using mud-rotary techniques. When mud rotary drilling is used, an electric log will be performed for additional lithological information. Also during mud rotary drilling, precautions will be taken to prevent mud from circulating contaminants by using a conductor casing to seal off contaminated zones. Samples will be collected for lithologic logging by continuous chip, and where needed by drive sample or core as specified by the supervising geologist.

Soil Sampling

Shallow soil borings will be drilled using a truck-mounted hollow-stem auger drilling rig, unless site conditions favor a different drilling method. Drilling and sampling methods will be consistent with ASTM Method D-1452-80. The auger size will be a minimum 6-inch nominal outside-diameter (O.D). No drilling fluids will be used during this drilling method. The augers and other tools used in the bore hole will be steam cleaned before use and between borings to minimize the possibilities of cross-contamination between borings.

Soil samples are typically collected at 5-foot intervals as a minimum from ground surface to total depth of boring. Additional soil samples will be collected based on significant lithologic changes and/or potential chemical content. Soil samples from each sampling interval will be lithologically described by a GSI geologist (Figure 1). Soil colors will be described using the Munsell Color Chart. Rock units will be logged using appropriate lithologic terms, and colors described by the G.S.A. Rock Color Chart.

Head-space analyses will be performed to check for the evidence of volatile organic compounds. Head-space analyses will be performed using an organic vapor analyzer; either an OVA, HNU, or OVM. Organic vapor concentrations will be recorded on the GSI field log of boring (Figure 1). The selection of soil samples for chemical analysis are typically based on the following criteria:

1) Soil discoloration
2) Soil odors
3) Visual confirmation of chemical in soil
4) Depth with respect to underground tanks (or existing grade)
5) Depth with respect to ground water
6) OVA reading

Soil samples (full brass liners) selected for chemical analysis are immediately covered with aluminum foil and the liner ends are capped to prevent volatilization. The samples are labeled and entered onto a Chain-of-Custody form, and placed in a cooler on blue ice for transport to a State-certified analytical laboratory.

Soil cuttings are stockpiled on-site. Soils are sampled and analyzed for site-specific chemical parameters. Disposition of soils is dependent of chemical analytical results of the samples.

Soil Sampling - cont.

Soil borings not converted to monitoring wells will be backfilled (sealed) to ground surface using either a neat cement or cement-bentonite grout mixture. Backfilling will be tremied by continuously pumping grout from the bottom to the top of the boring where depth exceeds 20' or as required by local permit requirements.

All field and office work, including exploratory boring logs, are prepared under the direction of a registered geologist.

Monitoring Well Installation

Monitoring well casing and screen will be constructed of Schedule 40, flush-joint threaded polyvinylchloride (PVC). The well screen will be factory mill-slotted unless additional open area is required (eg. conversion to an extraction well in a low-yield aquifer). The screen length will be placed adjacent to the aquifer material to a minimum of 2-feet above encountered water. No screen shall be placed in a borehole that potentially creates hydraulic interconnection of two or more aquifer units. Screen slot size and well sand pack will be compatible with encountered aquifer materials, as confirmed by sieve analysis.

Monitoring wells will be completed below grade (Figure 2) unless special conditions exist that require above-grade completion design. In the event a monitoring well is required in an aquifer unit beneath an existing aquifer, the upper aquifer will be sealed off by installing a steel conductor casing with an annular neat cement or cement-bentonite grout seal. This seal will be continuously tremie pumped from the bottom of the annulus to ground surface.

The monitoring well sand pack will be placed adjacent to the entire screened interval and will extend a recommended minimum distance of 2-feet above the top of the screen. No sand pack will be placed that interconnects two or more aquifer units. A minimum 2-foot bentonite pellet or bentonite slurry seal will be placed above the sand pack. Sand pack, bentonite, and cement seal levels will be confirmed by sounding the annulus with a calibrated weighted tape. The remaining annular space above the bentonite seal will be grouted with a bentonite-cement mixture and will be tremie-pumped from the bottom of the annular space to the ground surface. The bentonite content of the grout will not exceed 5 percent by weight. A field log of boring and a field well completion form will be prepared by GSI for each well installed.

Decontamination of drilling equipment before drilling and between wells will consist of steam cleaning, and/or Alconox wash.

Well Development

All newly installed wells will be properly developed within 48 hours of completion. No well will be developed until the well seal has set a minimum of 12 hours. Development procedures will include one or more of the methods described below:

Bailing

Bailing will be used to remove suspended sediments and drilling fluids from the well, where applicable. The bailer will be raised and lowered through the column of water in the well so as to create a gentle surging action in the screened interval. This technique may be used in conjunction with other techniques, such as pumping, and may be used alone if the well is of low yield.

Pumping

Pumping will be used in conjunction with bailing or surging. The pump will be operated in such a manner as to gently surge the entire screened interval of the well. This may involve operating the pump with a packer type mechanism attached and slowly raising and lowering the pump, or by cycling the pump off and on to allow water to move in and out of the screened interval. Care will be used not to overpump a well.

Surging

Surging will be performed on wells that are screened in known or suspected high yield formations and/or on larger diameter (recovery) wells. A surge block will be raised and lowered through the entire screened interval, forcing water in and out of the well screen and sand pack. Pumping or air lifting will be used in conjunction with this method of development to remove any sediment brought into the well during surging.

Air Lifting

Air lifting will be used to remove sediment from wells as an alternative to pumping under certain conditions. When appropriate, a surge block designed for use with air lifting will be used to agitate the entire screened interval and water will be lifted out of the well using forced air. When air lifting is performed, the air source will be either nitrogen or filtered air and the procedure will be performed gently to prevent any damage to the well screen or casing and to insure that discharged water is contained.

Well Development - cont.

All well developing equipment will be thoroughly decontaminated prior to development using a steam cleaner and/or Alconox detergent wash and clean water rinse. During development procedures, field parameters (temperature, specific conductance and pH) will be monitored and recorded on well development forms (Figure 3). Equilibration requirements consist of a minimum of three readings with the following accuracy standards:

pH	± 0.1 pH units
Specific Conductance	± 10% of full scale reading
Temperature	± 0.5 degrees Celsius

The wells will be developed until water is visibly clear and free of sediment, and well purging parameters stabilized. A minimum of 8 to 10 well volumes will be purged from each well, if feasible. If well purging parameters have not stabilized before 10 casing volumes have been removed, well development will continue until purging parameters have stabilized and formation water is being drawn into the well. The adequacy of well development will be judged by the field technician performing the well development and based on known formation conditions.

Well Surveying

Monitoring wells will be surveyed to obtain top of box elevations to the nearest ±0.01 foot. Water level measurements will be recorded to the nearest ±0.01 foot and referenced to Mean Sea Level (MSL). If additional wells are required, then existing and newly installed wells are surveyed relative to MSL.

GROUND-WATER SAMPLING AND ANALYSIS

Quality Assurance/Quality Control Objectives

The sampling and analysis procedures employed by Gettler-Ryan Inc. (G-R) for ground-water sampling and monitoring follow specific Quality Assurance/Quality Control (QA/QC) guidelines. Quality Assurance objectives have been established by G-R to develop and implement procedures for obtaining and evaluating water quality and field data in an accurate, precise, and complete manner so that sampling procedures and field measurements provide information that is comparable and representative of actual field conditions. Quality Control (QC) is maintained by G-R by using specific field protocols and requiring the analytical laboratory to perform internal and external QC checks. It is the goal of G-R to provide data that are accurate, precise, complete, comparable, and representative. The definitions for accuracy, precision, completeness, comparability, and representativeness are as follows:

- Accuracy - the degree of agreement of a measurement with an accepted referenced or true value.

- Precision - a measure of agreement among individual measurements under similar conditions. Usually expressed in terms of the standard deviation.

- Completeness - the amount of valid data obtained from a measurement system compared to the amount that was expected to meet the project data goals.

- Comparability - expresses the confidence with which one data set can be compared to another.

- Representativeness - a sample or group of samples that reflects the characteristics of the media at the sampling point. It also includes how well the sampling point represents the actual parameter variations which are under study.

As part of the G-R QA/QC program, applicable federal, state, and local reference guidance documents are followed. The procedures outlined in these regulations, manuals, handbooks, guidance documents, and journals are incorporated into the G-R sampling procedures to assure that; (1) ground-water samples are properly collected, (2) ground-water samples are identified, preserved, and transported in a manner such that they are representative of field conditions, and (3) chemical analysis of samples are accurate and reproducible.

April 20, 1990

Guidance and Reference Documents Used to Collect Groundwater Samples

These documents are used to verify G-R sampling procedures and are consistent with current regulatory guidance. If site specific work and sampling plans are required, those plans will be developed from these documents, and newly received applicable documents.

U.S.E.P.A. - 330/9-51-002	NEIC Manual for Groundwater/Subsurface Investigation at Hazardous Waste Sites
U.S.E.P.A. - 530/SW611	Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities (August, 1977)
U.S.E.P.A. - 600/4-79-020	Methods for Chemical Analysis of Water and Wastes (1983)
U.S.E.P.A. - 600/4-82-029	Handbook for Sampling and Sample Preservation of Water and Wastewater (1982)
U.S.E.P.A. - 600/4-82-057	Test Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (July, 1982)
U.S.E.P.A. - SW-846#, 3rd Edition	Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (November, 1986)
40 CFR 136.3e,Table II (Code of Federal Regulations)	Required Containers, Preservation Techniques, and Holding Times
Resources Conservation and Recover Act (OSWER 9950.1)	Groundwater Monitoring Technical Enforcement Guidance Document (September, 1986)
California Regional Water Quality Control Board (Central Valley Region)	A Compilation of Water Quality Goals (September, 1988); Updates (October, 1988)
California Regional Water Quality Control Board (North Coast, San Francisco Bay, and Central Valley)	Regional Board Staff Recommendations for Initial Evaluations and Investigation of Underground Tanks: Tri-Regional Recommendations (June, 1988)

Guidance and Reference Documents Used to Collect Groundwater Samples (cont.)

Regional Water Quality Control Board (Central Valley Region)	Memorandum: Disposal, Treatment, and Refuse of Soils Contaminated with Petroleum Fractions (August, 1986)
State of California Department of Health Services	Hazardous Waste Testing Laboratory Certification List (March, 1987)
State of California Water Resources Control Board	Leaking Underground Fuel Tank (LUFT) Field Manual (May, 1988), and LUFT Field Manual Revision (April, 1989)
State of California Water Resources Control Board	Title 23, (Register #85.#33-8-17-85), Subchapter 16: Underground Tank Regulations; Article 3, Sections 2632 and 2634; Article 4, Sections 2645, 2646, 2647, and 2648; Article 7, Sections 2670, 2671, and 2672 (October, 1986: including 1988 Amendments)
Alameda County Water District	Groundwater Protection Program: Guidelines for Groundwater and Soil Investigations at Leaking Underground Fuel Tank Sites (November, 1988)
American Public Health Association	Standard Methods for the Examination of Water and Wastewaters, 16th Edition
Analytical Chemistry (journal)	Principles of Environmental Analysis, Volume 55, Pages 2212-2218 (December, 1983)
Napa County	Napa County Underground Storage Tank Program: Guidelines for Site Investigations; February 1989.
Santa Clara Valley Water District	Guidelines for Preparing or Reviewing Sampling Plans for Soil and Groundwater Investigation of Fuel Contamination Sites (January, 1989)

Guidance and Reference Documents Used to Collect Groundwater Samples (cont.)

Santa Clara Valley Water District	Investigation and Remediation at Fuel Leak sites: Guidelines for Investigation and Technical Report Preparation (March 1989)
Santa Clara Valley Water District	Revised Well Standards for Santa Clara County (July 18, 1989)
American Petroleum Institute	Groundwater Monitoring & Sample Bias; API Publication 4367, Environmental Affairs Department, June 1983
American Petroleum Institute	A Guide to the Assessment and Remediation of Underground Petroleum Releases; API Publication 1628, February 1989
American Petroleum Institute	Literature Summary: Hydrocarbon Solubilities and Attenuations Mechanisms, API Publication 4414, August 1985
Site Specific (as needed)	General and specific regulatory documents as required.

Because ground-water samples collected by G-R are analyzed to the parts per billion (ppb) range for many compounds, extreme care is exercised to prevent contamination of samples. When volatile or semi-volatile organic compounds are included for analysis, G-R sampling crew members will adhere to the following precautions in the field:

1. A clean pair of new, disposable gloves are worn for each well being sampled.

2. When possible, samples are collected from known or suspected wells that are least contaminated (i.e. background) followed by wells in increasing order of contamination.

3. Ambient conditions are continually monitored to maintain sample integrity.

When known or potential organic compounds are being sampled for, the following additional precautions are taken:

1. All sample bottles and equipment are kept away from fuels and solvents. When possible, gasoline (used in generators) is stored away from bailers, sample bottles, purging pumps, etc.

2. Bailers are made of Teflon or Stainless Steel. Other materials such as plastic may contaminate samples with phthalate esters which interfere with many Gas Chromatography (GC) analyses.

3. Volatile organic ground-water samples are collected so that air passage through the sample does not occur or is minimal (to prevent volatiles from being stripped from the samples): sample bottles are filled by slowly running the sample down the side of the bottle until there is a positive convex meniscus over the neck of the bottle; the Teflon side of the septum (in cap) is positioned against the meniscus, and the cap screwed on tightly; the sample is inverted and the bottle lightly tapped. The absence of an air bubble indicates a successful seal; if a bubble is evident, the cap is removed, more sample is added, and the bottle is resealed.

4. Extra Teflon seals are brought into the field in case seals are difficult to handle and/or are dropped. Dropped seals are considered contaminated and are not used. When replacing seals or if seals become flipped, care is taken to assure that the Teflon seal faces down.

Sample analysis methods, containers, preservatives and holding times are shown on Table 1.

Laboratory and field handling procedures of samples are monitored by including QC samples for analysis with every submitted sample lot from a project site. QC samples may include any combination of the following:

A. Trip Blank: Used for purgeable organic compounds only; QC samples are collected in 40 milliliter (ml) sample vials filled in the analytical laboratory with organic-free water. Trip blanks are sent to the project site, and travel with project site samples. Trip blanks are not opened, and are returned from a project site with the project site samples for analysis.

B. Field Blank: Prepared in the field using organic-free water. These QC samples accompany project site samples to the laboratory and are analyzed for specific chemical parameters unique to the project site where they were prepared.

C. Duplicates: Duplicated samples are collected "second samples" from a selected well and project site. They are collected as either split samples or second-run samples collected from the same well.

D. Equipment Blank: Periodic QC sample collected from field equipment rinsate to verify decontamination procedures.

The number and types of QC samples are determined as follows:

A. Up to 2 wells - Trip Blank Only

B. 2 to 5 Wells - 1 Field Blank and 1 Trip Blank

C. 5 to 10 Wells - 1 Field blank, 1 Trip Blank, and 1 Duplicate

D. More than 10 Wells - 1 Field Blank, 1 Trip Blank, and 1 Duplicate per each 12 wells

E. If sampling extends beyond one day, quality control samples will be collected for each day.

Additional QC is performed through ongoing and random reviews of duplicate samples to evaluate the precision of the field sampling procedures and analytical laboratory. Precision of QC data is accomplished by calculating the Relative Percent Difference (RPD). The RPD is evaluated to assess whether values are within an acceptable range (typically ± 20% of duplicate sample).

SAMPLE COLLECTION

This section describes the routine procedures followed by G-R while collecting ground-water samples for chemical analysis. These procedures include decontamination, water-level measurements, well purging, physical parameter measurements, sample collection, sample preservation, sample handling, and sample documentation. Critical sampling objectives for G-R are to:

1. Collect ground-water samples that are representative of the sampled matrix and,

2. Maintain sample integrity from the time of sample collection to receipt by the analytical laboratory.

Sample analyses methods, containers, preservation, and holding times are presented in Table 1.

Decontamination Procedures

All physical parameter measuring and sampling equipment are decontaminated prior to sample collection using Alconox or equivalent detergent followed by steam cleaning with deionized water. Any sampling equipment surfaces or parts that might absorb specific contaminants, such as plastic pump valves, impellers, etc., are cleaned in the same manner.

Sample bottles, bottle caps, and septa used for sampling volatile organics are thoroughly cleaned and prepared in the laboratory. Sample bottles, bottle caps, and septa are protected from all potential chemical contact before actual usage at a sample location.

During field sampling, equipment placed in a well are decontaminated before purging or sampling the next well. The equipment are decontaminated by cleaning with Alconox or equivalent detergent followed by steam cleaning with deionized water.

Water-Level Measurements

Prior to purging and sampling a well, the static-water levels are measured in all wells at a project site using an electric sounder and/or calibrated portable oil-water interface probe (Figure 4). Both static water-level and separate-phase product thickness are measured to the nearest ±0.01 foot. The presence of separate-phase product is confirmed using a clean, acrylic or polyvinylchloride (PVC) bailer, measured to the nearest ±0.01 foot with a decimal scale tape.

Water-Level Measurements (continued)

The monofilament line used to lower the bailer is replaced between wells with new line to preclude the possibility of cross-contamination. Field observations (e.g. well integrity, product color, turbidity, water color, odors, etc.) are noted on the G-R Well Sampling Field Data Sheet shown in Figure 4. Before and after each use, the electric sounder, interface probe and bailer are decontaminated by washing with Alconox or equivalent detergent followed by rinsing with deionized water to prevent cross-contamination.

As mentioned previously, water-levels are measured in wells with known or suspected lowest dissolved chemical concentrations to the highest dissolved concentrations.

Well Purging

Before sampling occurs, well casing storage water and interstitial water in the artificial sand pack will be purged using (1) a positive displacement bladder pump constructed of inert, non-wetting, Teflon and stainless steel, (2) a pneumatic-airlift pumping system, (3) a centrifigal pumping system, or (4) a Teflon or Stainless steel bailer (Figure 5). Methods of purging will be assessed based on well size, location, accessibility, and known chemical conditions. Individual well purge volumes are calculated from borehole volumes which take into account the sand packed interval in the well annular space. As a general rule, a minimum of 3 and a maximum of 10 borehole volumes will be purged. Wells which dewater or demonstrate slow recharge periods (i.e. low-yield wells) during purging activities may be sampled after fewer purging cycles. If a low-yield (low recovery) well is to be sampled, sampling will not take place until at least 80 percent of the previously measured water column has been replaced by recharge, or as per local requirements. Physical parameter measurements (temperature, pH, and specific conductance) are closely monitored throughout the well purging process and are used by the G-R sampling crew as indicators for assessing sufficient purging. Purging is continued until all three physical parameters have stabilized. Specific conductance (conductivity) meters are read to the nearest ± 10 umhos/cm, and are calibrated daily. pH meters are read to the nearest ± 0.1 pH units and are calibrated daily. Temperature is read to the nearest 0.1 degree F. Calibration of physical parameter meters will follow manufacturers specifications. Monitoring wells will be purged according to the protocol presented in Figure 5. Collected field data during purging activities will be entered on the G-R Well Sampling Field Data Sheet shown in Figure 4. Copies of the G-R Field Data Sheets will be reviewed by the G-R Sampling Manager for accuracy and completeness.

DOCUMENTATION

Sample Container Labels

Each sample container will be labeled by an adhesive label, noted in permanent ink immediately after the sample is collected. Label information will include:

Sample point designation (i.e. well number or code)

Sampler's identification

Project number

Date and time of collection

Type of preservation used

Well Sampling Data Forms

In the field, the G-R sampling crew will record the following information on the Well Sampling Data Sheet for each sample collected:

Project number

Client

Location

Source (i.e. well number)

Time and date

Well accessibility and integrity

Pertinent well data (e.g. depth, product thickness, static water-level, pH, specific conductance, temperature)

Calculated and actual purge volumes

Chain-of-Custody

A Chain-of-Custody record (Figure 6) shall be completed and accompany every sample and every shipment of samples to the analytical laboratory in order to establish the documentation necessary to trace sample possession from time of collections. The record will contain the following information:

- Sample or station number or sample identification (ID)
- Signature of collector, sampler, or recorder
- Date and time of collection
- Place of collection
- Sample type
- Signatures of persons involved in chain of possession
- Inclusive dates of possession

Samples shall always be accompanied by a Chain-of-Custody record. When transferring the samples, the individual relinquishing and receiving the samples will sign, date, and note the time on the Chain-of-Custody record. G-R will be responsible for notifying the laboratory coordinator when and how many samples will be sent to the laboratory for analysis, and what types of analyses shall be performed.

TABLE 1

SAMPLE ANALYSIS METHODS, CONTAINERS, PRESERVATIONS, AND HOLDING TIMES

Parameter	Analytical Method	Reporting Units	Container	Preservation	Maximum Holding Time
Total Petroleum Hydrocarbons (Gasoline)	EPA 8015 (modified)	mg/l ug/l	40 ml. vial glass, Teflon	cool, 4 C HCl to pH<2	14 days (maximum)
Benzene Toluene Ethylbenzene Xylenes (BTEX	EPA 8020	mg/l ug/l	50 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	7 days (w/o preservative) 14 days (w preservative)
Oil & Grease	SM 503E	mg/l ug/l	1 l glass, Teflon lined septum	H2SO4 or HCl to pH<2	28 days (maximum)
Total Petroleum Hydrocarbons (Diesel)	EPA 8015 (modified)	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C	14 days (maximum)
Halogented Volatile Organics (chlorinated solvents)	8010	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C	14 days (maximum)
Non chlorinated solvents	8020	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	14 days (maximum)
Volatile Organics	8240	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	14 days (maximum)
Semi-Volatile Organics	8270	mg/l ug/l	1 l amber glass, Teflon lined septum	cool, 4 C	7 days extract 40 days (maximum to analyze)
Specific Conductance (Field test)		umhos/cm			
pH (Field test)		pH units			
Temperature (Field test)		Deg F			

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FIELD EXPLORATORY BORING LOG

FIGURE 1

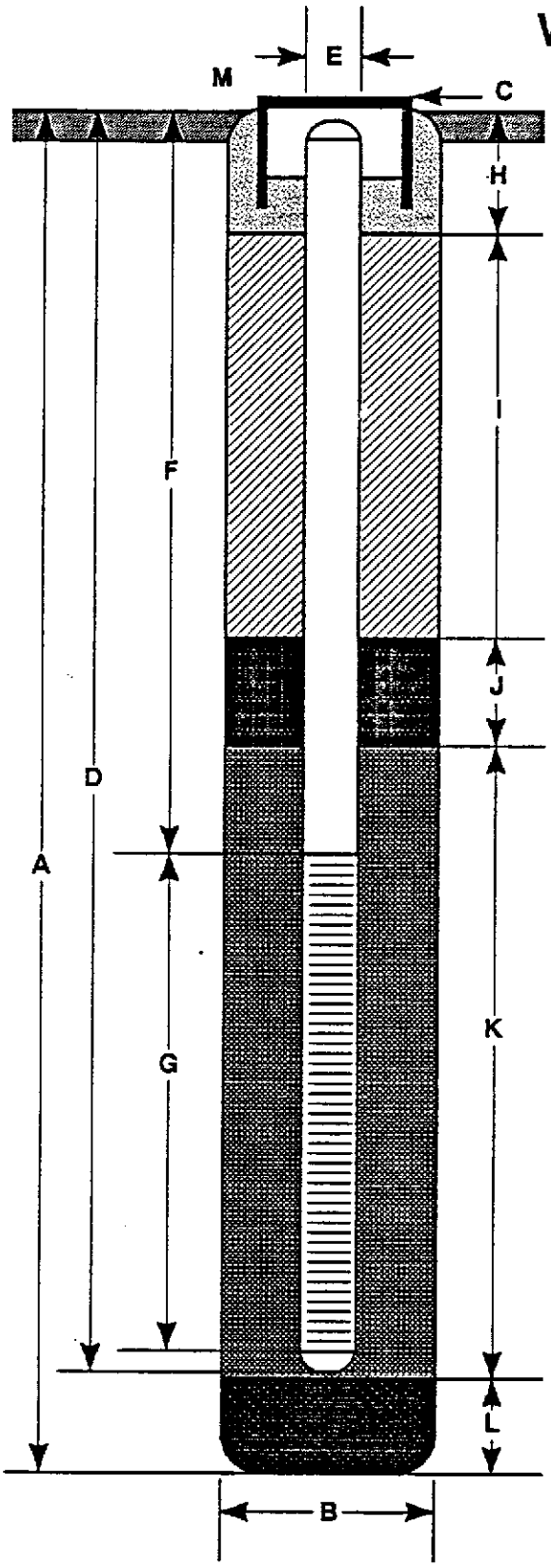
Field location of boring:	Project No.:	Date:	Boring No:
	Client:		
	Location:		
	City:		Sheet
	Logged by:	Driller:	of
Drilling method:	Casing installation data:		
Hole diameter:	Top of Box Elevation:		Datum:

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Water Level				
								Time				
								Date				
								Description				

Remarks:

WELL CONSTRUCTION DETAIL

FIGURE 2



A Total Depth of Boring _____ ft.

B Diameter of Boring _____ in.
Drilling Method _____

C Top of Box Elevation _____ ft.
☐ Referenced to Mean Sea Level
☐ Referenced to Project Datum

D Casing Length _____ ft.
Material _____

E Casing Diameter _____ in.

F Depth to Top Perforations _____ ft.

G Perforated Length _____ ft.
Perforated Interval from _____ to _____ ft.
Perforation Type _____
Perforation Size _____ in.

H Surface Seal from _____ to _____ ft.
Seal Material _____

I Backfill from _____ to _____ ft.
Backfill Material _____

J Seal from _____ to _____ ft.
Seal Material _____

K Gravel Pack from _____ to _____ ft.
Pack Material _____

L Bottom Seal _____ ft.
Seal Material _____

M _____

Note: Depths measured from initial ground surface

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Well Construction Detail

WELL NO.

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE

WELL DEVELOPMENT FORM FIGURE 3

Page_____ of_____

==========

(to be filled out in office)

Client_____ SS#_____ Job#_____

Name_____ Location_____

Well#_____ Screened Interval_____ Depth_____

Aquifer Material_____ Installation Date _____

Drilling Method_____ Borehole Diameter_____

Comments regarding well installation:_____

_____

_____

==========

(to be filled out in the field) Name_____

Date_____ Development Method_____

Total Depth_____ - Depth to liquid_____ = WaterColumn_____

Product thickness_____

_____ x _____ x _____ x 0.0408 = _____gals
Water Column Diameter (in.) #Vol

Purge Start_____ Stop_____ Rate_____ gpm

Gallons	Time	Clarity	Temp.	pH	Conductivity
0					

Total gallons removed_____ Development stop time_____

Depth to liquid _____at_____(time)

Odor of water_____ Water discharged to_____

Comments_____

_____

_____

GETTLER–RYAN INC.

General and Environmental Contractors

WELL SAMPLING FIELD DATA SHEET

FIGURE 4

COMPANY _____ JOB # _____

LOCATION _____ DATE _____

CITY _____ TIME _____

Well ID. _____ Well Condition _____

Well Diameter _____ in. Hydrocarbon Thickness _____ ft.

Total Depth _____ ft.

Depth to Liquid- _____ ft.

Volume Factor (VF)			
	2" = 0.17	6" = 1.50	12" = 5.80
	3" = 0.38	8" = 2.60	
	4" = 0.66	10" = 4.10	

(# of casing volumes) _____ x _____ x(VF) _____ = (Estimated Purge Volume) _____ gal.

Purging Equipment _____

Sampling Equipment _____

Starting Time _____ Purging Flow Rate _____ gpm.

(Estimated Purge Volume) _____ gal. / (Purging Flow Rate) _____ gpm. = (Anticipated Purging Time) _____ min.

Time	pH	Conductivity	Temperature	Volume

Did well dewater? _____ If yes, time _____ Volume _____

Sampling Time _____ Weather Conditions _____

Analysis _____ Bottles Used _____

Chain of Custody Number _____

COMMENTS _____

FOREMAN _____ ASSISTANT _____

FIGURE 5

Monitoring Well Sampling Protocol Schematic

Sampling Crew Reviews Project Sampling Requirements/Schedule

↓

Field Decontamination and Instrumentation Calibration

↓

Check Integrity of Well (Inspect for Well Damage)

↓

Measure and Record Depth to Water and Total Well Depth (Electric Well Sounder)

↓

Check for Floating Product (Oil/Water Interface Probe)

Floating Product Present

↓

Confirm Product Thickness (Acrylic or PVC Bailer)

↓

Collect Free-Product Sample

↓

Dissolved Product Sample Not Required

↓

Record Data on Field Data Form

Floating Product Not Present

↓

Purge Volume Calculation

$V = \pi (r/12)^2 h(\_\% \text{ vol})(7.48) = \_\_\_ \text{/gallons}$

V = Purge volume (gallons)

$\pi = 3.14159$

h = Height of Water Column (feet)

r = Borehole radius (inches)

↓

Evacuate water from well equal to the calculated purge volume while monitoring groundwater stabilization indicator parameters (pH, conductivity, temperature) at intervals of one casing volume.

Well Dewaters after One Purge Volume (Low yield well)

↓

Well Recharges to 80% of Initial Measured Water Column Height in Feet within 24 hrs. of Evacuation.

↓

Measure Groundwater Stability Indicator Parameters (pH, Temperature, Conductivity)

↓

Collect Sample and Complete Chain-of-Custody

↓

Preserve Sample According to Required Chemical Analysis

↓

Transport to Analytical Laboratory

Well Readily Recovers

↓

Record Groundwater Stability Indicator Parameters from each Additional Purge Volume

Stability indicated when the following Criteria are met:

pH :	± 0.1 pH units
Conductivity:	± 10%
Temperature:	1.0 degrees F

Groundwater Stability Achieved

↓

Collect Sample and Complete Chain-of-Custody

↓

Preserve Sample According to Required Chemical Analysis

↓

Transport to Analytical Laboratory

Groundwater Stability Not Achieved

↓

Continue Purging Until Stability is Achieved

↓

Collect Sample and complete Chain-of-Custody

↓

Preserve Sample According to Required Chemical Analysis

↓

Transport to Analytical Laboratory

Gettler - Ryan Inc.
ENVIRONMENTAL DIVISION

Chain of Custody
FIGURE 6

COMPANY _____ JOB NO. _____

JOB LOCATION _____

CITY _____ PHONE NO. _____

AUTHORIZED _____ DATE _____ P.O. NO. _____

SAMPLE ID	NO. OF CONTAINERS	SAMPLE MATRIX	DATE/TIME SAMPLED	ANALYSIS REQUIRED	SAMPLE CONDITION LAB ID

RELINQUISHED BY: _____ RECEIVED BY: _____

RELINQUISHED BY: _____ RECEIVED BY: _____

RELINQUISHED BY: _____ RECEIVED BY LAB: _____

DESIGNATED LABORATORY: _____ DHS #: _____

REMARKS: _____

DATE COMPLETED _____ FOREMAN _____

Field location of boring:

(See Plate 2)

Project No.:	7814	Date: 09/24/90	Boring No: U-1
Client:	UNOCAL Service Station		
Location:	3220 Lakeshore		
City:	Oakland, California		Sheet 1 of 2
Logged by:	RAL	Driller: Bayland	

Drilling method: Hollow Stem Auger

Hole diameter: 8-Inches

Casing installation data: (See Well Construction Detail)

Top of Box Elevation: Datum:

Water Level	10.0'	10.0'		
Time	09:30	13:20		
Date	09/24/90	09/24/90		

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				0				
				1				PAVEMENT SECTION - 1.0 foot
				2				FILL - Sandy Silt (ML) - yellowish brown (10YR 5/4), medium stiff, moist; 70% silt; 30% fine to coarse sand; strong chemical odor.
				3				
				4				CLAYEY SILT with SAND (ML/CL) - very dark gray (10YR 3/1), stiff, moist, medium plasticity; 50% silt; 30% clay; 20% fine sand; moderate chemical odor.
				5				
466	350	S&H						
	400		U1-	6				SANDY SILT (ML) - dark gray (N4/0), medium stiff, moist; 75% silt; 25% fine sand; strong chemical odor.
	450		6.5	7				
				8				
				9				
				10		▽ ▼		
	1	S&H						saturated; increasing clay to 25%; 10% peat; 10% dispersed gravel; no chemical odor.
13	2		U1-	11				
	3		11.5	12				
				13				hard drilling at 12.5 feet.
				14				
				15				
	9	S&H	U1-					
2	10		16.5	16				SAND with GRAVEL (SW) - light olive brown (10YR 5/4), medium dense, saturated; 85% fine to coarse sand; 15% fine to coarse gravel; no chemical odor.
	13			17				
				18				
				19				

Remarks:

GeoStrategies Inc.

Log of Boring

BORING NO. U-1

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

Field location of boring:	Project No.: 7814	Date: 09/24/90	Boring No:
(See Plate 2)	Client: UNOCAL Service Station		U-1
	Location: 3220 Lakeshore		
	City: Oakland, California		Sheet 2
	Logged by: RAL	Driller: Bayland	of 2
	Casing installation data:		
Drilling method: Hollow Stem Auger			
Hole diameter: 8-Inches	Top of Box Elevation:		Datum:

	Water Level			
	Time			
	Date			

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
	7	S&H	U1-					
2	5		21.5	20				
	7							
				21				
								CLAY (CL) - greenish gray (5G 4/1), stiff, moist; 100%
				22				clay; no chemical odor.
				23				
				24				
				25				
1	7							
	13	SPT		26				very stiff; no chemical odor.
	17							
				27				
								Bottom of sample at 26.5 feet.
				28				Bottom of boring at 26.5 feet.
								09/24/90
				29				
				30				
				31				
				32				
				33				
				34				
				35				
				36				
				37				
				38				
				39				

Remarks:

GeoStrategies Inc.

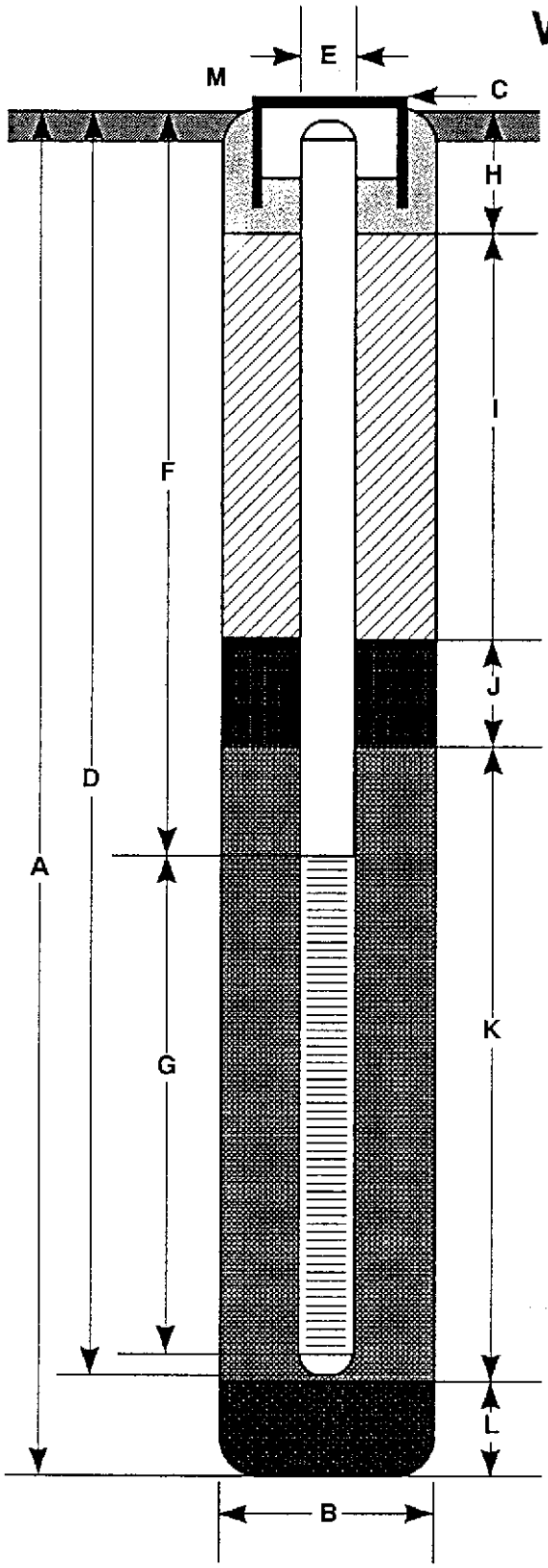
Log of Boring

BORING NO.

U-1

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

WELL CONSTRUCTION DETAIL



A	Total Depth of Boring	26.5 ft.
B	Diameter of Boring	8.0 in.
	Drilling Method	Hollow Stem Auger
C	Top of Box Elevation	ft.
	☐ Referenced to Mean Sea Level	
	☐ Referenced to Project Datum	
D	Casing Length	20.5 ft.
	Material	Schedule 40 PVC
E	Casing Diameter	3.0 in.
F	Depth to Top Perforations	5.0 ft.
G	Perforated Length	15.0 ft.
	Perforated Interval from 5.0 to 20.0	ft.
	Perforation Type	Machine Slot
	Perforation Size	0.020 in.
H	Surface Seal from 0 to 1.5	ft.
	Seal Material	Concrete
I	Backfill from 1.5 to 3.0	ft.
	Backfill Material	Concrete
J	Seal from 3.0 to 4.0	ft.
	Seal Material	Bentonite
K	Gravel Pack from 4.0 to 20.0	ft.
	Pack Material	Lonestar #2/12 Sand
L	Bottom Seal	3.0 ft.*
	Seal Material	Bentonite
M	Vault with locking well cap and lock.	

* Slough from 23.0 to 26.5 feet.

Note: Depth measured from initial ground surface.
Bottom 1.0 foot of casing is blank.

GeoStrategies Inc.

Well Construction Detail

WELL NO.

U-1

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

Field location of boring: (See Plate 2)	Project No.: 7814	Date: 09/24/90	Boring No. U-2		
	Client: UNOCAL Service Station				
	Location: 3220 Lakeshore				
	City: Oakland, California		Sheet 1 of 2		
	Logged by: RAL	Driller: Bayland			
Drilling method: Hollow Stem Auger	Casing installation data: (See Well Construction Detail)				
Hole diameter: 8-Inches	Top of Box Elevation:		Datum:		
	Water Level	10.0'	18.0'	16.0'	
	Time	11:15	11:45	13:10	
	Date	09/24/90	09/24/90	09/24/90	

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				0				
				1				PAVEMENT SECTION - 1.0 foot
				2				SANDY SILT (ML) - dark greenish gray (5G 4/1), medium stiff, moist, non plastic; 70% silt; 30% fine sand; moderate chemical odor.
				3				
				4				
				5				
846	350	S&H	U2-					
	400		6.0	6				SAND with GRAVEL (SW) - dark greenish gray (5GY 4/1), medium dense, moist; 85% fine sand; 15% fine gravel; strong chemical odor.
	450			7				
				8				
				9				
				10		▽		
	3	S&H	U2-					CLAYEY SILT with SAND (ML/CL) - very dark gray (10YR 3/1), medium stiff, saturated; 45% silt; 30% clay; 25% fine to coarse sand; sand evenly dispersed; roots and rootholes; moderate chemical odor.
66	2		11.5	11				
	4							
				12				
				13				
				14				
				15				
	4	S&H						CLAY (CL) - light olive brown (2.5Y 5/4), stiff, moist; 100% clay; trace fine to coarse gravel interspersed; no chemical odor.
1	6		U2-	16		▼		
	9		16.5					
				17				
				18				
				19				

Remarks:

GeoStrategies Inc.

Log of Boring

BORING NO. U-2

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

Field location of boring:	Project No.: 7814	Date: 09/24/90	Boring No:
(See Plate 2)	Client: UNOCAL Service Station		U-2
	Location: 3220 Lakeshore		
	City: Oakland, California		Sheet 2
	Logged by: RAL	Driller: Bayland	of 2
Drilling method: Hollow Stem Auger	Casing installation data:		
Hole diameter: 8-Inches	Top of Box Elevation:	Datum:	

	Water Level			
	Time			
	Date			

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				20				no chemical odor.
2	3	S&H						
	6		U2-	21				
	15		21.5					
				22				Bottom of sample at 21.5 feet.
				23				Bottom of boring at 21.5 feet.
								09/24/90
				24				
				25				
				26				
				27				
				28				
				29				
				30				
				31				
				32				
				33				
				34				
				35				
				36				
				37				
				38				
				39				

Remarks:

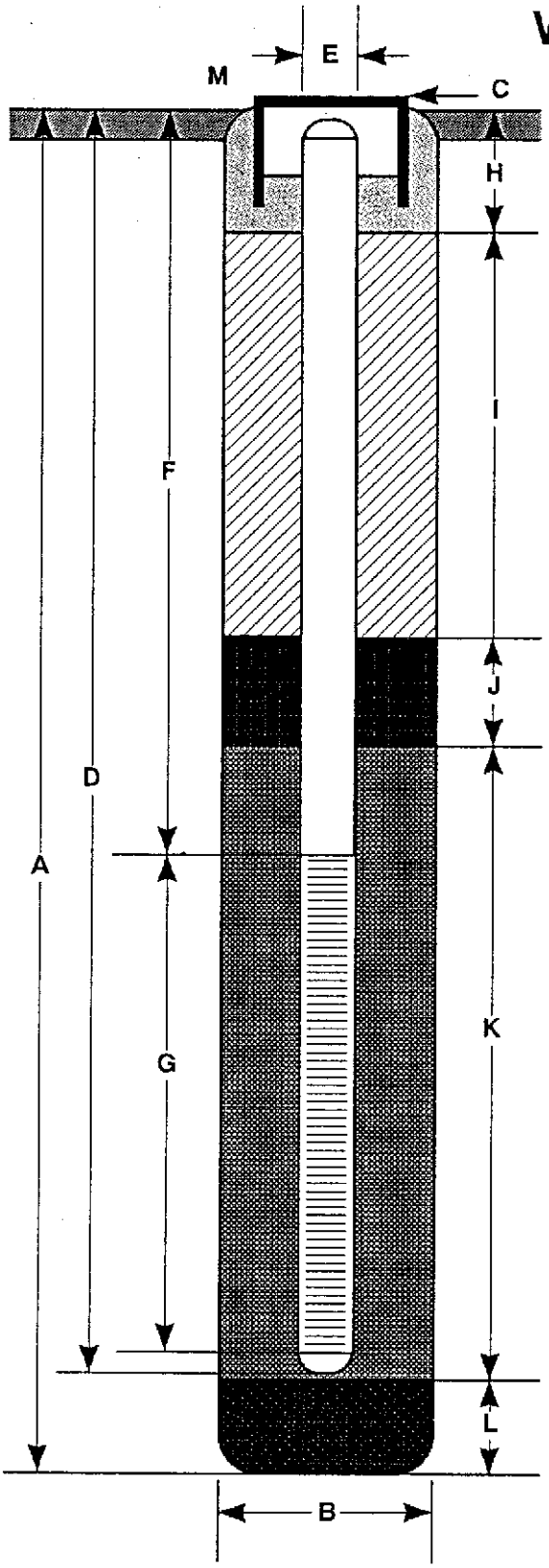
GeoStrategies Inc.

Log of Boring

BORING NO. U-2

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

WELL CONSTRUCTION DETAIL



A Total Depth of Boring 21.5 ft.

B Diameter of Boring 8.0 in.
Drilling Method Hollow Stem Auger

C Top of Box Elevation _____ ft.
☐ Referenced to Mean Sea Level
☐ Referenced to Project Datum

D Casing Length 20.5 ft.
Material Schedule 40 PVC

E Casing Diameter 3.0 in.

F Depth to Top Perforations 5.0 ft.

G Perforated Length 15.0 ft.
Perforated Interval from 5.0 to 20.0 ft.
Perforation Type Machine Slot
Perforation Size 0.020 in.

H Surface Seal from 0 to 1.5 ft.
Seal Material Concrete

I Backfill from 1.5 to 3.0 ft.
Backfill Material Concrete

J Seal from 3.0 to 4.0 ft.
Seal Material Bentonite

K Gravel Pack from 4.0 to 20.0 ft.
Pack Material Lonestar #2/12 Sand

L Bottom Seal 1.5 ft.
Seal Material Native Material

M Vault with locking well cap and lock.

Note: Depths measured from initial ground surface.
Bottom 1.0 foot of casing is blank.

GeoStrategies Inc.

Well Construction Detail

WELL NO.
U-2

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

Field location of boring:	Project No.: 7814	Date: 09/24/90	Boring No:
(See Plate 2)	Client: UNOCAL Service Station		U-3
	Location: 3220 Lakeshored		
	City: Oakland, California		Sheet 1 of 2
	Logged by: RAL	Driller: Bayland	
Drilling method: Hollow Stem Auger	Casing installation data: (See Well Construction Detail)		
Hole diameter: 8-Inches	Top of Box Elevation:		Datum:

	Water Level	10.5'	14.0'		
	Time	12:30	13:30		
	Date	09/24/90	09/24/90		

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				0				
				1				PAVEMENT SECTION - 1.0 foot
				2				SANDY SILT (ML) - very dark gray (5Y 3/1); 70% silt; 30% fine to coarse sand; weak chemical odor.
				3				
				4				
				5				
	300	S&H	U3-					no chemical odor.
3	400		6.5	6				
	450			7				
				8				
				9				
				10				
	0		U3-			▽		
2	2	S&H	11.5	11				SILTY SAND (SM) - dark greenish gray (5GY 4/1), loose, saturated; 75% fine sand; 25% silt; no chemical odor.
	2			12				
				13				
				14		▼		
				15				SILT with SAND (ML) - light olive brown (2.5Y 5/4), stiff, very moist; 80% silt; 20% fine sand; no chemical odor.
	300							
1	500	S&H	U3-	16				
	500		16.5					
				17				
				18				
				19				

Remarks:

GeoStrategies Inc.

Log of Boring

BORING NO. U-3

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

Field location of boring:	Project No.: 7814	Date: 09/24/90	Boring No:
(See Plate 2)	Client: UNOCAL Service Station		U-3
	Location: 3220 Lakeshore		
	City: Oakland, California		Sheet 2
	Logged by: RAL	Driller: Bayland	of 2
Drilling method: Hollow Stem Auger	Casing installation data:		
Hole diameter: 8-Inches	Top of Box Elevation:		Datum:
	Water Level		
	Time		
	Date		

PID (ppm)	Blows/ft. or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
				20				
	300		U3-					no chemical odor.
1	500	S&H	21.5	21				
	600							
				22				
								Bottom of sample at 21.5 feet.
				23				Bottom of boring at 21.5 feet.
								09/24/90
				24				
				25				
				26				
				27				
				28				
				29				
				30				
				31				
				32				
				33				
				34				
				35				
				36				
				37				
				38				
				39				

Remarks:

GeoStrategies Inc.

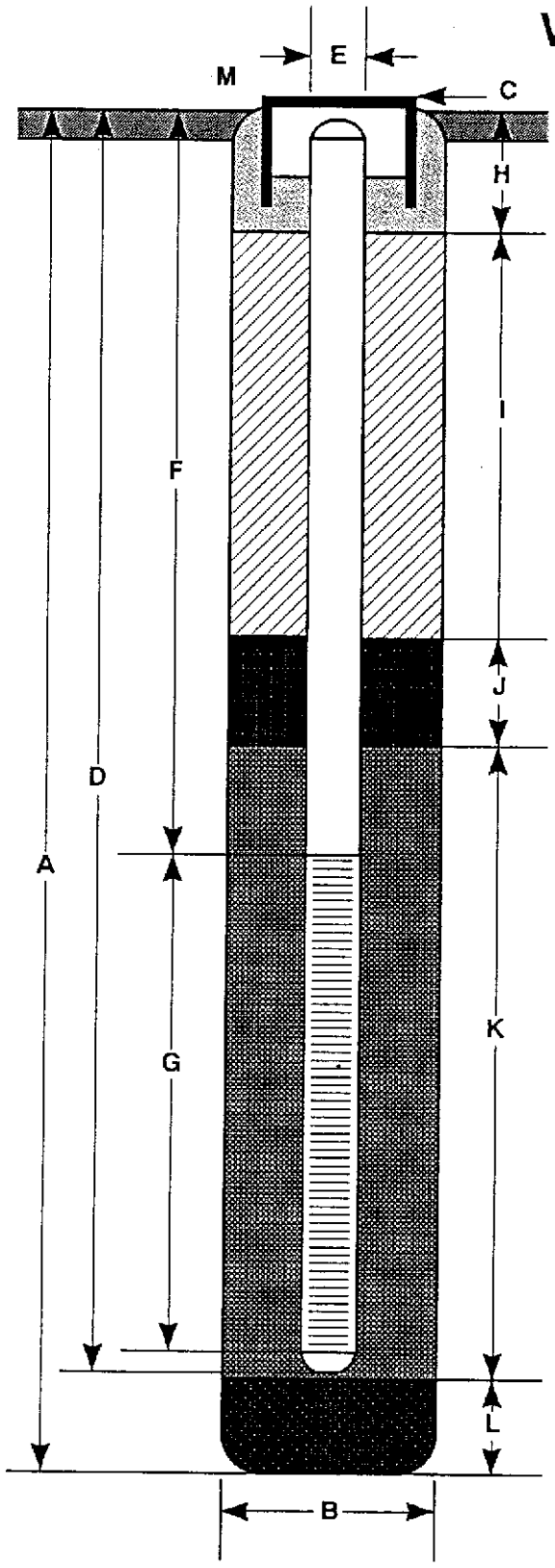
Log of Boring

BORING NO.

U-3

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

WELL CONSTRUCTION DETAIL



A Total Depth of Boring 21.5 ft.

B Diameter of Boring 8.0 in.
Drilling Method Hollow Stem Auger

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Material Schedule 40 PVC

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Seal Material Bentonite

K Gravel Pack from 4.0 to 20.0 ft.
Pack Material Lonestar #2/12 Sand

L Bottom Seal 1.5 ft.
Seal Material Native Material

M Vault with locking well cap and lock.

Note: Depths measured from initial ground surface.
Bottom 1.0 foot of casing is blank.

GeoStrategies Inc.

Well Construction Detail

WELL NO.
U-3

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
7814		09/90		

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

Date: 10/10/90

Gettler-Ryan
2150 West Winton
Hayward, CA 94545
John Werfal

Work Order: T0-09-243 P.O. Number: 7814

This is the Certificate of Analysis for the following samples:

Client Work ID: GR7814, UNOCAL
Date Received: 09/24/90
Number of Samples: 7
Sample Type: solid

TABLE OF CONTENTS FOR ANALYTICAL RESULTS

Reviewed and Approved:

Suzanne Veaudry
Project Manager

IT ANALYTICAL SERVICES
SAN JOSE, CA

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

Work Order: TO-09-243

TEST NAME: **Petroleum Hydrocarbons**

SAMPLE ID: **U1-6.5**
SAMPLE DATE: **09/24/90**
LAB SAMPLE ID: **TO09243-01**
SAMPLE MATRIX: **solid**
RECEIPT CONDITION: **Cool**

RESULTS in Milligrams per Kilogram:

	METHOD	EXTRACTION DATE	ANALYSIS DATE
BTEX	8020	09/28/90	10/08/90
Low Boiling Hydrocarbons	Mod.8015	09/28/90	10/08/90

PARAMETER	DETECTION LIMIT	DETECTED
Low Boiling Hydrocarbons calculated as Gasoline	50.	480.
BTEX		
Benzene	0.5	4.5
Toluene	0.5	29.
Ethylbenzene	0.5	14.
Xylenes (total)	0.5	74.

IT ANALYTICAL SERVICES
SAN JOSE, CA

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

Work Order: TO-09-243

TEST NAME: **Petroleum Hydrocarbons**

SAMPLE ID: **U1-11.5**
SAMPLE DATE: **09/24/90**
LAB SAMPLE ID: **T009243-02**
SAMPLE MATRIX: **solid**
RECEIPT CONDITION: **Cool**

RESULTS in Milligrams per Kilogram:

	METHOD	EXTRACTION DATE	ANALYSIS DATE
BTEX	8020	09/28/90	10/04/90
Low Boiling Hydrocarbons	Mod.8015	09/28/90	10/04/90

PARAMETER	DETECTION LIMIT	DETECTED
Low Boiling Hydrocarbons calculated as Gasoline	1.0	1.4
BTEX		
Benzene	0.005	0.64
Toluene	0.005	0.019
Ethylbenzene	0.005	0.015
Xylenes (total)	0.005	0.051

IT ANALYTICAL SERVICES
SAN JOSE, CA

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

Work Order: TO-09-243

TEST NAME: **Petroleum Hydrocarbons**

SAMPLE ID: **U2-6.0**
SAMPLE DATE: **09/24/90**
LAB SAMPLE ID: **TO09243-03**
SAMPLE MATRIX: **solid**
RECEIPT CONDITION: **Cool**

RESULTS in Milligrams per Kilogram:

	METHOD	EXTRACTION DATE	ANALYSIS DATE
BTEX	8020	09/28/90	10/08/90
Low Boiling Hydrocarbons	Mod.8015	09/28/90	10/08/90

PARAMETER	DETECTION LIMIT	DETECTED
Low Boiling Hydrocarbons calculated as Gasoline	20.	110.
BTEX		
Benzene	0.2	None
Toluene	0.2	1.6
Ethylbenzene	0.2	2.4
Xylenes (total)	0.2	12.

IT ANALYTICAL SERVICES
SAN JOSE, CA

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

Work Order: T0-09-243

TEST NAME: **Petroleum Hydrocarbons**

SAMPLE ID: **U2-11.5**
SAMPLE DATE: **09/24/90**
LAB SAMPLE ID: **T009243-04**
SAMPLE MATRIX: **solid**
RECEIPT CONDITION: **Cool**

RESULTS in Milligrams per Kilogram:

	METHOD	EXTRACTION DATE	ANALYSIS DATE
BTEX	8020	09/28/90	10/04/90
Low Boiling Hydrocarbons	Mod.8015	09/28/90	10/04/90

PARAMETER	DETECTION LIMIT	DETECTED
Low Boiling Hydrocarbons calculated as Gasoline	1.0	None
BTEX		
Benzene	0.005	0.007
Toluene	0.005	None
Ethylbenzene	0.005	None
Xylenes (total)	0.005	0.005

IT ANALYTICAL SERVICES
SAN JOSE, CA

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

Work Order: TO-09-243

TEST NAME: **Petroleum Hydrocarbons**

SAMPLE ID: **U3-6.5**
SAMPLE DATE: **09/24/90**
LAB SAMPLE ID: **TO09243-05**
SAMPLE MATRIX: **solid**
RECEIPT CONDITION: **Cool**

RESULTS in Milligrams per Kilogram:

	METHOD	EXTRACTION DATE	ANALYSIS DATE
BTEX	8020	09/28/90	10/04/90
Low Boiling Hydrocarbons	Mod.8015	09/28/90	10/04/90

PARAMETER	DETECTION LIMIT	DETECTED
Low Boiling Hydrocarbons calculated as Gasoline	1.0	None
BTEX		
Benzene	0.005	None
Toluene	0.005	None
Ethylbenzene	0.005	None
Xylenes (total)	0.005	None

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

IT ANALYTICAL SERVICES
SAN JOSE, CA

Work Order: TO-09-243

TEST NAME: **Petroleum Hydrocarbons**

SAMPLE ID: **U3-11.5**
SAMPLE DATE: **09/24/90**
LAB SAMPLE ID: **TO09243-06**
SAMPLE MATRIX: **solid**
RECEIPT CONDITION: **Cool**

RESULTS in Milligrams per Kilogram:

	METHOD	EXTRACTION DATE	ANALYSIS DATE
BTEX	8020	09/28/90	10/04/90
Low Boiling Hydrocarbons	Mod.8015	09/28/90	10/04/90

PARAMETER	DETECTION LIMIT	DETECTED
Low Boiling Hydrocarbons calculated as Gasoline	1.0	None
BTEX		
Benzene	0.006	None
Toluene	0.006	None
Ethylbenzene	0.006	None
Xylenes (total)	0.006	None

IT ANALYTICAL SERVICES
SAN JOSE, CA

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

Work Order: TO-09-243

TEST NAME: Petroleum Hydrocarbons

SAMPLE ID: U2-21.5
SAMPLE DATE: 09/24/90
LAB SAMPLE ID: T009243-07
SAMPLE MATRIX: solid
RECEIPT CONDITION: Cool

RESULTS in Milligrams per Kilogram:

	METHOD	EXTRACTION DATE	ANALYSIS DATE
BTEX	8020	09/28/90	10/04/90
Low Boiling Hydrocarbons	Mod.8015	09/28/90	10/04/90

PARAMETER	DETECTION LIMIT	DETECTED
Low Boiling Hydrocarbons calculated as Gasoline	1.0	None
BTEX		
Benzene	0.007	None
Toluene	0.007	None
Ethylbenzene	0.007	None
Xylenes (total)	0.007	None

Company: Gettler-Ryan
Date: 10/10/90
Client Work ID: GR7814, UNOCAL

IT ANALYTICAL SERVICES
SAN JOSE, CA

Work Order: TO-09-243

TEST CODE **TPHVB** TEST NAME **TPH Gas,BTEX by 8015/8020**

The method of analysis for low boiling hydrocarbons is taken from E.P.A. Methods 8015, 8020 and 5030. The sample is examined using the purge and trap technique. Final detection is by gas chromatograhy using a flame ionization detector as well as a photoionization detector. The result for total low boiling hydrocarbons is calculated as gasoline and includes benzene, toluene, ethylbenzene and xylenes.