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URS

November 28, 2003

Mr. Don Hwang
Hazardous Material Specialist
Alameda County Health Care Services
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Alameda County
DEC 0 2 2003
Environmental Health

SUBJECT: Soil and Groundwater Investigation Workplan
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, California
ACHCS Fuel Leak Case No. RO0000356

Dear Mr. Hwang:

On behalf of the Group Environmental Management Company (an affiliated company of BP), URS Corporation (URS) has prepared this workplan for additional soil and water characterization at the above referenced facility. This workplan was prepared in response to a letter from the Alameda County Health Care Services (ACHCS) to BP dated September 30, 2003 (Attachment A). This work plan includes a discussion of the Site background, Site hydrogeology, proposed scope of work, and schedule.

SITE FEATURES AND BACKGROUND

The Site is an active 76-branded gasoline retail outlet located at the north corner of Bancroft Avenue and 73rd Avenue in Oakland, California (Figure 1). The land use in the immediate vicinity of the Site is mixed commercial and residential. BP acquired the facility from Mobil Oil Corporation in 1989. In January 1994, BP transferred the property to TOSCO Marketing Company (TOSCO) and has not operated the facility since that time.

The Site consists of a service station building and three 12,000-gallon gasoline underground storage tanks (USTs) and one 10,000-gallon diesel UST with associated piping and dispensers. The Site is covered with asphalt or concrete surfacing except for planters along the southeastern and southwestern property boundaries and at the north corner of the property (Figures 2 and 3).

In 1984, the preexisting USTs at the Site were removed and three gasoline USTs (6,000-gallon, 10,000-gallon, and 12,000-gallon) and one 6,000-gallon diesel UST were installed immediately to the east (Attachment B-Figure 1). The newly installed USTs were single-walled fiberglass tanks. An associated UST removal report is not on file and may not have been prepared. No documentation was found referencing the conditions of the removed USTs and reporting evidence of hydrocarbon impacts in the soil and groundwater, if any, at the time of the UST removal.

In December 1989, a Phase II environmental audit was conducted on the adjacent Eastmont Mall Site located to the north and the northwest of the former BP Site. Part of the respective Phase II study relevant to the former BP Site included installing monitoring well MW-3 near the western boundary of the former BP Site (Figure 2). The analytical results of soil samples collected from 10 and 20 feet below ground surface (bgs) from MW-3 reported non-detectable concentrations of total petroleum hydrocarbons (TPH), benzene, toluene, ethyl benzene, and xylenes (BTEX), and Oil and Grease. The analytical results of groundwater samples from MW-3 reported concentrations of 2,700 micrograms per liter (μg/L) TPH and 530 μg/L benzene.

In December 1991, two soil borings (MW-1 and MW-2) were drilled on-Site to total depths of 40 feet bgs, soil samples were collected at 10 feet intervals between 5 and 25 feet bgs and the respective borings were subsequently converted into monitoring wells MW-1 and MW-2. First groundwater was encountered at approximately 30 feet bgs. The analytical results of the soil samples from MW-1 and MW-2 reported non-detectable concentrations of total petroleum hydrocarbon-gasoline (TPH-g) and BTEX (Attachment B-Table 1).

In July 1992, one on-Site boring (MW-4) and two off-Site borings (B-5 and MW-6) were drilled at locations shown in Figure 2 and Attachment B-Figure 1. Borings MW-4 and MW-6 extended to total depths of 40 feet bgs, and B-5 extended to 50 feet bgs. First groundwater was encountered at approximately 30 feet bgs in MW-4 and MW-6, and no free water was encountered in B-5. The analytical results of soil samples collected at 30 feet bgs from B-5 and MW-6 reported non-detectable concentrations of TPH-g and BTEX (Attachment B-Table 1). The analytical results of soil samples collected from MW-4 at 5 feet intervals between 15 and 25 feet bgs reported a maximum of 6,000 milligrams per kilograms (mg/kg) TPH-g and 34 mg/kg benzene at 20 feet bgs (Attachment B-Table 1). Borings MW-4 and MW-6 were subsequently converted into monitoring wells.

In September 1994, a supplemental Site assessment was conducted at the Site. Four exploratory soil borings (THP-1 and TB-2 through TB-4) were advanced up to 45 feet bgs at the following locations as shown in Attachment B-Figure 1: north of the former and existing UST complexes (THP-1), at the former service bays (TB-2), north of the north pump island (TB-3), and at a former pump island (TB-4). Additionally, one soil sample was collected from beneath each of five dispensers (TD-1 through TD-5). Groundwater was encountered in TB-2 and TB-3 at approximately 33 to 36 feet bgs and groundwater samples were collected from TB-2 and TB-3 via temporary well points. The analytical results of the respective samples reported a maximum of 16 mg/kg TPH-g (TD-3), non-detectable concentrations of benzene, and between 110 mg/kg to 5,800 mg/kg TPH-d in soils (TD-1 through TD-5), and non-detectable concentrations of TPH-g and a maximum concentration of 0.7 μg/L benzene (TB-3) in groundwater (Attachment B-Table 2).

In October 1994, one on-Site boring (MW-7) and two off-Site borings (MW-8 and MW-9) were drilled at locations shown in Figure 2. Boring MW-7 extended to a total depth of 45 feet bgs and boring MW-8 and MW-9 extended to total depths of 40 feet bgs. First encountered groundwater was at approximately 27 to 32 feet bgs. The analytical results of soil samples collected from 25 feet bgs from each boring reported non-detectable concentrations of TPH-g and BTEX (Attachment B-Table 3). The three borings were subsequently converted into monitoring wells MW-7 through MW-9.

In July 1997, one boring (MW-10) was drilled off-Site to a maximum depth of approximately 37.5 feet bgs, soil samples were collected and the boring was subsequently converted into a monitoring well (Figure 2). First groundwater was encountered at approximately 26 feet bgs. The analytical results of the soil samples from MW-10 reported non-detectable concentrations of TPH-g, BTEX, and methyl tertiary butyl ether (MTBE) (Attachment B-Table 4).

In August 1998, the three gasoline USTs (6,000-gallon, 10,000-gallon, and 12,000-gallon) and one 6,000-gallon diesel UST, associated dispensers and piping were removed from the Site and disposed off-Site. There was no visible evidence of leakage from the removed USTs. A total of eight native soil samples were collected from beneath each end of the removed USTs at depths of 14 through 16 feet bgs, and a total of 18 soil samples were collected from the former dispenser locations and from beneath the associated product lines at 3 feet bgs. The respective sample locations are shown in Attachment B-Figure 2 and the analytical results are presented in Attachment B-Table 5.

TPH-g was detected in five of the eight UST excavation samples with concentrations ranging between 3.7 to 5,300 mg/kg. Total petroleum hydrocarbon-diesel (TPH-d) was detected at 630 mg/kg and 800 mg/kg in two samples, benzene concentrations ranged between 0.40 to 0.95 mg/kg in three samples, MTBE concentrations ranged between 0.028 to 5.3 mg/kg in seven samples, and lead was not detected in the only sample that was analyzed for lead (Attachment B-Table 5). TPH-g was detected in nine of the eighteen dispenser and product line samples with concentrations ranging between 1.4 to 7,200 mg/kg. TPH-d was detected between 4.8 to 190 mg/kg in five samples, benzene was detected between 0.0089 to 22 mg/kg in three samples, and MTBE was detected between 0.048 to 15 mg/kg in ten samples (Attachment B-Table 5). During the 1998 tank replacement activities, approximately 389 tons of soil and backfill were transported off-Site for disposal. The existing 10,000-gallon diesel and three 12,000-gallon gasoline USTs were installed as replacements (Figure 2).

In April 1999, a groundwater recovery test was performed on wells MW-1 through MW-4, MW-6, MW-7 and MW-10 to assess the spatial variation in hydraulic conductivity in the shallow water-bearing zone across the Site. The hydraulic conductivity values estimated from the recovery testing are presented in Attachment B-Table 6. The geometric mean of the hydraulic conductivity values and the flow velocity were calculated to be 1.37×10^{-5} feet per second and 73.85 feet per year, respectively.

In November 1999, two 4-inch diameter wells (EX-1 and EX-2) were installed on-Site to facilitate potential remedial activities at the Site (Figure 2). Well EX-1 was drilled to 39.5 feet bgs and EX-2 was drilled to 36.5 feet bgs. Groundwater was first encountered at 26 feet bgs. The analytical results of soil samples collected from EX-1 and EX-2 reported non-detectable to relatively low concentrations of TPH-g, BTEX and MTBE (Attachment B-Table 7).

Between March 16 and April 30, 2000, interim remedial activities were conducted at the Site to evaluate the effectiveness of hydrocarbon and MTBE reduction using short-term groundwater extraction. Approximately 10,900 gallons of groundwater was extracted from wells EX-1, EX-2 and MW-2 during eight sessions. During the extraction events, stable to slightly decreasing hydrocarbon and MTBE concentration trends were exhibited in samples collected from wells MW-2 and EX-1, located immediately southwest of the existing USTs. Samples from well EX-2, which is located north of the existing USTs exhibited lower hydrocarbon and MTBE concentrations than MW-2 and EX-1.

In April 2000, during the batch extraction events, recovery tests were conducted on wells EX-1, EX-2 and MW-2. Based on the recovery test measurements, the geometric mean of the hydraulic conductivity values and flow velocities for wells EX-1, EX-2 and MW-2 was calculated as 3.0×10^{-4} feet per minute and 26 feet per year, respectively (Attachment B - Table 8).

During October 29, through November 2, 2001, a dual-phase soil vapor and groundwater extraction (DPE) pilot test was performed on the monitoring wells with the highest historical hydrocarbon concentrations (i.e., MW-2 and MW-4) and the extraction wells (EX-1 and EX-2) at the Site. The DPE test results indicated that the vacuum influence was limited to within 18 to 28 feet of the extraction well. Water levels typically decreased several feet in the extraction wells and had a varied response in the observation wells. Estimated vapor-phase removal rates were approximately 200-pounds of hydrocarbon per day in wells MW-4 and EX-1, and less than 5-pounds of hydrocarbon per day in wells MW-2 and EX-2. Soil vapor concentrations showed a decreasing trend in wells MW-4 and EX-1 during the short-term pilot tests. Grab water samples collected before and after the pilot tests remained the same order of magnitude. A total of 6,500 gallons of water was extracted during the DPE pilot test and appropriately disposed off-Site. Overall, the test results indicated that DPE is a feasible remedial alternative for the Site and ACHCS approved Cambria's August 8, 2002, 'Dual Phase Extraction Pilot Test Report' as a Corrective Action Plan (CAP).

A total of eleven wells are installed at the Site: wells MW-1 through MW-4, MW-6 through MW-10, and EX-1 and EX-2 (Figure 2). Wells MW-1 and MW-2 screen from approximately 20 to 40 feet bgs; well MW-3 screens from 30 to 45 feet bgs; wells MW-4 and MW-6 screen from approximately 20 to 40 feet bgs; and wells MW-7 through MW-9 screen from approximately 25 to 40 or 45 feet bgs. Wells EX-1 and EX-2 screen from approximately 18 to 38 feet bgs and 15 to 35 feet bgs, respectively. The boring logs of the 11 wells are attached as Attachment C.

A quarterly groundwater monitoring program was initiated at the Site since January 1992 and is ongoing. Currently wells MW-1, MW-2, MW-4, MW-6, MW-7 and MW-10 are sampled quarterly, wells MW-3 and MW-9 are sampled semi-annually (first and third quarter), and well MW-8 is sampled annually (first quarter). The analytical results of the groundwater monitoring program are included as Attachment B-Table 9 and the most recent quarterly (third quarter 2003) groundwater monitoring results are graphically presented in Attachment B-Figure 3.

SITE HYDROGEOLOGY

The Site is typically underlain by clays with 1 to 4 foot thick intervals of sands and gravels to a total explored depth of approximately 45 feet bgs. Boring logs for wells MW-1, MW-2, MW-6 and MW-7 indicate less than 5 feet of sand and/or gravel encountered, while those for wells MW-3, MW-4, MW-8, MW-9, MW-10, EX-1 and EX-2 indicate more than 10 feet of sand and/or gravel encountered (Attachment C). Groundwater was first encountered during drilling at depths ranging from 26 feet to 43.5 feet bgs (Attachment C). Geologic cross-sections depicting the lithology at the Site and in the immediate vicinity of the Site are presented in Attachment D.

The water table fluctuates seasonally and has risen about 10 feet since 1992. The static depth to water in monitoring wells at the Site has ranged between 13.02 and 33.74 feet bgs (Attachment B-Table 9). The historic groundwater flow direction between July 1992 and August 2003 has ranged between southwest through northeast but has predominantly been north to northeast, and the hydraulic gradient has ranged between 0.002 to 0.14 feet per foot (Attachment E-Table 1). A rose diagram indicating the historical hydraulic gradient magnitude and direction at the Site is presented in Attachment E.

The nearest surface water body is Arroyo Viejo, located approximately 1,300 feet south of the Site (Figure 1). In October 2000, Alisto Engineering Group conducted a potential receptor survey and a one-half-mile radius well survey for the Site (Attachment F). A review of the State of California Department of Water Resources (DWR) files identified that eleven off-Site monitoring wells, four cathodic protection wells, one industrial well, and one irrigation well were located within one-half-mile radius of the Site. The identified industrial and irrigation wells were between approximately ¼ and ½-mile north of the Site, respectively.

PROPOSED SCOPE OF WORK

The proposed scope of work to further characterize the nature and extent of hydrocarbon contamination associated with the Site includes:

- Preferential Pathway Survey;
- Contaminant Source Characterization;
- Contaminant Plume Definition;
- Groundwater Contaminant Plume Monitoring; and
- Corrective Action Plan.

PREFERENTIAL PATHWAY SURVEY

An underground utility Site survey was conducted in October 2000 by Alisto Engineering Group to identify potential migration pathways and conduits to assess the probability of the plume encountering preferential pathways and conduits that may promote the migration of petroleum hydrocarbons. An additional underground utility survey was recently conducted by URS to augment the previous survey and verify the depths of the underground utilities in the area of the Site. A map showing the locations of the underground utilities in the area of the Site is presented in Attachment G and Figure 3. Geologic cross-sections showing the locations and depths of the underground utilities in the area of the Site are presented in Attachment D. Based on the locations and relatively shallow depths of the underground utilities (maximum depth of approximately 10 feet), the lithology and the depth to water at the Site (between 13.02 and 33.74 feet bgs), preferential dissolved petroleum hydrocarbon migration pathways and conduits are unlikely to exist at the Site.

CONTAMINANT SOURCE CHARACTERIZATION

The purpose of the contaminant source characterization is to assess the lateral and vertical extent of petroleum hydrocarbons in soils in the vicinity of the contaminant sources, such as the former and current USTs, product dispensers, and product piping. The historical soil analytical data indicates that relatively elevated concentrations of petroleum hydrocarbons were encountered in soil samples collected from beneath the current UST locations at depths of 15 to 16 feet bgs, from the former dispenser areas at surface levels, and from boring MW-4 at depths from 15 to 25 feet bgs. Evaluation of the historical soil analytical data indicates the presence of data gaps that need to be addressed to adequately characterize the identified contaminant source areas.

Accordingly, URS proposes advancing 12 soil borings (A-1 through A-12) in the vicinity of the identified contaminant source areas such as the locations of the former and current USTs, product dispensers, and in the vicinity of MW-4. The proposed boring/sampling locations are shown in Figure 2. The analytical results of soil samples collected from the proposed boring locations and depths will address the identified data gaps allowing adequate characterization of the lateral and vertical extent of petroleum hydrocarbons in soils in the identified source areas.

The proposed sample locations are preliminary, and may be subject to change in order to obtain the necessary clearance from underground and above-ground utilities per the BP GEM drilling and utility clearance guidelines. In accordance to BP GEM's utility clearance policy, all proposed boring locations will be at a minimum 10 feet away from all USTs, product lines and dispensers. Each boring will be continuously cored using direct push methods to the depth of first encountered groundwater, which ranges between 26 feet and 43.5 feet bgs at the Site. However, the first 5 feet of each boring will be performed using air knife methods per BP GEM utility clearance procedures. Depth discrete soil samples for possible lab analysis will be collected at 5 feet depth intervals and each boring will be logged for lithologic characterization. Groundwater samples will not be collected from the respective borings as quarterly monitoring of six on-Site groundwater monitoring wells provide adequate data on the dissolved phase hydrocarbon concentrations at the Site.

Soil samples collected for possible laboratory analysis will be screened for volatile hydrocarbons by a photo-ionization detector (PID). Soil samples collected at a minimum of 5-foot depth intervals, at the groundwater interface, and intervals containing significant hydrocarbon concentrations as screened by the PID, will be selected for laboratory analysis. A State of California DHS Certified Laboratory will analyze the selected soil samples for TPH-g, BTEX and fuel oxygenates including MTBE and ethanol using EPA Method 8260B.

CONTAMINANT PLUME DEFINITION

The analytical results of the ongoing groundwater monitoring program indicate relatively elevated petroleum hydrocarbon concentrations in wells MW-2, MW-4, MW-9 and MW-10 (Attachment B-Figure 3 and Table 9). Well MW-2 is in the contaminant source area (former UST location), well MW-10 is downgradient (north to northeast) of the contaminant source area, and wells MW-4 and MW-9 are cross gradient (southeast) of the contaminant source area. Wells MW-1, MW-3, MW-6 through MW-8 adequately define the extent of the dissolved contaminant plume in the area southwest through north to northwest of the contaminant source areas (Figures 2 and 3).

To assist in additional definition of the dissolved contaminant plume in the contaminant source area, URS proposes incorporating extraction wells EX-1 and EX-2 into the ongoing groundwater monitoring program (Figure 2). To further define the downgradient, cross-gradient and upgradient (i.e., northern through eastern through southern) extent of the dissolved contaminant plume, URS proposes advancing borings at 6 sample locations (two borings per location) using a GeoProbe™ or equivalent direct push sampling rig. The proposed boring locations are shown on Figure 3.

The north through northeasterly downgradient extent of the dissolved contaminant plume will be defined by proposed boring locations UB-1 through UB-4, and the southeasterly cross-gradient to southerly upgradient extent of the plume will be defined by proposed boring locations UB-5 through UB-7. Borings UB-1 through UB-3 will be located in the parking lot of the adjacent Eastmont Mall and will be spaced approximately 120 feet apart from each other. Boring UB-1 will be located approximately 240 feet north to northwest of the former and current UST locations, and borings UB-2 and UB-3 will be located approximately 120 feet north to northeast and northeast of the former and current UST locations, respectively. Downgradient boring UB-4 will be located on a street median on 73rd Avenue approximately 160 feet northeast to east of the former and current UST locations. Cross-gradient boring UB-5 will be located in a City of Oakland owned vacant lot approximately 280 feet southeast of the former and current UST locations. Upgradient boring UB-6 will be located on a street median on Bancroft Avenue approximately 240 feet south of the former and current UST locations. The respective borings will be located at least 10 feet from the nearest underground utilities per BP GEM utility clearance procedures.

The borings will be advanced to total depths of 40 to 50 feet, or approximately 20 feet below expected depth to first encountered groundwater. The first 5 feet of each boring will be performed using air knife methods per BP GEM utility clearance procedures. Since it is not practical to collect depth discrete groundwater samples within a continuously cored soil boring, or conduct soil sampling while using depth discrete groundwater sampling probes, URS proposes a closely spaced pair of borings (within 2 feet apart) at each sampling location. Each pair of borings per sample location will be numbered UB-1A and UB-1B, etc. Foreknowledge of the lithologic and hydrogeologic conditions is necessary to anticipate proper discrete groundwater sampling depths. Therefore, URS proposes to continuously core the first soil boring at each location for lithologic characterization, with soil analytical samples to be collected at the soil/groundwater interface and from areas of obvious contamination.

A depth discrete groundwater sampling probe with a sealed retractable screen interval will then be advanced within 2 feet of the original boring using direct push methods to approximately 40 to 50 feet bgs. Depth discrete groundwater samples will be collected at the saturated/unsaturated zone interface, at 10 feet depth intervals below, and at multiple discrete water-bearing zones and lithologic changes, if encountered within the initial boring. As presented in Attachment H, standard direct push/GeoProbe™ drilling and sampling procedures will be followed. Additionally, all drilling and sampling methods will be consistent with ASTM Method D-1452-80 and all applicable county, state and federal regulations.

Soil samples collected for possible laboratory analysis will be screened for volatile hydrocarbons by a photo-ionization detector (PID). Soil samples collected at the groundwater interface, from areas of obvious contamination, and from intervals containing significant hydrocarbon concentrations as screened by the PID, will be selected for laboratory analyses. A State of California DHS Certified Laboratory will analyze the selected soil and groundwater samples for TPH-g, BTEX and MTBE using EPA Methods 8260B. As requested by ACHCS, the soil samples will also be analyzed for the lead scavengers ethylene dibromide (EDB) and ethylene Dichloride (EDC) using EPA Method 8260. In addition, the groundwater samples will also be analyzed for other fuel oxygenates, ethanol, tertiary amyl methyl ether (TAME), ethyl tertiary butyl ether (ETBE), di-isopropyl ether (DIPE), tertiary butyl alcohol (TBA), EDB, EDC, and 1,2-DCA using EPA Method 8260B.

GROUNDWATER CONTAMINANT PLUME MONITORING

Groundwater monitoring for wells MW-1 through MW-4 and MW-6 through MW-10 will continue on the current schedule to assess the nature and extent of the remaining dissolved petroleum hydrocarbons in groundwater both on-Site and off-Site, over time. URS also proposes incorporating on-Site extraction wells EX-1 and EX-2 into the quarterly groundwater monitoring program to further define the dissolved contaminant plume in the source area.

CORRECTIVE ACTION PLAN

The data obtained from the proposed Site assessment activities will be evaluated in conjunction with Cambria's August 8, 2002 'Dual Phase Extraction Pilot Test Report' proposing the use of DPE at the Site. Based on the evaluation, a CAP or a Remedial Action Plan will be submitted proposing a cost-effective final cleanup solution for the remaining petroleum hydrocarbons in soil and groundwater. The CAP will also select a final remedial alternative for soil and groundwater that will adequately address human health and safety, the environment, eliminate nuisance conditions, and protect water resources. The CAP will evaluate at least two technically and economically feasible methods to restore and protect the beneficial uses of water and to meet the cleanup objectives for each contaminant established in the CAP. The CAP will also propose verification monitoring to confirm completion of the correction actions and evaluate the CAP implementation effectiveness.

SCHEDULE AND PROJECT MANAGEMENT

The schedule for the above noted work is as follows:

- Soil and Water Investigation – Upon approval of this workplan and obtaining the necessary access agreements and permits;
- Soil and Water Investigation Report – 60 days after the completion of fieldwork; and
- Corrective Action Plan – 180 days after the completion of the Soil and Water Investigation Report.

In addition, quarterly groundwater monitoring reports will be completed within 45 days of each sampling event.

The Project Manager for this proposed work will be Mr. Leonard P. Niles, a California State Registered Geologist and Certified Hydrogeologist. Mr. Niles will oversee all technical aspects of this work and act as liaison between ACHCS and BP. Other URS staff of engineers, geologists and technicians will support Mr. Niles during the course of this project.

LIMITATIONS

This report is based on data, Site conditions and other information that is generally applicable as of the date of the report, and the conclusions and recommendations herein are therefore applicable only to that time frame. Background information including but not limited to previous field measurements, analytical results, Site plans and other data have been furnished to URS by Group Environmental Management Company, their previous consultants, and/or third parties, which URS has used in preparing this report. URS has relied on this information as furnished, and is neither responsible for nor has confirmed the accuracy of this information.

URS

Analytical data provided by the Group Environmental Management Company approved laboratory has been reviewed and verified by the laboratory. URS has not performed an independent review of the data and is neither responsible for nor has confirmed the accuracy of this data. Field measurements have been supplied by a groundwater sampling subcontractor. URS has not performed an independent review of the field sampling data and is neither responsible for nor has confirmed the accuracy of this data.

If you have any questions or concerns, please contact Leonard Niles at (510) 874-1720.

Sincerely,

URS CORPORATION

Srijesh Thapa
Environmental Scientist

CERTIFIED HYDROGEOLOGIST
LEONARD P. NILES
NO. HG357
EXP. 3/31/04
STATE OF CALIFORNIA

Leonard P. Niles, R.G. #5774, C.H.G. #357
Project Manager

cc: Mr. Paul Supple, BP, Environmental Resources Management, (electronic file uploaded to ENFOS)
Mr. Ade Fagorala, San Francisco Bay Regional Water Quality Control Board, 1515 Clay Street, Suite 1400, Oakland, California 94612
Ms. Liz Sewell, ConocoPhilips, 75 Broadway, Sacramento, California 95818

ATTACHMENTS

References
Figure 1 – Site Location Map
Figure 2 – Proposed Soil Borings Map for Contaminant Source Characterization
Figure 3 – Proposed Soil Borings Map for Contaminant Plume Definition
Attachment A – ACHCS September 30, 2003 Letter
Attachment B – Historical Soil and Water Analytical Data and Sample Locations
Attachment C – Boring Logs
Attachment D – Geologic Cross-Sections
Attachment E – Rose Diagram Of Historical Hydraulic Gradient Magnitude and Direction
Attachment F – Potential Receptor Survey and a One-Half-Mile Radius Well Survey
Attachment G – Underground Utility Location Map
Attachment H – Standard Direct Push Drilling and Sampling Procedures (US EPA Expedited Site Assessment Guidelines, Chapter V)

URS

REFERENCES

Hunter Environmental Services, Inc. *Phase II Environmental Audit.* Eastmont Mall Property, Oakland, Alameda County, California. December 20, 1989.

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Hydro Environmental Technologies, Inc. *Site Assessment Report.* BP Oil Station No. 11117, 7210 Bancroft Avenue, Oakland, California. March 9, 1995.

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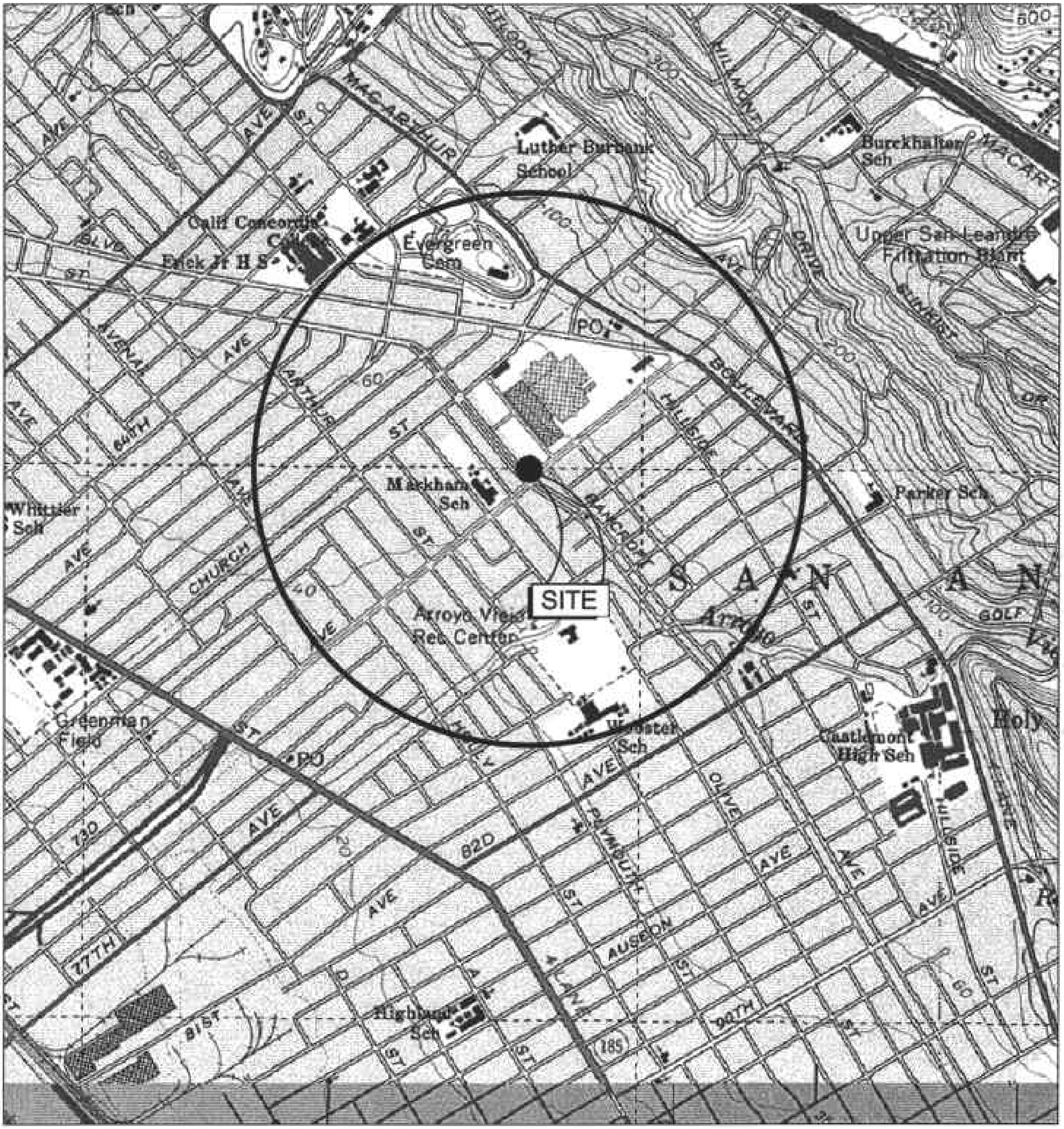
URS Corporation. *Third Quarter 2003 Groundwater MonitoringReport.* Former BP Service Station No. 11117, 7210 Bancroft Avenue, Oakland, California. October 3, 2003.



REF: BASE MAP FROM USGS TOPO!
7.5 MINUTE TOPOGRAPHIC
PHOTOREVISED 1998

QUADRANGLE LOCATION

NORTH

0 — 1400 FT

APPROXIMATE SCALE

URS	Project No. 38486396 Former BP Service Station #11117 7210 Bancroft Avenue Oakland, California	SITE LOCATION MAP	FIGURE 1

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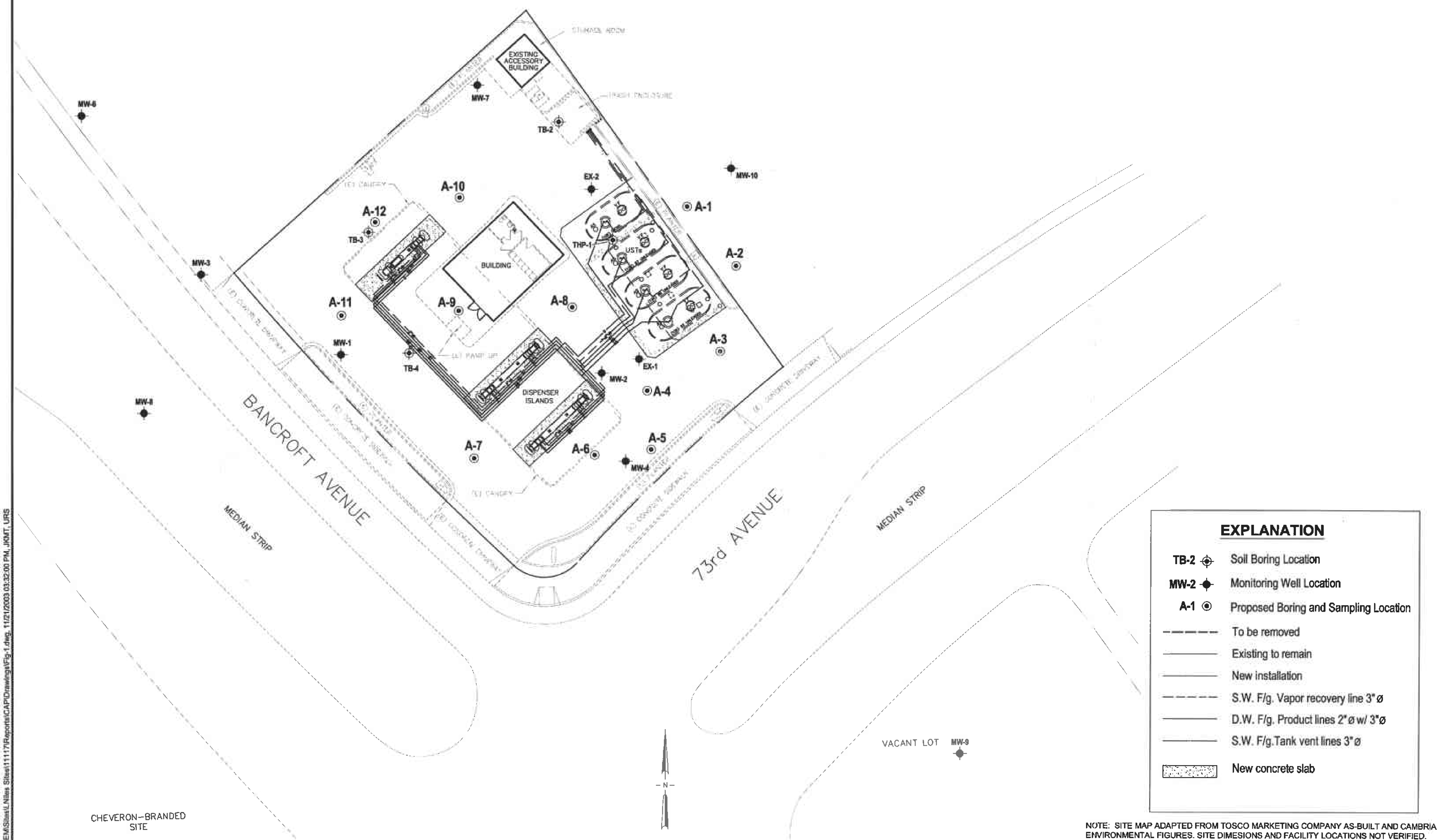

NOTE: SITE MAP ADAPTED FROM TOSCO MARKETING COMPANY AS-BUILT AND CAMBRIA ENVIRONMENTAL FIGURES. SITE DIMESIONS AND FACILITY LOCATIONS NOT VERIFIED.

0 15 30 45

Scale (ft)

URS	Project No. 38486396	SITE PLAN AND PROPOSED BORING LOCATIONS	FIGURE
	ARCO Service Station #11117 7210 Bancroft Avenue Oakland, California		2

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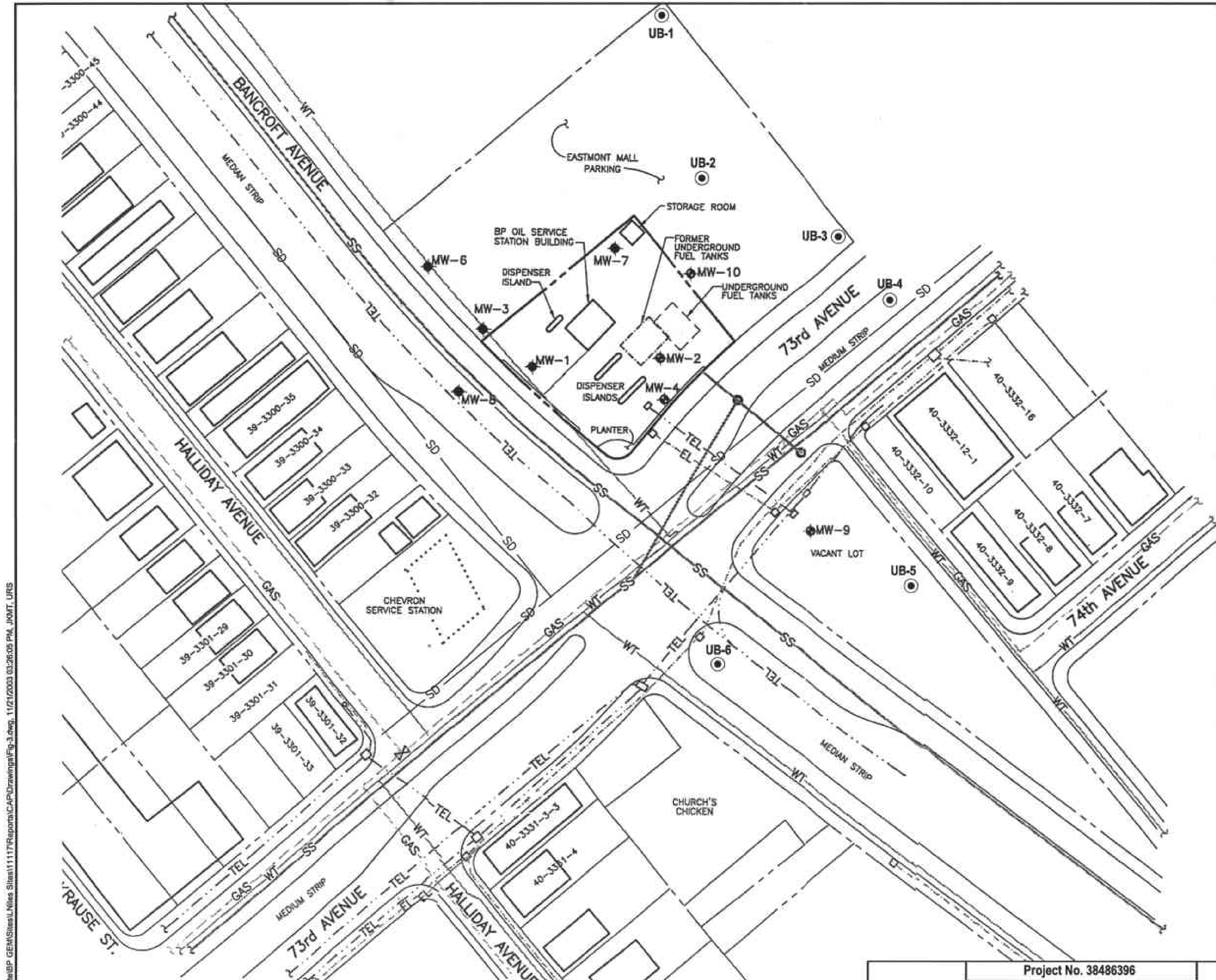

EXPLANATION

UB-1	Proposed Boring and Sampling Location
MW-1	Monitoring Well Location
MW-10	Well With Petroleum Hydrocarbons at Concentrations of Concern
?	Assessor's Parcel Number
	Drop Inlet Grate
	Manhole
	Above Ground Transformer
	Television Cable Vault
SSCO	Sanitary Sewer Cleanout
	Fire Hydrant
	Valve
	Power Pole

UNDERGROUND UTILITY LINES

SS	Sanitary Sewer Pipe
SD	Storm Drain Pipe
WT	Water Service Pipe
GAS	Gas Pipe
EL	Electrical Line
TEL	Telephone Line
TCL	Television Cable Line
	Unknown Destination
	End Of Pipe
(?)	Invert Elevation Relative To Bench Mark

NOTE:

Location of utilities are approximate and based upon information provided at the time of preparation. This map is not to be used for any construction or related activities.

N

0 40 80 120

Scale (ft)

NOTE: SITE MAP ADAPTED FROM ALISTO ENGINEERING GROUP FIGURES.
SITE DIMESIONS AND FACILITY LOCATIONS NOT VERIFIED.

SOURCE: Pacific Gas and Electric Company, Pacific Bell, East Bay Municipal Utility District, City Of Oakland, Alameda County Assessor's Office.

URS

Project No. 38486396

ARCO Service Station #11117
7210 Bancroft Avenue
Oakland, California

PROPOSED BORING / SAMPLING LOCATIONS

FIGURE 3

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ATTACHMENT A

ACHCS September 30, 2003 Letter

ALAMEDA COUNTY
HEALTH CARE SERVICES
AGENCY
DAVID J. KEARS, Agency Director

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ENVIRONMENTAL PROTECTION
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September 30, 2003

Paul Supple
Atlantic Richfield Co.
(a BP affiliated co.)
PO Box 6549
Moraga, CA 94570

Dear Mr. Supple:

Subject: Fuel Leak Case No. RO0000356, BP Station #11117, 7210 Bancroft Ave., Oakland, CA

Alameda County Environmental Health (ACEH) staff has reviewed the Leaking Underground Storage Tank Oversight Program file including "2nd Quarter 2003 Groundwater Monitoring Report" dated June 20, 2003 by URS Corporation (URS). We request that you address the following technical comments and send us the technical reports requested below.

TECHNICAL COMMENTS

1. Site Characterization - Up to 560,000 micrograms/liter (ug/l) Total Petroleum Hydrocarbons-Gasoline (TPH-G), 32,000 ug/l benzene, and 95,000 ug/l methyl tertiary-butyl ether (MTBE), have been detected in onsite and offsite monitoring wells. The lateral and vertical extent of your dissolved contaminant plume is undefined. Please propose sampling locations to define the plumes associated with your site in the Work Plan requested below. Include geologic cross-sections and show soil and groundwater analytical results, utility conduits, well screens, etc., and explain your rationale for the additional sampling locations. You may want to consider performing an investigation to quickly define the location of the contaminant plume downgradient from the release site prior to installing the permanent monitoring network. That will allow you to optimize the location and depth of the permanent wells, thereby reducing the cost of the monitoring work. Collection of groundwater samples using a one-time direct push water-sampling tool would be appropriate for this investigation.

2. Source Characterization – 6,000 mg/kg TPH-G and 34 mg/kg benzene were detected at MW-4. We request that you use the information from the tank removals to propose additional borings to delineate the lateral and vertical extent of soil contamination in the source area. Please propose boring locations in the Work Plan requested below.

3. Preferential Pathway Survey – An underground utility site survey was described and diagrams provided in a report dated October 19, 2000. However, depths were not indicated. In addition to the map(s) submitted, please use cross-sections showing the location and depth of all utility lines and trenches (including sewers, storm drains, pipelines, trench backfill, etc.) within and near the site and plume area(s). Evaluate the probability of the contaminant plumes encountering preferential pathways and conduits that could spread the contamination, particularly in the vertical direction to deeper water aquifers. Please submit with the Work Plan requested below.

4. Historical Hydraulic Gradients – Please show using a rose diagram with magnitude and direction; include cumulative groundwater gradients in all future reports submitted for this site.

5. Groundwater Analyses – We request that you include the other fuel oxygenates Tertiary Amyl Methyl Ether (TAME), Ethyl Tertiary Butyl Ether (ETBE), Di-Isopropyl Ether (DIPE), and Tertiary Butyl Alcohol (TBA), Ethanol by EPA Method 8260 and the lead scavengers, Ethylene Dibromide (EDB), Ethylene Dichloride (EDC) for analyses of grab and monitoring well groundwater samples, and for the lead scavengers, EDB and EDC, also perform analyses on soil samples. If any of the latter compounds are detected, and are determined to be of concern (poses a risk to human health, the environment, or water resources) it is to be incorporated into your regular monitoring plan.

6. 1984 Underground Storage Tank Removals - We do not have any reports of this removal. Please provide documents indicating the former locations of the tanks, their condition, whether the excavation had petroleum odors or discoloration indicative of leakage or contained groundwater, sample locations and results.

7. MW-3 Installation - We do not have any reports of this installation. Please provide a boring log and soil sample analyses.

8. 1998 Underground Storage Tank Removals - We do not have any reports of this removal. Please provide documents indicating the former locations of the tanks, their condition, whether the excavation had petroleum odors or discoloration indicative of leakage or contained groundwater, sample locations and analyses, and Oakland Fire Department inspection report.

9. Dual Phase Extraction (DPE) Pilot Test - The report concluded that DPE is feasible for remediation. However, there is no proposal to use DPE. If you plan to use DPE, please indicate in the Work Plan how it will be implemented.

TECHINCAL REPORT REQUEST

Please submit technical reports to the Alameda County Environmental Health (Attention: Don Hwang), according to the following schedule:

October 31, 2003 - Third Quarter 2003 Groundwater Monitoring Report
November 30, 2003 – Workplan
November 30, 2003 - 1984 & 1998 Underground Storage Tank Removal Documentation
November 30, 2003 - MW-3 Installation boring log and soil sample analyses
60 days after Work Plan approval - Soil and Water Investigation Report
January 31, 2004 - Fourth Quarter 2003 Groundwater Monitoring Report
April 30, 2004 – First Quarter 2004 Groundwater Monitoring Report
July 31, 2004 - Second Quarter 2004 Groundwater Monitoring Report

These reports are being requested pursuant to the Regional Water Quality Control Board's (Regional Board) authority under Section 13267 of the California Water Code. If you have any questions, please call me at (510) 567-6746.

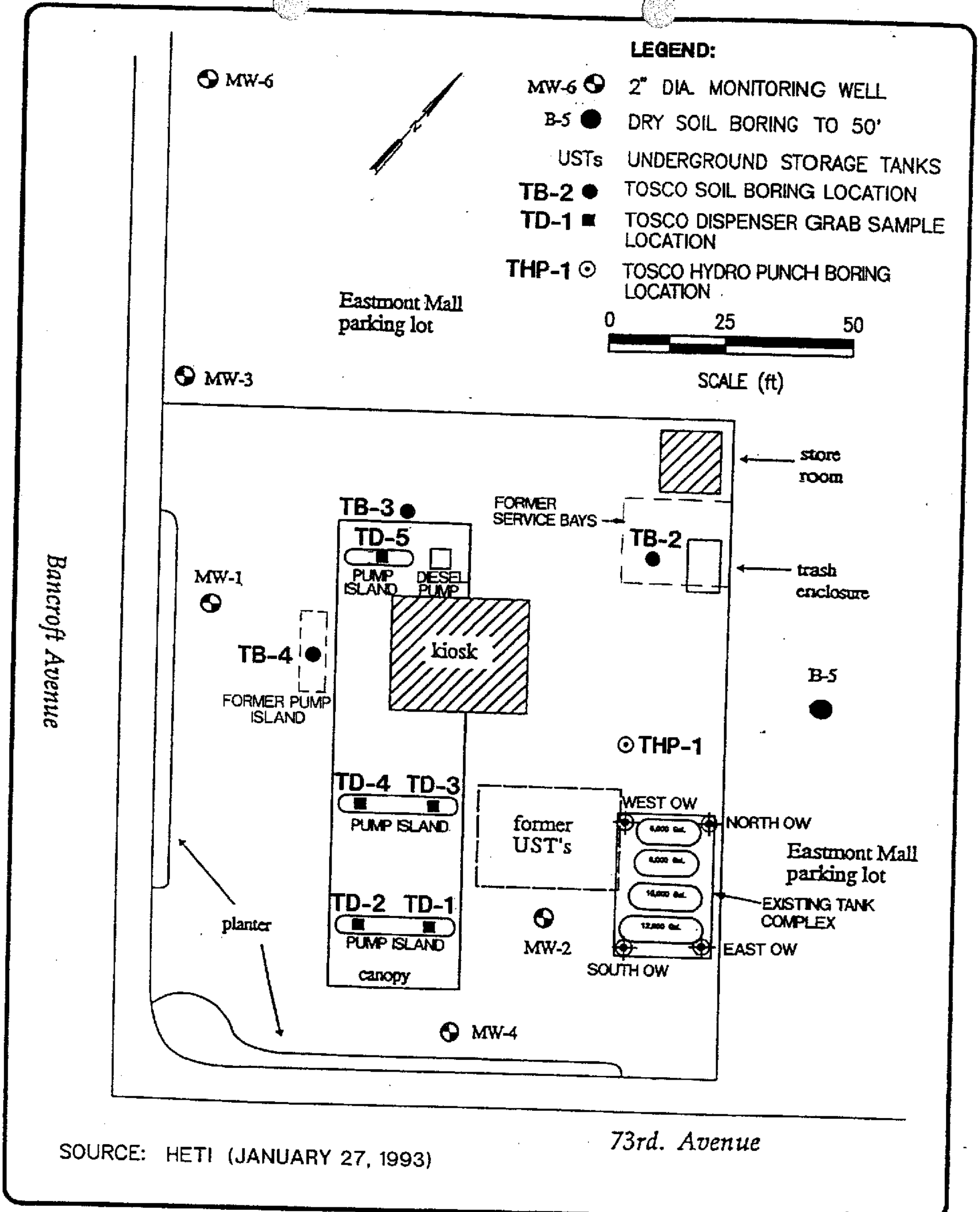
Sincerely,

Don Hwang
Hazardous Materials Specialist
Local Oversight Program

C: √Leonard Niles, URS Corporation, 500-12th St., Suite 200, Oakland, CA 94607-4014
Donna Drogos
File

ATTACHMENT B

Historical Soil and Water Analytical Data and Sample Locations

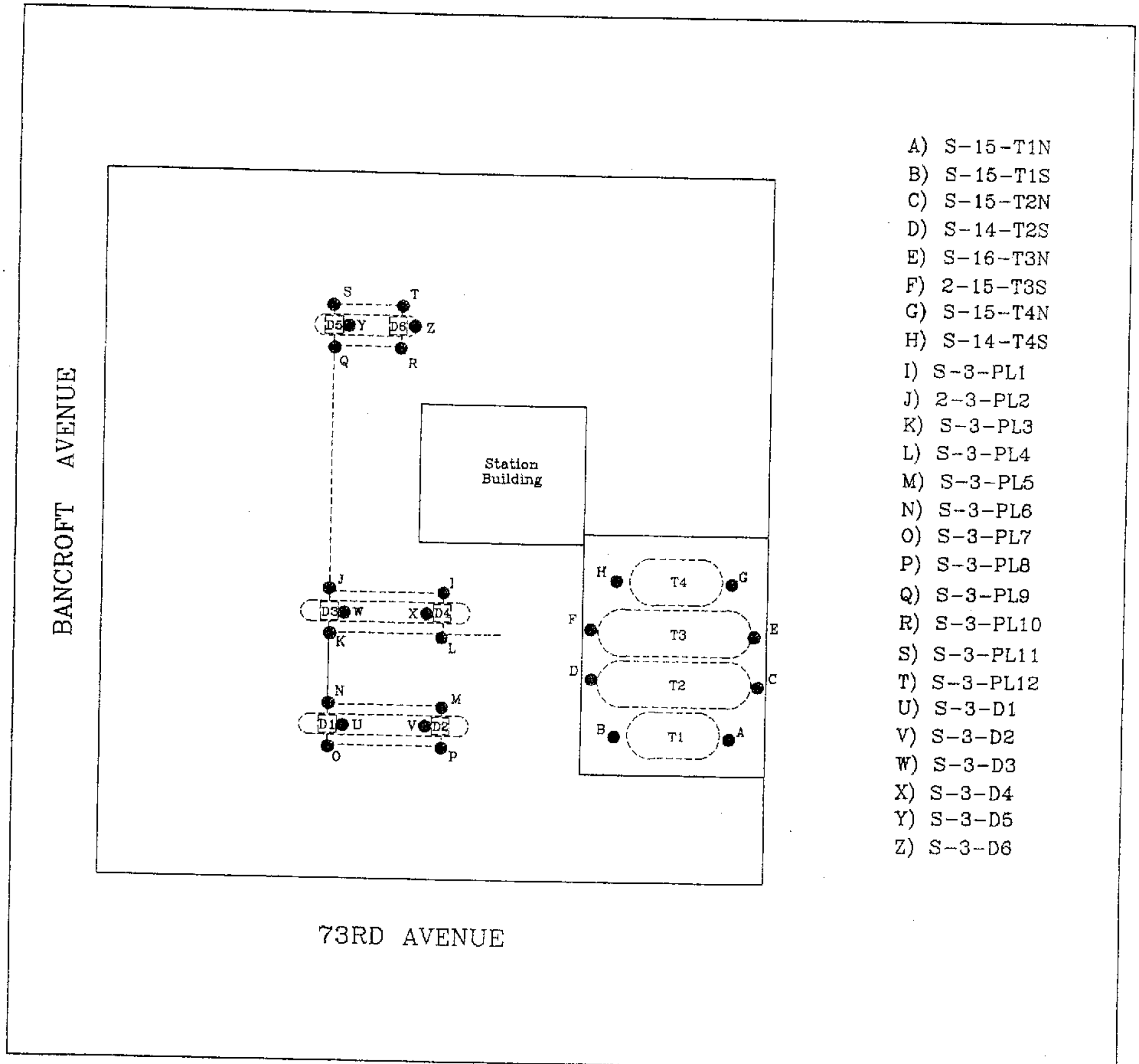


EMCON
Northwest, Inc.

DATE 12-20-94
DWN. MLP
REV.
APPR.
PROJECT NO.
0952-033.03

Figure 1
TOSCO #11117
7210 BANCROFT AVENUE
OAKLAND, CALIFORNIA

SITE PLAN

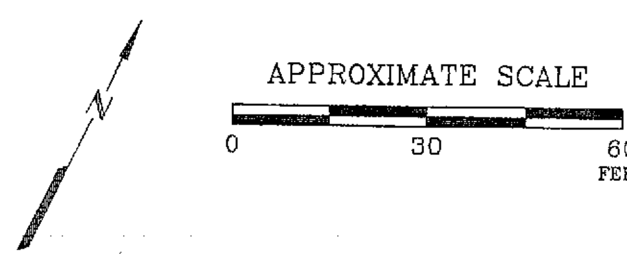


FN 23490002

EXPLANATION

● Soil Sample Location

S-15-T1N —— Tank/Product Line/Dispenser number
Depth
Soil Sample



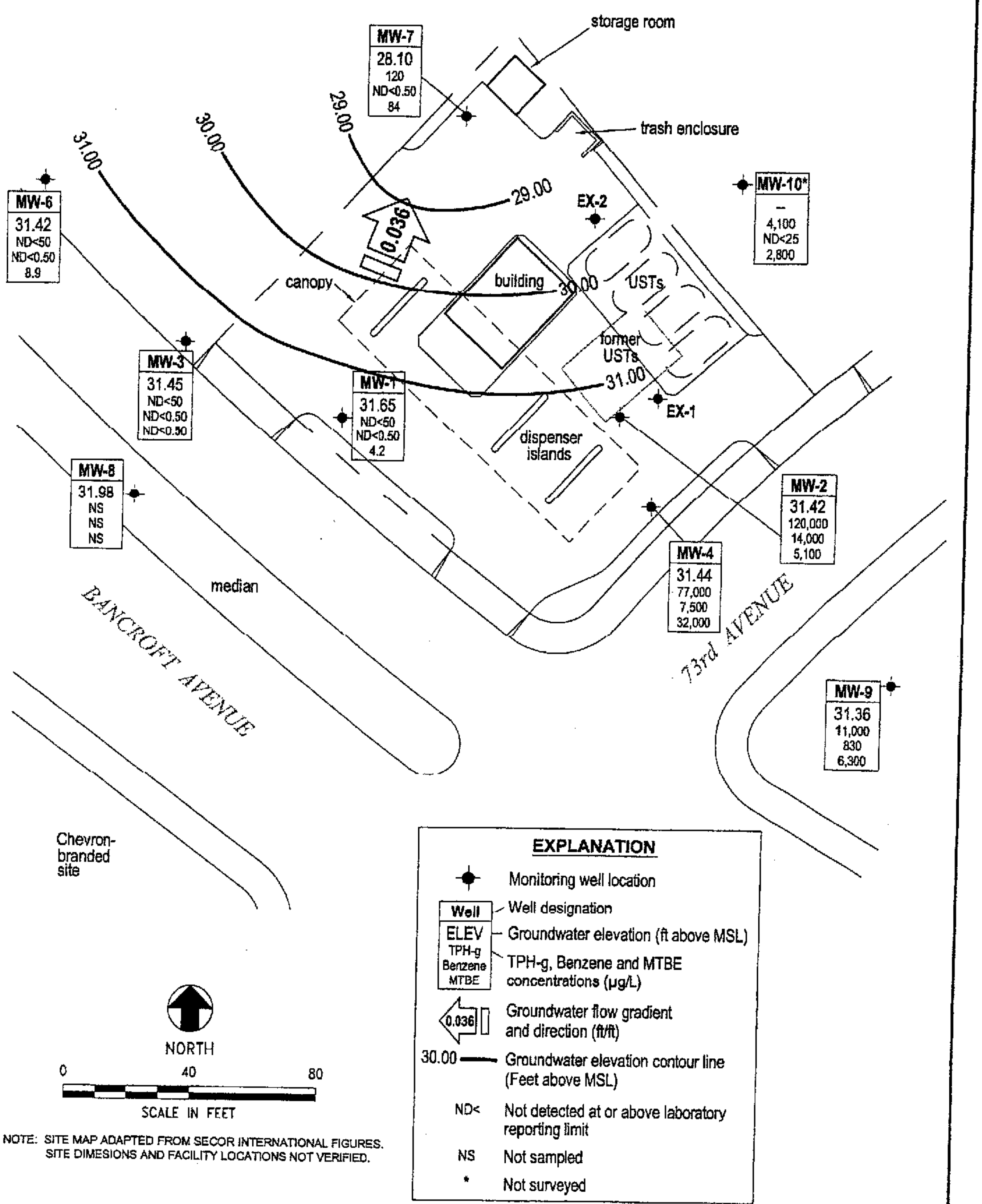
ERI ENVIRONMENTAL RESOLUTIONS, INC.

GENERALIZED SITE PLAN

TOSCO 76 SERVICE STATION 11117
7210 Bancroft Avenue
Oakland, California

PROJECT NO. 2349

PLATE 2



URS

Project No. 38486396

Former BP Service Station #11117
7210 Bancroft Avenue
Oakland, California

GROUNDWATER ELEVATION CONTOUR AND ANALYTICAL SUMMARY MAP
Third Quarter 2003 (August 27, 2003)

FIGURE 3

X:\x_env_waste\BP GEM\Sites\Niles Sites\11117\Reports\Monitoring\Qtr. 3, 2003\Drawings\GWEC_AS_8-27.dwg, 10/03/2003 10:51:57 AM, JKMT, URS

Table 1

SOIL SAMPLES
SUMMARY OF ANALYTICAL RESULTS

BP Oil Facility No. 11117
7210 Bancroft Avenue
Oakland, California

Sample Description	Date	TPHg (ppm)	B (ppm)	T (ppm)	E (ppm)	X (ppm)
MW-1 @ 5'	12/27/91	ND	ND	ND	ND	ND
MW-1 @ 15'	12/27/91	ND	ND	ND	ND	ND
MW-1 @ 25'	12/27/91	ND	ND	ND	ND	ND
MW-2 @ 5'	12/27/91	ND	ND	ND	ND	ND
MW-2 @ 15'	12/27/91	ND	ND	ND	ND	ND
MW-2 @ 25'	12/27/91	ND	ND	ND	ND	ND
MW-4 @ 15'	7/22/92	240	ND	6.6	5.7	27
MW-4 @ 20'	7/22/92	6,000	34	450	190	780
MW-4 @ 25'	7/22/92	1,100	1.6	36	27	140
B-5 @ 30'	7/22/92	ND	ND	ND	ND	ND
MW-6 @ 30'	7/23/92	ND	ND	ND	ND	ND

TPHg = Total petroleum hydrocarbons as gasoline

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes

ND = Not detected above the laboratory method detection limit

TPHg and BTEX analyses EPA 8015/8020 (DHS modified)

Table 2

Site Number 11117
7210 Bancroft Avenue, Oakland, California

Soil Sample Results of Analyses (ppm)

Sample Number	Depth (feet)	Date Collected	California DHS LUFT Method TPH-G	California DHS LUFT Method Hydrocarbon Scan		BTEX EPA Method 5030/8020			
			TPH-G	TPH-D	TPH-O	Benzene	Toluene	Ethylbenzene	Total Xylenes
TD-1 **	n/a	09/08/94	4.4	2,100	85	nd*	0.077	0.042	0.26
TD-2	n/a	09/08/94	nd	160	50	nd	nd	nd	nd
TD-3	n/a	09/08/94	16	5,800	880	nd*	0.088	0.053	0.51
TD-4	n/a	09/08/94	nd	110	36	nd	nd	nd	nd
TD-5	n/a	09/08/94	nd	2,400	340	nd	nd	nd	0.008
THP-1-22' ***	22	09/08/94	nd	nd	nd	nd	nd	nd	nd
TB2-S-13.5-14'	13.5-14	09/14/94	nd	nd	nd	nd	nd	nd	nd
TB3-S-11'	11	09/14/94	nd	nd	nd	nd	nd	nd	nd
TB4-S-6.5-7'	6.5-7	09/14/94	nd	nd	nd	nd	nd	nd	nd

Groundwater Sample Results of Analyses (ppb)

Sample Number	Depth to Water (feet)	Date Sampled	California DHS LUFT Method TPH-G	California DHS LUFT Method Hydrocarbon Scan		BTEX EPA Method 5030/8020			
			TPH-G	TPH-D	TPH-O	Benzene	Toluene	Ethylbenzene	Total Xylenes
TB2-W-36'	36	09/14/94	nd	nd*	nd*	nd	nd	nd	nd
TB3-W-36'	36	09/14/94	nd	nd*	nd*	0.7	0.6	nd	nd

NOTE:
- TPH-G = Total petroleum hydrocarbons as gasoline.
- TPH-D = Total petroleum hydrocarbons as diesel.
- TPH-O = Total petroleum hydrocarbons as oil.
- *nd* = Not detected at or above method reporting limit.
- *n/a* = Not applicable.
- — = Not analyzed.
- TW = Tosco well.
- TB = Tosco boring.
- TD = Tosco dispenser soil sample.
- THP = Tosco HydroPunch.
- SGP = Soil gas probe.
- * = Raised method reporting limits (see laboratory report in Attachment D).
- ** = TD-1 through TD-5 are referred to as PD-1 through PD-5 on lab reports.
- *** = HP-1 is referred to as PHP-1 on lab report.

TABLE 3
SOIL SAMPLE ANALYTICAL RESULTS
BP STATION No. 11117
7210 BANCROFT AVENUE, OAKLAND, CALIFORNIA

Sample No.	Date	TPHg (ppm)	B (ppm)	T (ppm)	E (ppm)	X (ppm)
MW-7-25' (1)	10/6/94	ND<1.0	ND<0.005	ND<0.005	ND<0.005	ND<0.005
MW-8-25'	10/6/94	ND<1.0	ND<0.005	ND<0.005	ND<0.005	ND<0.005
MW-9-25'	10/6/94	ND<1.0	ND<0.005	ND<0.005	ND<0.005	ND<0.005

Notes:

Sample No. :	Soil boring designation and sample collection depth.
Date :	Sample collection date.
TPHg :	Total petroleum hydrocarbons as gasoline by EPA Method 8015 (modified).
BTEX :	Benzene, toluene, ethylbenzene and total xylenes by EPA Method 8020 (modified).
ppm :	Parts per million (mg/kg).
ND :	Not detected in concentrations exceeding the indicated laboratory method detection limit (MDL).
(1):	Rock and gravel encountered at 25 ft bgs. Sample collected at 26.5 bgs.

Table 4
Summary of Soil Analytical Data

Sample ID - Depth	TPPH-g	Benzene	Toluene	Ethylbenzene	Xylenes	MtBE
MW-10 - 6'	<0.1 mg/kg	<1 µg/kg	<2 µg/kg	<2 µg/kg	<2 µg/kg	<100 µg/kg
MW-10 - 11'	<0.1 mg/kg	<1 µg/kg	<2 µg/kg	<2 µg/kg	<2 µg/kg	<100 µg/kg
MW-10 - 30'	<0.1 mg/kg	<1 µg/kg	<2 µg/kg	<2 µg/kg	<2 µg/kg	<100 µg/kg
MW-10 - 35'	<0.1 mg/kg	<1 µg/kg	<2 µg/kg	<2 µg/kg	<2 µg/kg	<100 µg/kg

Notes:
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram

TABLE 5
RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES
Tosco 76 Service Station 11117
7210 Bancroft Avenue
Oakland, California
(Page 1 of 2)

Sample #	Plate 2 Callout	Date Sampled	Depth (ft bgs)	TEPHd	TPPHg	MTBE	B	T	E	X	Total Lead
				<............	....	....	....	ppm	....	....	............>
Underground Storage Tanks											
S-15-T1N	A	8/14/98	15	630	480	1.6	0.40	0.46	2.3	1.2	NA
S-15-T1S	B	8/14/98	15	800	5,300	ND	ND	100	63	530	NA
S-15-T2N	C	8/14/98	15	NA	440	1.3	0.79	6.2	4.6	35	ND
S-14-T2S	D	8/14/98	14	NA	3.7	0.055	ND	0.019	0.060	0.52	NA
S-16-T3N	E	8/14/98	16	NA	810	5.3	0.95	4.2	16	99	NA
S-15-T3S	F	8/14/98	15	NA	ND	0.065	ND	ND	ND	0.013	NA
S-15-T4N	G	8/14/98	15	NA	ND	0.26	ND	ND	ND	ND	NA
S-14-T4S	H	8/14/98	14	NA	ND	0.028	ND	0.0090	ND	0.016	NA
Product Lines and Dispensers											
S-3-PL1	I	8/14/98	3	NA	240	15	ND	6.0	3.5	25	12
S-3-PL2	J	8/14/98	3	14	3.3	0.10	ND	0.026	0.018	0.18	NA
S-3-PL3	K	8/14/98	3	4.8	ND	0.86	ND	ND	ND	ND	NA
S-3-PL4	L	8/14/98	3	21	6.8	12	0.063	0.0081	0.17	0.46	NA
S-3-PL5	M	8/14/98	3	NA	ND	ND	ND	ND	ND	ND	NA
S-3-PL6	N	8/14/98	3	NA	4.8	ND	ND	0.11	0.0054	0.038	NA
S-3-PL7	O	8/14/98	3	NA	1.8	0.075	ND	0.084	0.019	0.097	NA
S-3-PL8	P	8/14/98	3	NA	ND	ND	ND	ND	ND	ND	NA
S-3-PL9	Q	8/14/98	3	18	ND	ND	ND	ND	ND	ND	NA
S-3-PL10	R	8/14/98	3	NA	ND	ND	ND	ND	ND	ND	NA
S-3-PL11	S	8/14/98	3	190	1.7	ND	ND	ND	0.0068	0.012	NA
S-3-PL12	T	8/14/98	3	ND	1.4	0.048	0.0089	0.025	0.0061	0.035	NA
S-3-D1	U	8/14/98	3	NA	72	10	ND	ND	ND	0.63	NA
S-3-D2	V	8/14/98	3	NA	ND	0.054	ND	ND	ND	ND	NA
S-3-D3	W	8/14/98	3	NA	ND	1.7	ND	0.010	ND	0.010	NA
S-3-D4	X	8/14/98	3	NA	7200	72/ND*	22	170	87	590	40
S-3-D5	Y	8/14/98	3	NA	ND	ND	ND	ND	ND	ND	NA
S-3-D6	Z	8/14/98	3	ND	ND	0.053	ND	ND	ND	ND	NA

TABLE 5
RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES
Tosco 76 Service Station 11117
7210 Bancroft Avenue
Oakland, California
(Page 2 of 2)

Sample #	Plate 2 Callout	Date Sampled	Depth (ft bgs)	TEPHd	TPPHg	MTBE	B	T	E	X	Total Lead
				<.....				ppm			.....>
Soil-Stockpile											
SP-1-(1-4)	NA	8/14/98	NA	9.3	16	NA	0.011	0.016	0.039	0.23	26
SP-2-(1-4)	NA	8/14/98	NA	17	19	NA	0.022	ND	0.034	0.11	30
SP-3-(1-4)	NA	8/14/98	NA	4.6	2.0	NA	ND	ND	ND	0.011	21
SP-4-(1-4)	NA	8/14/98	NA	5.3	2.4	NA	ND	ND	ND	0.014	23

Notes:

S-15-TIN = Soil Sample - depth - UST number/end.
S-3-PL1 = Soil Sample - depth - product line sample number.
S-3-D1 = Soil Sample - depth - dispenser number.
SP-1-(1-4) = Stockpiled soil sample - stockpile number - soil sleeve number.
TEPHd = Total extractable petroleum hydrocarbons as diesel analyzed using EPA method 8015 (modified).
TPPHg = Total purgeable petroleum hydrocarbons as gasoline analyzed using EPA method 8015 (modified).
MTBE = Methyl tertiary butyl ether analyzed using EPA method 8020.
BTEX = Benzene, toluene, ethyl benzene, and total xylenes analyzed using EPA method 8020.
Total Lead = Total threshold limit concentration of lead analyzed using EPA method 6010.
ft bgs = Feet below ground surface.
ppm = Parts per million.
NA = Not analyzed/not applicable.
ND = Not detected at or above laboratory method detection limits.
* = MTBE confirmed using EPA method 8260.

TABLE 6

Well ID	Hydraulic Conductivity		Flow Velocity ft/yr
	cm/sec	ft/sec	
MW-1	1.25×10^{-2}	4.10×10^{-4}	2217.21
MW-2	1.23×10^{-4}	4.04×10^{-6}	21.82
MW-3	1.94×10^{-4}	6.37×10^{-6}	34.41
MW-4	2.92×10^{-4}	9.58×10^{-6}	51.79
MW-6	1.01×10^{-2}	3.31×10^{-4}	1791.50
MW-7	5.53×10^{-5}	1.81×10^{-6}	9.81
MW-10	4.46×10^{-5}	4.46×10^{-6}	7.91
Geometric Mean	4.16×10^{-4}	1.37×10^{-5}	73.85

Note: Flow velocity for each well was calculated using the following equation (Fetter, C.W., 1988):

$$v = (K/n)(dh/dl)$$

where:
v = horizontal groundwater flow velocity
K = hydraulic conductivity
n = effective soil porosity (0.35 based on Fetter, 1988)
dh/dl = horizontal hydraulic gradient (0.06 based on July 21, 1998 sampling event)

CAMBRIA

Table 7 **Soil Analytical Data** - BP Oil Site No. 11117,
7210 Bancroft Avenue, Oakland, California

Sample ID (Depth - ft bgs)	Date Sampled	TPHg (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Xylenes (mg/kg)	MTBE (mg/kg)	Total Lead (mg/kg)	TOC (% w/w)
	EPA Method:	**8015m**	**8260**	**8260**	**8260**	**8260**	**8260**	**6010**	**Walkley-Black**
EX-1-15.5	11/30/99	<1.0	<0.005	<0.005	<0.005	<0.005	**0.011**	-	-
EX-1-21	11/30/99	<1.0	<0.005	<0.005	<0.005	<0.005	<0.005	-	-
EX-1-25.5	11/30/99	-	-	-	-	-	-	-	<0.318
EX-1-36	11/30/99	-	-	-	-	-	-	-	<0.318
EX-2-11	11/30/99	<1.0	<0.005	<0.005	<0.005	<0.005	**0.012**	-	-
EX-2-15.5	11/30/99	-	-	-	-	-	-	-	<0.318
EX-2-20.5	11/30/99	<1.0	<0.005	<0.005	<0.005	<0.005	<0.005	-	-
COMP	11/30/99	**1.0**	**0.016**	**0.096**	**0.042**	**0.236**	**0.17**	**5.85**	-

Abbreviations and Notes:

TPHg = Total petroleum hydrocarbons as gasoline
MTBE = Methyl tert-butyl ether
TOC = Total organic carbon
mg/kg = Milligrams per kilogram

CAMBRIA

Table 8 **Recovery Test Summary -** BP Oil Site No. 11117
7210 Bancroft Avenue, Oakland, California

Well ID	Date	Analytical Method	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/min)	Effective Porosity	Hydraulic Gradient	Flow Velocity (ft/year)
MW-2	4/27/00	Bouwer-Rice	4.23E-04	8.33E-04	0.3	0.05	73
	4/27/00	Horslev	9.40E-05	1.85E-04	0.3	0.05	16
	4/28/00	Bouwer-Rice	1.72E-04	3.39E-04	0.3	0.05	30
	4/28/00	Horslev	2.21E-04	4.36E-04	0.3	0.05	38
EX-1	4/27/00	Bouwer-Rice	1.96E-05	3.85E-05	0.3	0.05	3.4
	4/27/00	Horslev	1.03E-05	2.02E-05	0.3	0.05	1.8
EX-2	4/27/00	Bouwer-Rice	2.61E-04	5.13E-04	0.3	0.05	45
	4/27/00	Horslev	1.54E-04	3.04E-04	0.3	0.05	27
	4/28/00	Bouwer-Rice	1.08E-03	2.13E-03	0.3	0.05	187
	4/28/00	Horslev	5.38E-04	1.06E-03	0.3	0.05	93
	GEOMETRIC MEAN		**1.5E-04**	**3.0E-04**			**26**

Abbreviations and Notes:

cm/sec = centimeters per second
ft/min = feet per minute
ft/year = feet per year

Table 1
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)		Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)		Organic Lead (ug/L)	DO (ppm)	pH
MW-1		1/5/1992	49.80		33.16	---	16.64		57000	50000		2400	1000	1100	3100	---		ND	---	---
MW-1		1/10/1992	49.80		33.16	---	16.64		---	---		---	---	---	---	---		---	---	---
MW-1		6/5/1992	49.80		29.01	---	20.79		31000	---		2800	2100	800	2300	---		---	---	---
MW-1		7/24/1992	49.80		29.45	---	20.35		---	---		---	---	---	---	---		---	---	---
MW-1		7/27/1992	49.80		29.45	---	20.35		---	---		---	---	---	---	---		---	---	---
MW-1		9/15/1992	49.80		30.53	---	19.27		40000	1200	(c)	3400	3000	1300	3400	---		---	---	---
QC-1	(d)	9/15/1992	---		---	---	---		36000	---		3800	3400	1400	3800	---		---	---	---
MW-1		12/15/1992	49.80		31.26	---	18.54		27000	1100	(c)	1700	580	700	1900	---		---	---	---
QC-1	(d)	12/15/1992	---		---	---	---		22000	---		1500	440	510	1300	---		---	---	---
MW-1		3/15/1993	49.80		24.80	---	25.00		17000	580		1700	1200	590	1800	---	(l)	---	---	---
QC-1	(d)	3/15/1993	---		---	---	---		15000	---		1100	860	440	1400	---	(l)	---	---	---
MW-1		6/7/1993	49.80		25.01	---	24.79		750	100		0.8	0.8	ND<0.5	ND<0.5	---	(l)	---	---	---
QC-1	(d)	6/7/1993	---		---	---	---		720	---		0.7	0.7	ND<0.5	ND<0.5	---	(l)	---	---	---
MW-1		9/23/1993	49.80		28.70	---	21.10		40000	770		4000	500	920	3000	6619	(e)(l)	---	---	---
MW-1		12/27/1993	49.80		28.66	---	21.14		27000	---		2000	400	940	2600	13558	(e)(l)	---	---	---
QC-1	(d)	12/27/1993	---		---	---	---		21000	---		1700	380	830	2400	9219	(e)(l)	---	---	---
MW-1		4/5/1994	49.80		26.37	---	23.43		27000	---		3400	930	950	2900	8595	(e)(l)	---	---	---
QC-1	(d)	4/5/1994	---		---	---	---		29000	---		3700	1000	1000	3100	9672	(e)(l)	---	1.3	---
MW-1		7/22/1994	49.80		26.54	---	23.26		1700	---		220	2.3	2.0	3.4	262	(e)(l)	---	2.0	---
MW-1		10/13/1994	49.80		27.46	---	22.34		1200	---		250	21	ND<0.5	3.2	321	(e)(l)	---	2.6	---
MW-1		1/25/1995	49.80		20.96	---	28.84		1000	---		420	8	13	4	---		---	---	---
MW-1		4/19/1995	49.80		19.59	---	30.21		5200	---		420	51	230	340	---		---	6.0	---
MW-1		7/5/1995	49.80		19.61	---	30.19		320	---		4.2	ND<0.50	ND<0.50	ND<1.0	---		---	4.6	---
MW-1		10/5/1995	49.80		24.40	---	25.40		5800	---		1000	40	31	180	7800		---	2.3	---
MW-1		1/12/1996	49.80		25.44	---	24.36		370	---		ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<5.0		---	3.7	---
MW-1		4/22/1996	49.80		18.02	---	31.78		ND<50	---		ND<0.5	ND<1	ND<1	ND<1	ND<10		---	3.9	---
MW-1		7/2/1996	49.80		19.72	---	30.08		---	---		---	---	---	---	---		---	---	---
MW-1		7/3/1996	49.80		---	---	---		ND<250	---		ND<2.5	ND<5	ND<5	ND<5	ND<50		---	3.6	---
MW-1		11/8/1996	49.80		19.98	---	29.82		ND<50	---		ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.3	---
MW-1		1/3/1997	49.80		19.49	---	30.31		ND<50	---		ND<0.5	14	ND<1.0	ND<1.0	ND<10		---	4.6	---
MW-1		4/28/1997	49.80		20.20	---	29.60		ND<50	---		ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	3.9	---
MW-1		7/1/1997	49.80		22.53	---	27.27		ND<50	---		ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	3.9	---
MW-1		10/2/1997	49.80		24.27	---	25.53		ND<50	---		ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.6	---
MW-1		1/9/1998	49.80		21.07	---	28.73		ND<50	---		ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.2	---
MW-1		5/6/1998	49.80		14.94	---	34.86		60	---		ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	3.8	---
MW-1		7/21/1998	49.80		15.11	---	34.69		70	---		ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	3.8	---
MW-1		12/30/1998	49.80		19.95	---	29.85		---	---		---	---	---	---	---		---	---	---
MW-1		2/2/1999	49.80		19.12	---	30.68		420	---		ND<1.0	ND<1.0	ND<1.0	ND<1.0	390		---	---	---
MW-1		5/10/1999	49.80		15.51	---	34.29		---	---		---	---	---	---	---		---	---	---
MW-1		9/23/1999	49.80		21.65	---	28.15		440	---		49	ND<1.0	ND<1.0	ND<1.0	910		---	---	---

Table 1
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID	DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-1	12/23/1999	49.80		22.32	---	27.48		---	---	---	---	---	---	---	---	---	---
MW-1	3/27/2000	49.80		15.72	---	34.08		2500	---	230	3.0	83	36	4400	---	---	---
MW-1	5/22/2000	49.80		16.92	---	32.88		---	---	---	---	---	---	---	---	---	---
MW-1	8/31/2000	49.80		20.12	---	29.68		1700	---	18	5.5	7.9	5.0	510	---	---	---
MW-1	12/11/2000	49.80		20.72	---	29.08		---	---	---	---	---	---	---	---	---	---
MW-1	3/20/2001	49.80		15.91	---	33.89		880	---	38.2	ND<0.5	24.1	ND<1.5	391	---	---	---
MW-1	6/19/2001	49.80		18.38	---	31.42		---	---	---	---	---	---	---	---	---	---
MW-1	9/20/2001	49.80		21.23	---	28.57		3200	---	400	19.8	42	32.5	2510	---	---	---
MW-1	12/27/2001	49.80		16.72	---	33.08		750	---	70.1	0.536	4.74	3.76	649	---	---	---
MW-1	2/28/2002	49.80		15.25	---	34.55		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	8.7	---	---	---
MW-1	6/28/2002	49.80		16.57	---	33.23		110	---	0.977	ND<0.5	0.818	ND<1.0	8.35	---	---	---
MW-1	9/12/2002*	49.80		18.41	---	31.39		98	---	2.7	1.5	1.5	5.4	48	---	---	6.9
MW-1	12/12/2002	49.80		20.26	---	29.54		210	---	1.9	ND<0.50	ND<0.50	ND<0.50	32	---	---	6.8
MW-1	3/10/2003	49.80		16.22	---	33.58		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<0.50	3.2	---	---	6.9
MW-1	5/12/2003	49.80		14.30	---	35.50		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<2.5	---	---	7.1
MW-1 (n)	**8/27/2003**	**49.80**		**18.15**	**---**	**31.65**		**ND<50**	**---**	**ND<0.50**	**ND<0.50**	**ND<0.50**	**ND<0.50**	**4.2**	**---**	**---**	**7.1**

Table 1
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)		Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)		Organic Lead (ug/L)	DO (ppm)	pH
MW-2		1/5/1992	51.07		DRY	---	DRY		---	---		---	---	---	---	---		---	---	---
MW-2		1/10/1992	51.07		DRY	---	DRY		---	---		---	---	---	---	---		---	---	---
MW-2		6/5/1992	51.07		30.05	---	21.02		11000	---		2000	180	490	1900	---		---	---	---
MW-2		7/24/1992	51.07		30.72	---	20.35		---	---		---	---	---	---	---		---	---	---
MW-2		7/27/1992	51.07		30.52	---	20.55		---	---		---	---	---	---	---		---	---	---
MW-2		9/15/1992	51.07		31.56	---	19.51		75000	3200	(c)	2000	6500	2300	13000	---		---	---	---
MW-2		12/15/1992	51.07		32.40	---	18.67		34000	1600	(c)	6200	8900	2000	7900	---		---	---	---
MW-2		3/15/1993	51.07		26.14	---	24.93		150000	8400		12000	18000	3200	22000	82000	(e)	---	---	---
MW-2	(f)	6/7/1993	51.07		26.38	SHEEN	24.69		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	9/23/1993	51.07		31.43	1.92	21.08		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	12/27/1993	51.07		34.07	1.07	17.80		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	4/5/1994	51.07		30.44	3.30	23.11		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	7/22/1994	51.07		28.51	0.80	23.16		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	10/13/1994	51.07		29.33	0.70	22.27		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	1/25/1995	51.07		25.55	4.25	28.71		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	4/19/1995	51.07		19.78	0.12	31.38		---	---		---	---	---	---	---		---	---	---
MW-2		7/5/1995	51.07		20.88	0.09	30.26		140000	---		14000	30000	3500	26000	---		---	---	---
MW-2	(f)	10/5/1995	51.07		24.68	0.10	26.47		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	1/12/1996	51.07		25.72	0.06	25.40		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	4/22/1996	51.07		19.33	0.08	31.80		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	7/2/1996	51.07		20.01	0.04	31.09		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	11/8/1996	51.07		20.28	0.01	30.80		---	---		---	---	---	---	---		---	---	---
MW-2	(f)	1/3/1997	51.07		19.87	0.02	31.22		---	---		---	---	---	---	---		---	---	---
MW-2		4/28/1997	51.07		20.59	0.01	30.49		560000	---		1200	1300	290	2310	6100		---	3.9	---
MW-2		7/1/1997	51.07		22.90	0.01	28.18		24000	---		15000	16000	4900	24400	63000		---	3.7	---
QC-1	(d)	7/1/1997	---		---	---	---		150000	---		14000	13000	1800	14200	57000		---	---	---
MW-2		10/2/1997	51.07		24.65	0.02	26.44		---	---		---	---	---	---	---		---	---	---
MW-2		10/3/1997	51.07		---	---	---		250000	---		32000	39000	6000	42000	160000		---	4.5	---
MW-2		1/9/1998	51.07		21.22	0.01	29.86		420000	---		23000	29000	5800	43000	75000		---	4.0	---
QC-1	(d)	1/9/1998	---		---	---	---		300000	---		20000	25000	5200	37000	84000		---	---	---
MW-2		5/6/1998	51.07		15.10	0.01	35.98		180000	---		25000	26000	3400	22900	35000		---	3.7	---
MW-2		7/21/1998	51.07		15.31	0.01	35.77		270000	---		21000	20000	2700	18800	34000		---	3.8	---
MW-2		12/30/1998	51.07		21.10	0.10	30.05		300000	---		22000	24000	4200	26000	89000/9500(	(j)	---	---	---
MW-2		2/2/1998	51.07		20.11	---	30.96		410000	---		27000	43000	6700	50000	20000		---	---	---
MW-2		5/10/1999	51.07		16.68	---	34.39		220000	---		20000	20000	2800	20000	100000		---	---	---
MW-2		9/23/1999	51.07		22.50	---	28.57		160000	---		21000	24000	2900	20000	44000		---	---	---
MW-2	(k)	12/23/1999	51.07		22.64	---	28.43		170000	---		25000	41000	3100	24000	40000		---	---	---
MW-2		3/27/2000	51.07		16.88	---	34.19		140000	---		15000	25000	3400	21000	19000		---	---	---
MW-2		5/22/2000	51.07		17.75	---	33.32		150000	---		18000	31000	3500	22000	26000		---	---	---
MW-2		8/31/2000	51.07		21.97	---	29.10		200000	---		16000	26000	2500	16000	38000		---	---	---

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID	DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-2	12/11/2000	51.07		22.05	---	29.02		130000	---	18600	30000	3250	20600	21700	---	---	---
MW-2	3/20/2001	51.07		17.75	---	33.32		140000	---	15900	24800	3700	22100	12900	---	---	---
MW-2	6/19/2001	51.07		20.15	---	30.92		130000	---	15100	19500	3300	21400	20300	---	---	---
MW-2	9/20/2001	51.07		22.14	---	28.93		110000	---	12400	12600	2230	13000	39500	---	---	---
MW-2	12/27/2001	51.07		18.17	---	32.90		150000	---	17500	26000	3050	19500	27500	---	---	---
MW-2	2/28/2002	51.07		17.42	---	33.65		120000	---	13900	18800	3030	19600	17300	---	---	---
MW-2	6/28/2002***	51.07		17.04	---	34.03		3700	---	190	23.3	139	287	826	---	---	---
MW-2	9/12/2002*	51.07		19.52	---	31.55		100,000	---	13,000	22,000	3,600	20,000	18,000	---	---	6.6
MW-2	12/12/2002	51.07		21.08	---	29.99		120,000	---	13,000	21,000	4,400	25,000	16,000	---	---	6.6
MW-2	3/10/2003	51.07		17.84	---	33.23		100,000	---	17,000	21,000	3,400	20,000	4,400	---	---	6.8
MW-2	5/12/2003	51.07		16.66	---	34.41		150,000	---	16,000	24,000	3,500	22,000	3,600	---	---	7.1
MW-2 (n)	**8/27/2003**	**51.07**		**19.65**	**---**	**31.42**		**120,000**	**---**	**14,000**	**12,000**	**3,900**	**20,000**	**5,100**	**---**	**---**	**6.9**

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID	DATE OF SAMPLING/ MONITORING	TOC (Feet) (a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet) (b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)		Organic Lead (ug/L)	DO (ppm)	pH
MW-3	1/5/1992	49.95	33.69	---	16.26	7400	4000	790	23	210	40	---		ND	---	---
MW-3	1/10/1992	49.95	33.74	---	16.21	---	---	---	---	---	---	---		---	---	---
MW-3	6/5/1992	49.95	29.65	---	20.30	2000	---	130	5.3	93	20	---		---	---	---
MW-3	7/24/1992	49.95	30.14	---	19.81	---	---	---	---	---	---	---		---	---	---
MW-3	7/27/1992	49.95	30.14	---	19.81	---	---	---	---	---	---	---		---	---	---
MW-3	9/15/1992	49.95	31.07	---	18.88	450	ND<50	55	3.1	34	7.1	---		---	---	---
MW-3	12/15/1992	49.95	31.93	---	18.02	12000	710 (c)	940	ND<50	310	120	---		---	---	---
MW-3	3/15/1993	49.95	25.71	---	24.24	ND<50	60	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	(l)	---	---	---
MW-3	6/7/1993	49.95	25.80	---	24.15	150	ND<50	3.6	ND<0.5	0.9	1.3	---	(l)	---	---	---
MW-3	9/23/1993	49.95	29.18	---	20.77	---	---	---	---	---	---	---		---	---	---
MW-3	9/24/1993	49.95	---	---	---	160	ND<50	8.4	ND<0.5	3.7	1.3	15.3	(l)	---	---	---
MW-3	12/27/1993	49.95	29.25	---	20.70	9400	---	1100	48	530	120	2871	(e)(l)	---	---	---
MW-3	4/5/1994	49.95	26.84	---	23.11	7000	---	860	19	330	52	10414	(l)	---	2.0	---
MW-3	7/22/1994	49.95	26.90	---	23.11	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	(l)	---	2.1	---
MW-3	10/13/1994	49.95	27.83	---	22.12	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	(l)	---	2.6	---
MW-3	1/25/1995	49.95	21.65	---	28.30	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1	---		---	---	---
MW-3	4/19/1995	49.95	19.33	---	30.62	2400	---	170	8.0	130	27	---		---	5.0	---
MW-3	7/5/1995	49.95	20.27	---	29.68	ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	---		---	4.4	---
MW-3	10/5/1995	49.95	23.73	---	26.22	2300	---	210	3.1	10	5.1	2400		---	4.2	---
MW-3	1/12/1996	49.95	24.84	---	25.11	ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<5.0		---	4.1	---
MW-3	4/22/1996	49.95	18.60	---	31.35	ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10		---	4.4	---
MW-3	7/2/1996	49.95	18.88	---	31.07	ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10		---	4.2	---
MW-3	11/8/1996	49.95	19.14	---	30.81	ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.4	---
MW-3	1/3/1997	49.95	18.72	---	31.23	ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.6	---
MW-3	4/28/1997	49.95	19.38	---	30.57	ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.2	---
MW-3	7/1/1997	49.95	21.65	---	28.30	ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	3.8	---
MW-3	10/2/1997	49.95	23.45	---	26.50	ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.5	---
MW-3	1/9/1998	49.95	20.10	---	29.85	ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.1	---
MW-3	5/6/1998	49.95	15.57	---	34.38	ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	3.8	---
MW-3	7/21/1998	49.95	15.88	---	34.07	51	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	3.8	---
QC-1 (d)	7/21/1998	---	---	---	---	60	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	---	---
MW-3	12/30/1998	49.95	20.30	---	29.65	---	---	---	---	---	---	---		---	---	---
MW-3	2/2/1999	49.95	19.75	---	30.20	ND<50	---	ND<1.0	ND<1.0	ND<1.0	ND<1.0	ND<10		---	---	---
MW-3	5/10/1999	49.95	16.17	---	33.78	---	---	---	---	---	---	---		---	---	---
MW-3	9/23/1999	49.95	22.05	---	27.90	---	---	---	---	---	---	---		---	---	---
MW-3	12/23/1999	49.95	22.55	---	27.40	---	---	---	---	---	---	---		---	---	---
MW-3	3/27/2000	49.95	16.40	---	33.55	350	---	22	ND<0.5	ND<0.5	ND<0.5	580		---	---	---
MW-3	5/22/2000	49.95	9.49**	---	40.46	---	---	---	---	---	---	---		---	---	---
MW-3	8/31/2000	49.95	13.02**	---	36.93	---	---	---	---	---	---	---		---	---	---
MW-3	12/11/2000	49.95	13.30**	---	36.65	---	---	---	---	---	---	---		---	---	---

Table 1
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID	DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-3	3/20/2001	49.95		16.49	---	33.46		1000	---	66.4	0.597	6.96	ND<1.5	398	---	---	---
MW-3	6/19/2001	49.95		18.82	---	31.13		---	---	---	---	---	---	---	---	---	---
MW-3	9/20/2001	49.95		21.59	---	28.36		230	---	ND<0.5	0.593	ND<0.5	ND<1.5	289	---	---	---
MW-3	12/27/2001	49.95		17.37	---	32.58		---	---	---	---	---	---	---	---	---	---
MW-3	2/28/2002	49.95		15.81	---	34.14		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	0.58	---	---	---
MW-3	6/28/2002	49.95		17.09	---	32.86		---	---	---	---	---	---	---	---	---	---
MW-3	9/12/2002*	49.95		18.80	---	31.15		52	---	3.3	8.6	1.7	12	11	---	---	7.0
MW-3	12/12/2002	49.95		20.57	---	29.38		---	---	---	---	---	---	---	---	---	---
MW-3	3/10/2003	49.95		16.68	---	33.27		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<2.5	---	---	7.0
MW-3	5/12/2003	49.95		14.72	---	35.23		---	---	---	---	---	---	---	---	---	---
MW-3 (n)	**8/27/2003**	**49.95**		**18.50**	**---**	**31.45**		**ND<50**	**---**	**ND<0.50**	**ND<0.50**	**ND<0.50**	**0.50**	**ND<0.50**	**---**	**---**	**7.1**

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)		Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)		Organic Lead (ug/L)	DO (ppm)	pH
MW-4		7/24/1992	50.76		30.02	---	20.74		42000	---		3200	3600	1400	4100	---		---	---	---
MW-4		7/27/1992	50.76		30.02	---	20.74		---	---		---	---	---	---	---		---	---	---
MW-4		9/15/1992	50.76		31.14	---	19.62		55000	1700	(c)	7600	13000	2800	9500	---		---	---	---
MW-4		12/15/1992	50.76		31.98	---	18.78		36000	2200	(c)	3700	4700	1200	4000	---		---	---	---
MW-4		3/15/1993	50.76		25.34	---	25.42		69000	1200		7600	15000	2500	11000	---	(l)	---	---	---
MW-4		6/7/1993	50.76		25.67	---	25.09		73000	2500		10000	19000	3400	14000	---	(l)	---	---	---
MW-4		9/23/1993	50.76		29.37	---	21.39		---	---		---	---	---	---	---		---	---	---
MW-4		9/24/1993	50.76		---	---	---		68000	5700		11000	2100	8600	990	390	(l)	---	---	---
QC-1	(d)	9/24/1993	---		---	---	---		59000	---		5300	10000	2200	8400	309	(l)	---	---	---
MW-4		12/27/1993	50.76		29.40	---	21.36		32000	---		2500	4400	1300	4400	387	(l)	---	---	---
MW-4		4/5/1994	50.76		27.09	---	23.67		64000	---		6500	14000	1900	9600	413	(l)	---	1.4	---
MW-4		7/22/1994	50.76		27.33	---	23.43		85000	---		10000	20000	3200	13000	796	(l)	---	0.8	---
QC-1	(d)	7/22/1994	---		---	---	---		85000	---		11000	21000	3300	14000	435	(l)	---	---	---
MW-4		10/13/1994	50.76		28.25	---	22.51		51000	---		7100	13000	2100	8900	506	(e)(l)	---	2.9	---
QC-1	(d)	10/13/1994	---		---	---	---		51000	---		7400	13000	2100	9100	773	(l)	---	---	---
MW-4		1/25/1995	50.76		21.85	---	28.91		26000	---		3600	9600	1200	6400	---		---	---	---
QC-1	(d)	1/25/1995	---		---	---	---		28000	---		4200	12000	1500	7800	---		---	---	---
MW-4		4/19/1995	50.76		19.44	---	31.32		89000	---		12000	24000	3500	18000	---		---	5.1	---
QC-1	(d)	4/19/1995	---		---	---	---		100000	---		12000	26000	3800	21000	---		---	---	---
MW-4		7/5/1995	50.76		20.52	---	30.24		130000	---		13000	29000	3300	25000	---		---	4.3	---
MW-4		10/5/1995	50.76		24.23	---	26.53		110000	---		10000	23000	3600	17000	34000		---	2.1	---
MW-4		1/12/1996	50.76		25.34	---	25.42		46000	---		3500	8300	1100	8000	3000		---	3.3	---
QC-1	(d)	1/12/1996	---		---	---	---		40000	---		3500	9000	1200	8700	4300		---	---	---
MW-4		4/22/1996	50.76		19.13	---	31.63		40000	---		5100	9600	980	11800	29000		---	3.2	---
QC-1	(d)	4/22/1996	---		---	---	---		61000	---		8300	16000	1600	15200	36000		---	---	---
MW-4		7/2/1996	50.76		20.67	---	30.09		74000	---		9800	21000	2100	16600	41000		---	3.4	---
QC-1	(d)	7/2/1996	---		---	---	---		78000	---		9800	21000	1900	15300	42000		---	---	---
MW-4		11/8/1996	50.76		20.95	---	29.81		100000	---		7900	16000	2500	13700	37000		---	3.7	---
QC-1	(d)	11/8/1996	---		---	---	---		110000	---		9100	20000	3000	15400	39000		---	---	---
MW-4		1/3/1997	50.76		20.54	---	30.22		99000	---		17000	30000	4300	22700	79000		---	4.2	---
QC-1	(d)	1/3/1997	---		---	---	---		66000	---		12000	19000	2900	15000	69000		---	---	---
MW-4		4/28/1997	50.76		21.28	---	29.48		130000	---		12000	28000	3800	21000	37000		---	3.9	---
QC-1	(d)	4/28/1997	---		---	---	---		110000	---		11000	26000	3200	18200	34000		---	---	---
MW-4		7/1/1997	50.76		23.61	---	27.15		110000	---		16000	25000	4900	24400	37000		---	3.6	---
MW-4		10/2/1997	50.76		25.39	---	25.37		---	---		---	---	---	---	---		---	---	---
MW-4		10/3/1997	50.76		---	---	---		66000	---		8200	8600	2700	13400	80000		---	4.4	---
QC-1	(d)	10/3/1997	---		---	---	---		71000	---		8600	8700	2900	13500	84000		---	---	---
MW-4		1/9/1998	50.76		21.25	---	29.51		100000	---		9700	3200	1500	4700	92000		---	3.8	---
MW-4		5/6/1998	50.76		15.96	---	34.80		430000	---		6900	31000	11000	56000	ND<5000		---	3.9	---
QC-1	(d)	5/6/1998	---		---	---	---		440000	---		8000	39000	14000	70000	ND<5000		---	---	---

Table 4
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)		Organic Lead (ug/L)	DO (ppm)	pH
MW-4		7/21/1998	50.76		16.1	---	34.66		250000	---	11000	26000	5500	26900	29000		---	3.7	---
QC-1	(d)	7/21/1998	---		---	---	---		210000	---	11000	27000	5600	26800	29000		---	---	---
MW-4		12/30/1998	50.76		20.91	---	29.85		370000	---	11000	22000	8500	40000	90000/9200(	(j)	---	---	---
MW-4		2/2/1999	50.76		20.13	---	30.63		190000	---	4100	19000	4800	32000	28000		---	---	---
MW-4		5/10/1999	50.76		16.63	---	34.13		2700	---	23	7.1	8.1	25	120		---	---	---
MW-4		9/23/1999	50.76		22.48	---	28.28		180000	---	11000	29000	7000	38000	12000		---	---	---
MW-4	(k)	12/23/1999	50.76		22.94	---	27.82		66000	---	6300	5200	2200	7800	35000		---	---	---
MW-4		3/27/2000	50.76		16.84	---	33.92		120000	---	8700	12000	3800	16000	27000		---	---	---
MW-4		5/22/2000	50.76		17.85	---	32.91		110000	---	7600	16000	4400	20000	25000		---	---	---
MW-4		8/31/2000	50.76		21.71	---	29.05		110000	---	8800	7600	3400	14000	18000		---	---	---
MW-4		12/11/2000	50.76		22.05	---	28.71		70000	---	4580	3480	2550	9220	24400		---	---	---
MW-4		3/20/2001	50.76		17.68	---	33.08		100000	---	7100	4530	2540	9370	63100		---	---	---
MW-4		6/19/2001	50.76		19.40	---	31.36		180000	---	7430	14600	5400	25300	36100		---	---	---
MW-4	(f)	9/20/2001	50.76		22.01	0.03 (m)	28.75		---	---	---	---	---	---	---		---	---	---
MW-4		12/27/2001	50.76		17.96	---	32.80		120000	---	6880	9030	2840	14600	32300		---	---	---
MW-4		2/28/2002	50.76		17.06	---	33.70		80000	---	4920	5450	2220	12300	35900		---	---	---
MW-4		6/28/2002	50.76		17.76	---	33.00		48000	---	2780	2770	1530	6790	25100		---	---	---
MW-4		9/12/2002*	50.76		19.45	---	31.31		46,000	---	4,500	6,800	2,600	10,000	9,100		---	---	6.8
MW-4		12/12/2002	50.76		21.29	---	29.47		36,000	---	5,200	3,400	2,000	6,500	12,000		---	---	6.7
MW-4		3/10/2003	50.76		17.16	---	33.60		70,000	---	7,000	4,800	3,300	13,000	29,000		---	---	6.7
MW-4		5/12/2003	50.76		14.51	---	36.25		75,000	---	7,600	3,700	3,400	13,000	26,000		---	---	6.8
MW-4	**(n)**	**8/27/2003**	**50.76**		**19.32**	**SHEEN**	**31.44**		**77,000**	**---**	**7,500**	**1,300**	**2,100**	**4,000**	**32,000**		**---**	**---**	**6.8**

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)		Organic Lead (ug/L)	DO (ppm)	pH
MW-6		7/24/1992	50.32		30.63	---	19.69		ND	---	1.6	ND	ND	ND	---		---	---	---
MW-6		7/27/1992	50.32		30.63	---	19.69		---	---	---	---	---	---	---		---	---	---
MW-6		9/15/1992	50.32		31.52	---	18.80		ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---		---	---	---
MW-6		12/15/1992	50.32		32.42	---	17.90		58	ND<50	1.3	ND<0.5	ND<0.5	ND<0.5	---		---	---	---
MW-6		3/15/1993	50.32		26.29	---	24.03		ND<50	ND<50	ND<0.5	0.6	ND<0.5	0.7	---	(l)	---	---	---
MW-6		6/7/1993	50.32		26.33	---	23.99		ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	1.5	---	(l)	---	---	---
MW-6		9/23/1993	50.32		29.64	---	20.68		---	---	---	---	---	---	---		---	---	---
MW-6		9/24/1993	50.32		---	---	---		ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	28.5	(l)	---	---	---
MW-6		12/27/1993	50.32		29.75	---	20.57		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	55.4	(e)(l)	---	---	---
MW-6		4/5/1994	50.32		27.26	---	23.06		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	295	(e)(l)	---	1.7	---
MW-6		7/22/1994	50.32		27.34	---	22.98		350	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	419	(e)(l)	---	4.5	---
MW-6	(g)	10/13/1994	50.32		---	---	---		---	---	---	---	---	---	---		---	---	---
MW-6		1/25/1995	50.32		22.16	---	28.16		240	---	6	ND<0.5	ND<0.5	ND<1	---		---	---	---
MW-6	(g)	4/19/1995	50.32		---	---	---		---	---	---	---	---	---	---		---	---	---
MW-6		7/5/1995	50.32		20.80	---	29.52		180	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	---		---	4.9	---
MW-6		10/5/1995	50.32		24.20	---	26.12		860	---	ND<5.0	ND<5.0	ND<5.0	ND<10	3600		---	2.8	---
MW-6		1/12/1996	50.32		25.30	---	25.02		860	---	ND<5.0	ND<5.0	ND<5.0	ND<10	2800		---	4.2	---
MW-6		4/22/1996	50.32		19.13	---	31.19		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	470		---	4.3	---
MW-6		7/2/1996	50.32		20.66	---	29.66		100	---	ND<0.5	ND<1	ND<1	ND<1	1100		---	4.2	---
MW-6		11/8/1996	50.32		20.98	---	29.34		1100	---	ND<5	ND<10	ND<10	ND<10	1500		---	4.3	---
MW-6		1/3/1997	50.32		20.53	---	29.79		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	450		---	4.5	---
MW-6		4/28/1997	50.32		21.25	---	29.07		1400	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	3500		---	4.4	---
MW-6		7/1/1997	50.32		23.40	---	26.92		6100	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	9100		---	3.9	---
MW-6		10/2/1997	50.32		25.16	---	25.16		---	---	---	---	---	---	---		---	---	---
MW-6		10/3/1997	50.32		---	---	---		330	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	2600		---	4.4	---
MW-6		1/9/1998	50.32		21.13	---	29.19		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10		---	4.3	---
MW-6		5/6/1998	50.32		16.11	---	34.21		410	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	500		---	3.6	---
MW-6		7/21/1998	50.32		16.33	---	33.99		4300	---	ND<5	ND<10	ND<10	ND<10	3800		---	4.0	---
MW-6		12/30/1998	50.32		20.89	---	29.43		---	---	---	---	---	---	---		---	---	---
MW-6		2/2/1999	50.32		20.20	---	30.12		---	---	---	---	---	---	---		---	---	---
MW-6		5/10/1999	50.32		16.75	---	33.57		---	---	---	---	---	---	---		---	---	---
MW-6		9/23/1999	50.32		22.55	---	27.77		ND<50	---	ND<1.0	ND<1.0	ND<1.0	ND<1.0	1600		---	---	---
MW-6		12/23/1999	50.32		23.00	---	27.32		---	---	---	---	---	---	---		---	---	---
MW-6		3/27/2000	50.32		16.89	---	33.43		1700	---	4.4	0.54	ND<0.5	1.0	14000		---	---	---
MW-6		5/22/2000	50.32		18.02	---	32.30		---	---	---	---	---	---	---		---	---	---
MW-6		8/31/2000	50.32		21.62	---	28.70		1200	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	3900		---	---	---
MW-6		12/11/2000	50.32		21.81	---	28.51		---	---	---	---	---	---	---		---	---	---
MW-6		3/20/2001	50.32		16.97	---	33.35		3300	---	ND<0.5	ND<0.5	ND<0.5	ND<1.5	3760		---	---	---
MW-6		6/19/2001	50.32		19.30	---	31.02		---	---	---	---	---	---	---		---	---	---
MW-6		9/20/2001	50.32		22.00	---	28.32		2200	---	2.04	8.1	3.62	13.7	2460		---	---	---

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-6		12/27/2001	50.32		17.85	---	32.47		830	---	0.59	ND<0.5	ND<0.5	ND<1.0	1040	---	---	---
MW-6		2/28/2002	50.32		16.31	---	34.01		1100	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	1450	---	---	---
MW-6		6/28/2002	50.32		17.57	---	32.75		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	1020	---	---	---
MW-6		9/12/2002*	50.32		19.27	---	31.05		190	---	1.9	4.6	1	7.3	480	---	---	7.1
MW-6		12/12/2002	50.32		20.94	---	29.38		270	---	ND<2.5	ND<2.5	ND<2.5	ND<2.5	500	---	---	6.9
MW-6		3/10/2003	50.32		17.11	---	33.21		110	---	ND<0.50	ND<0.50	ND<0.50	ND<0.50	190	---	---	7.0
MW-6		5/12/2003	50.32		15.18	---	35.14		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<0.50	36	---	---	7.0
MW-6	**(n)**	**8/27/2003**	**50.32**		**18.90**	**---**	**31.42**		**ND<50**	**---**	**ND<0.50**	**ND<0.50**	**ND<0.50**	**ND<0.50**	**8.9**	**---**	**---**	**7.0**

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID	DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-7	1/25/1995	51.40		21.67	---	29.73		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1	---	---	7.0	---
MW-7	4/19/1995	51.40		25.27	---	26.13		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1	---	---	5.0	---
MW-7	7/5/1995	51.40		24.63	---	26.77		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	---	---	4.2	---
MW-7	10/5/1995	51.40		28.21	---	23.19		83	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	77	---	4.5	---
MW-7	1/12/1996	51.40		29.29	---	22.11		63	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	120	---	4.8	---
MW-7	4/22/1996	51.40		23.11	---	28.29		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	13	---	4.8	---
MW-7	7/2/1996	51.40		23.56	---	27.84		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10	---	4.8	---
MW-7	11/8/1996	51.40		20.06	---	31.34		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	5.1	---
MW-7	1/3/1997	51.40		23.42	---	27.98		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.7	---
MW-7	4/28/1997	51.40		24.12	---	27.28		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.9	---
MW-7	7/1/1997	51.40		26.40	---	25.00		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.2	---
MW-7	10/2/1997	51.40		28.14	---	23.26		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.7	---
MW-7	1/9/1998	51.40		24.02	---	27.38		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.1	---
MW-7	5/6/1998	51.40		21.00	---	30.40		1900	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	1800	---	3.5	---
MW-7	7/21/1998	51.40		21.17	---	30.23		50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.7	---
MW-7	12/30/1998	51.40		22.13	---	29.27		---	---	---	---	---	---	---	---	---	---
MW-7	2/2/1999	51.40		22.08	---	29.32		---	---	---	---	---	---	---	---	---	---
MW-7	5/10/1999	51.40		18.58	---	32.82		---	---	---	---	---	---	---	---	---	---
MW-7	9/23/1999	51.40		24.29	---	27.11		70	---	ND<1.0	ND<1.0	ND<1.0	ND<1.0	4700	---	---	---
MW-7	12/23/1999	51.40		24.53	---	26.87		---	---	---	---	---	---	---	---	---	---
MW-7	3/27/2000	51.40		18.58	---	32.82		910	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	2600	---	---	---
MW-7	5/22/2000	51.40		19.49	---	31.91		---	---	---	---	---	---	---	---	---	---
MW-7	8/31/2000	51.40		22.53	---	28.87		440	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	900	---	---	---
MW-7	12/11/2000	51.40		22.75	---	28.65		---	---	---	---	---	---	---	---	---	---
MW-7	3/20/2001	51.40		18.79	---	32.61		1100	---	ND<0.5	ND<0.5	ND<0.5	ND<1.5	1210	---	---	---
MW-7	6/19/2001	51.40		19.82	---	31.58		---	---	---	---	---	---	---	---	---	---
MW-7	9/20/2001	51.40		21.35	---	30.05		1300	---	1.21	ND<0.5	ND<0.5	ND<1.5	1550	---	---	---
MW-7	12/27/2001	51.40		20.36	---	31.04		510	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	643	---	---	---
MW-7	2/28/2002	51.40		21.86	---	29.54		250	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	317	---	---	---
MW-7	6/28/2002	51.40		22.64	---	28.76		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	102	---	---	---
MW-7	9/12/2002*	51.40		23.51	---	27.89		ND<50	---	ND<0.5	ND<0.5	ND<0.5	1	14	---	---	7.5
MW-7	12/12/2002	51.40		23.75	---	27.65		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<2.5	---	---	7.5
MW-7	3/10/2003	51.40		21.25	---	30.15		61	---	ND<0.50	ND<0.50	ND<0.50	ND<0.50	99	---	---	7.6
MW-7	5/12/2003	51.40		21.44	---	29.96		ND<100	---	ND<1.0	ND<1.0	ND<1.0	ND<1.0	120	---	---	7.6
MW-7 (n)	**8/27/2003**	**51.40**		**23.30**	**---**	**28.10**		**120**	**---**	**ND<0.50**	**ND<0.50**	**ND<0.50**	**ND<0.50**	**84**	**---**	**---**	**7.6**

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID	DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-8	1/25/1995	50.88		31.59	---	19.29		54	---	ND<0.5	ND<0.5	ND<0.5	ND<1	---	---	7.1	---
MW-8	4/19/1995	50.88		19.18	---	31.70		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1	---	---	5.1	---
MW-8	7/5/1995	50.88		19.03	---	31.85		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	---	---	4.5	---
MW-8	10/5/1995	50.88		24.40	---	26.48		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<5.0	---	4.1	---
MW-8	1/12/1996	50.88		25.51	---	25.37		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<5.0	---	4.6	---
MW-8	4/22/1996	50.88		18.00	---	32.88		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10	---	4.8	---
MW-8	7/2/1996	50.88		19.83	---	31.05		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10	---	4.5	---
MW-8	11/8/1996	50.88		20.09	---	30.79		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.7	---
MW-8	1/3/1997	50.88		19.72	---	31.16		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.4	---
MW-8	4/28/1997	50.88		20.44	---	30.44		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.1	---
MW-8	7/1/1997	50.88		22.72	---	28.16		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.8	---
MW-8	10/2/1997	50.88		24.51	---	26.37		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.2	---
MW-8	1/9/1998	50.88		21.17	---	29.71		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.5	---
MW-8	5/6/1998	50.88		18.34	---	32.54		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.6	---
MW-8	7/21/1998	50.88		18.55	---	32.33		90	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.3	---
MW-8	12/30/1998	50.88		20.40	---	30.48		---	---	---	---	---	---	---	---	---	---
MW-8	2/2/1999	50.88		19.28	---	31.60		---	---	---	---	---	---	---	---	---	---
MW-8	5/10/1999	50.88		15.62	---	35.26		---	---	---	---	---	---	---	---	---	---
MW-8	9/23/1999	50.88		21.74	---	29.14		---	---	---	---	---	---	---	---	---	---
MW-8	12/23/1999	50.88		22.83	---	28.05		---	---	---	---	---	---	---	---	---	---
MW-8	3/27/2000	50.88		16.25	---	34.63		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---
MW-8	5/22/2000	50.88		17.06	---	33.82		---	---	---	---	---	---	---	---	---	---
MW-8	8/31/2000	50.88		21.72	---	29.16		---	---	---	---	---	---	---	---	---	---
MW-8	12/11/2000	50.88		22.03	---	28.85		---	---	---	---	---	---	---	---	---	---
MW-8	3/20/2001	50.88		16.23	---	34.65		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1.5	0.991	---	---	---
MW-8	6/19/2001	50.88		19.35	---	31.53		---	---	---	---	---	---	---	---	---	---
MW-8	9/20/2001	50.88		21.95	---	28.93		---	---	---	---	---	---	---	---	---	---
MW-8	12/27/2001	50.88		16.98	---	33.90		---	---	---	---	---	---	---	---	---	---
MW-8	2/28/2002	50.88		15.38	---	35.50		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	ND<0.5	---	---	---
MW-8	6/28/2002	50.88		16.97	---	33.91		---	---	---	---	---	---	---	---	---	---
MW-8	9/12/2002*	50.88		19.47	---	31.41		---	---	---	---	---	---	---	---	---	---
MW-8	12/12/2002	50.88		20.84	---	30.04		---	---	---	---	---	---	---	---	---	---
MW-8	3/10/2003	50.88		16.56	---	34.32		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<0.50	3.0	---	---	7.1
MW-8	5/12/2003	50.88		13.63	---	37.25		---	---	---	---	---	---	---	---	---	---
MW-8 (n)	**8/27/2003**	**50.88**		**18.90**	**---**	**31.98**		**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-9		1/25/1995	51.05		22.32	---	28.73		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1	---	---	7.4	---
MW-9		4/19/1995	51.05		19.86	---	31.19		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1	---	---	5.2	---
MW-9		7/5/1995	51.05		20.78	---	30.27		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	---	---	4.4	---
MW-9		10/5/1995	51.05		24.33	---	26.72		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	---	---	2.3	---
QC-1	(d)	10/5/1995	---		---	---	---		52	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	160	---	---	---
MW-9		1/12/1996	51.05		25.44	---	25.61		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<5.0	---	3.2	---
MW-9		4/22/1996	51.05		18.01	---	33.04		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	11	---	3.5	---
MW-9		7/2/1996	51.05		19.70	---	31.35		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10	---	3.3	---
MW-9		11/8/1996	51.05		19.96	---	31.09		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.7	---
MW-9		1/3/1997	51.05		19.52	---	31.53		ND<250	---	ND<2.5	ND<5.0	ND<5.0	ND<5.0	ND<50	---	4.4	---
MW-9		4/28/1997	51.05		20.22	---	30.83		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.0	---
MW-9		7/1/1997	51.05		22.59	---	28.46		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.9	---
MW-9		10/2/1997	51.05		24.33	---	26.72		---	---	---	---	---	---	---	---	---	---
MW-9		10/3/1997	51.05		---	---	---		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.4	---
MW-9		1/9/1998	51.05		21.11	---	29.94		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.9	---
MW-9		5/6/1998	51.05		18.26	---	32.79		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.0	---
MW-9		7/21/1998	51.05		18.46	---	32.59		70	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	3.7	---
MW-9	(g)	12/30/1998	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	2/2/1999	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	5/10/1999	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	9/23/1999	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	12/23/1999	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	3/27/2000	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	5/22/2000	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	8/31/2000	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	12/11/2000	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	3/20/2001	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9	(g)	6/19/2001	51.05		---	---	---		---	---	---	---	---	---	---	---	---	---
MW-9		9/20/2001	51.05		22.20	---	28.85		6300	---	2.87	ND<0.5	ND<0.5	ND<1.5	8640	---	---	---
MW-9		12/27/2001	51.05		18.92	---	32.13		---	---	---	---	---	---	---	---	---	---
MW-9		2/28/2002	51.05		17.22	---	33.83		19000	---	1560	61.3	84	111	20200	---	---	---
MW-9		6/28/2002	51.05		18.20	---	32.85		---	---	---	---	---	---	---	---	---	---
MW-9		9/12/2002*	51.05		19.92	---	31.13		5100	---	570	180	ND<25	220	6400	---	---	6.8
MW-9		12/12/2002	51.05		21.78	---	29.27		---	---	---	---	---	---	---	---	---	---
MW-9		3/10/2003	51.05		18.25	---	32.80		26,000	---	2,500	ND<100	ND<100	ND<100	33,000	---	---	6.9
MW-9		5/12/2003	51.05		16.29	---	34.76		---	---	---	---	---	---	---	---	---	---
MW-9	**(n)**	**8/27/2003**	**51.05**		**19.69**	**---**	**31.36**		**11,000**	**---**	**830**	**ND<50**	**ND<50**	**ND<50**	**6,300**	**---**	**---**	**7.1**

Table 9

Groundwater Elevation and Analytical Data

Former BP Service Station #11117

7210 Bancroft Avenue, Oakland, CA

WELL ID	DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)	Organic Lead (ug/L)	DO (ppm)	pH
MW-10	1/9/1998	---	(h)	20.97	---	---		ND<50	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.3	---
MW-10	5/6/1998	---	(h)	18.07	---	---		800	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	980	---	3.9	---
MW-10	7/21/1998	---	(h)	18.28	---	---		80	---	ND<0.5	ND<1.0	ND<1.0	ND<1.0	ND<10	---	4.0	---
MW-10	12/30/1998	---	(h)	22.22	---	---		---	---	---	---	---	---	---	---	---	---
MW-10	2/2/1999	---	(h)	21.83	---	---		940	---	ND<10	ND<10	ND<10	ND<10	690	---	---	---
MW-10	5/10/1999	---	(h)	17.99	---	---		---	---	---	---	---	---	---	---	---	---
MW-10	9/23/1999	---	(h)	22.61	---	---		ND<50	---	ND<1.0	ND<1.0	ND<1.0	1.4	1000	---	---	---
MW-10	12/23/1999	---	(h)	23.75	---	---		---	---	---	---	---	---	---	---	---	---
MW-10	3/27/2000	---	(h)	18.83	---	---		1900	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	28000	---	---	---
MW-10	5/22/2000	---	(h)	19.47	---	---		---	---	---	---	---	---	---	---	---	---
MW-10	8/31/2000	---	(h)	22.64	---	---		1700	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	13000	---	---	---
MW-10	12/11/2000	---	(h)	22.84	---	---		---	---	---	---	---	---	---	---	---	---
MW-10	3/20/2001	---	(h)	19.57	---	---		16000	---	ND<0.5	ND<0.5	ND<0.5	ND<1.5	11900	---	---	---
MW-10	6/19/2001	---	(h)	20.63	---	---		---	---	---	---	---	---	---	---	---	---
MW-10	9/20/2001	---	(h)	23.07	---	---		5800	---	ND<0.5	ND<0.5	ND<0.5	ND<1.5	8160	---	---	---
MW-10	12/27/2001	---	(h)	20.92	---	---		6600	---	17.3	14.5	ND<12.5	ND<25	7750	---	---	---
MW-10	2/28/2002	---	(h)	18.52	---	---		3600	---	10.8	ND<0.5	ND<0.5	ND<1.0	5380	---	---	---
MW-10	6/28/2002	---	(h)	18.41	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<1.0	2570	---	---	---
MW-10	9/12/2002*	---	(h)	20.57	---	---		660	---	ND<5.0	ND<5.0	ND<5.0	ND<5.0	3300	---	---	7.2
MW-10	12/12/2002	---	(h)	22.80	---	---		1400	---	ND<5.0	ND<5.0	ND<5.0	ND<5.0	3300	---	---	6.9
MW-10	3/10/2003	---	(h)	19.26	---	---		1,700	---	ND<5.0	ND<5.0	5.3	15	2,800	---	---	6.9
MW-10	5/12/2003	---	(h)	17.90	---	---		1,500	---	ND<12	ND<12	ND<12	ND<12	2,200	---	---	6.9
MW-10 (n)	**8/27/2003**	**---**	**(h)**	**20.82**	**---**	**---**		**4,100**	**---**	**ND<25**	**ND<25**	**ND<25**	**ND<25**	**2,800**	**---**	**---**	**7.0**

Table 1

Groundwater Elevation and Analytical Data

Former BP Service Station #11117

7210 Bancroft Avenue, Oakland, CA

WELL ID		DATE OF SAMPLING/ MONITORING	TOC (Feet)	(a)	DTW (Feet)	PRODUCT THICKNESS (Feet)	GWE (Feet)	(b)	TPH-G (ug/L)	TPH-D (ug/L)	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	Xylenes (ug/L)	MTBE (ug/L)		Organic Lead (ug/L)	DO (ppm)	pH
QC-2	(i)	9/15/1992	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---		---	---	---
QC-2	(i)	12/15/1992	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---		---	---	---
QC-2	(i)	3/15/1993	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	(l)	---	---	---
QC-2	(i)	6/7/1993	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	(l)	---	---	---
QC-2	(i)	9/24/1993	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	(l)	---	---	---
QC-2	(i)	12/27/1993	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	(l)	---	---	---
QC-2	(i)	4/5/1994	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	(l)	---	---	---
QC-2	(i)	7/22/1994	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	(l)	---	---	---
QC-2	(i)	10/13/1994	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	(l)	---	---	---
QC-2	(i)	1/25/1995	---		---	---	---		ND<50	---	ND<0.5	2	0.6	1	---		---	---	---
QC-2	(i)	4/19/1995	---		---	---	---		ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---		---	---	---
QC-2	(i)	7/5/1995	---		---	---	---		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	---		---	---	---
QC-2	(i)	10/5/1995	---		---	---	---		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<5.0		---	---	---
QC-2	(i)	1/12/1996	---		---	---	---		ND<50	---	ND<0.50	ND<0.50	ND<0.50	ND<1.0	ND<5.0		---	---	---
QC-2	(i)	4/22/1996	---		---	---	---		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10		---	---	---
QC-2	(i)	7/2/1996	---		---	---	---		ND<50	---	ND<0.5	ND<1	ND<1	ND<1	ND<10		---	---	---

Table 9
Groundwater Elevation and Analytical Data
Former BP Service Station #11117
7210 Bancroft Avenue, Oakland, CA

ABBREVIATIONS:

TPH-G	Total petroleum hydrocarbons as gasoline
TPH-D	Total petroleum hydrocarbons as diesel
MTBE	Methyl tert butyl ether
DO	Dissolved Oxygen - field measurement
pH	pH Level - field measurement
ug/L	Micrograms per liter
ppm	Parts per million
ND	Not detected above reported detection limit
---	Not analyzed/applicable/measurable
TOC	Top of casing
DTW	Depth to water

NOTES:

(a) Casing elevations surveyed to the nearest 0.01 foot relative to mean sea level.

(b) Groundwater elevations adjusted assuming a specific gravity of 0.75 for free product.

(c) Concentrations reported as diesel from MW-1, MW-2 and MW-4 are primarily due to the presence of a lighter petroleum product, possibly gasoline or kerosene.

(d) Blind duplicate.

(e) A copy of the documentation for this data is included in Appendix C of Alisto report 10-018-05-004.

(f) Well not sampled due to presence of free product.

(g) Well inaccessible.

(h) Top of casing not surveyed.

(i) Travel blank.

(j) EPA method by 8020\8260.

(k) Samples ran outside of EPA recommended hold time.

(l) A copy of the documentation for this data can be found in Blaine Tech Services report 010619-C-2. The MTBE data for the March 15, 1993 and June 7, 1993 events have been destroyed.

(m) Thickness of SPH is only an estimate. The resulting groundwater elevation will not be used in contouring.

(n) Samples analyzed by EPA Method 8260B for TPH-g, BTEX, and fuel oxygenates

* During the third quarter of 2002, URS Corporation assumed groundwater monitoring activities for BP
** Depth to water and resulting groundwater elevation is anamolous and not used in groundwater contouring.
*** Anomalously low concentrations reported from Cambria. Do not appear to support historic trends.

Source: The data within this table collected prior to June 2002 was provided to URS by BP Group Environmental Management Company and their previous consultants. URS has not verified tenaccuracy of this information.

ATTACHMENT C

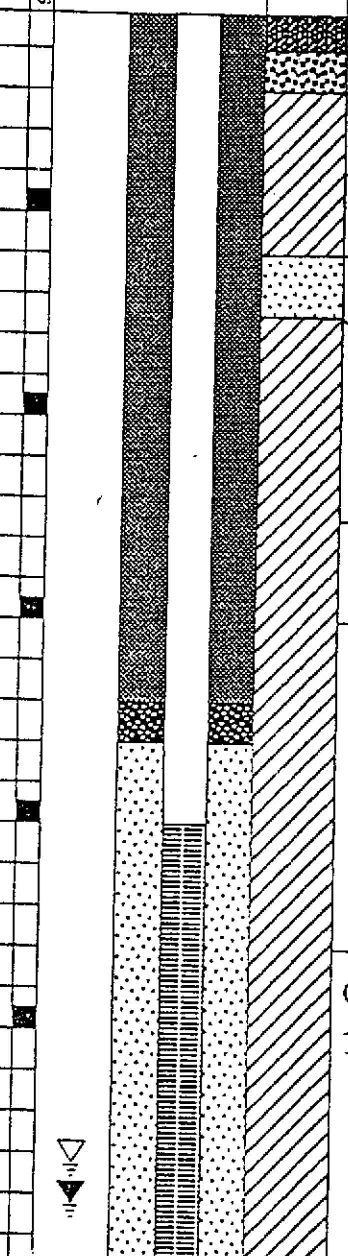
Boring Logs

SITE/LOCATION	BEGUN	BORING DIAMETER	ANGLE/BEARING	BORING NO
7210 Bancroft Avenue, Oakland, CA	12/27/91	8 Inches	90 Degrees	MW-1

DRILLING CONTRACTOR	Bayland Drilling
COMPLETED	12/27/91
FIRST ENCOUNTERED WATER DEPTH	28 Feet
OPERATOR	Tom Schmidt
LOGGED BY	T. Lane
STATIC WATER DEPTH/DATE	29 Feet
DRILL MAKE & MODEL	CME 75
SAMPLING METHOD	California modified split spoon
BOTTOM OF BORING	40 Feet
WELL MATERIAL	2" SCH 40 PVC
SLOT SIZE	0.020"
FILTER PACK	#2/16
WELL SEAL	Neat cement over bentonite
WELL NO.	MW-1

FIELD HEADSPACE *	DEPTH	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
	0–1	ASPHALT
	1–2	BASEROCK
	2–4	Silty CLAY (CL) dark brown, low plasticity, 20-25% silt, trace fine to coarse sand, trace pebble gravel, dry.
0.0 (5)	4–6	Sandy CLAY (CL) yellow-brown, low plasticity, 30-35% fine sand, trace pebble gravel, trace rootlets, moist.
	6–8	Gravelly SAND (SW) med. brown, well graded, medium to coarse grained, 15% sub-rounded pebble gravel, moist.
0.0 (10)	8–13	Silty CLAY (CL) medium brown, low plasticity, 15-20% silt, trace medium sand, damp.
0.0 (15)	13–15	Sandy CLAY (CL) medium brown, low plasticity, 35-40% fine sand, trace rounded pebble gravel, wet.
0.0 (20)	15–24	Silty CLAY (CL) medium yellow-brown, low plasticity, 15-20% silt, trace angular pebble gravel, trace charcoal fragments, wet.
0.0 (25)	24–30	Gravelly CLAY (CL) medium brown, low plasticity, 10-15% pebble gravel, damp.

Columns: FIELD HEADSPACE *, DEPTH, SAMPLE, WATER LEVEL, WELL CONSTR., GRAPHIC LOG



*PID (ppm)

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-1 AND WELL CONSTRUCTION MW-1

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-2

JOB NO. 9-029

SITE/LOCATION	BEGUN	BORING DIAMETER	ANGLE/BEARING	BORING NO
7210 Bancroft Avenue, Oakland, CA	12/27/91	8 Inches	90 Degrees	MW-1

DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH
Bayland Drilling	12/27/91	28 Feet

OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE
Tom Schmidt	T. Lane	29 Feet

DRILL MAKE & MODEL	SAMPLING METHOD	BOTTOM OF BORING
CME 75	California modified split spoon	40 Feet

WELL MATERIAL	SLOT SIZE	FILTER PACK	WELL SEAL	WELL NO.
2" SCH 40 PVC	0.020"	#2/16	Neat cement over bentonite	MW-1

FIELD HEADSPACE *	DEPTH	SAMPLE	WATER LEVEL	WELL CONSTR.	GRAPHIC LOG	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
	31					Gravelly CLAY (CL) medium brown, low plasticity, 20-30% sub-rounded coarse gravel, wet.
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					
	60					

*PID (ppm)

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-1 AND WELL CONSTRUCTION MW-1

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-3

JOB NO. 9-029

SITE/LOCATION: 7210 Bancroft Avenue, Oakland, CA	BEGUN: 12/27/91	BORING DIAMETER: 8 Inches	ANGLE/BEARING: 90 Degrees	BORING NO: MW-2
DRILLING CONTRACTOR: Bayland Drilling	COMPLETED: 12/27/91	FIRST ENCOUNTERED WATER DEPTH: 30 Feet		
OPERATOR: Tom Schmidt	LOGGED BY: T. Lane	STATIC WATER DEPTH/DATE: 30 Feet		
DRILL MAKE & MODEL: CME 75	SAMPLING METHOD: California modified split spoon			BOTTOM OF BORING: 40 Feet
WELL MATERIAL: 2" SCH 40 PVC; SLOT SIZE: 0.020"; FILTER PACK: #2/16	WELL SEAL: Neat cement over bentonite			WELL NO. MW-2

FIELD HEADSPACE*	DEPTH	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
	0–1	ASPHALT
	1–2	BASEROCK
	2–4	Silty CLAY (CL) dark brown, low plasticity, 20-25% silt, trace fine to coarse sand, trace pebble gravel, dry.
0.0	5	Sandy CLAY (CL) yellow-brown, low plasticity, 30-35% fine sand, trace pebble gravel, trace rootlets, moist.
	6–8	Gravelly SAND (SW) med. brown, well graded, medium to coarse grained, 15% sub-rounded pebble gravel, moist.
0.0	10	Silty CLAY (CL) medium brown, low plasticity, 15-20% silt, trace medium sand, damp.
0.0	15	Sandy CLAY (CL) medium brown, low plasticity, 35-40% fine sand, trace rounded pebble gravel, wet.
0.0	20	Silty CLAY (CL) medium yellow-brown, low plasticity, 15-20% silt, trace angular pebble gravel, trace charcoal fragments, wet.
	20–23	Gravelly SAND (SW) medium brown, well graded coarse sand, 10-15% well rounded pebble gravel, wet.
0.0	25	Gravelly CLAY (CL) medium brown, low plasticity, 10-15% pebble gravel, damp.

*PID (ppm)

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-2 AND WELL CONSTRUCTION MW-2

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-4

JOB NO. 9-029

SITE/LOCATION	BEGUN	BORING DIAMETER	ANGLE/BEARING	BORING NO
7210 Bancroft Avenue, Oakland, CA	12/27/91	8 Inches	90 Degrees	MW-2

DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH
Bayland Drilling	12/27/91	30 Feet

OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE
Tom Schmidt	T. Lane	30 Feet

DRILL MAKE & MODEL	SAMPLING METHOD	BOTTOM OF BORING
CME 75	California modified split spoon	40 Feet

WELL MATERIAL	SLOT SIZE	FILTER PACK	WELL SEAL	WELL NO.
2" SCH 40 PVC	0.020"	#2/16	Neat cement over bentonite	MW-2

FIELD HEADSPACE *	DEPTH	SAMPLE	WATER LEVEL	WELL CONSTR.	GRAPHIC LOG	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
	31					Gravelly CLAY (CL) medium brown, low plasticity, 20-30% sub-rounded coarse gravel, wet.
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
*PID	59					
(ppm)	60					

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-2
AND
WELL CONSTRUCTION MW-2

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE
A-5

JOB NO.
9-029

HunTer ENVIRONMENTAL SERVICES, INC.
537 Center Avenue, Suite 350
Martinez, California 94553
415-372-3637

LOG OF BORING NO. MW-3
PROJECT NO: 02-401-002
CLIENT: TOPA
SITE LOCATION: EASTMONT MALL OAKLAND, CA.
BORING LOCATION: SEE FIG 1
DRILLER: GREGG DRILLING & TESTING
LOGGED BY: J. BRYSON
SUPERVISOR: S. WICKHAM Susan Wickham RG [illegible]

PAGE 1 of 2
DATE: 12/6/89
REF. ELEV. —
METHOD: HOLLOW STEM AUGER
HOLE DIA: 8"

DEPTH (FT)	GRAPHIC LOG	BLOW/FT	VAPOR (PPM)	SAMPLE TYPE AND DEPTH	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	WELL CONSTRUCTION
0						3" Asphalt @ Surface	
2					CL	CLAY, black-grey, stiff, slightly moist, some silt, no odor.	
4			ND	RING @ 5'	CL	SILTY CLAY, brown, stiff, slightly moist, trace of gravel, no odor.	
6							
8							
10			ND	RING @ 10'	CL	As above, some medium sand to coarse gravel.	
12							
14			ND	RING @ 15'	SM	SILTY SAND, brown, some clay & gravel, medium to coarse grained, medium dense, slightly moist, no odor.	
16							
18			ND	RING @ 20'	SM	As above.	
20							
22							
24			ND	RING @ 25'	SW	SAND, brown with silt and small gravel, moist, medium dense, no odor.	
26							
28							

Completed By:

HUNTER ENVIRONMENTAL SERVICES, INC.

December 6, 1989

SOIL BORING LOG MW-3 AND WELL CONSTRUCTION MW-3

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-6

JOB NO. 9-029

HunTer ENVIRONMENTAL SERVICES, INC.
597 Center Avenue, Suite 350
Martinez, California 94553
415-372-3637

LOG OF BORING NO. MW-3 — PAGE 2 of 2
PROJECT NO: 02-401-002 — DATE: 12/5/89
CLIENT: TOPA — REF. ELEV. —
SITE LOCATION: EASTMONT MALL, OAKLAND, CA. — METHOD: HOLLOW STEM AUGER
BORING LOCATION: SEE FIG 1 — HOLE DIA: 8"
DRILLER: GREGG DRILLING & TESTING
LOGGED BY: J. BRYSON
SUPERVISOR: S. WICKHAM Steven Wickham RG 3851

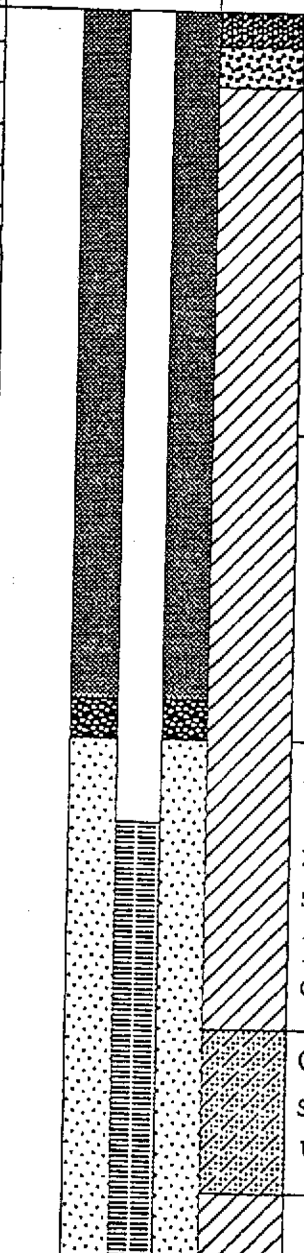
DEPTH (FT)	GRAPHIC LOG	BLOW/FT	VAPOR (PPM)	SAMPLE TYPE AND DEPTH	UNIFIED SOIL CLASSIFICATION	DESCRIPTION	WELL CONSTRUCTION
29–31			ND	RING @ 30'	SW	As above.	
33–35			ND	RING @ 35'	SW	As above, moist.	
37						▽	
39						As above, saturated.	
43–45						CLAY, silty, light brown, firm, slightly moist, no odor.	
45						TOTAL DEPTH — 45'	
47–57						Well Construction: 2"(0.02") slotted PVC 45'–30'; blank 2" PVC 30'–0; #3 lonestar sand 45'–25'; bentonite 25'–3'; cement 3'–0.	

Completed By:	SOIL BORING LOG MW-3 AND WELL CONSTRUCTION MW-3	PLATE A-7
HUNTER ENVIRONMENTAL SERVICES, INC. December 6, 1989	BP Oil Station No. 11117, 7210 Bancroft Avenue, Oakland, CA	JOB NO. 9-029

- **SITE/LOCATION:** 7210 Bancroft Avenue, Oakland, CA
- **BEGUN:** 7/22/92
- **BORING DIAMETER:** 8 Inches
- **ANGLE/BEARING:** 90 Degrees
- **BORING NO:** MW-4
- **DRILLING CONTRACTOR:** Bayland Drilling
- **COMPLETED:** 7/22/92
- **FIRST ENCOUNTERED WATER DEPTH:** 31 Feet
- **OPERATOR:** Frank Bartolovich
- **LOGGED BY:** T. Ramirez
- **STATIC WATER DEPTH/DATE:** 32.5 Feet
- **DRILL MAKE & MODEL:** CME 55
- **SAMPLING METHOD:** California modified split spoon
- **BOTTOM OF BORING:** 40 Feet
- **WELL MATERIAL:** 2" SCH 40 PVC
- **SLOT SIZE:** 0.020"
- **FILTER PACK:** #2/12
- **WELL SEAL:** Neat cement with 5% bentonite over hydrated pellets
- **WELL NO.:** MW-4

BLOWS/FOOT	FIELD HEAD-SPACE*	DEPTH	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		0–1	ASPHALT
		1–2	BASEROCK
		2–4	CLAY (CL) medium brown, moderate plasticity, 5-10% medium to coarse sand, dry.
7 24 24	462	4–6.5	Sandy CLAY (CL) light brown, low plasticity, 40% fine to medium angular sand, dry.
4 12 23	106	6.5–11	Sandy CLAY (CL) greenish-brown, moderate plasticity, 30% fine sub-angular to sub-rounded sand, 5-10% silt content, dry.
13 14 22	464	11–18	Sandy CLAY (CL) medium brown, low plasticity, 25-30% fine to coarse angular to sub-rounded sand, occasional gravel clast up to 5cm, dry.
6 10 13 3 13 21	442 673	18–25	Sandy CLAY (CL) interbedded light brown and dark brown layers. Dark brown sandy clay is 30% fine to medium sand, with moderate plasticity. Light brown sandy clay is 20% fine sand, 10% silt content, with low plasticity. Both are damp, with increasing moisture, clay content and plasticity with depth.
		25–29	Clayey SAND (SC) medium brown, fine to medium sub-rounded to rounded sand, 5% gravel with clasts up to 3cm, 15% clay content, moist.
		29–30	

*PID (ppm)



HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-4
AND
WELL CONSTRUCTION MW-4

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-8

JOB NO. 9-029

SITE/LOCATION 7210 Bancroft Avenue, Oakland, CA	BEGUN 7/22/92	BORING DIAMETER 8 Inches	ANGLE/BEARING 90 Degrees
DRILLING CONTRACTOR Bayland Drilling	COMPLETED 7/22/92	FIRST ENCOUNTERED WATER DEPTH 31 Feet	BORING NO MW-4
OPERATOR Frank Bartolovich	LOGGED BY T. Ramirez	STATIC WATER DEPTH/DATE 32.5 Feet	
DRILL MAKE & MODEL CME 55	SAMPLING METHOD California modified split spoon		BOTTOM OF BORING 40 Feet
WELL MATERIAL 2" SCH 40 PVC / SLOT SIZE 0.020" / FILTER PACK #2/12	WELL SEAL Neat cement with 5% bentonite over hydrated pellets		WELL NO. MW-4

BLOWS/FOOT	FIELD HEAD-SPACE*	DEPTH	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
13 50/6	691	31–34	Sandy CLAY (CL) medium brown, low plasticity, 30% fine to coarse, sub-angular to rounded sand, occasional gravel clast up to 2cm, moist to wet.
6 8 9		34–35	CLAY (CL) dark brown, high plasticity, wet.
		35–38	Silty SAND (SM) grey to light brown, fine to medium sand, 10% gravel up to 5cm, sub-rounded to rounded clasts, 20% silt content, saturated.
3 6 8		38–40	CLAY (CL) med. brown, moderate plasticity, approx. 5% rounded medium sand, wet.

Depth scale: 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

Columns: SAMPLE, WATER LEVEL, WELL CONSTR., GRAPHIC LOG

*PID (ppm)

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-4
AND
WELL CONSTRUCTION MW-4

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-9

JOB NO. 9-029

SITE/LOCATION	BEGUN	BORING DIAMETER	ANGLE/BEARING	BORING NO
7210 Bancroft Avenue, Oakland, CA	7/23/92	8 Inches	90 Degrees	MW-6

DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH
Bayland Drilling	7/23/92	31.5 Feet

OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE
Kurt Voss	T. Ramirez	31.5 Feet

DRILL MAKE & MODEL	SAMPLING METHOD	BOTTOM OF BORING
CME 75	California modified split spoon	40 Feet

WELL MATERIAL	SLOT SIZE	FILTER PACK	WELL SEAL	WELL NO.
2" SCH 40 PVC	0.020"	#2/12	Neat cement with 5% bentonite over hydrated pellets	MW-6

BLOWS/FOOT	FIELD HEAD-SPACE* *PID (ppm)	DEPTH	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		0–1	ASPHALT
		1–3	CLAY (CL) dark brown, high plasticity, 10% sub-angular to sub-rounded fine to medium sand, moist.
4 6 9	0.0	5	Sandy CLAY (CL) dark brown, high plasticity, 25% fine to coarse sand with occasional gravel clasts up to 3cm, dry.
		5–9	CLAY (CL) light brown, moderate plasticity, 5-10% fine sand, dry.
6 9 15	0.0	10	Sandy CLAY (SC) dark brown, high plasticity, 20% fine to coarse angular to sub-rounded sand, occasional gravel clasts up to 4cm, dry.
5 12 16	0.0	15	Sandy CLAY (CL) yellow brown, moderate plasticity, 20% fine to medium sand, 10% silt content, occasional gravel clasts up to 8cm, dry.
8 12 15	0.0	20	Sandy CLAY (CL) light brown, moderate plasticity, 40% fine to coarse sand, occasional angular to sub-rounded gravel clasts up to 10 cm, moist.
10 13 16	0.0	25	Sandy CLAY (CL) same as above except only 25% sand content.
9 16 20	0.0	30	Gravelly CLAY (CL) medium brown, 25% angular to sub-rounded gravel clasts up to 5cm, 20% fine to coarse sand, decrease gravel and sand content with depth, moist.

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-6 AND WELL CONSTRUCTION MW-6

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-12

JOB NO. 9-029

SITE/LOCATION: 7210 Bancroft Avenue, Oakland, CA	BEGUN: 7/23/92	BORING DIAMETER: 8 Inches	ANGLE/BEARING: 90 Degrees
BORING NO: MW-6			
DRILLING CONTRACTOR: Bayland Drilling	COMPLETED: 7/23/92	FIRST ENCOUNTERED WATER DEPTH: 31.5 Feet	
OPERATOR: Kurt Voss	LOGGED BY: T. Ramirez	STATIC WATER DEPTH/DATE: 31.5 Feet	
DRILL MAKE & MODEL: CME 75	SAMPLING METHOD: California modified split spoon		BOTTOM OF BORING: 40 Feet
WELL MATERIAL: 2" SCH 40 PVC	SLOT SIZE: 0.020"	FILTER PACK: #2/12	WELL SEAL: Neat cement with 5% bentonite over hydrated pellets
WELL NO.: MW-6			

BLOWS/ FOOT	FIELD HEAD-SPACE*	DEPTH	SAMPLE	WATER LEVEL	WELL CONSTR.	GRAPHIC LOG	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		31					
		32		▼			
4 12 20		33–36					Silty CLAY (CL) yellow-brown, 30% silt content, 10% sub-angular to sub-rounded gravel clasts up to 10cm, approx. 5% medium to coarse sand, increase sand content with depth, wet.
		37–38					Sandy GRAVEL (GP) light brown, gravel clasts up to 7cm, 30% fine to coarse sand, 10% silt content, saturated.
5 9 15		39–40					Silty SAND (SM) light grey, fine to medium sand with <5% coarse sand, 35% silt content, saturated.
		41					
		42					
		43					
		44					
		45					
		46					
		47					
		48					
		49					
		50					
		51					
		52					
		53					
		54					
		55					
		56					
		57					
		58					
	*PID	59					
	(ppm)	60					

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE:

APPROVED BY: Frederick G. Moss, PE No. 35162

SOIL BORING LOG MW-6 AND WELL CONSTRUCTION MW-6

BP Oil Station No. 11117
7210 Bancroft Avenue
Oakland, CA

PLATE A-13

JOB NO. 9-029

SITE/LOCATION	BEGUN	BORING DIAMETER	ANGLE / BEARING	BORING NO
BP/7210 Bancroft Ave, Oakland	10/6/94	8"	90	MW-7

DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH	BOTTOM OF BORING
West Hazmat Drilling Corp.	10/6/94	31.0' damp	45.0'

DRILL MAKE & MODEL	OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE	WELL NO.
Mobile B-57	Eugene Nunes	F. Maroni	43.67 10/10/94	MW-7

WELL MATERIAL	SLOT SIZE	SAMPLING METHOD	BOTTOM OF WELL
PVC Sch 40	0.020"	CA Modified Split Spoon	45.0'

FILTER PACK	WELL SEAL	PLANNED USE
#3 Monterey Sand	Bentonite	Monitoring

BLOWS/FOOT	PID FIELD HEADSPACE (ppm)	DEPTH	SAMPLE	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		0–2.5		3" Asphalt over baserock; Gravel (GP) with some reddish brown clay.
		2.5–3.5		Silty CLAY (CL); very dark brown, stiff, dry.
88	0.0	3.5–10		Sandy CLAY (CL); yellow brown, very stiff; trace very fine grained sand, dry.
65	0.0	10–13		Sandy CLAY (CL); reddish brown, iron oxide deposits, black streaks like coal, well graded coarse grained, subangular to angular sand; few gravel, dry.
		13–15		Clayey SAND (SC); brown, well graded coarse sand, some subangular to angular gravel, some fine-grained sand, moist.
90	0.0	15–20		Gravelly CLAY (CL); brown, iron oxide deposits, some coarse gravel, few coarse sand.
57	0.0	20–25		Sandy CLAY (CL); brown, medium stiff, well graded coarse sand, some angular to subangular gravel, dry.
50 w/ 5" rec.	0.0	25–26.5	MW-7-25'	Encountered rock/gravel (GP) at 25.5 feet. Drilled out to 26.5 ft.
50 w/ 10" rec.		26.5–30		Sandy CLAY (CL); brown, stiff, well graded, subangular to angular, coarse grained sand; some fine grained angular gravel; few fine grained sand.

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE: 11/2/94

APPROVED BY: GP

SOIL BORING LOG AND WELL CONSTRUCTION DIAGRAM

MW-7

PLATE C-1

SHEET 1 OF 2

JOB NO. 9-029

ITE/LOCATION	UN	BORING DIAMETER	ANGLE/B NG	BORING NO
BP/7210 Bancroft Ave, Oakland	10/6/94	8"	90°	MW-7

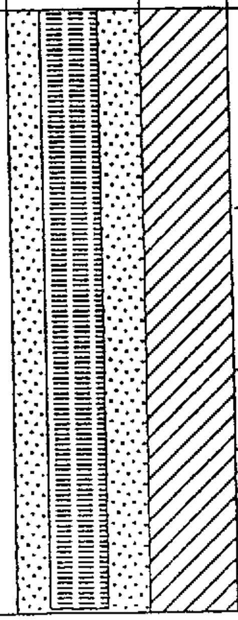
DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH	BOTTOM OF BORING
West Hazmat Drilling Corp.	10/6/94	31.0' damp	45.0'

DRILL MAKE & MODEL	OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE	WELL NO.
Mobile B-57	Eugene Nunes	F. Maroni	43.67' 10/10/94	MW-7

WELL MATERIAL	SLOT SIZE	SAMPLING METHOD	BOTTOM OF WELL
PVC Sch 40	0.020"	CA Modified Split Spoon	45.0'

FILTER PACK	WELL SEAL	PLANNED USE
#3 Monterey Sand	Bentonite	Monitoring

BLOWS/FOOT	PID FIELD HEADSPACE (ppm)	DEPTH	SAMPLE	WATER LEVEL	WELL CONSTR.	GRAPHIC LOG	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		31–34					Sandy CLAY (CL); brown, stiff, medium to coarse grained, subangular to subrounded sand; some fine grained to coarse grained, angular to subangular gravel, damp.
50 w/ 6" rec.	0.0	35–38					CLAY (CL); yellowish brown, very stiff, damp.
		39–40					Silty CLAY (CL); yellowish orange, very stiff, moist.
85 w/ 8" rec.	0.0	41–43		▼ (43.67')			Gravelly CLAY (CL); yellowish brown, fine to coarse grained angular gravel; some medium to coarse grained sand, moist.
82		44–45					CLAY (CL); yellowish brown, trace fine grained sand.



T.D. = 45.0"

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE: 11/3/94

APPROVED BY: GP

SOIL BORING LOG AND WELL CONSTRUCTION DIAGRAM

MW-7

PLATE C-1

JOB NO. 9-029

SITE/LOCATION	BEGUN	BORING DIAMETER	ANGLE BEARING	BORING NO
BP/7210 Bancroft Ave, Oakland	10/6/94	8"	90°	MW-8

DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH	BOTTOM OF BORING
West Hazmat Drilling Corp.	10/6/94	32.0'	40.0'

DRILL MAKE & MODEL	OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE	WELL NO.
Mobile B-57	Eugene Nunes	F. Maroni	28.51' 10/10/94	MW-8

WELL MATERIAL	SLOT SIZE	SAMPLING METHOD	BOTTOM OF WELL
PVC Sch 40	0.020"	CA Modified Split Spoon	40.0'

FILTER PACK	WELL SEAL	PLANNED USE
#3 Monterey Sand	Bentonite	Monitoring

BLOWS/FOOT	PID FIELD HEADSPACE (ppm)	DEPTH	SAMPLE	WATER LEVEL	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		0–1			Sandy topsoil (OL/OH); brown.
		1–5.5			Silty CLAY (CL); dark gray, very stiff, dry.
		5.5–9			Silty CLAY (CL); light brown, stiff; trace fine grained sand, dry.
90	0.0	10			Sandy CLAY (CL); light brown; some fine to coarse grained sand, some fine-grained, angular to subangular gravel, trace coarse grained gravel; trace silt, dry.
50 w/ 6" rec.	0.0	15			Gravely CLAY (CL); light brown; some fine to coarse grained, well graded, subangular to subrounded gravel, some well graded, medium grained sand, moist.
80	0.0	20			Sandy CLAY (CL); light brown, some fine-grained sand, moist.
50 w/ 6" rec.	0.0	25	MW-8-25'	▼ (28)	Sandy GRAVEL (GW); fine to coarse grained, well graded gravel; some fine to coarse grained, well-graded sand; trace clay, moist to wet.

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE: 11/3/94

APPROVED BY: GP

SOIL BORING LOG AND WELL CONSTRUCTION DIAGRAM

MW-8

PLATE C-1

SHEET 1 OF 2

JOB NO. 9-029

SITE/LOCATION	BEGUN	BORING DIAMETER	ANGLE BEARING	BORING NO
BP/7210 Bancroft Ave	10/6/94	8"	90°	MW-8

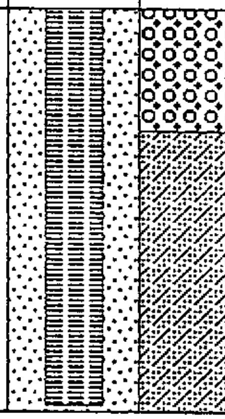
DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH	BOTTOM OF BORING
West Hazmat Drilling Corp.	10/6/94	32.0'	40.0'

DRILL MAKE & MODEL	OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE	WELL NO.
Mobile B-57	Eugene Nunes	F. Maroni	28.51' 10/10/94	MW-8

WELL MATERIAL	SLOT SIZE	SAMPLING METHOD	BOTTOM OF WELL
PVC Sch 40	0.020"	CA Modified Split Spoon	40.0'

FILTER PACK	WELL SEAL	PLANNED USE
#3 Monterey Sand	Bentonite	Monitoring

BLOWS/FOOT	PID FIELD HEADSPACE (ppm)	DEPTH	SAMPLE	WATER LEVEL	WELL CONSTR.	GRAPHIC LOG	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		31					As above.
		32		∇			
		33					
35 w/ 6" rec.		34					Clayey SAND (SC); brown, medium grained, well-graded sand; some clay; few fine grained, subrounded gravel, wet.
		35					
		36					
		37					
		38					
40 w/ 6" rec.		39					
		40					As above.



T.D. = 40.0'

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE: 11/3/94

APPROVED BY: GP

SOIL BORING LOG AND WELL CONSTRUCTION DIAGRAM

MW-8

PLATE C-1

SHEET 2 OF 2

JOB NO. 9-029

ITE/LOCATION	UN	BORING DIAMETER	ANGLE/B NG	BORING NO
BP/7210 Bancroft Ave, Oakland	10/6/94	8"	90°	MW-9
DRILLING CONTRACTOR	**COMPLETED**	**FIRST ENCOUNTERED WATER DEPTH**		**BOTTOM OF BORING**
West Hazmat Drilling Corp.	10/6/94	27.5'		40.0'
DRILL MAKE & MODEL / **OPERATOR**	**LOGGED BY**	**STATIC WATER DEPTH/DATE**		**WELL NO.**
Mobile B-57 / Eugene Nunes	F. Maroni	28.45' 10/10/94		MW-9
WELL MATERIAL / **SLOT SIZE**	**SAMPLING METHOD**			**BOTTOM OF WELL**
PVC Sch 40 / 0.020"	CA Modified Split Spoon			40.0'
FILTER PACK / **WELL SEAL**				**PLANNED USE**
#3 Monterey Sand / Bentonite				Monitoring

BLOWS/ FOOT	PID FIELD HEADSPACE (ppm)	DEPTH	SAMPLE	WATER LEVEL	WELL CONSTR.	GRAPHIC LOG	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		0–3					Backfill; GRAVEL (GP); cobble-sized.
		3–9					CLAY (CL); reddish brown, stiff, dry.
80	0.0	10					CLAY (CL); light brown, hard, trace fine grained sand, dry.
90	0.0	15					Silty CLAY (CL); light brown, hard, dry.
80	0.0	20					As above, moist.
70	0.0	25 (MW-9-25')	■	▽ 26 / ▼ 27			Clayey SAND (SC); brown; fine to medium grained, well graded, rounded to subrounded, moist.

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.

DATE: 11/2/94

APPROVED BY: GP

SOIL BORING LOG AND WELL CONSTRUCTION DIAGRAM

MW-9

PLATE C-1

SHEET 1 OF 2

JOB NO. 9-029

SITE/LOCATION	EGUN	BORING DIAMETER	ANGL' ARING	BORING NO
BP/7210 Bancroft Ave, Oakland	10/6/94	8"	90	MW-9

DRILLING CONTRACTOR	COMPLETED	FIRST ENCOUNTERED WATER DEPTH	BOTTOM OF BORING
West Hazmat Drilling Corp.	10/6/94	27.5'	40.0'

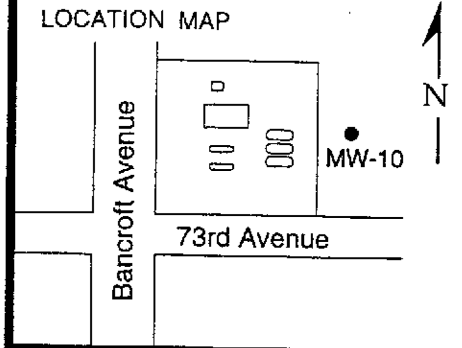
DRILL MAKE & MODEL	OPERATOR	LOGGED BY	STATIC WATER DEPTH/DATE	WELL NO.
Mobile B-57	Eugene Nunes	F. Maroni	28.45' 10/10/94	MW-9

WELL MATERIAL	SLOT SIZE	SAMPLING METHOD	BOTTOM OF WELL
PVC Sch 40	0.020"	CA Modified Split Spoon	40.0'

FILTER PACK	WELL SEAL	PLANNED USE
#3 Monterey Sand	Bentonite	Monitoring

BLOWS/FOOT	PID FIELD HEADSPACE (ppm)	DEPTH	SAMPLE	WATER LEVEL	WELL CONSTR.	GRAPHIC LOG	MATERIAL CLASSIFICATION & PHYSICAL DESCRIPTION
		31					Clayey SAND (SC); brown, fine-grained, well-graded, subrounded to rounded sand; few fine to coarse grained, angular to subrounded gravel, wet.
		32					
		33					Gravelly CLAY (CL); brown, fine grained, well graded, subangular to subrounded gravel; some fine grained sand, wet.
		34					
70		35					
		36					
		37					
		38					
		39					As above.
		40					T.D. = 40.0'

HYDRO-ENVIRONMENTAL TECHNOLOGIES, INC.	SOIL BORING LOG AND WELL CONSTRUCTION DIAGRAM	PLATE C-1 SHEET 2 OF 2
DATE: 11/2/94	MW-9	JOB NO. 9-029
APPROVED BY: GP		



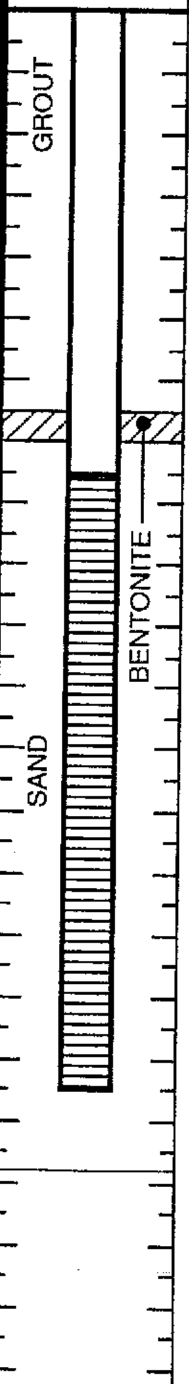
PACIFIC ENVIRONMENTAL GROUP, INC.

WELL NO. MW-10
PAGE 1 OF 1

PROJECT NO. 360-016.1A
LOGGED BY: T.B.
DRILLER: MITCHELL
DRILLING METHOD: HSA
SAMPLING METHOD: CAL MOD
CASING TYPE: SCH 40 PVC
SLOT SIZE: 0.020
GRAVEL PACK: #8 SAND

CLIENT: BP OIL COMPANY
DATE DRILLED: 7-7-97
LOCATION: 7210 Bancroft Ave., Oakland
HOLE DIAMETER: 8"
HOLE DEPTH: 37.5'
WELL DIAMETER: 2"
WELL DEPTH: 35'
CASING STICKUP: NA

WELL COMPLETION



MOISTURE CONTENT	PID	PENETRATION (BLOWS/FT)	DEPTH (FEET)	SOIL TYPE	LITHOLOGY / REMARKS
			0–2	GP	ASPHALT SANDY GRAVEL
			2–7	CL	SANDY CLAY: dark brown; medium plasticity; 75% fines; 25% fine to medium sand; no product odor.
Dry	0	>72	6		
			8	ML	SANDY SILT: strong brown; 75% fines; 24% fine sand; 1% gravel; no product odor.
	0	47	10		
			13	GP	SANDY GRAVEL: no recovery except 2 coarse gravel - r x fragments.
		>63	16		
		50	20		@20': no recovery.
Wt	80	>63	26		@25': brown; 15% fines; 20% fine sand; 65% gravel; no product odor.
Wt	off-scale	38	30		@30': gray; 10% fines; 30% sand; 60% gravel.
			31	ML	SANDY SILT: brown; no product odor.
Mst	22	24	35		@35': brown; 75% fines; 20% fine sand; 5% gravel; no product odor.
			37.5		BOTTOM OF BORING 37.5'

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44

Cambria Environmental Technology, Inc.
1144 - 65th St.
Oakland, CA 94608
Telephone: (510) 420-0700
Fax: (510) 420-9170

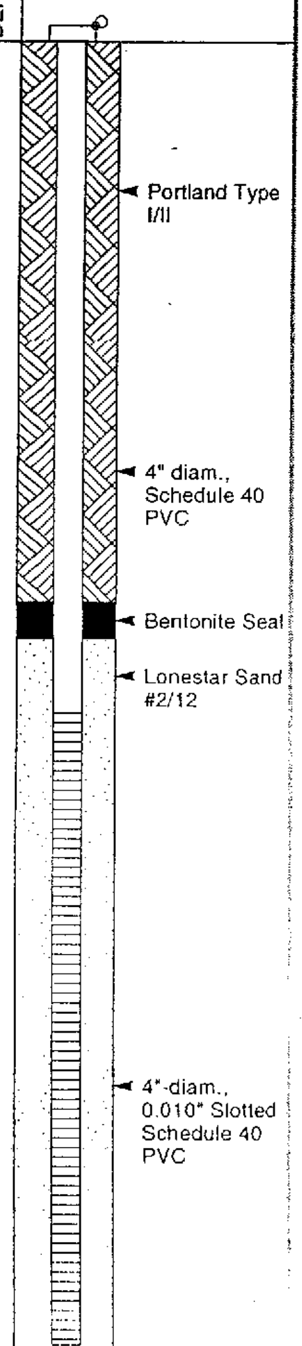
BORING/WELL LOG

CLIENT NAME	BP Oil Company	BORING/WELL NAME	EX-1
JOB/SITE NAME	BP-11117	DRILLING STARTED	30-Nov-99
LOCATION	7210 Bancroft Avenue, Oakland, California	DRILLING COMPLETED	30-Nov-99
PROJECT NUMBER	852-1546	WELL DEVELOPMENT DATE (YIELD)	30-Nov-99
DRILLER	V&W Drilling	GROUND SURFACE ELEVATION	Not Surveyed
DRILLING METHOD	Hollow-stem auger	TOP OF CASING ELEVATION	NA
BORING DIAMETER	10"	SCREENED INTERVAL	18 to 38 ft bgs
LOGGED BY	J. Jones	DEPTH TO WATER (First Encountered)	26.0 ft (30-Nov-99) ▽
REVIEWED BY	K. Rahman, RG	DEPTH TO WATER (Static)	20.55 ft (30-Nov-99) ▼

REMARKS: Hand augered to 5' bgs; located 5' from well MW-2.

TPHg (mg/kg)	BLOW COUNTS	SAMPLE ID	DEPTH (ft bgs)	U.S.C.S.	LITHOLOGIC DESCRIPTION	CONTACT DEPTH (ft bgs)
					ASPHALT.	1.0
					Silty GRAVEL; (FILL); light brown; dry; 5% clay, 35% silt, 20% sand, 40% gravel; low plasticity; moderate to high estimated permeability.	
	4 7 7	EX-1@6'	5		@ 5' - medium dense.	
					SAND; (SW); tan; loose; moist; 10% silt, 85% medium grained sand, 5% gravel; high estimated permeability.	
	4 4 5	EX-1@11'	10			
					Sandy Silty GRAVEL; (GM); brown; dense; moist; 5% clay, 35% silt, 15% medium grained sand, 45% angular gravel up to 2"; high estimated permeability.	13.0
<1.0	20 50	EX-1@15.5'	15	GM		
<1.0	14 17 20	EX-1@21'	20		@ 20' - olive brown; damp; 10% medium grained sand, 50% angular gravel up to 0.5". ▼	
					Gravelly Silty SAND; (SM); brown; dense; wet; 5% clay, 35% silt, 40% coarse grained sand, 20% gravel; high estimated permeability.	23.0
	20 50	EX-1@25.5'	25	SM	▽	
					Sandy Silty GRAVEL; (GM); olive; dense; wet; 20% silt, 35% sand, 45% gravel; high estimated permeability.	28.0
	20 50	EX-1@30.5'	30	GM		
					Sandy Silty CLAY; (CL); see next page.	33.0
			35			

WELL DIAGRAM



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WELL LOG (TPH-G) H:\BRITS-1\11117--1\GINT\BP-11117.GPJ DEFAULT.GDT 4/24/00

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1144 - 65th St.
Oakland, CA 94608
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BORING/WELL LOG

CLIENT NAME	BP Oil Company	**BORING/WELL NAME**	EX-1
JOB/SITE NAME	BP-11117	**DRILLING STARTED**	30-Nov-99
LOCATION	7210 Bancroft Avenue, Oakland, California	**DRILLING COMPLETED**	30-Nov-99

Continued from Previous Page

TPHg (mg/kg)	BLOW COUNTS	SAMPLE ID	EXTENT	DEPTH (ft bgs)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH (ft bgs)	WELL DIAGRAM
	17 23 33	EX-1@36'			CL		**Sandy Silty CLAY**; (CL); brown mottled with black; hard; damp; 45% clay, 35% silt, 20% very fine grained sand; low plasticity; low estimated permeability.		
	12 60/6	EX-1@39'						39.5	Bottom of Boring @ 39.5 ft

WELL LOG (TPH-G) H:\BRITIS~1\11117-~1\GINT\BP-11117.GPJ DEFAULT.GDT 4/24/00

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Oakland, CA 94608
Telephone: (510) 420-0700
Fax: (510) 420-9170

BORING/WELL LOG

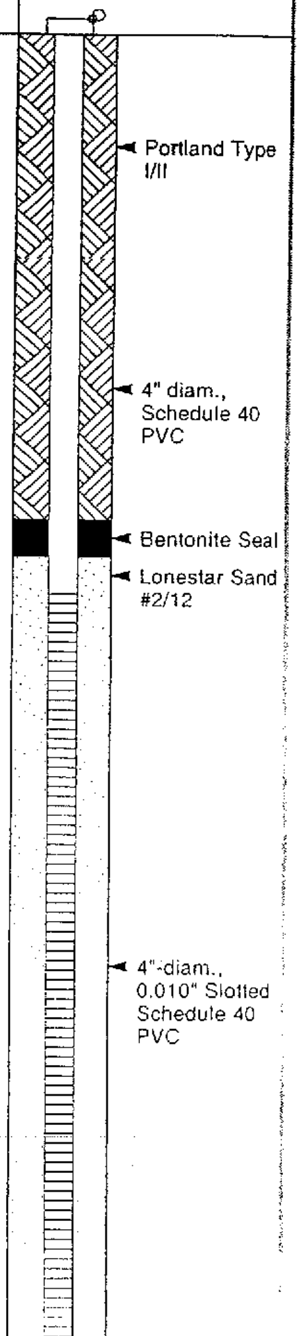
CLIENT NAME	BP Oil Company
JOB/SITE NAME	BP-11117
LOCATION	7210 Bancroft Avenue, Oakland, California
PROJECT NUMBER	852-1546
DRILLER	V&W Drilling
DRILLING METHOD	Hollow-stem auger
BORING DIAMETER	10"
LOGGED BY	J. Jones
REVIEWED BY	K. Rahman, RG
BORING/WELL NAME	EX-2
DRILLING STARTED	30-Nov-99
DRILLING COMPLETED	30-Nov-99
WELL DEVELOPMENT DATE (YIELD)	30-Nov-99
GROUND SURFACE ELEVATION	Not Surveyed
TOP OF CASING ELEVATION	NA
SCREENED INTERVAL	15 to 35 ft bgs
DEPTH TO WATER (First Encountered)	26.0 ft (30-Nov-99) ∇
DEPTH TO WATER (Static)	22.64 ft (30-Nov-99) ▼

REMARKS: Hand augered to 5' bgs; located between trash enclosure and UST slab.

TPHg (mg/kg)	BLOW COUNTS	SAMPLE ID	DEPTH (ft bgs)
	10, 12, 14	EX-2@6'	6
<1.0	13, 15, 19	EX-2@11'	11
	20, 50	EX-2@15.5'	15.5
<1.0	26, 55	EX-2@20.5'	20.5
	18, 26, 30	EX-2@26'	26
	10, 13, 26	EX-2@31'	31

U.S.C.S.	LITHOLOGIC DESCRIPTION	CONTACT DEPTH (ft bgs)
	ASPHALT.	1.0
	Silty Sandy GRAVEL; (FILL); brown; dry; 5% clay, 15% silt, 20% sand, 50% gravel; high estimated permeability.	4.0
ML	**Sandy SILT**; (ML); orange brown; very stiff; dry; 5% clay, 55% silt, 30% sand, 10% gravel; low plasticity; moderate estimated permeability.	8.0
GM	**Sandy Silty GRAVEL**; (GM); brown; dense; dry; 5% clay, 20% silt, 25% sand, 50% gravel; high estimated permeability.	18.0
SM	**Silty SAND**; (SM); brown; dense; damp; 25% silt, 70% medium grained sand, 5% gravel; high estimated permeability.	23.0
GP	**Silty Sandy GRAVEL**; (GP); brown; dense; wet; 15% silt, 20% medium to coarse grained sand, 65% gravel; high estimated permeability.	30.5
CL	**Sandy Silty CLAY**; (CL); light brown; hard; damp; 45% clay, 35% silt, 20% very fine grained sand; low plasticity; low estimated permeability.	

WELL DIAGRAM



WELL LOG (TPH-G) H:\BRITIS-1\11117-~1\GINT\BP-11117.GPJ DEFAULT.GDT 4/24/00

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1144 - 65th St.
Oakland, CA 94608
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Fax: (510) 420-9170

BORING/WELL LOG

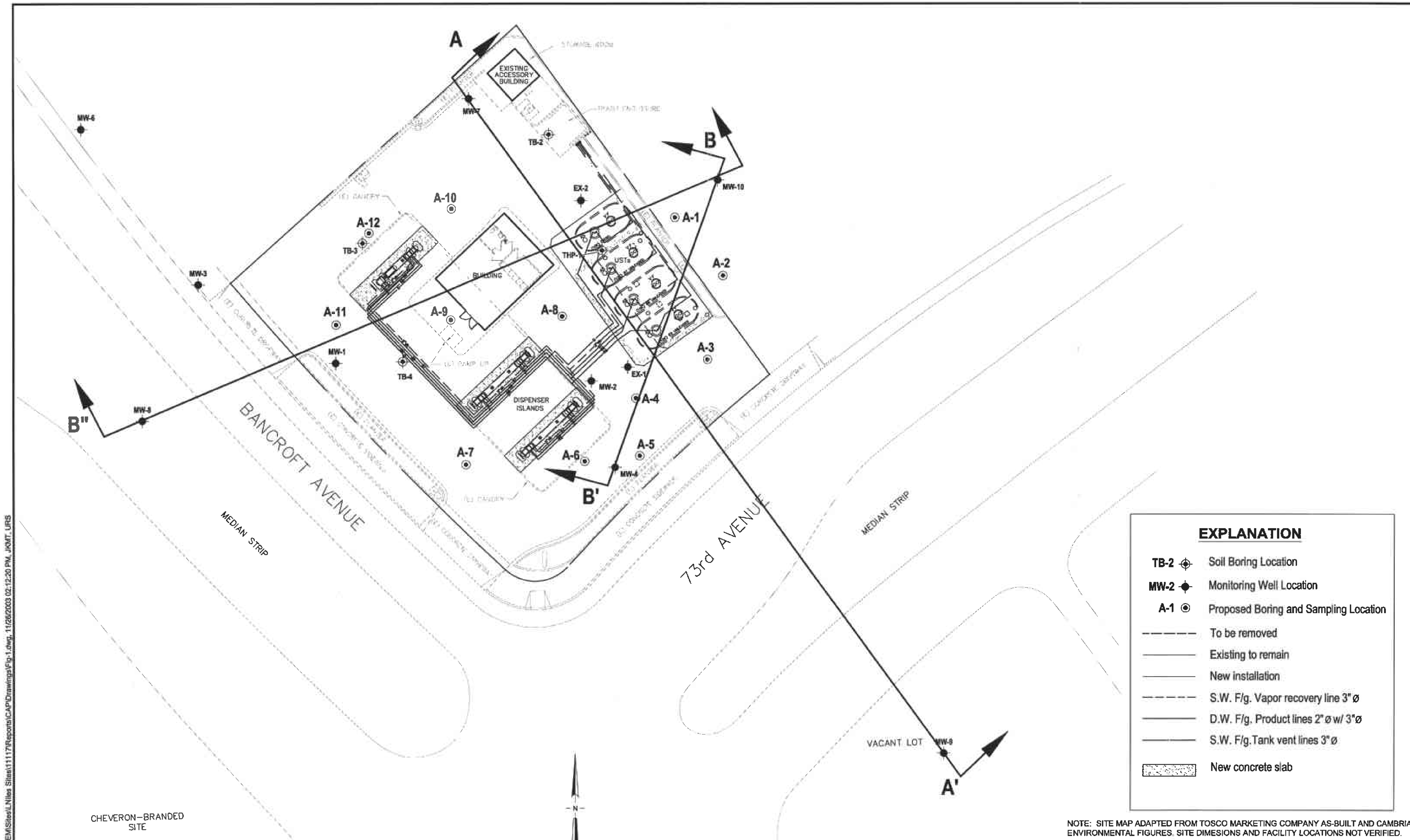
CLIENT NAME	BP Oil Company	**BORING/WELL NAME**	EX-2
JOB/SITE NAME	BP-11117	**DRILLING STARTED**	30-Nov-99
LOCATION	7210 Bancroft Avenue, Oakland, California	**DRILLING COMPLETED**	30-Nov-99

Continued from Previous Page

TPHg (mg/kg)	BLOW COUNTS	SAMPLE ID	EXTENT	DEPTH (ft bgs)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH (ft bgs)	WELL DIAGRAM
	10 13 32	EX-2@36'						36.5	Bottom of Boring @ 36.5 ft

ATTACHMENT D

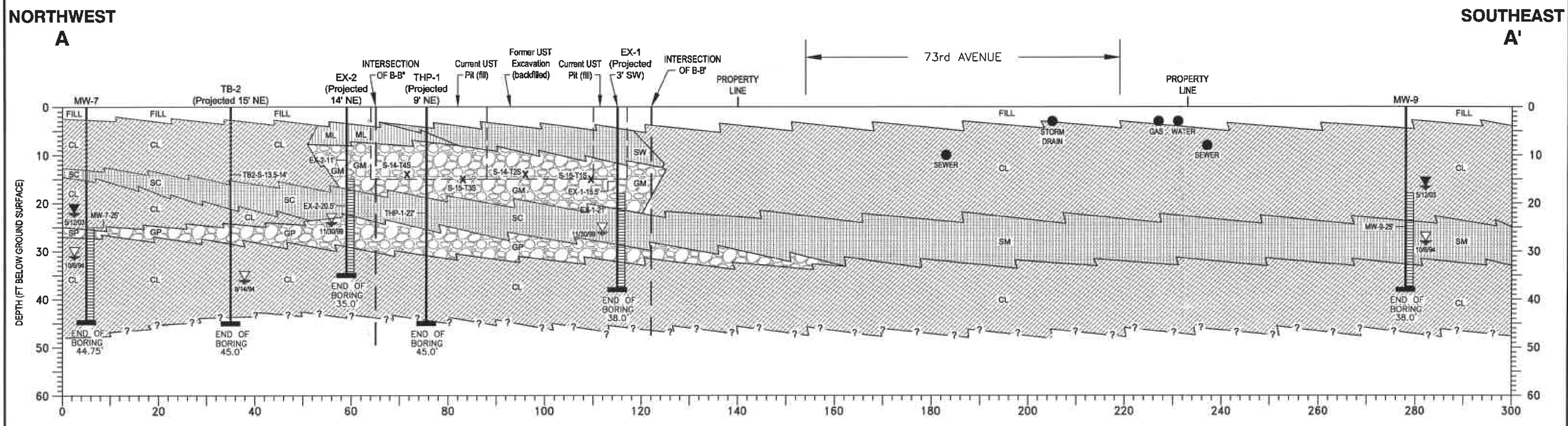
Geologic Cross-Sections



NOTE: SITE MAP ADAPTED FROM TOSCO MARKETING COMPANY AS-BUILT AND CAMBRIA ENVIRONMENTAL FIGURES. SITE DIMESIONS AND FACILITY LOCATIONS NOT VERIFIED.

URS	Project No. 38486396 ARCO Service Station #11117 7210 Bancroft Avenue Oakland, California	GEOLOGIC CROSS SECTION LOCATION MAP	FIGURE 1

X:\x_env_waste\BP GEM\Sites\L Niles Sites\11117\Reports\CAP\Drawings\Fig-1.dwg, 11/26/2003 02:12:20 PM, JKMT, URS



SOIL CONCENTRATIONS (ppm)				
Sample ID	Date	TPH-g	Benzene	MTBE
EX-2-11	11/30/99	ND<1.0	ND<0.005	0.012
EX-2-20.5	11/30/99	ND<1.0	ND<0.005	ND<0.005
EX-1-15.5	11/30/99	ND<1.0	ND<0.005	0.011
EX-2-21	11/30/99	ND<1.0	ND<0.005	ND<0.005
MW-7-25	10/6/94	ND<1.0	ND<0.005	–
MW-9-25	10/6/94	ND<1.0	ND<0.005	–
S-14-T4S	8/14/98	ND	ND	0.028
S-15-T3S	8/14/98	ND	ND	0.065
S-14-T2S	8/14/98	3.7	ND	0.055
S-15-T1S	8/14/98	5,300	ND	ND
TB2-S-13.5-14	9/14/94	ND	ND	ND
THP-1-22	9/14/94	ND	ND	ND

LEGEND

CL — Gravelly clays, sandy clays, silty clays, lean clays

ML — Silts and very fine sands

SW-SM, SC — Gravelly and/or silty to clayey sand

GP-GM — Sandy and/or silty gravel

MW-3 — Well or Soil Boring Number, Distance and Direction of Projection

CL — Soil Type using the Unified Soil Classification System

Analyzed Soil Sample

5/12/03 — Static water level/date

10/6/94 — First encountered water/date

END OF BORING 40.0' — Total depth of boring

THP-1-22' — Soil sample analytical results with TPH-g, Benzene, and MTBE concentrations in milligrams per kilogram (mg/kg) shown on table

Utility information provided by PG&E, EBMUD, and City of Oakland

0 10 20 40

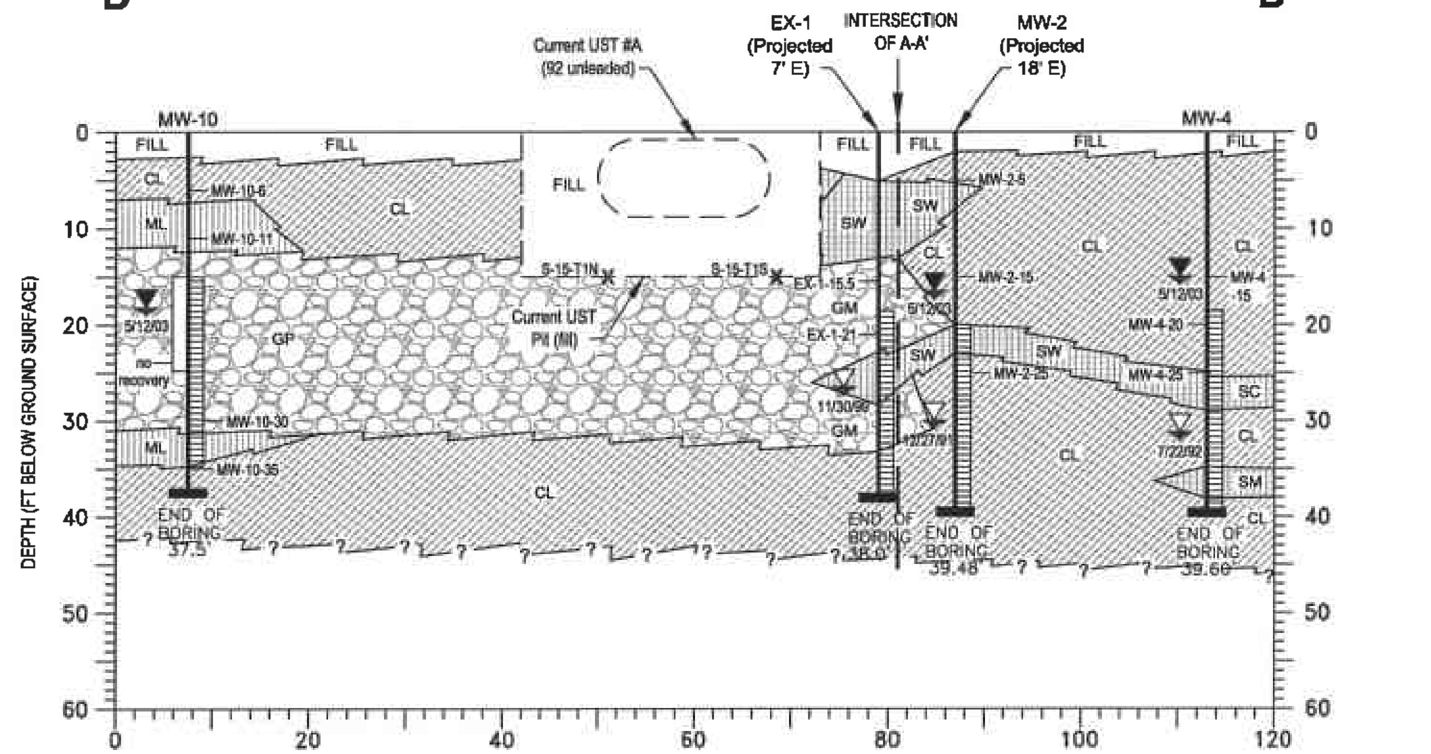
Scale (ft)

URS	Project No. 38486396 Former BP Service Station #11117 7210 Bancroft Avenue Oakland, California	GEOLOGIC CROSS SECTION A - A'	FIGURE 2

X:\x_envi_waste\BP GEM\Sites\L Niles Sites\11117\Drawings\A-A_XSECTION.dwg, 11/26/2003 02:04:19 PM, JKMT, URS

NORTH-NORTHEAST
B

SOUTH-SOUTHWEST
B'



SOIL CONCENTRATIONS (ppm)				
Sample ID	Date	TPH-g	Benzene	MTBE
EX-1-15.5	11/30/99	ND<1.0	ND<0.005	0.011
EX-1-21	11/30/99	ND<1.0	ND<0.005	ND<0.005
MW-2-5	12/27/91	ND	ND	ND
MW-2-15	12/27/91	ND	ND	ND
MW-2-25	12/27/91	ND	ND	ND
MW-4-15	7/22/92	240	ND	–
MW-4-20	7/22/92	6,000	34	–
MW-4-25*	7/22/03	1,100	1.6	–
MW-10-6	–	ND<0.1	ND<0.001	ND<0.1
MW-10-30	–	ND<0.1	ND<0.001	ND<0.1
MW-10-35	–	ND<0.1	ND<0.001	ND<0.1
S-15-T1N	8/14/98	480	0.4	1.6
S-15-T1S	8/14/98	5,300	ND	ND

LEGEND

CL — Gravelly clays, sandy clays, silty clays, lean clays

ML — Silts and very fine sands

SW-SM, SC — Gravelly and/or silty to clayey sand

GP-GM — Sandy and/or silty gravel

MW-4 — Well or Soil Boring Number Distance and Direction of Projection

CL — Soil Type using the Unified Soil Classification System

Analyzed Soil Sample

5/12/03 — Static water level/date

10/6/94 — First encountered water/date

END OF BORING 40.0' — Total depth of boring

THP-1-22' — Soil sample analytical results with TPH-g, Benzene and MTBE concentrations in milligrams per kilogram (mg/kg) shown on table

0 10 20 40
Scale (ft)

URS	Project No. 38486396 Former BP Service Station #11117 7210 Bancroft Avenue Oakland, California	GEOLOGIC CROSS SECTION B - B'	FIGURE 3

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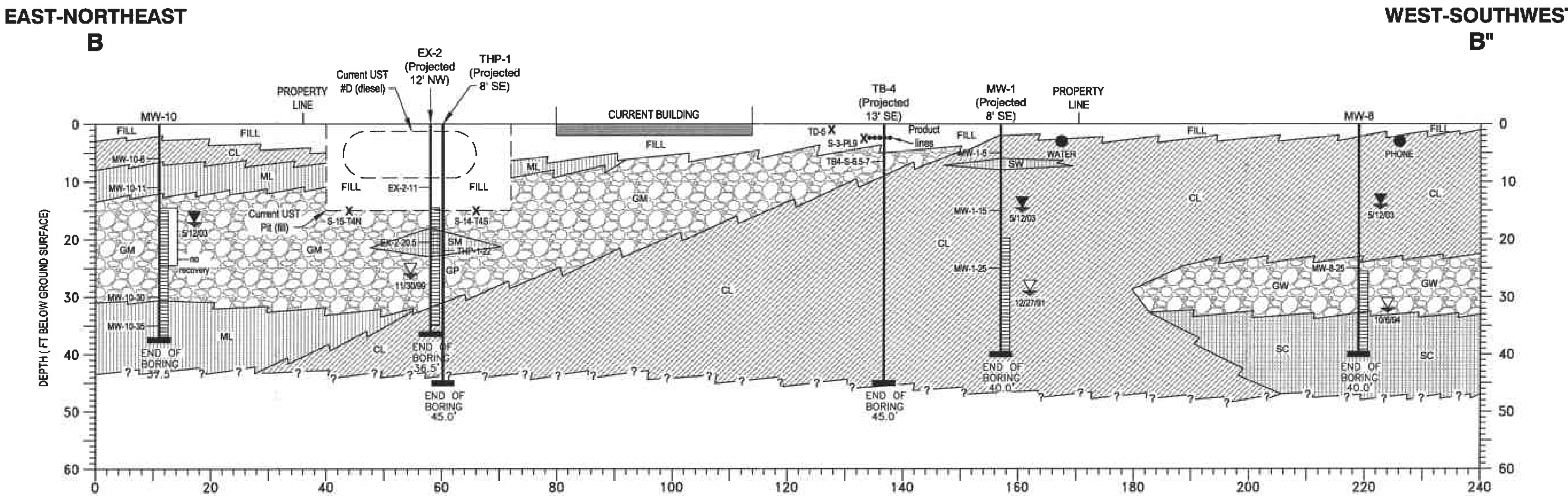


SOIL CONCENTRATIONS (ppm)				
Sample ID	Date	TPH-g	Benzene	MTBE
EX-2-11	11/30/99	ND<1.0	ND<0.005	ND<0.005
EX-2-20.5	11/30/99	ND<1.0	ND<0.005	ND<0.005
MW-1-5	12/27/91	ND	ND	ND
MW-1-15	12/27/91	ND	ND	ND
MW-1-25	12/27/91	ND	ND	ND
MW-8-25	10/6/94	ND<1.0	–	–
MW-10-6	7/7/97	ND<1.0	–	–
MW-10-11	7/7/97	ND<1.0	–	–
MW-10-30	7/7/97	ND<1.0	–	–
MW-10-35	7/7/97	ND<1.0	–	–
S-3-PL9 (proj. 8' NW)	8/14/98	ND	ND	ND
S-14-T4S	8/14/98	ND	ND	0.028
S-15-T4N	8/14/98	ND	ND	0.26
TB4-S-6.5-7	9/14/94	ND	ND	ND
TD-5 (proj. 14' NW)	9/8/94	ND	ND	ND
TPH-1-22	9/8/94	ND	ND	ND

LEGEND

CL	Gravelly clays, sandy clays, silty clays, lean clays
ML	Silts and very fine sands
SW-SM, SC	Gravelly and/or silty to clayey sand
GP-GM	Sandy and/or silty gravel
MW-1	Well or Soil Boring Number Distance and Direction of Projection
CL	Soil Type using the Unified Soil Classification System
	Analyzed Soil Sample
5/12/03	Static water level/date
10/6/94	First encountered water/date
END OF BORING 40.0'	Total depth of boring
THP-1-22'	Soil sample analytical results with TPH-g, Benzene and MTBE concentrations in milligrams per kilogram (mg/kg) shown on table

Utility information provided by PG&E, EBMUD, and City of Oakland

0 10 20 40
Scale (ft)

URS

Project No. 38486396

Former BP Service Station #11117
7210 Bancroft Avenue
Oakland, California

GEOLOGIC CROSS SECTION
B - B"

FIGURE
4

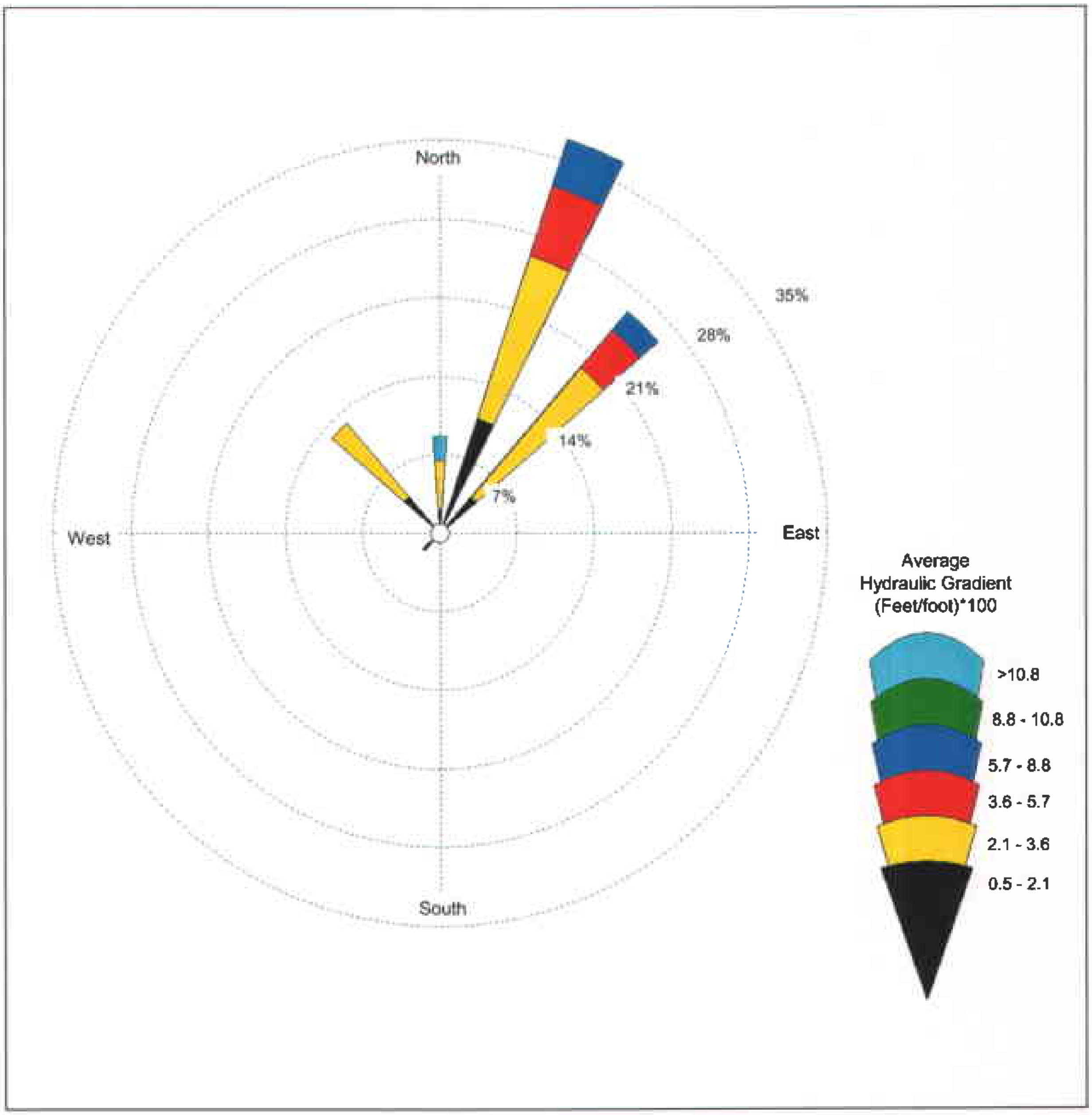
X:\x_env_waste\BP GEM\Sites\L Niles Sites\11117\Drawings\B-B" XSECTION.dwg, 11/26/2003 02:56:33 PM, JKMT, URS

ATTACHMENT E

Rose Diagram of Historical Hydraulic Gradient Magnitude and Direction

Rose Diagram of Historical Hydraulic Gradient Magnitude and Direction

Former BP Service Station #11117
7210 Bancroft Avenue
Oakland, California



Legend

Rose segments represent measured groundwater flow directions from 07/24/92 through 08/27/03.

Rose segments show frequency of flow directions expressed as percent (%) of total readings (46) from 07/24/92 through 08/27/03.

Source: The data within this figure collected prior to July 2002 was provided to URS by Group Environmental Management and their previous consultants. URS has not verified the accuracy of this information.

Table
Groundwater Flow Direction and Gradient

Former BP Service Station #11117
7210 Bancroft Avenue
Oakland, CA

Date Measured	Average Flow Direction	Average Hydraulic Gradient (feet per foot)
07/24/92	West	0.005
09/15/92	Northwest	0.008
12/15/92	North-Northwest	0.005
03/15/93	North	0.020
06/07/93	North-Northeast	0.010
09/23/93	North	0.003
12/27/93	Northeast	0.040
04/05/94	North-Northeast	0.020
07/22/94	North-Northeast	0.005
10/13/94	North	0.007
01/25/95	Northwest	0.010
04/19/95	North-Northeast	0.030
07/05/95	North-Northeast	0.040
10/05/95	North-Northeast	0.030
01/12/96	Northwest	0.030
04/22/96	North-Northeast	0.040
07/02/96	North-Northeast	0.020
11/08/96	Northwest	0.020
01/03/97	Northeast	0.020
04/28/97	Northeast	0.030
07/01/97	Northeast	0.030
10/02/97	North-Northeast	0.030
01/09/98	Northwest	0.020
01/09/98	Northeast	0.020
05/06/98	Northeast	0.050
05/06/98	North	0.140
05/06/98	North-Northeast	0.060
07/21/98	Northeast	0.060
12/30/98	Northwest	0.020
02/02/99	North	0.020
05/10/99	North-Northeast	0.020
09/23/99	Northeast	0.010
12/23/99	North-Northeast	0.007
03/27/00	North-Northeast	0.002
05/22/00	North-Northeast	0.010
08/31/00	North-Northeast	0.008
12/11/00	North-Northwest	0.004
03/20/01	North-Northeast	0.010
06/19/01	Northeast	0.010
09/20/01	Southwest	0.010
12/27/01	Northeast	0.019
09/12/02	Northeast	0.030
12/12/02	Northeast	0.020
03/10/03	North-Northeast	0.030
05/12/03	North-Northeast	0.055
08/27/03	North-Northeast	0.036

ATTACHMENT F

Potential Receptor Survey and a One-Half-Mile Radius Well Survey

Appendix A

BP Proprietary

Potential Receptor Survey

Site # 11117

Site #	11117
Address	7210 Bancroft Ave.
City/State	Oakland, CA
County	Alameda
Quadrangle	Latitude 37° 45' 59"
	Longitude 122° 10' 33"

Signature of ~~Preparer~~: William A. Bi

Company: Alisto Engineering Group

Date: 4/18/00

1. Potential Receptors

Provide Information for the following potential receptors	Yes/ No	Field Verify Y/N	Date Verify	Distance	Direction	Depth
				Complete as appropriate		
Is a basement or subsurface foundation within 100 feet of the source or source area?	N	Y	4/18/00	NA	NA	
Is a school within 1000 feet of the source or source area?	Y	Y	4/18/00	500 FT	SW	
Is a storm sewer within 50 feet of the source or source area?	Y	Y	4/18/00	30 FT	S	Unknown
Is a sanitary sewer within 50 feet of the source or source area?	Y	Y	4/18/00	40 FT	S	Unknown
Is a septic system leach field within 50 feet of the source or soruce area?	N	Y	4/18/00	NA	NA	
Is a water line main within 50 feet of source or source area?	Y	Y	4/18/00	50 FT	W	Unknown
Is a natural gas line main within 50 feet of the source or source area?	N	Y	4/18/00	NA	NA	NA
Is a buried telephone/television cable main within 50 feet of the source or source area?	Y	Y	4/18/00	40 FT	S	Unknown
Is a buried electrical cable main within 50 feet of source or source area?	Y	Y	4/18/00	40 FT	S	Unknown
Is a subway within 1000 feet of the source or source area?	N	Y	4/18/00	NA	NA	NA
Is the bedrock area prone to dissolution along joints or fractures within 100 feet of the source or source area?	N	Y	4/18/00			
Is there a fault or known fracture within 100 feet of the source or source area?	N	Y	4/18/00			

Potential Receptor Survey

Site # 11117

Source of information: Site Visit, PG&E, Pacific Bell, EBMUD, Geologic Maps of Upper Cenozoic Deposits in Central California, 1993

Verified By: William Bir Date: 4/18/00

2. Sensitive Areas

Provide Information for the following potential receptors	Yes/ No	Field Verify	Date Verify	If yes, give a brief explanation of classification
		Y/N		Complete as appropriate
Is this property classified as a sensitive area?	N	Y	4/18/00	

Source of information: California Department of Fish and Game Website *

Verified By: William Bir Date: 4/18/00

3. Drinking Water Supply

Provide Information for the following potential receptors	Yes/ No	Field Verify	Date Verify	Distance	Direction	Production Rate
		Y/N			Complete as appropriate	
Is a public water supply well within 3 miles of the source or source area?	N	Y	4/18/00			
Is a public water supply intake within 3 miles of the source or source area?	N	Y	4/18/00			
Is a private water supply well within 0.5 miles of the source or source area?	N	Y	4/18/00			

Source of information: California Dept. of Water Resources **

Verified By: William Bir Date: 4/18/00

* California Department of Fish and Game Website; Habitat Conservation Division; Wetlands Inventory and Conservation Unit; View Maps; Wetland and Riparian Classification for Bay Area Region of California (urban areas listed as "other")

** Review of DWR Well Data Sheets from the Sacramento office.

Potential Receptor Survey

Site # 11117

4. Surface Water Body

Provide Information for the following potential receptors	Yes	No	If yes, provide the following information.	
	Check one		Complete as appropriate	
Are there surface waters located within 1000 feet of the property?		✓	Name	
			Type	
			Distance from property	
			Direction from property	
			Name	
			Type	
			Distance from property	
			Direction from property	

Source of information USGS Oakland East Quad

Verified By William Bir Date 4/18/00

5. Describe type of local water supply:

Public ✓ Private ______

Supplier's Name East Bay Municipal Utilities District

Supplier's water supply source Mokelumne River

Water supply source distance and direction from property Approximately 150 Miles East

Intake distance and direction from property NA

Source of information EBMUD

Verified By William Bir Date 4/18/00

6. Aquifer Classification (include a brief explanation for classification)

______	Class I:	Special Ground Waters, Irreplaceable Drinking Water Source or Ecologically Vital
✓	Class II:	Current or Potential Drinking Water Source
______	Class III:	Not Potential Source of Drinking Water

Potential Receptor Survey — Site # 11117

Is this a sole source aquifer? Yes ____ No ✓

Depth to top of aquifer: Unknown

Source of information: California Dept. of Water Resources

Verified By: William Bir — Date: 4/18/00

7. Describe monitoring wells, if any:

Number: 7

Free Product: Yes ✓ No ____ Well(s) MW-2, MW-4

Source of information: Alisto Engineering Group

Verified By: William Bir — Date: 4/18/00

8.0 Relevant Ecological Receptors and Habitats

8.1 Property Characteristics

Size of Property (acres)	→	0.48 Acres
% of property that is wooded	→	0%
Dominant tree type	→	NA
% of property that is scrub/shrub	→	2%
Dominant Vegetation	→	Ornamental Plants/Shrubs
% of property that is open land	→	0%
% of property that is grass area	→	0%
% of property that is agricultural crops	→	0%
% of property that is barren	→	0%
% of property that is commercial or industrial use including paved areas	→	98%

Source of information: Site Visit

Verified By: William Bir — Date: 4/18/00

Potential Receptor Survey

Site # 11117

8.2 Fauna

List any fauna (e.g., mammals, birds, fish, reptiles) that are either observed or evidenced to be on property.	→	None
	→	
	→	
	→	
	→	
	→	
	→	
	→	

Source of information Site Visit

Verified By William Bir Date 4/18/00

8.3 Water Bodies on the Property

Identify the type of water body (e.g., river, creek, lake, stream)	→	None
Is water body naturally developed or man made?	→	NA
List the uses of the water body	→	NA
What is the source of the water for the water body	→	NA
What is the nature of the bottom of the water body (e.g., rocky or concrete bottom, drainage ways or impoundments)	→	NA
Describe the observed biota	→	NA

Source of information Site Visit

Verified By William Bir Date 4/18/00

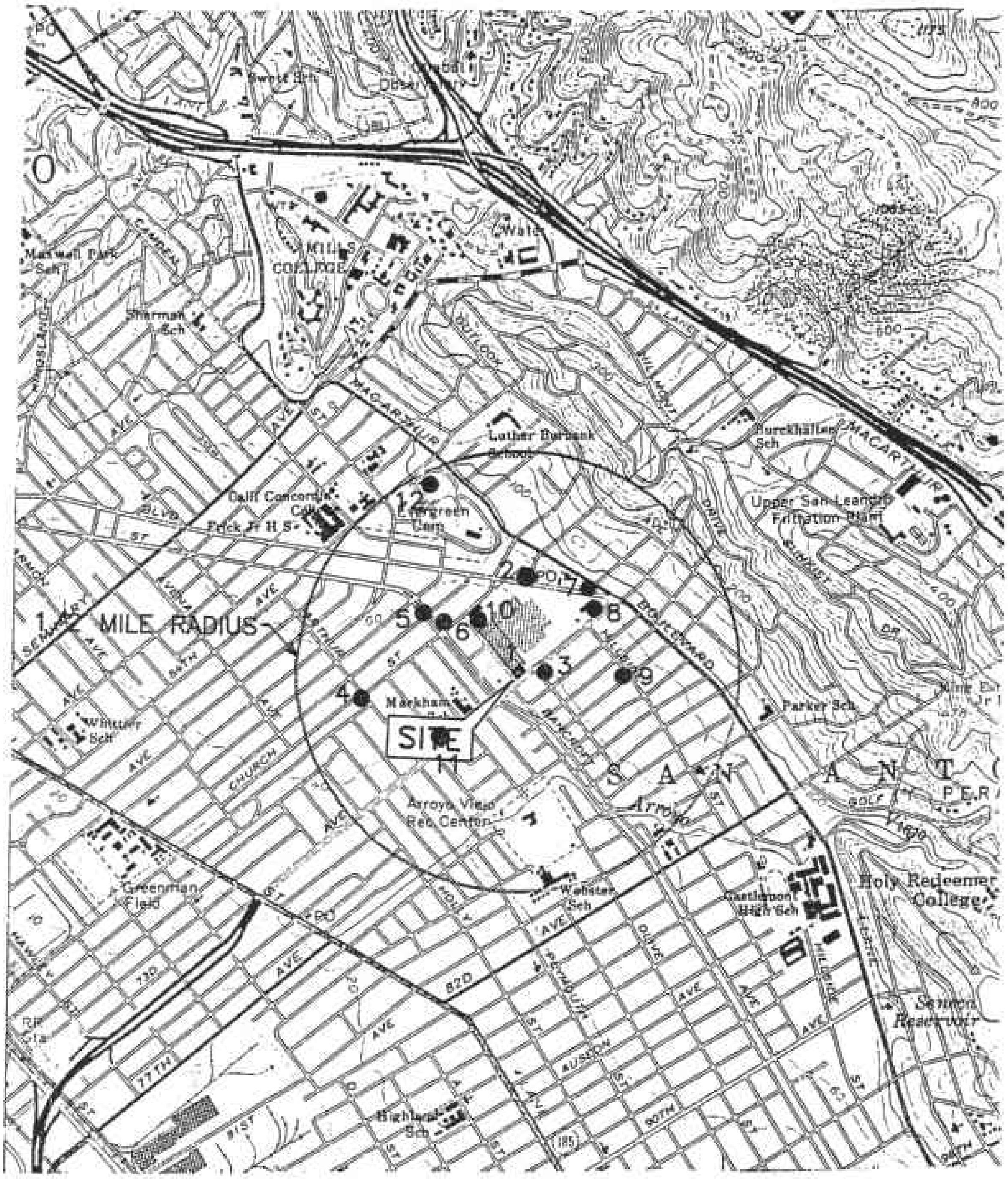
Potential Receptor Survey **Site #** 11117

8.4 *Wetlands*

Are there any wetlands present on the property?	→	No
Describe the type of vegetation present	→	NA
Identify the source of water	→	NA
Is the wetlands influenced by tidal changes?	→	NA
Describe the observed biota	→	NA

Source of information Site Visit

Verified By William Bir Date 4/18/00



● WELL LOCATION

SOURCE:
USGS MAP, OAKLAND EAST QUADRANGLE, CALIFORNIA, 7.5 MINUTE SERIES, 1959, PHOTOREVISED 1980.

N

0 1000' 2000'

CALIF
QUADRANGLE LOCATION

WELL LOCATION MAP

BP OIL SERVICE STATION NO. 11117
7210 BANCROFT AVENUE
OAKLAND, CALIFORNIA

PROJECT NO. 10-018

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

WELL SURVEY
BP Oil Co. Service Station No. 11117
7210 Bancroft Avenue
Oakland, California

Alisto Project No. 10-018

COUNTY\STATE WELL NO.	ALISTO MAP REFERENCE NO.	OTHER WELL NO.	WELL OWNER	WELL DEPTH (feet)	SEAL DEPTH (feet)	WELL USE	STATUS
2S/13W10Q8	1	MW-1	BP Oil Company 2868 Prospect Park Drive Rancho Cordova, CA 95670	40	19	Monitoring	Active
2S/3W10Q9	1	MW-2	BP Oil Company 2868 Prospect Park Drive Rancho Cordova, CA 95670	40	18	Monitoring	Active
2S/3W10Q3	1	MW-3	Topa Savings Bank 1800 Avenue of the Stars Los Angeles, CA 90067	45	25	Test Well	Active
2S/3W10Q09	1	MW-4	BP Oil Company 16400 South Center Pkwy, Ste. 300 Tukwila, WA 98188	40	18	Monitoring	Active
2S/3W10Q10	1	MW-6	BP Oil Company 16400 South Center Pkwy, Ste. 300 Tukwila, WA 98188	40	18	Monitoring	Active
2S/3W10Q1	2		Chevrolet-Oakland Div. of GM Foothill Boulevard and 69th Avenue Oakland, CA	400	0	Industrial	Unknown
2S/3W10Q	3	3350B	East Bay M.U.D. 2139 Adeline Street Oakland, CA 94607	65	33	Cathodic Protection	Active
2S/3W10P1	4	1-1253	Pacific Gas & Electric 4801 Oakport Street Oakland, CA 94601	120	120	Cathodic Protection	Active
2S/3W10L1	5		Exxon Oil USA	50	20	Other/ Monitoring	Unknown
2S/3W10K1	6	MW-2	Topa Savings Bank 1800 Avenue of the Stars Los Angeles, CA 90067	35	15	Test Well	Active
2S/3W10J1	7	MW-4	Topa Savings Bank 1800 Avenue of the Stars Los Angeles, CA 90067	25	8	Test Well	Active

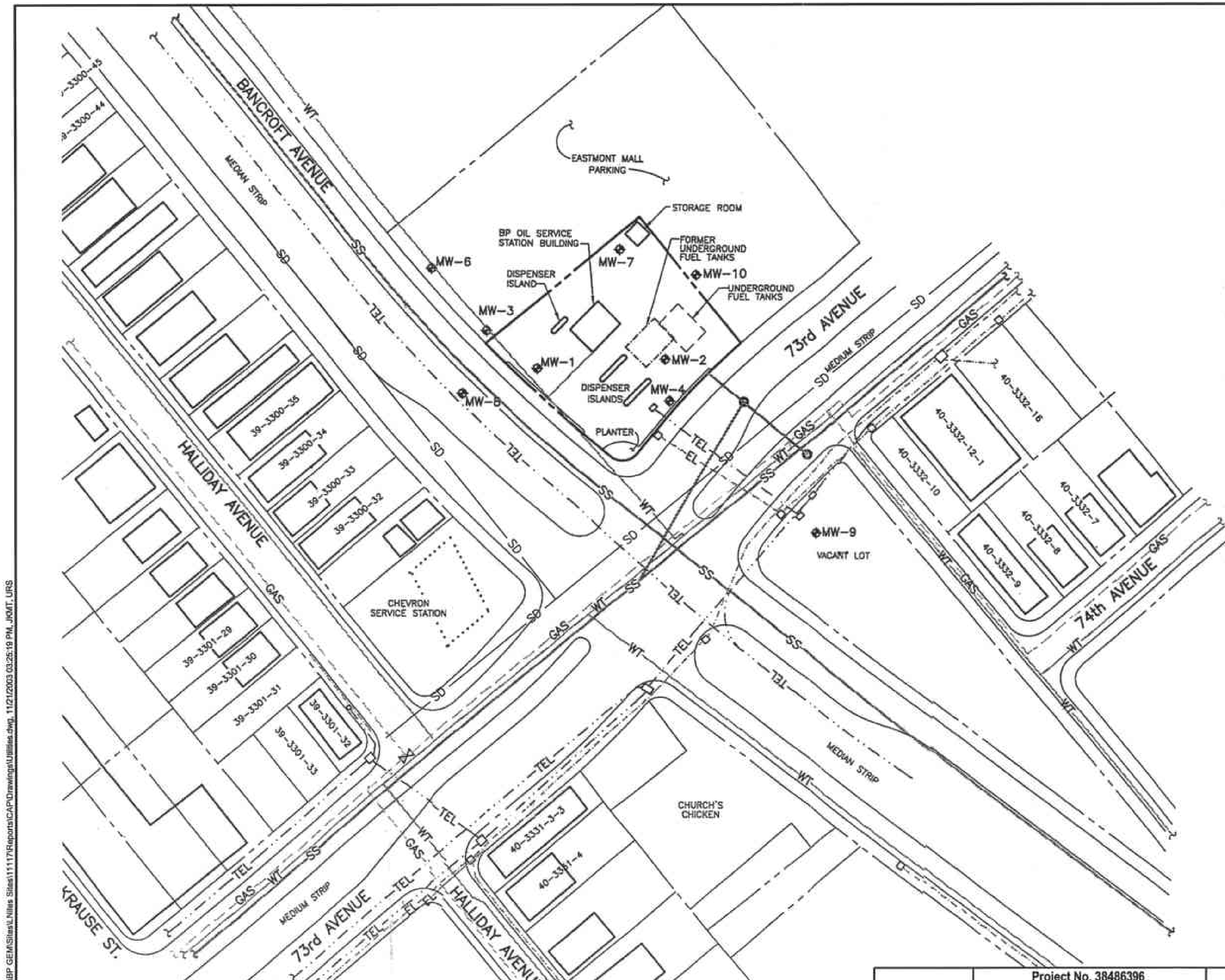
WELL SURVEY
BP Oil Co. Service Station No. 11117
7210 Bancroft Avenue
Oakland, California

Alisto Project No. 10-018

COUNTY\STATE WELL NO.	ALISTO MAP REFERENCE NO.	OTHER WELL NO.	WELL OWNER	WELL DEPTH (feet)	SEAL DEPTH (feet)	WELL USE	STATUS
2S/3W10J4	8		City of Oakland 7100 Foothill Boulevard Oakland, CA 94605	25	9	Monitoring	Active
2S/3W10R1	9		Pacific Gas & Electric 4801 Oakport Street Oakland, CA	120	Unknown	Cathodic Protection	Active
2S/3W10Q11-15	10	MW-5	Eastmont Mall One Eastmont Mall Oakland, CA 94605	50	28	Monitoring	Active
2S/3W10Q11-15	10	MW-6	Eastmont Mall One Eastmont Mall Oakland, CA 94605	50	28	Monitoring	Active
2S/3W10Q11-15	10	MW-7	Eastmont Mall One Eastmont Mall Oakland, CA 94605	50	23	Monitoring	Active
2S/3W10Q11-15	10	MW-8	Eastmont Mall One Eastmont Mall Oakland, CA 94605	49	25	Monitoring	Active
2S/3W10Q11-15	10	MW-9	Eastmont Mall One Eastmont Mall Oakland, CA 94605	50	33	Monitoring	Active
2S/3W-10J2	10	DM-1	J. C. Penny's	28	10	Monitoring	Active
2S/3W-10J3	10	DM-2	J. C. Penny's	28	8	Monitoring	Active
2S/3W15C1	11		East Bay Municipal Utilities P.O. Box 24055 Oakland, CA 94623	65	53	Cathodic Protection	Unknown
2S/3W10G1	12		Evergreen Cemetery 64th Ave. Oakland, CA	440	0	Irrigation	Unknown

ATTACHMENT G

Underground Utility Location Map



EXPLANATION

Symbol	Description
⊕	Monitoring Well Location
?	Assessor's Parcel Number
▦	Drop Inlet Grate
o	Manhole
□	Above Ground Transformer
⊠	Television Cable Vault
SSCO o	Sanitary Sewer Cleanout
	Fire Hydrant
⋈	Valve
	Power Pole

UNDERGROUND UTILITY LINES

Symbol	Description
SS	Sanitary Sewer Pipe
SD	Storm Drain Pipe
WT	Water Service Pipe
GAS	Gas Pipe
EL	Electrical Line
TEL	Telephone Line
TCL	Television Cable Line
	Unknown Destination
	End Of Pipe
(?)	Invert Elevation Relative To Bench Mark

NOTE:

Location of utilities are approximate and based upon information provided at the time of preparation. This map is not to be used for any construction or related activities.

N

0 40 80 120

Scale (ft)

X:\x_env_waste\BP GEM\Sites\LNilles Sites\11117\Reports\CAP\Drawings\Utilities.dwg, 11/21/2003 03:25:19 PM, JKMT, URS

NOTE: SITE MAP ADAPTED FROM ALISTO ENGINEERING GROUP FIGURES.
SITE DIMESIONS AND FACILITY LOCATIONS NOT VERIFIED.

SOURCE: Pacific Gas and Electric Company, Pacific Bell, East Bay Municipal Utility District, City Of Oakland, Alameda County Assessor's Office.

URS	Project No. 38486396	UTILITIES SITE MAP
	ARCO Service Station #11117 7210 Bancroft Avenue Oakland, California	

ATTACHMENT H

Standard Direct Push/ GeoProbe™ Drilling and Sampling Procedures (US EPA Expedited Site Assessment Guidelines, Chapter V)

Chapter V
Direct Push Technologies

Direct push (DP) technology (also known as "direct drive," "drive point," or "push" technology) refers to a growing family of tools used for performing subsurface investigations by driving, pushing, and/or vibrating small-diameter hollow steel rods into the ground. By attaching sampling tools to the end of the steel rods they can be used to collect soil, soil-gas, and groundwater samples. DP rods can also be equipped with probes that provide continuous *in situ* measurements of subsurface properties (*e.g.*, stratigraphy, contaminant distribution). DP equipment can be advanced with various methods ranging from 30 pound manual hammers to trucks weighing 60 tons.

DP technology has developed in response to a growing need to assess contaminated sites more completely and more quickly than is possible with conventional methods. As explained in Chapter II, The Expedited Site Assessment Process, conventional assessments have relied heavily on traditional drilling methods, primarily hollow stem augers (HSA), to collect soil and groundwater samples and install permanent monitoring wells. Because installing permanent monitoring wells with HSA is a relatively slow process that provides a limited number of samples for analysis, the most economical use for the equipment is to perform site assessments in phases with rigid work plans and off-site analysis of samples.

With the development of DP technologies, large, permanent monitoring wells are no longer the only method for collecting groundwater samples or characterizing a site. Multiple soil, soil-gas, and groundwater samples can now be collected rapidly, allowing high data quality analytical methods to be used on-site, economically. As a result, DP technologies have played a major role in the development of expedited site assessments (ESAs).

DP technologies are most applicable in unconsolidated sediments, typically to depths less than 100 feet. In addition to being used to collect samples from various media, they can also be used to install small-diameter (*i.e.*, less than 2 inches) temporary or permanent monitoring wells and small-diameter piezometers (used for measuring groundwater gradients). They have also been used in the installation of remediation equipment such as soil vapor extraction wells and air sparging injection points. Penetration is limited in semiconsolidated sediments and is generally not possible in consolidated formations, although highly weathered bedrock (*i.e.*, saprolite) is an exception for some equipment. DP equipment may also be limited in unconsolidated sediments with high percentages of gravels and cobbles. As a result, other drilling methods are necessary in site assessment and remediation activities where geological conditions are unfavorable for DP technologies or where larger diameter (*i.e.*, greater than 2 inches) wells are needed.

An additional benefit of DP technologies is that they produce a minimal amount of waste material because very little soil is removed as the probe rods advance and retract. Although this feature may result in some soil compaction that could reduce the hydraulic conductivity of silts and clays, methods exist for minimizing resulting problems.

In contrast, although most other drilling methods remove soil from the hole, resulting in less compaction, conventional drilling methods create a significant amount of contaminated cuttings and they also smear clay and silt across more permeable formations which can obscure their true nature. Moreover, these other drilling methods have the potential of causing a redistribution of contamination as residual and free product are brought to the surface.

Choosing a DP method (or combination of DP methods) appropriate for a specific site requires a clear understanding of data collection goals because many tools are designed for only one specific purpose (*e.g.*, collection of groundwater samples). This chapter contains descriptions of the operation of specific DP systems and tools, highlighting their main advantages and limitations; its purpose is to assist regulators in evaluating the appropriateness of these systems and tools.

This chapter does not contain discussions of specific tools manufactured by specific companies because equipment is evolving rapidly. Not only are unique tools being invented, but existing equipment is being used in creative ways to meet the needs of specific site conditions. As a result, the distinctions between types of DP equipment is becoming blurred and it is necessary to focus on component groups rather than entire DP systems. The four component groups discussed in this chapter include:

- Rod systems;
- Sampling tools;
- *In situ* measurements using specialized probes; and
- Equipment for advancing DP rods.

The chapter also includes a discussion of methods for sealing DP holes because of their importance in preventing the spread of contaminants and, therefore, in the selection of DP equipment. The cost of various DP equipment is not discussed in this chapter because cost estimates become quickly outdated due to rapid changes in the industry. An overview of the advantages and limitations of DP equipment and systems discussed in this chapter are presented in Exhibit V-1.

Exhibit V-1
Overview Of Direct Push Technologies

Direct Push Component	Example	Advantages	Limitations
Probing systems	Single-rod or cased	Minimizes the need for waste disposal or treatment	Compaction of sediments may decrease hydraulic conductivity
Soil, soil-gas, and groundwater sampling	Piston samplers, expendable tip samplers	Relatively rapid	Permanent monitoring wells are limited to 2 inch diameter or less
In situ measurement of subsurface conditions	Conductivity probes, laser induced fluorescence	Can be used to rapidly log site	Correlation with boring logs is necessary
Methods for advancing probe rods	Percussion hammers, hydraulic presses	Some methods are extremely portable	Very dense, consolidated formations are generally impenetrable
Sealing methods	Re-entry grouting, retraction grouting	Holes can be sealed so that contaminants cannot preferentially migrate through them	Appropriate sealing methods may limit sampling equipment options

DP systems use hollow steel rods to advance a probe or sampling tool. The rods are typically 3-feet long and have male threads on one end and female threads on the other. As the DP rods are pushed, hammered, and/or vibrated into the ground, new sections are added until the target depth has been reached, or until the equipment is unable to advance (*i.e.*, refusal). There are two types of rod systems, single-rod and cased. Both systems allow for the collection of soil, soil-gas, and groundwater samples. Exhibit V-2 presents a schematic drawing of single-rod and cased DP rod systems.

Single-Rod Systems

Single-rod systems are the most common types of rods used in DP equipment. They use only a single string (*i.e.*, sequence) of rods to connect the probe or sampling tool to the rig. Once a sample has been collected, the entire string of rods must usually be removed from the probe hole. Collection of samples at greater depths may require re-entering the probe hole with an empty sampler and repeating the process. The diameter of the rods is typically around 1 inch, but it can range from 0.5 to 2.125 inches.

Cased Systems

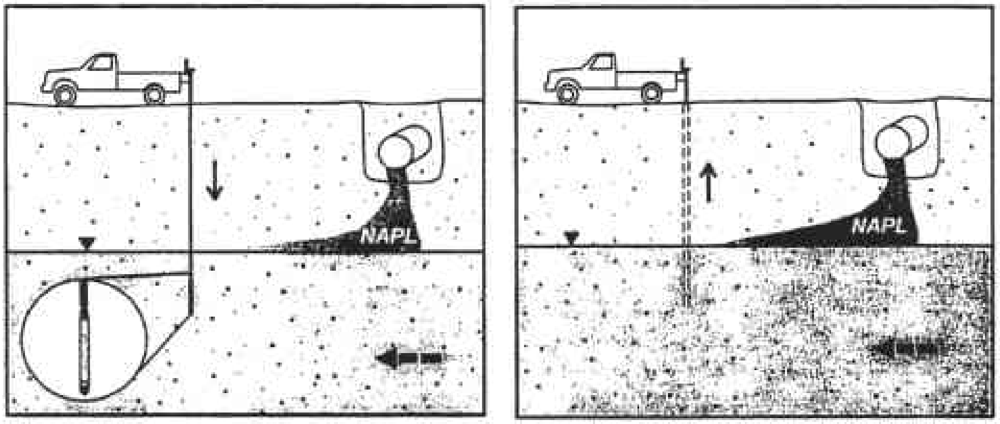
Cased systems, which are also called dual-tube systems, advance two sections--an outer tube, or casing, and a separate inner sampling rod. The outer casing can be advanced simultaneously with, or immediately after, the inner rods. Samples can, therefore, be collected without removing the entire string of rods from the ground. Because two tubes are advanced, outer tube diameters are relatively large, typically 2.4 inches, but they can range between 1.25 and 4.2 inches.

Discussion And Recommendations

Single-rod and cased systems have overlapping applications; they can be used in many of the same environments. However, when compared with cased systems, single-rod systems are easier to use and are capable of collecting soil, soil-gas, or groundwater samples more rapidly when only one sample is retrieved. They are particularly useful at sites where the stratigraphy is either relatively homogeneous or well delineated.

Exhibit V-2
Schematic Drawing Of Single And Cased Direct Push Rod Systems

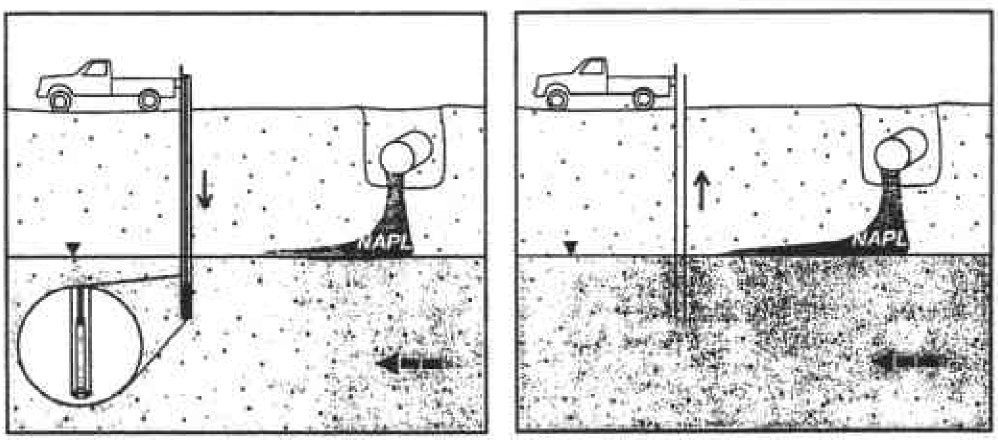
Single-Rod Direct Push System



1) DP sampling tool is advanced on the end of a single sequence of rods.

2) Once the sampling tool is full, tool and rods are withdrawn from the ground. To collect another sample, the tool must be re-inserted and pushed to the next sampling depth.

Cased Direct Push System



1) DP sampling tool is attached to inner rods. Sampling tool, inner rods, and outer drive casing are advanced simultaneously.

2) To collect the sample, only the sampling tool and inner rods are removed. The outer drive casing remains in the ground to prevent sloughing or hole collapse. To collect a deeper sample, the tool and inner rods are re-inserted to the bottom of probe hole and advanced along with the outer drive casing. The outer casing is removed only after the last sample has been collected.

The primary advantage of cased DP systems is that the outer casing prevents the probe hole from collapsing and sloughing during sampling. This feature allows for the collection of continuous soil samples that do not contain any slough, thereby preventing sample contamination. Because only the inner sample barrel is removed, and not the entire rod string, cased systems are faster than single-rod systems for continuous sampling at depths below 10 feet. The collection of continuous samples is especially important at geologically heterogeneous sites where direct visual observation of lithology is necessary to ensure that small-scale features such as sand stringers in aquitards or thin zones of non-aqueous-phase liquids (NAPLs) are not missed.

Another advantage of cased systems is that they allow sampling of groundwater after the zone of saturation has been identified. This feature allows investigators to identify soils with relatively high hydraulic conductivities from which to take groundwater samples. If only soils with low hydraulic conductivity are present, investigators may choose to take a soil sample and/or install a monitoring well. With most single-rod systems, groundwater samples must be taken without prior knowledge of the type of soil present. (Some exposed-screen samplers used with single-rod systems as described in the *Groundwater Sampling Tools* section are an exception.)

A major drawback of single-rod systems is that they can be slow when multiple entries into the probe hole are necessary, such as when collecting continuous soil samples. In addition, in non-cohesive formations (*i.e.*, loose sands), sections of the probe hole may collapse, particularly in the zone of saturation, enabling contaminated soil present to reach depths that may be otherwise uncontaminated. Sloughing soils may, therefore, contaminate the sample. This contamination can be minimized through the use of sealed soil sampling tools (*i.e.*, piston samplers, which are discussed in more detail in the *Soil Sampling Tools* section that follows).

Multiple entries made with single-rod systems into the same hole should be avoided when NAPLs are present because contaminants could flow through the open hole after the probe rods have been removed; particularly if dense-non-aqueous phase liquids (DNAPLs) are present. In addition, multiple entries into the probe hole may result in the ineffective sealing of holes. (These issues are discussed in more detail in *Methods For Sealing Direct Push Holes* at the end of the chapter.) If samples need to be taken at different depths in zones of significant NAPL contamination, single-rod systems can be used, but new entries into soil should be made next to previous holes.

The major drawback of cased systems is that they are more complex and difficult to use than single-rod systems. In addition, because they require larger-diameter probe rods, cased systems require heavier DP rigs, larger percussion hammers, and/or vibratory systems for advancing the probe rod. Furthermore, even with the additional equipment, penetration depths are often not as great as are possible with single-rod systems and sampling rates are slower when single, discrete samples are collected. Exhibit V-3 summarizes the comparison of single and cased systems.

Exhibit V-3
Comparison Of Single-Rod And Cased Systems

	Single-Rod	Cased
Allows collection of a single soil, soil-gas, or groundwater sample	✓ (faster)	✓
Allows collection of continuous soil samples	✓[1]	✓[2] (faster)
Allows collection of groundwater sampling after determining ideal sampling zone[3]		✓
Lighter carrier vehicles can be used to advance rods	✓	
Greater penetration depths	✓	
Multiple soil samples can be collected when NAPLs are present		✓

[1] Sloughed soil may also be collected.
[2] Faster at depths below approximately 10 feet.
[3] Some exposed-screen samplers, discussed in the groundwater sampling section, also have this ability.

A large number of DP tools have been developed for sampling soil, soil-gas, and groundwater. Each of these tools was designed to meet a specific purpose; however, many of these tools also have overlapping capabilities. This section describes the commonly used tools currently available and clarifies their applications. All of the tools described in this section can be advanced by rigs designed specifically for DP. In addition, many of these tools can also be used with conventional drilling rigs.

Soil Sampling Tools

There are two types of soil samplers: Nonsealed and sealed. Nonsealed soil sampling tools remain open as they are pushed to the target depth; sealed soil samplers remain closed until they reach the sampling depth.

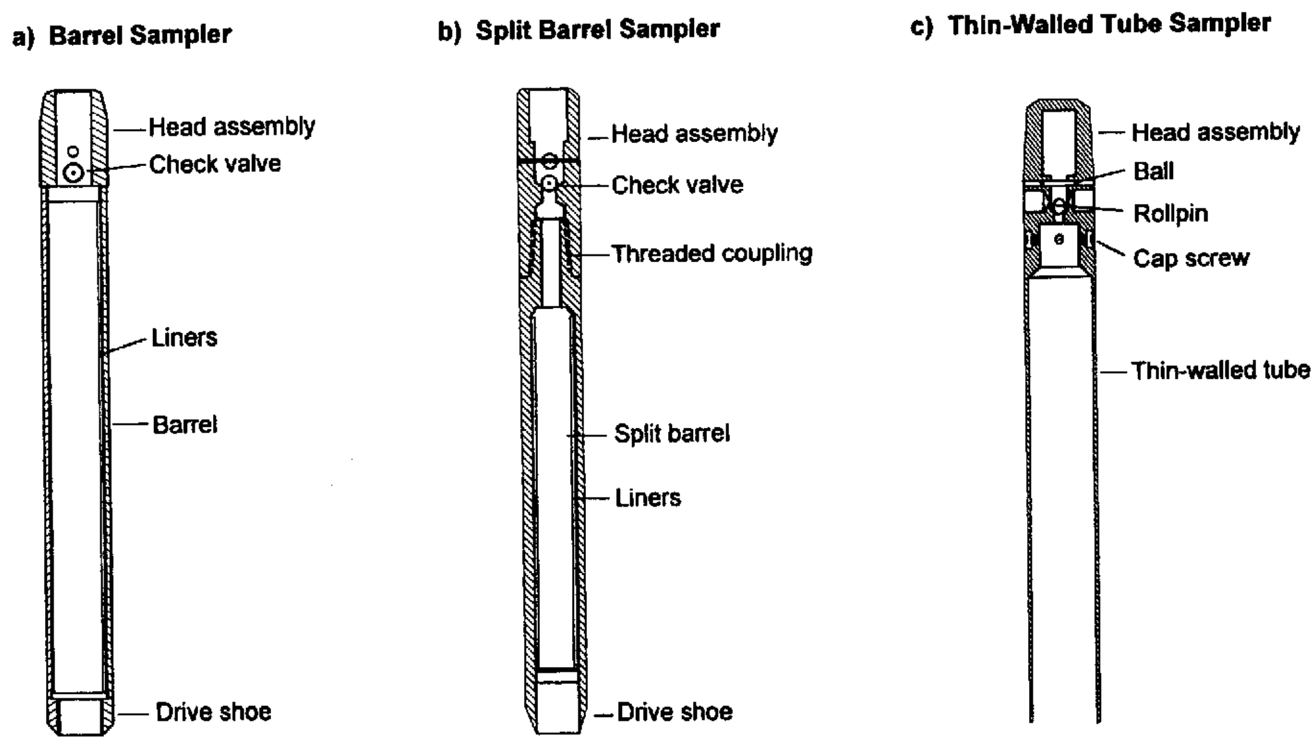
Nonsealed Soil Samplers

The three most commonly used nonsealed soil samplers are barrel, split-barrel, and thin-walled tube samplers. All three are modified from soil samplers used with conventional drilling rigs (*e.g.*, HSA). The primary difference is that DP soil samplers have smaller diameters. Nonsealed soil samplers should only be used in combination with single-rod systems when sampling in uncontaminated fine-grained, cohesive formations because multiple entries into the probe hole are required. When sloughing soils and cross-contamination are a significant concern, nonsealed soil samplers may be used with cased DP systems or more conventional sampling methods (*e.g.*, HSA). In addition, nonsealed samplers necessitate continuous soil coring because there is no other way to remove soil from the hole. All three types of nonsealed soil sampling tools are presented in Exhibit V-4.

Barrel Samplers

Barrel samplers, also referred to as solid-barrel or open-barrel samplers, consist of a head assembly, a barrel, and a drive shoe (Exhibit V-4a). The sampler is attached to the DP rods at the head assembly. A check valve, which allows air or water to escape as the barrel fills with soil, is located within the head assembly. The check valve improves the amount of soil recovered in each sample by allowing air to escape. With the use of liners, samples can be easily removed for volatile organic compound (VOC) analysis or for observation of soil structure.

Exhibit V-4
Types Of Nonsealed Direct Push Soil Sampling Tools



Source: Christensen/Acker

Without the use of liners, soil cores must be physically extruded using a hydraulic ram which may damage fragile structures (*e.g.*, root holes, desiccation cracks).

Split-Barrel Samplers

Split-barrel samplers, also referred to as "split-spoon" samplers, are similar to barrel samplers except that the barrels are split longitudinally (Exhibit V-4b) so that the sampler can be easily opened. The primary advantage of split-barrel samplers is that they allow direct observation of soil cores without the use of liners and without physically extruding the soil core. As a result, split-barrel samplers are often used for geologic logging. Split-barrel samplers, however, may cause more soil compaction than barrel samplers because the tool wall thickness is often greater. In addition, although liners are not compatible with all split-barrel samplers, liners are necessary if samples are used for analysis of VOCs.

Thin-Wall Tube Samplers

Thin-wall tube samplers (larger diameter samplers are known as Shelby Tubes) are DP sampling tools used primarily for collecting undisturbed soil samples (Exhibit V-4c). The sampling tube is typically attached to the sampler head using recessed cap screws or rubber expanding bushings. The walls of the samplers are made of thin steel (*e.g.*, 1/16-inch thick). The thin walls of the sampler cause the least compaction of the soil, making it the DP tool of choice for geotechnical sample analysis (*e.g.*, laboratory measurement of hydraulic conductivity, moisture content, density, bearing strength).

Samples are typically preserved, inside the tube, for off-site geotechnical analysis. If the samples are intended for on-site chemical analysis, they can be extruded from the sampler using a hydraulic ram, or the tubes can be cut with a hacksaw or tubing cutter. Because of their fragile construction, thin-wall tube samplers can be used only in soft, fine-grained sediments. In addition, the sampler is usually pushed at a constant rate rather than driven with impact hammers. If samples are needed for off-site VOC analysis, the tube is used as the sample container which can be capped and preserved.

Sealed Soil (Piston) Samplers

Piston samplers are the only type of sealed soil sampler currently available. They are similar to barrel samplers, except that the opening of the sampler is sealed with a piston. Thus, while the sampler is re-inserted into an open probe hole, contaminated soil and water can be prevented from entering the sampler. The probe displaces the soil as it is advanced. When the sampler has been pushed to the desired sampling depth, the piston is unlocked by releasing a retaining device, and subsequent pushing or driving forces soil into the sampler (Exhibit V-5).

Several types of piston samplers are currently available. Most use a rigid, pointed piston that displaces soil as it is advanced. Piston samplers are typically air- and water-tight; however, if o-ring seals are not maintained, leakage may occur. Piston samplers also have the advantage of increasing the recovery of unconsolidated sediments as a result of the relative vacuum that is created by the movement of the piston.

Discussion And Recommendations

Issues affecting the selection of soil samplers include the ability of the sampler to provide samples for lithological description, geotechnical characterization, or chemical analysis. In addition, the potential of a sample contamination with a specific sampler must be considered.

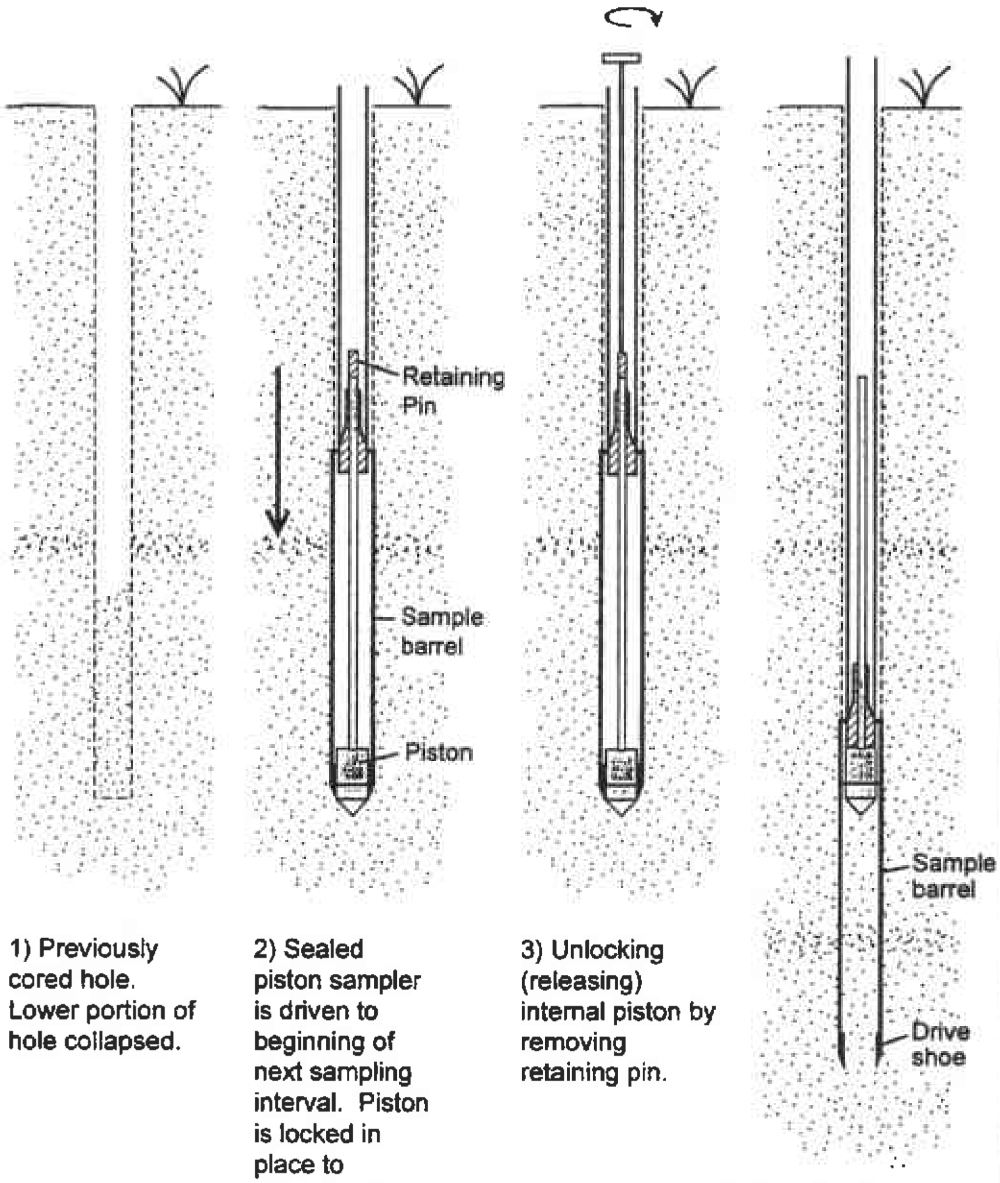
Lithologic Description/Geotechnical Characterization

All soil samplers can be used to some extent for lithologic description and geotechnical characterization but because the disturbance to the sample varies between tools, the preferred tool will vary depending on the application. Split-barrel samplers or barrel samplers used with split-liners are the best DP sampling methods for lithological description because they allow the investigator to directly inspect the soil without further disturbing the sample. Thin-walled tube samplers are best for collecting undisturbed samples needed for geotechnical analysis; barrel and piston samplers are the next best option. With single-rod systems, piston samplers are the only tools that can reliably be used for these same objectives because they produce discrete soil samples.

Chemical Analysis

All sealed or nonsealed soil samplers can be used for the collection of samples for VOC analysis. If samples are analyzed on-site, liners of various materials (*e.g.*, brass, stainless steel, clear acrylic, polyvinylchloride [PVC]) can be used as long as the soil is immediately subsampled and preserved. Soil samples intended for off-site analysis should be collected directly into brass or stainless steel liners within the DP soil sampling tool. Once the tool has been retrieved, the liners can be immediately capped, minimizing the loss of VOCs. Unfortunately, without extruding the soil core from the metal liners, detailed

Exhibit V-5
Using The Sealed Direct Push Soil Sampler (Piston Sampler)



1) Previously cored hole. Lower portion of hole collapsed.

2) Sealed piston sampler is driven to beginning of next sampling interval. Piston is locked in place to prevent soil and water from entering sample barrel.

3) Unlocking (releasing) internal piston by removing retaining pin.

4) Sampler driven to collect next soil core. Piston remains stationary while sample barrel is advanced. Soil core is retrieved by removing entire assembly from hole.

Source: Geoprobe® Systems

logging of the soil core is not possible. Short liners (4 to 6 inches long) may be useful for providing a minimal amount of lithological information. The soil lithology can be roughly discerned by inspecting the ends of the soil-filled liners; specific liners can then be sealed and submitted for chemical analysis. Extruding soil cores directly into glass jars for chemical analysis should be avoided since up to 90 percent of the VOCs may be lost from the sample (Siegrist, 1990).

Sample Contamination

The potential for sample contamination will depend on both the type of soil sampler and the type of DP rod system. The major concern with nonsealed samplers is that the open bottom may, when used with single-rod systems, allow them to collect soil that has sloughed from an upper section of the probe hole; they, therefore, may collect samples that are not representative of the sampling zone. If the sloughed soil contains contaminants, an incorrect conclusion could be made regarding the presence of contaminants at the target interval. Alternatively, if the overlying soil is less contaminated than the soil in the targeted interval, erroneously low concentrations could be indicated. As a result, nonsealed samplers should not be used with single-rod DP systems where contaminated soils are present. In such cases, piston samplers are the only appropriate soil samplers.

Nonsealed samplers can be safely used with cased DP systems above the water table. When sampling below the water table, particularly through geological formations with a high hydraulic conductivity, nonsealed samplers should not be used because contaminated water can enter the drive casing. In this situation, water-tight piston samplers must be used in combination with cased DP systems. In many low permeability formations, water does not immediately enter the outer drive casing of cased DP systems, even when the casing is driven to depths well below the water table. In these settings the potential for sample contamination is greatly reduced, and nonsealed soil samplers can be lowered through the outer casing. A summary of sealed and nonsealed soil samplers is presented in Exhibit V-6.

Active Soil-Gas Sampling Tools

Chapter IV, Soil-Gas Surveys, discusses the methods, capabilities, and applicabilities of both active and passive soil-gas surveys. Because active soil-gas sampling is performed with DP equipment, the various DP tools used in the collection of active soil-gas samples are covered in this section.

Exhibit V-6
Summary Of Sealed And Nonsealed Soil Sampler Applications

		Single-Rod System		Cased System	
		Nonsealed	Sealed	Nonsealed	Sealed
Sampling Above Watertable	NAPLs Not Present	✓[1]	✓	✓	✓
	NAPLs Present		✓	✓	✓
Sampling Below Watertable	NAPLs Not Present	✓[1]	✓	✓	✓
	NAPLs Present		✓	✓[2]	✓

[1] Fine-grained (cohesive) formations where probe hole does not collapse.
[2] In low permeability soil where groundwater does not enter drive casing.

In active soil-gas sampling, a probe rod is pushed (either manually or mechanically) to a specified depth below the ground surface (bgs) into the vadose zone. A vacuum is applied to the rods (or tubing within the rods), and the sample is collected. The use of probe tips with larger diameters than the probe rods is a practice that should be discouraged when soil-gas sampling. Some DP practitioners use these large tips in order to reduce friction on advancing probe rods and therefore increase depth of penetration. This practice, however, will increase the likelihood of sampling atmospheric gases and diluting constituent concentrations.

There are four variations of soil-gas sampling tools and procedures: expendable tip samplers, retractable tip samplers, exposed samplers, and cased system sampling. Exhibit V-7 presents several soil-gas sampling tools.

Expendable Tip Samplers

Expendable cone-shaped tips, made of either steel or aluminum, are held in a tip holder as the DP rod advances (Exhibit V-7a_1). Once the desired depth has been reached, the DP rods are pulled back a few inches (Exhibit V-7a_2) and the tip can be separated from the tip holder, exposing the soil. Deeper samples can be collected in the same hole by withdrawing the probe and attaching another expendable tip. The previous tip can usually be pushed out of the way in most soils; however, some soils (*e.g.*, dense clays) may prevent the tip from moving and, therefore, prevent re-entry into the same hole.

accomplished, but it requires longer sampling times and investigators must ensure that probe rod joints are completely sealed.

If a soil-gas survey requires multi-level sampling, retraction tip samplers are applicable; however, these samplers require multiple entries into the same probe hole. Exposed screen samplers and cased systems allow for rapid sampling without the problems associated with multiple entry (discussed previously in the *Direct Push Rod System* section). However, exposed samplers may also result in sample contamination if NAPLs are dragged down in the slots or screen.

If soil gas is to be sampled in fine-grained sediments, sampling through tubing should be used to minimize sample volumes and the rod string should be withdrawn a greater distance than normal in order to expose a larger sampling interval. Alternatively, expendable tip samplers and cased systems may be useful if macropores (*e.g.*, root holes, desiccation cracks) exist. These features may be sealed by the advancing probe rod. Expendable tip and cased systems may allow brushes to be inserted into the sampling zone to scour away compacted soil, thus restoring the original permeability. Exhibit V-8 provides a summary of the applicability of the soil-gas sampling tools discussed in this section.

Groundwater Sampling Tools

DP technologies can be used in various ways to collect groundwater samples. Groundwater can be collected during a one-time sampling event in which the sampling tool is withdrawn and the probe hole grouted after a single sample is collected; groundwater sampling tools can be left in the ground for extended periods of time (*e.g.*, days, weeks) to collect multiple samples; or, DP technologies can be used to construct monitoring wells that can be used to collect samples over months or even years.

In general, when the hydraulic conductivity of a formation reaches 10^{-4} cm/second (typical for silts), collection of groundwater samples through one-time sampling events is rarely economical. Instead, collection of groundwater samples requires the installation of monitoring devices that can be left in the ground for days, weeks, or months. In general, however, it is difficult to get an accurate groundwater sample in low permeability formations with any method (whether DP or rotary drilling) because the slow infiltration of groundwater into the sampling zone may cause a significant loss of VOCs. As a result, DP groundwater sampling is most appropriate for sampling in fine sands or coarser sediments.

As with soil-gas sampling, probe tips for one-time groundwater sampling events should not be larger than DP rods because they can create an open annulus that could allow for contaminant migration. When installing long-term monitoring points, large tips can be used in conjunction with sealing methods that do not allow contaminant migration (*e.g.*, grouting to the surface).

Although most DP groundwater sampling equipment can also be used for determining groundwater gradients, using piezometers (*i.e.*, non-pumping, narrow, short-screened wells used to measure potentiometric pressures, such as the water table elevation) early in a site assessment is typically the best method. Piezometers are quick to install; they are inexpensive to purchase, and, because of their narrow diameter, they are quick to reach equilibrium. DP-installed monitoring wells may also be used for this purpose; however, they are more appropriate for determining groundwater contaminant concentrations once groundwater gradients and site geology have been characterized. Undertaking these activities first greatly simplifies the task of determining contaminant location, depth, and flow direction.

Methods now exist for installing permanent monitoring wells with both single-rod and cased DP systems (Exhibit V-9). These methods allow for the installation of annular seals that isolate the sampling zone. In addition, some methods allow for the installation of fine-grained sand filter packs that can provide samples with low turbidity (although the need for filter packs is an issue of debate among researchers). When samples are turbid, they should not be filtered prior to the constituent extraction process because organic constituents can sorb onto sediment particles. As a result, filtering samples prior to extraction may result in an analytical negative bias. For further information on the need for sediment filtration, refer to Nielsen, 1991.

The following text focuses on the tools used for single-event sampling. These tools can be divided into two groups--exposed-screen samplers and sealed-screen samplers. Exhibit V-10 presents examples of these two groups of groundwater samplers. Exhibit V-10a is a simple exposed-screen sampler; Exhibit V-10b is a common sealed-screen sampler; and Exhibit V-10c is a sealed-screen sampling method used with cased systems. Because new tools are continually being invented, and because of the great variety of equipment currently available, this *Guide* can not provide a detailed description and analysis of all available groundwater sampling tools. Instead, the advantages and limitations of general categories of samplers is discussed.

Exposed-Screen Samplers

Exposed-screen samplers are water sampling tools that have a short (*e.g.*, 6 inches to 3 feet) interval of exposed fine mesh screens, narrow slots, or small holes at the terminal end of the tool. The advantage of the exposed screen is

Exhibit V-9
Permanent Monitoring Well Installed
With Pre-packed Well Screens

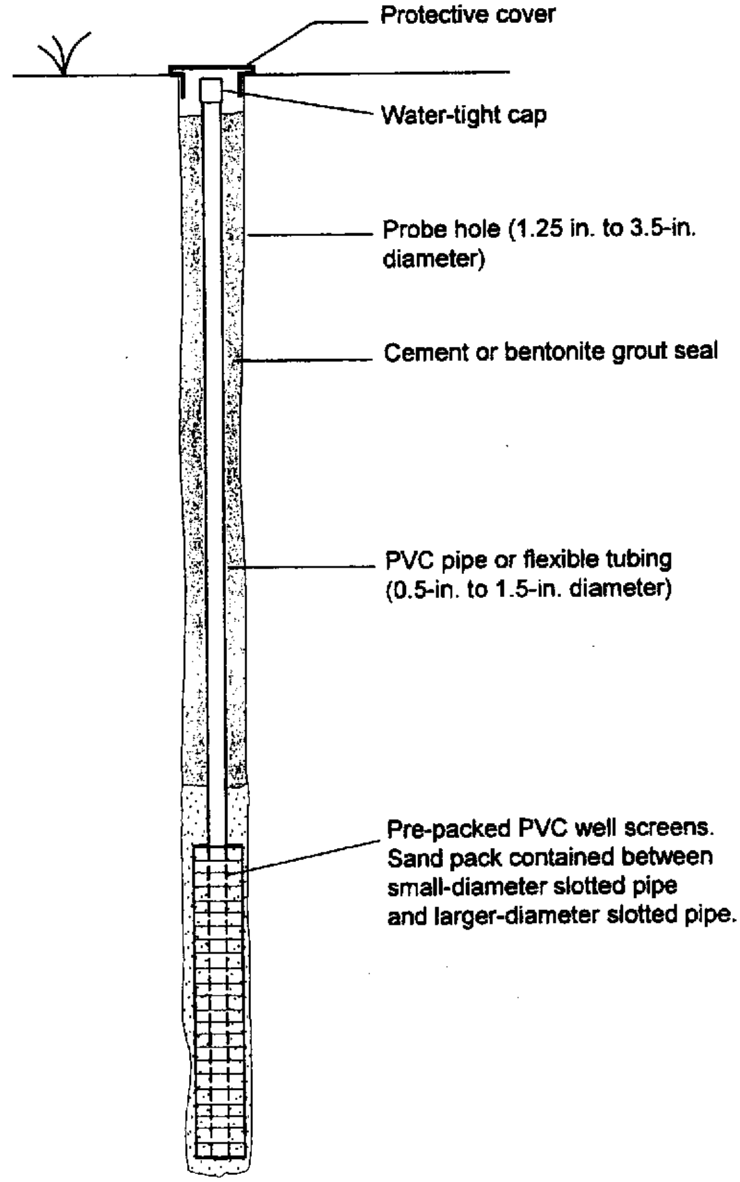
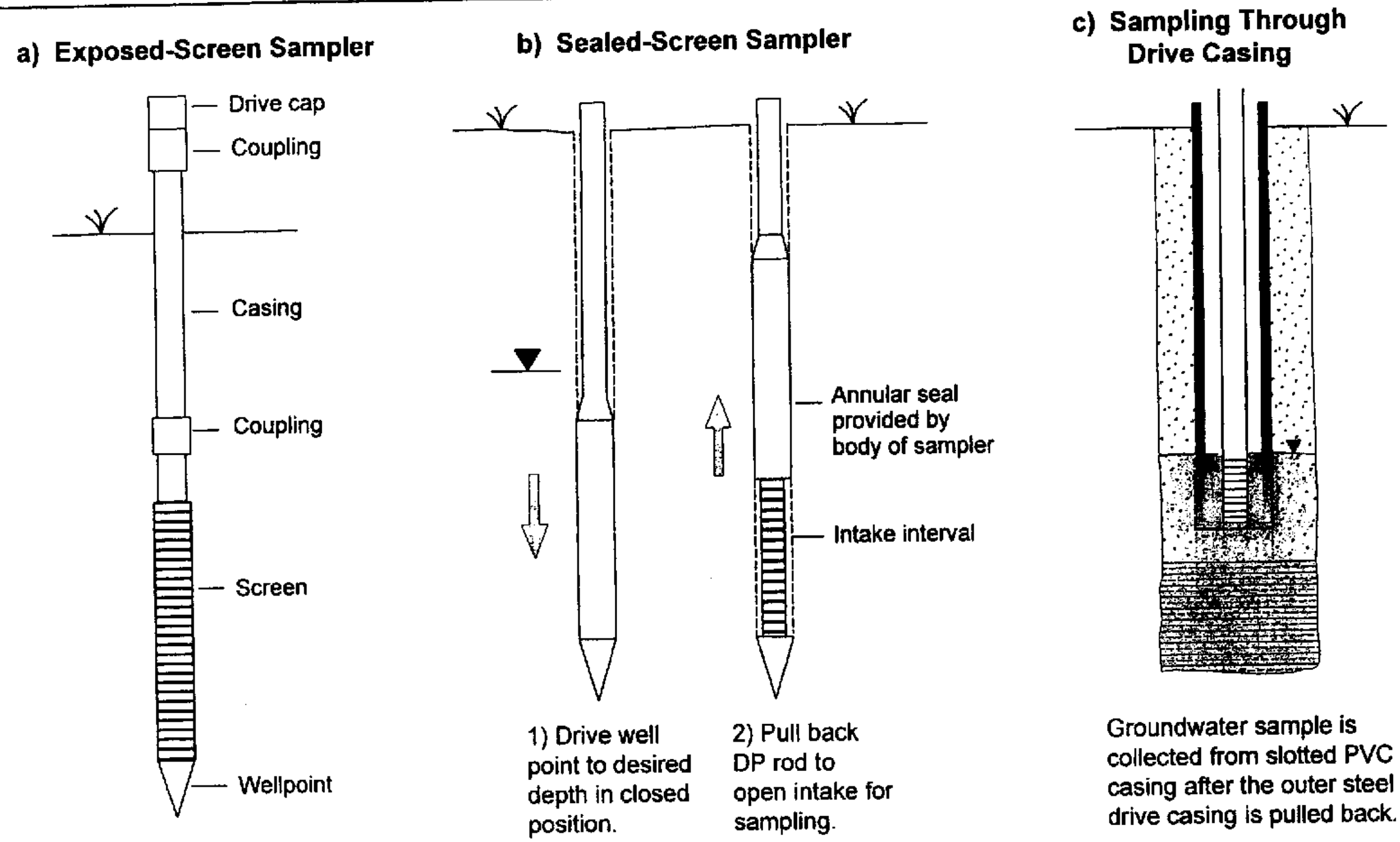


Exhibit V-10
Types Of Direct Push Groundwater Sampling Tools



Source: Aller, et al., 1991[1]

Source: Cordry, 1995[1]

Source: Precision Sampling, Inc.

[1] *Reprinted by permission of the National Ground Water Association, Westerville, Ohio. Copyright 1991 and 1995. All rights reserved.*

that it allows multi-level sampling in a single DP hole, without withdrawing the DP rods. The exposed screen, however, also causes some problems that should be recognized and resolved when sampling contaminants. These problems may include:

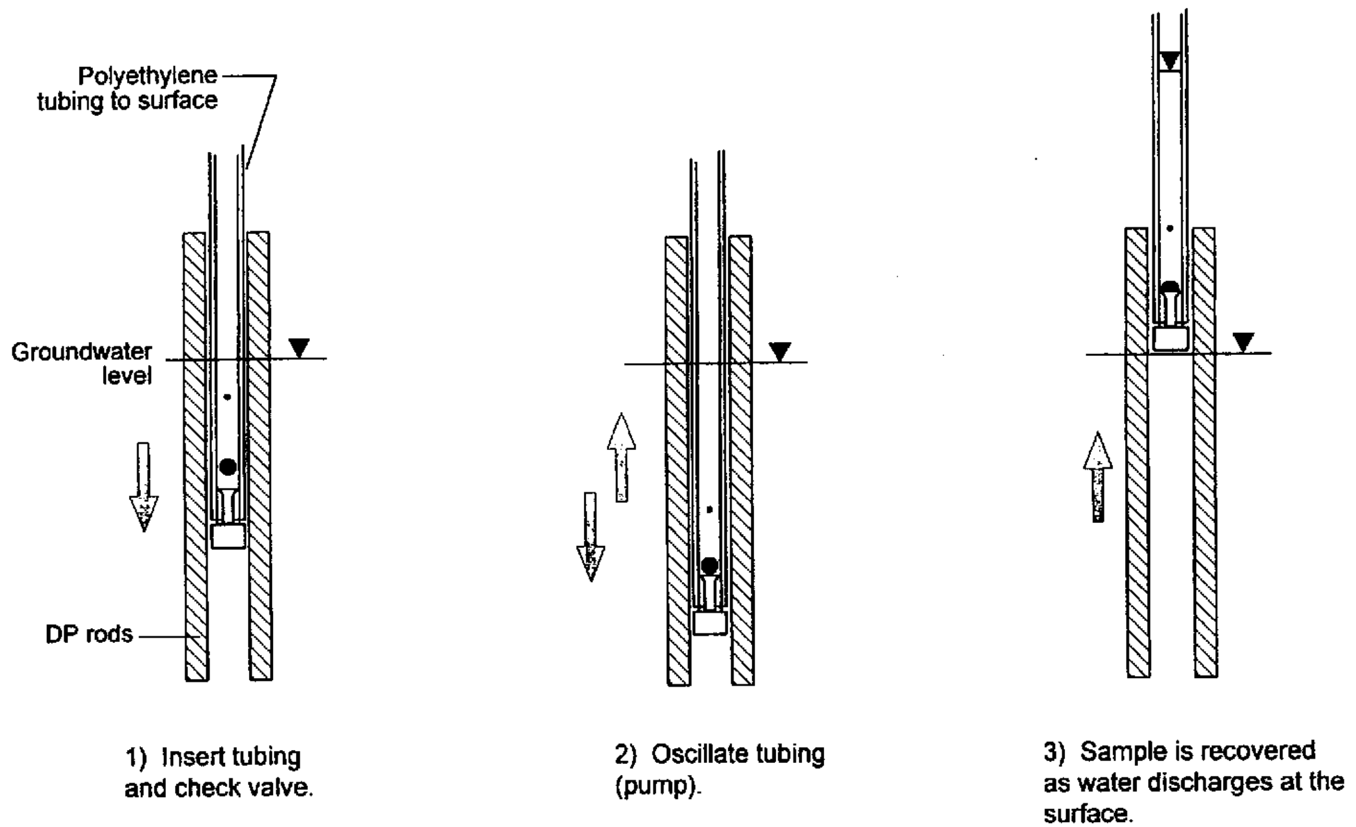
- Dragging down of NAPLs, contaminated soil, and/or contaminated groundwater in the screen;
- Clogging of exposed screen (by silts and clays) as it passes through sediments;
- The need for significant purging of sampler and/or the sampling zone because of drag down and clogging concerns; and
- Frigility of sampler because of the perforated open area.

There are several varieties of exposed-screen samplers. The simplest exposed-screen sampler is often referred to as a well point (Exhibit V-10a). As groundwater seeps into the well point, samples can be collected with bailers, check-valve pumps (Exhibit V-11), or peristaltic pumps. (Narrow-diameter bladder pumps may also soon be available for use with DP equipment.) Because well points are the simplest exposed-screen sampler, they are affected by all of the above mentioned limitations. As a result, they are more commonly used for water supply systems than groundwater sampling. They should not be used below NAPL or significant soil contamination.

The drive-point profiler is an innovative type of exposed-screen sampler that resolves many of the limitations of well points by pumping deionized water through exposed ports as the probe advances. This feature minimizes clogging of the sampling ports and drag down of contaminants and allows for collection of multiple level, depth-discrete groundwater samples. Once the desired sampling depth is reached, the flow of the pump is reversed, and groundwater samples are extracted. Purging of the system prior to sample collection is important because a small quantity of water is added to the formation. Purging is complete when the electrical conductivity of the extracted groundwater has stabilized. The data provided by these samples can then be used to form a vertical profile of contaminant distributions. Exhibit V-12 provides a schematic drawing of a drive-point profiler. Additional information about a drive-point profiling system is presented in Pitkin, 1994.

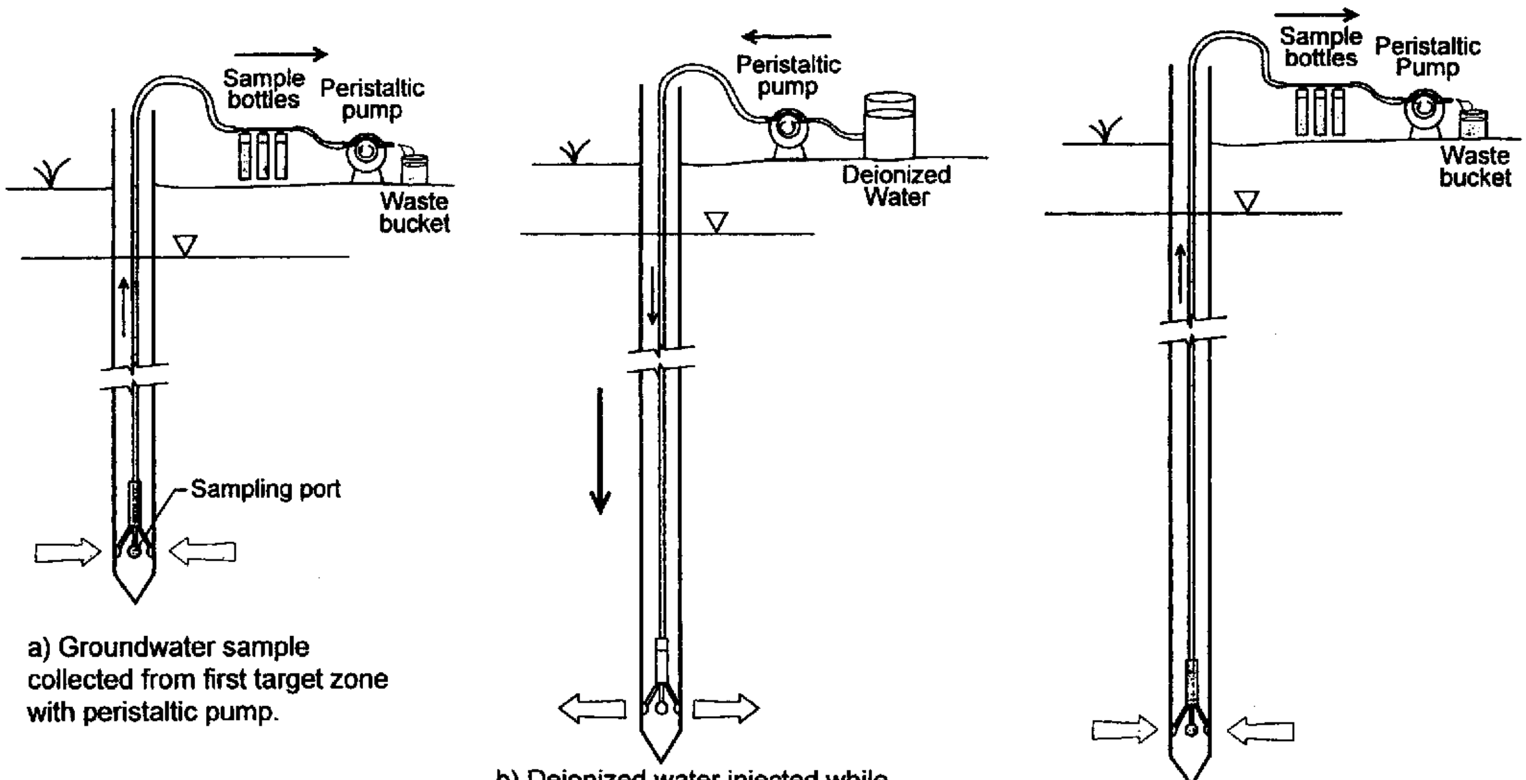
Another innovative exposed-screen sampler can be use in conjunction with cone penetrometer testing (CPT). This sampler allows for multi-level sampling by providing a mechanism for *in situ* clearing of clogged screens through the use of a pressurized gas and *in situ* decontamination of the sampling equipment with an inert gas and/or deionized water. Various CPT cones, which allow investigators to determine the soil conditions of the sampling zone, can be used simultaneously with this tool.

Exhibit V-11
Using The Check Valve Tubing Pump



Source: Geoprobe® Systems

Exhibit V-12
Using A Drive-Point Profiler



a) Groundwater sample collected from first target zone with peristaltic pump.

b) Deionized water injected while advancing tool to prevent sampling ports from becoming plugged.

c) Groundwater sample collected from second target zone with peristaltic pump.

Source: Precision Sampling, Inc.

Sealed-Screen Samplers

Sealed-screened samplers are groundwater samplers that contain a well screen nested inside a water-tight sealed body. The screen is exposed by retracting the probe rods once the desired sampling depth has been reached. They can be used for collecting accurate, depth-discrete samples. A very common type of sealed-screen sampler is presented in Exhibit V-10b.

The design of sealed-screen samplers is extremely variable. Many are similar to expendable or retractable tip samplers used for soil gas sampling. Some samplers are designed only for a single sampling event; others are designed to be left in the ground for an extended period of time (many weeks or even beyond one year) so that changes in concentrations can be monitored.

The main advantage of this type of sampler is that the well screen is not exposed to soil while the tool is being pushed to the target depth. Thus, the screen cannot become plugged or damaged, and the potential for sample contamination is greatly reduced. O-rings are used to make the sampler water-tight while it is being pushed to the sampling depth. (In order to ensure a water-tight seal, o-rings should be replaced frequently; water tightness can be checked by placing the sealed sampler in a bucket of water.) Sealed-screen samplers are appropriate for the collection of depth-discrete groundwater samples beneath areas with soil contamination in the vadose zone. Because there is no drag-down of contaminants or clogging of the sampling screens, sealed-screen samplers do not require purging.

Some sealed-screen samplers allow sample collection with bailers, check-valve pumps, or peristaltic pumps. (Bladder pumps can also be used with wide diameter cased DP systems.) The quantity of groundwater provided by these samplers is limited only by the hydraulic conductivity of the formation. Other samplers collect groundwater in sealed chambers, *in situ*, which are then are raised to the surface. Depending on their design, these samplers may be extremely limited in the quantity of groundwater that they can collect (*e.g.*, 250 ml per sampling event), and they may not collect free product above the water table. If the storage chamber is located above the screen intake, groundwater samples must be collected sufficiently below the water table to create enough hydrostatic pressure to fill the chamber. Only sampling chambers located below the screen intake are, therefore, useful for collecting groundwater or LNAPL samples at or above the water table.

Cased DP systems can also be used as sealed-screen groundwater samplers. After the target zone has been penetrated and the inner rods have been removed, well screen can be lowered through the outer casing to the bottom of the probe hole. The drive casing is then retracted (a few inches to a few feet) exposing the well screen (Exhibit V-10c). This method allows for the collection of deeper samples by attaching a sealed-screen sampling tool that is pushed into the formation ahead of the tip of the drive casing.

Discussion And Recommendations

Exposed-screen samplers are most appropriate for multi-level sampling in coarse-grained formations (*i.e.*, sediments of fine-grained sands and coarser material). They are typically used in a single sampling event. The major concern with using exposed-screen samplers is that they can cause cross contamination if precautions are not taken (*e.g.*, pumping deionized water through sample collection ports). As a result of these concerns, significant purging of the sampling zone is required.

Sealed-screen samplers are most appropriate for single-depth samples. When they are used in a single sampling event, they are appropriate in formations of fine-grained sands or coarser material because these soils typically allow rapid collection of groundwater. When they are used as either temporary or long-term monitoring wells, they can also be used in formations composed of silts. In addition, because sealed-screen groundwater samplers do not require purging of groundwater, they allow more rapid sampling from a single depth than exposed-screen samplers. Multi-level sampling with sealed-screened samplers is possible with cased and single-rod systems; however, with single-rod systems, the entire rod string must be withdrawn after samples are collected from a given depth. This practice with single-rod systems may create some cross contamination concerns in permeable, contaminated aquifers because the hole remains open between sampling events, allowing migration.

In addition, DP groundwater sampling tools have several advantages over traditional monitoring wells. DP tools allow groundwater samples to be collected more rapidly, at a lower cost, and at depth-discrete intervals. As a result, many more samples can be collected in a short period of time, providing a detailed 3-dimensional characterization of a site. Exhibit V-13 provides a summary of DP sampling tool applications.

General Issues Concerning Groundwater Sampling

There are several issues concerning the collection, analysis and interpretation of groundwater samples that affect both DP equipment and more conventional monitoring wells. Two major issues are the loss of VOCs and the stratification of contaminants.

Exhibit V-13
Summary Of Groundwater Sampling Tool Applications

	Exposed-Screen	Sealed-Screen
Multi-level sampling	✓[1]	✓[2]
Samples can be collected immediately, little or no purging required		✓[3]
Used to install long-term monitoring point	✓[4]	✓
Can be used in formations composed of silts		✓[5]
Appropriate below contaminated soil		✓

[1] Cross contamination may be an issue of concern, and purging is required.
[2] Multi-level sampling without withdrawing all DP rods is only possible with cased DP systems.
[3] Collection of a single sample is more rapid with this method.
[4] One type of exposed-screen sampler (*i.e.*, well points) has been used to install monitoring points, but this method is generally not recommended in zones of NAPL contamination. It may be appropriate at the leading edge of a contaminant groundwater plume.
[5] Sampling in silts is generally only appropriate when temporary monitoring wells are installed. Significant VOC loss may occur if water flows into sampling point over days, weeks, or months.

Loss Of VOCs

The ability of DP groundwater sampling methods to collect samples equivalent to traditional monitoring wells is a topic of continued debate and research. Loss of VOCs is the most significant groundwater sampling issue. All groundwater sampling methods--including methods used with traditional monitoring wells--can affect VOC concentrations to some degree. The key to preventing the loss of VOCs is to minimize the disturbance of samples and exposure to the atmosphere. Several studies that have compared VOC concentrations of samples collected with DP methods with samples collected by traditional monitoring wells have shown that DP methods compare favorably (Smolley *et al.*, 1991; Zemo, *et al.*, 1994).

Stratification Of Contaminants

Being able to take multiple, depth-discrete groundwater samples with DP equipment is both an advantage and a necessity. At least one recent study has shown that the concentration of organic compounds dissolved in groundwater can vary by several orders of magnitude over vertical distances of just a few centimeters (Cherry, 1994). Because DP sampling tools collect samples from very small intervals (*e.g.*, 6 inches to 3 feet), they may sometimes fail to detect dissolved contamination if the tool is advanced to the wrong depth. Therefore, multiple depths should be sampled to minimize the chances of missing contaminants. At sites with heterogeneous geology, contamination may be particularly stratified. Because the distribution of the contaminants is controlled by the site geology and groundwater flow system, the hydrogeology of the site must be adequately defined before collecting groundwater samples for chemical analysis.

The stratification of contaminants may also result in artificially low analytical results from traditional monitoring wells. These wells are typically screened over many feet (*e.g.*, 5 to 15 feet), while high concentrations of contaminants may be limited to only a few inches (in the case of LNAPLs, typically the top of the aquifer). The process of sampling groundwater, however, may cause the water in the well to be mixed, resulting in a sample that represents an average for the entire screen length (*i.e.*, very high concentrations from a specific zone may be diluted). DP methods avoid this problem by collecting depth-discrete samples.

Conclusion

The practice of collecting groundwater samples both with DP systems and with traditional monitoring wells is a subject of continued research and debate. Both methods can provide high quality groundwater samples for regulatory decisions. Both methods may also provide misleading information if appropriate procedures are not followed and/or if the hydrogeology of a site is not well characterized. Investigators and regulators must be aware of the issues that affect groundwater sample quality and interpretation in order to make appropriate site assessment and corrective action decisions.

Equipment For Advancing Direct Push Rods

A few years ago, small-diameter probes were advanced exclusively with manual hammers or rotohammers mounted in light-weight vans, and CPT rods were advanced using heavy (*e.g.*, 20-ton) trucks. Now, contractors mix and match DP rod systems and sampling tools depending on the objectives and scope of the investigation. It is not unusual to see DP rods, sampling tools, and CPT cones being advanced with a wide range of equipment, ranging from small portable rigs to heavy trucks. The following text describes some of the more common methods used to advance DP rods and sampling tools. Drawings of several types of equipment used for advancing DP rods are presented in Exhibit V-19.

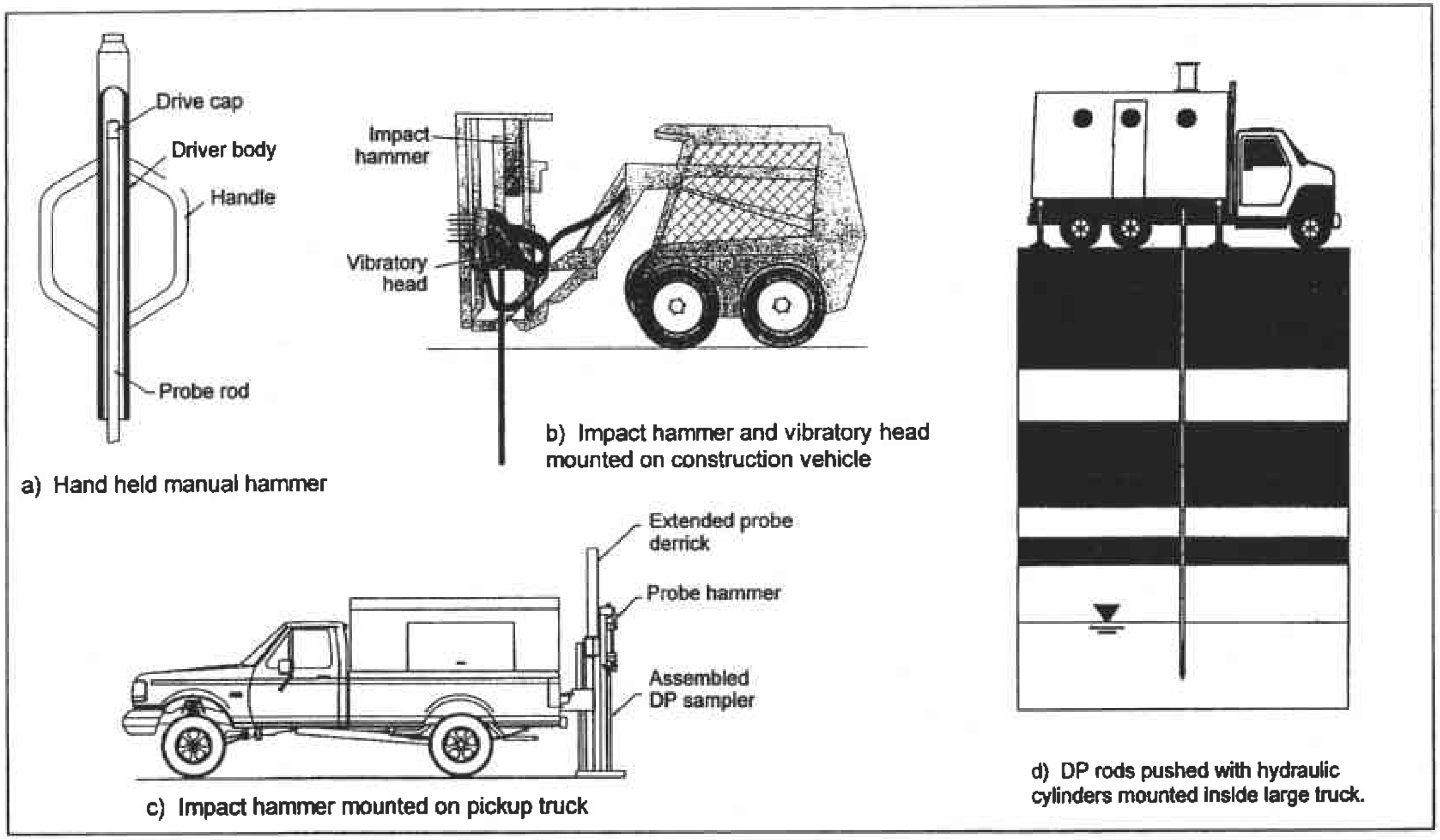
Manual Hammers

Manual hammers allow a single operator to advance small-diameter DP rods to shallow depths (Exhibit V-19a). Other names for this type of hammer are "fence post driver"or "slam bar," since it was adapted from hammers used to drive steel fence posts. Manual hammers are used mostly for driving 0.5- to 1-inch diameter soil-gas sampling tools and are best suited to advancing single DP rods to depths of 5 to 10 feet. The maximum attainable depth with this method is approximately 25 feet. These hammers are the smallest and lightest DP rod advancing equipment weighing between 30 to 60 pounds. As a result, manual hammers are the most portable method available, but they are capable of the least depth of penetration.

Hand-Held Mechanical Hammers

There are two types of hand-held mechanical hammers--jack hammers and rotohammers. Although rotohammers also rotate, they both apply high-frequency percussion to the DP rods, resulting in more rapid penetration and greater sampling depths than manual hammers can attain. Hand-held mechanical hammers are best suited to collecting soil, soil-gas, and groundwater samples using 0.5- to 1-inch diameter equipment. They may also be used to advance small-diameter cased DP rod systems. Typical attainable depth with this method is between 8 and 15 feet, while the maximum depth is approximately 40 feet. This equipment weighs between 30 and 90 pounds and is, therefore, extremely portable.

Exhibit V-19
Typical Equipment Used To Advance Direct Push Rods



a) Hand held manual hammer

b) Impact hammer and vibratory head mounted on construction vehicle

c) Impact hammer mounted on pickup truck

d) DP rods pushed with hydraulic cylinders mounted inside large truck.

Percussion Hammers And/Or Vibratory Heads Mounted On Small Vehicles

The most common methods for advancing DP rods are percussion hammers and vibratory heads mounted on small vehicles (Exhibit V-19b and 19c). Hydraulic cylinders press the rods into the ground with or without pounding or driving. The pounding/driving action is typically provided by hydraulic post-hole drivers or percussion hammers mounted on the vehicle. The hammers pound on a drive head attached to the uppermost DP rod. On some rigs, vibratory heads clamp onto the outside of the DP rods, applying high-frequency vibrations. The vibratory action reduces the side-wall friction, resulting in an increased rate of penetration and greater sampling depths. Some rigs are mounted on trucks, some on vans, yet others on the front of Bobcat®-like construction vehicles. These types of rigs can be used to advance single DP rods or cased DP systems. The reactive weight is typically between 5,000 and 17,000 pounds. Depths of 20 to 50 feet are generally attainable, and maximum depths of around 150 feet have been recorded. This equipment is as mobile as the vehicle on which it is mounted.

Small Hydraulic Presses Anchored To The Ground

Small hydraulic presses that are anchored to the ground are fairly light-weight units (200 to 300 pounds) and portable so they can be quickly disassembled and reassembled at new sampling locations. The reactive weight for these rigs is created by the weight of the rig and the pull-down pressure applied against the anchor. On concrete floors, the base plates of the rigs are anchored with concrete bolts or anchoring posts (referred to as "deadmen") that can be set in pre-drilled holes. On asphalt or open ground, earth augers are spun into the ground to anchor the rigs. Reactive forces as great as 40,000 pounds can be applied with these rigs. Hydraulic cylinders press the DP rods into the ground, usually without percussion hammers. These types of rigs are most commonly used for advancing CPT cones in areas that are difficult to access, but they can also be used to advance other types of DP rods and sampling tools. They can generally attain depths between 20 and 100 feet with a maximum attainable depth of approximately 200 feet.

Conventional Drilling Rigs

Conventional drilling rigs are commonly used to advance soil, soil-gas, and groundwater sampling DP tools inside of hollow-stem augers. In fact, open-barrel and split-barrel samplers have been advanced inside of hollow stem augers to collect soil samples for geotechnical investigations for decades. In geotechnical investigations, the force for advancing these samplers is applied by striking the DP rods with a 140-pound hammer dropped a distance of 30 inches as described in ASTM D1586 (American Society of Testing and Materials, 1984). In addition, many conventional drill rigs are now equipped with hydraulic percussion hammers to advance the DP sampling tools more rapidly. The reactive weight of conventional drill rigs is between 5,000 and 20,000 pounds. When they are used for DP sampling, they can generally attain depths of 20 to 80 feet with a maximum depth of approximately 200 feet. Because of their size, conventional drill rigs are less maneuverable than construction vehicles.

Trucks Equipped With Hydraulic Presses

Trucks equipped with hydraulic presses are commonly used to advance CPT cones (Exhibit V-19d). Because the force for advancing the rods comes from the weight of the truck, the maximum depth attainable with the DP rods depends on the weight of the truck. Generally, depths of 30 to 100 feet can be obtained; maximum penetration is about 300 feet. Most rigs weigh from 30,000 to 40,000 pounds. Although trucks weighing more than approximately 46,000 pounds are not allowed on public roads, CPT rigs as heavy as 120,000 pounds can be used if weight is added on site. Unlike other DP tools, the force applied to CPT cones is a static push; no pounding or vibration is applied to the rods which could damage the sensitive electrical components and circuitry in the cones.

Hydraulic cylinders mounted inside the trucks apply the static weight of the truck to the DP rods, pushing them into the ground. While designed for CPT applications, these large trucks are equally capable of advancing all other types of DP sampling tools using single-rod or cased DP systems. However, because the rigs were designed primarily for pushing CPT cones, few of them are equipped with hydraulic hammers or vibratory heads.

Discussion And Recommendations

The major differences among the kinds of equipment used to advance DP rods are their depth of penetration and their ability to access areas that are difficult to reach (*e.g.*, off-road, inside buildings). The depth of penetration is controlled primarily by the reactive weight of the equipment although other factors such as the type of hammer used (*e.g.*, vibratory, manual, percussion) can affect the attainable depth. Soil conditions generally affect all DP methods in a similar way. Ideal conditions for all equipment are unconsolidated sediments of clays, silts, and sands. Depending on their quantities and size, coarser sediments (*e.g.*, gravels, cobbles) may pose problems for DP methods. Semi-consolidated and consolidated sediments generally restrict or prevent penetration; however, saprolite (*i.e.*, weathered bedrock) is an exception.

The portability of equipment is controlled by its size and weight. For instance, 20-ton trucks with hydraulic presses would not be appropriate for rough terrain, and conventional drill rigs are often not capable of sampling below fuel dispenser canopies or below electrical power lines. On the other hand, manual hammers or hand-held mechanical hammers are capable of sampling in almost any location, including within buildings. Exhibit V-20 presents a summary of equipment for advancing DP rods.

Exhibit V-20
Summary Of Equipment For Advancing Direct Push Rods

	Reactive Weight (lbs)	Average Attainable Depth (ft)	Maximum Attainable Depth (ft)	Portability
Manual Hammers	30 to 60	5 to 10	25	Excellent
Hand-Held Mechanical Hammers	30 to 90	8 to 15	40	Excellent
Hammers Mounted On Vehicles	5,000 to 17,000	20 to 50	150	Good
Anchored Hydraulic Presses	200 to 40,000	20 to 100	200	Good
Conventional Drill Rig	5,000 to 20,000	20 to 80	200	Poor
Truck With Hydraulic Presses	30,000 to 120,000	30 to 100	300	Poor

Methods For Sealing Direct Push Holes

One of the most important issues to consider when selecting DP equipment is the method for sealing holes. Because any hole can act as a conduit for contaminant migration, proper sealing of holes is essential for ensuring that a site assessment does not contribute to the spread of contaminants. The issue of sealing holes and preventing cross-contamination is not an issue unique to DP technologies. Conventionally drilled holes must also be sealed; in fact, they may pose an even greater risk of cross-contamination because the larger diameter holes provide an even better conduit for contaminants. Many of the recommendations presented here apply to both DP and conventional drilling methods; however, because of the small diameter of DP holes, DP technologies provide some additional challenges.

The selection of appropriate sealing methods depends on site-specific conditions. For example, at sites underlain by homogeneous soil and shallow groundwater, light non-aqueous phase liquids (LNAPLs) released from an UST quickly penetrate the unsaturated soil and come to rest above the water table. Because the LNAPLs are lighter than water, the water table becomes a barrier to continued downward migration. In these settings, DP probe holes pose little risk to the spread of contaminants.

However, at other sites, improperly sealed DP holes can cause significant contaminant migration. For example, at UST sites where there are LNAPLs perched on clay layers in the unsaturated zone, intrusive sampling can facilitate deeper migration of contaminants. In addition, where interbedded formations create multiple aquifers, unsealed holes may allow for the vertical migration of dissolved contaminants into otherwise protected lower aquifers.

The presence of dense non-aqueous phase liquids (DNAPLs) poses an additional risk of cross-contamination. Because DNAPLs are denser than water and typically have low viscosities, they can quickly penetrate soil and migrate below the water table. Although DNAPLs are usually not the primary contaminant at UST sites, they may be present as a result of the use of chlorinated cleaning solvents (*e.g.*, trichloroethylene, methylene chloride). DNAPLs may also be present at refineries and other industrial sites where LUST investigations are performed.

The objective of hole sealing is to prevent preferential migration of contaminants through the probe hole. At a minimum, the vertical permeability of the sealed DP hole should not be any higher than the natural vertical permeability of the geologic formation. In some formations, preferential migration may be prevented without the use of sealants. For example, in heaving, homogeneous sands, the hole will cave immediately as the probe is withdrawn, thus re-establishing the original permeability of the formation. Or, in some expansive clays, the hole may quickly seal itself. Unfortunately, it is usually impossible to verify that holes have sealed completely with these "natural" methods. As a result, more proactive methods of probe hole sealing are generally necessary.

DP holes are typically sealed with a grout made of a cement and/or bentonite slurry. Dry products (*e.g.*, bentonite granules, chips, pellets) may also be used, but they may pose problems because small granules are typically needed for the small DP holes. These granules absorb moisture quickly and expand, often before reaching the bottom of the hole, resulting in bridging and an incomplete seal. Recent technological innovations are aimed at keeping these granules dry until they reach the bottom of the hole and may help to make the use of dry sealing materials more common with DP holes.

There are four methods for sealing DP holes--surface pouring, re-entry grouting, retraction grouting, and grouting during advancement. The following text summarizes the advantages, limitations, and applicability of these methods. Additional information can be found in Lutenegger and DeGroot (1995).

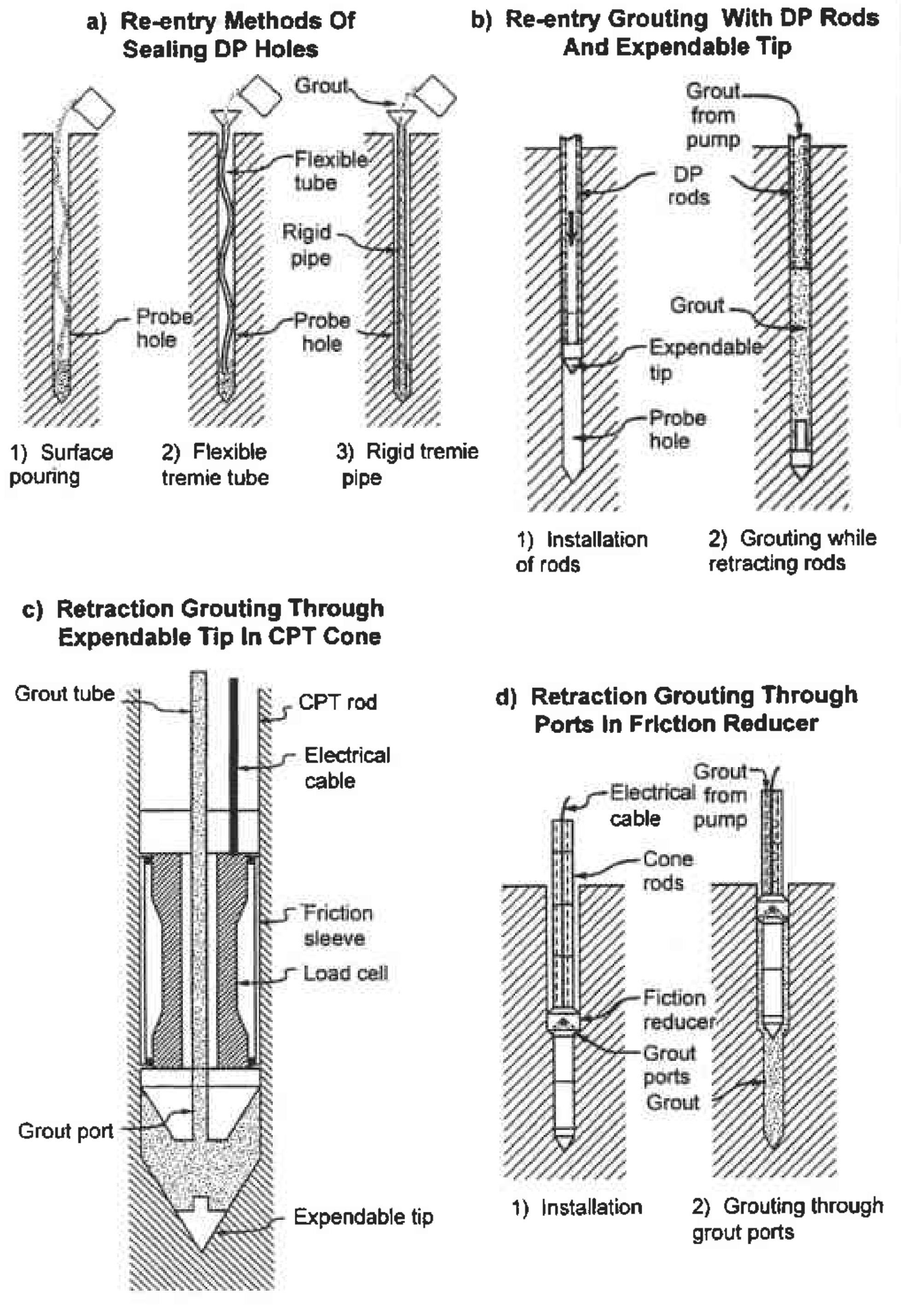
Surface Pouring

The simplest method for sealing holes is to pour grout or dry products through a funnel into the boring from the surface after DP rods have been withdrawn (Exhibit V-21a). This method is generally only effective if the hole is shallow (<10 feet), stays open, and does not intersect the water table. Usually, surface pouring should be avoided because the small DP holes commonly cause bridging of grout and dry bentonite products, leaving large open gaps in the hole.

Re-entry Grouting

Re-entry grouting is also a method in which the DP hole is sealed after the DP rods have been withdrawn from the ground. It is used to prevent the bridging of grout and to re-open sections of the hole that may have collapsed. One method is to place a flexible or rigid tube, called a tremie pipe, into the DP hole (Exhibit V-21a), and pump the grout (or pour the dry material) through the tremie pipe, directly into the bottom of the open hole. To ensure a complete seal by preventing bridging, the tremie pipe is kept below the surface of the slurry as the grout fills the hole. However, flexible or rigid tremie pipes may be difficult or impossible to use if the probe hole collapses. The flexible tremie pipe may not be able to penetrate the bridged soil and a rigid tremie may become plugged.

Exhibit V-21
Methods For Sealing Direct Push Holes



Source: Lutenegger & DeGroot, 1995

If tremie pipes are not appropriate for sealing DP holes, re-entry with probe rods and an expendable tip may be used (Exhibit V-21b). This method allows the rods to be pushed through soil bridges to the bottom of the probe hole. The probe rods are then withdrawn slightly, and the expendable tip is knocked out (by lowering a small diameter steel rod inside the DP rods) or blown off (by applying pressure with the grout pump). Grout is then pumped through the DP rods as they are withdrawn from the hole.

Re-entry grouting with DP rods and expendable tips usually results in adequate seals; however, this method is not always reliable because, on occasion, DP rods may not follow the original probe hole, but instead create a new hole adjacent to the original one. If this happens, sealing the original hole may be impossible. This situation is rare but may be a problem when sampling:

- Soft silts or clays that overlie a dense layer. In this situation, the clays provide little support and may not guide the rods back to the original hole.
- In cobbly or boulder-rich sediments overlying a clayey confining formation. Here the probe may be deflected, and the underlying clays may not guide the rods into the original hole.
- Loose homogenous sands that overlie a clayey formation. Here the sands may collapse as the rods are withdrawn. Without a hole to guide the rods, the underlying clay may be penetrated in a slightly different location. In these environments, the likelihood of new holes being created with re-entry grouting increases with smaller diameter probe rods and with deeper investigations.

Retraction Grouting

Retraction grouting is a method in which the DP hole is sealed as the DP rods are being withdrawn. The DP rods act as a tremie pipe for grout that is either poured or pumped down the hole, ensuring a complete seal of the probe hole. Retraction grouting can be used with single-rod systems; however, its application is limited by the sampling method. With cased systems, retraction grouting can be used in any situation.

There are two methods for using retraction grouting with single-rod systems. One method can be used when expendable tips or well screens are attached to the probe rod for soil-gas or groundwater sampling. Grouting with these sampling tools occurs as described in re-entry grouting with expendable tips except there is only a single entry, and the sampling tool is also used for grouting. With well screens, the screen must be expendable. With both tools, grout may be poured or pumped into the ground as the rods are retrieved. Other sampling tools attached to single-rod systems do not allow retraction grouting because the end of the DP rods is sealed by the sampling tools.

Cone penetrometer testing (CPT) allows a second method of retraction grouting with single-rod systems through the use of a small-diameter grout tube that extends from the cone to the ground surface inside the CPT rods. One variation utilizes an expendable tip that is detached from the cone by the pressure of the grout being pumped through the tube (Exhibit V-21c). Another variation of this method consists of pumping the grout through ports in the friction reducer instead of the cone (Exhibit V-21d). Most CPT contractors perform re-entry grouting instead of retraction grouting because the grout tube is very small and subject to frequent plugging.

With cased systems, retraction grouting can be used regardless of the type of sampling tools employed because the outer casing can maintain the integrity of the hole after samples have been collected. As a result, proper use of cased systems can ensure complete sealing of DP holes. This feature is presented in Exhibit V-22.

Grouting During Advancement

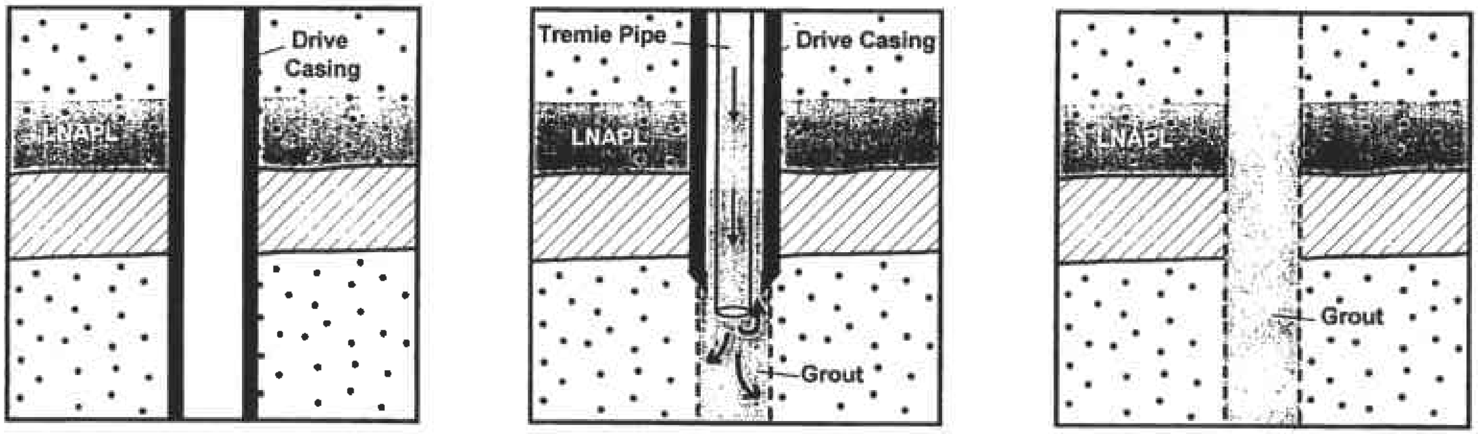
Grouting during advancement is a method that utilizes expendable friction reducers (*i.e.*, detachable rings that are fitted onto the DP probe or cone). The space between the probe rod and the hole, created by the friction reducer, is filled with grout that is pumped from the ground surface as the probe rod advances (Exhibit V-23). When the probe rods are withdrawn, the weight of the overlying grout forces the expendable friction reducer to detach. Additional grout is added, while the rods are being withdrawn, to fill the space that was occupied by the rods.

Discussion And Recommendations

Surface pouring can be used in shallow holes (less than 10 feet bgs) that do not penetrate the water table and in which the formation is cohesive. This method is the least favorable and should only rarely be used because the small size of the DP holes increases the probability of grout or dry products bridging and not completely sealing.

Re-entry grouting is the next best alternative and is often adequate for providing a completely sealed hole. Re-entry grouting can be used if deflection of probe rods is not likely, if NAPLs are not present, or if NAPLs are present but do not pose a risk of immediately flowing down the open hole. Because DNAPLs

Exhibit V-22
Sealing Direct Push Holes With Cased Systems

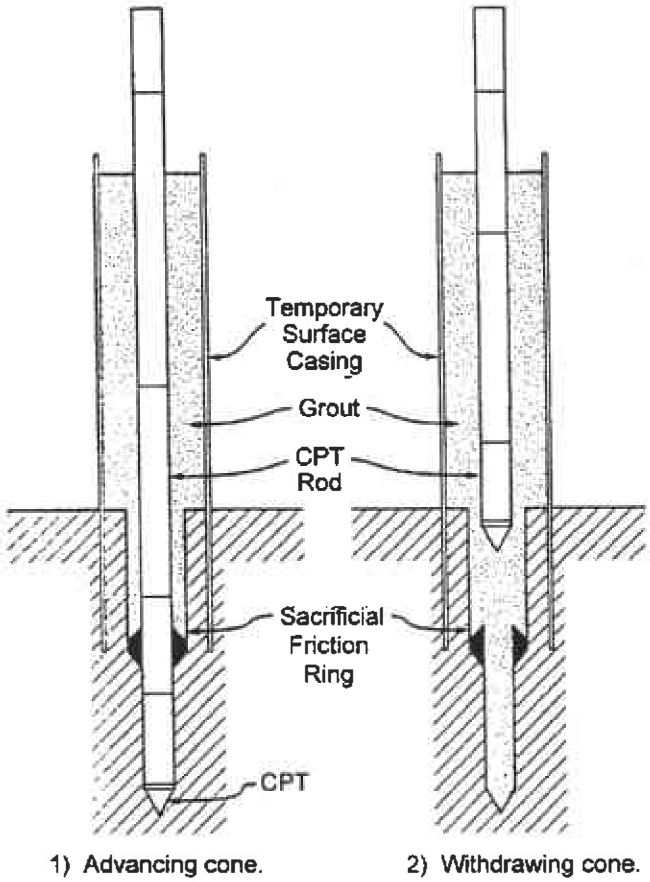


1) With cased systems, steel drive casing is advanced as sampling proceeds. The casing remains in the ground as soil and groundwater samples are retrieved thereby preventing cross-contamination of deeper zones.

2) After the last sample has been collected, the drive casing is removed. Grout is pumped into the borehole as the casing is withdrawn.

3) Pumping grout as the drive casing is withdrawn ensures that the borehole is properly sealed.

Exhibit V-23
Sealing Direct Push Holes By Grouting During Advancement



Source: Lutenegger & DeGroot, 1995

are denser than water and tend to have low viscosities, they easily overcome the soil pore pressure and, therefore, require retraction grouting or grouting during advancement. If LNAPLs are present the risk of cross-contamination will depend on many other factors (*e.g.*, soil grain size, quantity of LNAPLs). Hence, while re-entry grouting may at times effectively prevent cross-contamination in source areas, it should be used judiciously.

Retraction grouting and grouting during advancement are the most effective sealing methods for preventing cross-contamination. They are required if:

- DNAPLs are present,
- Sufficient LNAPLs are present to rapidly flow down an open hole,
- A perched, contaminated water table is encountered, or
- Deflection of probe rods may occur.

A summary of DP hole sealing methods is presented in Exhibit V-24.

Exhibit V-24
Summary Of Direct Push Hole Sealing Applications

		Surface Pouring[1]	Re-entry Grouting	Retraction Grouting	Grouting During Advancement
NAPLs Not Present	Cohesive Formation	✓	✓	✓	✓
	Formation Collapses		✓	✓	✓
NAPLs Present	Cohesive Formation	✓[2]	✓[2]	✓	✓
	Formation Collapses		✓[2]	✓	✓
Deflection Of Probe Rod May Occur[3]				✓	✓

[1] This method should not be used if the DP hole intersects the water table.
[2] These methods may be used if there is not an immediate danger of NAPLs flowing down the open hole (*i.e.*, DNAPLs are not present or large quantities of LNAPLs are not perched on clay layers).
[3] There are three conditions when this might occur: Sampling in soft silts or clays that overlie a denser layer; sampling in cobbly or boulder-rich sediments overlying a clayey confining formation; sampling in loose homogenous sands that overlie a confining formation. Note that these situations are not typical. The likelihood of probe deflection increases with depth and decreases with the increase in probe rod diameters.