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June 8, 1995
Project 0805-135.02

Mr. Michael Whelan
Environmental Engineer
ARCO Products Company
2155 South Bascom Avenue, Suite 202
Campbell, California 95008

Re: Remedial action plan, interim soil and groundwater remediation, ARCO service station 6148, 5131 Shattuck Avenue, Oakland, California

Dear Mr. Whelan:

As requested by ARCO Products Company (ARCO), EMCON has prepared the attached remedial action plan (RAP) for interim soil and groundwater remediation at ARCO service station 6148 in Oakland, California. The RAP will be submitted to the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), and the Alameda County Health Care Services Agency (ACHCSA) for review and approval before design, permitting, installation, and operation of the proposed soil and groundwater remediation systems.

The RAP briefly summarizes previous assessment work at the site, details results of the soil-vapor extraction (SVE) and air-sparge (AS) pilot tests performed at the site in February 1994, and recommends remedial measures for on-site petroleum hydrocarbon-impacted soils and groundwater, including a preliminary design for an SVE, AS, and air-bubbling system at the subject site. The proposed remedial measures are briefly summarized below.

Soil Remediation System

The proposed soil remediation system will use two pre-existing on-site vapor extraction wells (VW-1 and VW-3), two pre-existing groundwater monitoring wells (MW-1 and MW-5), and eight proposed vapor extraction wells (VW-2, VW-4 through VW-10) to address most of the on-site vadose-zone and capillary-fringe hydrocarbon-impacted soils between 15 and 20 feet below ground surface (BGS). The vapor extraction wells will be screened into the water table to help remediate the capillary-fringe soils when the water level in the aquifer drops.

Based on SVE and combined SVE and AS test results, hydrocarbon vapor at an average concentration of 7,850 milligrams per cubic meter (mg/m^3) (2,170 parts per million by volume [ppmv]) of total volatile hydrocarbons as gasoline (TVHG) can be extracted from the vapor extraction wells at an applied vacuum of 40 inches of water column (IWC) and a flow rate of 22.5 standard cubic feet per minute (scfm) per well. The effective radius of influence (ROI) for the SVE well at the above-specified applied vacuum and air flow rate was determined during the SVE test to be approximately 15 to 20 feet. A catalytic oxidizer can typically process extracted hydrocarbon vapor at no greater than 25 percent of the lower explosive limit (LEL, equivalent to 3,500 ppmv) of gasoline. Based on the relatively low extracted hydrocarbon vapor concentrations observed during the SVE test, a catalytic oxidizer unit was selected for off-gas abatement of extracted hydrocarbon vapor from the subsurface soils at the site.

Other off-gas abatement alternatives were evaluated for use with the SVE system at the site. Thermal oxidizers can typically process TVHG concentrations up to 11,200 ppmv, equivalent to 80 percent of the LEL for gasoline. The average TVHG concentration observed in extracted vapor during the SVE test was 2,170 ppmv. Considering that vapor concentrations from SVE systems typically decrease rapidly with time, use of a thermal oxidizer would likely result in high supplemental fuel and utility costs over the life of the project. As a result, thermal oxidation was not selected as a cost-effective method of off-gas abatement for the site. Using activated carbon to abate extracted vapor from the SVE system would be cost-prohibitive because the initial high influent TVHG concentrations would result in frequent carbon changeouts, and hence higher operation and maintenance costs.

The catalytic oxidizer will be replaced with an activated vapor-phase carbon adsorption system (two 1,000-pound carbon canisters in series) in the future, when influent hydrocarbon concentrations decrease, making it cost-effective. Once hydrocarbon concentrations have decreased further (less than 1 pound per day [lb/day] TVHG and less than 0.02 lb/day benzene), vapor extracted by the SVE system will be discharged to the atmosphere with no off-gas abatement.

Groundwater Remediation System

AS and air-bubbling systems are proposed for remediating hydrocarbon-impacted groundwater and saturated soils at the site.

The AS system proposed for groundwater remediation at the site will use one pre-existing on-site AS well (AS-1) and four proposed AS wells (AS-2 through AS-5), and an oil-less

air compressor to address most of the gasoline-impacted groundwater and saturated soils on site. The five AS wells will sparge air into the aquifer at approximately 24 to 26 feet BGS. An oil-less air compressor in the remediation compound will inject compressed air into the aquifer at approximately 9 pounds per square inch gauge (psig), as determined during the AS test. The effective ROI of AS at a flow rate of 3 actual cubic feet per minute (acfm) and pressure of 9 psig was estimated to be 10 to 15 feet based on the results of the AS test. Because the SVE ROI was estimated to be approximately 15 to 20 feet, the SVE system should adequately capture off-gas vapors from the sparge system. SVE air flow rates will be at least 5 to 10 times greater than AS flow rates.

To introduce additional oxygen into groundwater and thereby help promote natural biodegradation of petroleum hydrocarbons in saturated soils and groundwater, and to help volatilize hydrocarbons in the capillary fringe, an air-bubbling system will be installed. This system will further enhance remediation of capillary-fringe and saturated soils and groundwater. The system will bubble air into wells at low flow rates (less than 1 scfm per well) through a tube that delivers air approximately 2 feet above the bottom of the wells. Air from the oil-less compressor will be injected through the tube at a pressure sufficient to overcome the static head in each well. Air will be bubbled into the pre-existing and proposed SVE wells (VW-1 through VW-10), and the pre-existing groundwater monitoring wells (MW-1 through MW-5).

Because the SVE system's capacity for processing extracted vapor and sparge off-gas is limited to a total air flow of 100 scfm, all SVE wells cannot be operated at the same time. Therefore, combinations of AS and air bubbling wells, and SVE wells will be brought on-line in sequence as remediation progresses. Results of the AS test indicate the AS system will need to be pulsed periodically to develop new air migration pathways and close old ones. Using different combinations of SVE and AS wells, as described above, will help achieve this goal.

We recommend forwarding copies of the RAP to the following individuals:

Mr. Kevin Graves
Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, California 94612

Ms. Susan Hugo
Alameda County Health Care Services Agency
80 Swan Way, Suite 200
Oakland, California 94621

Please call if you have questions.

Sincerely,

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Attachments: Remedial Action Plan

REMEDIAL ACTION PLAN
INTERIM SOIL AND GROUNDWATER REMEDIATION

ARCO SERVICE STATION 6148
5131 SHATTUCK AVENUE
OAKLAND, CALIFORNIA

Prepared for

ARCO Products Company

June 1995

Prepared by

EMCON
1921 Ringwood Avenue
San Jose, California 95131-1721

Project 0805-135.02

Remedial Action Plan, Interim Soil and Groundwater Remediation
ARCO Service Station 6148
5131 Shattuck Avenue

The material and data in this report were prepared under the supervision and direction of the undersigned.

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1 INTRODUCTION

EMCON prepared this remedial action plan (RAP) for ARCO Products Company (ARCO) service station 6148 at 5131 Shattuck Avenue, Oakland, California (Figure 1). The RAP reviews the results of previous site investigations, presents appropriate interim soil and groundwater remedial approaches, describes a conceptual design for the proposed interim soil and groundwater remediation systems, and details the work steps required to implement the remedial measures.

EMCON prepared the RAP on behalf of ARCO for review, comment, and approval by the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), and the Alameda County Health Care Services Agency (ACHCSA) before designing, installing, and implementing the proposed interim soil and groundwater remediation systems at the subject site.

The site was initially investigated in three phases by RESNA Industries, Inc. (RESNA). Results of the initial subsurface investigation (Phase I) in December 1991 indicated the presence of petroleum constituents in subsurface soils and groundwater beneath the site (RESNA, September 1992). Based on these results, RESNA conducted an additional subsurface investigation (Phase II) in October 1992 to further assess the extent of petroleum hydrocarbons in subsurface soils and groundwater (RESNA, January 1993). RESNA conducted a Phase III investigation in April 1993. From these three phases of investigation, RESNA concluded that petroleum-hydrocarbon-impacted soils were limited to three general areas of the site: (1) in the immediate vicinity of the operating service station islands, (2) along the northern and south-southwestern edges of the underground storage tanks (USTs), and (3) in the vicinity of monitoring wells MW-1, MW-2, and MW-3, in the southern portion of the site. RESNA also concluded that petroleum-hydrocarbon impact to groundwater was greatest in the south-southwestern portion of the site (Figure 2).

Based on information available from site investigations, ARCO proposes an integrated in situ soil and groundwater treatment approach to remediating the site. The remediation approach includes a soil-vapor extraction (SVE) system for treating hydrocarbon-impacted vadose-zone and capillary-fringe soils, and air-sparge (AS) and air-bubbling systems for remediating petroleum hydrocarbons in saturated soils and groundwater beneath the site. The proposed SVE system will extract hydrocarbon vapors from

impacted soils and capture sparge off-gas from the AS and air-bubbling systems; a catalytic oxidizer will then abate the extracted vapors before discharge to the atmosphere.

The proposed AS system will consist of sparge wells through which compressed air from an oil-less compressor will be introduced into the aquifer at approximately 24 to 26 feet below ground surface (BGS). To introduce oxygen into groundwater and thereby help promote natural biodegradation of petroleum hydrocarbons in saturated soils and groundwater, and to help volatilize hydrocarbons in the capillary fringe, an air-bubbling system will be installed. This system will further enhance remediation of capillary-fringe and saturated soils and groundwater.

2 SITE DESCRIPTION AND BACKGROUND

The project site is on the southwestern corner of the intersection of 52nd Street and Shattuck Avenue, Oakland, California (Figure 1). The site is on a relatively flat lot at an elevation of approximately 110 feet above mean sea level (MSL). The site is described by Alameda County Assessor's Parcel Number 14-1216-31-2, with a total area of approximately 1/2 acre. The site is owned by ARCO and is currently an operating retail gasoline station.

2.1 Underground Storage Tanks

Based on a preliminary records search conducted by RESNA in October 1992 (RESNA, January 1993), before 1950, the subject site appears to have been a community park or a vacant lot. In 1969, the site appears to have been occupied by a commercial building. The site appears to have been developed as a service station sometime between 1969 and 1988. One UST containing waste oil was present at the site until June 1987. Currently, there are three 12,000-gallon gasoline USTs at the site (one regular unleaded, one mid-grade, and one premium unleaded UST).

2.2 Regional Geology and Hydrogeology

The site is located west of the East Bay Hills. This area lies within the Berkeley Alluvial Plain, which is a subarea of the East Bay Alluvial Plain. Soils in this area are mapped as older alluvium, which consists of a heterogeneous mixture of poorly consolidated to unconsolidated clay, silt, sand, and gravel units (Helley et al., 1979). The sediments were derived mainly from bedrock underlying the hills and represent successive coalescing alluvial fans deposited during the Pleistocene epoch.

Sediments beneath the East Bay Alluvial Plain are believed to be about 200 feet thick in the Berkeley area. Water-yielding capabilities of the sediments are highly variable. Generally, high yields come only from wells that are screened through several water-bearing sand and gravel beds. Groundwater in the East Bay Plain occurs predominantly under confined conditions and tends to flow towards the San Francisco Bay to the west and southwest (Hickenbottom and Muir, 1988).

2.3 Subsurface Investigations and Feasibility Tests

On June 1, 1987, Crosby and Oberton, and Erico Construction removed a waste-oil tank from the site. During tank removal, one soil sample was collected from the bottom of the waste-oil tank pit. After characterization, soil from the tank pit was excavated and transported to a landfill. Crosby and Oberton, and Erico Construction excavated and sampled additional soil from the waste-oil tank pit on June 3 and 10, 1987.

In December 1991, RESNA conducted a Phase I subsurface environmental investigation related to the former waste-oil tank. The investigation included drilling four on-site soil borings, B-1 through B-4, in the immediate vicinity of the tank pit, and subsequently converting three of the borings to groundwater monitoring wells MW-1, MW-2, and MW-3. Results of the investigation were summarized in an initial subsurface investigation report (RESNA, September 1992).

In October 1992, a Phase II investigation was conducted by RESNA, which included drilling four on-site soil borings, B-5 through B-8, and converting the borings to groundwater monitoring wells, MW-4 through MW-7. The investigation also included a 1/2-mile radius well and record search. Results of the investigation were summarized in an additional subsurface investigation report (RESNA, January 1993).

In April 1993, a Phase III investigation was conducted by which included drilling 11 test borings, TB-1 through TB-11, and installing an AS well, AS-1, in test boring TB-6. Results of the investigation were summarized in an additional subsurface investigation report (RESNA, September 1993).

In July 1993, RESNA drilled three soil borings, B-9, B-10, and B-11, and installed one combination AS/vapor extraction well, AS-2/VW-2, and two vapor extraction wells, VW-1 and VW-3, in the borings. All three wells were installed in the southern portion of the site in the vicinity of the former waste-oil tank. In February 1994, RESNA conducted AS and SVE pilot tests at the site. Results of the well installations, and the AS and SVE pilot tests were summarized in a report (RESNA, June 1994).

Groundwater monitoring and sampling at the site were initiated in December 1991 and March 1992, respectively.

3 REMEDIAL DESIGN CONSIDERATIONS

This section summarizes results of site investigations and pilot-scale feasibility tests performed to date at the site. Results of the pilot tests were used in selecting a viable soil and groundwater remedial alternative for the subject site. Section 4 presents the preliminary design for the proposed soil and groundwater remedial alternative for the site.

3.1 Local Subsurface Conditions

The earth materials encountered beneath the site during subsurface investigations consisted primarily of silty clay to clayey sand and sandy gravel. Graphic interpretations of the soil stratigraphy encountered in the borings from previous investigations are shown in geologic cross sections A-A´ through E-E´, presented in Figures 3 through 6. The lines of the cross section locations are shown in Figure 2.

In the vicinity of where the AS test was performed (near AS-2), groundwater was measured at a depth of approximately 17 feet BGS. The sediment immediately below and above groundwater surface is sand and gravel ranging from silty sand to sandy gravel. Above the groundwater surface the thickness of the sand- and gravel-based unit is limited to approximately 4 feet. A unit comprising lower-permeability sediments ranging from sandy clay to sandy silt overlies the aquifer sediments to near surface grade.

3.2 Site Hydrogeology

The initial subsurface investigation data indicate that groundwater at the site was first encountered at 18 feet BGS (RESNA, September 1992). A review of the historical groundwater level data indicates that seasonal groundwater fluctuations of approximately 2 to 3 feet have been occurring at the site (Appendix A). Historical groundwater data also indicate that groundwater beneath the site flows generally south-southwest. The groundwater gradient during the first quarter 1995 was determined to be 0.02 foot per foot (ft/ft) to the south-southwest (Figure 7).

3.3 Extent of Hydrocarbon-Impacted Soil

Historical soil analytical results from site investigations conducted to date are summarized in Appendix B and shown in Figures 3 through 6. Results of the subsurface investigations conducted at the site reported detectable concentrations of total petroleum hydrocarbons as gasoline (TPHG) in borings B-1 (470 milligrams per kilogram [mg/kg] or parts per million [ppm]), B-2 (740 mg/kg), B-3 (320 mg/kg), B-4 (65 mg/kg), TB-4 (470 mg/kg), and TB-7 (610 mg/kg). These concentrations were found at depths between approximately 15 and 18.5 BGS (in soils comprising primarily silty sands to sandy gravels, situated directly above the first-encountered water [i.e., the capillary fringe zone]). Nondetectable to less than 30 mg/kg of TPHG was reported in all other borings at depths of 5 to 30 feet BGS.

The highest concentrations of total petroleum hydrocarbons as diesel (TPHD) in soil were detected at a depth of 17 feet BGS in borings B-1 and B-2 at concentrations of 370 and 540 ppm, respectively. ARCO has no record of diesel being stored at the site. Evaluation of chromatograms for the reported analytical results for TPHD indicate that the hydrocarbon mixture detected in the soil samples did not match the typical diesel fingerprint but contained hydrocarbons intermediate to gasoline and diesel (between C-10 and C-12). Thus, it was concluded that the detected TPHD may actually be weathered gasoline.

Total oil and grease (TOG) was nondetectable in all soil samples collected from the soil borings. Volatile organic compounds (VOCs) were not detected in any of the soil samples collected from the borings, except for benzene, toluene, ethylbenzene, and total xylenes (BTEX) in the samples collected just above first-encountered groundwater (between depths of 17 and 18.5 feet BGS). Soil samples collected from the borings contained concentrations of metals within the typical range of natural background levels for soil (Scott, 1991).

Based on these results, BTEX and TPHG appear to be present in capillary-fringe soils in three general areas: (1) in the immediate vicinity of the operating service island close to the station building, (2) along the northern (near TB-4) and south-southwestern (B6/MW-5) edges of the USTs, and (3) in the vicinity of wells MW-1, MW-2, and MW-3 in the southern portion of the site. Most of the petroleum hydrocarbons in soil appear to be limited to the capillary-fringe zone and may be related to the lateral migration of hydrocarbons along the top of the water table.

3.4 Extent of Hydrocarbon-Impacted Groundwater

Historical groundwater analytical data for on-site wells since quarterly monitoring began in December 1991 are presented in Appendix C. Results of the first quarter 1995

monitoring and sampling event are shown in Figure 7. Review of the analytical results indicates that the highest concentrations of BTEX and TPHG in groundwater continue to be reported in the above-specified general areas of concern (in wells MW-1, MW-2, MW-3, and MW-5, screened approximately 14 to 24 feet BGS). No detectable levels of BTEX or TPHG are reported in upgradient monitoring wells MW-6 and MW-7. No detectable levels of BTEX or TPHG were reported in groundwater well AS-2, which is screened from 24.5 to 26.5 feet BGS, below the hydrocarbon-impacted capillary-fringe soils and groundwater.

Detectable levels of total recoverable petroleum hydrocarbons (TRPH, analyzed by U.S. Environmental Protection Agency [USEPA] method 418) and TOG were reported in wells MW-2 and MW-3. Evaluation of chromatograms for the reported analytical results for TRPH and TOG indicates that the hydrocarbon mixtures detected in the soil samples did not match the typical diesel or oil-and-grease fingerprints, but contained hydrocarbons intermediate to gasoline and diesel (between C-10 and C-12). Thus, it was concluded that the detected TRPH and TOG may actually be weathered gasoline.

Other than BTEX, VOCs (chlorinated hydrocarbons such as trichloroethene [TCE], and tetrachloroethene [PCE]) have also been reported in on-site wells MW-1 through MW-7. ARCO has no record of storing chlorinated VOCs on site and no detectable levels of these compounds were reported in soil samples collected at the site. The highest concentrations of these chlorinated hydrocarbons have been reported in upgradient monitoring wells MW-6 and MW-7. These results indicate a potential off-site source for the chlorinated hydrocarbons in site groundwater.

3.5 Results of Air-Sparge Test

AS test methods, procedures and results are summarized in *Report of Findings, Air Sparge Pilot Test* (RESNA, June 1994). A copy of the results is presented in Appendix D.

On February 16, 1994, RESNA conducted an AS test at the site using well AS-2 (screened in the saturated-zone soils from 24.5 to 26.5 feet BGS) as the injection well. On-site monitoring and vapor extraction wells (MW-1 through MW-4, VW-1, VW-2, and VW-3) were used as observation wells during the test. Air injection pressure equivalent to 9 pounds per square inch gauge (psig) resulted in an AS flow rate of 3 actual cubic feet per minute (acfm) at well AS-2. Based on the AS test results, RESNA concluded that the effective sparge radius of influence (ROI) was between 10 and 15 feet for AS-2 at the above-specified sparge pressure and flow rate.

3.6 Results of SVE and Combination SVE/AS Tests

3.6.1 Soil-Vapor Extraction Test

SVE test methods, procedures and results are summarized in *Report of Findings, Air Sparge Pilot Test* (RESNA, June 1994). A copy of the results is presented in Appendix D.

On February 17, 1994, RESNA conducted an SVE test at the site for approximately 60 minutes. During the test, soil vapors were extracted from vadose well VW-1 (screened from 14 to 24 feet BGS); on-site monitoring wells MW-1, MW-2, and MW-3 and vadose well VW-3 were used as observation points to measure induced vacuum responses in the vadose zone.

Vacuums of 28 to 40 inches of water column (IWC) were applied to well VW-1 during the SVE test to remove hydrocarbon-bearing vapor from vadose-zone soils beneath the site. Based on a well-head vacuum ranging from 28 to 40 IWC, an average air flow rate of 25 acfm (22.5 standard cubic feet per minute [scfm]), and induced vacuum responses at the monitoring points, the effective ROI for vapor extraction well VW-1 was estimated to be approximately 15 to 20 feet.

Laboratory analysis of a vapor sample collected from VW-1 at the end of the SVE test (after 60 minutes of SVE) detected total volatile hydrocarbons as gasoline (TVHG) at 7,300 milligrams per cubic meter (mg/m^3). A comparison of vapor-phase benzene concentrations as a percent of TVHG indicated that benzene on average made up approximately 2 percent of the vapor-phase TVHG concentration. Based on the achieved extraction flow rate (22.5 scfm) and the TVHG concentration in vapor extracted from VW-1 (7,300 mg/m^3), the hydrocarbon mass extraction rate was calculated as approximately 14.8 pounds per day (lb/day).

3.6.2 Combined Soil-Vapor Extraction and Air-Sparge Test

RESNA conducted a combined SVE and AS test at the site on February 17, 1994, after completing the 60-minute SVE test. During the combined test, AS was conducted at AS-2 while vadose well VW-1 was used as the SVE well to capture the sparge off-gas. Existing monitoring and vadose wells were used as observation points during the combination SVE/AS test.

Applied pressure of 9 psig resulted in an AS flow rate of 2.5 acfm at well AS-1. An extraction flow rate of 25 acfm was achieved at an applied vacuum of 36 IWC at VW-1. Results from the combined SVE/AS test indicated that sparge off-gas was captured by

vapor extraction well VW-1. TVHG concentrations in extracted vapor from VW-1 increased to 8,400 mg/m^3 as a result of AS.

3.7 Evaluation of Other Remedial Alternatives

EMCON proposes an integrated in situ interim soil and groundwater remediation approach to cleaning up on-site hydrocarbon-impacted soils and groundwater. Through field testing, as detailed in Sections 3.5 and 3.6, SVE, and AS coupled with air bubbling, were chosen as the soil and groundwater remedial alternatives. Other alternatives, such as soil excavation and groundwater pump-and-treat, were not proposed for further evaluation for the following reasons:

- Most of the on-site hydrocarbon-impacted soils are in the capillary-fringe and saturated-zone soils (from approximately 15 to 20 feet BGS), making soil remediation by excavation cost-prohibitive. In addition, during soil excavation, the site will have to be closed for a long period of time due to the large volume of soil to be excavated to the depths listed above. Closure of the operating service station will result in lost revenues at the site, further making soil excavation cost prohibitive.

- The selected in situ treatment method (AS coupled with air bubbling) for hydrocarbon-impacted groundwater does not extract groundwater, and is therefore advantageous from a water conservation perspective.

- Dissolved-phase hydrocarbon concentrations in site groundwater are relatively low (in the parts-per-billion [ppb] range). At these low concentrations, the net mass removal of hydrocarbons through groundwater extraction is typically low relative to the volume of water removed, thus making remediation of saturated soils by groundwater extraction slow (10 to 20 years or greater for cleanup) and cost-prohibitive.

- Based on EMCON's experience at other sites and recent studies of remedial alternatives as discussed in technical literature and as presented in technical seminars by professionals from the industry, the proposed remediation systems are more cost- and time-effective methods for remediation than groundwater pump and treat systems.

- The SVE, AS and air bubbling systems target remediation of the source (the capillary-fringe soils) more effectively than groundwater pump-and-treat systems because the hydrocarbon removal rates by SVE and AS are typically higher.

- In addition, because AS systems do not generally create a hydraulic capture zone, potential off-site chlorinated VOCs from a second source may be less likely to be drawn toward the site.

4 DESCRIPTION OF PROPOSED INTERIM SOIL AND GROUNDWATER REMEDIATION SYSTEMS

The proposed SVE, AS, and air-bubbling systems will function as interim remedial measures for on-site hydrocarbon-impacted soil and groundwater beneath the site.

4.1 SVE System

The proposed SVE system will use two pre-existing vapor extraction wells (VW-1 and VW-3), two pre-existing groundwater monitoring wells (MW-1 and MW-5), eight proposed vapor extraction wells (VW-2 and VW-4 through VW-10), a vacuum blower, and an off-gas abatement unit to address most of the gasoline-impacted soils in (1) the immediate vicinity of the operating service island, close to the station building, (2) along the northern and south-southwestern edges of the USTs, and (3) in the vicinity of wells MW-1, MW-2 and MW-3 in the southern portion of the site. Figure 8 depicts the locations of the proposed SVE wells. The current vapor extraction well VW-2 will be abandoned and reinstalled adjacent to its current location. The well needs to be abandoned because the bentonite seal between it and well AS-2 was temporarily broken during the SVE and AS tests.

Based on the ROI estimated from the results of the SVE pilot test, and the lateral extent of the hydrocarbon plume at the site, EMCON concluded that eight additional vapor extraction wells, VW-2 and VW-4 through VW-10, screened from 10 to 24 feet BGS, would be necessary to address the identified areas of concern. The SVE system will also be used to capture sparge off-gas from the AS system. The proposed SVE wells will be screened into the water table (10 to 24 feet BGS) to effectively capture the sparge off-gas from the AS system and remediate capillary-fringe soils when the water table is low.

Based on SVE test data, the effective ROI for the vapor extraction wells has been estimated to be approximately 15 to 20 feet for an average well-head air flow rate of 25 acfm (22.5 scfm) at an applied well-head vacuum of approximately 40 IWC. Benzene and TVHG concentrations in vapor extracted from VW-1 during the SVE and combined SVE and AS pilot tests averaged 1,440 and 7,850 mg/m^3 (444 and 2,170 parts per million by volume [ppmv]), respectively. The SVE system will be operated under conditions similar to those during the SVE test to achieve a similar estimated ROI for each well. A

conservative estimate of 15 feet for the effective ROI was used in designing the SVE system.

The actual ROI for the vapor extraction wells will vary depending on subsurface geologic conditions, the extent and distribution of hydrocarbon-impacted soil, and site-specific operating conditions of the SVE system. The effective ROI will be reevaluated after long-term operation of the SVE system.

4.1.1 Vapor Well-Head Connections

Subgrade remediation piping will consist of individual 2.5-inch-diameter polyvinyl chloride (PVC), Schedule (Sch) 40 piping runs from each SVE well to the on-site remediation compound. At the remediation compound, the individual piping runs will be stubbed up and manifolded above grade to a 3-inch-diameter PVC Sch 80 pipe. Each SVE line stubbed up in the remediation compound will be equipped with a vacuum gauge, a sample port, and a shutoff valve before manifolding so that flow through each well can be adjusted to maximize the total pounds of petroleum hydrocarbons being extracted from the soil. Well vault-boxes with traffic-rated covers will be installed at each vapor extraction well for protection.

Two additional 2.5-inch-diameter, Sch 40 PVC pipes will be installed from stubout locations STB-1 and STB-2 to the remediation compound for SVE at a later date if necessary. The remediation piping will be capped below grade and a brass monument marker (flushed to grade) installed over this stubout location. If necessary, SVE wells will be installed at these locations and tied into the remediation piping at a later date.

4.1.2 SVE Treatment Processes

The subsurface 2.5-inch-diameter vapor piping will direct extracted vapor from the SVE wells to an off-gas abatement unit at the remediation compound. Components of the SVE system in the remediation compound will include (1) a vapor extraction blower to extract vapor from the wells through the subgrade piping, (2) flow indicators to measure total extracted flow from each well and total flow to the off-gas abatement unit, (3) a condensate separator to remove entrained droplets of moisture, (4) an off-gas abatement unit, (5) associated piping, control valves, instrumentation, and controls, (6) a remote monitoring system to transmit the status of process variables and any alarm or upset conditions, and (7) a brick masonry wall enclosure for the remediation compound (typically 25 feet long by 20 feet wide by 8 feet high) to preclude public access. Figure 9 is a process flow schematic for the proposed SVE system.

A catalytic oxidizer is proposed to initially abate hydrocarbon vapors extracted from the vapor extraction wells, based on the flow rate and concentrations observed during the

SVE test. A catalytic oxidizer can typically process extracted hydrocarbon vapor at no greater than 25 percent of the lower explosive limit (LEL) of gasoline (equivalent to 3,500 ppmv TVHG or 12,661 mg/m^3 using an molecular weight of 87 grams per gram-mole). Appendix E contains manufacturer's specifications for the catalytic oxidizer (a Therm-Tech CATVAC 10 E) to be used at this site.

Assuming sufficient oxygen in extracted vapor (15 to 18 percent by volume), average TVHG concentrations of 7,850 mg/m^3 in extracted vapor, an extracted air flow rate of 22.5 scfm from each well at 40 IWC, and the catalytic oxidizer's capacity to process hydrocarbon vapors (25 percent of the LEL), a total of seven SVE wells can be on-line with the system. Based on these conditions, the initial hydrocarbon removal rate for the 100-scfm catalytic oxidizer unit is estimated to be approximately 114 lb/day or 18 gallons per day (gpd). This initial removal rate will rapidly decrease with time (sometimes by 90 percent within the first six months). The catalytic oxidizer, per manufacturer's specifications, will typically demonstrate destruction efficiencies of 90 percent or greater for petroleum hydrocarbons. The unit will be operated such that emission limits set by the Bay Area Air Quality Management District (BAAQMD) are not exceeded at the subject site.

Other off-gas abatement alternatives were evaluated for use with the SVE system. Thermal oxidizers can typically process TPHG concentrations up to 11,200 ppmv, equivalent to 80 percent of the LEL for gasoline. The average TVHG concentration observed during the SVE test was only 2,170 ppmv. Considering that vapor concentrations from SVE systems typically decrease rapidly with time, use of a thermal oxidizer would likely result in high supplemental fuel and utility costs over the life of the project. As a result, thermal oxidation was not selected as a cost-effective method of off-gas abatement for this site. Using activated carbon to abate extracted vapor from the SVE system would be cost-prohibitive because the high influent TPHG concentrations would result in frequent carbon changeouts, and hence higher operation and maintenance costs.

The catalytic oxidizer will be replaced with an activated vapor-phase carbon adsorption system (two 1,000-pound carbon canisters in series) in the future, when influent hydrocarbon concentrations have decreased, making it cost-effective and safe. Once hydrocarbon concentrations have decreased further (less than 1 lb/day TVHG and less than 0.02 lb/day benzene), vapor extracted by the SVE system will be discharged to the atmosphere with no off-gas abatement.

A remote monitoring system will be installed in the remediation compound to report alarm or shutdown conditions. When alarm conditions are triggered, the remote monitoring system will notify EMCON's San Jose office personnel so that the condition can be rectified before system restart. A fire extinguisher and "no smoking" signs will also be installed in the remediation compound. Aboveground or subgrade electrical conduits will also be installed from their respective on-site service points to the remediation compound.

4.2 AS System

The proposed groundwater remediation systems to be used at the site are AS and air-bubbling systems. The AS system will use pre-existing well AS-1 and four proposed AS wells (AS-2 through AS-5), and an oil-less air compressor to address most of the gasoline-impacted groundwater in the vicinity of wells MW-1 through MW-5 (i.e., the zone of hydrocarbon-impacted capillary-fringe soils). Figure 8 depicts the locations of the proposed AS wells and Figure 9 shows a process flow schematic for the AS treatment process.

The current well AS-2 will be abandoned and reinstalled adjacent to its current location. The well needs to be abandoned because the bentonite seal between it and VW-2 was temporarily broken during the SVE and AS tests.

4.2.1 Air-Sparge Treatment Process

AS involves injecting compressed air into groundwater through AS wells, which contain a 1- to 2-foot section of slotted screen installed near the bottom of the water-bearing zone of concern. The injected air forms bubbles and transient air pockets, which rise up through the saturated soils to enhance the volatilization of dissolved-phase gasoline hydrocarbons (in groundwater) and adsorbed-phase gasoline hydrocarbons (in capillary-fringe and saturated soils) within the ROI of each AS well. The gasoline-hydrocarbon-bearing vapors exit the groundwater surface and rise into the vadose-zone or capillary-fringe soils, where they are captured by an operating SVE system.

Based on the AS test results, the effective ROI of existing sparge wells was estimated to be 10 to 15 feet at an AS flow rate of 3 acfm and an AS pressure of 9 psig. Based on this estimated AS ROI, and the lateral and vertical extents of dissolved- and adsorbed-phase hydrocarbons in the capillary-fringe and saturated-zone soils, EMCON concluded that four additional AS wells, AS-2 through AS-5, screened from 24 to 26 feet BGS in the saturated-zone soils, would be necessary. Pre-existing well AS-1 will sparge air into the aquifer at approximately 26 to 28 feet BGS. An oil-less air compressor in the remediation compound will introduce compressed air into the aquifer at 9 psig, as determined during the AS test conducted on February 16 and 17, 1994, by RESNA. Because the ROI of each vapor extraction well was estimated to be approximately 15 to 20 feet, the SVE system should adequately capture sparge off-gas vapors.

A typical concern regarding AS is the potential resulting migration of the dissolved contaminant plume. This migration might be caused by lateral displacement of groundwater as air bubbles rise through the water column. The presence of low-permeability soil zones above the sparge point but below the water table can also restrict the vertical movement of sparge off-gas, which could potentially drive the dissolved plume in a horizontal direction. To prevent potential lateral migration of dissolved hydrocarbons

across the downgradient property as a result of AS, EMCON proposes to initiate AS at a low injection pressure of 9 psig, and a low air flow rate of 3 acfm (5 scfm) to initiate volatilization of dissolved- and adsorbed-phase gasoline hydrocarbons in capillary-fringe and saturated soils at the site, in conjunction with SVE.

Because the SVE system's capacity for processing extracted vapor and sparge off-gas is limited to a total air flow of 100 scfm, all SVE wells cannot be operated at the same time. Therefore, different combinations of the SVE wells and AS wells will be brought on-line in sequence as the remediation progresses. This use of a combination of sparge wells (pulsing the AS system) will help to periodically develop new air migration pathways and close old ones.

Another beneficial effect of AS is the introduction of dissolved oxygen into groundwater and saturated-zone soils, which may promote biodegradation of gasoline hydrocarbons at the site.

The advantage of AS systems is that AS can reduce dissolved-phase hydrocarbons in groundwater more effectively than pump-and-treat systems alone. This increased hydrocarbon removal results from the fact that AS reduces dissolved-phase hydrocarbons by direct volatilization within the water-bearing zone itself. By contrast, pump-and-treat systems require dissolved hydrocarbons to be hydraulically drawn toward the well for removal. The hydraulically induced migration of groundwater toward the recovery well is often slow (depending on subsurface geology and hydrogeology), and is compounded by the retardation of dissolved hydrocarbons (i.e., because of adsorption/desorption of dissolved phase hydrocarbons onto the soil matrix) as they flow through soil. In addition, extracted groundwater typically only contains dissolved hydrocarbons at the low ppm or ppb level. Consequently, in pump-and-treat systems, the net mass removal of hydrocarbons is typically low relative to the volume of water removed. An additional advantage of AS is that it can often target removal of the source (i.e., adsorbed-phase hydrocarbons and soils with residual saturation of nonaqueous-phase hydrocarbons [if any] at the capillary fringe and within the zone of water table fluctuation) more effectively than groundwater pumping alone. Finally, because AS systems do not generally create a hydraulic capture zone, potential off-site VOCs from a second source may be less likely to be drawn toward the site.

Appendix E contains manufacturer's specifications for the oil-less air compressor (a Powerex Rotary Scroll) to be used at this site.

4.2.2 Air-Sparge Well-Head Connections

Subgrade remediation piping consisting of individual 1/2-inch, Sch 80 PVC pipe for AS will be installed from each AS well to the remediation compound. The individual AS lines will be stubbed up in the remediation compound and manifolded to a single 1-inch, Sch 40

steel pipe. The 1-inch AS line will then be connected to the oil-less air compressor in the proposed remediation compound. Each AS line stubbed up in the remediation compound will be equipped with a flow regulator, a pressure gauge, a sample port, and a shutoff valve before manifolding to a single line so that compressed air flow to each sparge well can be adjusted to optimize the sparge flow, pressure, and ROI of each well. Well vault-boxes with traffic-rated covers will be installed at each sparge well for protection.

Two additional 0.5-inch-diameter, Sch 80 PVC pipes will be installed from stubout locations STB-1 and STB-2 to the remediation compound for AS or air-bubbling at a later date, if necessary. The remediation piping will be capped below grade and a brass monument marker (flushed to grade) installed over this stubout location. If necessary, air-bubbling wells or AS wells will be installed at these locations and tied into the remediation piping at a later date.

4.3 Air-Bubbling System

To introduce additional oxygen into groundwater and thereby promote natural biodegradation of petroleum hydrocarbons in saturated soils and groundwater, and to help volatilize hydrocarbons in the capillary fringe, an air-bubbling system will be installed. This system will further enhance remediation of capillary-fringe and saturated soils and groundwater. The system will bubble air into wells at low flow rates (less than 1 scfm per well) through a tube that delivers air approximately 2 feet above the bottom of the well. Air from the oil-less compressor will be injected through the tube at a pressure sufficient to overcome the static head in each well. Air will be bubbled into SVE wells VW-1 through VW-10, and groundwater monitoring wells MW-1 through MW-5.

Subgrade remediation piping consisting of individual ½ inch, Schedule 80 PVC pipe will be installed from each well to the remediation compound. Similar to the AS system, the individual air bubble lines will be stubbed up in the remediation compound and manifolded to a single 1-inch Schedule 40 steel pipe connected to the oil-less compressor.

5 DESIGN, INSTALLATION, AND EFFECTIVENESS VERIFICATION OF PROPOSED INTERIM REMEDIATION SYSTEMS

EMCON proposes the following tasks for installation and implementation of remedial measures for soil and groundwater.

5.1 Task 1. Remedial Action Plan

EMCON will submit this RAP to the RWQCB and ACHCSA for review and approval before design, permitting, installation, and operation of the proposed remediation systems. This RAP describes interim remedial measures to be implemented for on-site hydrocarbon-impacted soils and groundwater at the site, including design, construction, and proposed operation, maintenance, and monitoring of the remediation systems to be installed.

5.2 Task 2. Installation of AS and SVE Wells

EMCON proposes installing eight additional SVE wells (VW-2 and VW-4 through VW-10) and four additional AS wells (AS-2 through AS-5) at the locations shown in Figure 8. These wells will be installed to effectively address most on-site areas of concern. Well installation permits will be obtained from the Alameda County Flood Control and Water Conservation District (ACFCWCD). SVE wells VW-2 and VW-4 through VW-10 will be completed with 4-inch-diameter, Sch 40 PVC casing, and the screened interval will consist of 4-inch-diameter, 0.020-inch machine-slotted PVC. Wells VW-2 and VW-4 through VW-10 will be screened from approximately 10 to 24 feet BGS, to remediate vadose-zone and capillary-fringe soils. Because the water table fluctuates seasonally between approximately 16 and 19 feet BGS, a portion of the vapor well screen will be below the water table during part of the year. This screened interval will allow for more effective capture of sparge off-gas from the AS system and remediation of capillary-fringe soils when the water table is low.

Wells AS-2 through AS-5 will be completed with 2-inch-diameter, Sch 40 PVC casing, and the screened interval will consist of 2-inch-diameter, 0.020-inch machine-slotted PVC, set from approximately 26 to 28 feet BGS.

5.3 Task 3. Design of SVE, AS, and Air-Bubbling Systems

This phase of the proposed work will include (1) performing engineering calculations required for installing the systems; (2) preparing a list of necessary remediation equipment, materials, and instrumentation; (3) preparing plans and technical construction specifications, including site and remediation compound layouts, remediation compound equipment pad and brick wall enclosure details, trench and section details, and a process and instrumentation diagram (P&ID); (4) performing an in-house plan check and review, and (5) revising plans and specifications after review by ARCO.

Also under this task, EMCON personnel will, through written and verbal communications, meet with Pacific Gas and Electric Company (PG&E), Pacific Bell, and City of Oakland personnel to determine (1) the location and type of electrical service available and required at the site for operating the off-gas abatement equipment, (2) the location of telephone service for the remote monitoring system to report alarm conditions and operational parameters of the SVE system, and (3) City's requirements regarding the location of the remediation compound and installation of the proposed remediation systems.

5.4 Task 4. Permitting

An Authority-to-Construct and Permit-to-Operate application will be completed and submitted to the BAAQMD to allow for construction and installation of the proposed SVE and AS systems. The application will include a site history; SVE, AS, and air-bubbling system specifications; and analytical results for BTEX and TPHG in vapor extracted from wells during the SVE and AS tests.

The completed set of plans and technical specifications will also be submitted to the City of Oakland Building, Planning, and Fire departments for review, comment, and approval before construction and installation of the SVE, AS, and air-bubbling remediation systems.

5.5 Task 5. Bid Package Preparation and Evaluation

After the design is completed, permit applications are submitted, and a preliminary approval is received, a bid package will be prepared for installation of the proposed SVE, AS, and air-bubbling systems. At least three prequalified contractors will receive the bid package. One site meeting will be scheduled with each contractor to answer contractors' questions and assist them in preparing their bids. EMCON will evaluate contractor bids and make recommendations to ARCO for award of contract.

5.6 Task 6. Equipment Procurement

After the engineering design is completed, permits are obtained, and a contractor is selected, EMCON will provide ARCO with a list of long-lead capital equipment (greater than 4 weeks) to be ordered. Either ARCO or EMCON will order the equipment directly from the vendor. Possible capital equipment to be ordered includes a 100-scfm catalytic oxidizer, a vapor extraction blower, and an oil-less air compressor. Other equipment (valves, pipes, etc.) and instrumentation will be purchased by the contractor.

5.7 Task 7. Construction

Upon approval of the RAP, and after the City Building, Fire, and Planning department permits and the BAAQMD Permit to Construct have been secured, a general contractor has been selected, and equipment has been procured, the system will be installed consistent with the approved plans and technical specifications. Construction will include (1) installing subgrade remediation piping to SVE and AS wells; (2) pressure-testing subgrade lines before backfilling and paving; (3) installing well-head piping and instrumentation; (4) installing well-head boxes; (5) constructing the remediation compound; (6) hooking up subgrade and above-grade electrical and telephone services; and (7) installing and plumbing all process equipment (blower and off-gas abatement system) related to the SVE, AS, and air-bubbling systems.

5.8 Task 8. System Startup and Operation

This task details a monitoring plan to verify the effectiveness of the proposed SVE, AS, and air-bubbling systems at the site.

5.8.1 System Monitoring

After the SVE, AS, and air-bubbling systems are installed, they will be started up consistent with all applicable regulations. Startup procedures will include system monitoring, maintenance, and sampling within the first five days of operation. Operation and maintenance of the SVE and AS systems, as described above, typically includes daily site inspections for the first five days of operation, and site visits once a week for the first month. After the first month of operation, site visits will typically be performed once every two weeks, or as needed, over the operating life of the remediation systems. This schedule will be modified if additional requirements are specified by the BAAQMD in the Authority to Construct and Permit to Operate. Routine maintenance of the SVE and AS systems will be performed during these site visits, and as needed.

Site inspections will typically include (1) monitoring and adjustment of system parameters to optimize SVE and AS system efficiency; (2) periodic sampling and field-monitoring of extracted vapor influent and effluent to the catalytic oxidizer, as required by the BAAQMD; (3) depth-to-water measurements in on-site wells; (4) periodic sampling and field-monitoring of extracted vapor concentrations from each vapor extraction, air-bubbling, and observation well; (5) monitoring of AS pressure and flow rate at AS wells; (6) measurement of induced vacuum responses at observation wells; (7) measurement of dissolved oxygen (DO) levels in on-site monitoring wells, air-bubbling wells, and AS wells; (8) adjustment of vapor extraction air flow rates, sparge pressures, and air flow rates to optimize system efficiency; and (9) other periodic maintenance for continued operation of the remediation equipment. Hydrocarbon vapor concentrations will be monitored in the field with an organic vapor monitor approved by the BAAQMD.

5.8.2 System Sampling

SVE System. Typical BAAQMD guidelines require collection of SVE influent and effluent air samples during the startup phase of the off-gas abatement unit, to evaluate destruction efficiency of the unit for non-methane TVHG and benzene. To demonstrate compliance with BAAQMD regulations, the SVE system will likely be sampled at least twice during the first week of operation, and once a month for the life of the remediation system. Except for the influent and effluent air samples to be collected and analyzed as detailed above during the first week of operation and later on a monthly basis, all other sampling of the SVE wells will be conducted using a field organic vapor monitoring instrument approved by the BAAQMD. If at any time the results of laboratory analyses show emission limits to be exceeded, a confirmation air sample will be taken immediately and analyzed on a 24-hour turnaround basis. If emission limits are still exceeded, the system will be shut down and any necessary corrective action performed before repeating the startup sequence. BAAQMD will be notified within 24 hours that emission limits were exceeded.

The off-gas abatement unit will be modified to an activated carbon adsorption unit (two 1,000-pound vapor-phase activated carbon canisters in series) when the hydrocarbon concentrations of vapor extracted from subsurface soils approach 100 ppmv, or when it becomes cost-effective. Typical BAAQMD guidelines require that extracted vapor influent to and effluent from the carbon system be monitored daily with a field instrument approved by the BAAQMD until the frequency of carbon changeout can be determined. System monitoring frequency will likely be changed to biweekly or monthly with a field instrument, and monthly verification with bag samples upon determining the frequency of carbon changeout and receiving BAAQMD approval for revising the monitoring schedule.

If hydrocarbon concentrations decrease further with ongoing remediation such that extracted mass removal rates are below 1.0 lb/day TVHG and 0.02 lb/day benzene, the

SVE system will be operated with no off-gas abatement (direct discharge to the atmosphere).

AS and Air-Bubbling System. To monitor the effectiveness of the AS and air-bubbling systems, water samples will be collected once during the first month of operation, and later once every quarter, from all on-site monitoring and AS wells. Water samples will be analyzed for gasoline and diesel hydrocarbons and their constituents by USEPA methods 8015 and 8020. Increases in field parameters, such as DO levels in AS, air-bubbling, and monitoring wells, and organic vapor concentrations in SVE wells as a result of air bubbling as measured by a field instrument, will also be used to evaluate the effectiveness of the groundwater remediation systems.

5.9 Task 9. System Performance Evaluation

After a period of continuous SVE and AS system operation, the systems' performance will be evaluated to monitor their effectiveness. This evaluation will be performed in conjunction with continued groundwater monitoring and sampling at the subject site, and results will be submitted with the regularly scheduled quarterly monitoring and sampling reports. This report may include the following: hours of operation during which samples were collected; system influent and effluent field-monitoring readings; laboratory results of influent and effluent air and water samples; total and individual vapor extraction well, AS and air-bubbling flow rates; induced vacuum responses in observation wells; AS and air-bubbling pressures; all other relevant field data collected; and results obtained, such as observed SVE and AS ROIs, and system destruction efficiency for the catalytic oxidizer. Recommendations will then be made to further optimize system performance and enhance remediation of subsurface impacted soils and groundwater.

6 IMPLEMENTATION SCHEDULE

Figure 10 depicts EMCON's proposed preliminary time schedule for implementing the described tasks. These timelines do not include potential delays associated with regulatory approvals, permitting, availability of required electrical, and telephone services, equipment delivery, inclement weather, negotiations with lessee, or delays in utility installation.

The timeframes for the appropriate regulatory agencies to review and approve the RAP, permits, and construction plans and specifications are also estimated in the schedule (Figure 10). The permitting timeframe is expected to be about as long as the engineering timeframe.

The schedule assumes that soil remediation can be completed in about 2 years, provided optimum soil and operating conditions for the SVE system exist. Duration of cleanup can be more accurately predicted after the performance of the SVE and groundwater remediation systems have been evaluated in the first one year of operation.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

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Scott, C.M. 1991. *Background Metal Concentrations in Soils in Northern Santa Clara County, California.* M.S. Thesis at the University of San Francisco, Environmental Management Program.

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APPENDIX A

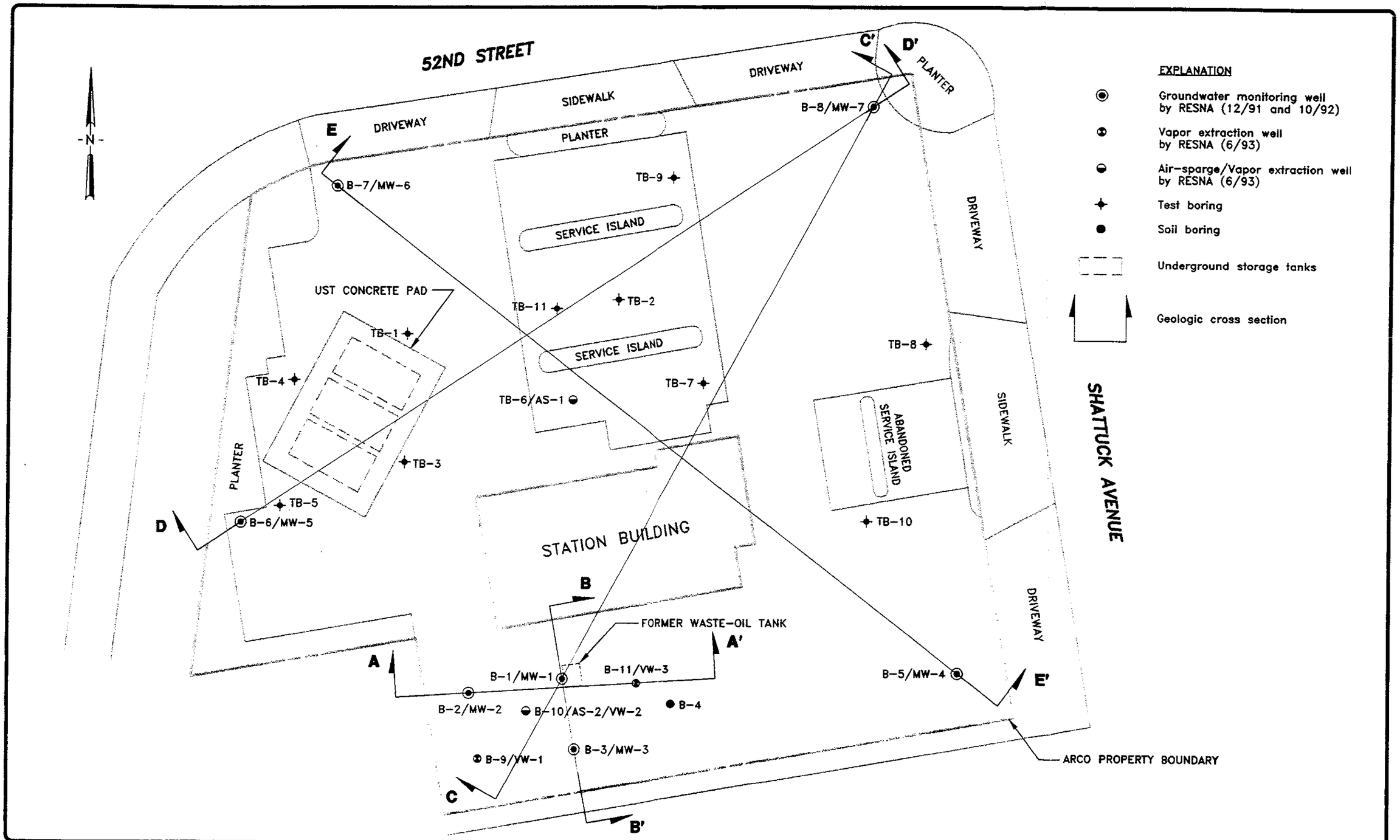
HISTORICAL GROUNDWATER ELEVATION DATA

APPENDIX B

SOIL SAMPLING ANALYTICAL DATA

APPENDIX C

HISTORICAL GROUNDWATER ANALYTICAL DATA



emcon

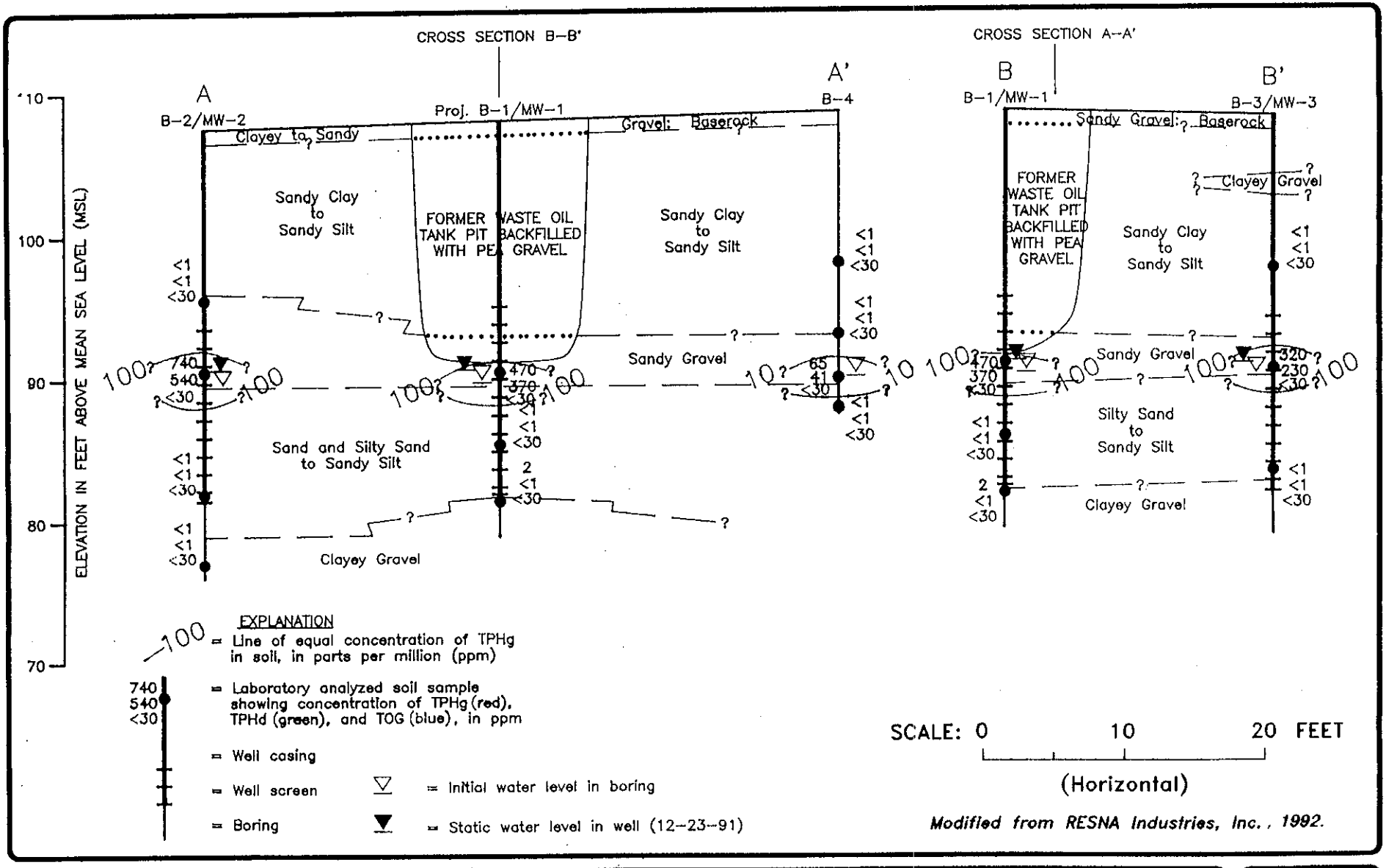
SCALE: 0 20 40 FEET

ARCO PRODUCTS COMPANY
SERVICE STATION 6148
5131 SHATTUCK AVENUE
OAKLAND, CALIFORNIA

SITE PLAN

FIGURE NO.
2

PROJECT NO.
805-135.02



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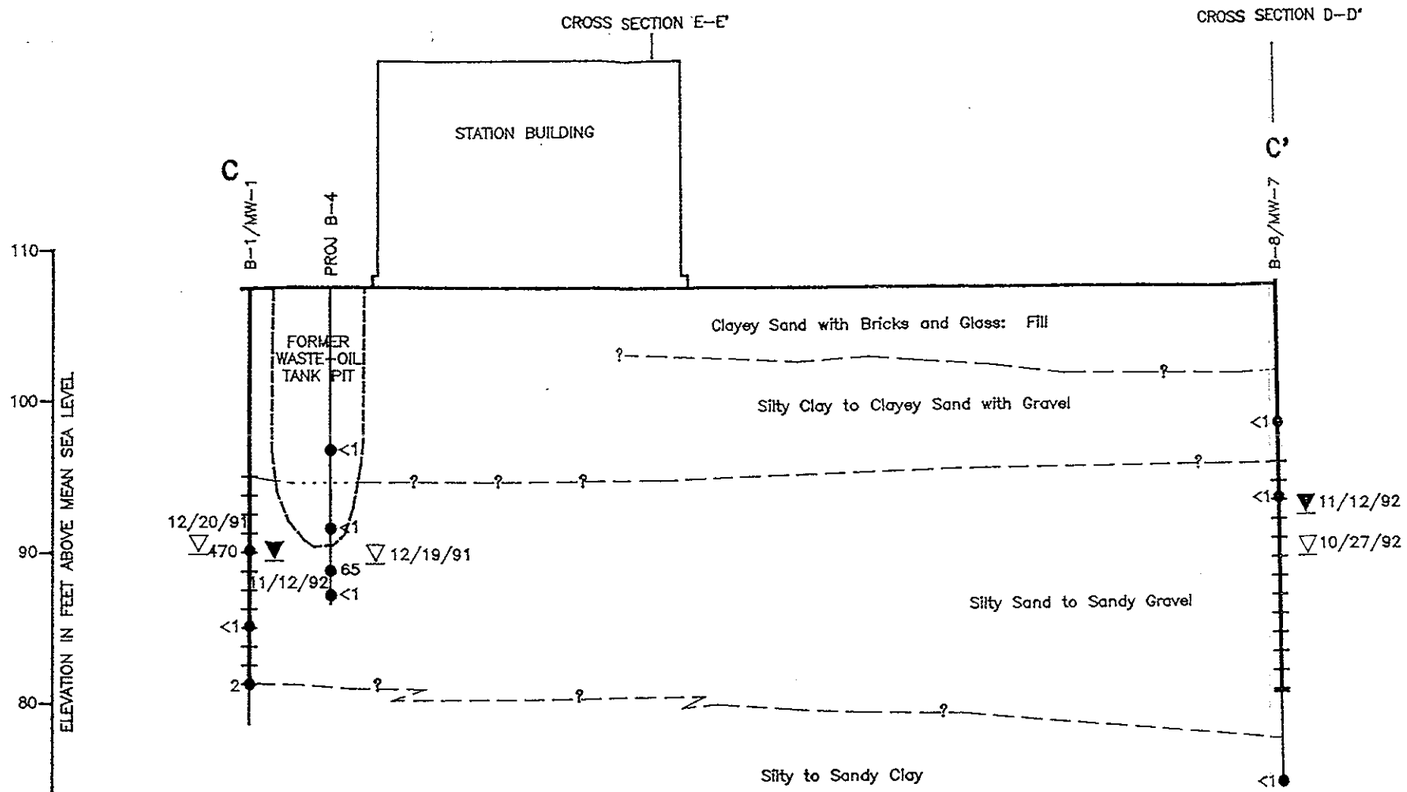
OAKLAND, CALIFORNIA

GEOLOGIC CROSS SECTIONS A–A' AND B–B'

FIGURE NO.
3

PROJECT NO.
805-135.02



EXPLANATION

740 = Laboratory analyzed soil sample showing concentration of TPHg in parts per million

= Well casing

= Well screen

= Boring

= Initial water level in boring

= Static water level in well

Modified from RESNA Industries, Inc., 1993.

EMCON

SCALE: 0 20 40 FEET
(Horizontal)

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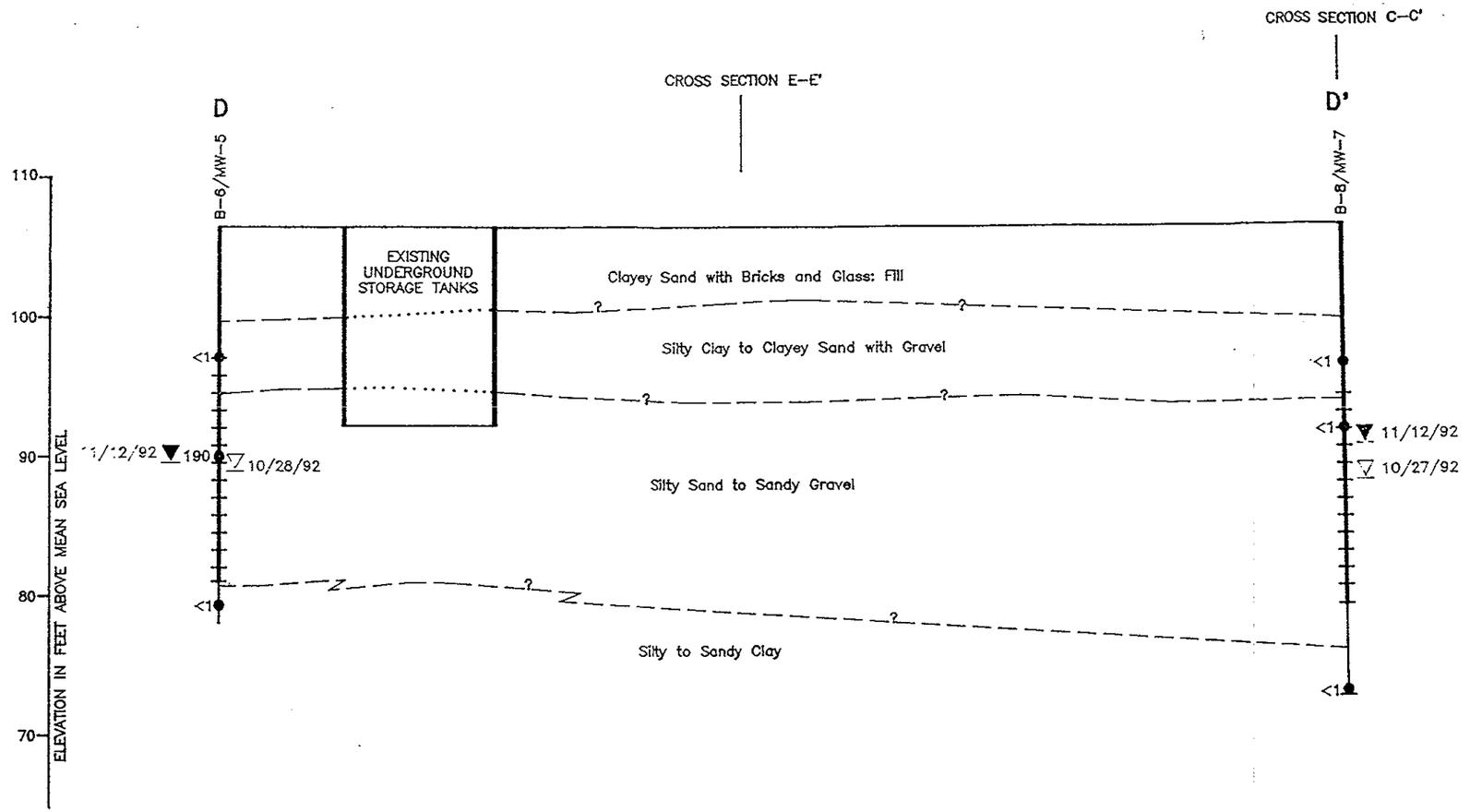
5131 SHATTUCK AVENUE
OAKLAND, CALIFORNIA

GEOLOGIC CROSS SECTION C–C'

FIGURE NO.
4
PROJECT NO.
805–135.02



EXPLANATION

190 = Laboratory analyzed soil sample showing concentration of TPHg in parts per million

= Well casing

= Well screen

= Boring

▽ = Initial water level in boring

▼ = Static water level in well

Modified from RESNA Industries, Inc., 1993.

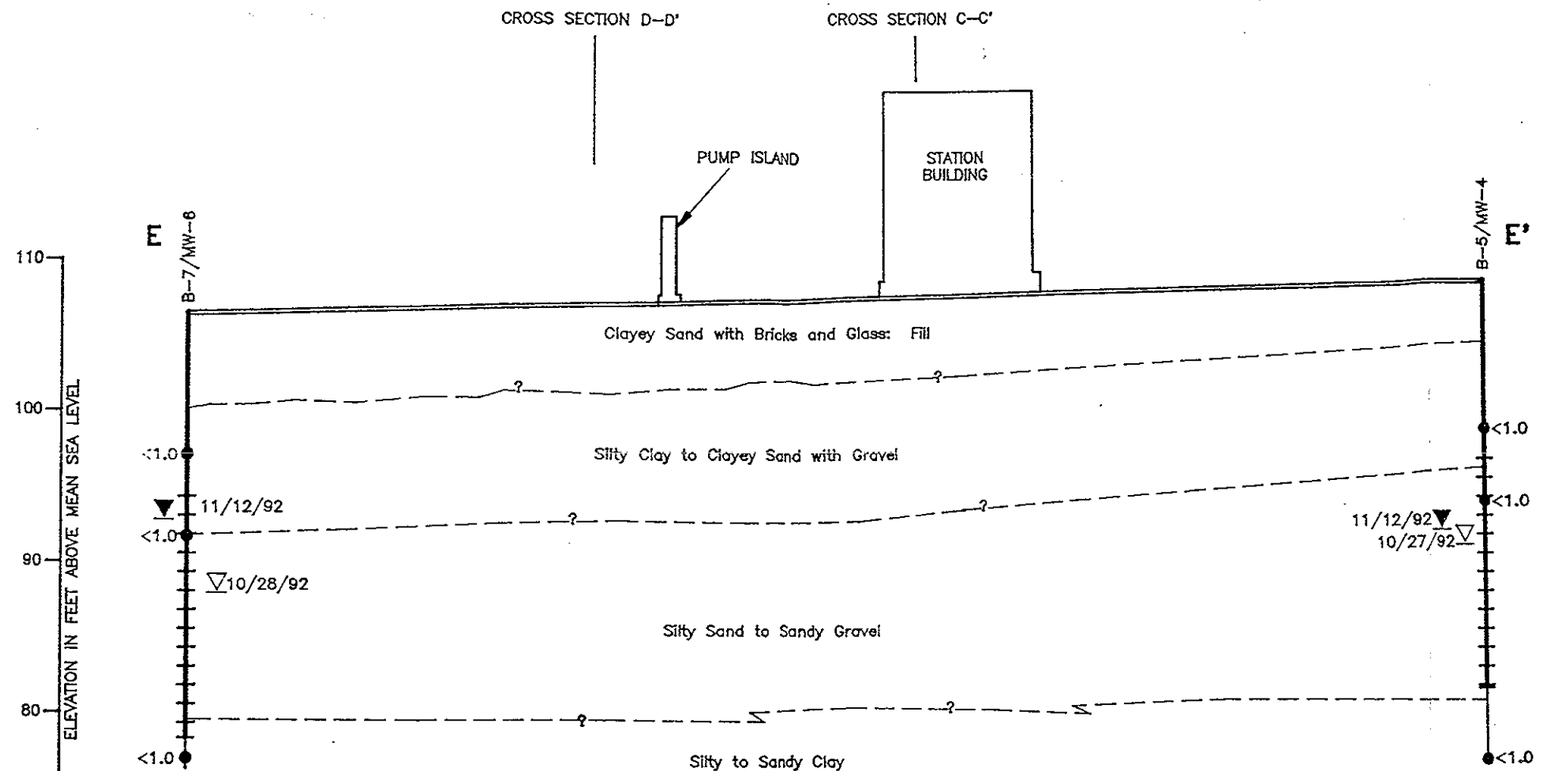
EMCON

SCALE: 0 20 40 FEET
(Horizontal)

ARCO PRODUCTS COMPANY
SERVICE STATION 6148
5131 SHATTUCK AVENUE
OAKLAND, CALIFORNIA

GEOLOGIC CROSS SECTION D–D'

FIGURE NO.
5
PROJECT NO.
805–135.02



EXPLANATION

<1.0 = Laboratory analyzed soil sample showing concentration of TPHg in parts per million

= Well casing

= Well screen

= Boring

▽ = Initial water level in boring

▼ = Static water level in well

Modified from RESNA Industries, Inc., 1993.

emcon

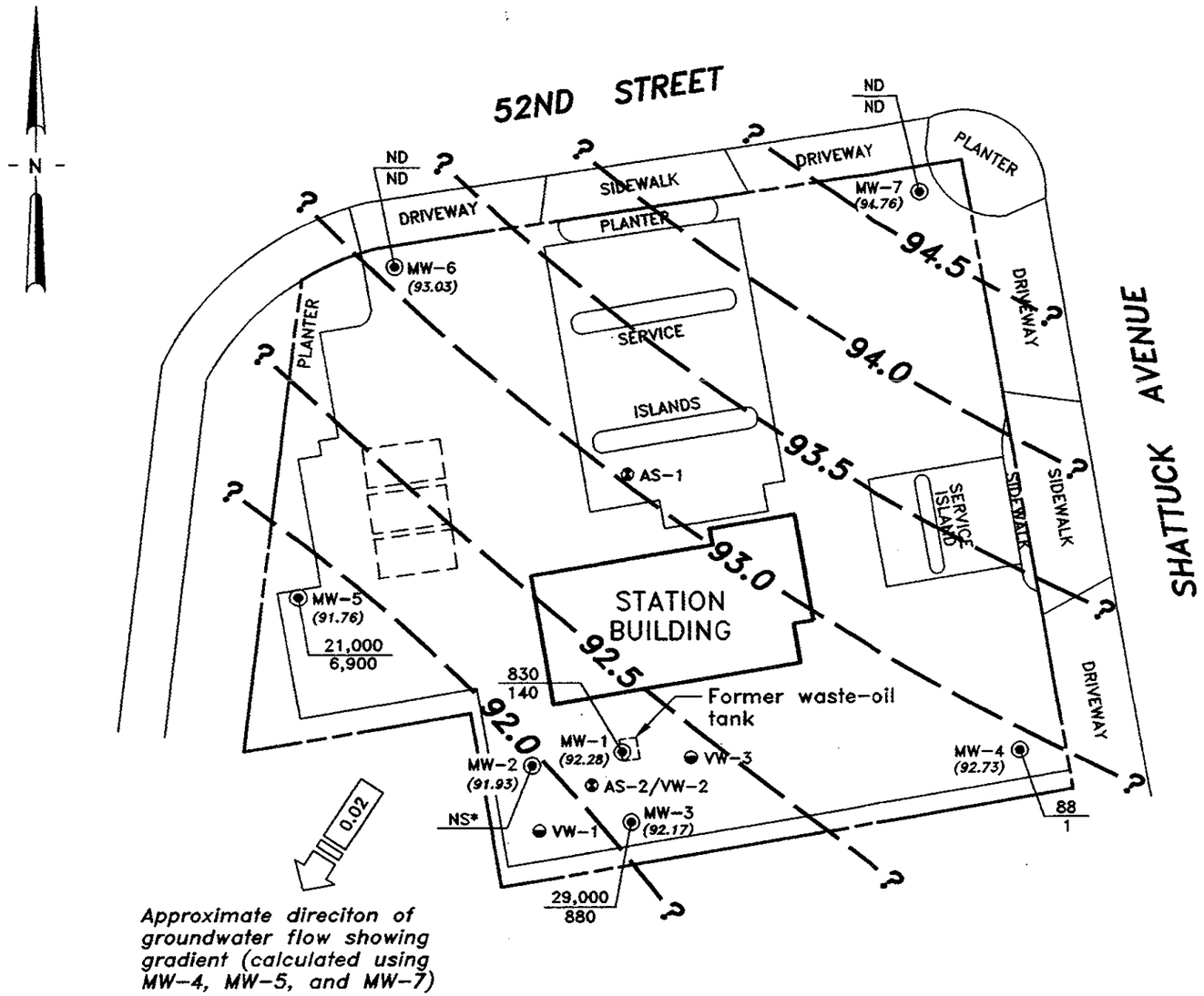
SCALE: 0 20 40 FEET
(Horizontal)

ARCO PRODUCTS COMPANY
SERVICE STATION 6148
5131 SHATTUCK AVENUE
OAKLAND, CALIFORNIA

GEOLOGIC CROSS SECTION E–E'

FIGURE NO.
6

PROJECT NO.
805–135.02



EXPLANATION

- Groundwater monitoring well
- Vapor extraction well
- Vapor extraction well
- Existing underground gasoline storage tank
- (92.28) Groundwater elevation (Ft.–MSL) measured 3/20/95
- Groundwater elevation contour (Ft.–MSL)
- 830 / 140 — TPHG, concentration in groundwater (µg/l); sampled 3/20/95; Benzene concentration in groundwater (µg/l); sampled 3/20/95
- NS — Not sampled
- * — Floating product entered well during purging

EMCON

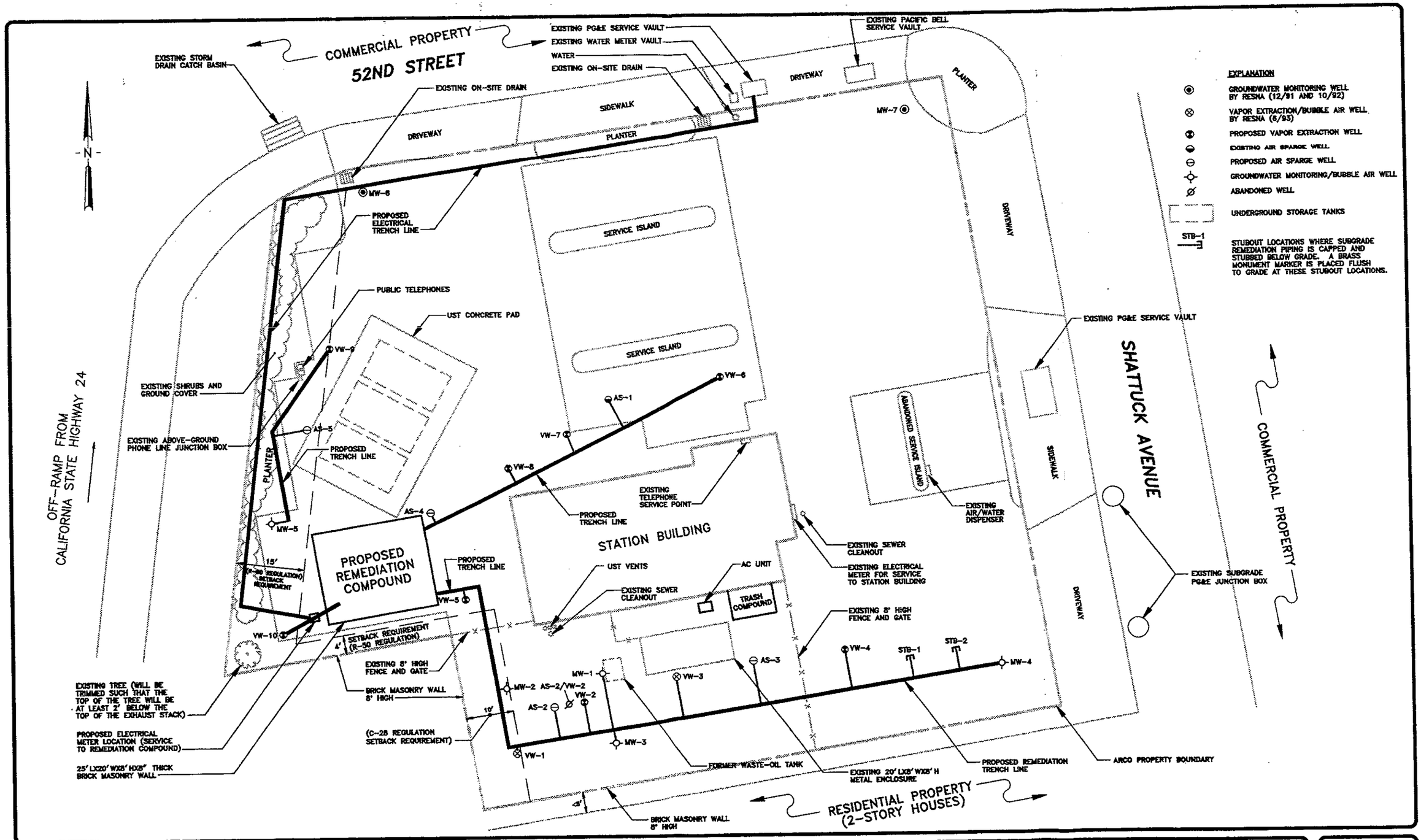
SCALE: 0 30 60 FEET
(Approximate)

ARCO PRODUCTS COMPANY
SERVICE STATION 6148, 5131 SHATTUCK AVENUE
REMEDIAL DESIGN
OAKLAND, CALIFORNIA

GROUNDWATER DATA
FIRST QUARTER 1995

FIGURE NO.
7

PROJECT NO.
805–135.02



emcon

SCALE: 0 20 40 FEET

ARCO PRODUCTS COMPANY
SERVICE STATION 6148
5131 SHATTUCK AVENUE
OAKLAND, CALIFORNIA

PROPOSED SVE AND AS BORING/WELL LOCATIONS

FIGURE NO.
8
PROJECT NO.
805-135.02

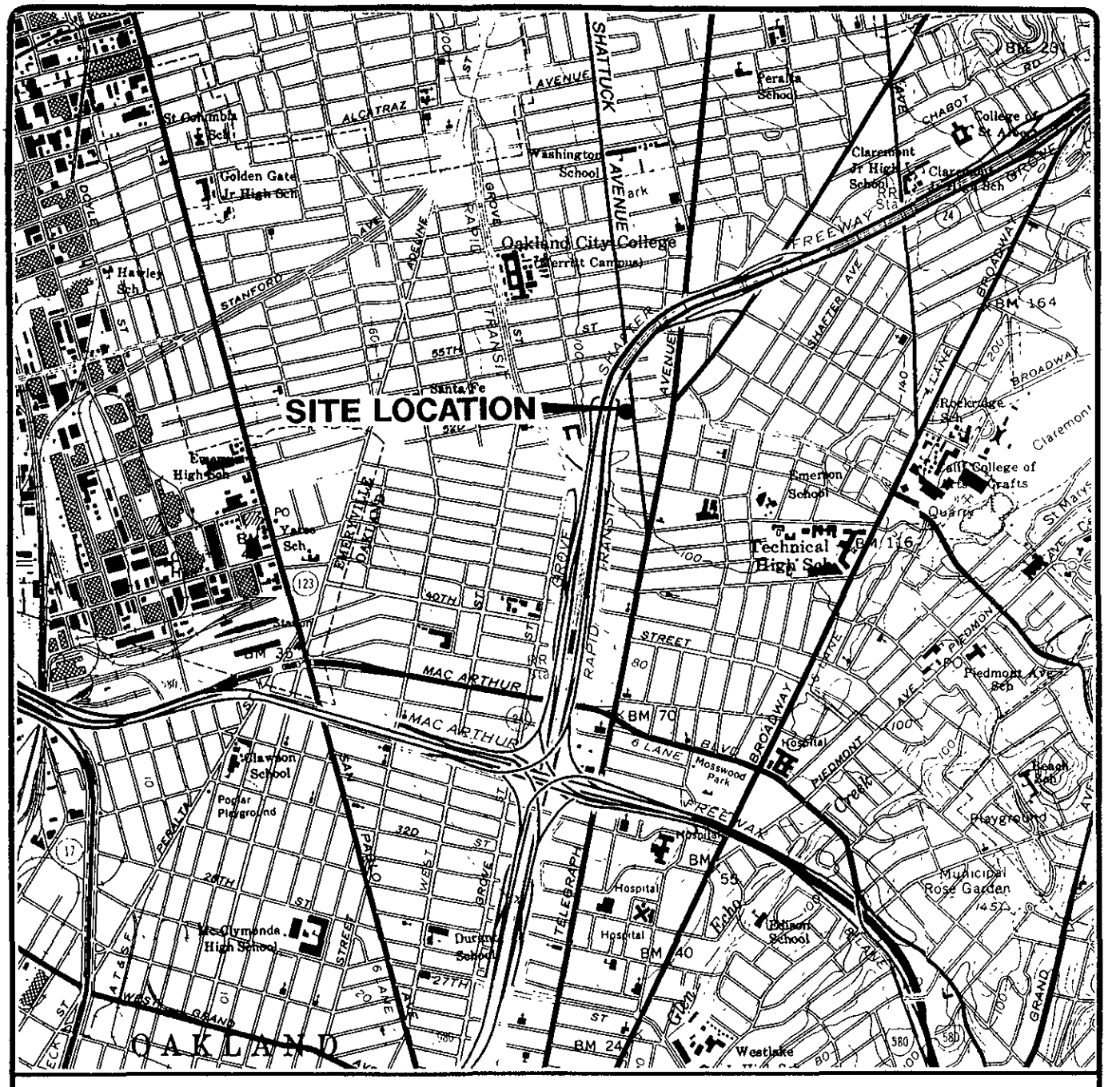
APPENDIX D

SOIL-VAPOR EXTRACTION AND AIR-SPARGE PILOT TEST RESULTS

APPENDIX E

MANUFACTURER'S SPECIFICATIONS FOR THE CATALYTIC OXIDIZER AND AIR COMPRESSOR

152753



Base map from USGS 7.5' Quad. Maps:
Oakland East and Oakland West, California.
Photorevised 1980.

Scale : 0 2000 4000 Feet

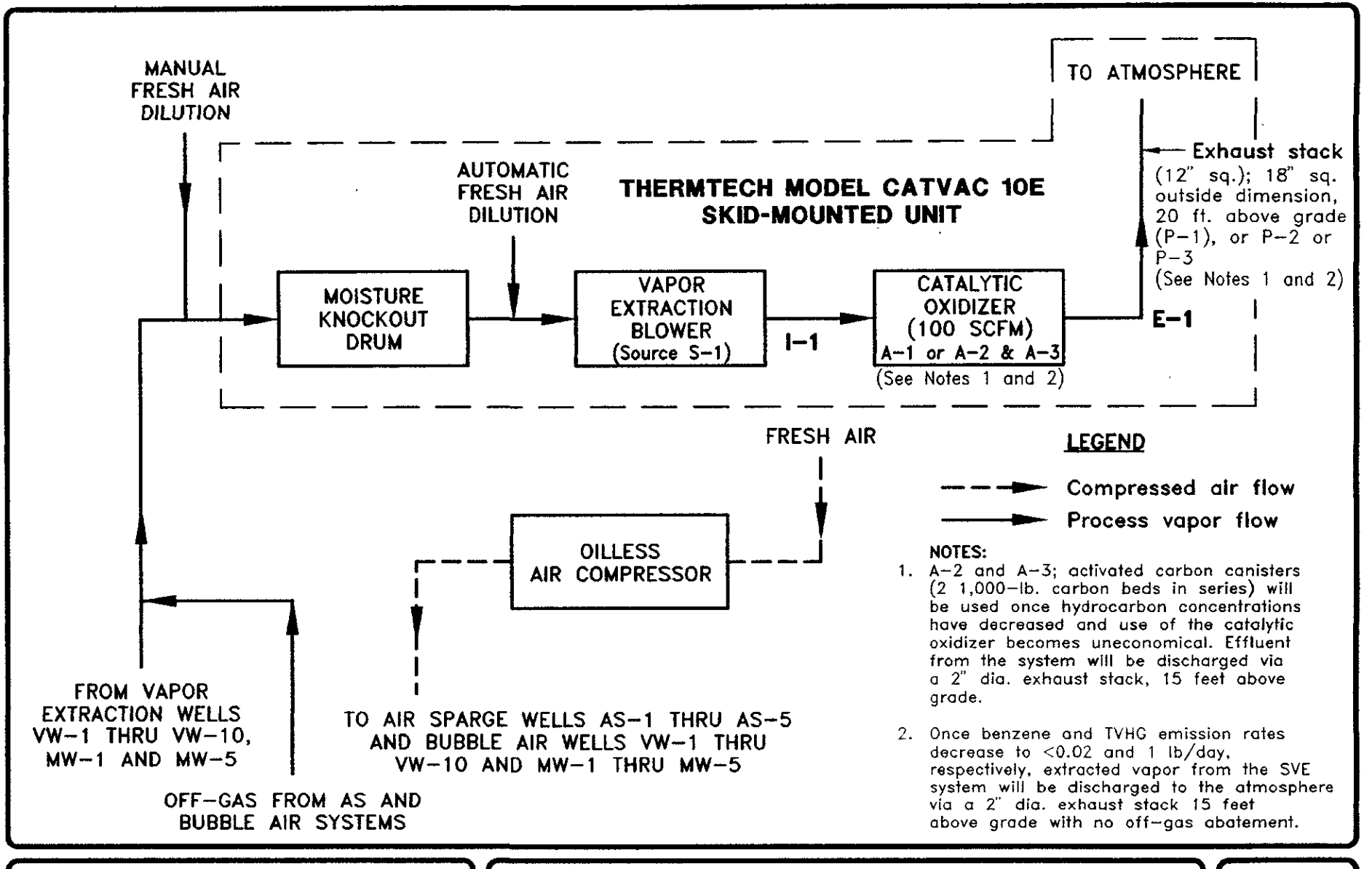
- N -

EMCON

ARCO PRODUCTS COMPANY
SERVICE STATION 6148, 5131 SHATTUCK AVENUE
REMEDIAL DESIGN
OAKLAND, CALIFORNIA

SITE LOCATION

FIGURE
1
PROJECT NO.
805-135.02



EMCON

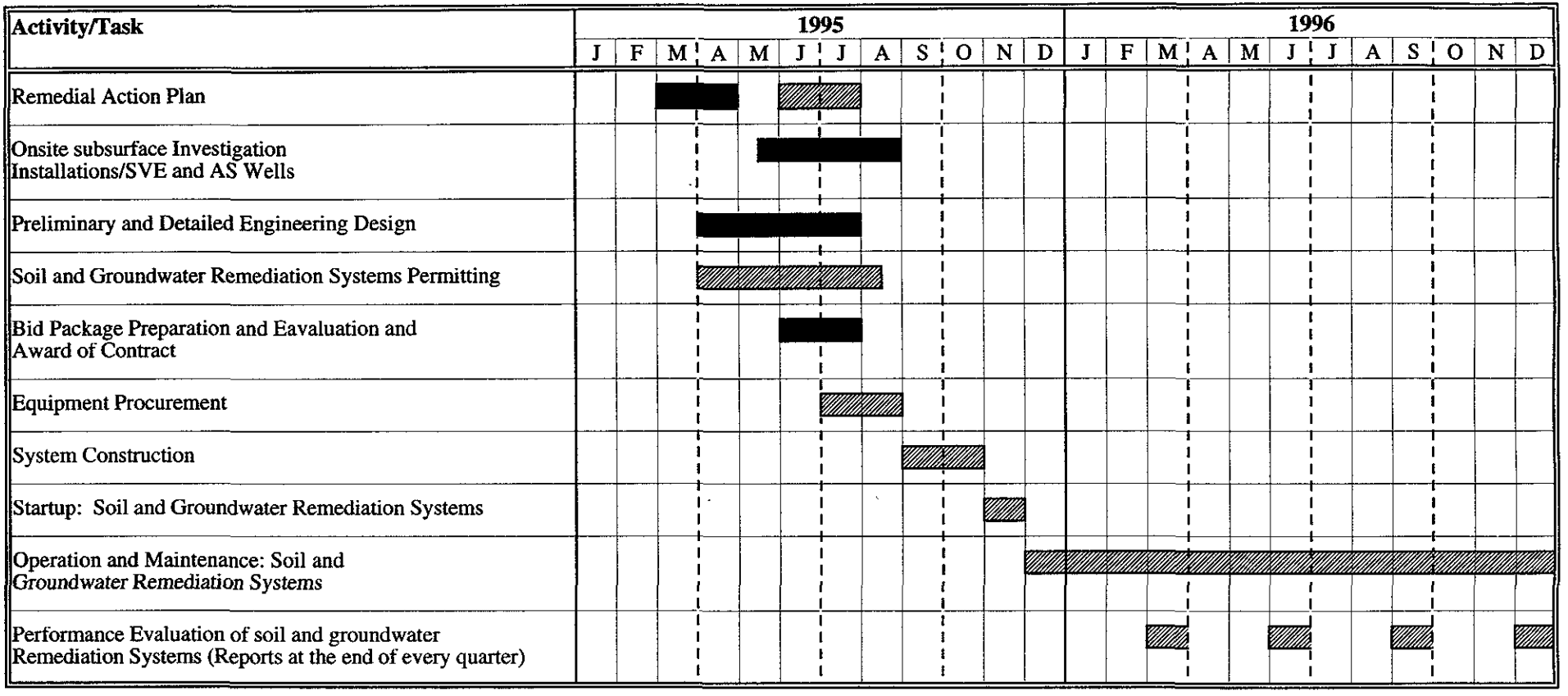
ARCO PRODUCTS COMPANY
SERVICE STATION 6148, 5131 SHATTUCK AVENUE
REMEDIAL DESIGN
OAKLAND, CALIFORNIA

PROCESS FLOW SCHEMATIC FOR SVE, AS, AND BUBBLE AIR SYSTEMS

FIGURE 9

PROJECT NO. 805-135.02

FIGURE 10
Proposed Implementation Schedule
ARCO Products Company
Service Station 6148
5131 Shattuck Avenue, Oakland, California



LEGEND

Probable schedule based on current deadlines and reasonable time necessary to complete each task; assumes no delays

Estimated schedule based on receiving regulatory and other approval on time, based on consultant's experience and other related work experience

Note: Duration of operation of soil and groundwater remediation systems can be more accurately predicted after the systems' performance has been evaluated for at least one year.

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APPENDIX A

HISTORICAL GROUNDWATER ELEVATION DATA

Table 1
Groundwater Monitoring Data
First Quarter 1995
Summary Report

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Level Field Date	TOC Elevation	Depth to Water	Ground-Water Elevation	Floating Product Thickness	Ground-Water Flow Direction	Hydraulic Gradient	Water Sample Field Date	TPHG	Benzene	Toluene	Ethyl-benzene	Total Xylenes	TOG or TRPH
		ft-MSL	feet	ft-MSL	feet	MWN	foot/foot		ppb	ppb	ppb	ppb	ppb	ppm
MW-1	03-20-95	108.03	15.75	92.28	ND			03-20-95	830	140	5	41	110	NA
MW-2	03-20-95	107.43	15.50	91.93	ND*			03-20-95	Not sampled: floating product entered well during purging					NA
MW-3	03-20-95	107.77	15.60	92.17	ND			03-20-95	29000	880	190	760	2000	16
MW-4	03-20-95	106.58	13.85	92.73	ND			03-20-95	88	1	<0.5	<0 5	0 7	NA
MW-5	03-20-95	106.68	14.92	91.76	ND			03-20-95	21000	6900	450	800	1300	NA
MW-6	03-20-95	105.16	12.13	93.03	ND			03-20-95	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	03-20-95	107 08	12.32	94.76	ND			03-20-95	<50	<0.5	<0 5	<0.5	<0.5	NA

TOC = Top of casing
ft-MSL = Elevation in feet, relative to mean sea level
MWN = Ground-water flow direction and gradient apply to the entire monitoring well network
TPHG = Total petroleum hydrocarbons as gasoline
TOG = Total oil and grease measured by EPA Method 5520 C&F
TRPH = Total recoverable petroleum hydrocarbons measured by EPA Method 418.1
ppb = Parts per billion or micrograms per liter (µg/l)
ppm = Parts per million or milligrams per liter (mg/l)
ND = None detected
SW = Southwest
NA = Not analyzed
* = Floating product entered the well during purging

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Table 2
Historical Groundwater Elevation Data
Summary Report

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135 03

Well Designation	Water Level Field Date	TOC Elevation	Depth to Water	Ground-Water Elevation	Floating Product Thickness	Ground-Water Flow Direction	Hydraulic Gradient
		ft-MSL	feet	ft-MSL	feet	MWN	foot/foot
MW-1	12-23-91	108.03	18.26	89.77	Sheen	NR	NR
MW-1	01-07-92	108.03	17 44	90.59	Sheen	NR	NR
MW-1	01-19-92	108.03	17.17	90.86	ND	NR	NR
MW-1	02-19-92	108.03	16.52	91.51	ND	NR	NR
MW-1	03-18-92	108.03	16.81	91.22	ND	NR	NR
MW-1	04-20-92	108.03	17.56	90.47	ND	NR	NR
MW-1	05-15-92	108.03	17.96	90.07	ND	NR	NR
MW-1	06-12-92	108 03	18.16	89.87	ND	NR	NR
MW-1	07-15-92	108.03	18.32	89.71	ND	NR	NR
MW-1	08-07-92	108.03	18.34	89.69	ND	NR	NR
MW-1	09-14-92	108.03	18.46	89.57	ND	NR	NR
MW-1	10-07-92	108.03	18.52	89.51	ND	NR	NR
MW-1	11-12-92	108.03	18.11	89.92	ND	NR	NR
MW-1	12-09-92	108.03	17.10	90.93	ND	NR	NR
MW-1	01-21-93	108.03	15.44	92.59	ND	NR	NR
MW-1	02-22-93	108.03	16.54	91.49	ND	NR	NR
MW-1	03-25-93	108.03	17.05	90.98	ND	NR	NR
MW-1	04-14-93	108.03	17.45	90.58	ND	NR	NR
MW-1	05-22-93	108.03	17.78	90.25	ND	NR	NR
MW-1	06-17-93	108.03	17.90	90.13	ND	NR	NR
MW-1	07-27-93	108.03	18.10	89.93	ND	NR	NR
MW-1	08-29-93	108.03	18.31	89.72	ND	NR	NR
MW-1	09-30-93	108.03	18.24	89.79	ND	NR	NR
MW-1	11-16-93	108.03	18.17	89.86	ND	NR	NR
MW-1	02-02-94	108.03	17.31	90.72	ND	NR	NR
MW-1	04-29-94	108.03	17.31	90.72	ND	NR	NR
MW-1	08-02-94	108.03	17.95	90.08	ND	SW	0.017
MW-1	11-16-94	108.03	17.04	90.99	ND	SW	0.02
MW-1	03-20-95	108.03	15.75	92.28	ND		

Table 2
Historical Groundwater Elevation Data
Summary Report

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Level Field Date	TOC Elevation ft-MSL	Depth to Water feet	Ground-Water Elevation ft-MSL	Floating Product Thickness feet	Ground-Water Flow Direction MWN	Hydraulic Gradient foot/foot
MW-2	12-23-91	107.43	17.98	89.45	Sheen	NR	NR
MW-2	01-07-92	107.43	17.15	90.28	Sheen	NR	NR
MW-2	01-19-92	107.43	17.47	89.96	ND	NR	NR
MW-2	02-19-92	107.43	16.28	91.15	ND	NR	NR
MW-2	03-18-92	107.43	16.52	90.91	ND	NR	NR
MW-2	04-20-92	107 43	17.27	90.16	ND	NR	NR
MW-2	05-15-92	107.43	17.62	89.81	ND	NR	NR
MW-2	06-12-92	107.43	^17.63	^89.80	0.05	NR	NR
MW-2	07-15-92	107.43	17.65	89.78	ND	NR	NR
MW-2	08-07-92	107.43	17.80	89.63	ND	NR	NR
MW-2	09-14-92	107.43	^18.09	^89.34	0.55	NR	NR
MW-2	10-07-92	107.43	^18.55	^88.88	0.31	NR	NR
MW-2	11-12-92	107.43	17.95	89.48	Sheen	NR	NR
MW-2	12-09-92	107.43	^16.85	^90.58	0.02	NR	NR
MW-2	01-21-93	107.43	^15.08	^92.35	0.01	NR	NR
MW-2	02-22-93	107.43	^16.20	^91.23	0.01	NR	NR
MW-2	03-25-93	107.43	^16.72	^90.71	0.01	NR	NR
MW-2	04-14-93	107.43	^17.15	^90.28	ND	NR	NR
MW-2	05-22-93	107.43	^17.44	^89.99	ND	NR	NR
MW-2	06-17-93	107.43	17.57	89.86	ND	NR	NR
MW-2	07-27-93	107.43	^17.71	^89.72	ND	NR	NR
MW-2	08-29-93	107.43	^18.20	^89.23	ND	NR	NR
MW-2	09-30-93	107.43	^18.14	^89.29	ND	NR	NR
MW-2	11-16-93	107.43	^17.85	^89.58	ND	NR	NR
MW-2	02-02-94	107.43	16.96	90.47	ND	NR	NR
MW-2	04-29-94	107.43	16.95	90.48	ND	NR	NR
MW-2	08-02-94	107.43	17.59	89.84	ND	SW	0.017
MW-2	11-16-94	107.43	16.73	90.70	ND	SW	0.02
MW-2	03-20-95	107.43	15.50	91.93	ND*		

Table 2
Historical Groundwater Elevation Data
Summary Report

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Level Field Date	TOC Elevation ft-MSL	Depth to Water feet	Ground-Water Elevation ft-MSL	Floating Product Thickness feet	Ground-Water Flow Direction MWN	Hydraulic Gradient foot/foot
MW-3	12-23-91	107.77	18.14	89.63	Sheen	NR	NR
MW-3	01-07-92	107 77	17.26	90.51	Sheen	NR	NR
MW-3	01-19-92	107.77	17 63	90.14	ND	NR	NR
MW-3	02-19-92	107.77	16.34	91 43	ND	NR	NR
MW-3	03-18-92	107.77	16.62	91.15	ND	NR	NR
MW-3	04-20-92	107.77	17.38	90.39	ND	NR	NR
MW-3	05-15-92	107.77	17.80	89.97	ND	NR	NR
MW-3	06-12-92	107.77	18.01	89.76	ND	NR	NR
MW-3	07-15-92	107.77	18.17	89.60	ND	NR	NR
MW-3	08-07-92	107.77	18.23	89.54	ND	NR	NR
MW-3	09-14-92	107.77	18.36	89.41	ND	NR	NR
MW-3	10-07-92	107.77	18.90	88.87	Sheen	NR	NR
MW-3	11-12-92	107.77	18.00	89.77	Sheen	NR	NR
MW-3	12-09-92	107.77	16.85	90.92	Droplets	NR	NR
MW-3	01-21-93	107.77	15.24	92.53	ND	NR	NR
MW-3	02-22-93	107.77	16.36	91.41	ND	NR	NR
MW-3	03-25-93	107 77	16 89	90.88	ND	NR	NR
MW-3	04-14-93	107.77	17 29	90.48	ND	NR	NR
MW-3	05-22-93	107.77	17.64	90.13	ND	NR	NR
MW-3	06-17-93	107.77	17.75	90.02	ND	NR	NR
MW-3	07-27-93	107.77	17.98	89.79	ND	NR	NR
MW-3	08-29-93	107.77	18.14	89.63	ND	NR	NR
MW-3	09-30-93	107.77	18.14	89.63	ND	NR	NR
MW-3	11-16-93	107.77	18 30	89.47	ND	NR	NR
MW-3	02-02-94	107.77	17.16	90.61	ND	NR	NR
MW-3	04-29-94	107.77	17.14	90.63	ND	NR	NR
MW-3	08-02-94	107.77	17.81	89.96	ND	SW	0.017
MW-3	11-16-94	107.77	16.91	90.86	ND	SW	0.02
MW-3	03-20-95	107.77	15.60	92.17	ND		

Table 2
Historical Groundwater Elevation Data
Summary Report

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Level Field Date	TOC Elevation	Depth to Water	Ground-Water Elevation	Floating Product Thickness	Ground-Water Flow Direction	Hydraulic Gradient
		ft-MSL	feet	ft-MSL	feet	MWN	foot/foot
MW-4	11-12-92	106.58	16.08	90.50	ND	NR	NR
MW-4	12-09-92	106 58	15.00	91.58	ND	NR	NR
MW-4	01-21-93	106.58	13.35	93.23	ND	NR	NR
MW-4	02-22-93	106.58	14.48	92.10	ND	NR	NR
MW-4	03-25-93	106.58	15.06	91.52	ND	NR	NR
MW-4	04-14-93	106.58	15.50	91.08	ND	NR	NR
MW-4	05-22-93	106.58	15.79	90.79	ND	NR	NR
MW-4	06-17-93	106.58	14.90	91.68	ND	NR	NR
MW-4	07-27-93	106.58	16.11	90.47	ND	NR	NR
MW-4	08-29-93	106.58	16.21	90.37	ND	NR	NR
MW-4	09-30-93	106.58	16.23	90.35	ND	NR	NR
MW-4	11-16-93	106.58	16.30	90.28	ND	NR	NR
MW-4	02-02-94	106.58	15.36	91.22	ND	NR	NR
MW-4	04-29-94	106.58	15.36	91.22	ND	NR	NR
MW-4	08-02-94	106.58	15.94	90.64	ND	SW	0.017
MW-4	11-16-94	106.58	14.99	91.59	ND	SW	0.02
MW-4	03-20-95	106.58	13.85	92.73	ND		
MW-5	11-12-92	106.68	16.81	89.87	ND	NR	NR
MW-5	12-09-92	106.68	16.40	90.28	ND	NR	NR
MW-5	01-21-93	106.68	14.58	92.10	ND	NR	NR
MW-5	02-22-93	106.68	15.65	91.03	ND	NR	NR
MW-5	03-25-93	106.68	16.07	90 61	ND	NR	NR
MW-5	04-14-93	106.68	16.34	90.34	ND	NR	NR
MW-5	05-22-93	106.68	16.56	90.12	ND	NR	NR
MW-5	06-17-93	106.68	Not surveyed:				
MW-5	07-27-93	106.68	16.80	89.88	ND	NR	NR
MW-5	08-29-93	106.68	16.93	89.75	ND	NR	NR
MW-5	09-30-93	106.68	16.97	89.71	ND	NR	NR
MW-5	11-16-93	106.68	17.03	89.65	ND	NR	NR
MW-5	02-02-94	106.68	16.38	90.30	ND	NR	NR
MW-5	04-29-94	106.68	16.41	90.27	ND	NR	NR
MW-5	08-02-94	106.68	16.81	89.87	ND	SW	0.017
MW-5	11-16-94	106.68	16.12	90.56	ND	SW	0.02
MW-5	03-20-95	106.68	14.92	91.76	ND		

Table 2
Historical Groundwater Elevation Data
Summary Report

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Level Field Date	TOC Elevation ft-MSL	Depth to Water feet	Ground-Water Elevation ft-MSL	Floating Product Thickness feet	Ground-Water Flow Direction MWN	Hydraulic Gradient foot/foot
MW-6	11-12-92	105.16	14.05	91.11	ND	NR	NR
MW-6	12-09-92	105.16	13.37	91.79	ND	NR	NR
MW-6	01-21-93	105.16	11.76	93.40	ND	NR	NR
MW-6	02-22-93	105.16	12.62	92.54	ND	NR	NR
MW-6	03-25-93	105.16	13.04	92.12	ND	NR	NR
MW-6	04-14-93	105.16	13.47	91.69	ND	NR	NR
MW-6	05-22-93	105.16	13.80	91.36	ND	NR	NR
MW-6	06-17-93	105.16	13.88	91.28	ND	NR	NR
MW-6	07-27-93	105.16	14.13	91.03	ND	NR	NR
MW-6	08-29-93	105.16	14.19	90.97	ND	NR	NR
MW-6	09-30-93	105.16	14.34	90.82	ND	NR	NR
MW-6	11-16-93	105.16	14.41	90.75	ND	NR	NR
MW-6	02-02-94	105.16	13.60	91.56	ND	NR	NR
MW-6	04-29-94	105.16	13.66	91.50	ND	NR	NR
MW-6	08-02-94	105.16	13.99	91.17	ND	SW	0.017
MW-6	11-16-94	105.16	13.11	92.05	ND	SW	0.02
MW-6	03-20-95	105.16	12.13	93.03	ND		
MW-7	11-12-92	107.08	14.75	92.33	ND	NR	NR
MW-7	12-09-92	107.08	12.55	94.53	ND	NR	NR
MW-7	01-21-93	107.08	11.52	95.56	ND	NR	NR
MW-7	02-22-93	107.08	12.82	94.26	ND	NR	NR
MW-7	03-25-93	107.08	13.43	93.65	ND	NR	NR
MW-7	04-14-93	107.08	13.98	93.10	ND	NR	NR
MW-7	05-22-93	107.08	14.41	92.67	ND	NR	NR
MW-7	06-17-93	107.08	14.50	92.58	ND	NR	NR
MW-7	07-27-93	107.08	14.82	92.26	ND	NR	NR
MW-7	08-29-93	107.08	15.05	92.03	ND	NR	NR
MW-7	09-30-93	107.08	15.04	92.04	ND	NR	NR
MW-7	11-16-93	107.08	15.12	91.96	ND	NR	NR
MW-7	02-02-94	107.08	14.04	93.04	ND	NR	NR
MW-7	04-29-94	107.08	14.10	92.98	ND	NR	NR
MW-7	08-02-94	107.08	14.61	92.47	ND	SW	0.017
MW-7	11-16-94	107.08	13.37	93.71	ND	SW	0.02
MW-7	03-20-95	107.08	12.32	94.76	ND		

Table 2
Historical Groundwater Elevation Data
Summary Report

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Desig-nation	Water Level Field Date	TOC Elevation	Depth to Water	Ground-Water Elevation	Floating Product Thickness	Ground-Water Flow Direction	Hydraulic Gradient
		ft-MSL	feet	ft-MSL	feet	MWN	foot/foot
AS-2	09-30-93	NR	18.31	NR	ND	NR	NR

TOC = Top of casing
ft-MSL = Elevation in feet, relative to mean sea level
MWN = Ground-water flow direction and gradient apply to the entire monitoring well network
NR = Not reported; data not available
ND = None detected
SW = Southwest
^ = Groundwater elevation (GWE) and depth to water (DTW) adjusted to include 80 percent of the floating product thickness (FPT)
[GWE = (TOC - DTW) + (FPT x 0.8)]
* = Floating product entered the well during purging

APPENDIX B

SOIL SAMPLING ANALYTICAL DATA

TABLE 1
CUMULATIVE RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES
ARCO Station 6148
Oakland, California
(Page 1 of 4)

Sample ID	TPHg	TPHd	B	T	E	X	TOG	RCI
S-17½-B1	470	370	2.3 [1.3]	5.1 [1.8]	5.1 [1.8]	24 [8.8]	<30	NA
S-22½-B1	<1.0	<1.0	0.010	<0.0050	<0.0050	<0.0050	<30	NA
S-26½-B1	2.0	<1.0	0.026	0.014	0.011	0.049	<30	MA
S-12-B2	<1.0	<1.0	<0.0050	<0.0050	<0.0050	<0.0050	<30	NA
S-17-B2	740	540	2.3 [4.3]	13 [92]	7.7 [57]	41 [360]	<30	NA
S-25½-B2	<1.0	<1.0	0.015	0.016	<0.0050	0.019	<30	NA
S-30½-B2	<1.0	<1.0	0.015	0.0080	<0.0050	<0.0050	<30	NA
S-10½-B3	<1.0	<1.0	0.0070	<0.0050	<0.0050	<0.0050	<30	NA
S-17½-B3	320	230	0.65	0.65	2.3	5.9	<30	NA
S-26½-B3	<1.0	<1.0	<0.0050	<0.0050	<0.0050	<0.0050	<30	NA
S-10½-B4	<1.0	<1.0	<0.0050	<0.0050	<0.0050	<0.0050	<30	NA
S-15½-B4	<1.0	<1.0	0.010	<0.0050	<0.0050	<0.0050	<30	NA
S-18½-B4	65	41	0.42 [0.46]	0.22 [0.24]	0.54 [1.7]	0.77 [3.2]	<30	NA
S-20-B4	<1.0	<1.0	0.0070	<0.0050	<0.0050	<0.0050	<30	NA
S-9½-B5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-14½-B5	<1.0	NA	0.13	<0.0050	<0.0050	0.0050	NA	NA
S-31½-B5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-9½-B6	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-16½-B6*	190	NA	0.24	0.55	1.0	1.3	NA	NA
S-27½-B6	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-10-B7	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-15-B7	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-29½-B7	<1.0	NA	<0.0050	<0.0050	<0.0050	0.025	NA	NA
S-9½-B8	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-14½-B8	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-33½-B8	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA

See notes on page 4 of 4.

TABLE 1
CUMULATIVE RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES
ARCO Station 6148
Oakland, California

Sample ID	TPHg	TPHd	B	T	E	X	TOG	RCI
S-6-TB1	<1.0	NA	<0.0050	0.014	<0.0050	0.018	NA	NA
S-9½-TB1	<1.0	NA	<0.0050	0.011	<0.0050	0.029	NA	NA
S-15-TB1	2.5	NA	0.12	0.042	0.014	0.027	NA	NA
S-5½-TB2	<1.0	NA	<0.0050	0.014	<0.0050	0.011	NA	NA
S-9½-TB2	<1.0	NA	<0.0050	0.015	<0.0050	0.012	NA	NA
S-15-TB2	5.3	NA	0.84	0.062	0.13	0.21	NA	NA
S-6½-TB3	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-9½-TB3	<1.0	NA	<0.0050	<0.0050	<0.0050	0.013	NA	NA
S-15-TB3	3.2	NA	0.11	0.079	0.023	0.12	NA	NA
S-6½-TB4	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-9½-TB4	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-15-TB4	470	NA	0.76	0.17	4.7	15	NA	NA
S-6½-TB5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-9½-TB5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-15-TB5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-6½-TB6	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-12-TB6	20	NA	<0.0050	<0.0050	0.074	0.61	NA	NA
S-15½-TB6	25	NA	0.30	2.4	1.0	6.3	NA	NA
S-28-TB6	<1.0	NA	0.0054	0.025	<0.0050	0.016	NA	NA
S-5-TB7	<1.0	NA	<0.0050	0.0059	<0.0050	0.032	NA	NA
S-12-TB7	3.9	NA	0.23	0.35	0.054	0.50	NA	NA
S-15-TB7	28	NA	1.4	3.9	0.80	4.7	NA	NA
S-16½-TB7	610	NA	4.1	36	15	91	NA	NA
S-4½-TB8	<1.0	NA	0.014	0.036	<0.0050	0.019	NA	NA
S-9½-TB8	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
S-15-TB8	<1.0	NA	0.0090	0.034	0.0072	0.029	NA	NA
S-18-TB8	<1.0	NA	0.0095	0.020	<0.0050	0.015	NA	NA

See notes on page 4 of 4.

TABLE 1
CUMULATIVE RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES
ARCO Station 6148
Oakland, California
(Page 3 of 4)

Sample ID	TPHg	TPHd	B	T	E	X	TOG	RCI
S-3½-TB9	<1.0	NA	<0.0050	0.0087	<0.0050	0.0069	NA	NA
S-9½-TB9	6.7	NA	0.019	0.024	0.049	0.45	NA	NA
S-15-TB9	3.9	NA	0.092	0.020	0.014	0.51	NA	NA
S-5-TB10	<1.0	NA	<0.0050	<0.0050	<0.0050	0.0080	NA	NA
S-9½-TB10	<1.0	NA	0.011	0.020	<0.0050	0.0071	NA	NA
S-14½-TB10	<1.0	NA	0.011	0.016	<0.0050	0.0078	NA	NA
S-6½-TB11	<1.0	NA	0.020	0.016	<0.0050	0.011	NA	NA
S-9½-TB11	<1.0	NA	0.080	0.012	<0.0050	0.028	NA	NA
S-15-TB11	19	NA	1.9	0.080	0.51	0.83	NA	NA
B9-1-5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
B9-2-9.5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
B9-3-14.5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
B9-5-25	<1.0	NA	0.0060	<0.0050	<0.0050	<0.0050	NA	NA
B10-3-16	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
B10-6-28	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
B11-3-14.5	<1.0	NA	<0.0050	<0.0050	<0.0050	<0.0050	NA	NA
B11-5-24.5	4.1	NA	0.20	0.52	0.13	0.66	NA	NA
SP-(A-D) other analyses: lead 0.22	4.3	NA	0.014	0.094	0.12	0.60	NA	pH 6.6 ignitability >100° reactivities none

See notes on page 4 of 4.

TABLE 1
CUMULATIVE RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES
ARCO Station 6148
Oakland, California
(Page 4 of 4)

Notes:

All results shown in parts per million (ppm)

TPHg: Total petroleum hydrocarbons as gasoline by EPA method 5030/8015/8020.

TPHd: Total petroleum hydrocarbons as diesel by EPA method 3550/8015. Laboratory reported samples matrix contained high boiling point fuel mixture calculated as diesel, possibly weathered gasoline.

B: Benzene, T: Toluene, E: Ethylbenzene, T: Total Xylene isomers;

BTEX: Measured by EPA method 8030/8015/8020.

TOG: Total oil and grease by Standard Method 5520 E&F.

[ ]: BTEX detected using EPA Method 8240.

RCI: Reactivity, corrosivity, and ignitability.

NA: Not analyzed.

*: Laboratory reported this as a gas and non-gas mix.

<: Results reported as less than the detection limit.

Sample Identification:

S-20-B4
- Boring number
- Depth in feet
- Soil sample

B11-5-24.5
- Depth in feet
- Sample number
- Boring number

SP-(A-D)
- Composite sample
- Soil pile

TABLE 3
RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES - VOCs and METALS
ARCO Station 6148
Oakland, California
December 19-20, 1991

Sample Identification	VOCs	Cd	Cr	Pb	Zn	Ni
S-17-1/2-B1	ND*	0.87	31	8.3	62	41
S-22-1/2-B1	ND	0.82	30	4.1	62	34
S-17-B2	ND*	0.87	24	6.7	68	46
S-25-1/2-B2	ND	<0.50	28	2.8	45	26
S-17-1/2-B3	NA	0.95	31	3.9	66	38
S-26-1/2-B3	ND	0.77	48	6.9	70	66
S-18-1/2-B4	ND*	<0.50	27	3.6	57	35
S-20-B4	ND	NA	NA	NA	NA	NA

All results shown in parts per million (ppm)
VOCs: Volatile Organic Compounds by EPA Method 8240.
Cd: Cadmium by EPA Method 6010.
Cr: Chromium by EPA Method 6010.
Pb: Lead by EPA Method 7421.
Zn: Zinc by EPA Method 6010.
Ni: Nickel by EPA Method 6010.
<: Results reported as less than the detection limit.
ND: All 37 compounds tested were not detected.
ND*: All compounds tested were not detected with the exception of BTEX.
NA: Not analyzed.

Sample Identification:

S-20-B4
- Boring number
- Depth in feet
- Soil sample

S-1220-SP-(A-D)
- Composite sample
- Soil pile
- Date sampled
- Soil sample

TABLE 1
RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES - TPHg and BTEX
ARCO Station 6148
Oakland, California
April 26-27, 1993
(Page 1 of 2)

Sample Identification	TPHg	B	T	E	X
April 26, 1993					
S-6-TB1	<1.0	<0.0050	0.014	<0.0050	0.018
S-9½-TB1	<1.0	<0.0050	0.011	<0.0050	0.029
S-15-TB1	2.5	0.12	0.042	0.014	0.027
S-5½-TB2	<1.0	<0.0050	0.014	<0.0050	0.011
S-9½-TB2	<1.0	<0.0050	0.015	<0.0050	0.012
S-15-TB2	5.3	0.84	0.062	0.13	0.21
April 27, 1993					
S-6½-TB3	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-9½-TB3	<1.0	<0.0050	<0.0050	<0.0050	0.013
S-15-TB3	3.2	0.11	0.079	0.023	0.12
S-6½-TB4	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-9½-TB4	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-15-TB4	470	0.76	0.17	4.7	15
S-6½-TB5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-9½-TB5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-15-TB5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-6½-TB6	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-12-TB6	20	<0.0050	<0.0050	0.074	0.61
S-15½-TB6	25	0.30	2.4	1.0	6.3
S-28-TB6	<1.0	0.0054	0.025	<0.0050	0.016
April 26, 1993					
S-5-TB7	<1.0	<0.0050	0.0059	<0.0050	0.032
S-12-TB7	3.9	0.23	0.35	0.054	0.50
S-15-TB7	28	1.4	3.9	0.80	4.7
S-16½-TB7	610	4.1	36	15	91
S-4½-TB8	<1.0	0.014	0.036	<0.0050	0.019
S-9½-TB8	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
S-15-TB8	<1.0	0.0090	0.034	0.0072	0.029
S-18-TB8	<1.0	0.0095	0.020	<0.0050	0.015
S-3½-TB9	<1.0	<0.0050	0.0087	<0.0050	0.0069
S-9½-TB9	6.7	0.019	0.024	0.049	0.45
S-15-TB9	3.9	0.092	0.020	0.014	0.51

See notes on page 2 of 2.

TABLE 1
RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES - TPHg and BTEX
ARCO Station 6148
Oakland, California
April 26-27, 1993
(Page 2 of 2)

Sample Identification	TPHg	B	T	E	X
April 26, 1993					
S-5-TB10	<1.0	<0.0050	<0.0050	<0.0050	0.0080
S-9½-TB10	<1.0	0.011	0.020	<0.0050	0.0071
S-14½-TB10	<1.0	0.011	0.016	<0.0050	0.0078
April 27, 1993					
S-6½-TB11	<1.0	0.020	0.016	<0.0050	0.011
S-9½-TB11	<1.0	0.080	0.012	<0.0050	0.028
S-15-TB11	19	1.9	0.080	0.51	0.83
SSP-1(A-D)	<1.0	<0.0050	<0.0050	<0.0050	<0.0050

All results shown in parts per million (ppm)
TPHg: Total petroleum hydrocarbons as gasoline by EPA methods 5030/8015.
B: Benzene, T: Toluene, E: Ethylbenzene, T: Total Xylene isomers.
BTEX: Measured by EPA method 8020.
NA: Not analyzed.
<: Results reported as less than the detection limit.

Sample Identification: S-15-TB1
- Test boring number
- Depth in feet
- Soil sample

SSP-1A-1D
- Composite soil sample numbers
- Composite soil sample

APPENDIX C

HISTORICAL GROUNDWATER ANALYTICAL DATA

Table 3
Historical Groundwater Analytical Data
(TPHG, BTEX, and TRPH)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Sample Field Date	TPHG	Benzene	Toluene	Ethyl-benzene	Total Xylenes	TOG or TRPH
		ppb	ppb	ppb	ppb	ppb	ppm
MW-1	03-18-92	790	310	26	12	44	<0.5 (1.4)
MW-1	06-12-92	1000	290	15	10	30	<0 5
MW-1	09-14-92	1000	370	6.5	6.5	17	0.9
MW-1	10-07-92	590	200	19	6.7	19	<0.5
MW-1	01-22-93	1200	370	57	18	39	NA
MW-1	04-14-93	140	46	<2.5	<2.5	<2.5	NA
MW-1	09-30-93	220	64	0.9	2.2	4	NA
MW-1	11-16-93	180	53	0.7	1.7	4.1	NA
MW-1	02-02-94	250	93	<0.5	1.9	1	NA
MW-1	04-29-94	350	99	1.3	3.9	11	NA
MW-1	08-02-94	210	82	<1	<1	2.5	NA
MW-1	11-16-94	650	260	38	6.1	15	NA
MW-1	03-20-95	830	140	5	41	110	NA
MW-2	03-18-92	8400	1400	1000	220	870	1.2 (3.0)
MW-2	06-12-92	Not sampled: well contained floating product					
MW-2	09-14-92	Not sampled: well contained floating product					
MW-2	10-07-92	Not sampled: well contained floating product					
MW-2	01-22-93	Not sampled: well contained floating product					
MW-2	04-14-93	Not sampled: well contained floating product					
MW-2	09-30-93	Not sampled: well contained floating product					
MW-2	11-16-93	Not sampled: well contained floating product					
MW-2	02-02-94	16000	1300	2500	540	2700	NA
MW-2	04-29-94	11000	1400	1200	360	1400	NA
MW-2	08-02-94	4900	800	290	120	620	NA
MW-2	11-16-94	49000	3300	8300	1400	7200	NA
MW-2	03-20-95	Not sampled: floating product entered well during purging					NA

Table 3
Historical Groundwater Analytical Data
(TPHG, BTEX, and TRPH)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Sample Field Date	TPHG	Benzene	Toluene	Ethyl-benzene	Total Xylenes	TOG or TRPH
		ppb	ppb	ppb	ppb	ppb	ppm
MW-3	03-18-92	20000	3200	560	380	1000	7 8 (8.1)
MW-3	06-12-92	46000	3400	4200	1300	5400	16
MW-3	09-14-92	53000	4300	5700	1300	7300	5.5
MW-3	10-07-92	Not sampled: well contained floating product					
MW-3	01-22-93	35000	2100	1400	1200	4400	31
MW-3	04-14-93	13000	1800	390	990	3500	26
MW-3	09-30-93	79000	2400	3400	1900	8100	23
MW-3	11-16-93	72000	1400	2100	1900	8300	38
MW-3	02-02-94	26000	1400	1200	1200	4400	7 7 (7.8)
MW-3	04-29-94	22000	1400	620	910	3400	10
MW-3	08-02-94	17000	530	410	720	2600	6.6
MW-3	11-16-94	18000	1400	560	790	2800	2.3
MW-3	03-20-95	29000	880	190	760	2000	16
MW-4	11-12-92	77	32	<0.5	<0.5	<0.5	NA
MW-4	01-22-93	170	66	0.8	<0.5	1.5	NA
MW-4	04-14-93	<50	4 6	<0.5	<0.5	<0.5	NA
MW-4	09-30-93	52	13	<0.5	<0.5	<0.5	NA
MW-4	11-16-93	230	34	<0.5	<0.5	<0.5	NA
MW-4	02-02-94	<50	3.9	<0.5	<0.5	<0.5	NA
MW-4	04-29-94	<50	4.2	<0.5	<0.5	<0.5	NA
MW-4	08-02-94	<50	3.8	<0.5	<0.5	<0.5	NA
MW-4	11-16-94	110	31	<0.5	<0.5	<0.5	NA
MW-4	03-20-95	88	1	<0.5	<0.5	0.7	NA
MW-5	11-12-92	2900	1300	12	67	18	NA
MW-5	01-22-93	17000	5000	780	260	330	NA
MW-5	04-14-93	12000	4600	<50	180	130	NA
MW-5	09-30-93	4500	1100	<10	39	16	NA
MW-5	11-16-93	3300	700	<10	22	<10	NA
MW-5	02-02-94	10000	3000	65	240	78	NA
MW-5	04-29-94	7600	2400	27	130	44	NA
MW-5	08-02-94	1900	680	<10	24	<10	NA
MW-5	11-16-94	17000	5900	700	440	320	NA
MW-5	03-20-95	21000	6900	450	800	1300	NA

Table 3
Historical Groundwater Analytical Data
(TPHG, BTEX, and TRPH)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Sample Field Date	TPHG	Benzene	Toluene	Ethyl-benzene	Total Xylenes	TOG or TRPH
		ppb	ppb	ppb	ppb	ppb	ppm
MW-6	11-12-92	51	2.6	<0.5	<0.5	<0.5	NA
MW-6	01-22-93	<50	1.2	<0.5	<0.5	<0.5	NA
MW-6	04-14-93	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-6	09-30-93	74	2	<0.5	<0.5	<0.5	NA
MW-6	11-16-93	72	2.6	<0.5	<0.5	<0.5	NA
MW-6	02-02-94	61	2.2	<0.5	<0.5	<0.5	NA
MW-6	04-29-94	<50	0.6	<0.5	<0.5	<0.5	NA
MW-6	08-02-94	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-6	11-16-94	<50	1.1	<0.5	<0.5	<0.5	NA
MW-6	03-20-95	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	11-12-92	<50	1.8	<0.5	<0.5	<0.5	NA
MW-7	01-22-93	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	04-14-93	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	09-30-93	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	11-16-93	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	02-02-94	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	04-29-94	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	08-02-94	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	11-16-94	<50	<0.5	<0.5	<0.5	<0.5	NA
MW-7	03-20-95	<50	<0.5	<0.5	<0.5	<0.5	NA
AS-2	09-30-93	<50	1.2	<0.5	<0.5	<0.5	NA

TPHG = Total petroleum hydrocarbons as gasoline
TOG = Total oil and grease measured by EPA Method 5520 C&F
TRPH = Total recoverable petroleum hydrocarbons measured by EPA Method 418.1
ppb = Parts per billion or micrograms per liter (µg/l)
ppm = Parts per million or milligrams per liter (mg/l)
NA = Not analyzed

Table 4
Historical Groundwater Analytical Data
(VOCs and SVOCs)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Sample Field Date	Halogenated Volatile Organic Compounds (VOCs) by EPA Method 5030/601						Semi-Volatile Organic Compounds (SVOCs) by EPA Method 3510/8270			
		PCE	TCE	Chloroform	cis-1,2-DCE	Vinyl Chloride	1,1-DCA	Naphthalene	2-Methylnaphthalene	Bis(2-ethylhexyl) Phthalate	Di-n-octyl Phthalate
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
MW-1	03-18-92	13	1.2	ND	ND	ND	ND	NA	NA	NA	NA
MW-1	06-12-92	18	1.4	ND	ND	ND	ND	NA	NA	NA	NA
MW-1	09-14-92	15	1.5	ND	ND	ND	ND	NA	NA	NA	NA
MW-1	10-07-92	23	1.5	0.6	ND	ND	ND	NA	NA	NA	NA
MW-1	01-22-93	11	0.9	ND	ND	ND	ND	ND	ND	ND	ND
MW-1	04-14-93	21	1.8	0.6	ND	ND	ND	NA	NA	NA	NA
MW-1	09-30-93	19	1.1	0.7	ND	ND	ND	NA	NA	NA	NA
MW-1	11-16-93	22	0.9	ND	ND	ND	ND	NA	NA	NA	NA
MW-1	02-02-94	11	1.1	ND	ND	ND	ND	NA	NA	NA	NA
MW-1	04-29-94	13	1.3	0.5	<0.5	<0.5	<0.5	NA	NA	NA	NA
MW-1	08-02-94	15	1.4	0.7	0.7	<0.5	<0.5	NA	NA	NA	NA
MW-1	11-16-94	12	1.1	0.5	1.2	<0.5	<0.5	NA	NA	NA	NA
MW-1	03-20-95	Not analyzed: sampling for additional parameters was discontinued									
MW-2	03-18-92	19	2.22	ND	0.5	ND	ND	NA	NA	NA	NA
MW-2	06-12-92	Not sampled: well contained floating product									
MW-2	09-14-92	Not sampled: well contained floating product									
MW-2	10-07-92	Not sampled: well contained floating product									
MW-2	01-22-93	Not sampled: well contained floating product									
MW-2	04-14-93	Not sampled: well contained floating product									
MW-2	09-30-93	Not sampled: well contained floating product									
MW-2	11-16-93	Not sampled: well contained floating product									
MW-2	02-02-94	13	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-2	04-29-94	9.4	1.9	<0.5	2 2	<0.5	<0.5	NA	NA	NA	NA
MW-2	08-02-94	15	2	<0.5	2.9	<0.5	<0 5	NA	NA	NA	NA
MW-2	11-16-94	9.6	1.8	<0.5	2.1	<0.5	<0.5	NA	NA	NA	NA
MW-2	03-20-95	Not analyzed: sampling for additional parameters was discontinued									

Table 4
Historical Groundwater Analytical Data
(VOCs and SVOCs)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Sample Field Date	Halogenated Volatile Organic Compounds (VOCs) by EPA Method 5030/601						Semi-Volatile Organic Compounds (SVOCs) by EPA Method 3510/8270			
		PCE	TCE	Chloroform	cis-1,2-DCE	Vinyl Chloride	1,1-DCA	Naphthalene	2-Methylnaphthalene	Bis(2-ethylhexyl) Phthalate	Di-n-octyl Phthalate
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
MW-3	03-18-92	2.7	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-3	06-12-92	1.9	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-3	09-14-92	2	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-3	10-07-92	Not sampled: well contained floating product									
MW-3	01-22-93	1.9	ND	ND	ND	ND	ND	440	350	280	13
MW-3	04-14-93	1.7	ND	ND	ND	ND	ND	130	100	250	14
MW-3	09-30-93	1.2	ND	ND	ND	ND	ND	480	320	ND	ND
MW-3	11-16-93	1.5	ND	ND	ND	ND	ND	590	640	ND	ND
MW-3	02-02-94	ND*	ND*	ND*	ND*	ND*	ND*	160	91	9	ND
MW-3	04-29-94	1.7	<0.5	<0.5	<0.5	<0.5	<0.5	110	50	<10	<10
MW-3	08-02-94	1	<0.5	<0.5	<0.5	<0.5	<0.5	120	53	10	<10
MW-3	11-16-94	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	100	53	<10	<10
MW-3	03-20-95	Not analyzed: sampling for additional parameters was discontinued									
MW-4	11-12-92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-4	01-22-93	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4	04-14-93	1.1	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-4	09-30-93	1.6	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-4	11-16-93	1.9	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-4	02-02-94	1.4	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-4	04-29-94	1.9	<0.5	<0.5	<0.5	<0.5	<0.5	NA	NA	NA	NA
MW-4	08-02-94	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	NA	NA	NA	NA
MW-4	11-16-94	1.8	<0.5	<0.5	<0.5	<0.5	<0.5	NA	NA	NA	NA
MW-4	03-20-95	Not analyzed: sampling for additional parameters was discontinued									

Table 4
Historical Groundwater Analytical Data
(VOCs and SVOCs)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Desig-nation	Water Sample Field Date	Halogenated Volatile Organic Compounds (VOCs) by EPA Method 5030/601						Semi-Volatile Organic Compounds (SVOCs) by EPA Method 3510/8270			
		PCE	TCE	Chloro-form	cis-1,2-DCE	Vinyl Chloride	1,1-DCA	Naphthalene	2-Methyl-naphthalene	Bis(2-ethylhexyl) Phthalate	Di-n-octyl Phthalate
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
MW-5	11-12-92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-5	01-22-93	11	4.7	ND	1.8	ND	ND	ND	ND	ND	ND
MW-5	04-14-93	7.9	2	ND	1.5	0.9	ND	NA	NA	NA	NA
MW-5	09-30-93	17	2.8	ND	2.9	0.8	ND	NA	NA	NA	NA
MW-5	11-16-93	19	5.1	ND	4	ND	ND	NA	NA	NA	NA
MW-5	02-02-94	2.7	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-5	04-29-94	10	2.7	<0.5	2.4	<0.5	<0.5	NA	NA	NA	NA
MW-5	08-02-94	13	5.4	<0.5	5.7	<0.5	<0.5	NA	NA	NA	NA
MW-5	11-16-94	1.1	1	<0.5	3.5	1.3	<0.5	NA	NA	NA	NA
MW-5	03-20-95	Not analyzed: sampling for additional parameters was discontinued									
MW-6	11-12-92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-6	01-22-93	120	6 2	6.6	1.8	ND	ND	NA	NA	NA	NA
MW-6	04-14-93	120	5.8	ND	1.1	ND	6.3	NA	NA	NA	NA
MW-6	09-30-93	220	5.2	ND	2.7	ND	ND	NA	NA	NA	NA
MW-6	11-16-93	160	8.5	15	3.2	ND	ND	NA	NA	NA	NA
MW-6	02-02-94	100	ND	6.7	ND	ND	ND	NA	NA	NA	NA
MW-6	04-29-94	95	6.6	7.2	<2.5	<2.5	<2.5	NA	NA	NA	NA
MW-6	08-02-94	87	6.1	4.6	<2.5	<2.5	<2.5	NA	NA	NA	NA
MW-6	11-16-94	86	6.8	8.9	<2.5	<2.5	<2.5	NA	NA	NA	NA
MW-6	03-20-95	Not analyzed: sampling for additional parameters was discontinued									

Table 4
Historical Groundwater Analytical Data
(VOCs and SVOCs)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Sample Field Date	Halogenated Volatile Organic Compounds (VOCs) by EPA Method 5030/601						Semi-Volatile Organic Compounds (SVOCs) by EPA Method 3510/8270			
		PCE	TCE	Chloroform	cis-1,2-DCE	Vinyl Chloride	1,1-DCA	Naphthalene	2-Methylnaphthalene	Bis(2-ethylhexyl) Phthalate	Di-n-octyl Phthalate
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
MW-7	11-12-92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-7	01-22-93	6.8	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-7	04-14-93	4.3	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-7	09-30-93	2.5	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-7	11-16-93	4	ND	ND	ND	ND	ND	NA	NA	NA	NA
MW-7	02-02-94	3.4	ND	0.8	ND	ND	ND	NA	NA	NA	NA
MW-7	04-29-94	3.4	<0.5	1.1	<0.5	<0.5	<0.5	NA	NA	NA	NA
MW-7	08-02-94	3.3	<0.5	0.8	<0.5	<0.5	<0.5	NA	NA	NA	NA
MW-7	11-16-94	3.3	<0.5	<0.5	<0.5	<0.5	<0.5	NA	NA	NA	NA
MW-7	03-20-95	Not analyzed: sampling for additional parameters was discontinued									
AS-2	09-30-93	29	1.5	1	ND	ND	ND	NA	NA	NA	NA

PCE = Tetrachloroethene
TCE = Trichloroethene
cis-1,2-DCE = cis-1,2-Dichloroethene
1,1-DCA = 1,1-Dichloroethane
ppb = Parts per billion or micrograms per-liter (µg/l)
ND = Not detected
* = Sample was analyzed for volatile organic compounds using EPA Method 624 (only BTEX was detected)

Table 5
Historical Groundwater Analytical Data
(Diesel and Metals)

ARCO Service Station 6148
5131 Shattuck Avenue, Oakland, California

Date: 04-04-95
Project Number: 0805-135.03

Well Designation	Water Sample Field Date	TPHD	Cadmium by EPA 6010	Chromium by EPA 6010	Lead by EPA 7421	Zinc by EPA 6010	Nickel by EPA 6010
		ppb	ppb	ppb	ppb	ppb	ppb
MW-1	03-18-92	<50	<3	5	3	31	<20
MW-1	06-12-92	<50	NA	NA	NA	NA	NA
MW-1	09-14-92	<80	NA	NA	NA	NA	NA
MW-1	10-07-92	<50	NA	NA	NA	NA	NA
MW-1	01-22-93	NA	NA	NA	NA	NA	NA
MW-1	04-14-93	NA	<3	<5	3	25	<20
MW-1	09-30-93	Not analyzed: sampling for additional parameters was discontinued					
MW-2	03-18-92	230*	<3	21	9	54	38
MW-2	06-12-92	Not analyzed: sampling for additional parameters was discontinued					
MW-3	03-18-92	2800*	<3	67	27	156	113
MW-3	06-12-92	1600*	NA	NA	NA	NA	NA
MW-3	09-14-92	40000*	NA	NA	NA	NA	NA
MW-3	10-07-92	Not sampled: well contained floating product					
MW-3	01-22-93	13000*	<3	10	8	28	23
MW-3	04-14-93	<50	<3	<5	3	25	<20
MW-3	09-30-93	17000*	<5	50	26	100	70
MW-3	11-16-93	Not analyzed: sampling for additional parameters was discontinued					
MW-4	11-12-92	Not analyzed: sampling for additional parameters was not initiated					
MW-5	11-12-92	Not analyzed: sampling for additional parameters was not initiated					
MW-6	11-12-92	Not analyzed: sampling for additional parameters was not initiated					
MW-7	11-12-92	Not analyzed: sampling for additional parameters was not initiated					
AS-2	09-30-93	Not analyzed: sampling for additional parameters was not initiated					

TPHD = Total petroleum hydrocarbons as diesel by EPA Method 3510/California DHS LUFT Method
ppb = Parts per billion or micrograms per liter (µg/l)
NA = Not analyzed
* = Chromatogram does not match the typical diesel fingerprint, but appears to be weathered gasoline

APPENDIX D

SOIL-VAPOR EXTRACTION AND AIR-SPARGE PILOT TEST RESULTS

TABLE 2
SPARGE AND VAPOR EXTRACTION WELL DATA SUMMARY
ARCO Station 6148
Oakland, California

Well ID	Well Type	Depth-to-Water	Screened Interval	Depth of Well
AS-2	Sparge	17.04	24.5 to 26.5	26.5
VW-1	Vadose	16.64	14 to 24	24
VW-2	Vadose	16.64	15 to 20	20
VW-3	Vadose	16.96	14 to 24	24
MW-1	Monitoring	17.14	13 to 26	26
MW-2	Monitoring	16.82	14 to 26	26
MW-3	Monitoring	16.98	14 to 26	26

Notes:
Measurements in feet below ground surface.

TABLE 3
AIR SPARGE TEST FIELD MONITORING DATA
ARCO Station 6148
Oakland, California
(Page 1 of 2)

February 16, 1994

Time	AS-2	MW-2	MW-1	VW-1	MW-3	VW-3
Pre-Sparge	$TPHg_{GW}$ = 180	$TPHg_{GW}$ = 12,000 $TPHg_V$ = 4,900	$TPHg_{GW}$ = 150 $TPHg_V$ = <5.0	$TPHg_{GW}$ = FP $TPHg_V$ = 2,900	$TPHg_{GW}$ = 11,000 $TPHg_V$ = 620	$TPHg_{GW}$ = 70,000 $TPHg_V$ = 2,900
4:45 (start sparge)	Q_A = 2.0 Q_H = 1.0 P_i = 9.0	—	—	—	—	
4:45-5:00		H_V = 0.13 H_s = 0.40	H_V = 0.09 H_s = 0.07	H_V = 0.15 H_s = 0.43	H_V = 0.21 H_s = 0.37	H_V = 0.32 H_s = 0.03
5:00-5:15		H_V = 0.05 H_s = 0.16	H_V = 0.28 H_s = 0.40	H_V = 0.03 H_s = 0.11	H_V = 0.18 H_s = 0.39	H_V = 0.66 H_s = 0.38
5:15-5:30		H_V = 1.5 H_s = 0.37	H_V = 0.14 H_s = 0.26	H_V = 0.03 H_s = 0.52	H_V = 0.00 H_s = 0.49	H_V = 0.49 H_s = 0.26
5:30-5:45		H_V = 4.8 H_s = 0.25	H_V = 0.07 H_s = 0.22	H_V = 0.00 H_s = 0.21	H_V = 0.04 H_s = 0.34	H_V = 0.47 H_s = 0.22
5:45 (end sparge)	$TPHg_{GW}$ = 220	$TPHg_{GW}$ = 22,000 $TPHg_V$ = 4,600	$TPHg_{GW}$ = 140 $TPHg_V$ = 300	$TPHg_{GW}$ = FP $TPHg_V$ = 8,400	$TPHg_{GW}$ = 10,000 $TPHg_V$ = 1,400	$TPHg_{GW}$ = 61,000 $TPHg_V$ = 3,700
Distance from sparge well		10'6"	14'	14'2"	14'7"	26'6"

See notes on page 2 of 2

TABLE 3
AIR SPARGE TEST DATA
ARCO Station 6148
Oakland, California
(Page 2 of 2)

Notes:

TPHg:	Total petroleum hydrocarbons as gasoline.
$TPHg_v$:	Concentrations of TPHg vapor in soil gas measured in mg/m^3.
$TPHg_{GW}$:	Concentrations of TPHg dissolved in groundwater measured in parts per billion.
Q_A:	Injection rate of sparge air measured in actual cubic feet per minute.
Q_H:	Injection rate of helium measured in actual cubic feet per minute.
P_i:	Combined air and helium injection pressure measured in pounds per square inch.
H_v:	Levels of helium in vadose zone measured in percent.
H_s:	Levels of helium in saturated zone measured in percent.
—:	Not applicable, not sampled, or not measured.

TABLE 4
COMBINATION VAPOR EXTRACTION/AIR SPARGE TEST FIELD MONITORING DATA
ARCO Station 6148
Oakland, California

February 17, 1994

Influent Air Stream from VW-1				Injection Well AS-2		Observation Wells			
						MW-2	MW-3	MW-1	VW-3
Elapsed Time (min)	Flow Rate (acfm)	Applied Vacuum ("H_2O)	OVM Readings (ppm)	Flow Rate (acfm)	Applied Pressure (psi)	Induced Vacuum ("H_2O)	Induced Vacuum ("H_2O)	Induced Vacuum ("H_2O)	Induced Vacuum ("H_2O)
0	25	28	5,700			0.07	0.06	0.04	0.02
15	25	38	5,800			0.07	0.06	0.02	0.03
30	25	40	4,900			0.07	0.05	0.01	0.02
45	25	39	8,750			0.06	0.05	0.01	0.03
60	25	38	5,110			0.06	0.05	0.01	0.03
		Begin Air Sparging							
75	25	38	6,400	2.5	9	0.03	0.03	0.00	0.01
90	25	36	6,120	2.5	9	0.03	0.03	0.00	0.01
105	25	35	6,500	2.5	9	0.03	0.03	0.00	0.02
120	25	35	5,470	2.5	9	0.03	0.03	0.00	0.01
Distance from extraction well VW-1 (feet):						14'3"	20'2"	28'	37'10"

Notes:
acfm = actual cubic feet per minute
" H_2O = inches of water column
ppm = parts per million
No detectable background fluctuations in atmospheric pressure.

APPENDIX E

MANUFACTURER'S SPECIFICATIONS FOR THE CATALYTIC OXIDIZER AND AIR COMPRESSOR

November 15, 1994

VAPOR CHECK

MODEL: CATVAC 10E

GENERAL DATA

* SCFM rating	100 SCFM (2.8 m³/min)
* maximum power consumption	16.7 KW/hr (w/o heat exchanger) 7.0 KW/hr (with heat exchanger)

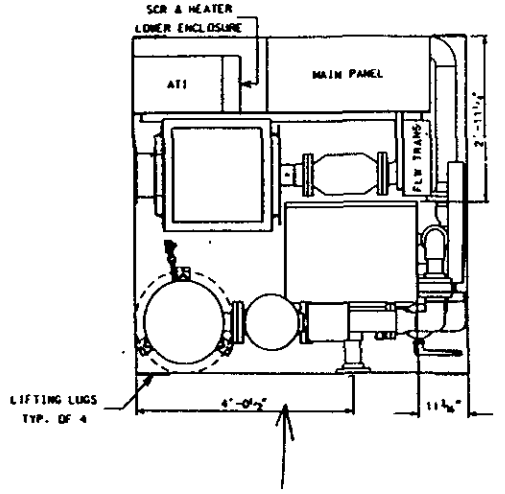
note: with a heat exchanger the power consumption is directly related to the concentrations in the process stream. 7.0 KW/hr is basically heating ambient air.

* stack ID	12" x 12" (30.5cm x 30.5cm)
* velocity through 4" process inlet	
● 50 SCFM (1.4 m³/min) from process stream	9.5 ft/sec (2.9 m/sec)
● 100 SCFM (2.8 m³/min) from process stream	19.0 ft/sec (5.8 m/sec)

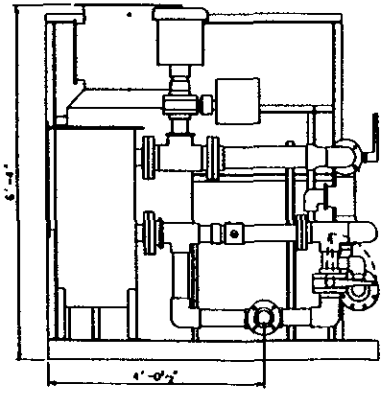
CATALYTIC DATA

* total ACFM @ 600°F (315°C)	200 ACFM (5.6 m³/min)
* catalyst volume for 95% plus destructive efficiency	0.27 ft³ (7,646 cm³)
* inlet temperature	600°F (315°C)
* maximum concentrations	25% of the LEL
* stack velocity @ 600°F (315°C)	
● 50 SCFM (1.4 m³/min) from process stream	1.7 ft/sec (0.52 m/sec)
● 100 SCFM (2.8 m³/min) from process stream	3.3 ft/sec (1.01 m/sec)

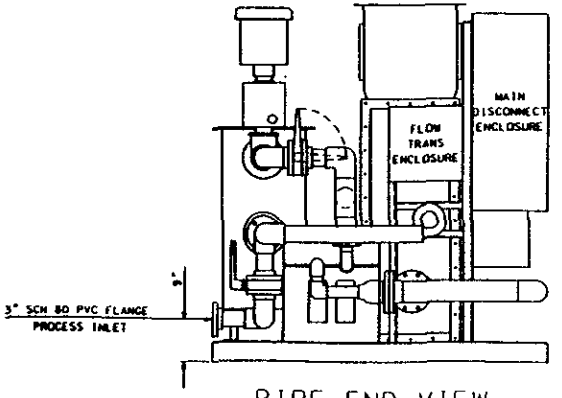
* The above data is intended to be used as general, guide line type information. For specific application proposal, please contact the manufacturer.



PLAN VIEW



PIPE SIDE VIEW



PIPE END VIEW

NOTES

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

NO.	DATE	BY	CHK'D	APP'D	REVISION

DRAWN	LEE Z
DATE	3/17/95
SCALE	N.T.S.
CHECKED	
APP'D	

CUSTOMER ARCO

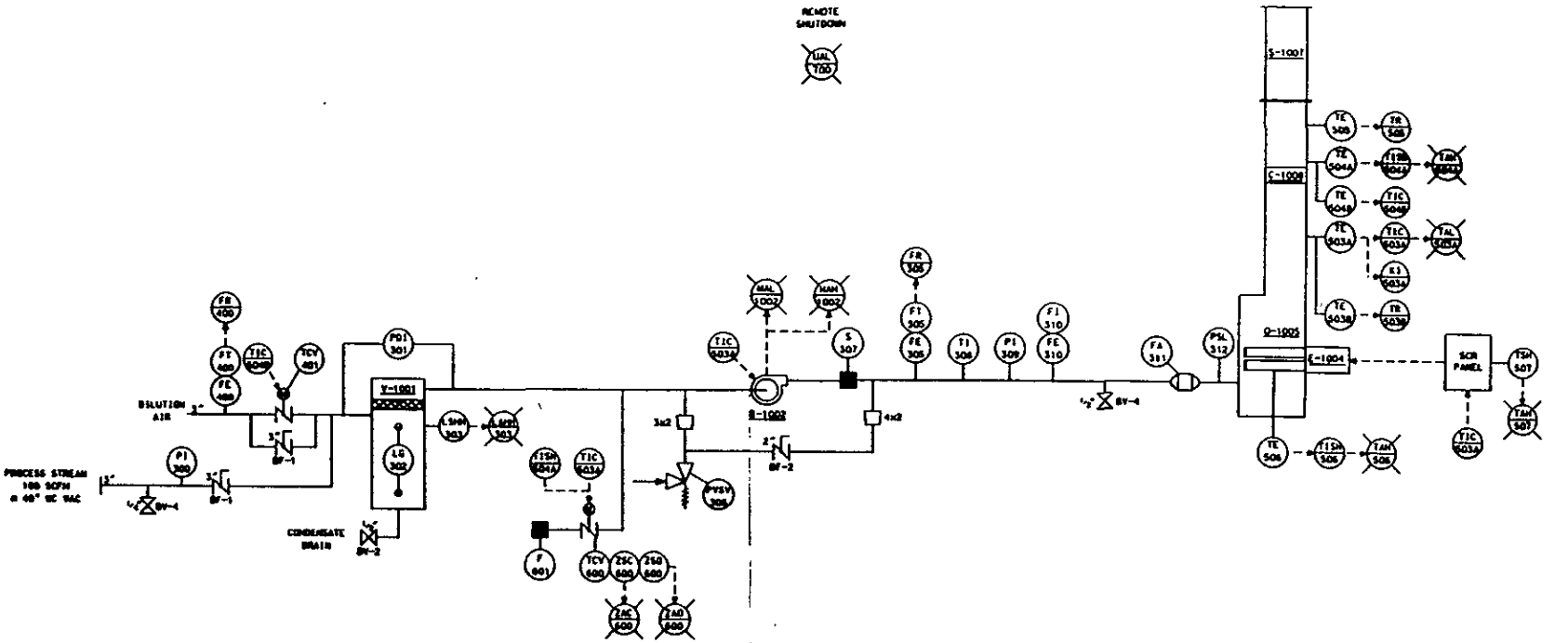
GENERAL ARRANGEMENT

THERMTECH INC.
POLLUTION CONTROL SYSTEMS
KINGWOOD, TEXAS 1-800-659-8271

JOB NO.	746
JOBSITE	N/A
REV. NO.	0
DWG NO.	7467GA
PAGE	1 OF 1

j:/dgn/elecvac dgn Mar 17, 1995 16:49:10

P-1000	V-1001	B-1002	E-1004	O-1005	S-1007	C-1008
CONDENSATE PUMP	KNOCK OUT POT 11 GAL	VACUUM PUMP 100 SCFM @ 55"WC 5½ HP	HEATING ELEMENTS 24 KW/HR	CATALYTIC OXIDIZER 650°F OPER TEMP 95 DRE	EXHAUST STACK	CATALYST MODULE 0.25 FT³



NOTES

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

- SUPPLIED BY CUSTOMER

▭ SUPPLIED BY THERMTECH INC. TO BE FIELD INSTALLED BY CUSTOMER

NO.	DATE	BY	CHK'D	APP'D	REVISION

CUSTOMER: ARCO

DRAWN	RJP
DATE	2/1/95
SCALE	NTS
CHECKED	
APP'D	

CATVAC10E TURNKEY P&ID

THERMTECH INC.
POLLUTION CONTROL SYSTEMS
KINGWOOD, TEXAS 1-800-659-8271

JOB NO.	746/747
JOBSITE	
REV NO.	
DWG NO.	
PAGE	1 OF 1

J:/dgn/pidele.dgn Mar. 16, 1995 09:18:37

SY this is the one we will us for Arco 6148. Valli 4/4/95

SUMMIT
INDUSTRIAL EQUIPMENT INC.
1850 Russell Avenue, Santa Clara, CA 95054-2034
Phone (408) 988-3900 Fax (408) 988-2612

April 3, 1995

EMCON Associates
1921 Ringwood Ave.
San Jose, CA 95131

453-7300
437-9526 FAX

Attn: Valli Voruganti

Re: Quotation #2 for ARCO 6148

We are pleased to submit the following quotation for your consideration.

QTY	PN	DESCRIPTION		PRICE
1	SLP05-3	Powerex Rotary Scroll Air Compressor		
		24"L x 25"W x 39"H (365#)		
		Totally Oil-Less		
		14.4 ACFM @ 100 PSIG		
		49 dB(A) Sound Level		
		Controls & Starter NEMA 1		
		208-230/460/60/1Ph/5Hp ODP Motor (1-phase)		$4,980
1	106H	Flex Hose 1/2" MPT 60" Long		$33
1	BV1/2	Ball Valve 1/2" FPT		$9
1	VT30-200	30 Gallon ASME Vertical Tank Painted		
		with Gauge, Safety Valve & Top Plate		$210
1	FRC05080A	Kaeser Filter Regulator Combination		
		5 Micron Fiber Element		$52
		Automatic Float Drain		$18
		0-160 PSIG Back Mount Gauge		$8
2	5Z280	Wilkerson Auto Drain Valve	$50/ea.	$100
			Total:	$5,410

NOTE* Prices do not include sales tax or installation costs.

Thank you for this opportunity to assist with your vacuum system needs. If you should have any further questions, please feel free to give me a call.

Did confirm w/ Summit on 4/4/95 that 14.4 ACFM is actually SCFM, free air & the unit will give higher air flow. at 50 psig (a few scfm higher).

Sincerely,

SUMMIT INDUSTRIAL EQUIPMENT, INC.

Arlan Wight Arlan Wight

AW/rlt

He is going to send me a revised quote ASAP
Valli 4/4/95