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# EXXON COMPANY, U.S.A.

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April 4, 1996

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

**RE: Exxon RAS #7-0236/6630 East 14th Street, Oakland, CA**

Dear Mr. Mishek:

Attached for your review and comment is a report entitled ***Corrective Action Plan*** for the above referenced site. The plan was prepared by Environmental Resolutions, Inc., (ERI), of Novato, California, and describes previous environmental work performed at the site, existing site conditions, and the results of analytical fate and transport modeling of dissolved hydrocarbons in groundwater. Based on the results of analytical modeling, Exxon requests passive bioremediation and semi-annual groundwater monitoring for two years be implemented as the selected remedial method prior to closure of the site.

If you have any questions or comments, please contact me at (510) 246-8776.

Sincerely,

Marla D. Guensler

Marla D. Guensler
Senior Engineer

MDG/jb

attachment: ERI Corrective Action Plan dated February 27, 1996

cc: w/attachment:
Thomas Peacock - Alameda Co. Health Care Service Agency

w/o attachment
Keith Romstad - ERI, Navoto

# CORRECTIVE ACTION PLAN

for

Exxon Service Station 7-0236
6630 East 14th Street
Oakland, California

ERI Job 200904.R01
February 27, 1996

Prepared for

Exxon Company, U.S.A.
2300 Clayton Road, Suite 640
Concord, California 94520

ERI
ENVIRONMENTAL RESOLUTIONS, INC.

ENVIRONMENTAL RESOLUTIONS, INC.

CORRECTIVE ACTION PLAN

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Report prepared for

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2300 Clayton Road, Suite 640
Concord, California 94520

by

Environmental Resolutions, Inc.

Keith A. Romstad
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February 27, 1996

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**Corrective Action Plan**

for

Exxon Service Station 7-0236
6630 East 14th Avenue
Oakland, California

For Exxon Company, U.S.A.

## 1.0 INTRODUCTION

At the request of Exxon Company, U.S.A. (Exxon), Environmental Resolutions, Inc. (ERI) has prepared this Corrective Action Plan (CAP) for Exxon Service Station 7-0236 located at 6630 East 14th Avenue in Oakland, California. This CAP describes previous environmental work performed at the site, existing site conditions, and analytical fate and transport modeling for the site. Based on review of site conditions and results of analytical modeling, it is ERI's opinion that passive bioremediation will be an effective remediation technique at the site.

## 2.0 BACKGROUND

### 2.1 Site Description

Exxon Service Station 7-0236 is an operating retail gasoline station located on the northern side of East 14th Street between Havenscourt Boulevard and 66th Avenue on Oakland, California, as shown on the Site Vicinity Map (Plate 1). Structures at the site include a service station building with two multi-pump fuel dispenser islands and three fuel underground storage tank, (USTs) and one used-oil UST.

The site is on a relatively flat, asphalt-covered lot at an elevation of approximately 20 feet above mean sea level (msl). The area surrounding the site is a mixed residential and light business district. Havenscourt Junior High School is located south of the site, across East 14th Street. The locations of the station facilities, existing underground storage tanks and service islands, current use of adjacent lots, and other pertinent site facilities are shown on the Generalized Site Plan (Plate 2).

## 2.2 Previous Site Investigations

To date, twelve soil borings have been drilled at or near the site, seven groundwater monitoring wells installed, and three vapor-extraction wells installed (Plate 2). The initial three monitoring wells were installed in March 1991. Four additional wells were installed in March 1992, and the three vapor-extraction wells were installed in November 1993. Groundwater samples were collected from the two remaining borings prior to backfilling. Exxon initiated quarterly groundwater monitoring at the site in January 1992.

In December 1993, RESNA Industries, Inc. (RESNA) performed a vapor extraction test (VET) and step drawdown test. Results of the VET indicated achievable flowrates of 31 to 79 actual cubic feet per minute (acfm). However, vacuum responses were either negligible or too low for use in evaluating the effective radius of influence. The relatively low extraction wellhead vacuums observed (3 to 21 inches of water), low vacuum response, and achievable flow rates, suggested short circuiting of air stream through the nearby UST cavity may have occurred near wells VE1 and VE3. Data obtained during the step drawdown test indicated a maximum sustainable water discharge rate from well MW2 of approximately 0.1 gallons per minute (RESNA, February 14, 1994).

Based on the data obtained, RESNA concluded pumping and treating groundwater from beneath the site did not appear to be a feasible remediation technique and vapor extraction will have limited practical application.

In a letter (dated March 7, 1994), the California Regional Water Quality Control Board, San Francisco Bay Region (CRWQCBSFBR) agreed that vapor-extraction and pumping groundwater are not appropriate remedial alternatives and that Exxon should continue monitoring and submitting quarterly reports and develop a plan to document that other wells do not become impacted.

# 3.0 SITE CONDITIONS

## 3.1 Site Geology and Hydrogeology

The site is located along the western portion of an alluvial fan, less than 1.5 miles northeast of the tidal canal, and north of San Leandro Bay.

The earth materials encountered at this site during the previous investigations consisted primarily of low permeability clay, silty clay, and gravely silt. Geologic cross-sections showing soil stratigraphic correlations are presented on Plates 3, 4, and 5.

Depth to groundwater has ranged from approximately 6.5 to 15.0 feet below grade during quarterly monitoring. The groundwater flow direction has been consistently towards the south-southwest. Data generated during the step drawdown test performed at the site indicated the sustainable discharge rate from well MW2 is approximately 0.1 gallons per minute (gpm) or approximately 144 gallons per day which is consistent with the earth materials encountered.

## 3.2 Soil Conditions

Soil containing residual gasoline and/or diesel hydrocarbons appears to be limited to the areas adjacent to existing underground storage tanks and beneath dispenser islands. Residual hydrocarbons are concentrated near the capillary fringe. Analyses detected a maximum total petroleum hydrocarbon as gasoline (TPHg) concentration of 200 parts per million (ppm) in VE1 (between existing tanks and dispenser island). Analyses detected a maximum concentration of total extractable petroleum hydrocarbons as diesel fuel (TEPHd) of 150 ppm in VE3 (adjacent to the northern dispenser island). The locations of these borings/wells are shown on Plate 2. These concentrations of petroleum hydrocarbons were detected at approximately 11 feet below grade (capillary fringe).

## 3.3 Groundwater Conditions

A limited dissolved gasoline and diesel fuel hydrocarbon plume exists beneath the site. The highest-concentrated portion of the plume generally exists near well MW2 and has been delineated in the general upgradient, crossgradient and downgradient directions of groundwater flow by wells MW1, MW4, MW5, and MW7.

## 3.4 Well Search and Utilities

ERI could not obtain information from the California Department of Water Resources (DWR) regarding water supply wells or municipal wells in the vicinity of the site because DWR indicated the files are not subject to public inspection.

According to East Bay Municipal Water District personnel, Oakland receives its water from surface water for distribution. Based on this fact, it does not appear probable that groundwater is being utilized for municipal purposes.

ERI also reviewed the files of selected public utility companies for locations of underground utilities, such as sewer lines in the vicinity of the site, to evaluate whether their locations would create conduits for migration. The locations of underground utilities in the vicinity of the site are shown on Plate 2. The utility lines in the vicinity of the site are typically not greater than 8 feet below ground surface (bgs), and the depth to groundwater beneath East 14th Street in the downgradient direction of groundwater flow is generally approximately 9 to 11 bgs. Therefore, the pipelines likely are not acting as conduits for preferential groundwater flow.

# 4.0 FATE AND TRANSPORT MODELING

Work performed by ERI included hand-augering one shallow soil boring on site and collecting and submitting a soil sample for appropriate analyses to assist in obtaining pertinent information for fate and transport modeling, and performing an analytical fate and transport assessment of dissolved hydrocarbons in groundwater. The purpose of the work was to evaluate the fate of dissolved hydrocarbons in groundwater and evaluate whether receptors would be impacted before natural degradation of hydrocarbons occurs.

## 4.1 Hand-auger Boring and Sampling

ERI hand-augered the shallow boring approximately 6 feet southwest of well MW3 (slightly west of existing UST's) to a depth of approximately 5 feet bgs and collected a soil sample for appropriate analyses. ERI collected the sample by driving a percussion sampler equipped with a 6-inch long brass sleeve into the soil in-place to obtain a sample representative of subsurface conditions. ERI collected the sample to assist in obtaining pertinent information for fate and transport modeling.

## 4.2 Analytical Methods and Results

The soil sample was submitted under Chain of Custody Record to Sequoia Analytical Laboratories in Redwood City, California. The Chain of Custody Record is attached in Appendix A. The soil sample was analyzed for moisture content, bulk and grain density, effective porosity, native state effective permeability to water, native state effective hydraulic conductivity, and total organic carbon (TOC) using methodology acceptable to American Standard Testing Methods (ASTM), the Environmental Protection Agency (EPA), and the American Petroleum Institute (API).

Analytical results of the soil sample indicated 21% by weight moisture content, 1.92 grams per cubic centimeter (g/cc) bulk density, 2.57 g/cc grain density, 25.4% bulk volume (Vb) effective porosity, 0.026 millidarcy native state effective permeability to water, 2.75E-06 centimeter per second (cm/s) native state effective hydraulic conductivity, and 5,400 milligrams per kilogram (mg/kg) TOC. The results are shown in Table 1.

## 4.3 Fate and Transport Assessment

### 4.3.1 Analysis of Problem

At the subject site, the USTs, service islands, and associated product lines are currently in use. A majority of gasoline and diesel fuel hydrocarbon-impacted soil appears to be concentrated within the capillary fringe (approximately 11 feet below grade) near the existing UST's and dispenser islands. Based on the potential off-site sources identified to date and the local southwesterly groundwater gradient, impact on the subject property from potential off-site sources identified to date does not appear to be occurring. The lateral extent of gasoline and diesel fuel hydrocarbons in the upper water-bearing zone has been delineated to the west, east, and south. The site is covered with asphalt pavement.

### 4.3.2 Site Parameters Affecting Fate and Transport

The three general processes affecting subsurface transport of petroleum hydrocarbons are hydrodynamic, abiotic (physiochemical), and biotic. Each of these processes in turn are dependent upon the physical properties of the subsurface, and the physiochemical and biological properties of petroleum hydrocarbons.

Hydrodynamic processes impact hydrocarbon transport by affecting the rate and direction(s) of groundwater flow and includes advection, dispersion, and preferential flow. These properties are largely controlled by the physical properties of the subsurface in terms of the hydraulic conductivity distribution, the driving head distribution (both spatially and temporally), and formation dispersivity. Generally, the chemical properties do not exert a strong influence on hydrodynamic processes. However, for very low groundwater flow velocities, molecular diffusion (controlled by chemical-specific diffusion) may be significant (Knox and others, 1993).

For dissolved hydrocarbons beneath the subject site, the abiotic process of sorption is one of the most important factors in assessing the fate of subsurface hydrocarbons. The physical property of the subsurface which largely controls this process is the TOC content of the sediments. The chemical properties which control sorption are solubility and octanol-water partition coefficient (Domenico and Schwartz, 1990).

Biotic processes controlling chemical transport are similarly affected by both the subsurface properties, including the presence of microorganisms, nutrients, oxygen, and the properties of chemical concentration and biochemical oxygen demand (Borden and Bedient, 1986).

The formation parameters controlling hydrodynamic processes at the site are not completely known but a reasonable range can be estimated for the purposes of analysis. The most important factor affecting transport is the hydraulic conductivity or permeability distribution. The logs of borings at the site have shown the shallow water bearing zone to be comprised of clay, silty clay, and gravelly silt (RESNA, February 14, 1994). Based on a review of three widely published groundwater texts, the range of hydraulic conductivity of these sediment types could range from approximately 0.28 feet per day to 0.0001 feet per day (C.W. Fetter, 1980; Driscoll, 1989; Freeze and Cherry, 1979). In order to provide a better site specific estimate for this parameter, ERI collected a soil sample to determine the hydraulic conductivity (as described in above Sections 4.1 and 4.2). The laboratory reported a K of $2.75 \times 10^{-6}$ cm/sec ($8 \times 10^{-3}$ ft/day), which is within the range reported within the literature.

The borings on the subject site, suggest the sedimentary section in the area is reasonably homogeneous at the scale of the station property. Some variations in the thickness of the individual logged units and lateral pinching or fining of the sediments towards the south-southwest are indicated by the logs.

No data were available for definitively addressing dispersion at the site. Flow analysis has included a scenario of zero dispersion, which will maximize downgradient hydrocarbon flow velocity and the predicted downgradient hydrocarbon concentrations.

The transport and fate of petroleum hydrocarbons beneath the site will be significantly affected by sorption. Low solubility, non-polar organic molecules, such as petroleum fuel hydrocarbons, have high distribution coefficients (high sorption potential). The primary factor controlling sorption (and therefore retardation) is the TOC content of the sediments in the water bearing zone. Therefore, one site soil sample has been analyzed for TOC content (as described in above Sections 4.1 and 4.2). Generally, high levels would be expected from the low energy depositional setting (lower fan/bay lowlands). The laboratory reported a TOC content of 5,400 mg/Kg which is consistent with this observation. ERI's transport analyses considers both retarded and unretarded hydrocarbon transport conditions. Typical retardation factors reported in the literature for gasoline hydrocarbons range from 1.5 to 5 indicating the importance of adsorption in evaluating the subsurface transport of these compounds (Knox and others, 1993; Kemblowski and others, 1987).

The biotic transformation of petroleum hydrocarbons is a significant factor affecting chemical transport at the site. Aerobic biodegradation of gasoline is widely documented in the literature and is generally modeled as a first order process with the rate of decay limited by the available oxygen (Borden and Bedient, 1986). Although precise modeling is difficult, even for sites where nutrient, oxygen levels, site hydraulics and transport velocities (retardation) are well known, the changes in chemical concentration along a flow path due to biodegradation can be analyzed by several approximate methods presented in the literature (Domenico and Schwartz, 1990; Borden and Bedient, 1986). The controlling parameters for these models of first order biodecay are the decay constant (degradation rate in percent per day) and the transport velocity.

Decay constants have been determined at laboratory and field scales for a number of gasoline constituents including benzene. Benzene decay constants from numerous studies reported average values ranging from 0.35 to 4.0% per day (Kemblowski and others, 1987, Howard and others, 1991).

### 4.3.3 Conceptual Model Description

The hydrogeologic setting at the site is characterized by low to moderately low permeability clays and gravely silt. The depth to first groundwater in the area has generally been in the range of 8 to 12 feet below ground surface with fluctuations ranging from approximately 6.5 to 15 feet below grade (ERI, 1995).

This implies that the capillary zone, and the majority of the hydrocarbon mass, is present within one or two feet of this interval for several reasons, including:

- The vertical migration of lighter than water hydrocarbons is inhibited at the zone of water saturation (capillary); and
- Advective transport in the horizonal plane is significantly greater than the vertical plane due to the hydraulic conductivity anisotropy associated with layered sediments, particularly with high clay content. Similarly, because dispersion is linearly related to advective velocity, dispersion in the vertical direction is also limited.

The gradient at and near the site over the previous three years has been southwest with an average magnitude of approximately 0.029 (Alton 1992, RESNA 1994, and ERI 1995).

The laboratory analyses of the sample collected from the hand-augered boring indicates a hydraulic conductivity (K) of 0.008 feet per day (ft/day) (Appendix A). Values for K presented in the literature indicate this value is probably representative of the silty clay sediments typically logged below ground surface on-site. The maximum anticipated K based on literature data is 0.28 feet/day.

The horizonal groundwater flow velocity within the shallow zone can be calculated using the measured hydraulic conductivity, the site gradient, and the laboratory measured effective porosity of 25.4% (Appendix A) as follows:

$$V = Ki/n_e$$

where,

| | | |
|---|---|---|
| $V$ | = | Horizontal groundwater flow velocity |
| $K$ | = | Hydraulic Conductivity = 0.008 ft/day |
| $i$ | = | Site groundwater gradient = 0.029 |
| $n_e$ | = | Effective porosity = 25.4% |

The advective groundwater flow velocity would be 0.0009 ft/day or 0.33 ft/year. Therefore, an unretarded chemical could be expected to move at approximately this rate.

It is well known that petroleum hydrocarbons, and benzene in particular, sorb readily into organic matter in the subsurface. The effect of sorption is to decrease the velocity of dissolved hydrocarbons relative to groundwater. The ratio of groundwater velocity to chemical velocity is equal to the retardation factor ($R_f$), which is calculated for benzene at this site as follows (Domenico and Schartz, 1990):

| | | |
|---|---|---|
| $R_f$ | = | $1 + \{ (1-n) / n \} p_s K_d$ , |
| | = | 5.07 |

where,

| | | |
|---|---|---|
| n | = | Effective porosity = 25.4% (from site sampling, Appendix A) |
| $p_s$ | = | grain density of sediment = 2.57 grams per cubic centimeter (gm/cc) (from site sampling, Appendix A) |
| $K_d$ | = | partition coefficient between dissolved phase and organic carbon = $f_{oc}$ x $K_{oc}$ |
| | = | 0.54 cubic centimeters per gram (cc/gm) |

where,

| | | |
|---|---|---|
| $f_{oc}$ | = | average organic carbon content of the aquifer |
| | = | 0.0054 (from site sampling, Appendix A) |
| $K_{oc}$ | = | organic carbon sorption coefficient for benzene |
| | = | 100 cc/gm (Montgomery, 1991) |

By factoring retardation into the advective flow analysis, the hydrocarbon transport velocity can be calculated. The hydrocarbon transport velocity is represented by retarded flow at the groundwater velocity rate determined from the measured hydraulic conductivity value which is calculated as follows:

Benzene velocity in groundwater = 0.33/5.07 = 0.06 ft/yr.

In summary, it appears that dissolved petroleum hydrocarbons are migrating downgradient largely in saturated silty clay sediments from approximately 8 to 12 feet below grade. Using benzene as the tracer compound, the maximum reasonable transport velocity is approximately 0.06 ft/yr. It also appears other factors are present which account for the significant decrease in dissolved concentrations along the flowpath from the tank pit to wells MW2 and MW3. These factors may include dispersion, sorption, and biodegradation.

### 4.3.4 Analytical Modeling of Biodegradation

To incorporate natural biodegradation into the fate analysis, and as an alternative calculation of the expected downgradient extent of dissolved hydrocarbon travel, two analytical transport solutions were utilized for one dimensional mass transport involving first order biodecay of benzene under oxygen limiting conditions.

Borden and Bedient (1986) presented the following equation:

$$C_x = C_o e^{(-mx/v)} \text{ (Equation 1)}$$

where,

| | | |
|---|---|---|
| $C_x$ | = | the concentration at a distance x downgradient of the source |
| $C_o$ | = | the source benzene concentration |
| m | = | the decay constant (percent per day) |
| v | = | the contaminant velocity |

To estimate the longitudinal downgradient distance that benzene would be expected to travel, Equation 1 was used with the following parameters:

| | | |
|---|---|---|
| $C_o$ | = | 210 parts per billion (ppb), based on the recent high during sampling of well MW2. This model assumes that this concentration is a steady source and does not diminish with time |
| m | = | 0.3 percent per day (0.003) decay constant, based on numerous independent determinations cited above, this value represents the lowest (slowest) published rate constant for benzene |
| v | = | 0.00016 feet per day (0.06 feet per year), from calculations with the site specific hydraulic parameters. |

Equation 1 predicts the distance downgradient of MW2 at which benzene will be at the maximum contaminant level (MCL) of 1.0 ppb is less than 1 foot. Using the maximum velocity value presented in the literature for the site-specific sediments (0.006 ft/day), the maximum distance at which benzene would be reduced to the MCL of 1.0 is approximately 10 feet.

A second approach to predicting the fate of dissolved gasoline hydrocarbons at the site was taken utilizing the method Domenico and Schartz (1990):

$$C_o = C_o e^{\{(x/2d)(1 - [1 + 4md/v]^{1/2})\}} \quad \text{(Equation 2)}$$

where,

| | | |
|---|---|---|
| $C_x$ | = | the steady state concentration at a distance x downgradient of a continuing source, |
| m | = | the biodegradation rate constant (percent per day), |
| v | = | the contaminant velocity, and |
| d | = | longitudinal dispersivity. |
| $C_o$ | = | steady state concentration |

Equation 2 was applied to predict benzene transport with the following parameters:

| | | |
|---|---|---|
| $C_o$ | = | 210 ppb |
| m | = | 0.3 percent per day (0.003) |
| v | = | 0.00016 feet per day |
| d | = | 100 feet, representing a typical, generally low dispersivity value. However, the dispersivity term occurs in two places in the equation such that they offset each other. Any reasonable value of $d_x$ can be utilized and the value of the exponential term of the equation will change less than 1 percent for a 3 order of magnitude change in dispersivity (Domenico and Schartz, 1990). Another words, the predicted downgradient concentration is insensitive to the assumed longitudinal dispersivity value. |

Equation 2 predicts the downgradient distance from well MW2 at which benzene is 1.0 ppb is approximately 13 feet.

While the input parameters of the analytical models discussed above are reasonably well constrained for analyzing benzene transport, prediction for the full range of gasoline hydrocarbons entails less certainty. Based on numerous determinations of biodegradation rates by Knox and others (1993), toluene, ethylbenzene, and total xylenes would be expected to conform closely to the benzene model. While TPHg analyses represents the sum concentrations of over one hundred individual hydrocarbon compounds, all are known to degrade aerobically (Knox and others, 1993).

It is important to recognize that this analytical modeling approach represents steady state conditions, that is, that the source concentration is consistent through time. This might represent a situation where a free product pool was present, or where continuous leakage was occurring. For the subject site, where no free product is present and existing tanks and lines continue to pass precision tests, this model represents a conservative approach (tending to overestimate downgradient concentrations). Both models reinforce the basic interpretation of the site chemical hydrogeology; that the low levels of petroleum hydrocarbons will naturally attenuate within a very limited distance of the source area. These calculations are intended to demonstrate the general mechanism controlling fate of hydrocarbons at the site. The approximate agreement indicates the characterization of the hydrodynamic, abiotic, and biotic processes are generally appropriate.

## 4.4 Modeling Conclusions

Analytical modeling of the chemical fate at the subject site was conducted using conservative assumptions which compound to account for any uncertainties within some model input parameters. Results of modeling indicate the following:

- No significant hydrocarbon migration will occur due to hydrogeologic or chemical characteristics. Transport and fate analyses under conservative assumptions indicate the downgradient extent of the hydrocarbon plume is unlikely to extend off site and the maximum distance the plume will migrate is approximately 13 feet downgradient of well MW2 (benzene concentrations at approximately 1 ppb). Biodegradation and concentration attenuation is apparent. The subject site has hydrogeologic conditions (silty/clayey water-bearing zone with moderate levels organic carbon) and chemical characteristics (petroleum hydrocarbons which degrade readily and are highly sorbed) that indicate the restricted plume migration will continue to degrade the hydrocarbon mass. These factors also make dissolved phase clean-up infeasible.

- The natural groundwater velocity is low and the hydrocarbon velocity slower still due to retardation and biodegradation.

- No significant potential horizonal migration pathways exist based upon correlation of sediments in boring logs.

- The hydrocarbon plume is limited and will naturally degrade within a limited horizonal extent (less than 30 feet from source), the mass confined to beneath the site, and limited to the upper water-bearing zone.

- Only low to moderate levels of dissolved hydrocarbons remain in the first water bearing zone.

- The site is covered with asphalt which will further limit hydrocarbon migration, and existing tanks are undergoing regular precision testing.

# 5.0 EVALUATION OF REMEDIAL ALTERNATIVES

## 5.1 Selection Criteria

The criteria used to evaluate potential remedial options for the site include relative effectiveness, treatment time, time constraints, cost, and future liability. Soil and groundwater remediation options considered include soil vapor extraction/groundwater extraction and treatment, excavation and disposal, and no action/periodic monitoring.

## 5.2 Soil and Groundwater Remediation Options

Based on the size of the plume, dissolved hydrocarbon concentrations, and the fine-grained soils present at the site, enhanced in-situ bioremediation, chemical oxidation, air sparging, and slurry wall containment do not appear economically feasible at this time. The following remedial options are presented:

### 5.2.1 Excavation and Disposal

Soil containing residual gasoline and diesel fuel is present near the existing underground storage tanks and dispenser islands. Because of the relatively shallow depths and limited lateral extent, these conditions are conducive to removal of hydrocarbon impacted soil by excavation. However, at the present time the site is an operating retail service station and this alternative would require the removal of underground storage tanks and associated lines. This alternative is very costly when incorporating removal and backfilling activities, disposal costs, and lost revenue based on a substantial non-operational period. This method may be implemented upon closure of the station and removal or replacement of tanks.

### 5.2.2 Soil Vapor Extraction/Groundwater Extraction and Treatment

The low permeability of shallow sediments at the site will severely limit vapor extraction and the mass removal rates. Pumping rates observed during well purging have typically been below 0.1 gallons per minute, which will effectively prohibit utilizing a pump and treat system. Additionally, mass removal rates are unlikely to significantly exceed natural degradation rates. The sustainable flowrate of 144 gallons per day (gpd) observed during the step drawdown test is below the minimum 200 gpd specified in the Regional Water Quality Control Board Policy entitled "Sources of Drinking Water" to consider groundwater suitable or potentially suitable, for municipal or domestic water supply. Furthermore, in a letter (dated March 7, 1994) the Regional Board agreed that vapor and pumping groundwater are not appropriate remedial alternatives. Therefore, ERI does not recommend vapor-extraction or pumping and treating groundwater at this site.

### 5.2.3 Monitoring of Natural Attenuation

The dissolved benzene concentrations consistently detected in well MW2 exceed the Primary MCL of 1 ppb. Historically, concentrations of dissolved benzene in MW3 have intermittently exceeded the Primary MCL. Based on the modeling summary above, advective transport, hydrodynamic dispersion, and natural degradation will reduce dissolved hydrocarbon concentrations in groundwater within a limited distance (13 feet) and dissolved hydrocarbons will likely remain on site. In ERI's opinion, monitoring groundwater to verify the limited migration and continued natural degradation of dissolved hydrocarbon concentrations in groundwater is a viable alternative for remediation of groundwater at this site.

## 6.0 SUMMARY AND RECOMMENDED REMEDIAL ACTION

Based on the results of modeling, it is ERI's opinion that adequate site investigation has been accomplished (see Plate 2) and dissolved hydrocarbons in groundwater likely will not migrate off site. The maximum distance the plume will travel downgradient of well MW2 is 13 feet. Furthermore, the soil and groundwater conditions existing at the site warrant passive bioremediation as a remedial alternative based on the following:

- Transport and fate analysis under conservative assumptions indicated the downgradient extent of the hydrocarbon plume is unlikely to extend off site and will not exceed 13 feet further than well MW2. Biodegradation and concentration attenuation is apparent.
- Active remediation approaches are severely constrained by the inherent low permeability of the shallow sediments. Moreover, the mass removal rates are unlikely to significantly exceed natural degradation.
- Given the limited mobility of the hydrocarbon plume, the need for further action at the site should focus on the beneficial uses of this shallow water bearing zone within the approximately 180 by 180 foot radius currently being monitored. Therefore, existing or potential beneficial uses in the immediate vicinity of the site must be considered. Due to the very low permeability in the shallow water bearing zone and based on step-drawdown test data, well productivity does not exceed 200 gallons per day. These data indicate that this water bearing zone would not have a beneficial use as municipal drinking water. This further implies uses such as commercial or agricultural supply are also not viable.

Due to the lack of any impact on existing beneficial uses of water, the limitations on any beneficial uses in the future, the infeasibility of effective active remediation, and the biodegradation rate and low mobility of remaining hydrocarbons, it is ERI's opinion that passive bioremediation be utilized as the remedial alternative. The above data substantiate the use of passive bioremediation at this site and reinforces the findings of Lawrence Livermore National Laboratories report to the State Water Resources Control Board recommending passive bioremediation (dated October 16, 1995).

## 7.0 LIMITATIONS

This report was prepared in accordance with generally accepted standards of environmental geological practice in California at the time this investigation was performed. This investigation was conducted solely for the purpose of evaluating environmental conditions of the soil and water. No soil engineering or geotechnical references are implied or should be inferred. Evaluation of the geologic conditions at the site for the purpose of this investigation is made from a limited number of observation points. Subsurface conditions may vary away from the data points available. Additional work, including further subsurface investigation, can reduce the inherent uncertainties associated with this type of investigation. This report has been prepared solely for Exxon Company, U.S.A., and any reliance on this report by third parties shall be at such party's sole risk.

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TABLE 1
**CUMULATIVE RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES**
Exxon Service Station 7-0236
6630 East 14th Street
Oakland, California


| Sample | Depth | TPHg | TPHd | B | T | E | X |
|---|---|---|---|---|---|---|---|
| | < | ........................ | ........ Parts per million | ........ | ........ | ........ | > |
| Alton GeoScience - March 1991 | | | | | | | |
| Soil Borings | | | | | | | |
| MW1 | 6' | <1.0 | NA | <0.003 | <0.003 | <0.003 | <0.003 |
| | 11' | <1.0 | NA | <0.003 | <0.003 | <0.003 | <0.003 |
| | 16' | <1.0 | NA | <0.003 | <0.003 | <0.003 | <0.003 |
| MW2 | 6' | <1.0 | NA | 0.008 | 0.018 | <0.003 | 0.025 |
| | 11' | <1.0 | NA | 0.074 | 0.12 | 0.24 | 0.19 |
| | 16' | <1.0 | NA | 0.051 | <0.03 | 0.018 | 0.009 |
| MW3 | 6' | <1.0 | NA | 0.009 | <0.003 | <0.003 | 0.1 |
| | 11' | <1.0 | NA | <0.003 | <0.003 | <0.003 | 0.018 |
| | 16' | <1.0 | NA | <0.003 | <0.003 | <0.003 | 0.004 |
| Alton GeoScience - March 1992 | | | | | | | |
| MW4 | 5' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 15' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| MW5 | 5' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 15' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| MW6 | 5' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 15' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| MW7 | 5' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 15' | 18 | 23 | <0.005 | <0.005 | <0.005 | <0.005 |
| RESNA Industries, Inc. - November 1993 | | | | | | | |
| B1 | 6.2' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 11.5' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| B2 | 8' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 11' | 4.6 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| VE1 | 8' | 4.8 | 8.5 | 0.024 | 0.014 | 0.057 | 0.023 |
| | 11.3' | 200 | 47 | <0.005 | <0.005 | <0.005 | 2.5 |
| VE2 | 6' | <1.0 | 7.2 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 11.2' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| VE3 | 6' | <1.0 | <5.0 | <0.005 | <0.005 | <0.005 | <0.005 |
| | 11.3' | 1.7 | 150 | <0.005 | <0.005 | <0.005 | <0.005 |

See notes on Page 2 of 2

TABLE 1
**CUMULATIVE RESULTS OF LABORATORY ANALYSES OF SOIL SAMPLES**
Exxon Service Station 7-0236
6630 East 14th Street
Oakland, California
(Page 2 of 2)

Environmental Resolutions, Inc. - October 1995

| | |
|---|---|
| S-5-HA1 | 21% by weight moisture content, 1.92 grams per cubic centimeter (g/cc) bulk density, 2.57 g/cc grain density, 25.4% bulk volume (Vb) effectiveness porosity, 0.026 millidarcy native state effective permeability to water, 2.75E-06 centimeter per second (cm/s) native state effective hydraulic conductivity, and 5,400 milligrams per kilogram (mg/Kg) total organic carbon |

< : Less than the laboratory detection limit.
NA : Not analyzed.
B: Benzene, T: Toluene, E: Ethylbenzene, X: Total Xylene isomers
BTEX : Analyzed by EPA method 8020.
TPHg : Total petroleum hydrocarbons as gasoline by EPA method 8015 (modified).
TPHd : Total petroleum hydrocarbons as diesel by EPA method 8015 (modified).

**TABLE 2**
**CUMULATIVE GROUNDWATER MONITORING AND SAMPLING DATA**
Exxon Service Station 7-0236
6630 East 14th Street, Oakland, California
(Page 1 of 5)

| Well ID # (TOC) | Sampling Date | SUBJ | DTW | Elev. | TEPHd | TPHg | B | T | E | X | MTBE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | < ........ | feet ......... | > | < ............... | parts per billion | ................. | | .......... | .... | > |
| MW1 | 03/15/91 | NR | 7.44 | 12.76 | --- | <50 | <0.3 | 0.5 | 0.3 | 1.3 | --- |
| (20.20) | 01/15/92 (H,T) | NR | 10.60 | 9.60 | <300 | <50 | <0.5 | 0.7 | <0.5 | 0.9 | --- |
| | 03/23/92 (H,T) | NR | 6.38 | 13.82 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 04/06/92 | NR | 7.55 | 12.65 | --- | --- | --- | --- | --- | --- | --- |
| | 07/08/92 (H,T) | NR | 9.85 | 10.35 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 10/13/92 (H,T) | NR | 12.95 | 7.25 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/09/93 | NLPH | 7.38 | 12.82 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 06/04/93 | NLPH | 8.55 | 11.65 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/02/93 | NLPH | 10.85 | 9.35 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 11/16/93 | NLPH | 12.43 | 7.77 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 02/04/94 | NLPH | 9.10 | 11.10 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 04/29/94 | NLPH | 8.45 | 11.75 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/20/94 | NLPH | 10.73 | 9.47 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 12/14/94 | NLPH | 7.35 | 12.85 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/27/95 | NLPH | 7.06 | 13.14 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 05/18/95 | NLPH | 7.32 | 12.88 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 08/08/95 | NLPH | 9.24 | 10.96 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | <2.5 |
| MW2 | 03/15/91 (H,T) | NR | 9.05 | 10.10 | 120 | 1,700 | 190 | 2.6 | 12 | 64 | --- |
| (19.15) | 01/15/92 (H,T) | NR | 11.60 | 7.55 | 1,000 | 6,800 | 81 | <10 | 320 | 170 | --- |
| | 03/23/92 (H,T) | NR | 9.42 | 9.73 | 3,000 | 7,100 | 740 | 30 | 810 | 490 | --- |
| | 04/06/92 | NR | 9.09 | 10.06 | --- | --- | --- | --- | --- | --- | --- |
| | 07/08/92 | NR | 10.08 | 9.07 | 2,100 | 7,000 | 250 | 14 | 300 | 160 | --- |
| | 10/13/92 | NR | 12.06 | 7.09 | 1,900 | 3,200 | 97 | 2.6 | 97 | 53 | --- |
| | 03/09/93 | sheen | 9.71 | 9.44 | --- | --- | --- | --- | --- | --- | --- |
| | 06/04/93 | sheen | 9.40 | 9.75 | --- | --- | --- | --- | --- | --- | --- |
| | 09/02/93 (M) | sheen | 10.46 | 8.69 | 3,700 | 11,000 | 210 | 18 | 260 | 59 | --- |
| | 11/16/93 (M*) | NLPH | 11.44 | 7.71 | 3,300 | 8,500 | 75 | 27 | 51 | 32 | --- |
| | 02/04/94 | NLPH | 10.41 | 8.74 | 2,700 | 4,400 | 120 | 16 | 22 | 7.7 | --- |
| | 04/29/94 (C,M*) | NLPH | 9.51 | 9.64 | 2,000 | 380 | 5.9 | 0.6 | 1.6 | <0.5 | --- |
| | 09/20/94 | NLPH | 10.57 | 8.58 | 1,800** | 19,000 | 190 | 29*** | 110 | 27*** | --- |

See notes on Page 5 of 5

**TABLE 2**
**CUMULATIVE GROUNDWATER MONITORING AND SAMPLING DATA**
Exxon Service Station 7-0236
6630 East 14th Street, Oakland, California


| Well ID # (TOC) | Sampling Date | SUBJ | DTW | Elev. | TEPHd | TPHg | B | T | E | X | MTBE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | < ......... | feet .......... | > | < ............... | | parts per billion ........ | | | | ........ > |
| MW2 (cont.) | 12/14/94 | sheen | 8.90 | 10.25 | --- | --- | --- | --- | --- | --- | --- |
| (19.15) | 09/20/94 | NLPH | 10.57 | 8.58 | 1,800** | 19,000 | 190 | 29*** | 110 | 27*** | --- |
| | 12/14/94 | sheen | 8.90 | 10.25 | --- | --- | --- | --- | --- | --- | --- |
| | 03/27/95 | NLPH | 7.72 | 11.43 | 1,700 | 6,300 | 210 | 15 | 250 | 43 | --- |
| | 05/18/95 | sheen | 8.65 | 10.50 | 2,000# | 6,000 | 180 | 9.9 | 220 | 55 | --- |
| | 08/08/95 | NLPH | 9.67 | 9.48 | 2,700 | 5,300 | 110 | <20 | 120 | <20 | 36,000 |
| MW3 | 03/15/91 (H,T) | NR | 7.84 | 11.75 | 160 | 3,100 | 2.2 | 1.9 | 100 | 84 | --- |
| (19.59) | 01/15/92 (H,T) | NR | 10.30 | 9.29 | <300 | 250 | 0.7 | 6.8 | 1.5 | 1.5 | --- |
| | 03/23/92 (H,T) | NR | 6.84 | 12.75 | 440 | 640 | <0.5 | 12 | 25 | 6.5 | --- |
| | 04/06/92 | NR | 7.84 | 11.75 | --- | --- | --- | --- | --- | --- | --- |
| | 07/08/92 (H,T) | NR | 8.63 | 10.96 | 960 | 2,900 | <0.5 | 2.6 | 12 | 63.7 | --- |
| | 10/13/92 (H) | NR | 12.10 | 7.49 | 400 | 1,100 | 5.5 | <0.5 | 4.6 | 1.1 | --- |
| | 03/09/93 | sheen | 9.05 | 10.54 | --- | --- | --- | --- | --- | --- | --- |
| | 06/04/93 | sheen | 8.43 | 11.16 | --- | --- | --- | --- | --- | --- | --- |
| | 09/02/93 | NLPH | 10.22 | 9.37 | 690 | 840 | 2.7 | 3.6 | 5.4 | 2.9 | --- |
| | 11/16/93 | NLPH | 11.44 | 8.15 | 310 | 650 | <0.5 | 11 | 7.7 | 2.4 | --- |
| | 02/04/94 | NLPH | 9.27 | 10.32 | 340 | 870 | 0.6 | 14 | 1.2 | 0.8 | --- |
| | 04/29/94 | NLPH | 8.10 | 11.49 | 290 | 790 | <0.5 | <0.5 | 0.8 | 1.0 | --- |
| | 09/20/94 | NLPH | 10.10 | 9.49 | 91** | 1,900 | <0.5 | <0.5 | 11 | 4.4 | --- |
| | 12/14/94 | NLPH | 8.00 | 11.59 | 190 | 1,700 | 17 | 22 | <0.5 | <0.5 | --- |
| | 03/27/95 | NLPH | 7.23 | 12.36 | 1,100 | 1,500 | 5.0 | 3.1 | 6.3 | 3.6 | --- |
| | 05/18/95 | NLPH | 7.73 | 11.86 | 470# | 1,000 | <0.5 | <0.5 | 4.1 | 0.94 | --- |
| | 08/08/95 | NLPH | 8.81 | 10.78 | 580 | 1,600 | 12 | <0.5 | 2.4 | 0.63 | 12 |
| MW4 | 04/06/92 | NR | 7.76 | 11.70 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| (19.46) | 07/08/92 | NR | 9.56 | 9.90 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 10/13/92 | NR | 12.09 | 7.37 | <80 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/09/93 | NLPH | 7.53 | 11.93 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 06/04/93 | NLPH | 8.50 | 10.96 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/02/93 | NLPH | 10.30 | 9.16 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |

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**TABLE 2**
**CUMULATIVE GROUNDWATER MONITORING AND SAMPLING DATA**
Exxon Service Station 7-0236
6630 East 14th Street, Oakland, California


| Well ID # (TOC) | Sampling Date | SUBJ | DTW | Elev. | TEPHd | TPHg | B | T | E | X | MTBE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | < ........ | feet | .......... > | < ............... | | parts per billion | .................. | | .......... | .... > |
| MW4 cont. | 11/16/93* | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (19.46) | 02/04/94 | NLPH | 8.82 | 10.64 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 04/29/94(D) | NLPH | 8.55 | 10.91 | 100 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/20/94 | NLPH | 10.21 | 9.25 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 12/14/94 | NLPH | 7.04 | 12.42 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/27/95 | NLPH | 6.38 | 13.08 | 140 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 05/18/95 | NLPH | 7.56 | 11.90 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 08/08/95 | NLPH | 8.92 | 10.54 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | <2.5 |
| MW5 | 04/06/92 | NR | 10.66 | 6.29 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| (16.95) | 07/08/92* | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 10/13/92 | NR | 15.02 | 1.93 | <50 | 69 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/09/93 | NLPH | 10.27 | 6.68 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 06/04/93 | NLPH | 11.35 | 5.60 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/02/93 | NLPH | 13.15 | 3.80 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 11/16/93 | NLPH | 14.35 | 2.60 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 02/04/94 | NLPH | 11.83 | 5.12 | 60 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 04/29/94 | NLPH | 11.15 | 5.80 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/20/94 | NLPH | 12.79 | 4.16 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 12/14/94 | NLPH | 9.95 | 7.00 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/27/95 | NLPH | 9.09 | 7.86 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 05/18/95 | NLPH | 10.29 | 6.66 | <50 | <50 | <0.5 | 4.6 | 0.65 | 2.8 | --- |
| | 08/08/95 | NLPH | 11.13 | 5.82 | 51 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | <2.5 |
| MW6 | 04/06/92(H) | NR | 8.29 | 10.50 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| (18.79) | 07/08/92(H,T) | NR | 9.22 | 9.57 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 10/13/92 | NR | 11.51 | 7.28 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/09/93 | NLPH | 8.26 | 10.53 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 06/04/93 | NLPH | 8.90 | 9.89 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/02/93 | NLPH | 9.92 | 8.87 | 60 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 11/16/93 | NLPH | 10.65 | 8.14 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |

See notes on Page 5 of 5

**TABLE 2**
**CUMULATIVE GROUNDWATER MONITORING AND SAMPLING DATA**
Exxon Service Station 7-0236
6630 East 14th Street, Oakland, California

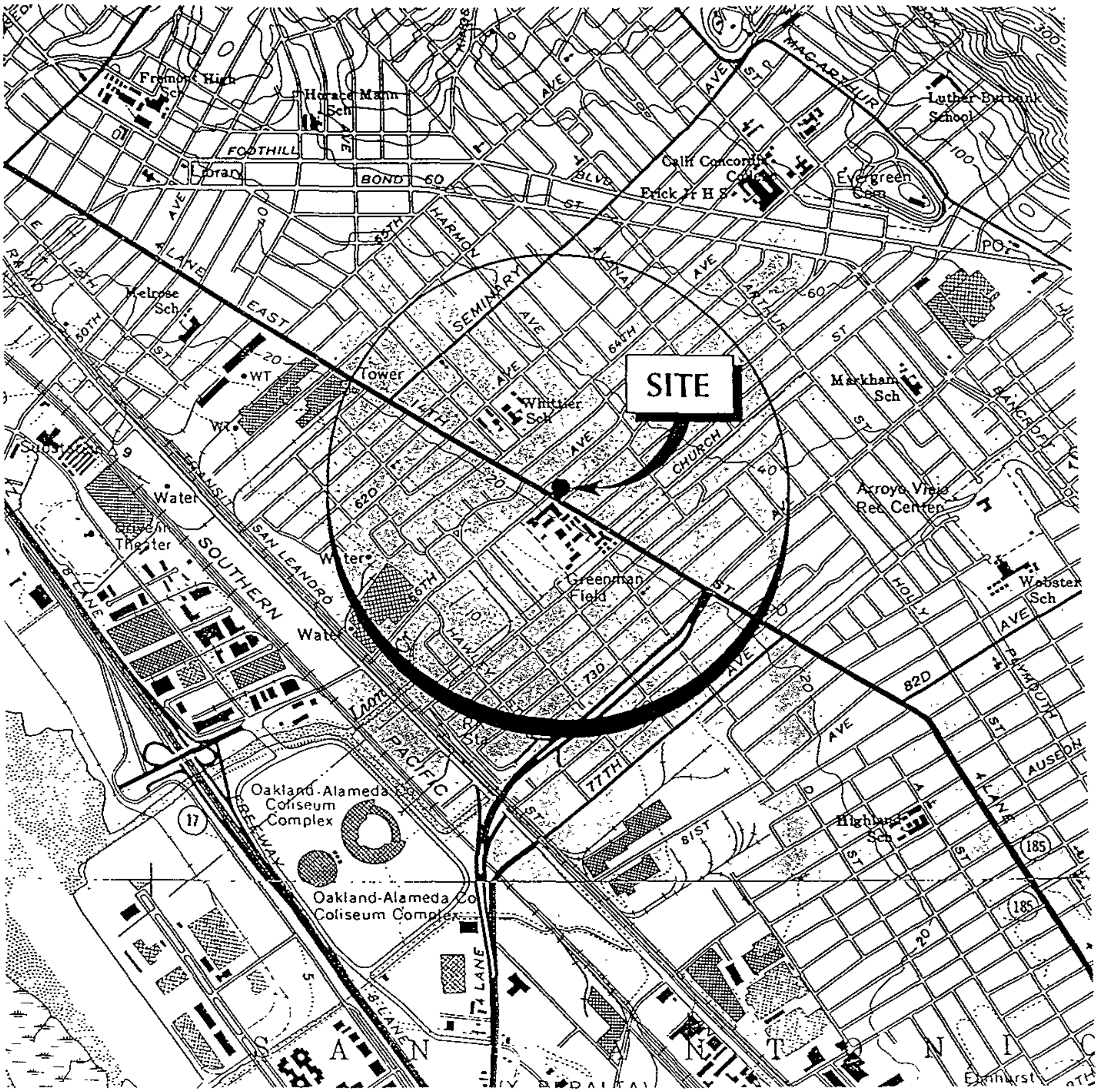

| Well ID # (TOC) | Sampling Date | SUBJ | DTW | Elev. | TEPHd | TPHg | B | T | E | X | MTBE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | < ........ | feet | ......... > | < ........ | ........ | parts per billion | ........ | ........ | ........ | .... > |
| MW6 cont. (18.79) | 02/04/94 | NLPH | 9.26 | 9.53 | 80 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 04/29/94 | NLPH | 8.33 | 10.46 | 110 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/20/94 | NLPH | 9.23 | 9.56 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 12/14/94 | sheen | 7.87 | 10.92 | --- | --- | --- | --- | --- | --- | --- |
| | 03/27/95 | NLPH | 7.63 | 11.16 | 54 | 56 | <0.5 | <0.5 | <0.5 | <0.50 | --- |
| | 05/18/95 | NLPH | 8.00 | 10.79 | 71 | 56 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 08/08/95 | NLPH | 8.92 | 9.87 | 60 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | <2.5 |
| MW7 (19.23) | 04/06/92 | NR | 8.34 | 10.89 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 07/08/92 | NR | 10.30 | 8.93 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 10/13/92 | NR | 12.91 | 6.32 | 94 | 670 | 0.8 | <0.5 | <0.5 | 2.5 | --- |
| | 03/09/93* | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 06/04/93 | NLPH | 8.68 | 10.55 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/02/93 | NLPH | 10.80 | 8.43 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 11/16/93 | NLPH | 12.38 | 6.85 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 02/04/94 | NLPH | 9.28 | 9.95 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 04/29/94 | NLPH | 9.19 | 10.04 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 09/20/94 | NLPH | 10.85 | 8.38 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 12/14/94 | NLPH | 8.44 | 10.79 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 03/27/95 | NLPH | 7.54 | 11.69 | 280 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 05/18/95 | NLPH | 8.11 | 11.12 | <50 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | --- |
| | 08/08/95 | NLPH | 9.48 | 9.75 | 52 | <50 | <0.5 | <0.5 | <0.5 | <0.5 | <2.5 |

See notes on Page 5 of 5

**TABLE 2**
**CUMULATIVE GROUNDWATER MONITORING AND SAMPLING DATA**
Exxon Service Station 7-0236
6630 East 14th Street, Oakland, California


Notes:

| | | |
|---|---|---|
| NLPH | = | Liquid phase hydrocarbons not present in well |
| TOC | = | Elevation of top of well casing; |
| SUBJ | = | Results of subjective evaluation, relative to mean sea level in feet sea level (MSL) |
| sheen | = | Liquid phase hydrocarbons present as a sheen |
| NR | = | Not recorded |
| DTW | = | Depth to water |
| Elev. | = | Elevation of groundwater; relative to mean sea level |
| TPHg | = | Total petroleum hydrocarbons as gasoline analyzed using modified EPA method 5030/8015 |
| TEPHd | = | Total extractable petroleum hydrocarbons as diesel analyzed using modified EPA method 5030/8015 |
| BTEX | = | Benzene, toluene, ethylbenzene, total xylene isomers analyzed using EPA method 5030/8020 |
| MTBE | = | Methyl tert-butyl ether analyzed using EPA method 5030/8020 |
| < | = | Less than the laboratory detection limit |
| - | = | Not sampled/Not measured |
| * | = | Well not accessible : well obstructed / wellhead cover damaged / well paved over |
| ** | = | Lighter hydrocarbons contribute to diesel range quantitation |
| *** | = | Results obtained past technical holding time (10/08/94) due to dilution requirements |
| C | = | High boiling point hydrocarbons are present in sample. |
| D | = | Sample pattern does not match diesel standard pattern. |
| H | = | EPA Method 8010 compounds not detected at or above their respective laboratory detection limits<br>Exceptions: MW-2, 03/15/91, Methylene chloride detected at 1 ppb<br>MW-3, 03/15/91, Methylene chloride detected at 21 ppb |
| M | = | Methyl tert-butyl ether detected at approximately 2,500 ppb |
| M* | = | A compound suspected to be Methyl tert-butyl ether was present |
| T | = | Total Oil and Grease (TOG) using EPA Method 5520 not detected at or above the laboratory detection limit of 5,000 ppb. |




20090001

*APPROXIMATE SCALE*

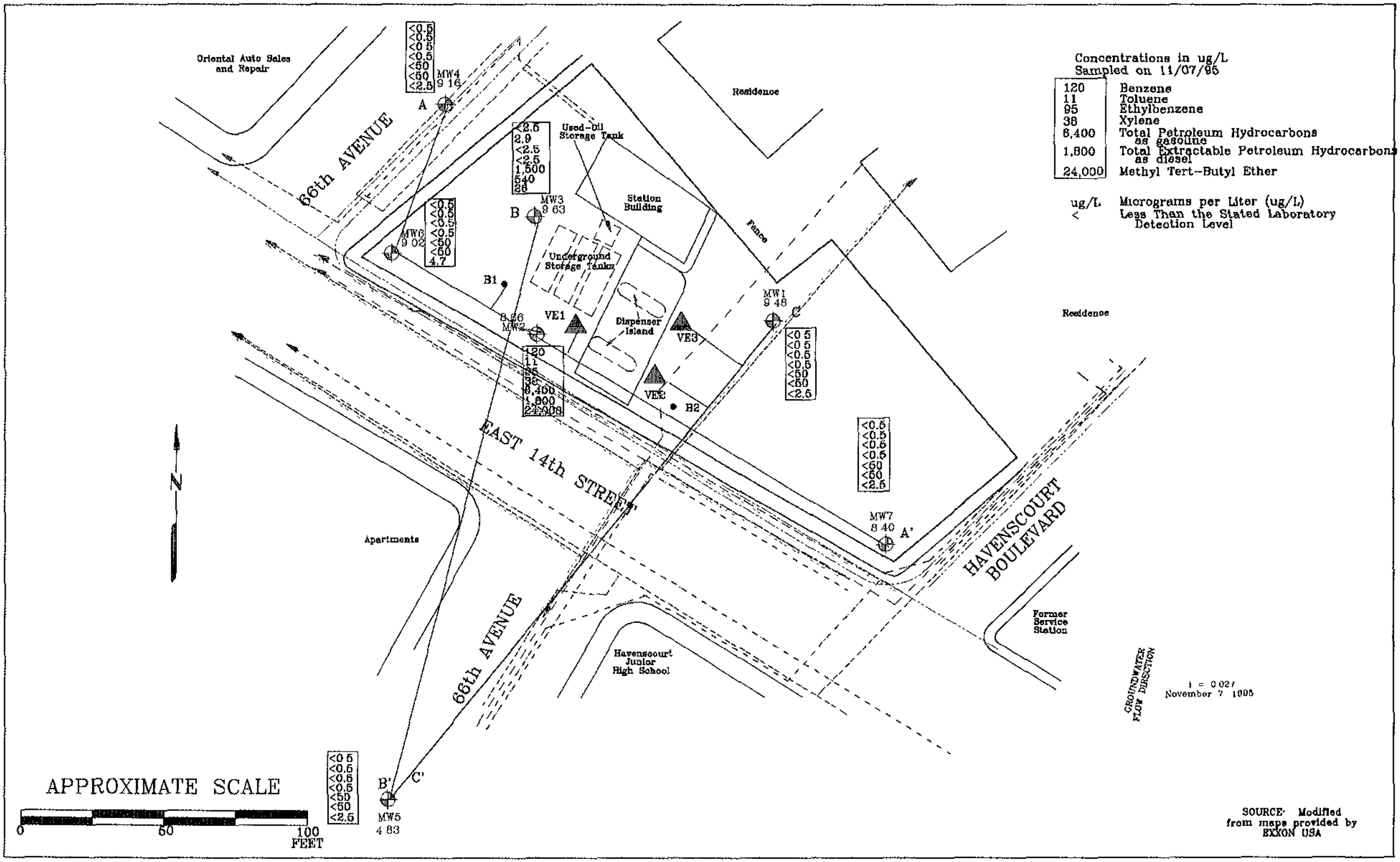
0 — 1/2 — 1

*MILE*

N

Source: U.S.G.S. 7-5 minute
topographic quadrangle map
Oakland East and
San Leandro, Calif. 1980

| ERI ENVIRONMENTAL RESOLUTIONS, INC. | **SITE VICINITY MAP** | **PLATE** |
|---|---|---|
| **PROJECT** ERI 2009 | EXXON SERVICE STATION 7-0236<br>6630 East 14th Street<br>Oakland, California | 1 |




FN 20090002

ERI ENVIRONMENTAL RESOLUTIONS, INC.

# GENERALIZED SITE PLAN

EXXON SERVICE STATION 7-0236
6630 East 14th Street
Oakland, California

**EXPLANATION**

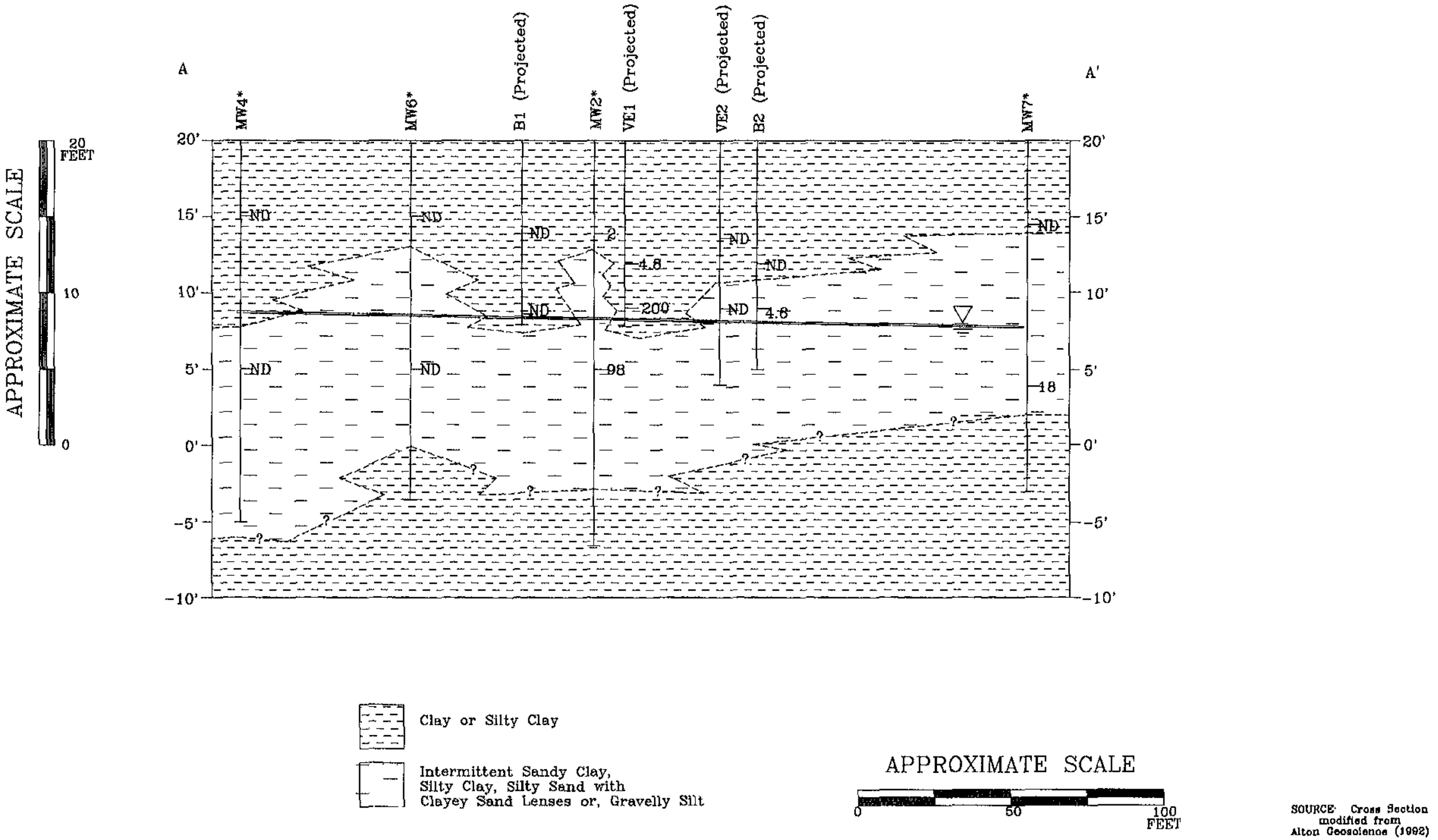
- Groundwater Monitoring Well
- MW7 8.40 — Groundwater Elevation; in Feet Above Mean Sea Level
- VE3 — Vapor Extraction Well
- B2 — Boring Location
- C-C' — Cross Section
- i = Interpreted gradient magnitude

Utilities
- Electric
- Gas
- Sewer
- Telephone
- Water
- Storm Drain

**PROJECT NO.** 2009

**PLATE** 2

DATE: 12/20/95




FN 2009XSAA

**ERI ENVIRONMENTAL RESOLUTIONS, INC.**

## CROSS SECTION A - A'

EXXON SERVICE STATION 7-0236
6630 East 14th Street
Oakland, California

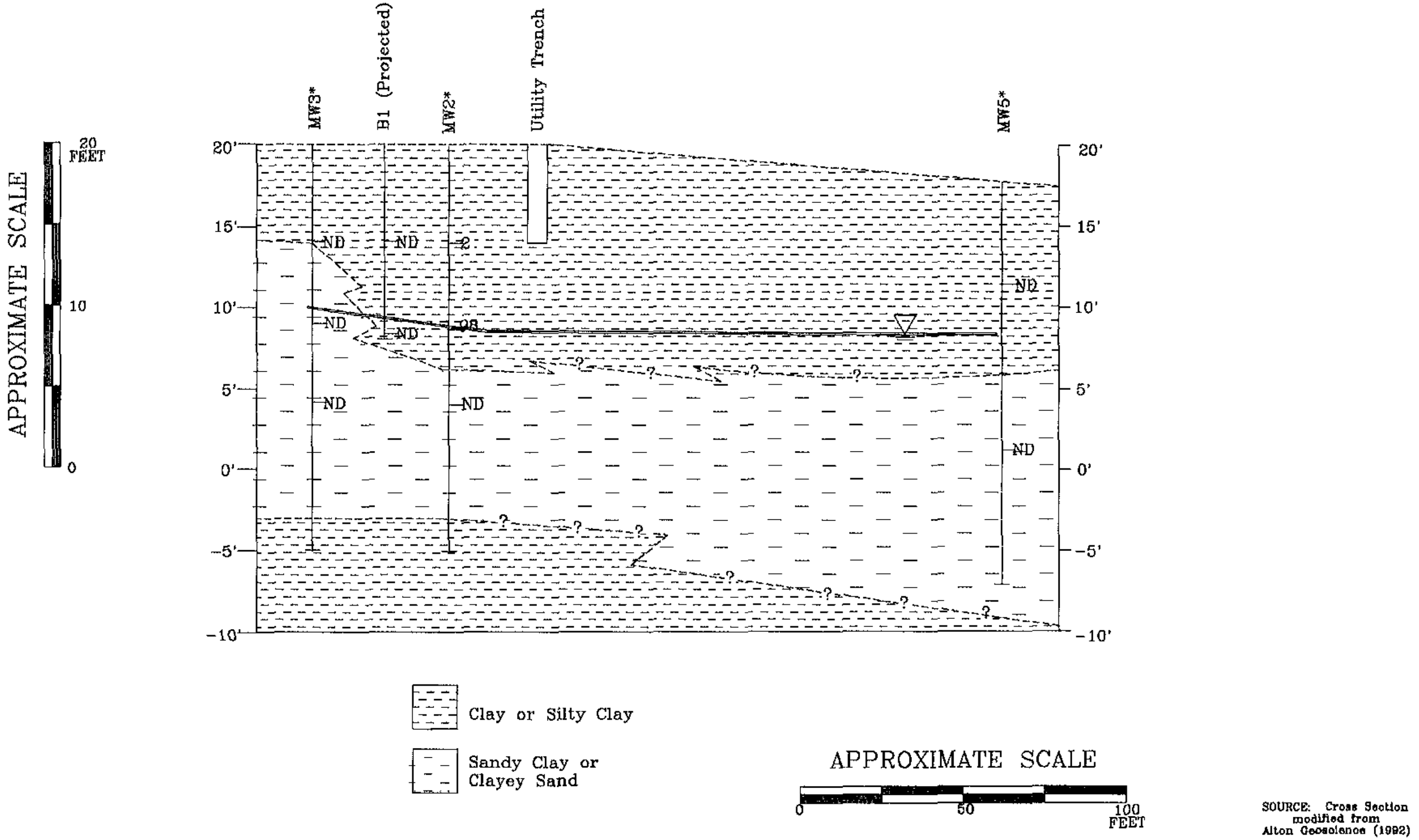
EXPLANATION

- * Boring logs not available; data acquired from Alton Geoscience cross section (5/92)
- 200 Parts Per Million (ppm) Concentration of total petroleum hydrocarbons as gasoline in soil
- ND Not Detected
- MW4 Monitoring Well
- B2 Soil Boring
- VE1 Vapor Extraction Well

**PROJECT NO.** 2009

**PLATE** 3

DATE: 12/15/95




FN 2009XSBB

ERI ENVIRONMENTAL RESOLUTIONS, INC.

## CROSS-SECTION B - B'

EXXON SERVICE STATION 7-0236
6630 East 14th Street
Oakland, California

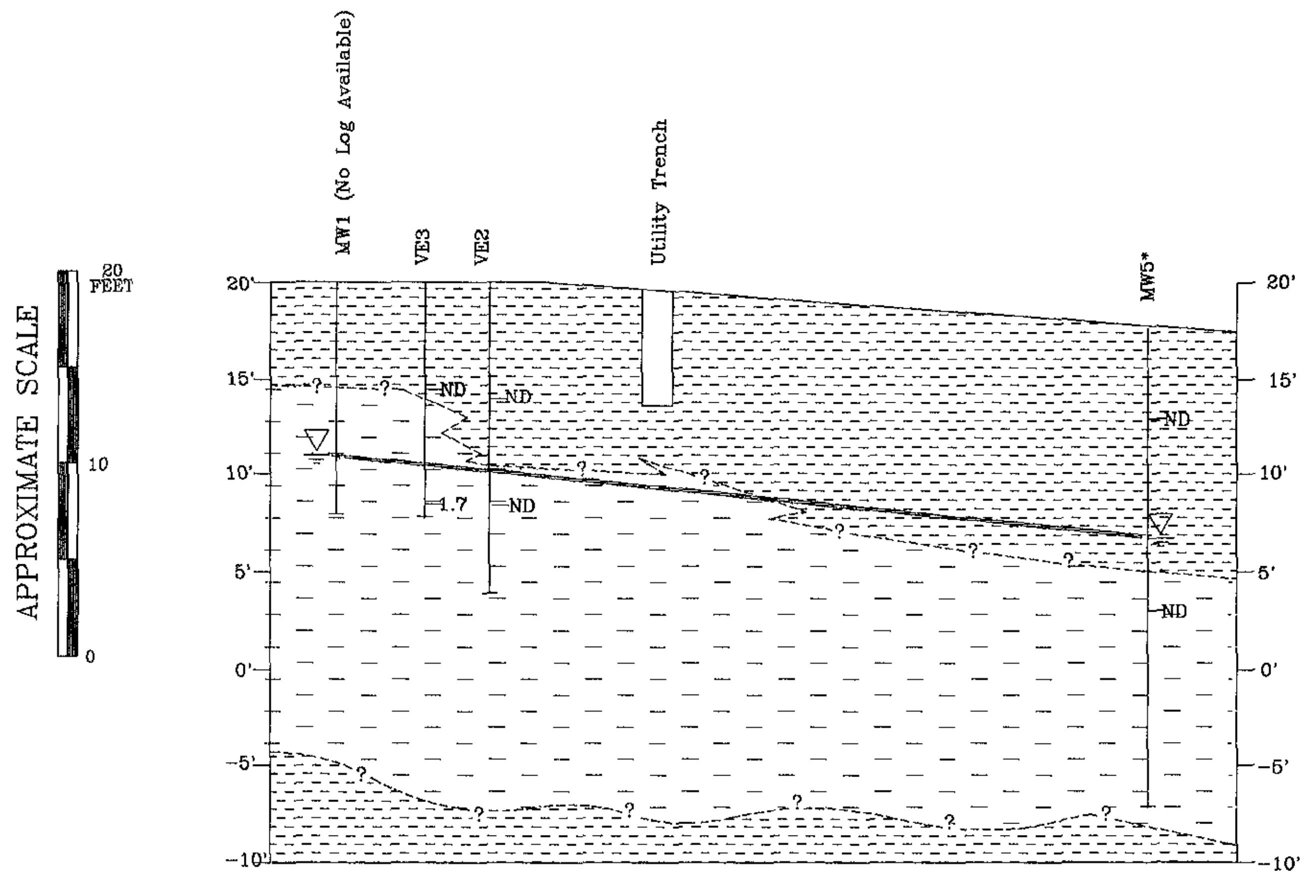
EXPLANATION

- * Boring logs not available; data acquired from Alton Geoscience cross section (1992)
- 98 Parts Per Million (ppm) Concentration of total petroleum hydrocarbons as gasoline in soil
- ND Not Detected
- MW5 Monitoring Well
- B1 Soil Boring

PROJECT NO. 2009

PLATE 4

DATE: 12/15/95




Clay or Silty Clay

Sandy Clay, Clayey Sand, Gravely Silt, or Clayey Silt

APPROXIMATE SCALE

0 50 100 FEET

SOURCE: Cross Section modified from Alton Geoscience (1992)

FN 2009XSCC

ERI ENVIRONMENTAL RESOLUTIONS, INC.

# CROSS-SECTION C - C'

EXXON SERVICE STATION 7-0236
6630 East 14th Street
Oakland, California

EXPLANATION

* Boring log not available; data acquired from Alton Geoscience cross section (5/92)

1.7 Parts Per Million (ppm) Concentration of total petroleum hydrocarbons as gasoline in soil

ND Not Detected

MW1 Monitoring Well

VE3 Vapor Extraction Well

PROJECT NO. 2009

PLATE 5

DATE. 12/15/95

# APPENDIX A

# LABORATORY ANALYSIS REPORTS AND CHAIN OF CUSTODY RECORDS

# PTS Laboratories, Inc.

CLIENT: SEQUOIA ANALYTICAL

FILE NO: 25159
DATE: NOVEMBER 1995
PROJ. NAME: N/A
PROJ. NO: 9510J54

## PHYSICAL PROPERTIES DATA

(METHODOLOGY: ASTM D2216, API RP40, EPA 9100)

| | | | | | | | | | CONDUCTED AT 25.0 PSI CONFINING STRESS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID. | DEPTH, ft. | SAMPLE ORIENT. (1) | MOISTURE CONTENT (% wt) | DENSITY BULK (g/cc) | DENSITY GRAIN (g/cc) | EFFECTIVE POROSITY, % Vb | PORE FLUID SATURATION, % Pv WATER (2) | PORE FLUID SATURATION, % Pv CONTAMINANT (3) | NATIVE STATE EFFECTIVE PERMEABILITY TO AIR (millidarcy) | NATIVE STATE EFFECTIVE AIR CONDUCTIVITY (cm/s) | NATIVE STATE EFFECTIVE PERMEABILITY TO WATER (millidarcy) | NATIVE STATE EFFECTIVE WATER CONDUCTIVITY (cm/s) |
| S-5-HA1 | N/A | V | 21.4 | 1.92 | 2.57 | 25.4 | | | | | 0.026 | 2.75E-08 |

(1) SAMPLE ORIENTATION:
H = HORIZONTAL
V=VERTICAL

(2) 0.9986 gm/cc USED TO CALCULATE WATER SATURATION
(3) 0.7500 gm/cc USED TO CALCULATE HYDROCARBON SATURATION
ND = NOT DETECTED

Vb = BULK VOLUME, cc
Pv = PORE VOLUME, cc

25184 8100 Secura Way, Santa Fe Springs, CA

# SUB-CHAIN OF CUSTODY

SEQUOIA ANALYTICAL
680 CHESAPEAKE DRIVE
REDWOOD CITY, CA 94063
TEL415-364-9600 FAX415-364-9233

PROJECT SUBBED TO: PTS LABS

310-907-3607

TAT REQUESTED: [ ] 24H [ ] 48H [ ] 72H [ ] 5D [ ] 10D

DUE DATE: 11-1-95

REPORT TO: V. CLARKE

WORKORDER #: 9510J54

PROJECT NAME:

ANALYSIS REQUESTED

| FRACTION NUMBER | SAMPLE DESCRIPTION | MATRIX | NUMBER OF CONT. | TYPE CONT. | SAMPLING TIME/DATE | Vertical Permeability | Porosity | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1B | S-5-HA1 | S | 1 | CORE | 10-25-95 | X | X | | | | | | |

| RELINQUISHED FROM SEQUOIA BY: | DATE | TIME | RECEIVED BY: | DATE | TIME | SAMPLE CONDITION? |
|---|---|---|---|---|---|---|
| J. Baug | 10/30/95 | 09:30 | Lisa Gerdes | 10/31/95 | 1:30pm | |
| RELINQUISHED BY: | DATE | TIME | RECEIVED BY: | DATE | TIME | TEMP? |
| | | | | | | |
| RELINQUISHED BY: | DATE | TIME | RECEIVED BY: | DATE | TIME | |
| | | | | | | |

Sequoia Analytical
680 Chesapeake Dr.
Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

# EXXON COMPANY, U.S.A.

P.O. Box 2180, Houston, TX 77002-7426

## CHAIN OF CUSTODY

Page 1 of 1

Consultant's Name: Environmental Resolutions Inc

Address: 359 Bel Marin Keys Suite 20 Novato Ca 94949

Site Location: 6630 East 14th Street Oakland, Ca

Project #: 7-0236

Consultant Project #: 200904x

Consultant Work Release #: 19432502

Project Contact: Mark Briggs

Phone #: 415 382 9105

Laboratory Work Release #:

EXXON Contact: Marla Guensler

Phone #: 510 246 8776

EXXON RAS #: 7-0236

Sampled by (print): Scott Graham

Sampler's Signature: Scott Graham

Shipment Method:

Air Bill #:

TAT: ☐ 24 hr ☐ 48 hr ☐ 72 hr ☐ 96 hr ☒ Standard (10 day)

ANALYSIS REQUIRED 9510J54

| Sample Description | Collection Date | Collection Time | Matrix Soil/Water/Air | Prsv | # of Cont. | Sequoia's Sample # | TPH/Gas BTEX/ 8015/ 8020 | TPH/ Diesel EPA 8015 | TRPH S.M. 5520 | total organic carbon porosity | vertical permeability moisture content | Temperature: ___ Inbound Seal: Yes No Outbound Seal: Yes No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5-HA1 | 10/25/95 | 15:46 15:55 | SOIL | ICE | 2 | 1 | | | | X | X | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

| RELINQUISHED BY / AFFILIATION | Date | Time | ACCEPTED / AFFILIATION | Date | Time | Additional Comments |
|---|---|---|---|---|---|---|
| Scott Graham | 10/25/95 | 10:25 AM | SR | 10/25 | 10:25 AM | |
| SR | 10/25/95 | 11:30 AM | [illegible] | 10/25/95 | [illegible] | |

Pink - Client Yellow - Sequoia White - Sequoia