THE MARK GROUP, INC.
ENGINEERS & GEOLOGISTS

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May 5, 1995
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Texaco Refining and Marketing, Inc.
10 Universal City Plaza, 7th Floor
Universal City, CA 91608-7812

Attention: Mr. Tom Hargett, R.G.

Subject: FINAL REPORT - Limited Ecological Risk Assessment
Former Texaco Service Station
South Shore Shopping Center
2375 Shoreline Drive
Alameda, California

Dear Mr. Hargett:

The MARK Group, Inc. (MARK) is pleased to provide you two copies of the Limited Ecological Risk Assessment for the former Texaco site in South Shore Shopping Center, Alameda, California.

If you have any questions on the report, please call either of the undersigned at (510) 946-1055.

Sincerely,

The MARK Group, Inc.

Alan D. Gibbs, R.G.
Associate

Pamela Han Silkwood, R.E.A.
Project Toxicologist

ADG PHS:scd
ECO-RA.LTR

PROFESSIONAL CERTIFICATION

LIMITED ECOLOGICAL RISK ASSESSMENT
FORMER TEXACO SERVICE STATION
SOUTH SHORE SHOPPING CENTER
2375 SHORELINE DRIVE
ALAMEDA, CALIFORNIA

92-1175307.80
May 5, 1995

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The findings, recommendations, specifications or professional opinions are presented, within the limits prescribed by the client, after being prepared in accordance with generally accepted professional engineering and geologic practice. There is no other warranty, either expressed or implied.

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REPORT
LIMITED ECOLOGICAL RISK ASSESSMENT
FORMER TEXACO SERVICE STATION
ALAMEDA, CALIFORNIA

92-1175307.80

May 5, 1995

ECO-RA COV

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1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

The MARK Group, Inc. (MARK) is pleased to submit this limited ecological risk assessment for the former Texaco Service Station located in the South Shore Shopping Center, at the northwest corner of Park Avenue and Shore Line Drive, in Alameda, California (Figure 1-1). This ecological risk assessment was conducted to obtain closure status on the former Texaco site from the Alameda County Health Agency and the Regional Water Quality Control Board (RWQCB). This report was conducted in accordance with the United States Environmental Protection Agency's (USEPA) "Framework for Ecological Risk Assessment," dated February 1992, and the RWQCB's proposed revision of the "Water Quality Control Plan, San Francisco Region," dated January 17, 1995.

As directed by Mr. Tom Hargett, R.G., of Texaco Refining and Marketing, Inc., this limited ecological risk assessment was conducted to focus on two constituents of concern, 1,2-dichloroethane and chloroform, detected in monitoring well MW-22. No other constituents of concern were detected in this well. Monitoring well MW-22 is a particular focus for Texaco because of its downgradient location to the site and its proximity to the San Francisco Bay. Groundwater samples collected from this well indicate the condition of groundwater which flows to the Bay.

1.2 Background

The former Texaco Service Station is located on the southeast corner of the South Shore Shopping Center in Alameda, California. This corner of the shopping center has been identified as having gasoline and cleaning solvent impacts in soil and groundwater, ostensibly as a result of several businesses that have previously leased space at the shopping center, including South Shore Car Wash Service Station, Texaco Service Station, a dry cleaner/laundromat, pet hospital, and Goodyear (see Figure 1-2) All of the structures previously leased to the above-mentioned tenants were removed as of 1989 except for the Goodyear building which was remodeled into a Big 5 Sporting Goods Store (Clayton, 1992).

Woodward-Clyde Consultants conducted a Phase II investigation of the shopping center in 1989 This investigation revealed the following: 1) shallow groundwater at the former Texaco Station was impacted by petroleum hydrocarbons; 2) groundwater at the former dry cleaner site was impacted by dry cleaning solvents (tetrachloroethylene, dichloroethylene, and trichloroethylene); 3) shallow soil at the Goodyear building was impacted by oil and grease; and 4) shallow soils and groundwater at the South Shore Car Wash Service Station were impacted with petroleum hydrocarbons. Soil and groundwater investigation and remediation began at the shopping center in 1989 and continues today.

At the former Texaco Service Station, the following constituents were detected in the shallow groundwater during the Phase II investigation:

- Total petroleum hydrocarbons as gasoline (TPH-g) at 2.5 milligrams per liter (mg/l);
- TPH as diesel (TPH-d) at 3.8 mg/l;
- Benzene at 10 mg/l;
- Toluene at 0.26 mg/l;
- Ethylbenzene at 2.6 mg/l; and
- Total xylenes at 1.6 mg/l (Clayton, 1991).

In June and July 1990, Clayton conducted an investigation at the Texaco site which included monitoring well installation, groundwater sampling, trenching, and soil sampling (Clayton, 1990). In the 1990 report, Clayton identified the former locations of the underground storage tanks, dispensers along Park Street, and fuel lines, to be the source of TPH-g, benzene, toluene, ethylbenzene, and total xylenes (BTEX) in soil and groundwater. Clayton recommended the soil impacted by petroleum hydrocarbons be excavated and aerated on-site.

In December 1990, McLaren-Hart excavated soil from an area approximately 70 feet in length (north of Park Boulevard) by 60 feet in width and 6 to 7 feet in depth. A total of approximately 575 cubic yards of soil were excavated and stockpiled at the site and subsequently disposed at a Class III Landfill. Soil samples collected from within the excavation reported TPH-g, TPH-d, TPH as oil and grease (TPH-O&G) and BTEX in excess of 100 milligrams per kilogram (mg/kg).

Six monitoring wells were installed at the site in 1990 by Clayton Environmental Consultants, Inc. (Clayton). In 1990, Clayton also installed three additional monitoring wells downgradient of the site to better define the lateral extent of the impacted groundwater. Groundwater monitoring at the site began in 1990. The groundwater monitoring well locations, flow direction, and gradient are shown in Figure 1-2. The analytical results of previous sampling rounds from the years 1990 to 1994 are presented in Appendix A.

Monitoring well MW-22 is located approximately 80 feet south of the site on the corner of Park Avenue and Shore Line Drive. Groundwater from this monitoring well has been tested to identify the quality of groundwater in proximity of the San Francisco Bay. This well is a particular focus to this limited ecological risk assessment because of its proximity to the San Francisco Bay.

Only 1,2-dichloroethane (1,2-DCA) and chloroform at concentrations of 0.014 mg/l and 0.00065 mg/l, respectively, were detected in the groundwater samples collected from monitoring well MW-22 in the fourth quarter (October) of 1994 (MARK, 1995). Lower concentrations of 1,2-DCA and chloroform (0.0082 mg/l and non-detect, respectively) were reported in the groundwater samples collected from this well in the first quarter (January) of 1995. The groundwater results for monitoring well MW-22 are tabulated in Table 1-1.

1.3 Environmental Setting

The site is located in a commercial area of Alameda approximately 300 feet from the San Francisco Bay. The Bay consists of two reaches. The northern reach includes San Pablo and Susuin Bays, and the southern reach extends from the southern tip of Alameda to San Jose. Between the two reaches is the Central Bay. The location of the site is near the Central Bay (see Figure 1-1).

Dredged fill was placed in the regional area of the site in the 1950s. Bay Mud was encountered 14 feet below ground surface (bgs) (Clayton, 1991). Based on groundwater monitoring, depth to groundwater ranges from 5 to 7 feet bgs. Groundwater beneath the former Texaco site appears to be mounded in the eastern portion of the site and flows westerly to southwesterly away from Park Avenue and towards the San Francisco Bay and Shoreline Drive (MARK, 1995).

1.4 Ecological Risk Assessment

This document is intended to obtain closure status for the former Texaco site. Soil at the site has been remediated and low concentrations of 1,1-DCA and chloroform continues to be monitored in the groundwater at the site on a quarterly basis. Although the groundwater beneath the site may be considered suitable or potentially suitable for municipal or domestic water supply under the RWQCB Resolution No. 89-39, this groundwater is unlikely to be used either for municipal or domestic water supply due to the natural general chemistry of the groundwater.

When comparing the general chemistry data of the groundwater samples collection from the on-site wells (MW-5B, MW-9, MW-14, MW-15, and MW-22) in April 1994 (see Table 1-2) with the RWQCB's water quality objectives for municipal supply, the following conclusions are made:

- Specific conductance of the groundwater samples ranged from 1,150 umhos/cm to 3,800 umhos/cm. The mean specific conductance is 2,532 umhos/cm with a standard deviation of 777 umhos/cm, which is significantly higher than the RWQCB's water quality objective of 900 umhos/cm.

- The pH of on-site groundwater samples ranged from 7.44 to 8.22. The mean pH is 7.77 with a standard deviation of 0.3, which is slightly more basic than the RWQCB's water quality objective of 6.5.

- The total dissolved solids (TDS) of on-site groundwater samples ranged from 840 mg/l to 2,700 mg/l. The mean TDS concentration is 1,592 mg/l with a standard deviation of 777 mg/l, which is higher than the RWQCB's water quality objective of 500 mg/l.

Because the natural general chemistry of the groundwater beneath the site does not meet the RWQCB's water quality objectives for municipal water supply, it is unlikely that this water will be used as a drinking water source. The beneficial uses of the groundwater beneath the site is better defined as groundwater which flows to marine habitat (MAR) due to the oceanic characteristics of the Central Bay (as discussed in Section 2.2). Marine habitat is defined by the RWQCB as water that "provides for the preservation of the marine ecosystem, including the propagation and sustenance of fish, shellfish, marine mammals, water fowl and vegetation."

Because the quality of the water is critical to the marine habitat, this ecological risk assessment was conducted to focus on the adverse effects of the chemical stressors to their habitat. This limited ecological risk assessment is conducted in three phases. These phases are:

Phase I: Problem Formulation

The problem formulation phase includes a preliminary characterization of exposure and an evaluation of effects through the examination of scientific data and regulatory water pollution control criteria to identify the critical toxicity data for the constituents of concern.

Phase II: Analysis

The analysis phase involves the characterization of exposure and the characterization of ecological effects by using existing data from monitoring well MW-22. The purpose of this phase is to predict spatial and temporal distribution of a stressor and its contact with the ecological components of concern.

Phase III: Risk Characterization

The risk characterization phase uses the information gathered from the previous phases to evaluate the likelihood of adverse ecological effects from exposure to the chemical stressors.

Phase I, problem formulation, is discussed in Section 2.0 of this report; Phase II, analysis, is discussed in Section 3.0 of this report; and Phase III, risk characterization, is discussed in Section 4.0 of this report.

TABLE 1-1: Groundwater Analytical Results for Monitoring Well MW-22 Former Texaco Service Station South Shore Shopping Center Alameda, California		
MW-22*	1,2-DCA (mg/l)	Chloroform (mg/l)
10/18/94	0.014	0.00065
02/15/95	0.0082	<0.0005

Notes:

1,2-DCA = 1,2 - dichloroethane
mg/l = milligrams per liter
< = non-detect
* All other volatile organic compounds analyzed by EPA Method 601 were not detected in the groundwater samples collected from MW-22.

TABLE 1-2: General Chemistry for On-site and Downgradient Monitoring Wells
April 1994
Former Texaco Service Station
South Shore Shopping Center
Alameda, California

Well I.D.	pH	Specific Conductance (umhos/cm)	TDS (mg/l)
MW-5B	7.44	3,800	2,700
MW-9	7.82	1,150	920
MW-14	7.56	2,460	840
MW-15	8.22	2,100	1,500
MW-22	7.81	3,150	2,000
$\bar{x}$	7.77	2,532	1,592
s	0.30	1,011	777
RWQCB Objective*	6.5	900	500

Notes:

TDS = total dissolved solids
mg/l = milligrams per liter
RWQCB = Regional Water Quality Control Board
$\bar{x}$ = mean concentration
s = standard deviation

* RWQCB's water quality objectives for municipal water supply

2.0 PROBLEM FORMULATION

2.1 Stressor Characteristics

Groundwater monitoring of well MW-22 in the last two quarters indicate the presence of two organic compounds in the groundwater: 1,2-DCA and chloroform (chloroform detected only in 10/18/94 sampling event). This section describes the physicochemical properties of the two compounds. These properties will be used to assess their fate and distribution in the aquatic system. Table 2-1 presents the physical, chemical, and fate data for 1,2-DCA and chloroform used in this assessment. The information presented in this section were obtained from the following sources:

- USEPA, 1986, Superfund Public Health Evaluation Manual;
- Vogel, T.M. and Criddle, C.S., 1986, Transformations of Halogenated Aliphatic Compounds, Environmental Science Technology, Volume 21, Number 8;
- Macalady, D.L., 1984, Transformations of Pollutant Organic Chemicals in Aquatic Systems; and
- Klaassen, C.D. et al., 1986, Casarett and Douell's Toxicology, 3rd Edition.

2.1.1 1,2-DCA

2.1.1.1 Physical, Chemical, and Fate Data - 1,2-DCA is a hydrophobic compound with a water solubility of 8,520 mg/l at 20°C. This compound is generally not mobile in groundwater. Its vapor pressure is 6.40 mm Hg at 20°C.

The volatilization rate of 1,2-DCA from water depends on its vapor pressure and water solubility. The Henry's law constant (Ka) is the ratio of the compound's vapor pressure to its solubility. The Henry's law constant for 1,2-DCA is 9.78 x 10^{-4} atm-m^3/mol, which indicates that the compound does not volatilize readily from water.

Adsorption of 1,2-DCA to soils and sediments can be estimated by soil sorption constant (Kp), although other factors such as type of soils and pH play a strong role in the chemical adsorption. The sorption characteristics of a chemical is normalized by use of Koc which relates sorption properties to soil/sediment organic matter. The Koc was estimated by assuming 10 percent of organic matters in the sediment. The Koc for 1,2-DCA is

1.4 ml/gram which indicates that the compound has a strong affinity to adsorb in soil/sediment.

The partitioning of organic chemicals from water into lipophilic tissues of organisms is often expressed by the octanol-water partition coefficient (log of Kow). The log of Kow for 1,2-DCA is 1.48 indicating that this compound does not concentrate in animal tissue.

Another measure of chemical uptake in tissue is the bioconcentration factor (BCF). BCF, a measure of the partitioning of a chemical between water and fish, is suitable for biota, in general. The BCF for 1,2-DCA is 1.2, which indicates that the compound does not bioconcentrate in biota.

2.1.1.2 Transformation - Important transformation reactions of 1,2-DCA in the aquatic environment are microbial transformation and hydrolysis. Anaerobic bacteria predominantly mediates substitution reactions of 1,2-DCA. Anaerobic bacteria transforms 1,2-DCA to chloroethanol, which is subsequently mineralized to carbon dioxide. Hydrolysis reaction involves substitution and dehydrohalogentation of 1,2-DCA in water to chloroethanol, which is also subsequently mineralized to carbon dioxide. Biotic transformation is known to proceed much faster than hydrolysis providing that there are sufficient substrate and nutrient and a microbial population. The half-life of 1,2-DCA is 0.17 days in surface waters.

2.1.2 Chloroform

2.1.2.1 Physical Chemical, and Fate Data - Chloroform, like 1,2-DCA, is a hydrophobic compound, with a water solubility of 8,200 mg/l at 20°C. This compound is not very mobile in water. The Ka for chloroform is 2.87×10^{-3} atm-m^3/mol, indicating that this compound does not volatilize readily from water. The Koc for chloroform is 3.1 mg/gram. This compound has a strong affinity to adsorb in soil or sediment. The log of Kow for chloroform is 1.97 and the BCF is 3.75, indicating that the compound does not tend to bioacummulate in the lipophilic tissues of organisms.

2.1.2.2 Transformation - Important transformation reactions of chloroform in the aquatic environment are microbial transformation and hydrolysis. Anaerobic bacteria predominantly mediates substitution reactions of chloroform. Anaerobic bacteria biodegrades chloroform by respiration cooxidation. Aerobic bacteria biodegrades chloroform by reductive dechlorination. Hydrolysis reaction involves substitution and dehydrohalogentation reactions of chloroform in water to trichloromethanol, which is subsequently mineralized to carbon dioxide.

Biotic transformation is known to proceed much faster than hydrolysis providing that there are sufficient substrate and nutrient and a microbial population. The half-life of chloroform is 0.3 to 30 days in surface waters, with approximately 35 percent of the chloroform concentration being reduced in 2 days.

2.2 Ecosystem Potentially at Risk

The San Francisco Bay represents 88 to 89 percent of total area covered by estuaries in California. Estuaries are transitional zones (ecotones) between fresh water and marine habitats, characterized by the mixing of seawater with fresh water by tidal exchange and diffusion (U.S. Department of Interior, 1981).

The subject site is located near the Central Bay between the two reaches of the San Francisco Bay. The Central Bay has oceanic characteristics. It is deeper than the two reaches and has large inflow of salty Pacific water though the Golden Gate (American Association for Advancement of Science, 1982). Salinity range for the Central Bay is 25 to 33 parts per thousand (ppt) while for the two reaches is 0 to 25 ppt (U.S. Department of Interior, 1981). Due to the high salinity, the Central Bay does not provide the fresh water and marsh backwater habitat ideal for spawning of salmon, striped bass, herring, mallet, and shrimp.

The following sections discuss the organisms found in the Central Bay. Information discussed in the following section were mainly derived from four sources:

- American Association for the Advancement of Science, Pacific Division, 1982, San Francisco Bay, Use and Protection, Library of Congress Catalog No. 82-071291;
- Aquatic Habitat Institute, 1991, State of the Estuary, Conference Proceedings;
- Goldman, C.R. and Horne, A.J., 1983, Limnology, McGraw-hill, Inc.; and
- U.S. Department of Interior, 1981, An Ecological Characterization of the Central and Northern California Coastal Region, Volumes I through III.

2.2.1 Phytoplankton

The distribution of phytoplankton in the Central Bay reflects its close connection with the ocean. Peak phytoplankton growth occurs from March through June, and the assemblage is dominated by typical coastal marine species, primarily diatoms.

2.2.2 Zooplankton and Benthic Animals

The most abundant species is the capepod *Acartia clausi*. Populations of polychaete worms, clams, oysters, and crabs also exist in the San Francisco Bay. The bentic larvae in the estuaries move upstream using the counter current seeking more saline deeper water. For instance, the older planktonic larvae of the American oyster, *Crassostrea virginica*, actively seek the more saline deeper water on flood tides.

2.2.3 Fish Populations

Fish are the major endpoint receptors of chemical releases to the San Francisco Bay. The Chinook salmon, *Oncorhynchus tshawytscha*, is the species of salmon native to the Sacramento River system. The salmon spawn on gravel beds in clear-water streams and then migrate to the ocean to live for 2 to 4 years before reaching maturity. Mature fish return to their native streams to spawn and then die.

Striped bass, *Morone saxatilis*, spawn in the delta area and spend most of their adult lives in the northern reaches, the Central Bay, and the Pacific Ocean. This striped bass requires fresh water for spawning and estuarine marsh backwaters during the first few months after hatching.

The Pacific herring, *Clupea harengus pallasi*, lives as a juvenile and adult in the coastal ocean, and adults enter the Central Bay from November through March. They lay their eggs on rocks and seaweeds in the intertidal and shallow subtidal areas near Sausalito and Tiburon.

2.2.4 Waterfowls

There are typically 600,000 to 800,000 water birds in the San Francisco Bay at any given time. Seventy-five species of water birds are residents or regular visitors to the Bay including loons, grebes, pelicans, cormorants, geese, rails, swans, dabbling ducks, diving ducks, gulls, terns, and gallinules.

2.2.5 Endangered Species

Two species, the California clapper rail and the saltwater harvest mouse, which inhibit the San Francisco Bay Area marshes are listed as endangered species by the United States Department of Interior and the California Department of Fish and Game.

The California clapper rail (*Rallus longirostris obsoletus*) is a resident in saltwater marshes of the San Francisco Bay. They have declined in population largely due to diking and development and loss of tidal habitats to shoreline erosion. The clapper rails feed on mussels, spiders, clams, and small numbers of snails, nereid worms, and insects. Their nests are located on or near the ground, usually on a slight rise near a tidal slough.

The saltwater marsh harvest mouse, *R.r raviventris*, inhibits the central and southern part of the Bay. The mouse inhibits the high saltwater marsh essentially restricted to the zones occupied by *Sali cornia virginica* (pickleweed), with *Atriplex patula* (salt brush), *Atriplex sanibaccata* (Australian Salt Brush), and *Frankenia grandifolia*. Their status as endangered is attributed primarily to habitat loss. The diet of the mice includes stems of plants restricted to salty soils (halopytes) primarily the pickleweed, and some seeds, but no insects. The mice use the seawater for drinking.

2.3 Ecological Effects

This section provides scientific data on the effects of organisms from exposures to 1,2-DCA and chloroform. The information presented in this section were obtained from four main sources:

- USEPA, 1986, Quality Criteria for Water;
- American Society for Testing and Materials (ASTM), 1985, Aquatic Toxicology and Hazard Assessment;
- Verschueron, K., 1983, Handbook of Environmental Data on Organic Chemical Data; and
- Klaassen, C.D., et al., 1980, Casarett and Douell's Toxicology, 3rd Edition.

2.3.1 1,2-DCA

Cell multiplication inhibition tests have shown the toxicity threshold concentration of 1,2-DCA for bacteria to be 135 mg/l; algae to be 105 mg/l; green algae to be 710 mg/l; and protozoa to be 1,050 mg/l. The concentration of 1,2-DCA in water shown to produce death in 50 percent (LC_{50}) of fathead minnows is 500 mg/l and for guppy is 106 mg/l. The adverse effect level of 1,2-DCA for rainbow trout and bluegill, is 5 mg/l after a 24-hour period and for dab is 60 mg/l after 96 hour exposure. The oral dosage of chemical needed to produce death of 50 percent of rats (LD_{50}) is 680 mg/kg after 432 minutes. The LD_{50} for inhalation is 1,000 parts per million (ppm) also after 432 minutes. No specific types of tumor were noted on rats and mice after 104 weeks of inhalation exposure of 1,2-DCA.

2.3.2 Chloroform

Cell multiplication inhibition tests have shown the toxicity threshold concentration of chloroform for bacteria to be 125 mg/l; algae to be 185 mg/l; green algae to be 1,100 mg/l; and protozoa to be greater than 6,560 mg/l. The LC_{50} for larvae of oyster is 1 mg/l at initial concentration. During this test, only approximately 15 percent of original concentration remained after 48 hours. The LC_{50} for guppy is 102 mg/l over a 14-day period. Other data indicate acute toxicity to freshwater aquatic life occurs at concentrations of 29 mg/l. Rats exposed to 25, 50, and 85 ppm of chloroform for a six-month period indicated necrosis and cloudy swelling kidney. The effects of the 25 ppm dose were characterized as mild and reversible.

2.4 <u>Endpoint Selection</u>

Because of the oceanic characteristics of the Central Bay and the types of organism found in the Central Bay (discussed in Section 2.2), the USEPA's National Ambient Water Quality Criteria for Saltwater Aquatic Life Protection will be used as ecologically based endpoints to protect the ecosystem from the chemical stressors.

Criteria to protect aquatic life from acute exposure to 1,2-DCA is 113 mg/l. Because of the short half-life of 1,2-DCA in surface water, there are presently no criteria for chronic exposure to 1,2-DCA. Criteria to protect aquatic life from acute exposure to chloroform is 12 mg/l. Criteria to protect aquatic life from chronic exposure to chloroform is 6.4 mg/l.

A separate evaluation of the endangered species was also conducted, and this evaluation is presented in Section 3.2 of this report.

TABLE 2-1: Physical, Chemical, and Fate Data for 1,2-DCA and Chloroform Former Texaco Service Station South Shore Shopping Center Alameda, California		
	1,2-DCA	Chloroform
Solubility (mg/l at 20°C)	8,520	8,200
Vapor Pressure (mmHg at 20°C)	6.40	151
Ka (atm-m³/mol)	9.78×10^{-4}	2.87×10^{-3}
Kp (ml/g)	3.0	9.3
Koc (mg/g)*	1.48	1.97
Kow	1.2	3.75
Half-life (days)	0.17	0.3 - 30 (35% loss in 2 days)

Notes:

mg/l	=	milligrams per liter
mmHg	=	millimeters of mercury
mg/g	=	milligrams per gram
Ka	=	Henry's Law Constant
atm-m³/mol	=	atmosphere-cubic meter per mole
Kow	=	Octanol-water coefficient
Kp	=	soil absorption constant
Koc	=	soil sorption coefficient

Source: United States Environmental Protection Agency, 1986, Superfund Public Health Evaluation Manual

* Assuming 10% organic matter in sediment.

3.0 ANALYSIS

3.1 Exposure Assessment for Aquatic Organisms

Environmental fate processes active in aquatic environment, control the compartmentalization and ultimately the concentration of a chemical in a compartment. Processes such as sorption, volatilization, hydrolysis, and biodegradation, control the fate of the chemicals in the aquatic environment.

To assess the fate of 1,2-DCA and chloroform, partitioning of the compounds into three compartments: sediment, water, and fish, was conducted using the partitioning coefficients and the average concentrations of 1,2-DCA and chloroform reported in the groundwater samples collected from the last two monitoring periods. As a conservative estimate, volatilization was not considered largely because 1,2-DCA and chloroform do not readily volatilize from water. The following formula was used to assess the concentrations of the compounds in each compartment at equilibrium (Klaassen, C.D. et al, 1986):

Equation 1:

$$\textit{Concentration in water} = \frac{\textit{Concentration in groundwater sample}}{Kow + Koc + 1}$$

Equation 2:

$$\textit{Concentration in Sediment} = Koc \times \textit{Concentration in Water}$$

Equation 3:

$$\textit{Concentration in Fish} = Kow \times \textit{Concentration in Water}$$

Table 3-1 presents the resultant concentrations of each compound in the three compartments.

3.1.1 Sorption

Of these environmental fate processes, sorption (partitioning) of compounds to abiotic and biotic solids occurs in all aquatic systems and is perhaps the single most important environmental process affecting the pollutant fate of some chemicals (ASTM, 1985). For the purpose of this evaluation, only adsorption of constituents to sediment was considered. Sediment concentrations of 1,2-DCA and chloroform were calculated using the average concentrations of these compounds detected in the last two quarters with the corresponding Koc (Kp multiplied by the organic carbon content of 10%). This is an extremely conservative estimate because the initial groundwater concentration used in the partitioning calculation does not take into account dilution, transformation, and retardation which would significantly reduce the concentrations of the compounds both in water and in sediment. The sediment concentrations for 1,2-DCA and chloroform were calculated to be as follows:

$$1,2\text{-}DCA = 0.06 \ \frac{mg\ Chemical\ Soil\ /\ kg\ of\ Organic\ Carbon\ in\ Soil}{mg\ Chemical\ Water\ /\ kg\ of\ Water}$$

$$Chloroform = 0.00044 \ \frac{mg\ Chemical\ Soil\ /\ kg\ of\ Organic\ Carbon\ in\ Soil}{mg\ Chemical\ Water\ /\ kg\ of\ Water}$$

Aquatic organisms such as sediment-feeding clams, polychaete worms, and fish "mouthing" sediments can be exposed to the compounds adsorbed to sediment.

3.1.2 Water

The concentrations of 1,2-DCA and chloroform that remain in the water in equilibrium with concentrations adsorbed in sediment is 0.02 mg/L and 4.73×10^{-5} mg/L, respectively. Again, these are very conservative estimates because the initial groundwater concentration used in the partitioning calculation does not take into account dilution, transformation, and retardation which would occur as the groundwater enters the Bay and would significantly reduce the concentrations of the compounds both in water and in sediment.

3.1.3 Fish

Concentrations of 1,2-DCA and chloroform that may uptake in lipophilic tissues of organisms were calculated using the average concentrations of the compounds detected in the last two quarters with the corresponding Kow. The concentrations for 1,2-DCA and chloroform in fish were calculated to be as follows:

$$1{,}2\text{-}DCA = 0.03\ \frac{mg\ Chemical\ /\ L\ n\text{-}octanol}{mg\ Chemical\ /\ L\ of\ Water}$$

$$Chloroform = 9.31\ x\ 10^{-5}\ \frac{mg\ Chemical\ /\ L\ n\text{-}octanol}{mg\ Chemical\ /\ L\ of\ Water}$$

Again, these are very conservative estimates because the initial groundwater concentration used in the partitioning calculation does not take into account dilution, transformation, and retardation which would occur as the groundwater enters the Bay and would significantly reduce the concentrations of the compounds both in fish and in water.

3.2 Endangered Species

The RWQCB, in the Water Quality Control Plan, identified 34 significant marshes within the San Francisco Bay Region, most of which are saltwater marshes. An important beneficial use of the marshes is the preservation of rare and endangered species. The nearest significant marsh from the site identified by the RWQCB is located within 5 miles north, hydrologically upgradient, of the site, at the Emeryville Crescent (RWQCB, 1995). Because of the upgradient locations and distance of the saltwater marsh from the site, the groundwater conditions beneath the site are unlikely to impact this saltwater marsh habitat.

The area of the Bay closest to the site is not identified by the RWQCB as a significant saltwater marsh habitat. However, this does not preclude the idea that the California clapper rail and the saltwater marsh harvest mouse may reside in this area. Because these endangered species may be potential receptors to the chemical releases from the site, exposure pathways for these species were evaluated. The potential pathway for exposure to 1,2-DCA and chloroform is from the ingestion of food and water from the Bay. Inhalation exposure to these compounds as they volatilize from water is unlikely due to the compounds' low volatilization rate and strong affinity to adsorb to sediment. Dermal exposure from water and sediment should be insignificant, taking into account significant dilution of the compounds as they enter the Bay.

As discussed in Section 3.2, the major food for the California clapper rail is shellfish, mainly mussels and clams, and for the saltwater marsh harvest mouse is the pickleweed. According to the USEPA, the BCF can be used to estimate bioconcentrations in edible tissue (muscle) of shellfish and uptake concentrations of chemicals from soil/sediment to plants, in absence of site-specific information (USEPA, 1989). As discussed in Section 2.1, 1,2-DCA and chloroform have low BCF (1.2 and 3.75, respectively) indicating that they do not tend to concentrate in shellfish or in plants. Additionally, because of the short half-life of 1,2-DCA and chloroform (as discussed in Section 2.1), the likelihood of these species being exposed to these compounds from ingestion of shellfish and pickleweed is extremely low.

TABLE 3-1
Fate Calculations for 1,2-DCA and Chloroform
Former Texaco Service Station
South Shore Shopping Center
Alameda, California

Compartment	1,2-DCA	Chloroform
Sediment $\left(\frac{mg\ Chemical\ Soil\ /\ kg\ Organic\ Carbon\ in\ soil}{mg\ Chemical\ Water\ /\ kg\ of\ Water}\right)$	0.06	0.00044
Water $(mg\ Chemical\ /\ L\ of\ Water)$	0.02	$4.73X10^{-5}$
Fish $\left(\frac{mg\ Chemical\ Soil\ /\ L\ n\text{-}Octanol}{mg\ Chemical\ Water\ /\ L\ of\ Water}\right)$	0.03	$9.31x10^{-5}$

Notes.

1,2-DCA = 1,2-dichloroethane
mg = milligram
kg = kilogram
L = liter

ECO-RA.T3

4.0 RISK CHARACTERIZATION

Studies on toxic effects of benthic invertebrates to organic compounds adsorbed in sediment indicates that toxic effects can be expected to occur only if the chemical concentration reached by desorption is equal to or higher than the concentration demonstrated to cause an effect in a water exposure test (ASTM, 1985). Because the concentrations of 1,2-DCA and chloroform adsorbed in sediment are lower than the concentrations established by the USEPA to protect aquatic life (established by water exposure test), these compounds are not likely to cause a significant adverse effect to aquatic organisms as a result of sediment exposure. Currently, there are no protective criteria set by the USEPA for 1,2-DCA and chloroform in sediment.

Concentrations of 1,2-DCA and chloroform detected in the groundwater samples, even without taking into account partitioning of the compounds to various aquatic compartments, are lower than the corresponding USEPA's National Ambient Water Quality Criteria for Saltwater Aquatic Life Protection, indicating no significant adverse effect to the aquatic life in the Central Bay. The concentrations of compounds in the aquatic system used in this comparison are extremely conservative because factors that would significantly lower the concentrations such as dilution, transformation, sorption, and volatilization were not considered.

5.0 CONCLUSION AND RECOMMENDATION

The following conclusions are made based on this limited ecological risk assessment:

- Very low concentrations of 1,2-DCA and chloroform were detected in the downgradient monitoring well (MW-22) at the site.

- The general chemistry data (i.e., pH, specific conductance, and TDS) of the groundwater samples collected from on-site wells in April 1994, do not meet the RWQCB's water quality objectives for municipal water supply. This water is unlikely to be a drinking water source.

- The site is located closest to the Central Bay. The Central Bay has oceanic characteristics and does not provide the same habitat as eutrophic estuaries. The beneficial use of this water is best defined as groundwater which flows to marine habitat.

- Two endangered species, the California clapper rail and the saltwater marsh harvest mouse, reside in the saltwater marshes of the San Francisco Bay. The RWQCB did not identify the area of the Bay in proximity of the site as a significant saltwater marsh habitat. The nearest significant marsh habitat from the site identified by the RWQCB is located within 5 miles north, hydrologically upgradient of the site, and this area is unlikely to be impacted by the site.

- Because of the oceanic characteristics of the Central Bay, the USEPA's National Ambient Water Quality Criteria for Saltwater Aquatic Life Protection is the most appropriate ecological based endpoint for this project.

- 1,2-DCA and chloroform are not very mobile in groundwater; they do not volatilize readily in water; and they do not concentrate in animal tissue. They have a strong affinity to adsorb to sediment. Transformation of these compounds allow for a short half-life in surface water.

- Potential exposure to 1,2-DCA and chloroform by aquatic life is from ingestion and contact of water and sediment. Potential exposure to these compounds by endangered species, the California clapper rail and the saltwater marsh harvest mouse, is mainly from ingestion of food, mainly shellfish and pickleweed, respectively.

- 1,2-DCA and chloroform in water is lower than the corresponding USEPA's National Ambient Water Quality Criteria for Saltwater Aquatic Life Protection, indicating no significant adverse effect to the aquatic life from potential chemical exposures. The concentrations of 1,2-DCA and chloroform in the aquatic system used for this comparison is extremely conservative since factors which would significantly reduce the concentrations (sorption, transformation, and dilution volatilization) were not considered.

- 1,2-DCA and chloroform are not likely to adversely effect the endangered species because of the compounds' short half-lives and because these compounds do not tend to concentrate in the tissue of their food (i.e., shellfish and pickleweed). Additionally, because these compounds adsorb in sediment and taking into account dilution of the compounds as they enter the Bay, inhalation and dermal exposure are likely to be insignificant.

Based on the ecological risk assessment, we recommend that the quarterly monitoring program conclude and the site receive a closure status.

6.0 REFERENCES

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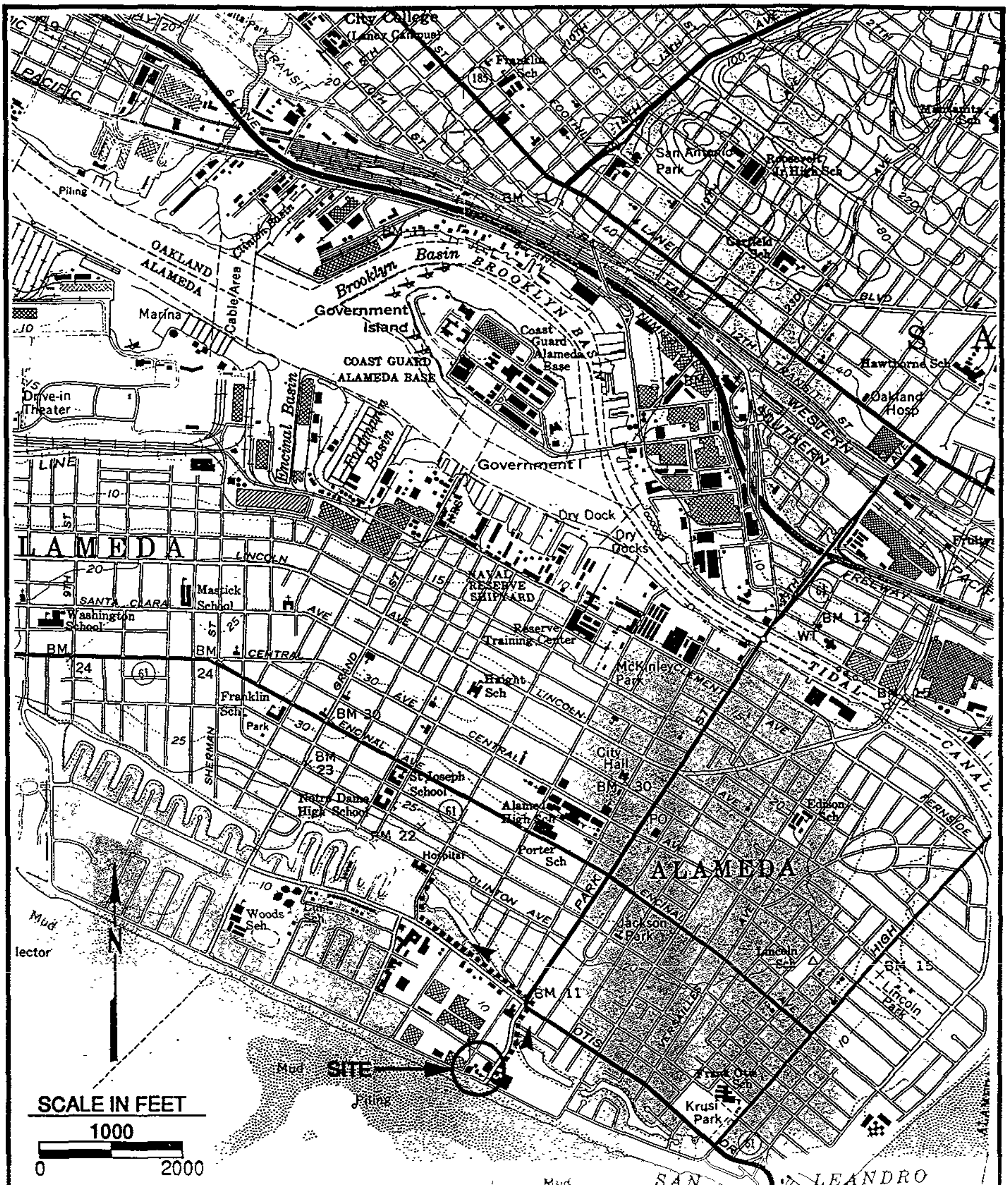
Drawings



SITE LOCATION MAP

THE MARK GROUP, INC.
ENGINEERS & GEOLOGISTS

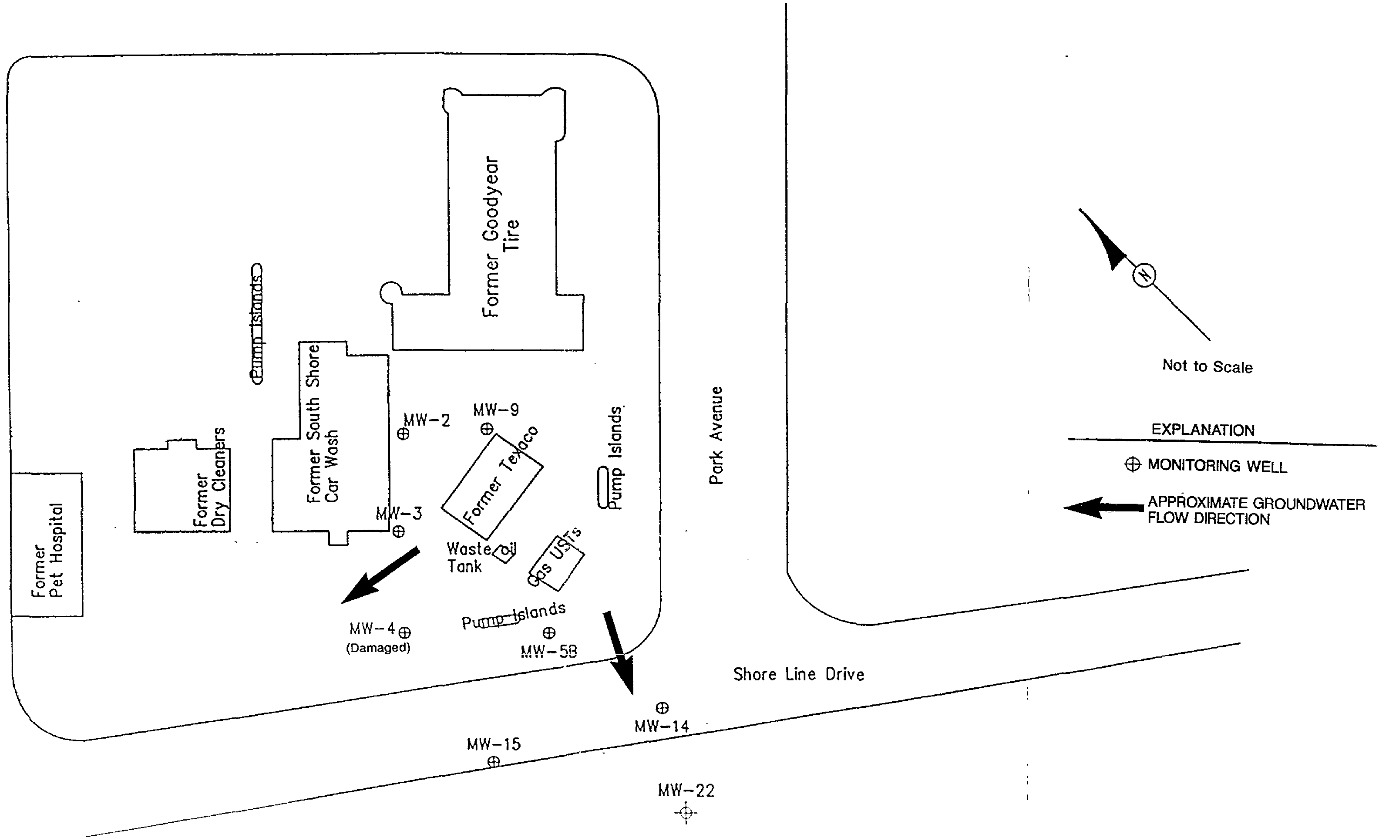
Limited Ecological Risk Assessment
Former Texaco Service Station
Southshore Shopping Center
Alameda, California

PROJECT NO. 92-1175307

DRAWING NO. 1-1

PREPARED BY RSS REVIEWED BY ADG DATE 6/22/94

TBLCK (5/28/92)



SITE LAYOUT AND MONITORING WELL LOCATION MAP

THE MARK GROUP, INC.
ENGINEERS & GEOLOGISTS

Limited Ecological Risk Assessment
Former Texaco Service Station
Southshore Shopping Center
Alameda, California

PROJECT NO
92-1175307

DRAWING NO
1-2

Prepared By RSS
Approved By ADG
Date 6/28/94

Appendix A

Table: Groundwater Analytical Results
Texaco Service Station
Alameda, California

Date Sample	TPH as Diesel	TPH as Gasoline	Benzene	Toluene	Xylenes	Ethyl-Benzene	Chloro-benzene	1,2-DCA	1,1-DCE	Trans-1,2-DCE	PCE	TCE	Chloro-form	Cis-1,2-DCE
Texaco Well MW-22														
4/28/94	<0.05	<0 05	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	0.015	<0.002	<0.001	<0.001	<0.002	<0.001	NR
10/18/94	<0 05	<0 05	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.014	<0.0005	<0.0005	<0.0005	<0.0005	0.00065	<0.0005
02/15/95	<0 05	<0 05	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0082	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Explanation

All results are in milligrams per liter
< = Non-detect; detection limit shown
NR = Analytical results not reported by laboratory
TPH as Gasoline = Total Petroleum Hydrocarbons as Gasoline analyzed using EPA Methods 5030 and TPH LUFT. Benzene, toluene, xylenes and ethylbenzene analyzed using EPA Method 602.
TPH as Diesel = Total Petroleum Hydrocarbons as Diesel analyzed using EPA Methods 3510 and TPH LUFT. Priority pollutants analyzed using EPA Methods 5030 and 601.
1,2-DCA = 1,2-Dichloroethane
1,1-DCE = 1,1-Dichloroethene
Trans-1,2-DCE = Trans-1,2-Dichloroethene
PCE = Tetrachloroethene
TCE = Trichloroethene
Cis-1,2-DCE = Cis-1,2-Dichloroethene

HARSCH TBL