HUMAN HEALTH RISK ASSESSMENT FOR
THE PROPERTY LOCATED AT
400 SAN PABLO AVENUE
ALBANY, CALIFORNIA

Aug 1997

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Glen Leong

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Project No. 2211

Prepared by

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Eva,

I spoke to Mansoor (principal of Soma Engineering) and these were my comments:

1. Redo the indoor pathway using RBCA methodology without using degradation rate
2. Use the average of the past 4 quarters of monitoring as site specific concentrations
3. If site specific (measured) values are not available for porosity, fraction organic carbon content, etc, then use the RBCA default numbers
4. Give a rationale for not using the chlorinated solvents in the risk assessment
5. Do a qualitative and quantitative ecological risk assessment due to the presence of the creek on the site. If additional investigation is conducted, then those results should also be incorporated in the human health and ecological risk assessment,

He wants a letter sent to him, His address is on the report. I misplaced his phone number and I do not know his full name. I also told him that you may requesting additional work from the client. Maybe you can address them all in the same letter.

Madhulla

① Any more recent sampling of creek.
should resome w/ that.

② Add'l Borings to collect GW W and SW of
tank pit. and along storm drain line

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Executive Summary

This baseline human health risk assessment (HHRA) report has been prepared by SOMA Environmental Engineering, Inc. (SOMA) on behalf of Kamur Industries. The project site is located at 400 San Pablo Avenue, Albany, California (the "Site"). The Site is bordered by El Cerrito Creek to the north, San Pablo Avenue to the east and Adams Street to the west.

The Site was vacant until the late 1950s when the Plaza Car Wash and the adjacent Norge Dry Cleaner buildings were constructed. Currently, the Site is operated by Kamur Industries. Three underground fuel storage tanks were installed on the Site in 1970. Petroleum free product was observed in the adjacent El Cerrito Creek, on July 3, 1989. This prompted the Albany Fire Department to recover the free product from the Creek using absorbent materials and booms. A storm drain underneath the Adams Street, which borders the Site on the west, was found to be the source of the petroleum products discharging into the Creek. Later, inventory reconciliation records reviewed by Kamur Industries in July 1989, showed discrepancies in the unleaded gasoline inventory. A product line test conducted in mid-July 1989, confirmed a small leak in the unleaded gasoline fuel lines beneath the pump island which was later repaired.

In November 1990, the three underground storage tanks were removed. During the removal of the tanks, approximately 650 cubic yards of contaminated soil were also removed from the Site. Although, the petroleum impacted soils have been removed and backfilled with clean soils, petroleum contaminants in the form of benzene, toluene, ethylbenzene and xylene (BTEX) still remain in the groundwater beneath the Site.

Besides BTEX, low levels of chlorinated hydrocarbons such as 1,2-dichloroethane, chloroform, trichloroethene, and tetrachloroethene have been detected at MW-3 and El Cerrito Creek in early 1996. The results of three subsequent groundwater monitoring events have not indicated the presence of chlorinated solvents at any of groundwater monitoring wells including MW-3 and newly installed monitoring wells of STMW-3, STMW-4, and STMW-5. The source of chlorinated hydrocarbons is suspected to be the Norge Cleaners. This HHRA does not address the human health risk associated with the presence of chlorinated solvents in groundwater and El Cerrito Creek.

The purpose of this baseline HHRA is to evaluate the adverse potential health impacts of BTEX-affected groundwater beneath the Site on on-site commercial workers as well as future on-site construction workers. The report also evaluates the impact of BTEX found in groundwater on El Cerrito Creek water quality conditions. The concentrations of the chemicals detected in the Creek have been compared with the Fresh and Marine Water Quality Standards.

commercial

Currently, the Site is zoned for industrial/commercial purposes. The Site's zoning is expected to remain industrial/commercial in the future. Therefore, the risk associated with on- and off-site residents were not considered in this study. The adverse health effects of contaminants found in saturated sediments and groundwater on future construction workers has also been addressed.

The results of this HHRA are as follows:

- For the hypothetical on-site indoor commercial worker, the total excess cancer risk from inhalation of volatile emissions was estimated to be equal to 1.40E-06. This is within the acceptable range of risk defined by the EPA (1×10^{-6} to 1×10^{-4}). The non carcinogenic hazard index was estimated to be equal to 2.38E-02, which is well below 1.0 and would be considered negligible. The risk and hazard for off-site indoor retail/commercial workers will be lower than that for on-site indoor commercial workers. Since the risk for on-site indoor commercial workers is negligible, the risk for off-site indoor commercial workers were not considered further in this HHRA.

- For the hypothetical on-site commercial outdoor worker, the total excess cancer risk was estimated to be equal to 1.64E-07. The estimated risk is well below the acceptable range defined by the EPA. The hazard index was estimated to be equal to 2.77E-03 which is negligible. The risk and hazard for off-site outdoor retail/commercial workers will be lower than that for on-site outdoor commercial workers. Since the risk for on-site retail/commercial outdoor workers is negligible, the risk for off-site outdoor workers were not considered further in this HHRA.

- The risk associated with future construction activities were evaluated under two scenarios. The first scenario assumes that during construction activities, the saturated sediments beneath the Site will be dewatered. This will eliminate direct dermal contact with chemically impacted groundwater. However, construction workers will be exposed to chemicals due to inhalation of vapors emanating from sediments, dermal contact and incidental ingestion of chemically affected soils and sediments. Under this scenario, the carcinogenic risk for a construction worker was estimated to be 1.71E-10. The hazard index was estimated to be equal to 4.81E-04. The second scenario assumes that the saturated sediments will not be dewatered. Therefore, construction workers will be exposed to chemicals due to direct contact with groundwater, volatilization of chemicals from free water surface and incidental ingestion of wet soils. Under this scenario, the carcinogenic risk was estimated to be 3.81E-07 which is negligible. The hazard index was estimated to be equal to 0.732 which is below the maximum acceptable limit of 1.0.

- The results of the qualitative evaluation of water quality in El Cerrito Creek indicated that currently the concentrations of BTEX in Creek is lower than the fresh and marine water quality standards for aquatic organisms. Low ppb levels of halogenated hydrocarbons such as chloroform, trichloroethene and tetrachlorethene were detected in the June 1996 monitoring event in the water sample collected in the storm drain outlet. They were not detected in any other water samples collected from the Creek. However, the concentrations of the halogenated hydrocarbons detected in the sample collected from the storm drain outlet were lower than their fresh and marine water quality standards.

Based on the results of the risk assessment, the contaminants in groundwater detected beneath the Site does not impose any significant threat to human health and environment.

1.0 Introduction

This baseline human health risk assessment (HHRA) report has been prepared by SOMA Environmental Engineering, Inc. (SOMA) on behalf of Kamur Industries. The project site is located at 400, San Pablo Avenue Albany, California (the "Site"), see Figure 1. The Site is bordered by El Cerrito Creek to the north, San Pablo Avenue to the east and Adams Street to the west.

The Site was vacant until the late 1950s when the Plaza Car Wash and the adjacent Norge Dry Cleaner buildings were constructed. At present, the Site is operated by Kamur Industries. Three underground fuel storage tanks were installed on the Site in 1970. Petroleum free product was observed in the adjacent El Cerrito Creek, on July 3, 1989. This prompted the Albany Fire Department to recover the free product from the Creek using absorbent materials and booms. A storm drain, which borders the Site on the west, was found to be the source of the petroleum products discharging into the Creek.

Later, inventory reconciliation records were reviewed by Kamur Industries in July 1989. The records showed discrepancies in the unleaded gasoline inventory. A product line test conducted in mid-July 1989, confirmed a small leak in the unleaded gasoline fuel lines beneath the pump island. The leak was later repaired.

In November 1990, the three underground storage tanks were removed. During the tank removal operations, approximately 650 cubic yards of fuel-affected soil was excavated. This gasoline affected soil was aerated on-site between mid-December 1990 and April 2, 1991. Treatment consisted of aerating the soil twice a week by adding nutrients (bacteria-enriched compost) to the contaminated soil. Later, the treated soil was transported to Redwood Landfill in Novato, California. Although, the petroleum inputted soils have been removed and backfilled with clean soils, petroleum constituents in the form of benzene, toluene, ethylbenzene and xylene (BTEX) still remain in the groundwater. and vadose zone !

The purpose of this baseline HHRA is to evaluate the adverse potential health impacts of petroleum-impacted groundwater beneath the Site on current on-site outdoor and indoor commercial workers. Currently, the Site is zoned for industrial/commercial purposes. The Site's zoning is expected to remain industrial/commercial in future. Therefore, the risk associated with residents were not considered in this risk assessment. However, the risk associated with future construction activities was also evaluated.

The report also studies the impact of site contaminants on the water quality of the El Cerrito Creek. The concentrations of the chemicals detected in the Creek were compared to their Fresh and Marine Water Quality Standards for aquatic organisms.

2.0 Site Characterization

2.1 Previous Site Investigations

In August 1989, Subsurface Consultants, Inc. (SCI) was retained by Kamur Industries to perform a site assessment. SCI drilled five soil borings and collected soil samples for a laboratory analysis. Four of the soil borings (MW-1 through MW-4) were later converted to monitoring wells. Laboratory analysis showed the presence of gasoline contaminants in all soil and groundwater samples.

Per the request of California Regional Water Quality Control Board (RWQCB), water samples were also obtained from El Cerrito Creek and the storm drain outlet on August 3, 1989. Laboratory analysis revealed high levels of dissolved hydrocarbons at the storm drain outlet and low levels approximately 20 ft downstream from the confluence of the storm drain and the El Cerrito Creek. A soil gas survey conducted by SCI in the area of the Plaza Car Wash and adjacent properties revealed the presence of hydrocarbon contamination in the soil.

On September 19, 1989, Pacific Pipeline Survey conducted a video inspection of the Adams Street storm drain. The inspection revealed excess concrete along the pipe bottom, a bend across the pipe section and large cracks in the pipe. The bend area was considered to be the most likely location where petroleum products can potentially enter into the storm drain pipe and eventually reach the El Cerrito Creek.

Later, the storm drain pipe was excavated and joints were sealed with mortar. All excavated soils found to be impacted by petroleum hydrocarbons using organic vapor analyzer. The excavated soils were removed and stored on-site before disposal.

Stockpiled soils from the product line repair areas were treated on-site and transported to the West Contra Costa Sanitary Landfill for disposal.

In December 1989, Kamur industries retained International Technology Environmental Services (ITES) to conduct monitoring and sampling of on-site monitoring wells, the Adam Street sump and El Cerrito Creek. Monitoring and sampling were conducted on a monthly basis from December 1989 through May 1990. All on-site wells showed high levels of dissolved hydrocarbons, and one well showed traces of floating product. The samples collected from the El Cerrito Creek after each significant rainstorm, showed non detectable levels in the upstream station. However, the storm drain outlet samples showed moderate levels of dissolved hydrocarbons and the down stream station showed fairly low to non detectable levels.

In September 1990, Kamur Industries, Inc., retained AGS and STE to remove three underground tanks, and to perform site characterization including soil sampling, excavation, and off-site disposal of the contaminated soils. In addition, STE conducted surface water sampling of the El Cerrito Creek during rainy months per Regional Water Quality Board's requirements and installed additional monitoring wells as requested by the Alameda County Health Agency (ACHA).

In February 1991, STE installed two on-site monitoring wells (STMW-1 and STMW-2). In addition, the on-site monitoring wells of MW-1 and MW-4 were abandoned during soil excavation near the former underground tank area. The investigation did not reveal a presence of floating product in the wells. Dissolved hydrocarbons were detected in all on- and off- site wells during the investigation.

Since December 1992, STE has performed quarterly groundwater monitoring at the Site. The results of the groundwater monitoring have indicated presence of BTEX in groundwater.

In November 1996, STE installed three additional monitoring wells (STMW-3, STMW-4 and STMW-5). Water samples collected from all the seven on-site wells (MW-2, MW-3 and STMW-1 through STMW-5) were analyzed for TPH-G, BTEX and MTBE. The results indicated that the concentrations of TPH-G and BTEX were below laboratory detection limits in MW-2, STMW-4 and STMW-5. Low to moderate levels of TPH-G were detected in MW-3, STMW-1, STMW-2 and STMW-3. Low levels of BTEX were also detected in these four monitoring wells. MTBE was not detected in any of the water samples collected during this monitoring event.

The results of the investigations performed by STE revealed that despite the removal of contaminated soil, total petroleum hydrocarbons (TPH) and chemicals such as (BTEX) remain in the groundwater. Therefore, this HHRA only addresses the impact of petroleum impacted-groundwater including BTEX on human health beneath the Site.

2.2 Site Hydrogeology

The stratigraphy of the shallow soil beneath the Site has been explored by STE. The native soil beneath the Site mainly consists of sandy to silty clay soils (STE, 1996). Groundwater has been encountered at depths ranging between 4.75 and 7.33 feet below ground surface (bgs) during the recent monitoring event conducted in May 1997. The El Cerrito Creek which forms the northern Site's boundary flows from east to west.

Since December 1992, quarterly groundwater monitoring events have been conducted on the Site. Currently, there are seven monitoring wells, namely, MW-2, MW-3 and STMW-1 through STMW-5. The locations of these seven monitoring wells are shown in Figure 2. The static water levels measured at these monitoring wells during the recent groundwater monitoring event conducted on May 19, 1997 which are presented in Table 1. The groundwater elevation contour map based on the water levels measured in May 1997 monitoring event is also presented in Figure 3. As Figure 3 shows, in the eastern portion of the Site, the water levels in the El Cerrito Creek are higher than the groundwater elevations in the wells (STMW-3, STMW-1, and STMW-4) However, in the western portions of the Site, the water levels in the Creek are lower than the groundwater elevations in the adjacent groundwater monitoring wells of STMW-5 and MW-3. This indicates that in the upstream areas the Creek acts as a losing stream and in the downstream areas it acts as a gaining stream.

Geological Cross Sections A-A' and B-B' have been presented in Figures 5 and 6 respectively. The locations of the geologic cross-sections A-A' and B-B' have been shown in Figure 4. Geological Cross-Section A-A' indicates that the groundwater elevation beneath the Adams Street is higher than the elevation of the storm drain at this location. This indicates that contaminated groundwater can enter into the drain through the observed cracks in the storm drain. The results of laboratory analysis on water samples collected from the storm drain is comparable with the results of laboratory analysis on groundwater samples at this location. This further verifies the that storm drain acting as a drainage conduit at this location. The elevation of groundwater beneath the Site at this location (i.e. the western portions of the Site) is also higher than the water level in the Creek. Therefore, contaminated groundwater may also be discharged into the Creek by seepage flow. However, during the recent monitoring event, the concentrations of BTEX in the monitoring well STMW-5 which is in close proximity from the Creek was below detection limits. Therefore, groundwater contamination will not significantly impact water quality conditions in the El Cerrito Creek through seepage flow.

Geological Cross-Section B-B' shows the water levels in the monitoring wells of STMW-2 and STMW-3 as well as surface water elevation in the Creek in upgradient locations. As Figure 6 shows, the elevation of groundwater beneath the Site is lower than the water level in the Creek at this location (i.e. the eastern portions of the Site). Therefore, this indicates that the Creek acts as a losing stream in upgradient locations.

2.3 Nature and Extent of Groundwater Contamination

Since December 1992, quarterly groundwater monitoring has been conducted on the Site. Groundwater samples collected from these monitoring wells have been analyzed for the presence of BTEX. The results of the laboratory analysis have been tabulated in Tables 2 through 6.

A review of the water quality data at the seven groundwater monitoring wells shows that the maximum concentration of chemicals detected in the groundwater were reported during investigations conducted in 1993 and 1994. The maximum concentration of benzene at 14,000 ppb was detected in a groundwater sample collected at MW-3 on 10/11/93. The maximum concentration of toluene at 12,000 ppb was detected in the groundwater sample collected at STMW-3 on 11/8/94. The maximum concentration of ethyl benzene at 7,800 ppb was detected at MW-3 on 01/07/94 and that of xylene equal to 18,000 ppb was detected at MW-3 on 08/03/94.

Tables 2 through 6 also show that the results of laboratory analysis on groundwater samples collected since February 1995 have revealed considerably lower concentrations of BTEX than those detected in the earlier monitoring events. Figure 7 shows the historical concentration of benzene in the groundwater at different groundwater monitoring wells. Reduction in chemical concentrations in groundwater since 1995, could be attributed to the removal of the tanks (source) from the Site and the excavation and transport of the contaminated soil from the surrounding areas. As Figure 7 presents, the concentrations of benzene in groundwater have remained fairly consistent since February 1995 (see Figure 7). The maximum, average and the 95% Upper Confidence Limit (UCL) concentrations of BTEX since February 1995 have also been presented in Tables 2 through 6.

Groundwater samples from the four monitoring wells (MW-2, MW-3, STMW-1 and STMW-2) were analyzed for the presence of halogenated volatile organic compounds (VOCs) during the monitoring events conducted in February and June 1996. VOCs were detected in only one monitoring well, MW-3 during these investigations. 1,2-dichloroethane, chloroform, trichloroethene and tetrachloroethene were detected at concentrations of 35 ppb, 160 ppb, 110 ppb and 80 ppb respectively in MW-3 during the February 1996 monitoring event. Chloroform, trichloroethene and tetrachloroethene were also detected at concentrations of 31 ppb, 110 ppb and 610 ppb respectively in groundwater monitoring well of MW-3 during groundwater monitoring event of June 1996. Halogenated hydrocarbons also have been detected in surface water samples collected from El Cerrito Creek (see Section 5.0). Since June 1996 the halogenated hydrocarbons have not been detected in any of groundwater monitoring wells including newly installed groundwater monitoring wells of STMW-3, STMW-4, and STMW-5. The source of halogenated hydrocarbons is suspected to be the Norge Cleaners located upgradient from MW-3 and El Cerrito Creek.

2.4 Conceptual Site Model (CSM)

The Conceptual Site Model (CSM) was developed based on previous Site investigations. The CSM synthesizes site characterization data (geology, hydrogeology, contaminant distribution, migration pathways and potential human receptors) to provide a framework for selecting pathways for quantitative analysis in this HHRA. The CSM is shown graphically in Figure 8.

The contaminated soil at the Site has been previously excavated, off-hauled and backfilled with clean soil. Therefore, the CSM identifies groundwater beneath the Site as the only source of chemical contamination. Groundwater and ambient air are identified as transport media. Chemicals (BTEX) detected in groundwater can volatilize and travel by diffusion toward the land surface, and enter buildings or ambient air. Here, they may impact workers via inhalation.

The CSM also considers future construction activities to be performed at the Site. The CSM considers two scenarios under which the risk associated with the construction worker will be evaluated. The first scenario assumes that dewatering would be performed at the Site prior to construction activities. Under this scenario, the construction workers will be exposed to chemicals in wet soils in the previously saturated zone. The chemicals in the wet soils will come in contact with the construction workers by volatilization, incidental ingestion and dermal contact. The other scenario assumes that no dewatering will be performed at the Site prior to construction activities. Thus, the chemicals in the freely exposed groundwater may come in contact with the construction workers by volatilization and dermal contact. The chemicals in the wet soils will also be available to the construction workers via incidental ingestion.

BTEX in groundwater can also enter into the storm drain beneath Adams Street through the observed cracks and eventually enter into the El Cerrito Creek. Therefore, the groundwater contamination beneath the Site may impact the water quality of the Creek. Therefore, the concentrations of the chemicals in the Creek will be compared with their corresponding Fresh Water and Marine Water Quality Standards for aquatic organisms.

3.0 Quantitative Modeling

Computer models were used to quantitatively assess chemical transport in the groundwater and air at the Site. The purpose of modeling was to estimate current and future exposure point concentrations for potential human receptors. The following computer modeling and quantitative calculations were performed in the evaluation:

- Estimation of emission rates of chemicals from affected groundwater to the atmosphere;
- Estimation of emission rates of chemicals from saturated sediments; and
- Air quality modeling to estimate on-site chemical concentrations in ambient outdoor and indoor air due to volatilization from affected groundwater and saturated sediments.

This section describes the methodology used and the assumptions made in conducting emission rate calculations and air quality simulations.

3.1 Estimation of Chemical Emission Rates from Groundwater

Steady-state surface vapor emissions from shallow groundwater underlying the Site were estimated for BTEX using a model developed by Farmer et al. (1980). Farmer's model is a modified application of Fick's Law in which the tortuosity factor of Millington and Quirk (1961) takes into account the reduced flow area and the increased flow pathway of diffusing gas in partially saturated soil.

Farmer's model for the emission rate calculation is:

$$E_i = D_{air}\left(\frac{C_v - C_i}{L}\right)\left(\frac{P_a^{10/3}}{P_t^2}\right) \tag{1}$$

where:

E_i = estimated emission rate of chemical i (mg/(m^2-sec));

D_{air} = chemical air diffusion coefficient (m^2/sec);

C_v = chemical concentration in vapor phase at depth L (mg/m^3);

C_i = gas phase chemical concentration immediately above the soil surface (mg/m^3);

L = the thickness of the overlying soil cover in (m);

P_a = air-filled porosity of the soil cover in (m^3/m^3); and

P_t = total porosity of the soil cover in (m^3/m^3).

Chemical property values used in the calculation are listed in Table 7, while soil property values are listed in Table 8.

The thickness of the overlying soil cover, or the depth to the top of the aquifer (depth to groundwater), ranges approximately between 4.75 and 7.33 ft. For simplicity, L was conservatively assumed to be 1.5 m (5 ft) everywhere beneath the study area.

In keeping with the conservative nature of this evaluation, it was assumed that C_i was equal to zero. The vapor concentration of the chemicals in the unsaturated soils above the capillary fringe, C_v, was estimated from groundwater concentrations using Henry's Law:

$$C_v = HC_w \tag{2}$$

where:

C_w = chemical concentration in groundwater in mg/m^3;
H = dimensionless Henry's Law coefficient.

The 95% UCL concentrations of the chemicals detected in groundwater since February 1995 were calculated. In case of absence of more than six detections of a chemical in a groundwater monitoring well, the maximum value of the chemical was used instead as shown in Tables 2 through 6. The 95% UCL or the maximum concentrations of the chemicals in each monitoring well have been tabulated in Table 9. For the calculation of the vapor phase concentration of a chemical, the highest value of the 95% UCL/maximum concentrations of the chemical detected in groundwater (in all the monitoring wells) was used. These values have been presented in Table 9.

why only 3 wells?

Table 7 lists Henry's Law and air diffusion coefficients for BTEX. The emission rates of the chemicals were estimated using Equation 1 and are presented in Table 10.

3.2 Estimation of Chemical Emission Rates from Saturated Sediments

The relationship between the concentrations of the chemicals in the soil and the aqueous phase in the saturated zone is given by:

$$C_0 = K_d \, C_w. \qquad (3)$$

where:

C_0 = Concentration of the chemical in the soil (absorbed phase) , mg/kg;

?

K_d = distribution coefficient of the chemical, m^3/kg; and

C_w = concentration of the chemical in groundwater, (solution phase) mg/m^3

The concentrations of the chemicals detected in groundwater during the recent monitoring event conducted on May 13, 1997 were used as the representative concentrations.

should avg last 4 qtrs.

If the groundwater level is lowered due to dewatering operations; the concentration of the chemicals in the sediments above the water table (which were previously in the saturated zone) will remain the same. The chemicals that were detected in the saturated zone beneath the Site were benzene, toluene, ethylbenzene and xylene. The emission rates of these chemicals from the saturated sediments were simulated using Jury's model (1990).

why time dependent now!

This model is appropriate for situations in which the time-dependent vapor emission rates are to be estimated. The soil is assumed to have been affected by an organic chemical to a given depth, L, with specified initial chemical concentration, C_O. Three phases of the chemical are considered by the model, including vapor phase, the aqueous phase and the sorbed or solid phase. All three phases are assumed to be in equilibrium with each other, as prescribed by Henry's Law (for the liquid-vapor equilibrium) and linear partitioning in the solid-liquid equilibrium.

The estimated vapor emission rates using Jury's model are based on several loss pathways, such as transport of a chemical species through volatilization at the soil surface, advective transport in soil moisture, and diffusion through air-filled soil pores. The model is based on mass conservation principles. The time-varying depletion of the soil concentration must be taken into consideration since there is only a finite amount of chemical initially present.

The partial differential equation governing chemical transport in vadose zone given by Jury et al. (1990) is:

$$\frac{\partial C_T}{\partial t} + \mu C_T = \frac{\partial}{\partial z}\left(D_E \frac{\partial C_T}{\partial z}\right) - V_E \frac{\partial C_T}{\partial z} \tag{4}$$

where:

C_T = Total concentration (mg/m^3 soil);

μ = First order biodegradation rate (sec^{-1});

T = Time (sec);

z = Depth from ground surface (m);

V_E = Effective solute velocity (m/sec); and

D_E = Effective diffusion coefficient (m^2/sec)

Effective solute velocity, V_E is a variable associated with recharge. The effective diffusion coefficient, D_E is a variable which can be expressed as:

$$D_E = \frac{P_a^{\frac{10}{3}} D_{ga} K_H + P_w^{\frac{10}{3}} D_{lw}}{P_t^2 (\rho_b f_{oc} K_{oc} + P_w + P_a K_H)} \tag{5}$$

where:

P_a = Air-filled porosity (0.04); why so low

P_t = Total porosity (0.4); where?

P_w = Water-filled porosity, or volumetric water content (0.36);

D_{ga} = Gaseous diffusion coefficient in air (m^2/sec);

D_{lw} = Liquid diffusion coefficient in water (m^2/sec);

ρ_b = Bulk density of soil (mg/m^3);

K_H = Dimensionless form of Henry's constant;

f_{oc} = Organic carbon content; and

K_{oc} = Organic carbon partition coefficient (m^3/mg)

The concentration distribution of the organic chemical can be solved for first, and then the emission rate can be calculated using the following equation:

$$E_i = D_E \frac{\partial C_T}{\partial z} \tag{6}$$

where:

E_i = Emission rate for chemical i (mg/m^2-sec).

Tables 7 and 8 present the parameter values used in the evaluation of the emission rates using Jury's model.

3.3 Air Dispersion Modeling

SOMA used two models to estimate chemical concentrations in ambient outdoor and indoor air associated with volatilization of chemicals from contaminated groundwater and sediments in the saturated zone based on their emission rates calculated as described above. To estimate chemical concentrations in on-site indoor air involving occupational exposure inside buildings constructed over the groundwater contaminant plume, a simple mass-balance indoor mixing model was used (Daugherty 1991). For areas overlying contaminated groundwater and saturated sediments, we used the "box model" described by Pasquill (1975). The box model is a steady-state analytical mass-balance model which was used to estimate concentrations of BTEX in ambient outdoor air. These models are described in the following subsections.

3.3.1 Indoor Air Quality Model

Indoor air concentrations of BTEX were estimated using the 95% UCL of the emission rates calculated for these chemicals as described in Section 3.1. This was done by using a simple mass-balance mixing model (Daugherty 1991). This model is based on the following assumptions:

- Vapor-phase chemical emission rates from groundwater are constant through time (steady-state assumption);
- Chemical vapors emitted from groundwater beneath a building are uniformly and instantaneously mixed within the entire air space within the building; and
- Indoor air is exchanged with clean outdoor air (zero chemical concentration) at a constant rate.

The model uses the following mass balance equation to estimate the chemical concentration in indoor air resulting from vapor-phase emissions:

$$C_{in} = \frac{bEA}{Q} \tag{7}$$

where:

C_{in} = chemical concentration in indoor air (mg/m^3);

b = attenuation factor (unitless);

E = 95% UCL of the chemical emission rates from groundwater ($mg/m^2 \cdot s$);

A = area covered by building (m^2); and

Q = ventilation rate (m^3/s).

An attenuation factor of 0.1, representing an order-of-magnitude attenuation of chemical emission rates, was used to account for the effects of the building foundation (i.e., concrete slab construction). The ventilation rate, Q, was calculated assuming an exchange rate with outside air of 48 exchanges per day or 2 exchanges per hour (AHIRE, 1990):

$$Q = \frac{AhR}{C_f} \tag{8}$$

where:

h = interior height of building (6 m);

R = exchange rate (2 hr^{-1}); and

C_f = unit conversion factor (3600 s/hr).

Estimated on - site indoor air concentrations are presented in Table 11.

3.3.2 Box Model

The box model is a control volume approach used to calculate outdoor air concentrations (Pasquill 1975). This model assumes steady and uniform conditions of dispersion, so that emissions are uniformly distributed throughout a "box" defined by the area of the source and the mixing height.

The box model equation is:

$$C_i = \frac{Q_i}{\frac{H}{2} \; W \; U} \qquad (9)$$

where:

Ci = the outdoor air concentration for chemical i (mg/m^3);
Qi = the mass flux of the chemical i (mg/sec);
H = height of the box (mixing height) (m);
W = cross wind width of the area source (m); and
U = annual average wind speed (m/sec).

The mass flux was calculated by:

$$Q_i = E_i \quad A_i \qquad (10)$$

where:

E_i = emission rate of chemical i (mg/m^2-sec); and
A_i = current or simulated area of chemical i in groundwater.

The mixing height (H) was estimated using the following equation presented by Pasquill (1975):

$$X = 6.25\, Z_0 [\frac{H}{Z_0} \ln(\frac{H}{Z_0}) - 1.58\ (\frac{H}{Z_0}) + 1.58] \qquad (11)$$

where:

X = downwind distance aligned with wind direction along the Site (m);

H = height of the box (m); and

Z_0 = roughness height which is used to characterize surface roughness (m).

This expression assumes a neutral stability class (D). At lower stability classes (A, B, and C), the mixing height would be larger, resulting in lower ambient concentrations. At higher stability classes (E and F), the mixing height would be smaller, resulting in higher ambient concentrations.

The height of the box represents the mean vertical height that a vapor molecule would attain after traveling across the entire length of the box. Because exposure to emissions could occur anywhere in the box, not just on the downwind edge, the average air concentration was calculated by using one-half of the calculated box height in the box-model equation. Table 12 lists the parameters and their selected values in conducting air quality modeling.

In estimating the height of the box, the roughness height, Z_0, was chosen as 0.60 meters, corresponding to a suburban setting with medium size buildings. This descriptor approximates Site conditions. The annual average wind speed and the prevailing direction were obtained from the RISKPRO database. The prevailing wind direction is toward the west with an average speed of 3.98 meters per second.

The Box Model was used to estimate the outdoor air concentrations of BTEX under three scenarios:

- Calculation of outdoor air concentrations of BTEX due to volatile emissions from groundwater;
- Calculation of outdoor air concentrations of BTEX due to volatile emissions from saturated sediments; and
- Calculation of outdoor air concentrations of BTEX due to volatile emissions from freely exposed groundwater due to excavation and trenching operations.

Calculation of Outdoor Air Concentrations due to Volatile Emissions from Groundwater

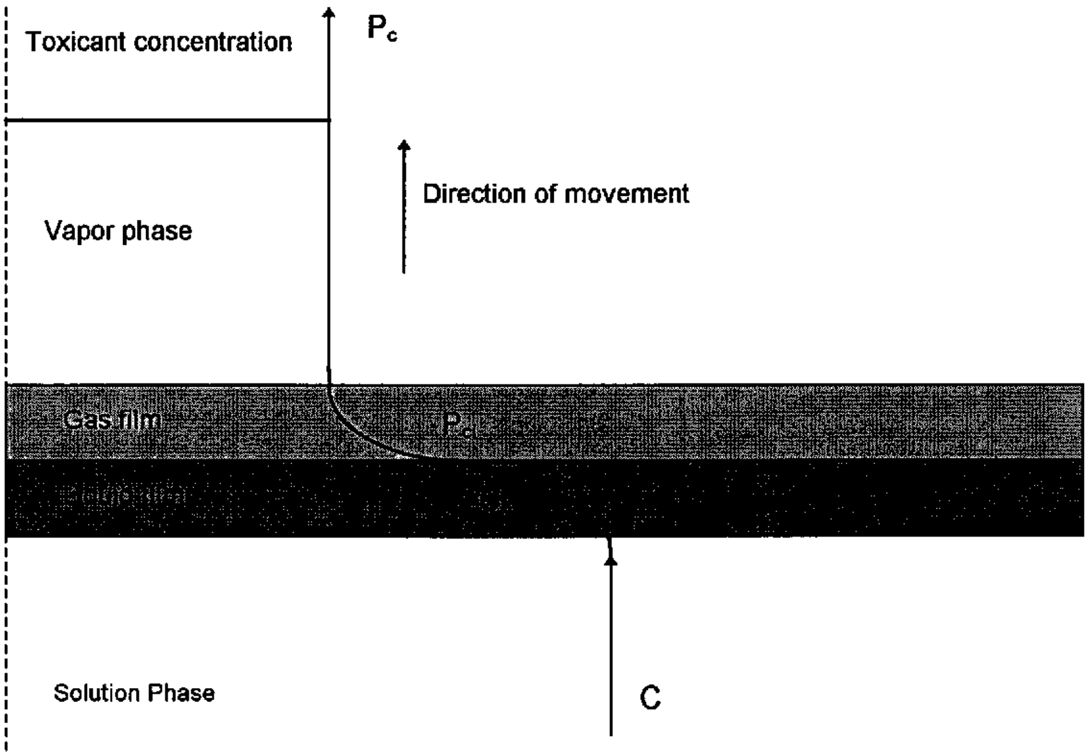
The emission rates of the chemicals from groundwater were calculated as described in Section 3.1. It was further conservatively assumed that the entire area of the Site has been impacted by the chemicals. The total mass fluxes of the chemicals due to the volatile emissions were calculated using Equation 10. The mass fluxes of the chemicals were then substituted in Equation 9, in order to calculate the outdoor air concentrations of BTEX. Table 13 presents the on-site outdoor air concentrations of chemicals due to volatile emissions from groundwater.

Calculation of Outdoor Air Concentrations due to Volatile Emissions from Saturated Sediments

Under this scenario it was assumed that during construction activities, saturated sediments beneath the Site will be dewatered. However, the sediments in the previously saturated zone will still remain wet and retain their BTEX concentrations. The concentrations of the chemicals in the wet soils have been tabulated in Table 14. The emission rates of the chemicals from the wet soils were calculated using Jury's model as described in Section 3.2. It was further assumed that one tenth of the area of the Site will be excavated during the construction period. The mass fluxes of the chemicals were calculated according to Equation 10. These mass fluxes were then substituted in Equation 9, in order to calculate the outdoor air concentrations of BTEX. The outdoor air concentrations under this scenario have been tabulated in Table 15.

Calculation of Outdoor Air Concentrations due to Volatile Emissions from Freely Exposed Water as a Result of Excavation and Trenching Operations

To evaluate the emission rate of chemicals emanating from free groundwater surface at excavated areas during the construction period, a two film theory of volatilization which has been described in EPA (1985) was adopted. When a chemical volatilizes from water, the process can be visualized as a mass transfer occurring over several distinct steps. The following figure presents a schematic representation of the process. The concentration of the chemical is C in the bulk liquid solution. As the chemical moves upward in the bulk solution it moves through a thin "liquid film" where a concentration gradient develops because the transfer rate is limited by diffusion. The dissolved chemical then volatilizes and passes through a thin "gas film", where again transfer may be limited, before reaching the bulk vapor phase.



Schematic Representation of Volatilization form Solution Phase to Liquid Phase

At the interface between the gas and liquid film the concentrations in the liquid (C_i) and in the gas (P_{ci}, expressed as partial pressure) are assumed to be in equilibrium and to obey Henry's Law:

$$P_{ci} = K_H \, C_i \tag{12}$$

In the absence of net accumulation at the interface the mass flux from one phase must equal the mass flux from the other, or:

$$E_i = -\frac{k_{gi}}{RT}\,(P_c - P_{ci}) = k_{li}\,(C - C_i) \tag{13}$$

where:

E_i	Emission Rate mg/m^2-sec;
k_{gi}	mass transfer coefficient in the gas phase across "gas film" (m/sec);
k_{li}	mass transfer coefficient in the liquid [phase across "liquid film" (m/sec);
R	universal gas constant ; and
T	temperature in Kelvin

P_c, P_{ci}, C, C_i, are defined in the figure.

Equation 13 was used to calculate the emission rate from water surface. To evaluate the mass transfer coefficient Table II-9 of EPA (1985) was used. It was assumed that one tenth of the area of the Site will be excavated during the construction period. The mass fluxes of the chemicals were calculated according to Equation 10. These mass fluxes were then substituted in Equation 9, in order to calculate the outdoor air concentrations of BTEX. The outdoor air concentrations under this scenario have been tabulated in Table 16.

4.0 Human Health Risk Assessment (HHRA)

The purpose of this HHRA is to provide a screening level approach to evaluate potential impacts to humans that might result from exposure to contaminants (BTEX) in the groundwater beneath the Site.

4.1 Identification of Exposure Pathways and Potential Receptors

Since the contaminated soil has been excavated and backfilled with clean soil; the only source of chemicals on the Site is the groundwater contamination. Currently, the Site and surrounding areas are zoned for industrial /commercial use. At the present time, the only exposure pathway at the Site is inhalation of volatile emissions from groundwater. A hypothetical worker was therefore evaluated with potential exposure to the Site contaminants from inhalation of volatile emissions from the groundwater.

The adverse health risks associated with groundwater contamination for future construction workers have also been considered. The risk for construction workers was evaluated under two scenarios. First scenario assumes that dewatering would be performed at the Site prior to construction activities. Under this scenario, the construction workers will come in contact with chemicals in wet soils in the previously saturated zone. The chemicals in the wet soils will come in contact with the construction workers by volatilization, incidental ingestion and dermal contact. The second scenario assumes that no dewatering will be performed at the Site prior to construction activities. This scenario assumes that construction workers will be exposed to volatile emissions directly from the free groundwater surface. Thus, the chemicals in groundwater will come in contact with construction workers by volatilization and dermal contact. The chemicals in the wet soils may also come in contact with the construction workers through incidental ingestion.

4.2 Exposure Point Concentrations

Emission rates and subsequent indoor and outdoor air concentrations for BTEX from groundwater were estimated as described in detail in Section 3.0. The risk associated with halogenated hydrocarbons which was detected in early 1996 at MW-3 was not included in this HHRA.

Estimated on -site indoor and outdoor air concentrations due to the volatile emissions from groundwater, have been tabulated in Tables 11 and 13 respectively.

The concentrations of the chemicals in the wet soils have been tabulated in Table 14. The on-site outdoor air concentrations under the first scenario were evaluated as described in Section 3.2 and are tabulated in Table 15. The concentrations of the chemicals in groundwater that may be directly exposed to the construction workers have been tabulated in Table 14. The maximum concentrations in groundwater detected in the recent monitoring event have been assumed as the representative groundwater concentrations. The outdoor air concentrations under the second scenario were evaluated as described in Section 3.2. The simulated concentrations have been tabulated in Table 16.

4.3 Estimating Chemical Intake (Dose)

The following equation presents the chemical intake from inhalation of volatile emissions in air for the occupational and construction worker exposure scenarios:

Inhalation Intake (mg/kg-day)

$$= \frac{C_a * InhR * EF * ED}{BW * AT}$$

where:

C_a = Estimated chemical concentration in air, mg/m^3;

InhR = Inhalation rate, (m^3/day)

- 20 m^3/day for a worker (EPA 1991b);

EF = Exposure frequency, (days/year)

- 250 days/year for a worker (EPA 1991b);

ED = Exposure duration, (years)

- 25 years for a commercial worker (EPA 1991b);
- 0.25 years (3 months) for a construction worker

BW = Body weight, (kg)

- 70 kg for a worker (EPA 1991b); and

AT = Averaging time, days
= ED * 365 days/year for noncarcinogens
= 70 years * 365 days/year for carcinogens.

The following equation presents the chemical intake from incidental ingestion of soil for a construction worker exposure scenario:

$$\underline{\textit{\textbf{Incidental Ingestion Intake (mg/kg-day)}}} = \frac{C_s * IngR * EF * ED * CF_1}{BW * AT}$$

where:

C_s = Representative COPC soil concentration, mg/kg

IngR = Soil ingestion rate, (mg/day)

- 100 mg/day for a construction worker

EF = Exposure frequency, (days/year)

- 250 days/year for a worker (EPA 1991b)

ED = Exposure duration, (years)

- 0.25 years (3 months) for a construction worker (professional judgment)

CF_1 = Conversion factor, 1×10^{-6} kg/mg

BW = Body weight, (kg)

- 70 kg for a worker (EPA 1991b)

AT = Averaging time, days

- ED * 365 days/year for noncarcinogens
- 70 years * 365 days/year for carcinogens

The following equation presents the chemical intake due to dermal contact with wet soil (under Dewatering Condition) for a construction worker exposure scenario:

$$\textbf{Dermal Contact Intake (mg/kg-day)} = \frac{C_s * SA * AF * CF * EF * ED}{BW * AT}$$

where:

C_s = Representative COPC soil concentration, mg/kg

SA = Occupational skin surface area for exposure (cm^2)

- 2,685 cm^2 for a hypothetical commercial worker (derivation of this skin surface area is presented in Appendix 1). The skin surface area for a construction worker was assumed to be the same as that for a commercial worker

AF = Soil to skin adherence factor, (mg/cm^2)

- 1.0 mg/cm^2 for a construction worker

CF = Conversion Factor, 1 x 10^{-6} kg/mg

EF = Exposure Frequency, (days/year)

- 250 days/year for construction worker (EPA 1991b)

ED = Exposure Duration, (years)

- 0.25 years (3 months) for a construction worker

BW = Body Weight, (kg)

- 70 kg for a worker (EPA 1991b)

AT = Averaging Time, days

- ED * 365 days/year for noncarcinogens
  70 years * 365 days/year for carcinogens

The following equation presents the chemical intake due to dermal contact with freely exposed groundwater (under No Dewatering Condition)for the construction worker exposure scenario;

Dermal Contact Intake (mg/kg-day) = $$\frac{C_w * SA * Kp * CF * EF * ED * ET}{BW * AT}$$

where:

C_w = Representative COPC soil concentration, mg/kg

SA = Occupational skin surface area for exposure (cm^2)

- 2,685 cm^2 for a hypothetical commercial worker (derivation of this skin surface area is presented in Appendix 1). The skin surface area for a commercial worker was assumed to be the same as that for a construction worker

Kp = Dermal Permeability Coefficient (cm/hour)

CF = Conversion Factor, ($1/cm^3$)

EF = Exposure Frequency, (days/year)

- 250 days/year for construction worker (EPA 1991b)

ED = Exposure Duration, (years)

- 0.25 years (3 months) for a construction worker

ET = Exposure time (hours/day)

- 2 hours/day for a construction worker

BW = Body Weight, (kg)

- 70 kg for a worker (EPA 1991b)

AT = Averaging Time, days

- ED * 365 days/year for noncarcinogens
  70 years * 365 days/year for carcinogens

4.4 Toxicity Assessment

This section describes the process of characterizing the relationship between the exposure to an agent and the incidence of adverse health effects in exposed populations. In a quantitative carcinogenic risk assessment, the dose-response relationship of a carcinogen is expressed in terms of a slope factor (oral) or unit risk (inhalation), which are used to estimate the probability risk of cancer associated with a given exposure pathway. Cancer slope factors and unit risk factors as published by the California Environmental Protection Agency (Cal-EPA), Office of Environmental Health Hazard Assessment (OEHHA) (Cal-EPA 1994) were used in this HHRA.

For noncarcinogenic effects, toxicity data developed from animal or human studies are typically used to develop non cancerous acceptable levels, or reference doses (RfDs). A chronic RfD is defined as an estimate of daily exposure for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects during a lifetime. The chronic reference doses, as published in IRIS (1995) or HEAST (1992), were used in this evaluation.

Table 17 summarizes the cancer slope factors, reference doses, and data source for the chemicals evaluated in this human health risk assessment.

4.5 Risk Characterization

This section describes the approach used to assess the potential carcinogenic risk and noncarcinogenic health hazard for the populations of concern represented by the chemical contaminants in the groundwater beneath the Site. Potential carcinogenic effects were estimated from the predicted intakes and chemical-specific dose-response information. Potential noncarcinogenic effects were estimated by comparing the predicted intakes of the chemicals to their respective toxicity criteria.

4.5.1 Noncarcinogenic Health Effects

In order to estimate the potential effects from exposure to multiple chemicals, the hazard index (HI) approach was used. The HI is defined as the summation of hazard quotients for each chemical, for each route of exposure, and is represented by the following equation:

$$HI = \frac{\text{Predicted Dose}_a}{RfD_a} + \frac{\text{Predicted Dose}_b}{RfD_b} + \frac{\text{Predicted Dose}_i}{RfD_i} \quad (14)$$

A total HI less than or equal to unity is indicative of acceptable levels of exposure for chemicals assumed to exhibit additive health effects. A HI less than or equal to 1.0 suggests that adverse health effects would not be expected following a lifetime of exposure, even in sensitive members of the population.

4.5.2 Carcinogenic Health Effects

Benzene was the only carcinogenic chemical in this study and the risk associated with it was calculated according to the following equation:

$$R_b = q_b \times E_b \quad (15)$$

where:

R_b = Estimated incremental risk of cancer associated with benzene;
q_b = Cancer slope factor for benzene, $(mg/kg\text{-}day)^{-1}$; and
E_b = Exposure dose for benzene, mg/kg-day.

4.6 Regulatory Context

The EPA, through its Memorandum on the Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions (OSWER Directive 9355.0-30) states the following:

Where the cumulative carcinogenic Site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the noncarcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts.

The regulatory point of departure for cumulative Site carcinogenic risks has been 1×10^{-6}. Consequently, the range of risk between 1×10^{-6} and 1×10^{-4} is considered the acceptable risk range, depending upon Site-specific and surrounding area considerations.

4.7 Receptor Specific Risks and Hazards

The following section presents the estimated carcinogenic risks and noncarcinogenic health hazards for the hypothetical on - site indoor and outdoor commercial worker (see Tables 18 and 19). Detailed dose and risk/hazard calculations are presented in Appendix 2.

4.7.1 Hypothetical On Site Indoor Commercial Worker

Under current use of the Site, on-site receptors will only be exposed to inhalation of volatile emissions in the groundwater. For the on-site indoor commercial worker, the total excess cancer risk from inhalation of volatile emissions under current conditions was estimated to be equal to 1.40E-06. The calculated risk is within the acceptable range of risk defined by EPA (1×10^{-6} to 1×10^{-4}).

The total noncarcinogenic health hazard was estimated to be equal to 2.38E-02. The estimated hazard is well below 1.0, and would be considered negligible.

The risk and the hazard for an off-site indoor commercial worker will be lower than that for an on-site indoor commercial worker. Since both the risk and the hazard for an on-site indoor commercial worker are negligible, the off-site commercial indoor worker was not considered further in this risk assessment.

4.7.2 Hypothetical On-Site Outdoor Commercial Worker

For the on-site outdoor commercial worker; the total excess cancer risk from inhalation of volatile emissions was estimated to be equal to 1.64E-07 which is well below the acceptable range of risk defined by EPA (1×10^{-6} to 1×10^{-4}).

The total non carcinogenic health hazard was estimated to be equal to 2.77E-03, which is well below unity and is hence considered negligible.

The risk and the hazard for an off-site outdoor commercial worker will be lower than that for an on-site outdoor commercial worker. Since both the risk and the hazard for an on-site outdoor commercial worker are negligible, the off-site outdoor commercial worker was not considered further in this risk assessment.

4.7.3 Hypothetical On-Site Construction Worker

The risk associated with incidental ingestion of wet soil, dermal contact with wet soil and inhalation of volatile emissions from wet soil (under "Dewatering" scenario) was estimated to be equal to 1.71E-10. The total non carcinogenic hazard index was estimated to be equal to 4.81E-04. Under this scenario, both the risk and the hazard are negligible.

Under the "No Dewatering" scenario, the risk associated with incidental ingestion of wet soil, inhalation of volatile emissions from groundwater and dermal contact with groundwater was estimated to be equal to 3.81E-07 which is negligible. The non carcinogenic hazard index was estimated to be equal to 0.732 which is below the acceptable limit of 1.0.

5.0 Surface Water Quality Assessment

As described in Section 2.2, the El Cerrito Creek acts as a losing stream in upgradient areas in the eastern portions of the Site and acts as a gaining stream at down-gradient in the western portions of the Site. Therefore, in the eastern portions of the Site, the Creek is discharging into groundwater and hence the Creek water quality will not be impacted by groundwater contamination. In the western portions, where the Creek is acting as a gaining stream, a possibility of the Creek water degradation due to groundwater contamination exists. However, the concentrations of BTEX in the monitoring well STMW-5 which is closest to the Creek is below detection limits. Therefore, groundwater contamination will not impose a serious threat to the water quality of the Creek water.

As discussed previously, the storm drain beneath the Adams Street acts as a drain and discharges into the El Cerrito Creek. Therefore, besides direct groundwater flow (seepage flow) into the Creek, the contaminants beneath the Site may enter into the El Cerrito Creek through the storm drain. Chemicals such as BTEX, TPH-G and halogenated hydrocarbons have been detected historically in the Creek. The grab water samples have been collected from four locations, namely C-1, C-2, C-3 and C-4 in the Creek. These sampling locations have been shown in Figure 9.

The four surface water sampling locations along the El Cerrito Creek have been designated as:

C-1 - Approximately 20 ft up-stream from the confluence of storm drain outlet and the El Cerrito Creek
C-2 - Within the storm drain outlet
C-3 - At confluence of the storm drain and the El Cerrito Creek
C-4 - 50 ft downstream from the confluence of storm drain outlet and the Creek

The maximum concentration of TPH-G equal to 470 ppm was detected in the water sample collected at C-2 on 8/3/89, immediately following the discovery of the product in the El Cerrito Creek. However, as Table 20 shows, the concentrations of TPH-G at C-2 have reduced with time. At the other locations, TPH-G has been detected sporadically at negligible concentrations.

The water samples collected from the Creek were analyzed for the presence of BTEX on 2/29/96 and 6/7/96. The concentrations of BTEX detected in the water samples collected from the El Cerrito Creek have been presented in Tables 21 through 24. BTEX concentrations in low ppb levels were detected at C-1 and C-2 surface water sampling locations on 2/29/96. However, the detected concentrations of BTEX were considerably lower than their corresponding Fresh and Marine Water Quality Criteria for Aquatic Organisms (EPA (1986)). BTEX were never detected at C-3 and C-4 surface water sampling locations. BTEX were not detected in any of the water samples collected on 6/7/96.

The samples collected from the Creek on 2/29/96 and 6/7/96 were also analyzed for the presence of halogenated hydrocarbons. The halogenated hydrocarbons were not detected in any of the water samples collected from the Creek on 2/29/96. However, the water sample collected on 6/7/96 at C-2 sampling location contained chloroform, trichloroethene, and tetrachloroethene at concentrations of 19, 69 and 63 ppb respectively (see Table 25). However, the detected halogenated hydrocarbon concentrations were considerably lower than their Fresh and Marine Water Quality Standards for aquatic organisms. The halogenated hydrocarbons were not detected in other water samples (such as C-1, C-3, and C-4) collected during this monitoring event.

6.0 Conclusions

The following specific conclusions were reached for the Site:

- The total carcinogenic risks for on-site indoor and outdoor commercial workers were well below the range of the acceptable risk, as defined by the EPA.
- The hazard index for on-site indoor and outdoor commercial workers were well below 1.0 and are considered negligible.
- The carcinogenic health risk and the non carcinogenic health hazard associated with construction workers were well below the acceptable limits.
- The groundwater contamination beneath the Site will not pose any threat to the water quality of the El Cerrito Creek.
- The risk associated with halogenated hydrocarbons detected at MW-3 was not addressed in this report. The source of halogenated hydrocarbons is suspected to be Norge Cleaners.

7.0 References

ANSI/ASHIRE 1990, An American National Standard-Ventilation for Acceptable Air Quality, ANSI/ASHIRE 62-1989.

Daugherty, S.J. 1991. Regulatory Approaches to Hydrocarbon Contamination from Underground Storage Tanks, in Hydrocarbon Contaminated Soils and Groundwater, Chapter 2, P.T. Kostecki and E.J. Calabrese editors, Lewis Publishers, Ann Arbor, Michigan.

EPA (Environmental Protection Agency), 1989a. Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A).

EPA (Environmental Protection Agency), 1989b. Exposure Factors Handbook.

EPA (Environmental Protection Agency), 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, OSWER Directive 9285.6-03.

Farmer, W.J., M.S. Yang, J. Letey, and W.F. Spencer, 1980. *Land Disposal of Hexachlorobenzene Wastes: Controlling Vapor Movement in Soil*, EPA 600/2-80-119, US. Environmental Protection Agency, Office of Research and Development, Municipal Environmental Research Laboratory, Cincinnati, Ohio, 69 pp.

Freeze, R.A., and Cherry, J.A., 1979. Groundwater, Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632

HEAST 1992. United States Environmental Protection Agency (US. EPA), Health Effects and Summary Tables, NTS No. PB92-921199.

IRIS 1995. United States Environmental Protection Agency (US. EPA), Integrated Risk Information System.

Pasquill, F., 1975. The Dispersion of Material in the Atmospheric Boundary Layer-The Basis for Generalization. In *Lectures on Air Pollution and Environmental Analysis*, American Meteorological Society, Boston, Massachusetts.

Soil Tech Engineering, Inc. May 12, 1991. Report on Soil Remediation at the Plaza Car Wash, 400 San Pablo Avenue, Albany, California.

Soil Tech Engineering, Inc. May 14, 1991. Report of Supplemental Subsurface Investigation for Kamur Industries, Inc. at the Plaza Car Wash, 400 San Pablo Avenue, Albany, California.

Soil Tech Engineering, Inc. June 27, 1996. June 1996 Sampling of El Cerrito Creek Adjacent to Plaza Car Wash Located at 400 San Pablo Avenue, Albany, California.

Soil Tech Engineering, Inc., November 15, 1996. Additional Subsurface Investigation at the Property Located at San Pablo Avenue, Albany, California.

Soil Tech Engineering, Inc. February 20, 1997. Quarterly Groundwater Monitoring and Sampling for the Property Located at 400 San Pablo Avenue, Albany, California.

U.S. Environmental Protection Agency, 1985, Water Quality Assessment: A Screening Procedure for Toxic Conventional Pollutants in Surface and Ground Water-Part I, (Revised 1985).

U.S. Environmental Protection Agency (U.S. EPA), 1986 Quality Criteria for Water. EPA 440/5-86-001

U.S. Environmental Protection Agency (U.S. EPA), 1989. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A), Interim Final. EPA/540/1-89/002. December.

FIGURES

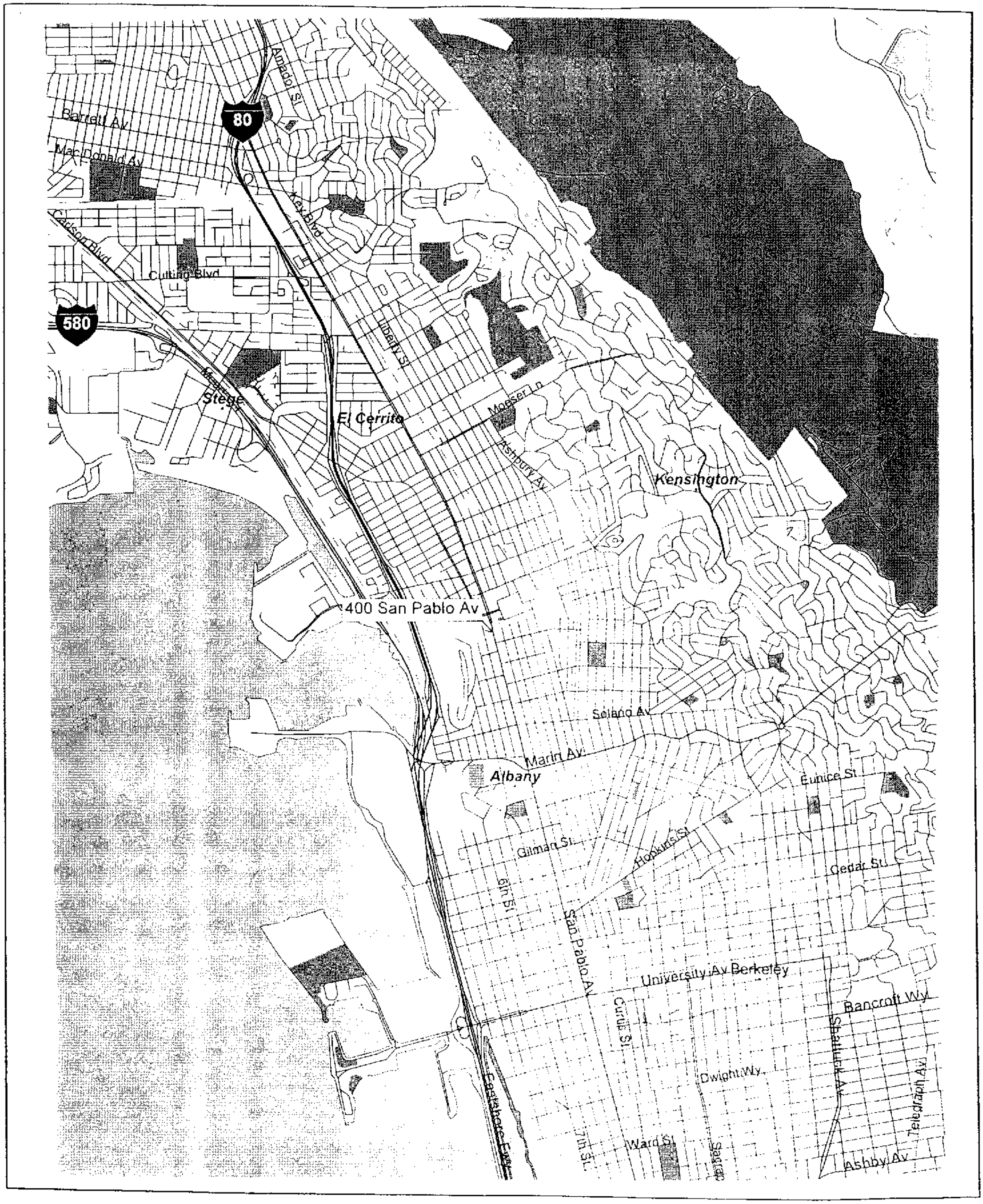


Figure 1: Site Location Map

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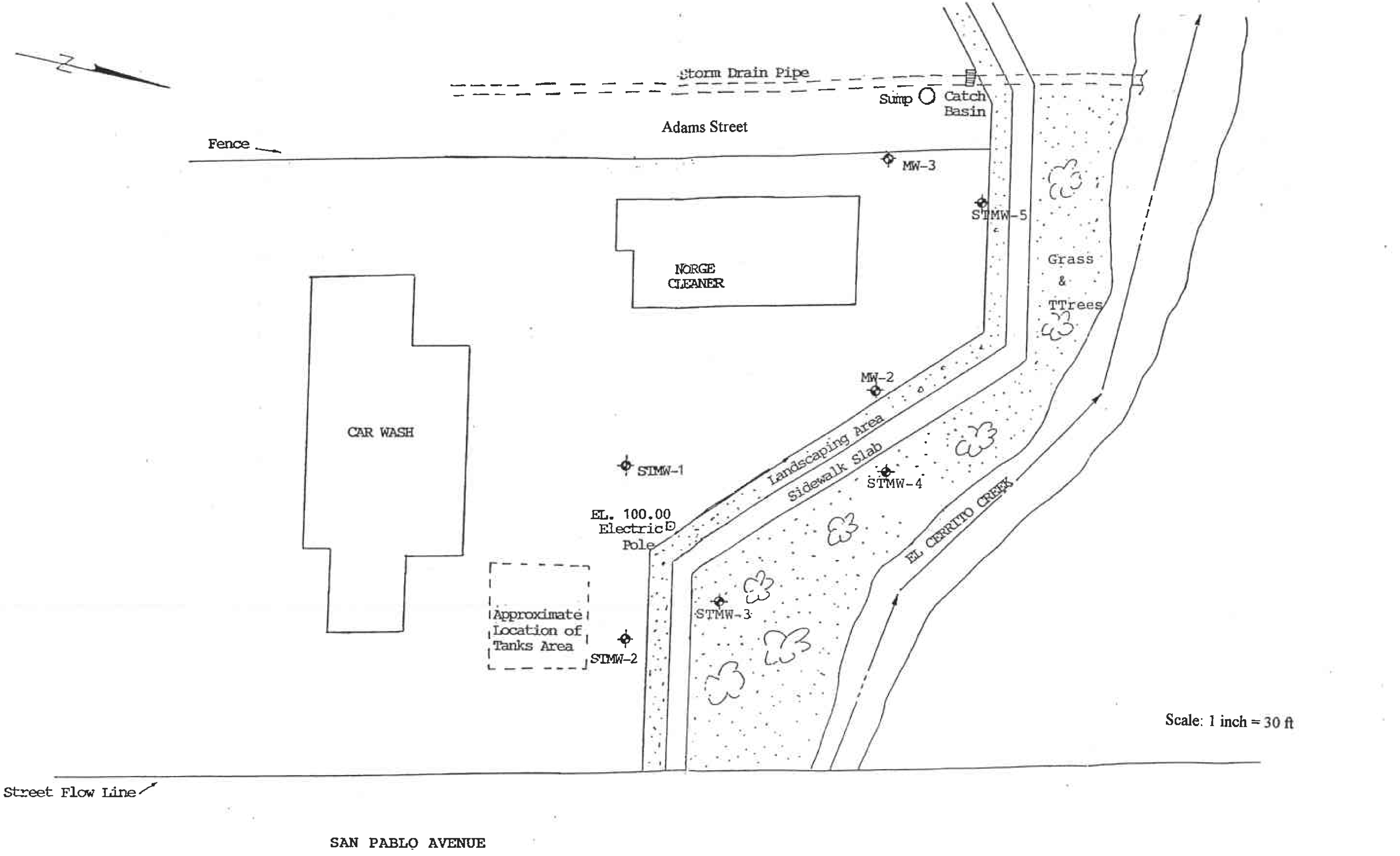

Figure 2: Location of the Monitoring Wells at the Site

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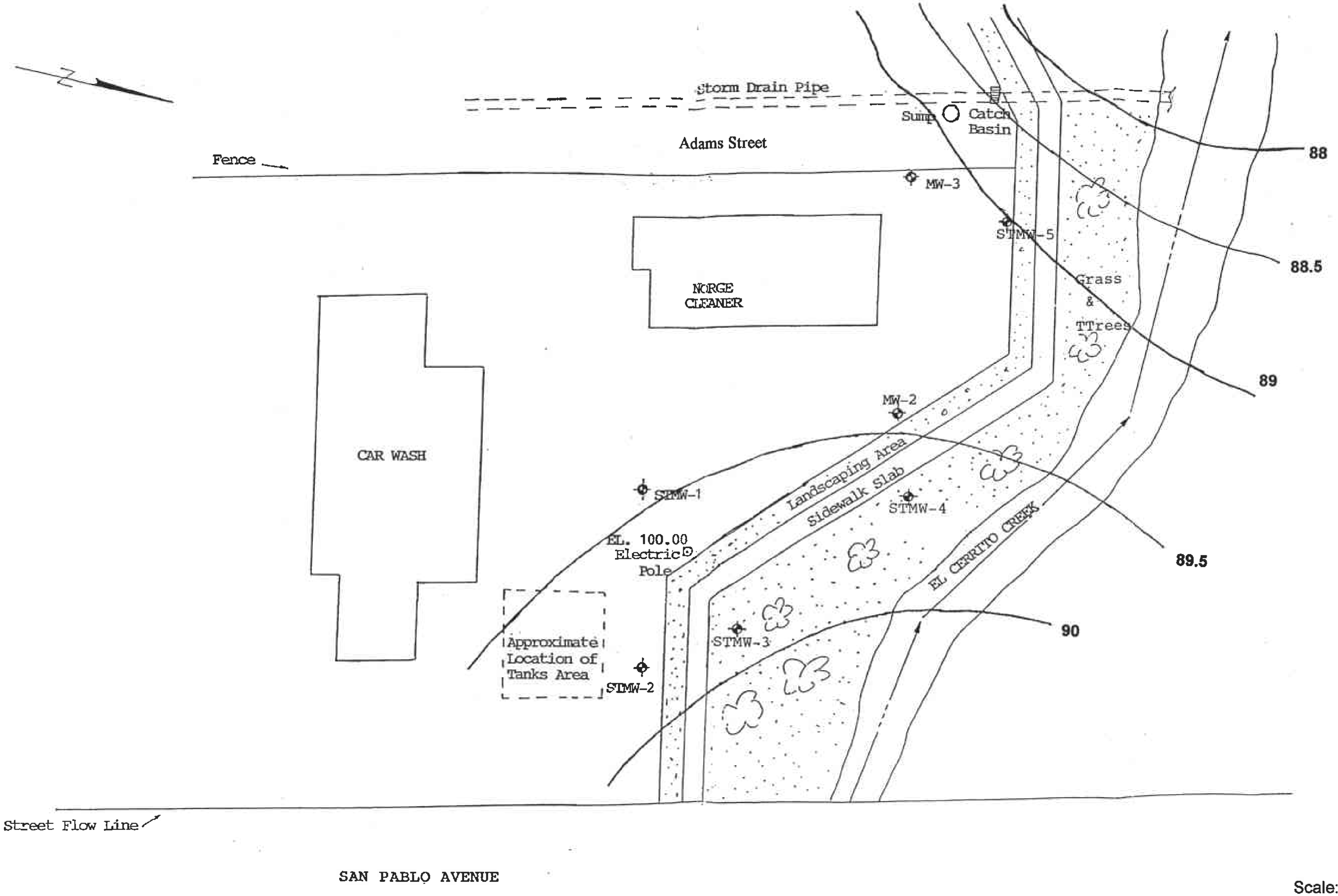

Scale: 1 inch = 30 ft

Figure 3: Groundwater Elevation Contour Map (13th May 1997)

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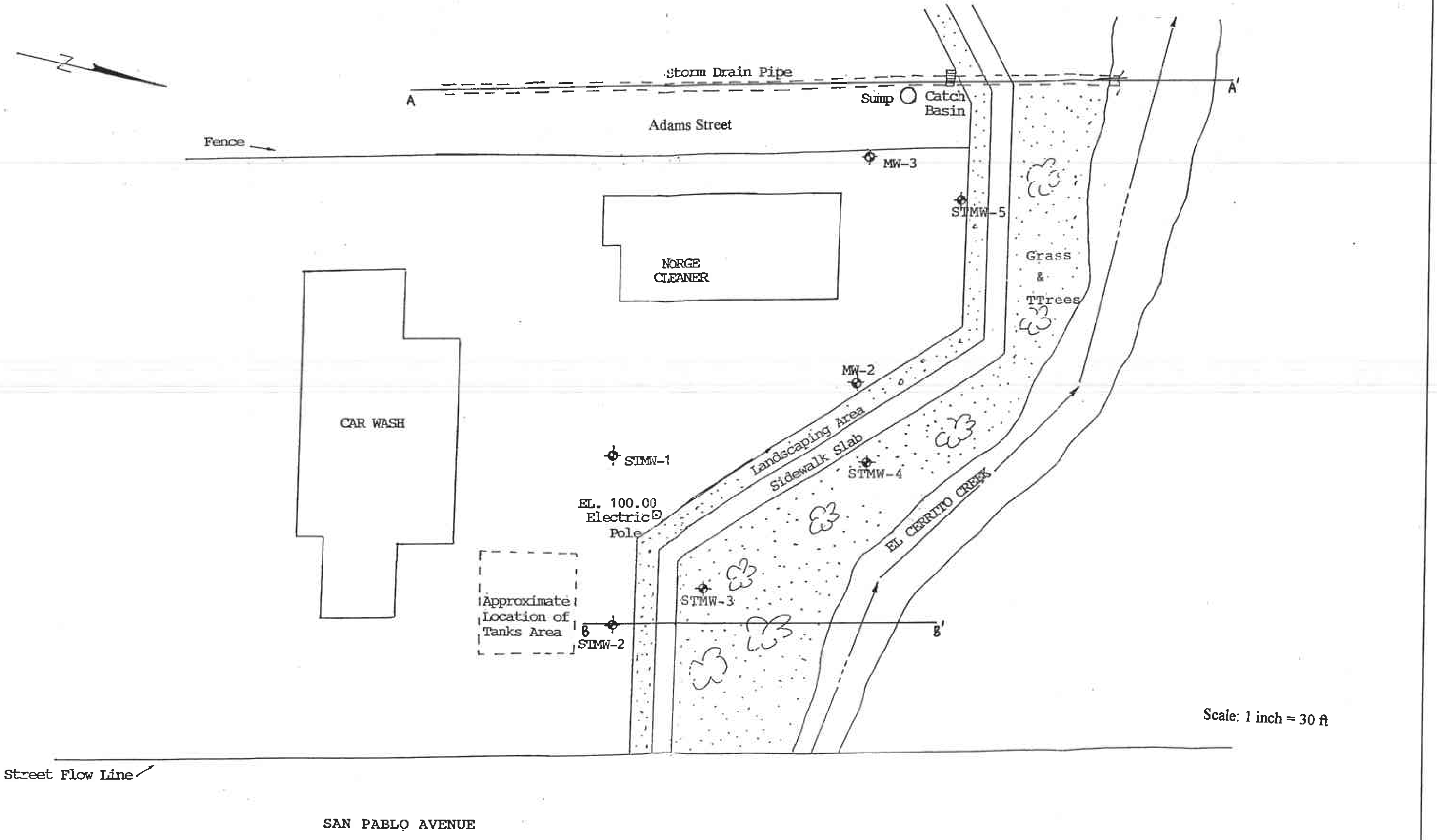

Figure 4: Location of the Geologic Cross-Sections A-A' and B-B'

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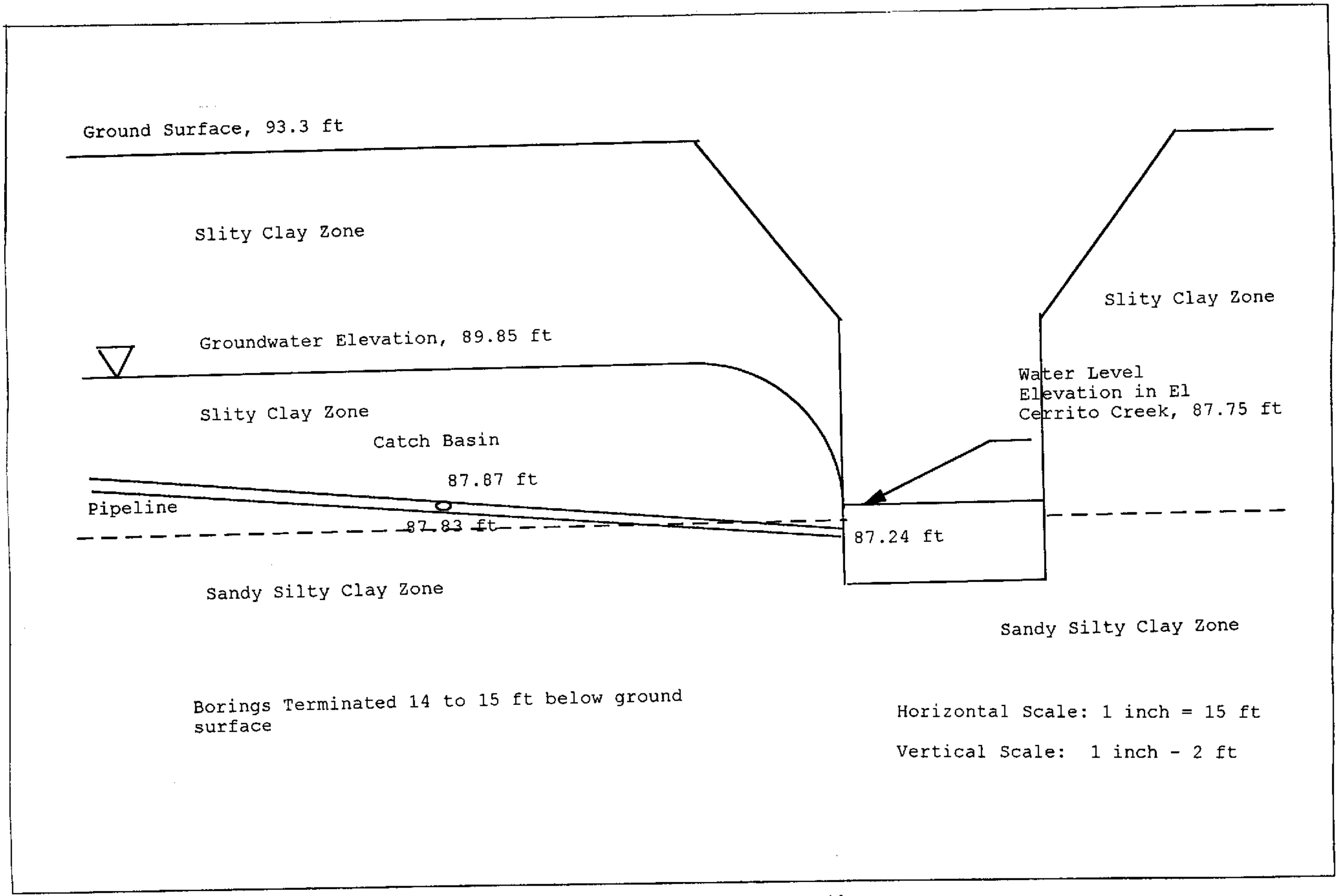

Figure 5: Geologic Cross-Section A-A'

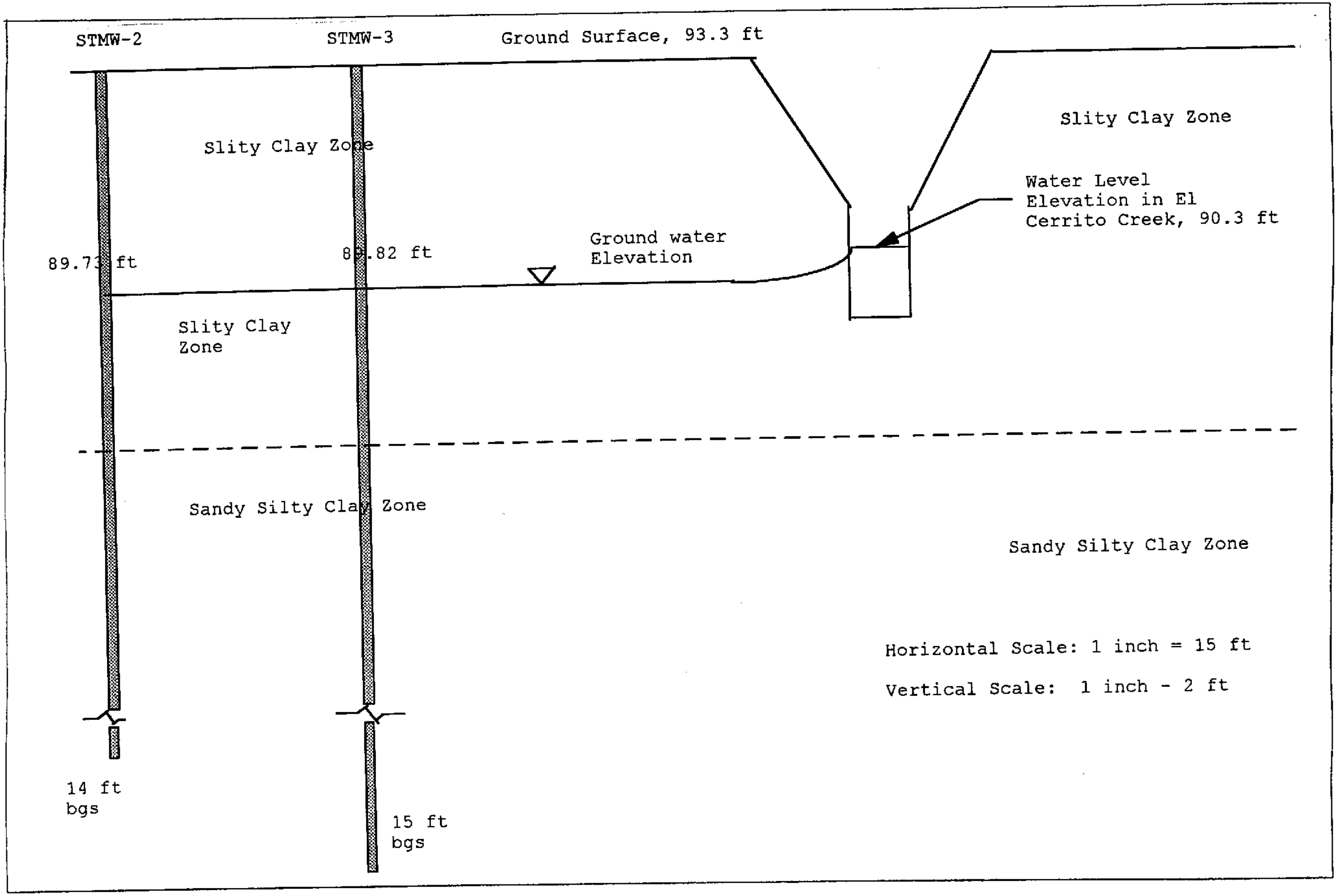

Figure 6: Geologic Cross-Section B-B'

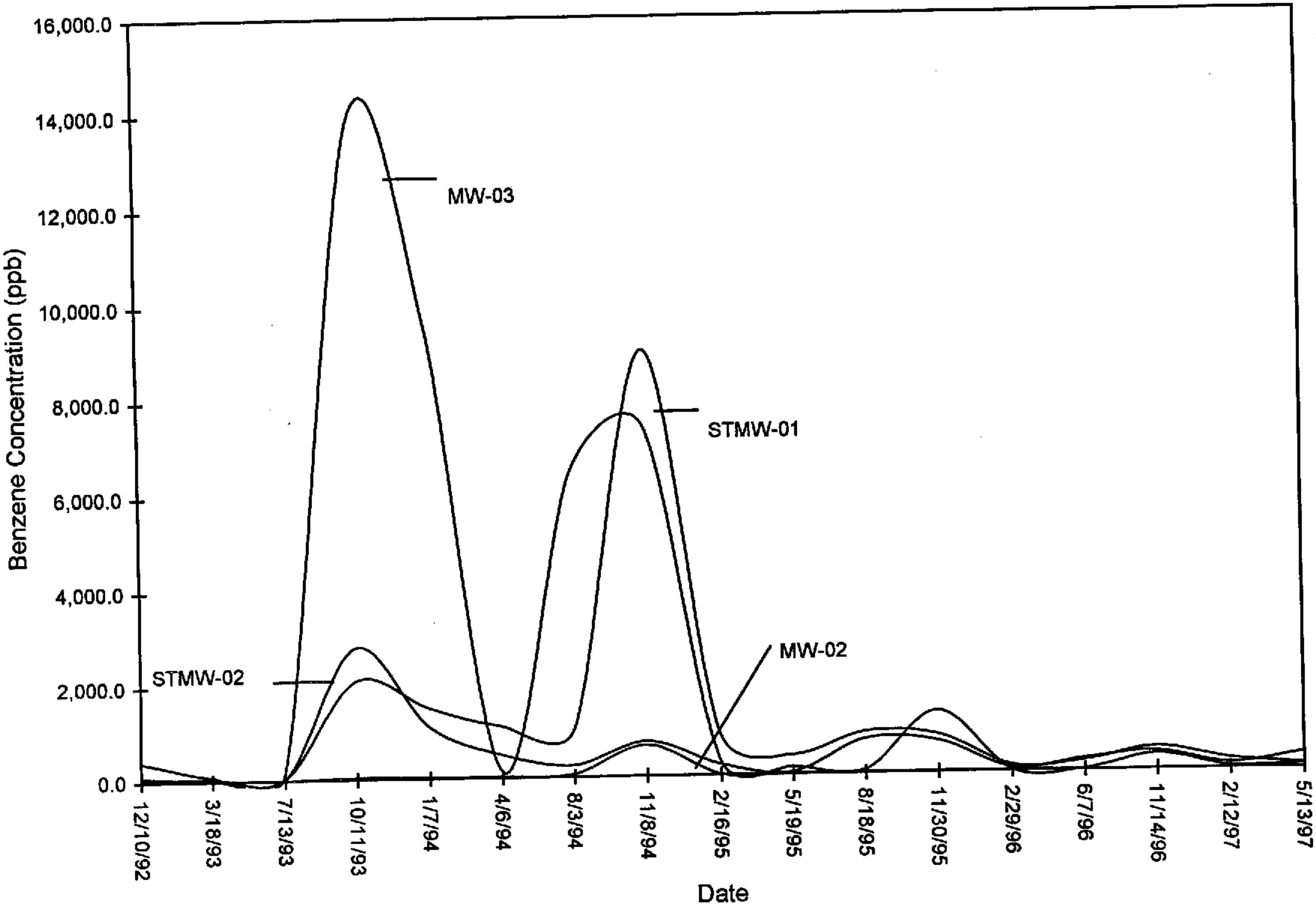

Figure 7: Historical Concentrations of Benzene in the Monitoring Wells STMW-1, STMW-2, MW-2 and MW-3

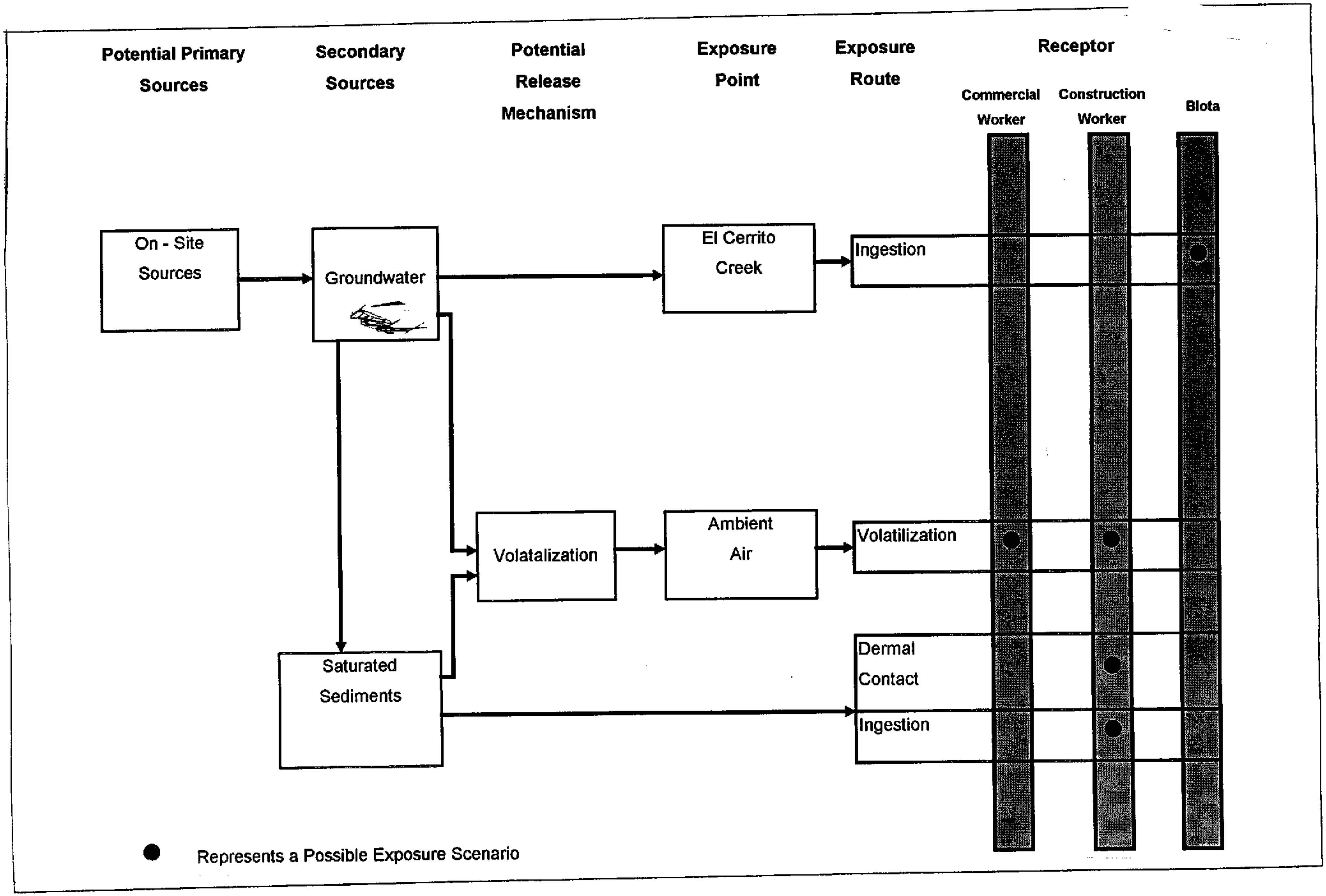

Figure 8: Conceptual Site Model (CSM)

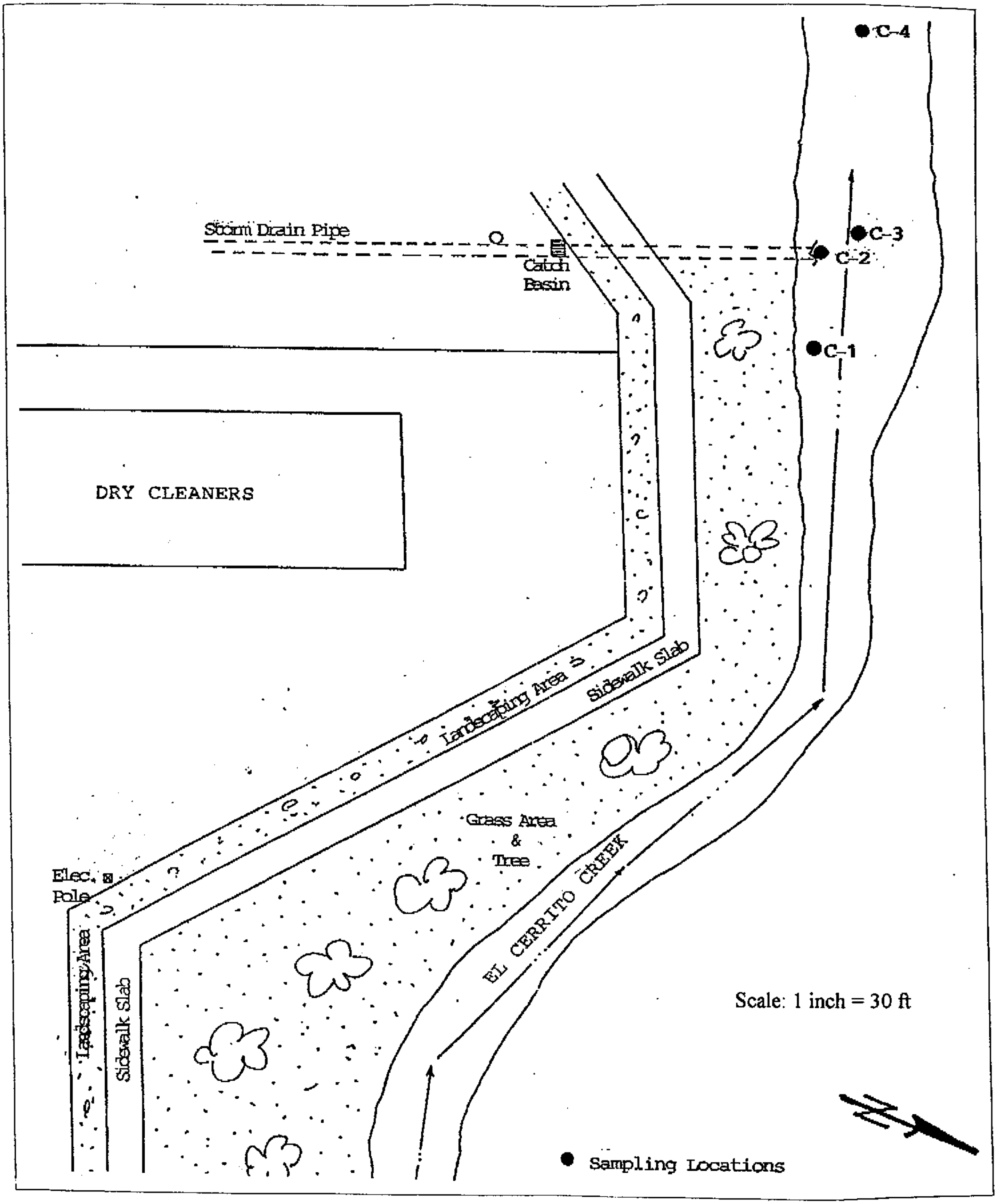

Figure 9: Location of the Water Sampling Locations, C-1, C-2, C-3, C-4 in the El Cerrito Creek

TABLES

Table 1

Groundwater Monitoring Data (May 13th 1997)

Well ID	Well Head Elevation (ft)	Depth to Water (ft)	Groundwater Elevation (ft)
STMW-1	96.81	7.33	89.48
STMW-2	96.79	7.06	89.73
STMW-3	95.24	5.42	89.82
STMW-4	94.41	4.75	89.66
STMW-5	94.49	5.30	89.19
MW-2	95.22	5.63	89.59
MW-3	95.62	5.77	89.85

Table 2

Groundwater Analytical Results at STMW-01

Date	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	MTBE (ppb)
12/10/92	54.0	79.0	83.0	220.0	NA
3/18/93	49.0	52.0	55.0	180.0	NA
7/13/93	34.0	43.0	17.0	NA	NA
10/11/93	2,100.0	2,400.0	530.0	2,600.0	NA
1/7/94	1,500.0	1,600.0	450.0	2,500.0	NA
4/6/94	1,100.0	560.0	300.0	1,600.0	NA
8/3/94	1,000.0	1,700.0	640.0	4,700.0	NA
11/8/94	9,000.0	12,000.0	1,600.0	9,100.0	NA
2/16/95	850.0	540.0	400.0	1,200.0	NA
5/19/95	400.0	330.0	170.0	610.0	NA
8/18/95	880.0	780.0	540.0	1,700.0	NA
11/30/95	800.0	910.0	390.0	1,500.0	NA
2/29/96	120.0	95.0	18.0	260.0	NA
6/7/96	210.0	140.0	81.0	210.0	NA
11/14/96	480.0	490.0	420.0	1,200.0	ND
2/12/97	210.0 A	190.0	60.0	190.0	ND
5/13/97	83.0	27.0	45.0	130.0	NA
Max	880.0	910.0	540.0	1,700.0	ND
Average	448.1	389.1	236.0	777.8	ND
n	9	9	9	9	NA
t(0.95,1)	1.9	1.9	1.9	1.9	NA
StDev	322.0	312.2	200.1	623.7	NA
95% UCL	652.1	586.9	362.7	1,172.8	NA

Max, Average, Standard Deviation and 95% UCL Calculated For Groundwater Concentrations Detected Since February 1995

Table 3

Groundwater Analytical Results at STMW-02

Date	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	MTBE (ppb)
12/10/92	84.0	96.0	120.0	350.0	NA
3/18/93	22.0	31.0	40.0	110.0	NA
7/13/93	18.0	24.0	26.0	89.0	NA
10/11/93	2,800.0	3,900.0	670.0	4,400.0	NA
1/7/94	1,100.0	1,000.0	280.0	1,800.0	NA
4/6/94	490.0	140.0	330.0	62.0	NA
8/3/94	250.0	52.0	55.0	240.0	NA
11/8/94	730.0	790.0	200.0	1,300.0	NA
2/16/95	230.0	88.0	92.0	320.0	NA
5/19/95	40.0	16.0	22.0	68.0	NA
8/18/95	720.0	550.0	520.0	1,400.0	NA
11/30/95	660.0	510.0	370.0	1,500.0	NA
2/29/96	75.0	55.0	52.0	150.0	NA
6/7/96	250.0	75.0	180.0	470.0	NA
11/14/96	380.0 4	230.0	270.0	720.0	ND
2/12/97	110.0	28.0	48.0	140.0	ND
5/13/97	320.0	48.0	94.0	200.0	NA
Max	720.0	550.0	520.0	1,500.0	ND
Average	309.4	177.8	183.1	552.0	ND
n	9	9	9	9	NA
t(0.95,1)	1.9	1.9	1.9	1.9	NA
StDev	243.3	209.4	170.9	547.3	NA
95% UCL	463.6	310.4	291.3	898.6	NA

Max, Average, Standard Deviation and 95% UCL Calculated For Groundwater Concentrations Detected Since February 1995

Table 4

Groundwater Analytical Results at STMW-03, STMW-04 and STMW-05

Date	Well I.D.	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	MTBE (ppb)
11/14/96	STMW-03	9.1	2.8	4.7	13	ND
2/12/97	STMW-03	ND	ND	ND	ND	ND
5/13/97	STMW-03	ND	ND	ND	ND	NA
Max		9.1	2.8	4.7	13	ND
Average		9.1	2.8	4.7	13	ND
11/14/96	STMW-04	ND	ND	ND	ND	ND
2/12/97	STMW-04	ND	ND	ND	ND	ND
5/13/97	STMW-04	ND	ND	ND	ND	NA
Max		ND	ND	ND	ND	ND
Average		ND	ND	ND	ND	ND
11/14/96	STMW-05	ND	ND	ND	ND	ND
2/12/97	STMW-05	ND	ND	ND	ND	ND
5/13/97	STMW-05	ND	ND	ND	ND	NA
Max		ND	ND	ND	ND	ND
Average		ND	ND	ND	ND	ND

Table 5

Groundwater Analytical Results at MW-02

Date	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	MTBE (ppb)
12/10/92	15.0	23.0	32.0	82.0	NA
3/18/93	8.3	11.0	13.0	48.0	NA
7/13/93	4.7	6.2	6.8	25.0	NA
10/11/93	43.0	2.6	4.5	12.0	NA
1/7/94	25.0	3.1	ND	20.0	NA
4/6/94	25.0	3.1	ND	20.0	NA
8/3/94	57.0	1.0	17.0	25.0	NA
11/8/94	650.0	85.0	500.0	1,000.0	NA
2/16/95	6.4	1.0	5.6	8.9	NA
5/19/95	11.0	10.0	23.0	26.0	NA
8/18/95	15.0	1.6	15.0	20.0	NA
11/30/95	9.3	ND	0.5	3.5	NA
2/29/96	6.1	1.2	6.2	8.7	NA
6/7/96	ND	ND	ND	ND	NA
11/14/96	ND	ND	ND	ND	ND
2/12/97	ND	ND	ND	ND	ND
5/13/97	ND	ND	ND	ND	NA
Max	15.0	10.0	23.0	26.0	ND
Average	9.6	3.5	10.1	13.4	ND
n	NA	NA	NA	NA	NA
t(0.95,1)	NA	NA	NA	NA	NA
Stdev	NA	NA	NA	NA	NA
95% UCL	NA	NA	NA	NA	NA

Max and Average Calculated For Groundwater Concentrations Detected Since February 1995

Table 6

Groundwater Analytical Results at MW-03

Date	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	MTBE (ppb)
12/10/92	400.0	410.0	430.0	1,100.0	NA
3/18/93	92.0	130.0	160.0	590.0	NA
7/13/93	160.0	210.0	230.0	820.0	NA
10/11/93	14,000.0	8,800.0	320.0	9,400.0	NA
1/7/94	9,500.0	4,600.0	7,800.0	230.0	NA
4/6/94	120.0	23.0	22.0	190.0	NA
8/3/94	6,500.0	5,700.0	1,500.0	18,000.0	NA
11/8/94	7,400.0	8,500.0	2,200.0	12,000.0	NA
2/16/95	280.0	120.0	120.0	570.0	NA
5/19/95	150.0	68.0	69.0	160.0	NA
8/18/95	74.0	28.0	38.0	100.0	NA
11/30/95	1,300.0	510.0	250.0	2,400.0	NA
2/29/96	12.0	3.8	10.0	24.0	NA
6/7/96	23.0	6.9	14.0	34.0	NA
11/14/96	320.0	130.0	250.0	620.0	ND
2/12/97	43.0	9.0	20.0	41.0	ND
5/13/97	68.0	30.0	60.0	110.0	NA
Max	1300.0	510.0	250.0	2400.0	ND
Average	252.2	100.6	92.3	451.0	ND
n	9	9	9	9	NA
t(0.95,1)	1.9	1.9	1.9	1.9	NA
Stdev	408.3	160.7	95.6	765.7	NA
95% UCL	510.8	202.4	152.9	935.9	NA

A

Max, Average, Standard Deviation and 95% UCL Calculated For Groundwater Concentrations Detected Since February 1995

Table 7

Chemical Property Values Used in the Emission Rate Calculations

Chemical Name	Henry's Law Constant at 25° C (atm-m^3/mol)	Ref.	Henry's Law Constant at 25° C (Dimensionless)	Molecular Weight (g/mole)	Air Diffusion* Coefficient at 25° C (cm^2/sec)
Benzene	5.59E-03	2	2.29E-01	78.11	0.0871
Ethylbenzene	8.68E-03	2	3.56E-01	106.17	0.0641
Toluene	6.74E-03	1	2.76E-01	92.14	0.0738
Xylene	5.27E-03	1	2.16E-01	106.17	0.0641

1) Groundwater Chemicals Desk Reference, John H. Montgomery and Linda M. Welkom
2) Basics of Pump and Treat, Groundwater Remediation Technology,
EPA 600/8-90/0033 March 1990)
*) Source Superfund Exposure Manual EPA/540/1-88/001

Table 8

Soil Property Values Used in Emission Rate Calculations*

Parameter	Definition	Value	Units
p	Dry Soil Bulk Density	105	(lbs/ft^3)
Pt	Total Soil Porosity	0.4	(Dimensionless)
Pa	Air Filled Porosity	0.13	(Dimensionless)
Pa, Saturated Sediments**	Air Filled Porosity, Saturated Sediments	0.04	(Dimensionless)

0.38

No!

*) Site Specific Values Were Not Available, Hence Values From Literature Were Used

**) Air Content in Saturated Sediments (Used in Jury's Model)

Table 9

95% UCL/Max Concentrations of Chemicals in Groundwater Monitoring Wells Since February 1995

Well ID	Max/95% UCL Concentration (ppb)			
	Benzene	Toluene	Ethylbenzene	Xylene
MW-02	15.0	10.0	23.0	26.0
MW-03	510.8	202.4	152.9	935.9
STMW-01	652.1	586.9	326.7	1172.8
STMW-02	720.0	550.0	520.0	1500.0
STMW-03	9.1	2.8	4.7	13.0
STMW-04	ND	ND	ND	ND
STMW-05	ND	ND	ND	ND
Max	720.0	586.0	520.0	1500.0

If 95% UCL Concentration could not be Calculated, Then Maximum Concentration was Tabulated

Port Aquantes

Table 10

Estimation of Emission Rates Due to Volatile Emissions From Groundwater Using Farmer's Equation

Chemical Name	Groundwater Concentration (mg/cm^3)	Gas Phase Concentration (mg/cm^3)	Air Diffusion Coefficient at 25° C (cm^2/sec)	Emission Rate (mg/cm^2-sec)
Benzene	7.20E-04	1.65E-04	0.0871	6.70E-10
Toluene	5.87E-04	1.62E-04	0.0738	5.58E-10
Ethylbenzene	5.20E-04	1.85E-04	0.0641	5.54E-10
Xylene	1.50E-03	3.24E-04	0.0641	9.69E-10

Table 11

Estimation of Indoor Air Concentrations of BTEX due to Volatile Emissions From Groundwater

Name of the Chemical	Emission Rate (mg/m^2-sec)	Indoor Air Concentration (mg/m^3)
Benzene	6.70E-06	2.01E-04
Toluene	5.58E-06	1.67E-04
Ethylbenzene	5.54E-06	1.66E-04
Xylene	9.69E-06	2.91E-04

Table 12

Parameters Used in Box Model

Parameters	Definition	Value	Units
On -site			
Z_0	Roughness Height, California Site Mitigation Decision Tree Manual	0.6	m
U	Average Windspeed, Alameda	3.98	m/sec
X	Length of Site Along the Primary Wind Direction'	55	m
H	Height of Box	7.9	m
W	Width of the Site, Perpendicular to the Primary Wind Direction	70	m

Table 13

Estimation of Outdoor Air Concentrations of BTEX due to Volatile Emissions From Groundwater

Name of the Chemical	Emission Rate (mg/m^2-sec)	Area of the Site (m^2)	Outdoor Air Concentration (mg/m^3)
Benzene	6.70E-06	3,850	2.34E-05
Toluene	5.58E-06	3,850	1.95E-05
Ethylbenzene	5.54E-06	3,850	1.94E-05
Xylene	9.69E-06	3,850	3.39E-05

Table 14

Concentrations of the Chemicals in the Groundwater and the Saturated Sediments Measured During the May 1997 Monitoring Event

Chemical Name	Maximum Concentration in Groundwater (mg/liter)	Distribution Coefficient (liter/kg)	Maximum Concentration in Soil (mg/kg)
Benzene	0.320	0.089	0.028
Toluene	0.048	0.137	0.007
Ethylbenzene	0.094	0.231	0.022
Xylene	0.200	0.184	0.037

Table 15

Estimated Outdoor Air Concentrations of BTEX due To Volatile Emissions from Saturated Sediments

Chemical Name	Maximum Detected Groundwater Conc (mg/liter)	Maximum Soil Conc (mg/kg)	Emission Rate (mg/m2-sec)	Area of the Trench (m2)	Mass Flux (mg/sec)	Outdoor Air Conc (mg/m3)
Benzene	0.32	0.028	4.48E-07	385	1.72E-04	1.57E-07
Toluene	0.048	0.007	9.92E-08	385	3.82E-05	3.47E-08
Ethylbenzene	0.084	0.022	7.54E-06	385	2.90E-03	2.64E-06
Xylene	0.2	0.037	4.32E-07	385	1.66E-04	1.51E-07

Table 16

Estimation of Outdoor Air Concentrations of BTEX due to Volatile Emissions From Freely Exposed Groundwater

Name of the Chemical	Henry's Law Coefficient (Dimensionless)	Volatilization Rate K (m/sec)	Concentration of Chemical in Groundwater (mg/m³)	Concentration of Chemical in Gas Phase (mg/m³)	Emission Rate (mg/m²-sec)	Area of the Trench (m²)	Outdoor Air Concentration (mg/m³)
Benzene	0.229	5.14E-05	3.20E+02	7.33E+01	1.27E-02	385	4.44E-03
Toluene	0.276	5.06E-05	4.80E+01	1.32E+01	1.76E-03	385	6.15E-04
Ethylbenzene	0.356	4.92E-05	9.40E+01	3.35E+01	2.98E-03	385	1.04E-03
Xylene	0.216	5.17E-05	2.00E+02	4.32E+01	8.10E-03	385	2.83E-03

Table 17

Carcinogenic and Non Carcinogenic Human Toxicity Criteria

Name of Chemical	Criteria for Noncarcinogens				Criteria for Carcinogens			
	Inhalation RfD (mg/kg-day)	Source	Oral Rfd (mg/kg-day)	Source	Inhalation Slope factor (mg/kg-day)-1	Source	Oral Slope factor (mg/kg-day)-1	Source
Benzene	1.70E-03	c	1.70E-03	b	1.00E-01	d	1.00E-01	d
Toluene	1.10E-01	e	2.00E-01	a	N/A			
Ethylbenzene	2.90E-01	a	1.00E-01	a	N/A			
Xylene	2.00E-01	b	2.00E-01	a	N/A			

a) USEPA Integrated Risk Information System, September 1995

b) Route to Route Extropolation

c) USEPA Environmental Criteria and Assessment Office

d) California Environmental Protection Agency (Cal-EPA).

Office of Environmental Health Hazard Assessment (OEHHA)

e) USEPA Health Effects Assessment Summary Tables (HEAST), 1994

Table 18

Summary Table of Carcinogenic Risks for Receptors of Concern

Receptor of Concern	Excess Cancer Risks					Total Excess Cancer Risk
	Inhalation of Volatile Emissions:		Dermal Contact with Groundwater	Dermal Contact with Wet Soil	Incidental Ingestion of Wet Soil	
	Indoor Air	Outdoor Air				
On-Site Outdoor Worker	NA	1.64E-07	NA	NA	NA	1.64E-07
On- Site Indoor Worker	1.40E-06	NA	NA	NA	NA	1.40E-06
Construction Worker						
Scenario1: Dewatering Condition	NA	1.10E-11	NA	1.50E-10	9.78E-12	1.71E-10
Scenario 2: No Dewatering Condition	NA	3.10E-07	7.09E-08	NA	9.78E-12	3.81E-07

Table 19

Summary Table of Non Carcinogenic Health Hazards for Receptors of Concern

Receptor of Concern	Non Carcinogenic Health Hazard					Total Non Carcinogenic Hazard
	Inhalation of Volatile Emissions		Dermal Contact with Groundwater	Dermal Contact With Wet Soil	Incidental Ingestion of Wet Soil	
	Indoor Air	Outdoor Air				
On-Site Outdoor Worker	NA	2.77E-03	NA	NA	NA	2.77E-03
On- Site Indoor Worker	2.38E-02	NA	NA	NA	NA	2.38E-02
Construction Worker Scenario1: Dewatering Condition	NA	2.01E-05	NA	4.44E-04	1.65E-05	4.81E-04
Scenario 2: No Dewatering Condition	NA	5.16E-01	2.16E-01	NA	1.65E-05	7.32E-01

Table 20

TPH-G Concentrations in the Water Samples of the El Cerrito Creek

Date	Sample Location			
	C-1 (mg/liter)	C-2 (mg/liter)	C-3 (mg/liter)	C-4 (mg/liter)
8/3/89	ND	470	NS	2.7
12/8/89	ND	33	ND	ND
1/3/90	ND	99	0.9	0.8
1/15/90	ND	16	0.84	0.16
1/17/90	ND	15	ND	ND
2/2/90	ND	16	0.06	0.13
2/8/90	ND	7	0.1	0.14
2/19/90	ND	26	0.03	0.2
3/6/90	0.065	30	0.6	0.12
3/13/90	ND	30	0.36	0.1
4/6/90	ND	42	3	0.4
11/27/90	ND	160	4.4	0.055
12/18/90	ND	33	0.066	ND
1/11/91	ND	14	0.37	ND
2/6/91	ND	11	ND	ND
3/6/91	ND	55	1.1	0.12
3/29/91	ND	31	ND	0.057
4/23/91	ND	28	ND	0.086
1/1/92	ND	3.3	ND	NS
1/10/92	ND	20	0.83	NS
2/21/92	ND	8.9	ND	NS
3/9/92	ND	2.1	ND	NS
3/20/92	ND	0.65	ND	NS
2/29/96	0.13	2.7	ND	ND
6/7/96	ND	ND	ND	ND

ND: Not Detected (Below Detection Limits)
NS: Not Sampled

C-1 C-2 C-3 C-4

Table 21

Benzene Concentrations in the Water Samples of the El Cerrito Creek

Date	Sample Location	Measured Concentration (ppb)	Fresh Water Standards*		Marine Water Standards*	
			Acute (ppb)	Chronic (ppb)	Acute (ppb)	Chronic (ppb)
2/29/96	C-1	0.9	5,300	nd	5,100	700
	C-2	7.2	5,300	nd	5,100	700
	C-3	ND	5,300	nd	5,100	700
	C-4	ND	5,300	nd	5,100	700
6/7/96	C-1	ND	5,300	nd	5,100	700
	C-2	ND	5,300	nd	5,100	700
	C-3	ND	5,300	nd	5,100	700
	C-4	ND	5,300	nd	5,100	700

nd: no data

ND: Not Detected (Below Detection Limits)

*) Standards for Fresh and Marine Water Aquatic Life (EPA, 1986)

Table 22

Toluene Concentrations in the Water Samples of the El Cerrito Creek

Date	Sample Location	Measured Concentration (ppb)	Fresh Water Standards*		Marine Water Standards*	
			Acute (ppb)	Chronic (ppb)	Acute (ppb)	Chronic (ppb)
2/29/96	C-1	ND	17,500	nd	6,300	5,000
	C-2	3.3	17,500	nd	6,300	5,000
	C-3	ND	17,500	nd	6,300	5,000
	C-4	ND	17,500	nd	6,300	5,000
6/7/96	C-1	ND	17,500	nd	6,300	5,000
	C-2	ND	17,500	nd	6,300	5,000
	C-3	ND	17,500	nd	6,300	5,000
	C-4	ND	17,500	nd	6,300	5,000

nd: no data

ND: Not Detected (Below Detection Limits)

*) Standards for Fresh and Marine Water Aquatic Life (EPA, 1986)

Table 23

Ethylbenzene Concentrations in the Water Samples of the El Cerrito Creek

Date	Sample Location	Measured Concentration (ppb)	Fresh Water Standards*		Marine Water Standards*	
			Acute (ppb)	Chronic (ppb)	Acute (ppb)	Chronic (ppb)
2/29/96	C-1	1.4	32,000	nd	430	nd
	C-2	5.8	32,000	nd	430	nd
	C-3	ND	32,000	nd	430	nd
	C-4	ND	32,000	nd	430	nd
6/7/96	C-1	ND	32,000	nd	430	nd
	C-2	ND	32,000	nd	430	nd
	C-3	ND	32,000	nd	430	nd
	C-4	ND	32,000	nd	430	nd

nd: no data
ND: Not Detected (Below Detection Limits)
*) Standards for Fresh and Marine Water Aquatic Life (EPA, 1986)

Table 24

Xylene Concentrations in the Water Samples of the El Cerrito Creek

Date	Sample Location	Measured Concentration (ppb)	Fresh Water Standards		Marine Water Standards	
			Acute (ppb)	Chronic (ppb)	Acute (ppb)	Chronic (ppb)
2/29/96	C-1	6.2	17,500	nd	6,300	5,000
	C-2	13	17,500	nd	6,300	5,000
	C-3	ND	17,500	nd	6,300	5,000
	C-4	ND	17,500	nd	6,300	5,000
6/7/96	C-1	ND	17,500	nd	6,300	5,000
	C-2	ND	17,500	nd	6,300	5,000
	C-3	ND	17,500	nd	6,300	5,000
	C-4	ND	17,500	nd	6,300	5,000

nd: no data

ND: Not Detected (Below Detection Limits)

Data for Xylene was not available, therefore data for Toluene was used for the comparison

*) Standards for Fresh and Marine Water Aquatic Life (EPA, 1986)

Table 25

Concentrations of Halogenated Volatile Organic Compounds in the Water Sample C-2 Collected From the Storm Drain Outlet

Date	Sample Location	Measured Concentration (ppb)	Fresh Water Standards*		Marine Water Standards*	
			Acute (ppb)	Chronic (ppb)	Acute (ppb)	Chronic (ppb)
2/29/96	Chloroform	ND	28,900	1,240	nd	nd
	Trichloroethene	ND	45,000	21,900	2,000	nd
	Tetrachloroethene	ND	5,280	840	10,200	450
6/7/96	Chloroform	19	28,900	1,240	nd	nd
	Trichloroethene	69	45,000	21,900	2,000	nd
	Tetrachloroethene	63	5,280	840	10,200	450

nd: no data

ND: Not detected (Below detection limits)

*) Standards for Fresh and Marine Water Aquatic Life (EPA, 1986)

APPENDIX 1

Estimation of the Skin Surface Area for The Occupational Exposure Scenario

The skin surface area of 2685 cm^2 for a hypothetical outdoor worker is based on an assumed male construction worker. The head, hands, and forearms are assumed to be exposed for 7-months of the year and the head and hands only are considered for the other 5-months, taking into account local weather conditions. The surface area of the exposed body parts was obtained from:

> EPA (1989). Exposure Factors Handbook, *Table 4-1, Surface Area by Body Parts for Adults.*

The body part and associated surface area are summarized as follows:

Exposed Body Part	**Surface Area**
Head	1,180 cm^2
Hands	840 cm^2
Forearms	1,140 cm^2

The weighted average exposed skin surface area over the 12 months is:

$$\frac{7 \text{ months} * (1{,}180 + 840 + 1{,}140 \text{ cm}^2) + 5 \text{ months} * (1{,}180 + 840 \text{ cm}^2)}{12 \text{ months}}$$

$$= \quad 2{,}685 \text{ cm}^2$$

APPENDIX 2

Noncarcinogenic Health Hazards from Inhalation of On-Site Volatile Emissions in Outdoor Air for a Hypothetical Occupational Scenario

Name of Chemical	On-Site Outdoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient (HQ)
Volatiles				
Benzene	2.34E-05	4.58E-06	1.70E-03	2.69E-03
Ethylbenzene	1.94E-05	3.80E-06	2.90E-01	1.31E-05
Toluene	1.95E-05	3.82E-06	1.10E-01	3.47E-05
Xylenes	3.39E-05	6.63E-06	2.00E-01	3.32E-05
		Hazard Index		**2.77E-03**

Carcinogenic Risks from Inhalation of On-Site Volatile Emissions in Outdoor Air for a Hypothetical Occupational Scenario

Name of Chemical	On-Site Outdoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)	Incremental Cancer Risk
Volatiles				
Benzene	2.34E-05	1.64E-06	1.00E-01	1.64E-07
		Total Risk		**1.64E-07**

Noncarcinogenic Health Hazards from Inhalation of On-Site Volatile Emissions in Indoor Air for a Hypothetical Occupational Scenario

Name of Chemical	On-Site Indoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient (HQ)
Volatiles				
Benzene	2.01E-04	3.93E-05	1.70E-03	2.31E-02
Ethylbenzene	1.66E-04	3.25E-05	2.90E-01	1.12E-04
Toluene	1.67E-04	3.27E-05	1.10E-01	2.97E-04
Xylenes	2.91E-04	5.69E-05	2.00E-01	2.85E-04
		Hazard Index		**2.38E-02**

Carcinogenic Risks from Inhalation of On-Site Volatile Emissions in Indoor Air for a Hypothetical Occupational Scenario

Name of Chemical	On-Site Indoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)$^{-1}$	Incremental Cancer Risk
Volatiles				
Benzene	2.01E-04	1.40E-05	1.00E-01	1.40E-06
		Total Risk		**1.40E-06**

Scenario 1: Dewatering Performed Prior to Construction
Dermal Contact with COPCsin Soil

Non Carcinogenic Hazard

Chemical Name	COPC Conc. in Soil (mg/kg)	Exposed Skin Surface Area SA (cm2)	Soil to Skin Adherence Factor (mg/cm2)	Conversion Factor CF (kg/mg)	Exposure Frequency (EF) (days/yr)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (days)	Chemical Intake (mg/kg-day)	Oral Reference Dose (RfDo) (mg/kg-day)	Hazard Quotient
Benzene	0.028	2685	1	1.00E-06	250	0.25	70	91.25	7.36E-07	1.70E-03	4.33E-04
Toluene	0.007	2685	1	1.00E-06	250	0.25	70	91.25	1.84E-07	2.00E-01	9.20E-07
Ethylbenzene	0.022	2685	1	1.00E-06	250	0.25	70	91.25	5.78E-07	1.00E-01	5.78E-06
Xylene	0.037	2685	1	1.00E-06	250	0.25	70	91.25	9.72E-07	2.00E-01	4.86E-06
										Total	4.44E-04

Total Excess Carcinogenic Risk

Chemical Name	COPC Conc. in Soil (mg/kg)	Exposed Skin Surface Area SA (cm2)	Soil to Skin Adherence Factor (mg/cm2)	Conversion Factor CF (kg/mg)	Exposure Frequency (EF) (days/yr)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (days)	Chemical Intake (mg/kg-day)	Oral Slope Factor (SFo) (mg/kg-day)	Excess Cancer Risk
Benzene	0.016	2685	1	1.00E-06	250	0.25	70	25550	1.50E-09	1.00E-01	1.50E-10
Toluene	0.0452	2685	1	1.00E-06	250	0.25	70	25550	3.20E-09	NA	NA
Ethylbenzene	0.0324	2685	1	1.00E-06	250	0.25	70	25550	2.30E-09	NA	NA
Xylene	0.0551	2685	1	1.00E-06	250	0.25	70	25550	3.90E-09	NA	NA
										Total	1.50E-10

Scenario 1: Dewatering Performed Prior to Construction
Non Carcinogenic Hazard Due to Volatile Emissions From Saturated Sediments

Name of Chemical	On-Site Outdoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient (HQ)
Volatiles				
Benzene	1.57E-07	3.07E-08	1.70E-03	1.81E-05
Ethylbenzene	2.64E-06	5.17E-07	2.90E-01	1.78E-06
Toluene	3.47E-08	6.79E-09	1.10E-01	6.17E-08
Xylenes	1.51E-07	2.95E-08	2.00E-01	1.48E-07
		Hazard Index		**2.01E-05**

Excess Carcinogenic Risk

Name of Chemical	On-Site Outdoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)$^{-1}$	Incremental Cancer Risk
Volatiles				
Benzene	1.57E-07	1.10E-10	1.00E-01	1.10E-11
		Total Risk		**1.10E-11**

Risk Assessment for Construction Worker
Scenario 2: No Dewatering Performed

Dermal Contact with COPCs Dissolved in Freely Exposed Groundwater
Non Carcinogenic Hazard

Chemical Name	Maximum Detected Groundwater Conc (mg/liter)	Exposed Skin Surface Area SA (cm2)	Dermal Permeability Coefficient (Kp) (cm/hour)	Conversion Factor CF (l/cm3)	Exposure Time (ET) (hours/day)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (days)	Chemical Intake (CDI) (mg/kg-day)	Oral Reference Dose (RfDo) (mg/kg-day)	Hazard Quotient
Benzene	0.32	2685	0.021	1.00E-03	* 2	250	0.25	70	91.25	3.53E-04	1.70E-03	2.08E-01
Toluene	0.048	2685	0.045	1.00E-03	2	250	0.25	70	91.25	1.13E-04	2.00E-01	5.67E-04
Ethylbenzene	0.084	2685	0.074	1.00E-03	2	250	0.25	70	91.25	3.27E-04	1.00E-01	3.27E-03
Xylene	0.2	2685	0.08	1.00E-03	2	250	0.25	70	91.25	8.41E-04	2.00E-01	4.20E-03
											Total	2.16E-01

Dermal Contact with COPCs Dissolved in Freely Exposed Groundwater

Total Excess Carcinogenic Risk

Chemical Name	Maximum Detected Groundwater Conc (mg/liter)	Exposed Skin Surface Area SA (cm2)	Dermal Permeability Coefficient (Kp) (cm/hour)	Conversion Factor CF (l/cm3)	Exposure Time (ET) (hours/day)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (days)	Chemical Intake (mg/kg-day)	Oral Cancer Slope Factor (SFo) (mg/kg-day)-1	Excess Cancer Risk
Benzene	0.18	2685	0.021	1.00E-03	2	250	0.25	70	25550	7.09E-07	1.00E-01	7.09E-08
Toluene	0.33	2685	0.045	1.00E-03	2	250	0.25	70	25550	2.79E-06	NA	NA
Ethylbenzene	0.14	2685	0.074	1.00E-03	2	250	0.25	70	25550	1.94E-06	NA	NA
Xylene	0.3	2685	0.08	1.00E-03	2	250	0.25	70	25550	4.50E-06	NA	NA

* check with Bill

Scenario 2: No Dewatering Performed Prior to Construction
Non Carcinogenic Hazard Due to Volatile Emissions From Freely Exposed Groundwater

Name of Chemical	On-Site Outdoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient (HQ)
Volatiles				
Benzene	4.44E-03	8.69E-04	1.70E-03	5.11E-01
Ethylbenzene	1.04E-03	2.04E-04	2.90E-01	7.02E-04
Toluene	6.15E-04	1.20E-04	1.10E-01	1.09E-03
Xylenes	2.83E-03	5.54E-04	2.00E-01	2.77E-03
		Hazard Index		**5.16E-01**

Excess Carcinogenic Risk

Name of Chemical	On-Site Outdoor Air Concentration (mg/m^3)	Occupational Chemical Intake (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)$^{-1}$	Incremental Cancer Risk
Volatiles				
Benzene	4.44E-03	3.10E-06	1.00E-01	3.10E-07
		Total Risk		**3.10E-07**

Risk Assessment for Construction Worker
Scenario 1 and 2
Incidental Ingestion with COPCs in Soil

Non Carcinogenic Hazard

Chemical Name	Conc. in Soil (mg/kg)	Ingestion Rate (mg/day)	Conversion Factor CF (kg/mg)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (days)	Chemical Intake (mg/kg-day)	Oral Reference Dose (RfDo) (mg/kg-day)	Hazard Quotient
Benzene	0.028	100	1.00E-06	250	0.25	70	91.25	2.74E-08	1.70E-03	1.61E-05
Toluene	0.007	100	1.00E-06	250	0.25	70	91.25	6.85E-09	2.00E-01	3.42E-08
Ethylbenzene	0.022	100	1.00E-06	250	0.25	70	91.25	2.15E-08	1.00E-01	2.15E-07
Xylene	0.037	100	1.00E-06	250	0.25	70	91.25	3.62E-08	2.00E-01	1.81E-07
									Total	1.65E-05

Total Excess Carcinogenic Risk

Chemical Name	Conc. in Soil (mg/kg)	Ingestion Rate (mg/day)	Conversion Factor CF (kg/mg)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (days)	Chemical Intake (mg/kg-day)	Slope Factor (mg/kg-day)-1	Excess Cancer Risk
Benzene	0.028	100	1.00E-06	250	0.25	70	25550	9.78E-11	1.00E-01	9.78E-12
Toluene	0.007	100	1.00E-06	250	0.25	70	25550	1.60E-10	NA	NA
Ethylbenzene	0.022	100	1.00E-06	250	0.25	70	25550	1.10E-10	NA	NA
Xylene	0.037	100	1.00E-06	250	0.25	70	25550	1.90E-10	NA	NA
									Total	9.78E-12