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94-2050

May 17, 1994

Ms. Susan Hugo
Sr. Hazardous Materials Specialist
Alameda County Health Agency
Department of Environmental Health
80 Swan Way, Room 350
Oakland, California 94621

Subject: Baseline Health Risk Assessment for Area C at the Yerba Buena Project Site

Dear Ms. Hugo:

On behalf of Catellus Development Corporation, SOMA Environmental Engineering, Inc. is submitting the enclosed Baseline Health Risk Assessment (HRA) for the Yerba Buena Project Site, Area C, in Oakland and Emeryville, California. This HRA was performed by SOMA at the request of Catellus and its environmental consultant, Levine·Fricke, Inc. in response to a request by your office that a human health risk assessment be performed for the subject site. The HRA was performed in accordance with SOMA's Work Plan dated March 23, 1994.

Sincerely,

John M. Faustini

John M. Faustini, R.G.
Senior Associate Hydrogeologist

enclosure

cc: Mr. Ron Goloubow, Levine·Fricke, Inc.
Ms. Kim Brandt, Catellus Development Corp.
Dr. Ravi Arulanantham, Alameda County Department of Environmental Health
Mr. Lester Feldman, California Water Quality Control Board, San Francisco Bay Region

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BASELINE HEALTH RISK ASSESSMENT
FOR THE
YERBA BUENA PROJECT SITE, AREA C
EMERYVILLE AND OAKLAND, CALIFORNIA

Project No. 94-2050

May 16, 1994

Prepared for

Catellus Development Corporation
201 Mission Street, 30th Floor
San Francisco, California 94105

at the request of

Levine·Fricke, Inc.
1900 Powell Street, 12th Floor
Emeryville, California 94608

Prepared by

SOMA Environmental Engineering, Inc.
155 Filbert Street, Suite 230
Oakland, California 94607

CERTIFICATION AND LIMITATIONS

This report has been prepared by SOMA Environmental Engineering, Inc. (SOMA) for the exclusive use of Levine·Fricke, Inc. and Catellus Development Corporation for their use in evaluating potential human health risks associated with proposed commercial development of the subject property due to chemicals detected in on-site soil and groundwater, as described herein. The evaluation and resulting conclusions are based on data provided to us by Levine·Fricke and Catellus and believed to be true and accurate. SOMA has provided its professional services using the degree of care and skill ordinarily exercised by other scientists and engineers practicing in this field. No other warranty, express or implied, is made as to the conclusions and professional opinions and recommendations contained in this report.

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May 16, 1994
Project No. 94-2050

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EXECUTIVE SUMMARY

Introduction

Catellus Development Corporation owns a large parcel of land, known as the Yerba Buena Project Site (the "Site"), in a former industrial area on the Oakland-Emeryville border near the junction of the Interstate 80, 580, and 880 freeways. Catellus plans to develop the northwestern portion of the Site, designated "Area C," as a retail shopping center. Due to concern over groundwater contamination by volatile organic compounds (VOCs) which appear to be migrating into Area C across the Site's northeastern boundary, the Alameda County Department of Environmental Health ("the County") requested that a baseline health risk assessment be performed to evaluate potential health risks associated with the proposed land use due to chemicals found in soil and groundwater within Area C. At the request of Levine·Fricke, Catellus' environmental consultant, SOMA Environmental Engineering, Inc. (SOMA) performed a baseline health risk assessment (HRA) for Area C.

The objective of the HRA was to evaluate potential human health risks associated with exposure to hazardous chemicals detected in subsurface soil and groundwater in Area C which might occur during construction and operation of the proposed retail shopping center. The HRA evaluated potential risks to construction workers during construction of the proposed development as well as risks to future retail workers in the completed shopping center. Exposure pathways evaluated for future retail workers were limited to inhalation of chemical vapors emitted by contaminated soil and groundwater beneath the proposed buildings, as no other credible exposure pathways were identified. Exposure pathways evaluated for construction workers included inhalation of chemical vapors as well as dermal contact with and incidental ingestion of contaminated soil. The scope of the HRA was limited to an evaluation of the potential health risks to on-site workers posed by chemicals present in soil and groundwater within Area C.

Site Background

Area C has experienced a variety of industrial and commercial land uses since the early 1900s, including warehouse storage, an automobile warehouse and service shop, a bus and truck service garage, a coal storage yard, and passenger and freight rail lines. The site is currently vacant and all structures have been removed.

Levine·Fricke has conducted environmental investigation and remediation activities at the Yerba Buena Project Site since September 1989. Based on a review of historical activities within Area C, these investigations focussed on characterizing subsurface soil and groundwater conditions and on identifying, delineating, and mitigating soil and groundwater contamination by VOCs, semi-volatile organic compounds (SVOCs), petroleum hydrocarbons, and priority pollutant metals. Limited remedial actions have been implemented to address localized surface and subsurface contamination of soil and perched groundwater by petroleum hydrocarbons and metals.

Site Hydrogeology

Shallow soils beneath Area C are predominantly fine-grained, consisting principally of clay and silty clay with minor amounts of sand and gravel to a depth of at least ten feet below ground surface (bgs). Beneath this depth, sand and gravel are more abundant, with an average total thickness of about 3½ feet of sand and/or gravel occurring in one or two layers between the depths of approximately 10 and 20 feet bgs. This zone of coarse-grained sediments constitutes the shallow aquifer beneath Area C.

The depth to groundwater measured in Area C monitoring wells has historically ranged between approximately 4 and 8 feet bgs, while the depth to groundwater observed during drilling and excavation activities has been approximately 8 to 10 feet bgs (Levine·Fricke, 1994). This observation suggests that shallow groundwater occurs under predominantly semi-confined conditions beneath Area C. The shallow groundwater flow direction beneath Area C is southwestward, toward San Francisco Bay.

Nature and Extent of Contamination

The principal finding of Levine·Fricke's remedial investigation activities was that shallow groundwater in Area C is contaminated by several VOCs—principally trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), and vinyl chloride—at a combined concentration of up to several parts per million (ppm). The source of the VOCs in groundwater in Area C appears to located off-site, upgradient (i.e., opposite the groundwater flow direction, or northeast) of the northeastern property boundary. Concentrations of VOCs in groundwater in Area C, and particularly along the northeastern boundary, have decreased significantly since groundwater samples were first collected in January 1990.

Elevated concentrations of metals and SVOCs were not detected in shallow groundwater in Area C. Elevated concentrations of TPH as oil (7.8 ppm) were detected in groundwater at one location adjacent to a former underground storage tank, where perched groundwater with an oily sheen and a strong odor was also identified; this area was subsequently remediated in accordance with a Site Remedial Plan developed by Levine·Fricke and approved by the County. Elsewhere, only low concentrations of TPH, principally classified as oil, was reported in groundwater samples, with a maximum concentration of 1.5 ppm.

The chlorinated VOCs detected in groundwater were generally not detected in soil except within the saturated zone, where low reported concentrations of VOCs were likely due to groundwater contamination. Toluene, however, was reported in a majority of widely distributed soil samples collected at a depth of less than 8 feet, or within the vadose (unsaturated) zone in Area C. Localized elevated concentrations of lead, zinc, and petroleum hydrocarbons (principally as motor oil) were identified and remediated in accordance with a Site Remedial Plan developed by Levine·Fricke and approved by the County. SVOCs were not detected in Area C soils except for 0.2 ppm of PCB Arochlor 1260 in a single sample.

Chemicals of Concern

Based on a thorough review of available site characterization data, the following chemicals of concern (COCs) were identified:

Groundwater

- TCE
- 1,2-DCE
- Vinyl Chloride

Soil

- 1,2-DCE
- Toluene
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- Zinc

Even though metals were generally not detected at elevated concentrations in on-site soils, they were included as COCs in the risk assessment at the request of Levine·Fricke to address regulatory agency concerns.

Chemical Fate and Transport Modeling and Estimation of Exposure Point Concentrations

Chemical fate and transport modeling was performed in order to estimate current and future exposure point concentrations of COCs. Processes modeled include groundwater flow and chemical transport, volatilization of chemicals from groundwater and diffusion to the ground surface, and mixing and dispersion of chemicals in indoor air. Modeling results were used to predict concentrations of COCs in indoor air at one of three proposed building locations, selected for its proximity to the location of maximum VOC concentrations in groundwater, both at the present time and 30 years in the future. The predicted concentrations were then used to calculate potential carcinogenic and noncarcinogenic inhalation risks for the various scenarios considered.

For potential dermal and ingestion exposure evaluations, the 95% upper confidence limit (95% UCL) of the mean of the reported concentrations was calculated for each soil COC. The calculated 95% UCL concentrations were used as the exposure point concentrations for potential dermal and ingestion exposures in the construction scenario of the risk assessment.

Risk Assessment

The risk assessment considered two scenarios: a construction worker scenario and a future retail store worker scenario.

The construction worker scenario considered potential exposures due to inhalation of chemical vapors emitted by soil and groundwater as well as incidental ingestion of and dermal contact with contaminated soil. A worst-case evaluation was performed, assuming exposure 8 hours per day, 5 days per week for 6 months for a laborer working in a 5-foot deep excavation, where potential inhalation exposures are increased due to increased proximity to contaminated groundwater and decreased mixing of vapor emissions with ambient air due to the confined nature of the excavation. The construction worker scenario also evaluated potential exposures due to incidental ingestion of and dermal contact with contaminated soils.

The future retail store worker scenario considered potential inhalation exposures only, as the proposed development would eliminate the potential for significant exposures to Area C soils. This scenario assumed that a typical store worker would be indoors and exposed to VOCs which might potentially accumulate in indoor air for 8 hours per day, 5 days a week over a 25-year period.

For each scenario, both carcinogenic risks and noncarcinogenic hazards were evaluated. Carcinogenic risks were evaluated in terms of the estimated probability that a worker exposed to a chemical at the level assumed in the scenario would develop a cancer as a result of that exposure. Cancer risks associated with each COC and each exposure route were then summed to produce a total cancer risk estimate. A cancer risk equal to or less than 1×10^{-6}, or one in one million, is considered to be negligible and not a cause for concern.

Noncarcinogenic hazards were evaluated by comparing the predicted chemical intake, or dose, of each chemical to an EPA-approved reference dose (a dose believed to have no significant adverse health effects) and summing the resulting hazard quotients for each chemical to produce a hazard index (HI). This is a conservative approach which assumes that all noncarcinogenic adverse health effects are additive. An HI of less than or equal to one is indicative of no likelihood of significant adverse health effects.

Conclusions and Recommendations

The total estimated cancer risk for construction workers was 5.43×10^{-7} for all routes of exposure (inhalation, ingestion, and dermal exposure). The estimated cancer risk for indoor retail workers was 6.05×10^{-7} based on current concentrations of VOCs in groundwater and 6.14×10^{-7} based on predicted future groundwater VOC concentrations. These risk estimates are less than one in one million and are considered negligible.

For the construction scenario, the estimated hazard indices for inhalation of chemical vapors, ingestion of soil, and dermal contact with soil were 2.37, 2.26×10^{-2}, and 6.06×10^{-3}, respectively. The estimated inhalation hazard index exceeds a value of unity, with toluene contributing 87 percent of the hazard. Although this result is indicative of potential adverse health effects, it should be noted that the inhalation hazard was derived using chronic reference doses, which is overly conservative given the relatively short exposure duration of 6 months. The HI becomes less than one when a subchronic inhalation reference dose is used in place of the chronic reference dose.

For future retail store workers, the HI for inhalation was estimated to be 1.61×10^{-1} and 5.89×10^{-2} for the estimated current and future air concentrations, respectively. These values indicate that no adverse health effects would be anticipated for a worker exposed to these air concentrations 8 hours per day, 250 days per year, for a working lifetime of 25 years.

In summary, no significant health risks associated with the proposed development of Area C as a retail shopping center were identified by this HRA. However, this HRA is not intended as a substitute for a Site Safety Plan (SSP). An SSP should be prepared prior to initiating construction in Area C. The SSP should address potential hazards due to inhalation of VOCs emitted from soil or groundwater as well as hazards associated with potential contact with contaminated soils, and should specify work procedures designed to minimize potential exposure of workers to hazardous chemicals.

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May 16, 1994

BASELINE HEALTH RISK ASSESSMENT FOR THE YERBA BUENA PROJECT SITE, AREA C EMERYVILLE AND OAKLAND, CALIFORNIA

1.0 INTRODUCTION

1.1 Background

Catellus Development Corporation owns a large parcel of land in a former industrial area on the Oakland-Emeryville border near the junction of the Interstate 80, 580, and 880 freeways (Figure 1). Catellus has retained Levine·Fricke, Inc. to perform environmental investigations and remediation activities at the property, designated the Yerba Buena Project site (the "Site"), since 1990.

The northwestern portion of the Site, designated "Area C," (Figure 2) is proposed for a large retail development. Levine·Fricke has identified residual concentrations of various chemicals in soil and groundwater in Area C. Six underground storage tanks (USTs) have been removed from Area C, and various other remedial activities to address on-site contamination issues have been or are scheduled to be completed under a Site Remedial Plan (Levine·Fricke, 1991) approved by the Alameda County Department of Environmental Health (the "County"). However, due to concern over groundwater contamination by volatile organic compounds (VOCs) which appear to be migrating into Area C across the Site's northeastern boundary, the County requested that a baseline health risk assessment be performed to evaluate potential health risks associated with the proposed land use due to chemicals found in soil and groundwater within Area C. At the request of Levine·Fricke, SOMA Environmental Engineering, Inc. (SOMA) performed a baseline health risk assessment (HRA) for Area C.

1.2 Objectives and Scope

The primary objective of the HRA was to evaluate potential human health risks associated with exposure to hazardous chemicals detected in subsurface soil and groundwater in Area C which might occur during construction and operation of a proposed retail commercial development. Specific objectives of the proposed HRA included the following:

- Estimate carcinogenic and noncarcinogenic risks to construction workers during construction of the proposed development due to potential exposure to hazardous chemicals in groundwater and soil. Exposure pathways evaluated included inhalation of chemical vapors as well as dermal contact with and incidental ingestion of contaminated soil.

- Estimate potential carcinogenic and noncarcinogenic risks to retail workers in the proposed shopping mall associated with inhalation of chemical vapors from contaminated soil and groundwater.

This HRA evaluates the potential human health risks associated with existing subsurface contamination beneath Area C only. Evaluation of potential risks associated with contamination in other areas of the Site or with contamination in off-site areas (except as they may impact groundwater quality beneath Area C) was beyond the scope of this investigation.

The methods and assumptions that formed the framework of this risk assessment are those found in the following State and federal guidelines:

- California Environmental Protection Agency (Cal EPA). 1992. Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities. Prepared by the Office of the Science Advisor, July

- California Department of Health Services (DHS). 1990. Book II - Scientific and Technical Standards for Hazardous Waste Sites (Draft). Toxic Substances Control Program, Program and Administrative Support Division, Technical Services Branch, DHS. August 1990. DHS Doc. No. 7540-958-1102-0

- U.S. Environmental Protection Agency (U.S. EPA). 1989. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, (Part A), Interim Final. Office of Solid Waste and Emergency Response, Washington, D.C. EPA/540/1-89/002, December

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

- U.S. Environmental Protection Agency (U.S. EPA). 1988. Superfund Exposure Assessment Manual. Office of Remedial Response, U.S. EPA, Washington, D.C. April 1988. EPA 540/1-88-001

- U.S. Environmental Protection Agency (U.S. EPA). 1991. Health Effects Assessment Summary Tables: Annual FY-1991. Office of Emergency and Remedial Response, Washington, D.C., OERR 9200.6-303-(91-1)

- U.S. Environmental Protection Agency (U.S. EPA). 1993. Integrated Risk Information System (IRIS). Chemical-specific reference doses and cancer potency factors and EPA Toxicology Background Documents. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, Ohio

2.0 SITE DESCRIPTION

2.1 Location and Setting

The Site is located on the Oakland-Emeryville border just west of the Interstate 80/580/880 interchange (Figure 1), in a former heavy industrial area. In recent years, adjacent areas have been redeveloped for retail and commercial office use, as well as medium to high-density residential use. Current development plans for Area C, which occupies the northwestern quadrant of the Site (Figure 2), call for construction of a shopping center containing a variety of retail stores. Under the proposed development plans, with the exception of small planter areas, the entirety of Area C would be covered by asphalt-paved streets and parking areas or buildings with concrete slab foundations.

The Site is essentially flat and slopes gently toward the southwest. It is located approximately 2,000 feet east of San Francisco Bay at its western edge. Area C is currently vacant and all structures have been removed.

2.2 Site History

Area C has experienced a variety of industrial and commercial land uses since the early 1900s. These uses included warehouse storage, predominantly of dry goods but also limited quantities of hazardous materials (e.g., oxides and acids); an automobile warehouse and service shop; a bus and truck service garage; a coal storage yard; and several passenger and freight rail transit lines. Additional details of past site usage are presented in a Phase I and Phase II Environmental Investigation report prepared by Levine·Fricke (1990).

2.3 Previous Investigations

Levine·Fricke has conducted environmental investigation and remediation activities at the Yerba Buena Project Site since September 1989. The environmental investigation was conducted in three phases: Phase I, Phase II, and Phase III. Remediation activities in Area C have included removal of USTs and associated piping as well as hydraulic lifts and an oil/water separator, and excavation of soil contaminated by metals (lead and zinc) and petroleum hydrocarbons (gasoline, diesel and oil).

Phase I investigations by Levine·Fricke consisted of targeted and non-targeted soil and groundwater sampling. Samples were analyzed for volatile organic compounds (VOCs; EPA Methods 8240 and 8020), semivolatile organic compounds (SVOCs; EPA Method 8270), total petroleum hydrocarbons (TPH; EPA Method 8015), and metals (EPA Method 7000 series). Phase II and III investigations were conducted to better assess areas of potential environmental concern revealed by the Phase I investigation, and consisted of targeted sampling and the use of analytical methods similar to those used during Phase I.

To assess shallow groundwater quality in Area C, groundwater samples were collected from five monitoring wells (LF-9, LF-10, LF-11, LF-12, and LF-16; see Figure 2) and four grab groundwater sampling locations (C-10, C-15, C-18, and C-20; see Figure 3) during the Phase I investigation in 1989 and 1990. Following the removal of four USTs in 1991 and 1992, monitoring wells LF-31 and LF-32 were installed in 1993 to assess groundwater quality downgradient from the former UST locations (Figure 2). Significant results of the environmental investigations conducted by Levine·Fricke as they pertain to the risk assessment are summarized in Section 3.2.

3.0 DATA COLLECTION, SITE CHARACTERIZATION, AND IDENTIFICATION OF CHEMICALS OF CONCERN

In order to quantitatively assess the potential human health risk posed by chemical contaminants in the soil and/or groundwater at a site, it is necessary to characterize the distribution and concentration of chemicals of potential concern in the affected media. This requires collection of representative samples from each medium of concern (e.g., soil and groundwater). The number and location of such samples must be sufficient to adequately assess the spatial distribution of contaminants in each medium. The site characterization data generated by the sampling program form the basis for identifying and selecting chemicals of concern (COCs), performing environmental fate and transport modeling and estimating exposure point concentrations, and quantifying potential health risks.

3.1 Data Collection

This HRA is based primarily on data generated in previous investigations by Levine·Fricke (1990, 1994). These data were obtained following standard protocol for ensuring representativeness of the samples and preservation of sample integrity. Sampling and analytical procedures and results are described in the referenced reports.

The sampling and analysis plan developed for the Phase I investigation was based on the results of a background information review and consisted of targeted and nontargeted soil and groundwater sampling (Levine·Fricke, 1994). During the Phase I investigation, 28 soil borings were drilled to depths of 10 to 15 feet. Selected soil samples from these borings as well as from the borings for monitoring wells LF-9, LF-10, LF-11, and LF-12 were analyzed for one or more of the following:

- volatile organic compounds (VOCs) using EPA Method 8240,
- semivolatile organic compounds (SVOCs) using EPA Method 8270,
- total petroleum hydrocarbons (TPH) using EPA Method 8015, and
- priority pollutant metals using EPA Method 7000 series.

Additional soil sampling conducted during the Phase II and III investigations consisted of targeted sampling employing the same analytical methods and focussing on potential areas of concern identified in the Phase I investigation.

Seven monitoring wells (LF-9, LF-10, LF-11, LF-12, LF-16, LF-31, and LF-32) have been installed in Area C by Levine·Fricke for purposes of characterizing and monitoring groundwater flow and quality. In addition, shallow groundwater monitoring well LF-13 was installed in Area D immediately downgradient of Area C (Figure 2). Data obtained from the monitoring wells include lithologic information obtained during drilling, potentiometric (groundwater elevation) measurements, hydraulic (slug) test data, and chemical analysis results for the same analytes as listed above for soils. Monitoring wells LF-12 and LF-16 have subsequently been abandoned pursuant to the development of Area C, and monitoring well LF-11 was replaced by well LF-11R in November 1993.

3.2 Site Characterization

Prior to performing the HRA, SOMA reviewed available site characterization data from previous site investigations. This section of the report summarizes the results of the data review and identifies the COCs selected on the basis of that review.

The discussion in this section is based upon a review of the following documents which we received from Levine·Fricke:

- Levine·Fricke, Inc., "Phase I and Phase II Environmental Investigation, Yerba Buena Project Site, Emeryville, California," Volumes I and II of IV, August 15, 1990.
- Levine·Fricke, Inc., "Site Remedial Plan, Yerba Buena Project Site, Emeryville and Oakland, California," (Draft) February 11, 1991.
- Levine·Fricke, Inc., "Summary of Environmental Investigation Results for Area C of the Yerba Buena Project Site, Emeryville and Oakland, California," March 9, 1994.

Our review of these documents focussed on data pertaining to Area C, particularly with regard to soil and groundwater sampling results, since the HRA is targeted to address only soil and groundwater contamination present in Area C.

3.2.1 Hydrogeology

Soil borings have been drilled at the Site and in Area C for purposes of collecting soil samples for chemical analysis and installing monitoring wells. Lithologic logs for the monitoring wells are summarized in Table 3-2. Monitoring well locations are shown in Figure 2. The well logs, which extend to a maximum depth of slightly more than 20 feet below ground surface (bgs), indicate that shallow soils beneath Area C consist primarily of clay and silty clay, sometimes containing significant amounts of gravel, interbedded with lesser amounts of sand and gravel. Sand and gravel appear to be more abundant below a depth of about ten feet bgs. Monitoring well boring logs indicate that an average of about 3½ feet of sand and gravel (ranging from clayey sand to silty sand and gravel) are present in one or two layers between depths of 10 and 20 feet beneath most of Area C. This sand and gravel zone is largely absent in the northeastern corner of the area, near monitoring well LF-31 and former monitoring wells LF-9 and LF-16 (Figure 2), where little or no sand and gravel were encountered other than shallow fill materials. A particularly thick but apparently localized sequence of coarse-grained material, consisting of silty sandy gravel, was encountered between depths of six and 20 feet at the location of monitoring well LF-32.

In order to obtain information on site-specific soil properties for use in chemical fate and transport modeling for the risk assessment, Levine·Fricke drilled soil borings BW-10 and BW-32 adjacent to monitoring wells LF-10 and LF-32, respectively. Samples collected at depths of 2.5, 4.0, 6.5, and 16.5 feet from boring BW-10 and depths of 2.5 and 11.5 feet from BW-32 were tested for bulk density, moisture content and organic carbon content. Based on the bulk density and soil moisture data, the porosity of the soil materials was calculated assuming an average soil particle density of 2.65 gm/cm^3. These data are presented in Table 3-2. Based on four samples, the average porosity of the predominantly fine-grained vadose zone materials was estimated to be 0.42, while the average porosity of the coarser aquifer materials was estimated to be 0.35 based on two samples.

The depth to groundwater measured in Area C monitoring wells has historically ranged between approximately 4 and 8 feet bgs, while the depth to groundwater observed during drilling and excavation activities has been approximately 8 to 10 feet bgs (Levine·Fricke, 1994). This observation suggests that shallow groundwater occurs under predominantly semi-confined conditions beneath Area C. This conclusion is also supported by the position of the potentiometric surface (4 to 8 feet bgs) relative to the depth of more permeable coarse-grained deposits (typically greater than 10 feet bgs).

The shallow groundwater flow direction beneath Area C is toward the southwest (Figure 2). This flow direction has been consistent over at least four sets of potentiometric (water-level) measurements obtained by Levine·Fricke since January 1992.

3.2.2 Nature and Extent of Soil Contamination

As described in Section 2.3, Area C soil samples collected during previous investigations were analyzed for VOCs, SVOCs, total petroleum hydrocarbons, and metals. Phase I soil sampling locations are shown in Figure 3.

3.2.2.1 VOCs in Soil

During the Phase I Investigation, 31 soil samples from 22 soil boring and monitoring well locations in Area C were analyzed for VOCs (EPA Methods 8010 and/or 8020). The sampling locations and analytical results are presented in Figure 3 and Table 3-3. Several VOCs were detected in soil samples collected within Area C, including trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), and toluene. However, TCE and 1,2-DCE which were each reported in 4 of 24 Phase I soil samples analyzed for VOCs, were detected (at maximum concentrations of 0.24 and 0.039 mg/kg, respectively) only in samples collected from depths ranging from 8 to 13 feet bgs—that is, within the saturated zone—except for one sampling location (C17, Figure

3) where 1,2-DCE was reported at a concentration of 0.034 mg/kg at a depth of 4 feet. Because TCE and 1,2-DCE were not detected in vadose zone samples (with one exception as noted), and because they have been detected in groundwater at concentrations of up to 7.6 and 4.7 mg/l, respectively, it is reasonable to conclude that the concentrations of these chemicals reported in soil samples in Area C are attributable to groundwater contamination.

Toluene, which has not been reported in groundwater samples collected from Area C, was reported in 26 of 31 soil samples collected in Area C during the Phase I Investigation which have were analyzed for VOCs, including 20 of 22 samples collected within the vadose zone (Table 3-3). The maximum reported toluene concentration in Area C soils is 0.55 mg/kg, but most samples were reported to contain less than 0.1 mg/kg (Table 3-3). However, reported toluene concentrations in Area C soil samples may be due in part to the use of electrical tape, which typically contains toluene, to secure plastic end caps to the sampling brass tubes. If the reported concentrations reflect actual site conditions, toluene is widespread in Area C soils at low concentrations. No source for such widespread low-level contamination has been identified.

3.2.2.2 SVOCs, Metals, and Petroleum Hydrocarbons in Soil

Of 20 Area C soil samples analyzed for SVOCs using EPA Method 8270, no SVOCs were detected except for 0.2 mg/kg of PCB Aroclor 1260 in a single sample. This concentrations is well below the cleanup goal of 1 mg/kg established in the Site Remedial Plan (SRP) (Levine·Fricke, 1991).

Table 3-4 summarizes the analytical results for Priority Pollutant Metals detected in soil samples collected in the Phase I Investigation, including the maximum detected concentration and the 95% Upper Confidence Limit (95% UCL) concentration for each compound. As Table 3-4 shows, metals concentrations reported for soil samples collected in Area C were generally within typical ranges of published values for uncontaminated soils. However, elevated concentrations of lead (8,800 mg/kg) and zinc (47,000 mg/kg) were detected in a shallow (1 foot deep) soil sample from a single location (C-17) in Area C. Additional sampling revealed that elevated concentrations of lead and zinc in soil were very limited in lateral and vertical extent. Approximately 120 cubic yards of soil were excavated from the vicinity of the sampling location C-17 in accordance with the SRP.

Localized areas of petroleum hydrocarbon contamination were identified in the Phase I investigation and subsequently further investigated in the Phase II and Phase III investigations. Heavy fraction TPH characterized as oil was detected at 7 of 27 sampling locations during the Phase I investigation, generally at concentrations in the range of 50 to 680 mg/kg. TPH as oil was detected at a concentration of 2,600 mg/kg at a depth of 4 feet bgs at one location (C-19). TPH as diesel was also detected at one location (C-13) at a concentration of 490 mg/kg. TPH as gasoline was detected at low concentrations (less than 1 mg/kg) at three locations. Management of soil TPH contamination issues is addressed in the SRP (Levine·Fricke, 1991), which was approved by the County.

3.2.3 Nature and Extent of Groundwater Contamination

Results of the Phase I and Phase II investigations did not indicate the presence of elevated concentrations of metals or SVOCs in shallow groundwater. TPH and BTEX concentrations reported in groundwater samples collected from monitoring wells and Phase I soil borings in Area C are summarized in Table 3-6. Elevated concentrations of TPH as oil (7.8 mg/l) were detected in groundwater at monitoring well location LF-9, adjacent to former underground storage tanks at this locations. Perched groundwater with an oily sheen and a strong fuel odor was detected in this vicinity during the Phase I investigation; this area was subsequently remediated in accordance with the SRP. Elsewhere, only low concentrations of TPH, principally classified as oil, was reported in groundwater samples, with a maximum concentration of 1.5 mg/l at well LF-10 (Table 3-6) No BTEX has been reported in groundwater in association with these limited instances of TPH contamination, with the exception of 2 ug/l of toluene in one sample collected from well LF-16.

3.2.3.1 VOCs in Groundwater

Analytical results for VOCs detected in groundwater in Area C are summarized in Table 3-5. The following VOCs have been detected in groundwater samples from Area C:

- 1,1-dichloroethene (DCE)
- 1,2-dichloroethene (1,2-DCE)
- trichloroethene (TCE)
- chlorobenzene
- 1,1-dichloroethane (1,1-DCA)
- 1,1,1-trichloroethane (1,1,1-TCA)
- tetrachloroethene (PCE)
- 1,1,2-trichloroethane (1,1,2-TCA)
- vinyl chloride
- chloroform
- methylene chloride (DCM)

As Table 3-5 clearly shows, TCE and 1,2-DCE (including cis and/or trans isomers) are the principal VOC contaminants in groundwater beneath Area C. These compounds have been consistently detected in samples collected from monitoring wells LF-10, LF-11/11R, LF-12, and recently installed monitoring wells LF-31 and LF-32. TCE was also detected in the sample from well LF-13 in the March 1994 sampling event. In all, TCE has been reported in at least one sample from every Area C monitoring well except LF-16, while 1,2-DCE has been reported in every monitoring well except LF-13 and LF-16. The highest concentrations of TCE and 1,2-DCE were reported for well LF-10, adjacent to the northern property boundary, at 7,600 and 3,200 ug/l respectively, in February 1990. TCE concentrations detected at well LF-10 have consistently declined over time, to 1,500 ug/l by March 1994. 1,2-DCE concentrations have also declined significantly at LF-10 since 1990, but have fluctuated between about 300 and 600 ug/l in samples collected in 1993 and 1994.

Vinyl chloride also has been reported in samples collected from well LF-10 (Table 3-5), decreasing from a reported concentration of 1,000 ug/l in February 1990 to about 100 ug/l in

March 1994. Vinyl chloride has not been detected in any other Area C monitoring wells, except for a 1 ug/l concentration reported in one of two duplicate samples collected from monitoring well LF-11R.

Most of the other compounds listed above have been detected only on one or two occasions at one or two sampling locations. As Table 3-5 shows, 1,1-DCE, PCE, and 1,1,2-TCA were each reported in only one sample collected from well LF-10 during one of three sampling events in 1990. These chemicals were not reported in samples collected during two subsequent sampling events in 1993, but were again detected at very low concentrations (5, 15, and 2 ug/l, respectively) in one of two duplicate samples collected from well LF-10 in March 1994 and analyzed by American Environmental Network (AEN, Table 3-5). Several additional chemicals were detected for the first time in this same sample, including chlorobenzene, 1,1-DCA, 1,2-DCA, and 1,1,1-TCA, all at concentrations of 5 ug/l or less. With the exception of 1,1,1-TCA, which was also detected at trace level concentration (0.8 ug/l) in duplicate samples collected from well LF-13 in March 1994, none of these additional compounds has been reported in any other groundwater samples collected from Area C monitoring wells.

Methylene chloride (also known as dichloromethane, or DCM) was also reported for the first time in the March 1994 sampling event, in a duplicate sample from well LF-10 analyzed by Anametrix, Inc. (Table 3-5). Methylene chloride is a common laboratory contaminant, and since it was not detected in the duplicate sample analyzed by AEN, which had a lower detection limit, it is likely that the reported concentration of 130 ug/l in the sample analyzed by Anametrix represents laboratory contamination.

3.3 Identification of Chemicals of Concern

Based on the data review discussed in Sections 3.1 and 3.2, the following VOCs were identified as chemicals of concern (COCs) in Area C:

Groundwater
- Trichloroethene (TCE)
- 1,2-Dichloroethene (1,2-DCE)
- Vinyl chloride

Soil
- 1,2-DCE
- Toluene

VOCs detected for the first time in Area C groundwater samples in the March 1994 sampling event (chlorobenzene, chloroform, 1,1-DCA, 1,2-DCA, DCM, and 1,1,1-TCA) were not included as COCs. These compounds were detected only at very low concentrations (less than 5 ug/l, except for DCM, which is believed to be the result of laboratory contamination) and, except for chloroform and 1,1,1-TCA, were detected in only one of two duplicate samples collected from monitoring well LF-10 (Table 3-5). Chloroform was reported only in duplicate samples from well LF-31, at concentrations of 1.2 and 1.4 ug/l. 1,1,1-TCA, which is not a carcinogen, was reported at a concentration of 5 ug/l in one of two duplicate samples from well LF-10 and at 0.8 ug/l in both duplicate samples from well LF-13 in the March 1994 sampling event (Table 3-5).

1,1-DCE, a carcinogen, was reported at a concentration of 31 ug/l in a single sample collected from well LF-10 in February 1990, and was subsequently not detected until the March 1994 sampling event, when it was again reported in one of two duplicate samples collected from well LF-10 at a concentration of 5 ug/l. Because 1,1-DCE has only been detected sporadically and at concentrations more than an order of magnitude lower than those reported for vinyl chloride, a chemical with similar toxicity characteristics and greater mobility in the subsurface which is evaluated in this HRA, 1,1-DCE was not selected as a COC for evaluation in the risk assessment. For similar reasons, PCE and 1,1,2-TCA, which were both reported in the same two samples collected from well LF-10 as was 1,1-DCE, were also not selected as COCs for inclusion in the risk assessment.

In addition to the four VOCs listed above, the following 11 Priority Pollutant Metals detected in on-site soils were included in the risk evaluation for on-site construction workers:

- Arsenic (As)
- Beryllium (Be)
- Cadmium (Cd)
- Chromium (Cr)
- Copper (Cu)
- Lead (Pb)
- Mercury (Hg)
- Nickel (Ni)
- Selenium (Se)
- Silver (Ag)
- Zinc (Zn)

These compounds were not included as COCs in the evaluation for retail workers since no credible exposure pathway for non-volatile chemicals in Area C soils exists for the retail worker scenario.

4.0 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

4.1 Overview of Contaminant Fate and Transport Modeling

Because documented concentrations of chemicals of concern in Area C are present only in the subsurface environment, where direct contact with potential human receptors is unlikely to occur, SOMA employed environmental fate & transport modeling techniques in order to evaluate exposure point concentrations of COCs. Exposure point concentrations are chemical concentrations in a medium of concern (e.g., soil, water, or air) at a location where exposure to COCs by the receptor population is likely to occur. Examples of exposure point concentrations would be the chemical concentration of a COC in groundwater at an existing or potential drinking water supply well location, the concentration in ambient air at the ground surface, or the concentration in indoor air inside a home or office building.

In this HRA, contaminant fate & transport modeling methods were used to generate the following data:

- estimated future chemical concentrations in groundwater as a function of location and time,
- estimated chemical vapor emission rates at the ground surface due to volatilization of chemicals from groundwater, and
- estimated maximum average chemical concentrations in outdoor and indoor air likely to result from vapor emissions from contaminated groundwater.

These data were then used to perform the quantitative health risk assessment.

4.1.1 Environmental Pathways Evaluated

Potential environmental pathways for chemical migration from subsurface soil and groundwater containing COCs (i.e., exposure pathways) include the following:

- Ingestion of soil containing COCs.
- Dermal contact with soil containing COCs exposed by excavation activities.
- Inhalation of chemical vapors emitted by soil containing VOCs.
- Inhalation of chemical vapors emitted by groundwater containing VOCs.

4.1.2 Mathematical Models Used to Evaluate Contaminant Fate and Transport

Several different mathematical models were used to evaluate contaminant fate and transport in the subsurface and in ambient and indoor air. These models are listed below and are described in Sections 4.2 through 4.6.

- To evaluate chemical transport in groundwater, the numerical finite-difference transport model MT3D developed by S.S. Papadopulos (Zheng, 1992) was used in conjunction with the finite-difference groundwater flow model MODFLOW developed by the U.S. Geological Survey (McDonald and Harbaugh, 1988).
- Vapor emission rates from groundwater were estimated using a modified application of Fick's Law (a steady-state analytical transport equation) described by Farmer et al. (1980).
- The methodology of the Orange County Public Health Care Agency's Simplified Vapor Pathway Evaluation (SVPE) (Daugherty, 1991) was used to estimate indoor air concentrations of COCs in a proposed building location in Area C.

4.2 Contaminant Transport in Groundwater

4.2.1 Transport Processes

The transport of aqueous phase (dissolved) chemicals in groundwater is governed by the processes of advection, dispersion, and sorption. In addition, chemical reactions can affect concentrations of a given chemical species in groundwater. Advection, or flow with the groundwater, is the dominant transport mechanism for dissolved chemicals in groundwater. Dispersion, which results from small-scale variations in the groundwater flow velocity (direction and magnitude) due to small-scale heterogeneities and the inherently tortuous nature of flow through a porous medium, causes spreading of chemicals both in the direction of groundwater flow and transverse to the flow direction. The process of sorption of chemicals onto soil particles—typically a temporary, reversible reaction—impedes the transport of the affected chemicals in the groundwater. Chemical degradation or reactions between dissolved chemical species and the porous medium or other dissolved species can remove a chemical from groundwater or add it to groundwater.

4.2.2 Groundwater Flow Modeling

Since advective and dispersive transport are both dependent upon groundwater flow, it is necessary to model groundwater flow in order to model chemical transport in groundwater. The Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) developed by the U.S. Geological Survey (McDonald and Harbaugh, 1988) was used to simulate steady-state groundwater flow conditions at the Site. The model domain and the finite-difference grid used for the groundwater flow model are shown in Figure 5.

The groundwater flow model was calibrated by varying model boundary conditions and aquifer hydraulic parameter values in order to achieve the best possible fit with observed groundwater elevations measured in on-site monitoring wells. Groundwater elevation data collected by Levine·Fricke on July 9, 1993 (Figure 2) were selected as representative groundwater elevation data for purposes of calibrating the groundwater flow model. Although measured groundwater elevations have fluctuated significantly over time, a review of historical groundwater elevation data (Table 3-2) and groundwater elevation contour maps for the Site (Levine·Fricke, 1990, 1993a, 1993b, 1993c) indicates that the potentiometric head distribution—and hence, the groundwater flow pattern—has remained fairly constant. Table 4-1 presents a comparison of simulated vs. measured groundwater elevations at selected monitoring well locations for the calibrated groundwater flow model. The data show a very close correlation between measured and simulated groundwater elevations, with an average difference of less than 0.06 feet.

A detailed description of the groundwater flow modeling methodology, including a discussion of hydraulic parameter values, boundary conditions, and the model calibration process, is presented in Appendix B.

4.2.3 Groundwater Chemical Transport Modeling

Chemical transport in groundwater was simulated using MT3D, a modular three-dimensional transport code developed by S.S. Papadopulos & Associates, Inc. (Zheng, 1992). MT3D is designed to be used in conjunction with any block-centered finite-difference groundwater flow model, such as MODFLOW. Using the steady-state hydraulic head distribution calculated by MODFLOW as input, MT3D was run to simulate chemical transport in groundwater, including the processes of advection, dispersion, and sorption. Potential biological and/or chemical degradation of organic chemicals in groundwater was neglected, a conservative assumption which should result in a tendency to overestimate future chemical concentrations in groundwater.

Chemical concentrations reported for groundwater samples collected in March 1994 by Levine·Fricke, which represent the most recently documented groundwater quality conditions for Area C, were used for model calibration. Table 4-2 presents a comparison of simulated vs. reported chemical concentrations in for VOCs in groundwater at Area C monitoring well locations following calibration of the contaminant transport model.

As described in Section 3.2.3, the source of VOCs detected in groundwater beneath Area C is unconfirmed, but is clearly located off-site. This was simulated in the contaminant transport model by assigning fixed chemical concentrations to selected finite-difference grid cells along the northern boundary of the model domain (Figures B-2 and B-3). The location(s) of chemical source areas and the source strength was determined during the model calibration process by varying source locations and strengths for each chemical to achieve the best fit with observed data using a trial-and-error process. The resultant chemical "source areas" (i.e., boundary nodes assigned a constant chemical concentration in the simulations) assumed in the model are shown in Figures B-2 and B-3 (Appendix B).

Following model calibration, MT3D was used to simulate future chemical concentrations in groundwater after 30 years assuming that chemicals of concern continue to enter groundwater in the assumed chemical source areas at an undiminished rate. The use of a non-diminishing source term constitutes a conservative assumption which would be expected to result in an overestimation of future chemical concentrations in groundwater. Given this conservative assumption, the estimated future chemical concentrations in groundwater predicted by MT3D in the 30-year simulations represent a worst-case scenario assuming that no groundwater remediation or source removal actions will be implemented.

Results of the groundwater contaminant transport modeling using MT3D were used as input data for calculations of chemical vapor emission rates from groundwater, as described in Section 4.3. A more detailed description of the MT3D model and the methodology used in its application to this project is given in Appendix B.

4.3 Chemical Vapor Emissions from Groundwater

4.3.1 Factors Influencing Vapor Emissions from Groundwater

In order for chemicals to move from groundwater to the ambient air above the ground surface, they must first volatilize from groundwater to air-filled pore spaces in the overlying vadose zone (unsaturated) soils. The chemicals then move toward the ground surface through the air-filled soil pores by the process of diffusion. Diffusion is a process where by vapor phase chemicals move from areas with higher concentration toward areas with lower concentrations. The driving force for diffusion is the tendency for molecules in a vapor or liquid to distribute themselves uniformly in space. A measure of this driving force is the concentration gradient, or the ratio of the difference in the concentration of a given chemical at two locations to the distance between those points.

The tendency of a chemical to volatilize from the aqueous phase (that is, to move from solution in water to vapor phase in air, as in moving from solution in groundwater to vapor phase in air-filled pores in overlying soil) is dependent upon the vapor pressure of the chemical and its solubility in water. Chemicals with high vapor pressures and low water solubility tend to volatilize more readily from the aqueous phase. (The vapor pressure of a chemical is a measure of the tendency of the chemical in pure form to undergo a phase change from liquid or solid phase to vapor phase.) One measure of the tendency of a chemical to volatilize from the aqueous phase to the vapor phase is the Henry's Law constant. The Henry's Law constant is the ratio of the concentration of a chemical in air to its concentration in water in an air-water system at chemical equilibrium.

VOCs tend to have high vapor pressures and hence to volatilize readily in pure form. Most of the VOCs detected in groundwater at the Site also have relatively low solubility in water; hence, these chemicals tend to have relatively high Henry's Law constants, indicating a tendency to volatilize readily from the aqueous phase. SVOCs are less volatile and generally have lower Henry's Law constants. Henry's Law constants for all COCs evaluated in this HRA are presented in Table 4-3.

Another chemical property affecting the diffusion process is the air diffusion coefficient, which is a measure of the rate at which a chemical will diffuse in air. Chemicals with lower molecular weights tend to have a higher air diffusion coefficient and to diffuse more rapidly than chemicals with a higher molecular weight. Air diffusion coefficients for the COCs evaluated in this HRA are presented in Table 4-3.

Environmental factors influencing the diffusion of chemicals through the vadose zone include soil type, soil moisture content, and the quantity of organic matter present in the soil. Fine-grained soils, such as the silts and clays which predominantly comprise the vadose zone soils at the Site, generally have a higher porosity than coarse-grained soils (e.g., sand) which comprise the the shallow water-bearing sediments beneath Area C. However, the pore spaces of fine-grained soils tend to be smaller and less interconnected than those of coarse grained soils, thus tending to inhibit diffusion.

The moisture content of soils is an important factor governing the diffusion process because diffusion of chemical vapors can only occur through air-filled pore spaces. Thus, the greater the moisture content, the fewer pore spaces are available for diffusive transport, and the lower the rate of diffusion will be.

The organic carbon content of a soil influences the adsorption of organic chemicals onto soil particles. The greater the organic carbon content of a soil, the greater is its sorptive capacity. Thus, a soil with a higher organic carbon content will tend to adsorb organic chemicals more strongly than a soil with a lower organic carbon content, thereby attenuating the rate of diffusive transport of organic chemicals through the soil.

Fine-grained soils have a greater tendency to retain moisture than do coarse-grained soils, and thus tend to have higher moisture contents. Fine-grained soils also tend to contain more organic matter than do coarse-grained soils. For these reasons, fine-grained soils such as those that predominantly comprise the vadose zone soils at the Site tend to inhibit diffusion of chemical vapors from groundwater to the atmosphere.

4.3.2 Estimation of Chemical Vapor Emission Rates from Groundwater

Chemical vapor emission rates to the atmosphere from contaminated groundwater were estimated using a steady-state model developed by Farmer et al. (1980). Farmer's model, a modified application of Fick's Law, is a screening tool for predicting worst-case emission rates from contaminated soil or groundwater. Because it assumes a non-diminishing chemical source concentration (i.e., chemical concentrations in groundwater are assumed not to be affected by volatilization), Farmer's model tends to substantially over-estimate long-term chemical vapor emissions.

To facilitate chemical vapor emission rate calculations, SOMA developed a computer program to calculate chemical emission rates using Farmer's model for each cell in the finite-difference grid (Figure 5) used in the groundwater flow and contaminant transport models. The program reads the groundwater chemical concentration calculated by MT3D for each cell in the finite-difference grid and can calculate and sum emission rates over any area(s) of interest (i.e., one or more blocks of finite-difference grid cells).

4.4 Chemical Concentrations in On-Site Indoor Air

Chemical concentrations in on-site indoor air were calculated for each COC using the methodology of the Orange County Public Health Care Agency's Simplified Vapor Pathway Evaluation (SVPE) (Daugherty, 1991). The SVPE uses a mass balance approach to estimate chemical concentrations which could accumulate in indoor air inside a building located in an area where vapor emissions from contaminated soil or groundwater occur. The SVPE methodology, equations, and input parameters are described in Appendix B.

Indoor air concentrations for each COC were calculated for a 51,000 square foot building for commercial/retail use which has been proposed for construction in Area C at the site of the former Bay Area Warehouse adjacent to the northern property boundary (Proposed Building 2, Figure 4). This location was chosen for the risk analysis for indoor air concentrations of VOCs because it is located adjacent to monitoring well LF-10, where the highest VOC concentrations in groundwater in Area C have consistently been reported; thus it represents a worst-case scenario. The estimated indoor air concentrations after 30 years are presented in Table 4-3; building parameter values used in the calculations are listed in Table B-4 (Appendix B). The shaded grid cells in Figure 4 were used to calculate the average emission rate beneath the building.

The SVPE incorporates a building attenuation factor to account for the effects of building construction on vapor emission rates entering the building. In calculating indoor air concentrations for purposes of this HRA, an order-of-magnitude reduction of vapor emissions (i.e., an attenuation factor of 0.1) was assumed. Given that the proposed building design incorporates a concrete slab floor, the assumption of a simple order-of-magnitude attenuation of vapor emissions entering the building is a conservative one.

4.5 Chemical Concentrations in Air in On-Site Construction Excavation

Chemical concentrations which might occur in air in on-site excavations associated with demolition/construction activities at the site were calculated to provide a basis for estimating potential inhalation risks to construction workers. Calculations were made for assumed excavation depths of five and eight feet. Based on present-time groundwater chemical concentration results from the calibrated MT3D model, chemical vapor emission rates from groundwater for the shaded area in Figure 5 (i.e., at the location of Proposed Building 2) were calculated using Farmer's model, assuming that the entire area was excavated to a depth of five feet. Average chemical emission rates for this area were then used to calculate chemical concentrations in air which might occur in a trench or other excavation at the proposed location of Building 2.

The excavation air concentrations were estimated using the same SVPE methodology used to calculate indoor air concentrations. The rationale for this approach is that a trench or other excavation is like a building without a roof. Conservatively, an air exchange rate of 1/hr was assumed for these calculations. (That is, it was assumed that air in excavation would be completely replaced by mixing with outside air once every hour.) Unlike the indoor air calculations, an attenuation factor of one (i.e., no attenuation) was assumed in these calculations since the excavation would have no floor to impede chemical vapor emissions. The estimated air concentrations for each COC for excavation depths of five and eight feet are presented in Table 4-7.

5.0 TOXICITY ASSESSMENT

A Toxicity Assessment is the process of evaluating whether a potential exists for adverse health effects to occur in humans in response to exposure to a chemical or group of chemicals. The process examines the relationship between the dose of a substance and the probability of an adverse health effect. Although there are some data on human exposures, most of the data available on the potential health effects of chemical exposures is derived from animal studies. In addition, for practical reasons most such data are derived from studies of relatively high dose levels for relatively short-term exposures and are extrapolated to much lower doses for the long-term, chronic exposures which are more typically the subject of human health risk assessments. A relatively high degree of uncertainty is associated with these extrapolation procedures.

5.1 Noncarcinogenic Chemicals

Chemicals that exhibit adverse effects other than cancer or mutagenic or developmental effects are generally believed to have a threshold dose below which no adverse health effects are expected to occur. When extrapolating from animal studies to human exposures, a safety factor is typically applied to account for the uncertainty inherent in the extrapolation (See Section 7.1.1). The magnitude of the safety factor applied is dependent upon a number of factors such as the type, duration and results of the studies which have been done. Following this approach, the U.S. EPA has established reference doses (RfDs) for noncarcinogenic chemicals for specific routes of exposure (e.g., oral intake and inhalation). An RfD is a daily dose to which humans may be exposed throughout their lifetimes without adverse health effects. Reference doses for the COCs evaluated in this HRA are presented in Table 5-1, which also summarizes identified critical health effects of these chemicals.

5.2 Carcinogenic Chemicals

The U.S. EPA has evaluated the evidence of carcinogenicity of a large number of chemicals and has developed a classification scheme based on the strength of available evidence for a given chemical. Candidate chemicals are classified into one of the following groups based upon the weight of evidence for or against carcinogenicity in animal toxicity and epidemiological studies (U.S. EPA, 1989a):

- Group A - human carcinogen (sufficient evidence of carcinogenicity in humans)

- Group B - probable human carcinogen

  B1 - limited evidence of carcinogenicity in humans
  B2 - sufficient evidence of carcinogenicity in animals with inadequate evidence in humans

- Group C - possible human carcinogen (limited evidence of carcinogenicity in animals; absence of human data)

- Group D - not classified as to human carcinogenicity (inadequate or no evidence)

- Group E - evidence of noncarcinogenicity for humans (no evidence of carcinogenicity in adequate studies)

Carcinogenic chemicals are generally considered to have no threshold doses. That is, there is no dose level at which a carcinogen is presumed to have no adverse health effects. This assumption is considered overly conservative by many scientists, but it is part of the generally accepted regulatory process, which is designed to minimize the possibility of under-predicting risk.

The U.S. EPA generally uses the linearized multistage model for low-dose extrapolation. Cancer slope factors (CSFs) are used to quantitatively estimate carcinogenic risks. The cancer slope factor, as used here, is the upper 95 percent confidence limit of the probability of a carcinogenic response per daily intake of a chemical over a lifetime. This estimate of carcinogenic response is conservative in that the true risk is more-than-likely lower than this estimate and could even be as low as zero.

The carcinogenic classification of the COCs evaluated in this HRA are presented in Table 5-1, along with the cancer slope factors used in quantifying potential carcinogenic risks.

6.0 EXPOSURE ASSESSMENT

An exposure assessment consists of the following principal elements:

(1) identification of potential exposure pathways,

(2) definition of reasonable and site-specific exposure scenarios, including the identification of potentially exposed populations of concern,

(3) evaluation of the impact of fate and transport processes, including the estimation of concentrations at points of exposure, and

(4) estimation of the predicted level of chemical intake (dose).

Each of these elements is described in the following sections.

6.1 Identification of Pathways of Human Exposure

Pathways of exposure are the means through which an individual may come into contact with a chemical contaminant. These are determined by environmental conditions (e.g., distance to the nearest potentially exposed populations), potential for a chemical to move from one medium (e.g., air, soil, and water) to another, and by the general behaviors and lifestyles of the potentially exposed populations. Although several potential pathways may exist, only a few are usually significant.

For an exposure pathway to be complete, each of the following elements must be present:

(1) a source and mechanism for chemical release,

(2) an environmental transport medium (e.g., air, water, soil),

(3) a point of potential human contact with the medium, and

(4) a route of exposure (e.g., inhalation, ingestion, dermal contact).

6.1.1 Potential Sources of Human Exposure

The following section summarizes the chemical contaminants in the various site media, the potential for transport of these chemical contaminants in the site media or from one medium to another, and the potential for direct contact with chemical contaminants in the various media.

Groundwater:

Of primary and immediate concern are the levels of VOCs in groundwater just beneath the surface in Area C. This becomes important, given that the site will be redeveloped in the near future with the construction of a shopping center containing a variety of retail stores. Volatile emissions may migrate through the soil and into the ambient air and pose potential health threats to workers during construction activities and to workers within the retail stores who may be exposed to VOCs in indoor air.

It should be kept in mind that the VOCs in groundwater beneath Area C are not site-related, but are most likely the result of off-site contamination and migration in the groundwater to Area C. Nonetheless, these potential VOC emissions will be evaluated in this risk assessment in order to ensure the protection of health of both workers and visitors at the proposed shopping center development.

Chemicals of concern in groundwater beneath Area C are:

- 1,2-DCE
- TCE
- Vinyl Chloride

Soils:

Presently, surface and near surface soils in Area C contain both VOCs and metals. Specifically, the soil COCs are:

Volatile Organic Compounds (Depths of 8 feet or less)

- 1,2-DCE
- Toluene

Metals

- Arsenic (As)
- Beryllium (Be)
- Cadmium (Cd)
- Chromium (Cr)
- Copper (Cu)
- Lead (Pb)
- Mercury (Hg)
- Nickel (Ni)
- Selenium (Se)
- Silver (Ag)
- Zinc (Zn)

VOCs in soil, as for groundwater, may pose a health threat due to volatilization through the soil and into the ambient air where they can be inhaled by workers during construction activities as well as by future indoor workers at the proposed retail stores. Only VOCs in vadose zone soils (i.e., above the groundwater table) are significant for this pathway, since in the saturated zone soils (beneath the groundwater table) volatilization cannot occur. As indicated above, the only VOCs which have been reported in vadose zone soils in Area C are toluene and 1,2-DCE. The 95% UCL of the arithmetic mean concentration for these chemicals in Area C vadose zone soils (depths of 8 feet or less) are 0.158 and 0.009 mg/kg, respectively (Table 3-3).

Table 6-1 presents the 95% upper confidence limit (UCL) of the arithmetic mean for each metal detected in Area C, as well as the background range of metal concentrations and mean metal concentration for the Western United States. The 95% UCL mean concentrations of arsenic, beryllium, and chromium were less than the mean Western U.S. levels. Even though the 95% UCL mean concentrations of copper, lead, mercury, nickel, selenium and zinc were greater than the mean Western U.S. values, they all fell at the lower end of the range of typical values in the Western U.S. Since no site-specific background study was performed for metals, all metals will be carried through the quantitative risk assessment for the exposure scenarios defined in the next section, even though these metals are most likely within true background levels.

6.2 Definition of Exposure Scenarios to be Evaluated

The Site is currently zoned for industrial/commercial land use. A review of the site history suggests that past uses were also industrial. In the near future, Area C is scheduled to be developed into a shopping center with the construction of three buildings housing retail stores and associated parking spaces.

The only populations that could be potentially exposed to site contaminants in Area C are future construction workers during the development phase of the property and future workers and visitors (shoppers) at the retail stores. Construction workers could be exposed to site contaminants through incidental ingestion of soil, dermal contact with soil, and inhalation of VOCs from soil. Workers and visitors at the retail stores could only be exposed to site contaminants through inhalation of VOCs from groundwater and soil that enter the indoor air through the building foundation. Since the entire site will be covered with structures, asphalt/concrete, and landscaping, workers and visitors could not come into contact with soil contaminants through incidental ingestion or dermal contact.

All exposure scenarios were designed to represent a Reasonable Maximum Exposure (RME) as specified by EPA's Risk Assessment Guidance for Superfund (RAGS) (EPA 1989a). The RME is intended to estimate a conservative exposure case that is within the range of possible exposures. The RME is determined by incorporating the following combination of exposure parameters:

- 95% UCL of the arithmetic mean soil concentration;
- 90 to 95 percentile values for intake/contact rates, exposure frequency, and exposure duration;
- Mean values for body weights.

Each exposure scenario, including specific parameters chosen and the rationale for selection are discussed in the following sub-sections.

6.2.1 Construction Worker Scenario

This scenario conservatively assumed that a construction worker would be involved in trenching operations (a five foot deep trench was assumed) and could potentially be exposed by inhalation of VOCs from soil and by ingestion of and dermal contact with VOCs and metals in soil. All exposure parameters were derived from EPA's Standard Default Exposure Parameters (EPA 1991), EPA's Exposure Factors Handbook, and the South Coast Air Quality Management District (SCAQMD) Multi-Pathway Health Risk Assessment Input Parameters Guidance Document (SCAQMD,1988), with the exception of the 0.5-year exposure duration that was based on professional judgement. Exposure parameters for each pathway are summarized as follows:

<u>All Exposure Pathways</u>

Soil/air concentration = 95% UCL
Exposure frequency = 250 days/year
Exposure duration = 0.5 years
Body weight = 70 kg

<u>Incidental Ingestion of Soil</u>

Soil ingestion rate = 100 mg/day
Oral bioavailability = 100%

<u>Dermal Contact with Soil</u>

Soil to skin adherence = 1.0 mg/cm^2
Skin surface area = 2685 cm^2 (EPA, 1989b)
Dermal bioavailability (SCAQMD,1988) = 10% for organics
= 1% for metals (SCAQMD, 1988)

Inhalation of VOCs

Inhalation rate = 20 m^3/day

6.2.2 Retail Store Worker Scenario

This scenario assumed that a typical store worker would be indoors and exposed to potential indoor air VOCs 8 hours per day, five days per week, 250 days per year for 25 years. The inhalation rate was developed from the EPA Exposure Factors Handbook (EPA, 1989b) as follows:

> The mean ventilation rates for a moderate level of work were chosen for males (40.9 L/min.) and females (26.5 L/min.) and averaged for an 8-hour workday, as follows:

Males

$$\frac{40.9\ L}{min} \times \frac{60\ min}{hr} \times \frac{8\ hr}{day} \times \frac{1\,L}{1000\ m^3} = \frac{19.63\ m^3}{day}$$

Females

$$\frac{26.5\ L}{min} \times \frac{60\ min}{hr} \times \frac{8\ hr}{day} \times \frac{1\,L}{1000\ m^3} = \frac{12.72\ m^3}{day}$$

Average Indoor inhalation Rate = 16.18 m^3/day

Inhalation Pathway Parameter Summary

Inhalation rate = 16.18 m^3/day
Exposure frequency = 250 days/year
Exposure duration = 25 years
Body weight = 70 kg

6.3 Methodology for Estimating Exposure Point Concentrations

The following section presents the approaches and methodologies for determining exposure concentrations of chemicals of concern in soil and ambient air (both outdoor and indoor). These estimated exposure concentrations will serve as input terms for estimation of chemical contaminant intake for each exposure pathway described earlier.

6.3.1 Exposure Concentrations in Soil

All available Area C site characterization data were evaluated for incorporation into this risk assessment as described in detail in Section 3.0. For surface and near-surface soils, 95% UCLs of the arithmetic means were chosen as representative chemical contaminant concentrations. These values will serve as input terms for estimation of chemical intakes from potential incidental ingestion of soil and dermal contact with soil.

6.3.2 Contaminant Concentrations in Groundwater

As discussed previously, groundwater contaminants are believed to be due to off-site activities that will ultimately impact the Yerba buena site in the future. Volatile contaminants that migrate in groundwater can volatilize through the soil, pass through the building foundations and accumulate in the indoor air, potentially representing a health concern for indoor workers. In order to predict groundwater concentrations beneath the proposed retail stores 30-years in the future, the MT3D numerical finite-difference transport model and MODFLOW finite-difference groundwater flow model were used. These mathematical models, model parameter selection, and model outputs are discussed in detail in Section 4.2 and in Appendix B.

6.3.3 Chemical Contaminant Vapor Emissions from Groundwater

In order for chemical contaminants to migrate from the groundwater to the ambient air above the ground surface, they must first volatilize from the groundwater into the air-filled pore spaces in the overlying soils and then travel via diffusion to the ground surface. Vapor emission rates from groundwater were estimated using a modified application of Fick's Law (a steady-state semi-analytical transport equation) described by Farmer et al. (1980). A detailed discussion of this mathematical model and the estimated vapor emission rates is presented in Section 4.3 and in Appendix B.

6.3.4 Chemical Contaminant Concentrations in Indoor Air

Using the chemical vapor emission rates from Section 4.3, chemical concentrations in on-site indoor air were calculated for each COC according to the SVPE methodology of the Orange County Public Health Care Agency (Daugherty, 1991). The application of this model is described in Section 4.5. The SVPE methodology, equations, and input parameters are presented in Appendix B.

Indoor air concentrations were estimated assuming a 51,000 square foot building at the location indicated in Figure 4 for "Proposed Building 2," consistent with current design plans for the development of Area C. The SVPE model incorporates a building attenuation factor to account for the effects of building construction on vapor emission rates that enter the building. In estimating indoor air concentrations, a conservative attenuation factor of 0.1 was used, or an order of magnitude reduction of surface soil vapor emissions that enter the building due to the concrete slab foundation. Estimated indoor air concentrations, currently and after 30 years, are presented in Table 4-3.

6.3.5 Chemical Contaminant Concentrations in Air During Construction/Excavation

Based on the present-time groundwater chemical concentrations from the MT3D model, chemical vapor emission rates from groundwater were estimated, as described in detail in Section 4.6. The excavation air concentrations were based on an assumed excavation depth of five feet. The air concentrations were estimated using the same SVPE methodology described earlier. The rationale for using this approach is that a trench is assumed to be identical to a building, but without a roof. Conservatively, an air exchange rate of only one per hour was assumed (air in the excavation was replaced with fresh outside air only once per every hour). Unlike the indoor air calculations, an attenuation factor of one (i.e., no vapor emission attenuation) was assumed. The excavation air concentrations in a five foot trench are presented in Table 4-4.

6.3.6 Estimation of Blood Lead Levels from Soil-Lead Concentrations

The assessment of potential health risks from inorganic lead in soil was performed according to the guidance provided by the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), Volume 6, Chapter 5 of the Guidance for Site Characterization and Multimedia Risk Assessment for Hazardous Substances Release Sites.

This guidance describes a mathematical model for estimating blood lead concentrations in adults and children resulting from contact with lead-contaminated soil. The lead concentration of concern in both children and adults is 10 ug/dl blood.

This method estimates blood lead concentrations (Pb_b) resulting from exposure via the five following pathways:

- Dietary intake
- Drinking water intake
- Soil and dust ingestion intake
- Inhalation intake
- Dermal contact intake

Each pathway is represented by an equation relating incremental blood lead increase to a specific concentration in a medium using contact rates and empirically derived ratios. The contributions from each of the five above mentioned pathways are summed to provide an estimate of the median blood lead concentration resulting from the multipathway exposure. Ninetieth, ninety-fifth, ninety-eighth, and ninety-ninth percentile concentrations are estimated from the median value by assuming a log-normal blood lead distribution with a geometric standard deviation of 1.42. The methodology and resulting computer outputs are presented in Appendix C.

For dietary intake and drinking water intake, no data would be available for future construction or retail store workers. Then, the model default values were used, specifically,

Dietary intake = 10 ug lead/kg food, and

Drinking water intake = 15 ug lead/l water.

For soil ingestion and dermal contact, both the 95% UCL and maximum detected soil-lead concentrations were directly input into the model. For inhalation intake, the model assumes a default input parameter of 0.18 ug lead/m^3 air.

Estimated Pb_b levels associated with exposure to lead in soil for construction/excavation workers are presented in Tables 6-2 and 6-3 for the 95% UCL and maximum soil-lead concentrations, respectively.

6.4 Quantification of Exposure: Estimation of Chemical Intake (Dose)

The level of health risk associated with exposure to a chemical is dependent upon the degree of uptake (amount absorbed into the blood and tissues). For any route of exposure, the uptake is the product of exposure and absorption efficiency or bioavailability. Chemical uptake will be calculated for each route of exposure according to the following example equations.

Example Equation 1: Estimating the intake of contaminated soil through ingestion

$$Intake\ (mg/kg \cdot day) = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where

CS = Chemical concentration in soil, mg/kg

IR = Soil ingestion rate, mg soil/day

CF = Conversion factor, 10^{-6} kg/mg

FI = Fraction ingested from the source, 100%

EF = Exposure frequency, days/year

ED = Exposure duration, years

BW = Body weight, kg

AT = Averaging time
= ED × 365 days/year for noncarcinogens
= 70 years × 365 days/year for carcinogens

Parameters Used:

Construction Worker Scenario

IR = 50 mg/day
EF = 250 days/year
ED = 0.5 years
BW = 70 kg

Example Equation 2: **Estimating the intake of chemical contaminants through dermal contact**

$$Intake\ (mg/kg \cdot day) = \frac{CS \times CF \times AF \times SA \times ABS \times EF \times ED}{BW \times AT}$$

where

CS = Chemical concentration in soil, mg/kg

CF = Conversion factor, 10^{-6} kg/mg

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

SA = Skin surface area available for contact, cm^2/event

ABS = Dermal absorption factor, unitless

EF = Exposure frequency, days/year

ED = Exposure duration, years

BW = Body weight, kg

AT = Averaging time
= ED × 365 days/year for noncarcinogens
= 70 years × 365 days/year for carcinogens

Parameters Used:

Construction Worker Scenario

AF = 1.0 mg/cm^2
SA = 2685 cm^2
ABS = 0.1 for organics
= 0.01 for metals
EF = 250 days/year
ED = 0.5 years
BW = 70 kg

Example Equation 3: Estimation of volatile chemical contaminant through inhalation

$$Intake\ (mg/kg \cdot day) = \frac{CA \times VR \times ABS \times EF \times ED}{BW \times AT}$$

where

CA = Chemical concentration in air, mg/m^3

VR = Ventilation rate, m^3/day

ABS = Inhalation bioavailability factor, 100%

EF = Exposure frequency, days/year

ED = Exposure duration, years

BW = Body weight, kg

AT = Averaging time
= ED × 365 days/year for noncarcinogens
= 70 years × 365 days/year for carcinogens

Parameters Used:

Construction Worker Scenario

VR = 20 m^3/day
EF = 250 days/year
ED = 0.5 years
BW = 70 kg

Retail Store Worker (Indoor) Scenario

VR = 16 m^3/day
EF = 250 days/year
ED = 25 years
BW = 70 kg

7.0 RISK CHARACTERIZATION

This section of the risk assessment provides a quantitative and qualitative summary of the plausible health risks posed by COCs in groundwater and soil in Area C. The risk characterization addresses potential noncarcinogenic health effects and carcinogenic risks for both construction workers under current site conditions and for future retail store workers.

7.1 Estimation of Noncarcinogenic Health Hazards

As a screening level assessment of the potential noncarcinogenic effects of exposure to multiple chemicals, the total of all hazard quotients or the hazard index (HI) approach was used. In this analysis, it was assumed that all chemicals were additive in their ability to produce an adverse effect, This is not a scientifically rigorous approach but is useful for illustrating the lack of hazard if the sum is low. The HI is defined as follows:

$$HI = \frac{PredictedDose_a}{RfD_a} + \frac{PredictedDose_b}{RfD_b} + \ldots + \frac{PredictedDose_i}{RfD_i}$$

Where

Predicted Dose_i = The intake of chemical i, mg/kg-day, estimated according to the example equations presented in Section 6.0.

RfD_i = The accepted reference dose for chemical i, mg/kg-day, obtained from data bases such as IRIS, HEAST.

Although the hazard index does not define dose-response relationships and should not be construed to be a direct estimate of potential risk, the HI may provide an estimate of toxicity from exposure to a mixture of chemicals. A summed HI less than or equal to unity is indicative of acceptable levels of exposure for chemicals exhibiting additive effects. Predicting the total hazard by summing the HI for each chemical, for each route of exposure, will tend to overestimate the actual health hazards.

7.1.1 Reference Health Criteria

It is widely accepted that most biological effects of chemical substances occur only after a threshold dose is reached. For the purposes of establishing health-based criteria, the threshold dose is usually estimated from the no observed adverse effect level (NOAEL) or the lowest observed adverse effect level (LOAEL) derived from animal studies. Chronic studies are typically performed for long durations and provide data on effects from low levels of exposure.

Uncertainty factors or safety factors are applied to the NOAEL derived from animal studies to establish RfDs in an attempt to account for limitations in the quality or quantity of available data. An uncertainty factor of 10 is usually used to account for variations in human sensitivity when extrapolating from valid human studies involving subchronic or long-term exposure. An additional 10-fold factor is usually applied for each of the following extrapolations:

- From long-term animal studies to human exposure;
- From a LOAEL to a NOAEL, and
- To expand from subchronic to chronic exposure.

For the purposes of this risk assessment, EPA reference doses were derived from the following sources (in the order of preference):

- EPA Integrated Risk Information System (IRIS)
- EPA Health Effects Assessment Summary Tables (HEAST)
- EPA Region IX PRG Tables.

7.1.2 Site-Specific Noncarcinogenic Health Hazards

The following section presents the noncarcinogenic health hazards for future, indoor retail store workers and construction workers.

Future Retail Store Workers

The total noncarcinogenic health hazard for future retail workers under current predicted indoor air concentrations and indoor air concentrations 30-years in the future, are presented in Tables 7-1 and 7-2, respectively. The HI was estimated to be 1.61 x 10^{-1} and 5.89 x 10^{-2} for workers exposed to current air concentrations and to air concentrations 30-years in the future, respectively.

The estimates of noncarcinogenic health hazard indicate that no adverse health effects would be anticipated for a worker exposed to these air concentrations 8-hours per day, 250-days per year, for a working lifetime of 25 years.

Construction/Excavation Workers

Construction workers were assumed to have exposure to site contaminants via working in a 5-foot deep trench, 8-hours per day, 5-days per week for 6 months. Exposure was assumed to be through inhalation of volatile emissions from groundwater, incidental ingestion of soil contaminants, and dermal contact with soil contaminants. The estimated noncarcinogenic health hazards from inhalation of volatiles, ingestion of soil, and dermal contact with soil are presented in Tables 7-3, 7-4, and 7-5, respectively.

The inhalation hazard was estimated to be 2.37, with toluene contributing 87 percent of the hazard. Even though this number is indicative of potential adverse health effects, it should be noted that the inhalation hazard was derived by using chronic reference doses. In reality, construction workers would only be exposed for 6 months, which is not a chronic exposure. If the subchronic inhalation reference dose for toluene is used (RfD = 5.71×10^{-1}, HEAST, 1992), the inhalation hazard for toluene becomes 3.63×10^{-1} and the total inhalation hazard then becomes 6.61×10^{-1}.

The soil ingestion hazard was estimated to be 2.26×10^{-2}. The dermal contact hazard was estimated to be 6.06×10^{-3}. The total noncarcinogenic HI, summing the inhalation, ingestion and dermal hazards was estimated to be 6.89×10^{-1}, indicating that no adverse health effects would be expected for construction workers.

7.2 Potential Carcinogenic Health Risks

Carcinogenic health risks are defined in terms of probability, i.e., the probability of an individual developing cancer as a result of exposure to a particular chemical at a given concentration for a prolonged period of time. The incremental probability of developing cancer is based on the average lifetime daily dose, i.e., the total incremental dose of the chemical received as a result of the activity of interest averaged over an expected lifetime of 70 years. Once the lifetime average daily dose (LADD) has been estimated, the excess cancer risk can be calculated as follows:

$$\text{Excess Cancer Risk} = \text{LADD} * \text{CSF}$$

Where,

LADD = Lifetime average daily dose, mg/kg-day

CSF = Cancer slope factor, $(\text{mg/kg-day})^{-1}$

Regulatory agencies have generally assumed that chemicals which are carcinogenic should be treated as if they do not have threshold doses. The dose-response curve for carcinogens used for regulatory purposes only allows for zero risk at zero dose, i.e., for all doses, some risk is assumed to be present. It is important to recognize that, since direct estimates of carcinogenic risk at very low levels of exposure would require the testing of prohibitively large numbers of animals, much higher doses of a potential carcinogen have been administered to relatively small populations of animals in order to elicit a response.

To estimate the theoretically plausible response at very low doses, various mathematical models have been employed. The predicted risk at the dose of interest is a function of how well the mathematical model predicts the actual relationship between dose and risk at these very low dose levels. The USEPA generally uses the linearized multistage model for low-dose extrapolation. The cancer slope factor, as used here, is the upper 95 percent confidence limit of the probability of a carcinogenic response per daily intake of a chemical over a lifetime. This estimate of carcinogenic response is conservative in that the true risk is more-than-likely lower than this estimate and could even be as low as zero.

For the purposes of this risk assessment, cancer slope factors were obtained from the following sources:

- EPA Integrated Risk Information System (IRIS)
- EPA Health Effects Assessment Summary Table (HEAST)
- EPA Region IX Preliminary Remediation Goals (PRGs).

7.2.1 Site-Specific Carcinogenic Risks

The following section presents the estimated incremental carcinogenic risk for future retail store workers and construction workers.

Future Retail Store Workers

The estimated incremental carcinogenic risk for future workers indoors from inhalation exposure to volatiles is presented in Tables 7-6 and 7-7 for current air concentrations and air concentrations following 30-years, respectively. The estimated risk for an indoor worker under current air concentrations is 6.05 x 10^{-7}. The estimated risk for an indoor worker from air concentrations 30-years from now is 6.14 x 10^{-7}. These risk estimates are below one in one million, and would be considered negligible or de minimis.

Construction/Excavation Workers

The estimated carcinogenic risks for a construction worker assumed to spend all his time in a trench, are presented in Tables 7-8, 7-9, and 7-10 for inhalation, ingestion and dermal contact, respectively. The carcinogenic risks from inhalation of volatiles, incidental ingestion of soil, and dermal contact with soil were estimated to be 4.38 x 10^{-7}, 8.25 x 10^{-8}, and 2.22 x 10^{-8}, respectively. The total carcinogenic risk, from all routes of exposure, for construction/excavation activities is 5.43 x 10^{-7}. This total risk is less than one in one million and would be considered negligible.

8.0 UNCERTAINTY EVALUATION

The assumptions, procedures, and parameters used in this risk assessment are subject to various degrees of uncertainty. Uncertainty is inherent in the risk assessment process. The uncertainty analysis provides an understanding of the limitations in the interpretation of the quantitative estimates of risk presented in this HRA.

8.1 Sample Collection and Analysis

Environmental sampling and analysis error can stem from improper sample collection and handling procedures, inadequate sample numbers, laboratory analysis errors, and the heterogeneity of site soil. The use of standard techniques such as the collection of duplicates, and the use of trip and method blanks can be used to reduce the likelihood of errors. Errors in data analyses can occur from the simplest tabulation and typographical errors to complex interpretational errors. Matrix interferences due to the presence of high concentrations often raise the detection limits of other chemicals in the analytical procedure and introduce uncertainty in the method of data analyses.

The sampling effort implemented on site was specifically designed to identify areas that were suspected to have elevated chemical concentrations. This sampling bias resulted in a data base that focused on the worst-case areas of the Site. This focused approach resulted in certain assumptions that make this risk assessment worst-case in nature. These conditions will result in a significant overestimate of on-site risk.

8.2 Exposure Parameters

Exposure scenarios that incorporate the most likely site-specific exposure pathways and represent the greatest potential for exposure were selected to evaluate potential exposure. Conservative assumptions consistent with State and federal guidelines were used to conceptualize the exposure scenarios. The methods and procedures contribute to an overall overestimation of potential exposure. Numerous conservative exposure assumptions were made in selecting the exposure parameters used in this assessment. Duration, frequency, and other input parameters were selected to represent the maximally exposed individual and are not an accurate portrayal of time spent at a place of residency. The quantitative effect of these uncertainties would be considered moderate in overestimating overall potential health risk.

8.3 Toxicological Data

Several aspects of the toxicological data employed in this HRA contain a high degree of uncertainty that affects estimates of potential risk. These uncertainties arise in two primary areas. First, CSFs used in this assessment were estimates representing the 95 percent UCL. This assumption means actual risks are likely to be lower than the risk estimates calculated in this assessment. Use of the 95 percent UCL CSF values is consistent with the approach of determining risk as indicated by Cal EPA and U.S. EPA.

Second, results of animal studies are often used to predict the potential human health effects of a chemical. Extrapolation of toxicological data from animal tests is one of the largest sources of uncertainty in the human health risk evaluation process. There may be important but unidentified differences in uptake, metabolism, distribution, and elimination of chemicals between a test species and humans. Animal studies are usually conducted under high-dose conditions, whereas humans are rarely exposed to such high doses. The dose level itself may be responsible for the observed carcinogenic effects. Animal lifetimes tend to be less than two years and assumed human life expectancy is 70 years.

In the absence of pathway-specific toxicological criteria, surrogate values were used in an effort to screen potential adverse health effects. This type of surrogate-based calculation will provide estimates of risk that reflect a high degree of uncertainty. These types of calculations have been pointed out during the course of the risk evaluation.

8.4 Uncertainties Associated with Combinations of Conservative Assumptions

Uncertainties from different sources may be compounded in this assessment. This evaluation consistently incorporated conservative assumptions in calculating risk. The overall effect of using conservative assumptions in each step of the risk assessment is likely to result in an overestimation of potential risk. Thus, evaluation results must be reviewed with an understanding of the uncertainties involved and how they effect risk estimations. Findings of insignificant risk may reflect conditions close to reality; however, findings of measurable risk may reflect conditions that result from the conservative nature of the evaluation.

9.0 CONCLUSIONS

The object of the HRA was to identify and quantify potential risks resulting from measurable concentrations of chemical contaminants in groundwater and soil within Area C with respect to the proposed development of the property as a retail shopping center. This HRA represents an upper-bound estimate of risk and follows U.S. EPA guidelines emphasizing conservativeness. The underlying assumptions and methodology are designed such that the inherent uncertainty is biased toward over-protectiveness of human health. The calculated risks represent potential risks that will tend to over-estimate the actual site-related risks posed by chemicals in groundwater and soil in Area C.

Estimated cancer and noncancer risks associated with chemicals of concern (COCs) identified in the exposure assessment were characterized by comparing calculated chronic daily intakes (CDIs) or lifetime average daily doses (LADDs) with U.S. EPA approved health-based criteria. This procedure follows guidelines outlined in the Risk Assessment Guidance for Superfund (U.S. EPA, 1989). Two scenarios were evaluated to estimate potential health risks caused by potential exposures to chemicals in on-site soil and/or groundwater. The first scenario pertained to potential exposure of construction workers to chemicals in soil and groundwater via inhalation of VOCs emitted from soil and groundwater and via dermal absorption (skin contact) and incidental ingestion of contaminated soil containing VOCs and metals. The second scenario pertained to potential exposure of indoor retail workers after site development to chemical vapors emitted from groundwater and soil.

9.1 Noncarcinogenic Health Hazards

Potential noncarcinogenic health effects were evaluated by means of a hazard index (HI). While the HI is not a direct estimate of risk, an HI value of less than or equal to one is indicative of acceptable levels of exposure for chemicals exhibiting additive effects. Predicting the total hazard by summing the HI for each chemical, for each route of exposure, will tend to overestimate the actual health hazards.

Construction Workers

Potential noncarcinogenic hazards to construction workers were estimated for an exposure scenario in which the workers were assumed to be working in a 5-foot deep trench for an 8-hour day, 5 days per week for 6 months. The estimated HIs for inhalation of chemical vapors, ingestion of soil, and dermal contact with soil were 2.37, 2.26×10^{-2}, and 6.06×10^{-3}, respectively. The inhalation hazard exceeds a value of unity, with toluene contributing 87 percent of the hazard. Although this result is indicative of potential adverse health effects, it should be noted that the inhalation hazard was derived using chronic reference doses, which is overly conservative given the relatively short exposure duration of 6 months. The HI becomes less than one when a subchronic inhalation reference dose is used in place of the chronic reference dose.

Potential worker exposures can be managed through specific work practices (e.g., limiting shifts for workers at greatest risk of maximum chemical exposures), air monitoring, and engineering controls (e.g., providing ventilation in excavations). These issues should be addressed in a site-specific health and safety plan prior to the onset of construction activities.

Future Retail Store Workers

Potential noncarcinogenic inhalation hazards to future retail workers due to inhalation of chemical vapors emitted from underlying soil and groundwater were estimated for predicted indoor air concentrations at present and 30 years in the future. The HI was estimated to be 1.61×10^{-1} and 5.89×10^{-2} for the current and future air concentrations, respectively. These values indicate that no adverse health effects would be anticipated for a worker exposed to these air concentrations 8 hours per day, 250 days per year, for a working lifetime of 25 years.

9.2 Carcinogenic Risks

Carcinogenic health risks were estimated in terms of the probability of an individual developing cancer as a result of exposure to a particular chemical at a given concentration for a prolonged period of time. The incremental probability of developing cancer is based on the average lifetime daily dose, i.e., the total incremental dose of the chemical received as a result of the activity of interest averaged over an expected lifetime of 70 years. The estimated cancer risks for all carcinogenic chemicals evaluated are then summed to estimate the total cancer risk for each exposure route and for all exposure routes combined. A cancer risk equal to or less than 1×10^{-6}, or one in one million, is considered to be negligible and not a cause for concern.

Construction Workers

The estimated total carcinogenic risk for a construction worker conservatively assumed to work full-time in a 5-foot deep excavation for a 6-month construction period was 5.43×10^{-7} for all routes of exposure (inhalation, ingestion, and dermal absorption) combined. This risk is less than one in one million and would be considered negligible.

Future Retail Store Workers

The estimated total carcinogenic risk for an indoor worker due to inhalation of volatile chemicals emitted from underlying soil and groundwater over a 25-year working lifetime is 6.05×10^{-7} based on estimated indoor air concentrations for current conditions and 6.14×10^{-7} based on predicted indoor air concentrations 30 years in the future. These risk estimates are below one in one million and would be considered negligible.

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Table 3-1
Physical Properties and Organic Carbon Content of On-Site Soils
Yerba Buena Project Site, Area C

Boring Loc./ Sample ID	Depth (ft)	Dry Unit Wt. (lbs/ft^3) (1)	Bulk Density (g/cm^3) (1)	Moist. Cont. (Wt. %)	Moist. Cont. (Vol. %)	Porosity (1)	Organic Carbon (%)
BW-32	2.5	101.30	1.62	22.88	0.37	0.39	
BW-32*	11.5	108.95	1.75	18.26	0.32	0.34	0.067
BW-10	2.5	84.57	1.35	32.46	0.44	0.49	
BW-10	4.0	--	--	22.61	--	--	
BW-10	6.5	99.64	1.60	24.53	0.39	0.40	0.160
BW-10*	16.5	106.22	1.70	20.72	0.35	0.36	0.070
Vadose Zone Average		95.17	1.52	25.62	0.40	0.42	--
Aquifer Average		100.14	1.60	24.15	0.34	0.35	0.069

* Indicates sample of aquifer material. Remaining sample are vadose zone soils.

(1) Porosity calculated assuming an average soil particle density of 2.65 g/cm^3.

Notes:

Shading indicates calculated values. Unshaded values represent laboratory-reported values.

Unit weight and moisture content (wt.%) were analyzed by Woodward-Clyde Consultants' Soils Testing Laboratory in Pleasant Hill, California using ASTM Method D2850.

Organic carbon content was analyzed by Sequoia Analytical of Concord, California using EPA Method 415.1.

Table 3-2
Lithology for Monitoring Well Borings in Area C
Yerba Buena Project Site

Well Number	Depth (ft)	Type of Soil	Thickness of Sand & Gravel (ft)
LF-9	2.0-3.7	Sand	
	3.7-8.5	Sandy Silty Clay	
	8.5-9.1	Clayey Sand	0.6
	9.1-?	Silty Clay	
			0.6
LF-10	0.8-4.2	Gravelly Sandy Silt	
	4.2-6.0	Gravelly Sandy Silt	
	6.0-10.0	Silty Clay	
	10.0-11.4	Silty Sandy Gravel	1.4
	11.4-13.1	Silty Clay	
	13.1-19.0	Gravelly Clayey Sand	5.9
	19.0-?	Silt	
			7.3
LF-11	0.0-11.1	Silty Clay	
	11.1-13.8	Sandy Silty Clay	
	13.8-16.3	Clayey Sandy Gravel/Gravelly San	2.5
	16.3-17.5	Sand	1.2
	17.5-20.5	Silty Clay	
			3.7
LF-11R	0.0-5.0	Silty Clay	
	5.0-12.0	Silty Clay with Gravel and Sand	
	12.0-12.5	Sand Lens	0.5
	12.5-14.0	Silty Clay with Gravel and Sand	
	14.0-15.0	Sand Lens	1.0
	15.0-?	Silty Clay with Gravel and Sand	
			1.5
LF-12	0.6-5.0	Sandy Silty Gravel	
	5.0-10.2	Silty Clay	
	10.2-11.8	Sandy Silty Clay	
	11.8-14.7	Clayey Sand	2.9
	14.7-?	Silty Clay	
			2.9
LF-13	1.5-16.0	Gravelly Silty Clay	
	16.0-17.5	Sandy Silt	
	17.5-19.1	Gravelly Silty Sand	1.6
	19.1-?	Silty Clay	
			1.6

Table 3-2

Lithology for Monitoring Well Borings in Area C

Yerba Buena Project Site

Well Number	Depth (ft)	Type of Soil	Thickness of Sand & Gravel (ft)
LF-16	2.0-5.0	Silty Clay	
	5.0-?	Clayey Silt	
			0.0
LF-31	1.0-3.0	Gravelly Silty Clay	
	3.0-7.5	Silty Clay	
	7.5-?	Gravelly Clayey Silt	
			0.0
LF-32	0.5-6.0	Gravelly Silty Clay	
	6.0-20.0	Silty Sandy Gravel	14.0
	20.0-?	Gravelly Sandy Clay	
			14.0
Average Total Thickness of Saturated Sand/Gravel			**3.5**

TABLE 3-3
VOLATILE ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES IN PHASE I INVESTIGATION
YERBA BUENA PROJECT SITE, AREA C
(concentrations in ppm)

SAMPLE LOCATION ID	NOTES	SAMPLE ID	DATE SAMPLED	SAMPLE DEPTH (feet)	Benzene	Toluene	Ethyl Benzene	Total Xylenes	1,1-DCA	1,1-DCE	TCE	1,2-DCE
C1		C1(3.5)B	31-Jan-90	3.5	*ND	*ND	*ND	**ND	ND	ND	ND	ND
C5		C5(4)B	30-Jan-90	4.0	*ND	0.013	*ND	**ND	ND	ND	ND	ND
C8		C8(4)B	06-Feb-90	4.0	*ND	0.54	*ND	**ND	ND	ND	ND	ND
C9	(1)	C9(3.5)B	08-Feb-90	3.5	ND	ND	ND	ND	NA	NA	NA	NA
C9	(1)	C9(9)C	08-Feb-90	9.0	ND	ND	ND	ND	NA	NA	NA	NA
C10	(1)	C10(4)B	08-Feb-90	4.0	ND	0.045	ND	ND	NA	NA	NA	NA
C10	(1)	C10(9.5)C	08-Feb-90	9.5	ND	ND	ND	ND	NA	NA	NA	NA
C12		C12(3.5)B	31-Jan-90	3.5	*ND	0.012	*ND	**ND	ND	ND	ND	ND
C15		C15(9.5)C	31-Jan-90	9.5	*ND	0.15	*ND	**ND	ND	ND	ND	ND
C17		C17(1)A	08-Feb-90	1.0	*ND	0.18	*ND	**ND	ND	ND	ND	ND
C17		C17(4)B	08-Feb-90	4.0	*ND	0.006	*ND	**ND	ND	ND	ND	0.034
C17		C17(9)C	08-Feb-90	9.0	*ND	0.033	*ND	**ND	ND	ND	0.24	0.039
C18		C18(3.5)B	07-Feb-90	3.5	*ND	0.085	*ND	**ND	ND	ND	ND	ND
C19		C19(4)B	08-Feb-90	4.0	*ND	0.052	*ND	**ND	ND	ND	ND	ND
C19	(1)	C19(4)B	08-Feb-90	4.0	ND	0.078	ND	ND	NA	NA	NA	NA
C20		C20(3)B	07-Feb-90	3.0	ND	0.027	ND	ND	NA	NA	NA	NA

TABLE 3-3
VOLATILE ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES IN PHASE I INVESTIGATION
YERBA BUENA PROJECT SITE, AREA C
(concentrations in ppm)

SAMPLE LOCATION ID	NOTES	SAMPLE ID	DATE SAMPLED	SAMPLE DEPTH (feet)	Benzene	Toluene	Ethyl Benzene	Total Xylenes	1,1-DCA	1,1-DCE	TCE	1,2-DCE
C21		C21(4)B	08-Feb-90	4.0	*ND	0.078	*ND	**ND	ND	ND	ND	ND
C21		C21(8)C	08-Feb-90	8.0	*ND	0.073	*ND	**ND	ND	ND	ND	0.022
C21		C21(13)	08-Feb-90	13.0	*ND	0.12	*ND	*ND	ND	ND	0.18	0.034
C23		C23(10)C	07-Feb-90	10.0	*ND	0.006	*ND	**ND	ND	ND	ND	ND
C24		C24(10)C	22-Feb-90	10.0	*ND	0.07	*ND	*ND	ND	ND	0.009	ND
C24		C24(3.5)B	22-Feb-90	3.5	*ND	0.25	*ND	*ND	ND	ND	ND	ND
C25		C25(4.5)B	30-Jan-90	4.5	*ND	0.005	*ND	**ND	ND	ND	ND	ND
C26		C26(3)B	22-Feb-90	3.0	*ND	0.083	*ND	*ND	ND	ND	ND	ND
C27		C27(10)C	07-Feb-90	10.0	*ND	0.014	*ND	**ND	ND	ND	ND	ND
C27		C27(3)B	07-Feb-90	3.0	*ND	0.015	*ND	**ND	ND	ND	ND	ND
C28	(1)	C28(4)B	12-Feb-90	4.0	ND	0.55	ND	ND	NA	NA	NA	NA
LF9		LF9(10)C	30-Jan-90	10	*ND	*ND	*ND	**ND	ND	ND	0.007	ND
LF10		LF10(4.5)B	31-Jan-90	4.5	*ND	0.035	*ND	**ND	ND	ND	ND	ND
LF11		LF11(4)B	01-Feb-90	4.0	*ND	0.014	*ND	**ND	ND	ND	ND	ND
LF12		LF12(4.5)B	12-Feb-90	4.5	*ND	0.068	*ND	*ND	ND	ND	ND	ND

TABLE 3-3
VOLATILE ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES
IN PHASE I INVESTIGATION
YERBA BUENA PROJECT SITE, AREA C
(concentrations in ppm)

SAMPLE LOCATION ID	NOTES	SAMPLE ID	DATE SAMPLED	SAMPLE DEPTH (feet)	Benzene	Toluene	Ethyl Benzene	Total Xylenes	1,1-DCA	1,1-DCE	TCE	1,2-DCE
Detection Limit					0.001	0.001	0.001	0.003	0.005	0.005	0.005	0.005

Statistical Summary for Vadose Zone Samples (Depth <= 8 ft)

	Benzene	Toluene	Ethyl Benzene	Total Xylenes	1,1-DCA	1,1-DCE	TCE	1,2-DCE
No. Detects	0	20	0	0	0	0	0	2
Min.	0.0005	0.0005	0.0005	0.0015	0.0025	0.0025	0.0025	0.0025
Max.	0.0025	0.55	0.0025	0.005	0.0025	0.0025	0.0025	0.034
Mean	0.0020455	0.1005455	0.0020455	0.0038636	0.0025	0.0025	0.0025	0.0055
Std. Dev.	0.0008579	0.1558866	0.0008579	0.0015674	0	0	0	0.00873
No. Analyses	22	22	22	22	17	17	17	17
Student's t	1.721	1.721	1.721	1.721	1.746	1.746	1.746	1.746
95%UCL (2)	**----**	**0.158**	**----**	**----**	**----**	**----**	**----**	**0.009**

NOTES:
All samples analyzed by Med-Tox Associates of Pleasant Hill, California, using EPA Method 8240 unless otherwise noted.

Key to Abbreviations:

NA = not analyzed
ND = not detected
95%UCL = 95% Upper Confidence Limit concentration (ppm)
* Detection Limit (ppm) 0.005
** Detection Limit (ppm) 0.010
(1) Sample analyzed using EPA Method 8020
(2) 95% UCL calculated using one-half of detection limit for "ND" results. No value calculated for compounds not detected in any sample.

1,1-DCA = 1,1-DICHLOROETHANE
1,1-DCE = 1,1-DICHLOROETHENE
TCE = TRICHLOROETHENE
1,2-DCE = 1,2-DICHLOROTHENE

TABLE 3-4
PRIORITY POLLUTANT METALS DETECTED IN SOIL SAMPLES IN PHASE I INVESTIGATION
YERBA BUENA PROJECT SITE, AREA C
(concentrations in ppm)

SAMPLE LOCATION ID	SAMPLE ID	DATE SAMPLED	SAMPLE DEPTH (feet)	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
C1	C1(3.5)B	31-Jan-90	3.5	2.0	0.3	ND	30	12	5	ND	15	ND	ND	24
C2	C2(1)A	30-Jan-90	1.0	25	2.1	0.2	36	30	56	0.2	31	ND	ND	89
C2	C2(4)B	30-Jan-90	4.0	3	0.5	ND	36	13	6	0.2	24	ND	ND	28
C3	C3(4)B	31-Jan-90	4.0	3.8	0.4	ND	34	15	6	ND	24	ND	ND	30
C4	C4(4)B	30-Jan-90	4.0	1.6	0.4	ND	30	9	4	ND	18	ND	ND	18
C5	C5(4)B	30-Jan-90	4.0	1.6	0.4	ND	39	16	4	ND	21	ND	ND	30
C6	C6(1)A	15-Feb-90	1.0	ND	0.3	0.2	39	21	14	ND	33	ND	ND	42
C6	C6(3)B	15-Feb-90	3.0	ND	0.4	ND	43	11	4	ND	32	ND	ND	25
C7	C7(4)B	31-Jan-90	4.0	2.1	0.6	ND	42	15	5	ND	25	ND	ND	32
C8	C8(4)B	06-Feb-90	4.0	1.3	0.4	0.3	33	29	27	ND	38	ND	ND	68
C9	C9(3.5)B	08-Feb-90	3.5	NA	NA	NA	NA	NA	5.0	NA	NA	NA	NA	NA
C9	C9(9)C	08-Feb-90	9.0	NA	NA	NA	NA	NA	3.0	NA	NA	NA	NA	NA
C10	C10(4)B	08-Feb-90	4.0	NA	NA	NA	NA	NA	5.0	NA	NA	NA	NA	NA
C10	C10(9.5)C	08-Feb-90	9.5	NA	NA	NA	NA	NA	4.0	NA	NA	NA	NA	NA
C12	C12(3.5)B	31-Jan-90	3.5	6.8	0.4	0.3	45	27	9	ND	33	ND	ND	58
C13	C13(3)B	15-Feb-90	3.0	2	0.3	ND	41	16	5	ND	30	ND	ND	29
C14	C14(4)B	05-Feb-90	4.0	ND	ND	ND	33	29	27	ND	38	ND	ND	27
C15	C15(.5)A	31-Jan-90	0.5	22	0.4	0.9	39	72	240	0.2	42	ND	ND	420
C15	C15(4)B	31-Jan-90	4.0	ND	0.5	ND	33	29	5	ND	29	ND	ND	38
C16	C16(4)B	31-Jan-90	4.0	5.6	0.6	0.2	36	24	7	ND	32	ND	ND	44
C17	C17(1)A **	08-Feb-90	1.0	14	0.4	5.4	46	310	8800	0.5	33	ND	1	47000

TABLE 3-4
PRIORITY POLLUTANT METALS DETECTED IN SOIL SAMPLES IN PHASE I INVESTIGATION
YERBA BUENA PROJECT SITE, AREA C
(concentrations in ppm)

SAMPLE LOCATION ID	SAMPLE ID	DATE SAMPLED	SAMPLE DEPTH (feet)	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
C17	C17(4)B	08-Feb-90	4.0	ND	ND	ND	28	7.0	3.0	ND	14	1	ND	16
C17	C17(9)C	08-Feb-90	9.0	3.4	0.3	0.5	22	20	3	ND	35	2	ND	50
C18	C18(2)A	07-Feb-90	2.0	1.4	0.3	ND	21	64	9.0	ND	35	ND	ND	84
C18	C18(3.5)B	07-Feb-90	3.5	1	0.3	ND	18	8.0	3.0	ND	16	ND	ND	15
C20	C20(3)	07-Feb-90	3.0	NA	NA	NA	NA	NA	10	NA	NA	NA	NA	NA
C21	C21(1)A	08-Feb-90	1.0	7	0.2	1	35	120	190	0.6	58	ND	ND	300
C21	C21(4)B	08-Feb-90	4.0	1.7	0.3	ND	19	30	8	ND	31	ND	ND	48
C21	C21(8)C	08-Feb-90	8.0	1.2	0.3	ND	17	12	6	ND	35	ND	ND	18
C21	C21(13)	08-Feb-90	13.0	2.4	0.3	0.3	20	22	3	ND	25	ND	ND	37
C23	C23(10)C	07-Feb-90	10.0	0.7	0.5	ND	27	21	4.0	ND	29	ND	ND	43
C24	C24(10)C	23-Feb-90	10.0	1.6	0.4	ND	28	13	3.0	ND	21	ND	ND	30
C25	C25(4.5)B	30-Jan-90	4.5	1.4	0.3	ND	38	10	4	ND	15	ND	ND	22
C26	C26(3)B	23-Feb-90	3.0	ND	0.4	ND	24	11	4	ND	21	ND	ND	33
C27	C27(10)C	07-Feb-90	10.0	0.8	0.4	ND	23	11	4.0	ND	12	ND	ND	16
LF10	LF10(4.5)B	31-Jan-90	4.5	3.8	0.5	ND	31	17	6	ND	37	ND	ND	38
LF11	LF11(1.5)A	31-Jan-90	1.5	2.2	0.6	0.2	35	30	6	ND	32	ND	ND	50
LF11	LF11(4)B	01-Feb-90	4.0	2.3	0.2	ND	36	8	4	ND	16	ND	ND	20
LF12	LF12(4.5)B	12-Feb-90	4.5	2	ND	ND	61	36	18	ND	43	ND	ND	80

TABLE 3-4
PRIORITY POLLUTANT METALS DETECTED IN SOIL SAMPLES IN PHASE I INVESTIGATION
YERBA BUENA PROJECT SITE, AREA C
(concentrations in ppm)

SAMPLE LOCATION ID	SAMPLE ID	DATE SAMPLED	SAMPLE DEPTH (feet)	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
	Western U.S. Range		low	<0.1	<1	NL	30	2	<10	<0.01	<5	<0.1	NL	10
			high	97	15	NL	2,000	300	700	4.6	700	4.3	NL	2,100
	Western U.S. Mean			5.5	0.68	NL	41	21	17	0.046	15	0.23	NL	55
			TTLC	500	75	100	2,500	2,500	1,000	20	2,000	100	500	5,000
			STLC	5.0	0.75	1.0	560	25	5.0	0.2	20	1.0	5.0	250
	Detection Limit			0.5	0.2	0.2	1.0	1.0	1.0	0.2	1.0	1.0	0.3	2.0
	Method Reference			7060	7090	7130	7190	7210	7420	7471	7520	7740	7760	7950
Statistical Summary														
No. Detects				28	31	11	34	34	38	5	34	2	1	33
Min.				0.25	0.1	0.1	17	7	3	0.1	12	0.5	0.15	15
Max.				25	2.1	5.4	61	310	240	0.6	58	2	1	420
Mean				3.68	0.41	0.35	32.88	32.88	19	0.14	28.62	0.56	0.18	58
Std. Dev.				5.70	0.33	0.92	9.41	53.71	48	0.11	9.94	0.27	0.15	82
No. Analyses				34	34	34	34	34	38	34	34	34	34	33
Student's t				1.693	1.693	1.693	1.693	1.693	1.688	1.693	1.693	1.693	1.693	1.694
95%UCL				**5.34**	**0.51**	**0.61**	**35.6**	**48.5**	**32.4**	**0.17**	**31.5**	**0.64**	**0.22**	**81.7**

NOTES:

NL - not listed
NA - not analyzed
ND - not detected
** Shallow soils (<4 ft) were subsequently excavated from the vicinity of sampling location C17. Hence, these data are not included in the statistical summary.

Key to Abbreviations:

As = Arsenic
Be = Beryllium
Cd = Cadmium
Cr = Chromium
Cu = Copper
Pb = Lead
Hg = Mercury
Ni = Nickel
Se = Selenium
Ag = Silver
Zn = Zinc

Table 3-5
Volatile Organic Compounds Detected in Groundwater in Area C Monitoring Wells
Yerba Buena Project Site, Area C

Well Number	Sampling Date	Lab	Analysis Method	Concentration (ug/L)													
				CBEN	Cloro-form	1,1-DCA	1,2-DCA	1,1-DCE	1,2-DCE	C-1,2-DCE	T-1,2-DCE	DCM	PCE	1,1,1-TCA	1,1,2-TCA	TCE	VC
LF-9	01/30/90	MED	8240	<5	<5	<5	<5	<5	<5	NA	NA	<5	<5	<5	<5	<5	<10
	01/30/90	MED	8240	<5	<5	<5	<5	<5	<5	NA	NA	<10	<5	<5	<5	<5	<10
	02/08/90	MED	8240	<5	<5	<5	<5	<5	<5	NA	NA	<5	<5	<5	<5	34	<10
LF-10	01/30/90	MED	8240	<5	<5	<5	<5	<5	<5	NA	NA	<5	<5	<5	<5	<5	<10
	02/08/90	MED	8240	<5	<5	<5	<5	31	3200	NA	NA	<6	41	<5	7.0	7600	1000
	11/29/90	BCA	8010	<50	<50	<50	<50	<50	4700	4600	140	<50	<50	<50	<50	5900	290
	02/10/93	ANA	8010	<25	<25	<25	<25	<25	368	300	68	<50	<25	<25	<25	1600	<25
	07/13/93	ANA	8010	<25	<25	<25	<25	<25	322	260	62	<50	<25	<25	<25	1500	<25
	03/16/94	ANA	8010	<5	<5	<5	<5	<5	NA	510	110	130	<5	<5	<5	1800	120
	03/16/94	AEN	8010	3	<0.5	2.0	2.0	5.0	NA	360	90	<0.5	15	5.0	2.0	1500	88
LF-11	02/01/90	MED	8240	<5	<5	<5	<5	<5	<5	NA	NA	<5	<5	<5	<5	<5	<10
	02/09/90	MED	8240	<50	<50	<50	<50	<50	51	NA	NA	<50	<50	<50	<50	310	<100
	02/10/93	ANA	8010	<2.5	<2.5	<2.5	<2.5	<2.5	36	33	2.9	<2.5	<2.5	<2.5	<2.5	140	<5
LF-11R	03/16/94	ANA	8010	<2.5	<2.5	<2.5	<2.5	<2.5	NA	16	<2.5	<5	<2.5	<2.5	<2.5	76	<2.5
	03/16/94	AEN	8010	<0.5	<0.5	<0.5	<0.5	<0.5	NA	16	2.0	<0.5	<0.5	<0.5	<0.5	76	1.0
LF-12	02/12/90	MED	8240	<5	<5	<5	<5	<5	<5	NA	NA	<5	<5	<5	<5	<5	<10
	02/23/90	MED	8240	<5	<5	<5	<5	<5	67	NA	NA	<5	<5	<5	<5	8.0	<10
	02/10/93	ANA	8010	<0.5	<0.5	<0.5	<0.5	<0.5	36	32	3.8	<1	<0.5	<0.5	<0.5	2.0	<0.5
	07/13/93	ANA	8010	<0.5	<0.5	<0.5	<0.5	<0.5	44	39	4.5	<1	<0.5	<0.5	<0.5	1.7	<0.5

Table 3-5

Volatile Organic Compounds Detected in Groundwater in Area C Monitoring Wells

Yerba Buena Project Site, Area C

Well Number	Sampling Date	Lab	Analysis Method	Concentration (ug/L)													
				CBEN	Cloro-form	1,1-DCA	1,2-DCA	1,1-DCE	1,2-DCE	C-1,2-DCE	T-1,2-DCE	DCM	PCE	1,1,1-TCA	1,1,2-TCA	TCE	VC
LF-13	03/16/94	ANA	8010	<0.5	<0.5	<0.5	<0.5	<0.5	NA	<0.5	<0.5	<1	<0.5	0.8	<0.5	20	<0.5
	03/16/94	AEN	8010	<0.5	<0.5	<0.5	<0.5	<0.5	NA	<0.5	<0.5	<0.5	<0.5	0.8	<0.5	19	<0.5
LF-16	02/23/90	MED	8240	<5	<5	<5	<5	<5	<5	NA	NA	<5	<5	<5	<5	<5	<10
LF-31	05/26/93	ANA	8010	<0.5	<0.5	<0.5	<0.5	<0.5	NA	3.9	<0.5	<1	<0.5	<0.5	<0.5	20	<0.5
	07/17/93	ANA	8010	<0.5	<0.5	<0.5	<0.5	<0.5	NA	2.4	<0.5	<1	6.3	<0.5	<0.5	7.3	<0.5
	03/11/94	ANA	8010	<0.5	1.2	<0.5	<0.5	<0.5	NA	3.0	<0.5	<1	<0.5	<0.5	<0.5	5.4	<0.5
	03/11/94	ANA	8010	<0.5	1.4	<0.5	<0.5	<0.5	NA	3.4	<0.5	<1	<0.5	<0.5	<0.5	6.0	<0.5
LF-32	03/11/94	ANA	8010	<0.5	<0.5	<0.5	<0.5	<0.5	NA	0.8	<0.5	<1	<0.5	<0.5	<0.5	2.5	<0.5
	03/11/94	ANA	8010	<0.5	<0.5	<0.5	<0.5	<0.5	NA	0.9	<0.5	<1	<0.5	<0.5	<0.5	2.6	<0.5

Abbreviations:

CBEN	Chlorobenzene	1,2-DCA	1,2-Dichloroethane	C-1,2-DCE	cis-1,2-Dichloroethene	TCE	Trichloroethene
1,1-DCE	1,1-Dichloroethene	1,2-DCE	1,2-Dichloroethene	T-1,2-DCE	trans-1,2-Dichloroethene	VC	Vinyl Chloride
1,1-DCA	1,1-Dichloroethane	PCE	Tetrachloroethene	1,1,1-TCA	1,1,1-Trichloroethane	DCM	Methylene Chloride (Dichloromethane)
<	Less than Indicated Detection Limit			1,1,2-TCA	1,1,2-Trichloroethane		
ANA	Anametrix, Inc. of San Jose, California			BCA	BC Analytical of Emeryville, California	NA	Not Available
MED	Med-Tox Associates of Pleasant Hill, California			AEN	American Environmental Network		

Table 3-6
Total Petroleum Hydrocarbons (TPH) and BTEX Detected in Groundwater Samples Collected from Monitoring Wells and Phase I Soil Borings
Yerba Buena Project Site, Area C

Sampling Location	Sampling Date	BTEX and TPH Concentration (ug/L)						
		Benzene	Toluene	Ethyl-Benzene	Xylene	TPH as Diesel	TPH as Gasoline	TPH as Oil
C-7	01/30/90	NA	NA	NA	NA	<300	<100	500
C-10	02/08/90	NA	NA	NA	NA	NA	<100	NA
C-16	01/31/90	NA	NA	NA	NA	<300	<100	700
C-18	02/07/90	NA	NA	NA	NA	<100	<500	<500
C-20	02/07/90	NA	NA	NA	NA	NA	200	NA
C-28	02/12/90	NA	NA	NA	NA	<300	<100	<500
C-29	02/15/90	NA	NA	NA	NA	<300	<100	<500
LF-9	01/30/90	<5	<5	<5	<10	<300	<4000	7800
	02/08/90	<5	<5	<5	<10	<300	<100	500
LF-10	02/08/90	<5	<5	<5	<10	<300	<100	1500
LF-11	02/09/90	<5	<5	<5	<10	<300	100	600
LF-12	02/23/90	<5	<5	<5	<10	500	<100	<500
LF-16	02/23/90	<5	<5	<5	<10	<300	<100	<500
	05/14/92	<0.3	<0.3	<0.3	<1	NA	<50	6600
	05/28/92	<0.3	<0.3	<0.3	<1	50	<50	<500
	10/22/92	<0.3	<0.3	<0.3	<1	50	<50	<500
	02/12/93	<0.5	<0.5	<0.5	<0.5	<50	<50	NA
	05/26/93	<0.5	<0.5	<0.5	<0.5	54	<50	NA
	07/14/93	<0.5	2	<0.5	<0.5	<50	50	<5
LF-31	02/12/93	<0.5	<0.5	<0.5	<0.5	<50	<50	<5000
	05/26/93	NA	NA	NA	NA	200	NA	<5000
	05/26/93	NA	NA	NA	NA	310	NA	<5000
	07/14/93	NA	NA	NA	NA	150	NA	<5000
	07/14/93	NA	NA	NA	NA	400	NA	<1000
	12/09/93	NA	NA	NA	NA	200	<50	<5000
	03/11/94	<0.5	<0.5	<0.5	<0.5	110	NA	210
LF-32	05/26/93	<0.5	<0.5	<0.5	<0.5	440	50	NA
	07/14/93	<0.5	<0.5	<0.5	<2	<200	<50	NA
	07/14/93	<0.5	<0.5	<0.5	<5	230	<50	NA
	10/09/93	<0.5	<0.5	<0.5	<5	660	<50	NA
	03/11/94	<0.5	<0.5	<0.5	<5	890	110	850
	03/11/94	NA	NA	NA	NA	NA	110	NA
	03/11/94	NA	NA	NA	NA	NA	<50	NA

Abbreviations:

NA	Not analyzed	BTEX	Benzene, Toluene, Ethylbenzene and Xylene
<	Less than indicated detection limit		

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Table 4-1
Comparison of Simulated vs. Measured Groundwater Elevations at Monitoring Well Locations
Yerba Buena Project Site, Area C

Well No.	Grid Location Row No.	Grid Location Column No.	Measured* Water Level (ft)	Simulated Water Level (ft)	Difference (ft)
LF-10	3	24	8.00	8.05	0.05
LF-11	3	17	***4.65***	4.73	0.08
LF-12	5	3	0.55	0.57	0.02
LF-13	13	13	1.95	1.95	0.00
LF-16	6	34	10.86	10.92	0.06
LF-31	4	33	10.45	10.50	0.05
LF-32	7	20	5.11	4.99	-0.12
Average difference					0.0543

* Water level measurements were conducted on July 9, 1993

Note: Groundwater elevation at LF-11 was not measured during the 07/09/93 measurement event. For the purpose of calibration of groundwater level in groundwater flow modeling, the water level at LF-11 on 07/09/93 was estimated by correlating available paired data from the 06/22/93 and 07/09/93 water level measurement events.

Table 4-2
Comparison of Reported vs. Simulated VOC Concentrations in Groundwater at Monitoring Well Locations
Yerba Buena Project Site, Area C

Well No.	Grid Location		Trichloroethene		1,2-Dichloroethene		Vinyl Chloride	
	Row No.	Column No.	Reported* (ug/L)	Simulated (ug/L)	Reported (ug/L)	Simulated (ug/L)	Reported (ug/L)	Simulated (ug/L)
LF-10	3	24	1500-1800	1505.6	450-620	469.9	88-120	82.9
LF-11R	3	17	76	121	16-18	32.4	1.0	6.4
LF-12**	5	3	1.7	1.5	44	43.9	<0.5	0.6
LF-13	13	13	19-20	20.5	<0.5	17.4	<0.5	28.6
LF-16***	6	34	<5	0.2	<5	0.4	<10	0.0
LF-31	4	33	5.4-6.0	2.0	3.0-3.4	3.6	<0.5	0.2
LF-32	7	20	2.5-2.6	442.0	0.8-0.9	240.5	<0.5	67.6

* All reported concentrations except for LF-12 and LF-16 are from March 1994 sampling event. There were no reported concentrations available for wells LF-12 and LF-16 from March 1994 sampling event.

** Reported concentrations for LF-12 are from July 1993 sampling event.

*** Reported concentrations for LF-16 are from February 1990 sampling event.

Table 4-3
Estimated Chemical Concentrations in Indoor Air At Present and after 30 Years
Yerba Buena Project Site, Area C

Chemical Name	Present Time		After 30 Years	
	Flux Rate (mg/cm ^ 2/s)	Conc. in Air (mg/m ^ 3)	Flux Rate (mg/cm ^ 2/s)	Conc. in Air (mg/m ^ 3)
Trichloroethene	1.25E-10	9.00E-03	1.38E-10	9.94E-03
1,2-Dichloroethene	6.83E-11	4.92E-03	7.24E-11	5.21E-03
Toluene	4.49E-08	3.23E+00	1.467E-08	1.06E+00
Vinyl Chloride	1.41E-11	1.02E-03	1.41E-11	1.02E-03

Table 4-4
Estimated Chemical Concentrations in Ambient Air in On-Site Construction Excavation to 5 Foot Depth
Yerba Buena Project Site, Area C

Chemical Name	**Trench with 5' Depth**	
	Flux Rate (mg/cm^2/s)	Conc. in Air (mg/m^3)
Trichloroethene	3.32E-10	7.84E-03
1,2-Dichloroethene	1.82E-10	4.30E-03
Toluene	4.49E-08	1.06E+00
Vinyl Chloride	3.76E-11	8.88E-04

Table 5-1

Toxicity Critria for Chemicals of Concern

Yerba Buena Project Site, Area C

Chemical of Concern	Oral RfD (mg/kg-day)	Source	Critical Effect	Inhalation RfD (mg/kg-day)	Source	Critical Effect	Weight of Evidence	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1	Source
1,2-Dichloroethene	2.00E-02	IRIS, 1994	Increased serum alkaline phosphatase in male mice	2.00E-02	IRIS, 1994	a	NA	NA	NA	NA
Toluene	2.00E-01	IRIS,1994	Altered liver/kidney weight	1.00E-01	IRIS,1994	CNS effects		NA	NA	NA
Trichloroethene	6.00E-03	ECAO		6.00E-03	ECAO		B2	1.10E-02	6.00E-03	ECAO
Vinyl Chloride	ND	NA		ND	NA		A	NA	3.00E-01	HEAST, 1992
Arsenic	3.00E-04	IRIS, 1994	Skin keratosis/hyperpigmentation	NA	NA	NA	A	1.80E+00	NA	NA
Beryllium	5.00E-03	IRIS, 1994	None observed	NA	NA	NA	B2	4.30E+00	NA	NA
Cadmium	5.00E-04	IRIS, 1994		NA	NA	NA	b	NA	NA	NA
Chromium	1.00E+00	IRIS, 1994	None observed	NA	NA	NA	NA	NA	NA	NA
Copper	3.70E-02	HEAST, 1992	Gastrointestinal irritation	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA		NA	NA	NA	NA	NA	NA	NA
Mercury	3.00E-04	HEAST, 1992	Kidney effects	NA	NA	NA	NA	NA	NA	NA
Nickel	2.00E-02	IRIS, 1994	Decreased body/organ weights	NA	NA	NA	NA	NA	NA	NA
Selenium	5.00E-03	IRIS, 1994	Selenosis	NA	NA	NA	NA	NA	NA	NA
Silver	5.00E-03	IRIS, 1994	Skin/agyria	NA	NA	NA	NA	NA	NA	NA
Zinc	3.00E-01	IRIS, 1994	Blood/anemia	NA	NA	NA	NA	NA	NA	NA

a	Route-to-route extrapolation
b	Only carcinogenic by the inhalation route; not applicable to this risk assessment
NA	Not applicable
ND	No data
IRIS	EPA Integrated Risk Information System
~~HEAST~~	~~EPA Health Effects Assessment Summary Tables~~

Table 6-1
95% UCL Mean Concentrations of Metals in Soil Yerba Buena Project Site, Area C

Chemical Contaminant	95% UCL Mean Conc. (mg/kg)	Background Levels: Western U.S. Observed Range (mg/kg)	Background Levels: Western U.S. Mean (mg/kg)
Arsenic	5.34	<0.1 - 97	5.5
Beryllium	0.51	<1 - 15	0.68
Cadmium	0.61	(a)	(a)
Chromium	35.6	3.0 - 2000	41
Copper	48.5	2 - 300	21
Lead	32.4	<10 - 700	17
Mercury	0.17	<0.01 - 4.6	0.046
Nickel	31.5	<5 - 700	15
Selenium	0.64	<0.1 - 4.3	0.23
Silver	0.22	(a)	(a)
Zinc	81.7	10 - 2100	55

(a) No data available

Table 6-2
Construction Worker Blood-Lead Levels at the 95% UCL Lead Concentration
Yerba Buena Project Site, Area C

Model Exposure Input Parameters	Median Blood-Lead (ug/dl)	90th Percentile Blood-Lead (ug/dl)	95th Percentile Blood-Lead (ug/dl)	98th Percentile Blood-Lead (ug/dl)	99th Percentile Blood-Lead (ug/dl)
Dietary intake = 10 ug Pb/kg (default parameter) Drinking water intake = 15 ug Pb/l (default parameter) Soil Concentration = 32.4 ug/g Air Concentraion = 0.18 ug/m3 (default parameter)	2.04	3.19	3.62	4.18	4.6

Table 6-3
Construction Worker Blood-Lead Levels at the Maximum Detected Lead Concentration
Yerba Buena Project Site, Area C

Model Exposure Input Parameters	Median Blood-Lead (ug/dl)	90th Percentile Blood-Lead (ug/dl)	95th Percentile Blood-Lead (ug/dl)	98th Percentile Blood-Lead (ug/dl)	99th Percentile Blood-Lead (ug/dl)
Dietary intake = 10 ug Pb/kg (default parameter) Drinking water intake = 15 ug Pb/l (default parameter) Soil Concentration = 240 ug/g Air Concentraion = 0.18 ug/m3 (default parameter)	2.17	3.4	3.85	4.46	4.9

Table 7-1
Indoor Worker Inhalation Hazards at Present Time
Yerba Buena Project Site, Area C

Chemical Contaminant	Concentration in Air (mg/m3)	Indoor Worker Intak (mg/kg-day)	Inhalation RfD (mg/kg-day)	RfD Source	Inhalation Hazard Quotient (HQ)
1,2-Dichloroethene	1.47E-04	2.33E-05	2.00E-02	IRIS,1994 (1)	1.16E-03
Toluene	9.64E-02	1.53E-02	1.00E-01	IRIS, 1994	1.53E-01
Trichloroethene	2.68E-04	4.24E-05	6.00E-03	ECAO	7.07E-03
Vinyl Chloride	3.03E-05	4.80E-06	NA		
			Hazard Index		1.61E-01

Table 7-2
Indoor Worker Inhalation Hazards After 30 Years
Yerba Buena Project Site, Area C

Chemical Contaminant	Concentration in Air (mg/m3)	Indoor Worker Intak (mg/kg-day)	Inhalation RfD (mg/kg-day)	RfD Source	Inhalation Hazard Quotient (HQ)
1,2-Dichloroethene	1.55E-04	2.45E-05	2.00E-02	IRIS,1994 (1)	1.23E-03
Toluene	3.15E-02	4.99E-03	1.00E-01	IRIS, 1994	4.99E-02
Trichloroethene	2.96E-04	4.69E-05	6.00E-03	ECAO	7.81E-03
Vinyl Chloride	3.03E-05	4.80E-06	NA		
			Hazard Index		5.89E-02

Table 7-3
Construction Worker Inhalation Hazards During Trenching Operations
Yerba Buena Project Site, Area C

Chemical Contaminant	Concentration in Air (mg/m3)	Construction Worker Intak (mg/kg-day)	Inhalation RfD (mg/kg-day)	RfD Source	Inhalation Hazard Quotient (HQ)
1,2-Dichloroethene	4.30E-03	8.41E-04	2.00E-02	IRIS,1994 (1)	4.21E-02
Toluene	1.06E+00	2.07E-01	1.00E-01	IRIS, 1994	2.07E+00
Trichloroethene	7.84E-03	1.53E-03	6.00E-03	ECAO	2.56E-01
Vinyl Chloride	8.88E-04	1.74E-04	NA		
			Hazard Index		2.37E+00

Table 7-4

Construction Worker Incidental Ingestion Hazards DuringTrenching Operations

Yerba Buena Project Site, Area C

Chemical Contaminant	95% UCL Soil Conc. (mg/kg)	Construction Worker Intake (mg/kg-day)	Oral RfD (mg/kg-day)	RfD Source	Oral Hazard Quotient (HQ)
1,2-Dichloroethene	0.009	8.81E-09	2.00E-02	IRIS,1994 (1)	4.40E-07
Toluene	0.158	1.55E-07	2.00E-01	IRIS, 1994	7.73E-07
Arsenic	5.34	5.23E-06	3.00E-04	IRIS, 1994	1.74E-02
Beryllium	0.51	4.99E-07	5.00E-03	IRIS, 1994	9.98E-05
Cadmium	0.61	5.97E-07	5.00E-04	IRIS, 1994	1.19E-03
Chromium	35.6	3.48E-05	1.00E+00	IRIS, 1994	3.48E-05
Copper	48.5	4.75E-05	3.70E-02	HEAST,1992	1.28E-03
Lead	32.4	3.17E-05			
Mercury	0.17	1.66E-07	3.00E-04	HEAST,1992	5.54E-04
Nickel	31.5	3.08E-05	2.00E-02	IRIS,1994	1.54E-03
Selenium	0.64	6.26E-07	5.00E-03	IRIS,1994	1.25E-04
Silver	0.22	2.15E-07	5.00E-03	IRIS,1994	4.31E-05
Zinc	81.7	7.99E-05	3.00E-01	IRIS,1994	2.66E-04
	Hazard Index				2.26E-02

Table 7-5
Construction Worker Dermal Hazards During Trenching Operations
Yerba Buena Project Site, Area C

Chemical Contaminant	95% UCL Soil Conc. (mg/kg)	Construction Worker Intake (mg/kg-day)	Oral RfD (mg/kg-day)	RfD Source	Dermal Hazard Quotient (HQ)
1,2-Dichloroethene	0.009	2.36E-08	2.00E-02	IRIS,1994 (1)	1.18E-06
Toluene	0.158	4.15E-07	2.00E-01	IRIS, 1994	2.08E-06
Arsenic	5.34	1.40E-06	3.00E-04	IRIS, 1994	4.68E-03
Beryllium	0.51	1.34E-07	5.00E-03	IRIS, 1994	2.68E-05
Cadmium	0.61	1.60E-07	5.00E-04	IRIS, 1994	3.21E-04
Chromium	35.6	9.35E-06	1.00E+00	IRIS, 1994	9.35E-06
Copper	48.5	1.27E-05	3.70E-02	HEAST,1992	3.44E-04
Lead	32.4	8.51E-06			
Mercury	0.17	4.47E-08	3.00E-04	HEAST,1992	1.49E-04
Nickel	31.5	8.28E-06	2.00E-02	IRIS,1994	4.14E-04
Selenium	0.64	1.68E-07	5.00E-03	IRIS,1994	3.36E-05
Silver	0.22	5.78E-08	5.00E-03	IRIS,1994	1.16E-05
Zinc	81.7	2.15E-05	3.00E-01	IRIS,1994	7.15E-05
			Hazard Index		6.06E-03

Table 7-6
Indoor Worker Incremental Cancer Risk at Present Time
Yerba Buena Project Site, Area C

Chemical Contaminant	Concentration in Air (mg/m3)	Indoor Worker Intak (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)	CSF Source	Inhalation Cancer Risk
Trichloroethene	2.68E-04	1.52E-05	6.00E-03	ECAO	9.09E-08
Vinyl Chloride	3.03E-05	1.71E-06	3.00E-01	HEAST, 1992	5.14E-07
				Total Risk	6.05E-07

Table 7-7
Indoor Worker Incremental Inhalation Cancer Risks After 30 Years
Yerba Buena Project Site, Area C

Chemical Contaminant	Concentration in Air (mg/m3)	Indoor Worker Intak (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)	CSF Source	Inhalation Cancer Risk
Trichloroethene	2.96E-04	1.67E-05	6.00E-03	ECAO	1.00E-07
Vinyl Chloride	3.03E-05	1.71E-06	3.00E-01	HEAST, 1992	5.14E-07
				Total Risk	6.14E-07

Table 7-8
Construction Worker Incremental Inhalation Cancer Risks During Trenching Operations
Yerba Buena Project Site, Area C

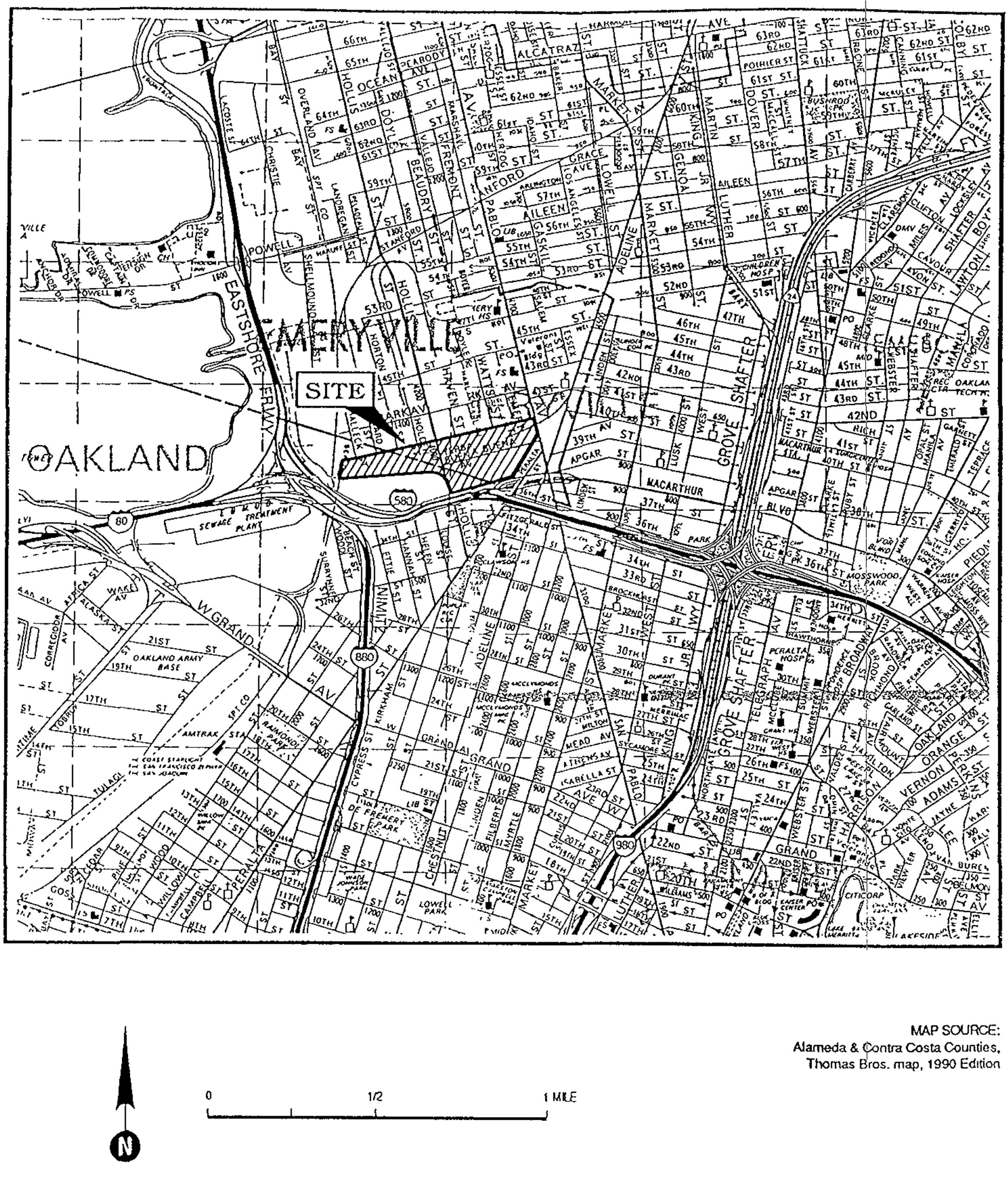
Chemical Contaminant	Concentration in Air (mg/m3)	Construction Worker Intak (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)	CSF Source	Inhalation Cancer Risk
Trichloroethene	7.84E-03	1.10E-05	6.00E-03	ECAO	6.58E-08
Vinyl Chloride	8.88E-04	1.24E-06	3.00E-01	HEAST, 1992	3.72E-07
				Total Risk	4.38E-07

Table 7-9
Construction Worker Incremental Ingestion Cancer Risks from Trenching Operations
Yerba Buena Project Site, Area C

Chemical Contaminant	95% UCL Soil Conc. (mg/kg)	Construction Worker Intake (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	CSF Source	Oral Cancer Risk
Arsenic	5.34	3.73E-08	1.80E+00	IRIS,1994	6.72E-08
Beryllium	0.51	3.56E-09	4.30E+00	IRIS,1994	1.53E-08
				Total Risk	8.25E-08

Table 7-10
Construction Worker Incremental Dermal Cancer Risks from Trenching Operations
Yerba Buena Project Site, Area C

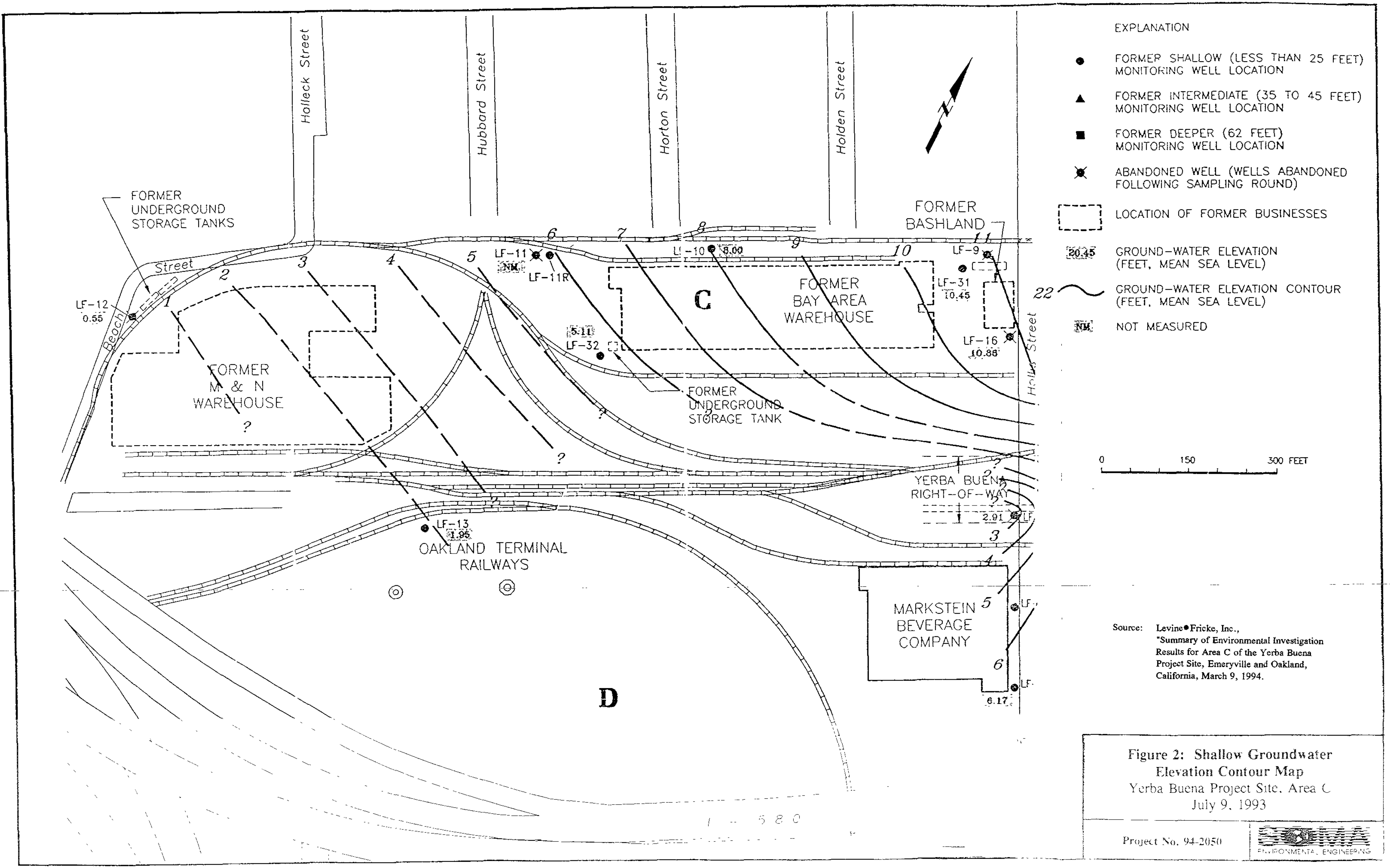
Chemical Contaminant	95% UCL Soil Conc. (mg/kg)	Construction Worker Intake (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	CSF Source	Dermal Cancer Risk
Arsenic	5.34	1.00E-08	1.80E+00	IRIS,1994	1.80E-08
Beryllium	0.51	9.57E-10	4.30E+00	IRIS,1994	4.12E-09
				Total Risk	2.22E-08



MAP SOURCE:
Alameda & Contra Costa Counties,
Thomas Bros. map, 1990 Edition

Figure 1 : SITE LOCATION MAP
YERBA BUENA PROJECT SITE

SOMA
ENVIRONMENTAL ENGINEERING



Source: Levine•Fricke, Inc., "Summary of Environmental Investigation Results for Area C of the Yerba Buena Project Site, Emeryville and Oakland, California, March 9, 1994.

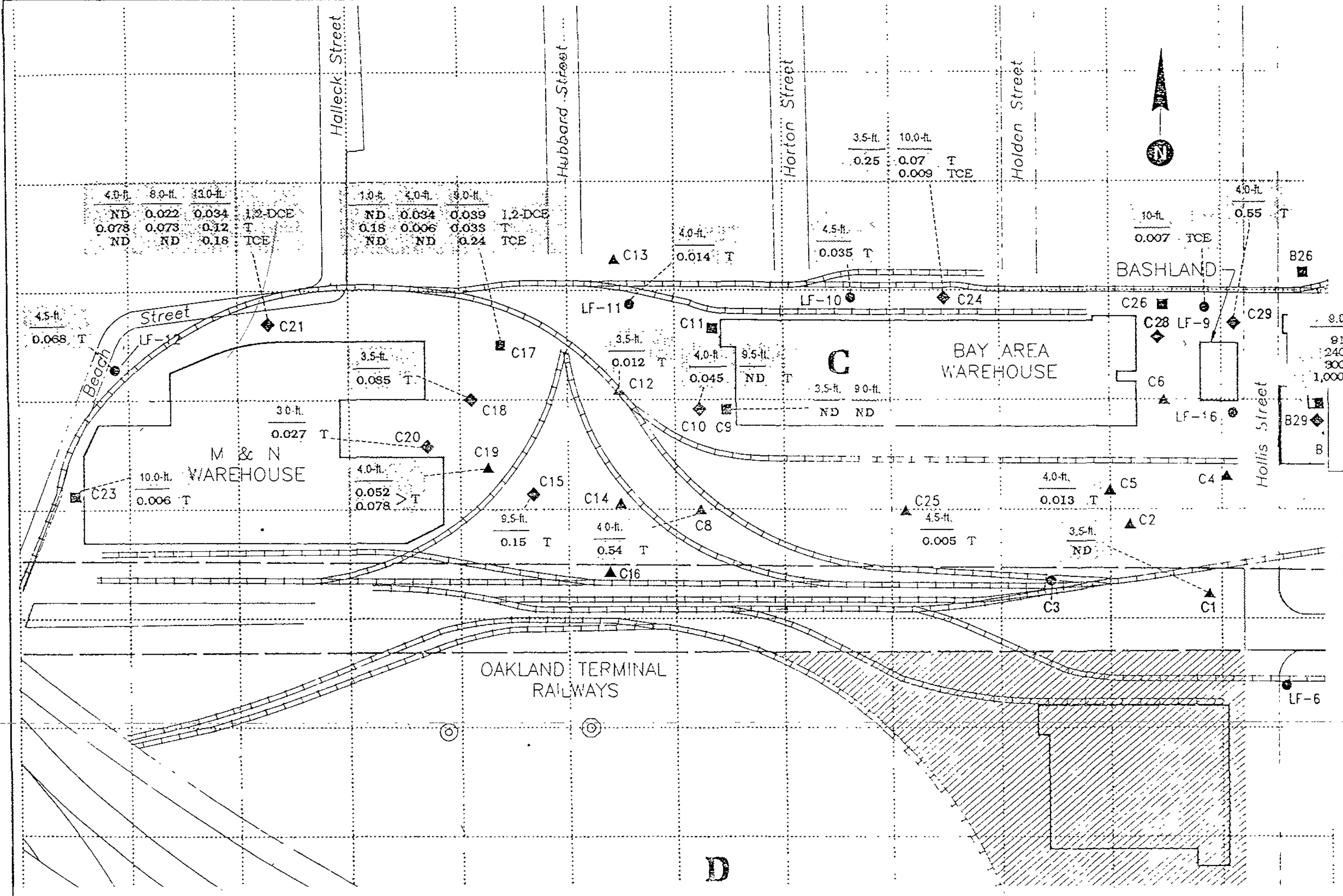
Figure 2: Shallow Groundwater Elevation Contour Map

Yerba Buena Project Site, Area C

July 9, 1993

Project No. 94-2050

ENVIRONMENTAL ENGINEERING



EXPLANATION

- ● MONITORING WELL LOCATION
- ▲ PHASE I INVESTIGATION SHALLOW SOIL SAMPLING LOCATION (LESS THAN 5 FEET)
- ▣ PHASE I INVESTIGATION DEEPER SOIL SAMPLING LOCATION (6 TO 18 FEET)
- ◆ PHASE I INVESTIGATION DEEPER SOIL SAMPLING LOCATION (13 TO 18 FEET) AND GRAB GROUND-WATER SAMPLE LOCATION
- ▨ NON-ACCESSIBLE AREA

9.0-ft. — DEPTH OF SAMPLE

91/100	B	BENZENE
240/200	T	TOLUENE
300/190	E	ETHYLBENZENE
1,000/910	X	XYLENES

CHEMICAL COMPOUND

DUPLICATE ANALYSIS

CONCENTRATION DETECTED IN SOIL SAMPLES (PPM)

ND NOT DETECTED

KEY TO ABBREVIATIONS

1,1-DCA 1,1-DICHLOROETHANE
1,2-DCE 1,2-DICHLOROETHENE
TCE TRICHLOROETHENE

0 150 300 FEET

Source: Levine•Fricke, Inc., "Summary of Environmental Investigation Results for Area C of the Yerba Buena Project Site, Emeryville and Oakland, California, March 9, 1994.

Figure 3:

Volatile Organic Compounds Detected in Area C Soil Samples Phase I Investigation

Project No. 94-2050

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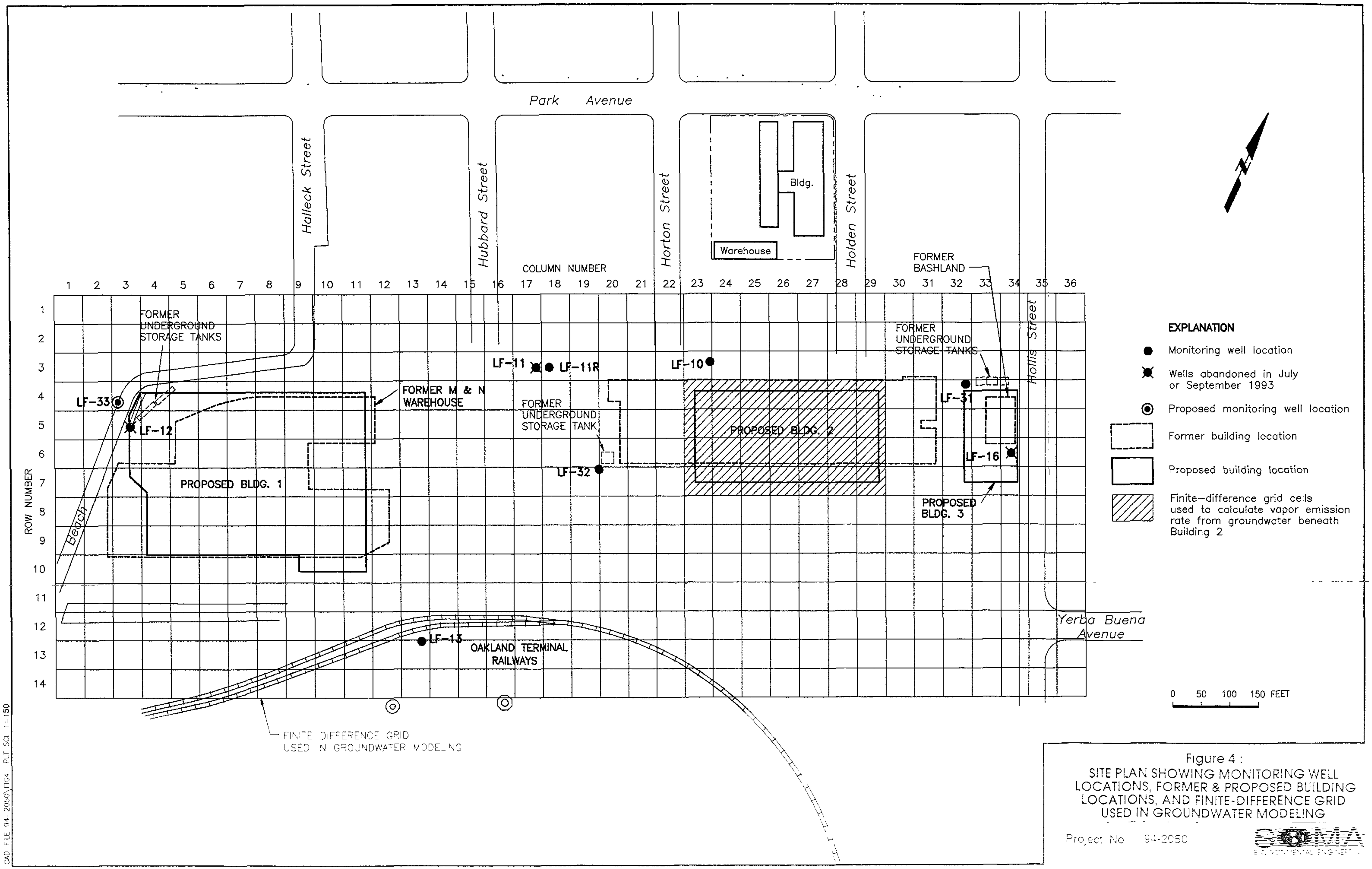

Figure 4 :
SITE PLAN SHOWING MONITORING WELL LOCATIONS, FORMER & PROPOSED BUILDING LOCATIONS, AND FINITE-DIFFERENCE GRID USED IN GROUNDWATER MODELING

Project No 94-2050

SOMA ENVIRONMENTAL ENGINEERING

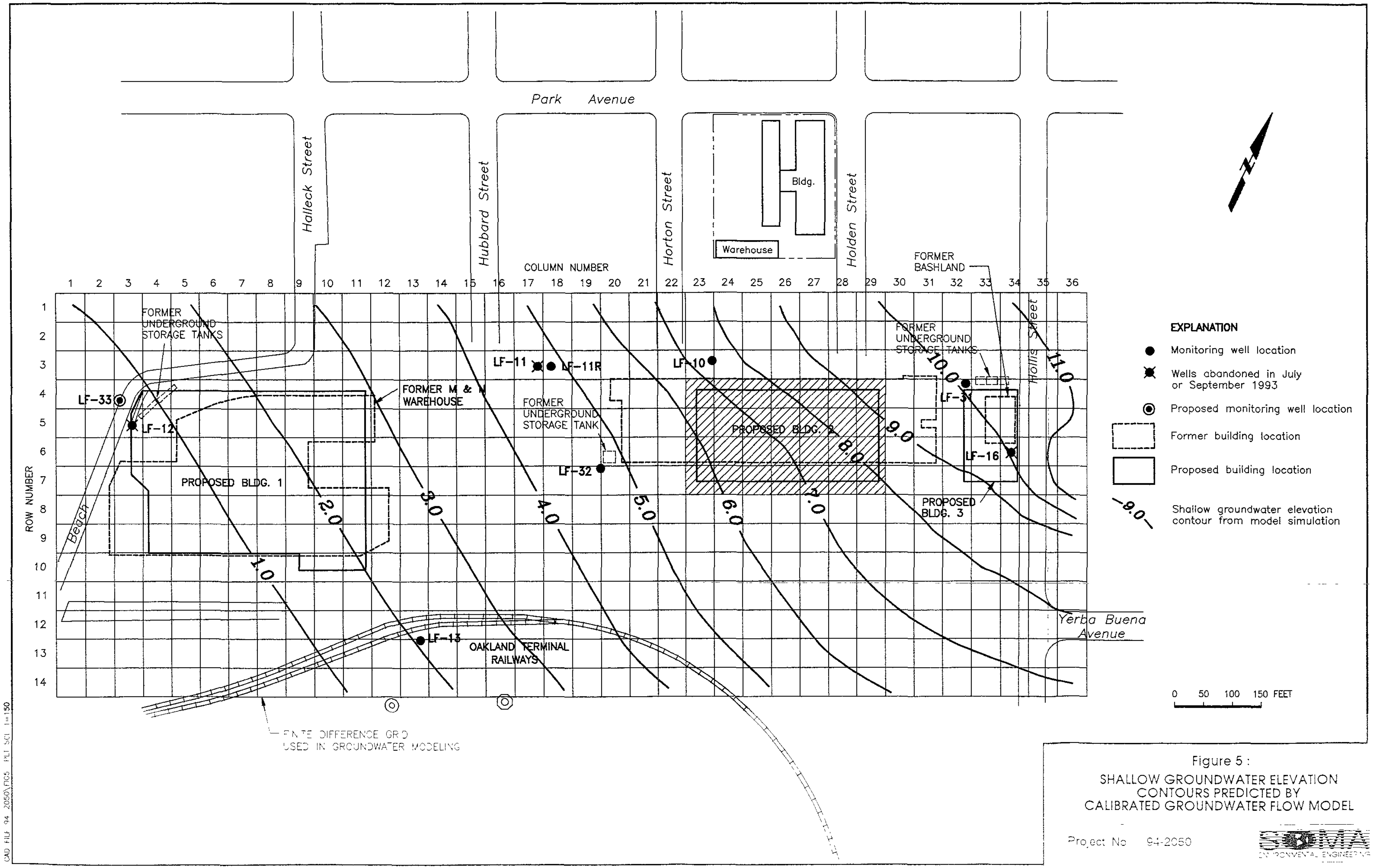

Figure 5 :

SHALLOW GROUNDWATER ELEVATION CONTOURS PREDICTED BY CALIBRATED GROUNDWATER FLOW MODEL

Project No 94-2050

SOMA ENVIRONMENTAL ENGINEERING

ENVIRONMENTAL ENGINEERING, INC.
155 Filbert Street, Suite 230, Oakland, CA 94607
TEL (510) 832-SOMA • FAX (510) 893-SOMA

APPENDIX A1

LABORATORY SOIL TEST RESULTS

ASTM D2850

WATER CONTENT(%), WET & DRY UNIT WEIGHT(PCF)

PROJECT NAME LEVINE FRICKE 1649.26 PROJECT NO. 16148A DATE 03/18/94

TESTED BY J. HEBEL REDUCED BY S. CAPPS REVIEWED BY C. WASON

LOCATION EAST BAY BRIDGE - EMERYVILLE, CA PAGE 1 OF 1

SPECIMEN NUMBER	DIAM. INCH	HEIGHT CM.	WET WT. GRAMS	DRY WT. GRAMS	SOIL DESCRIPTION	WATER CONTENT	WET UNIT WEIGHT	DRY UNIT WEIGHT
BW-32 2.5	1.94	14.80	562.8	458.0	DARK GRAY BROWN FINE SANDY SILTY CLAY WITH GRAVEL	22.88	124.4	101.3
BW-32 11.5	1.94	11.70	460.5	389.4	YELLOWISH BROWN GRAVELLY CLAYEY SAND	18.26	128.8	108.9
BW-10 2.5	1.94	11.40	390.1	294.5	DARK BROWN SILTY CLAY WITH TRACES OF ORGANICS	32.46	112.0	84.5
BW-10 4	----	----	339.5	276.9	DARK BROWN SILTY CLAY WITH TRACES OF GRAVEL/ORGANIC	22.61	-----	-----
BW-10 6.5	1.94	12.55	475.7	382.0	OLIVE BROWN FINE SANDY SILTY CLAY WITH SHELL FRAGS.	24.53	124.0	99.6
BW-10 16.5	1.94	11.20	438.7	363.4	REDDISH GRAY BRN GRAVELLY SILTY CLAYEY SAND	20.72	128.2	106.2

Woodward-Clyde

CHAIN OF CUSTODY / ANALYSES REQUEST FORM

Project No.: 1649.26
Field Logbook No.:
Date: 3/16/94
Serial No.: № 12681
Project Name: East Baybridge
Project Location: Emeryville
Sampler (Signature): William Madison
Samplers: William Madison

SAMPLE NO.	DATE	TIME	LAB SAMPLE NO.	NO. OF CONTAINERS	SAMPLE TYPE	EPA 601	EPA 624	Density	moisture content	Total organic carbon - TOC		HOLD	RUSH	REMARKS
BW32-2.5	3/16/94			1	Soil			X	X					
BW32-11.5	↓			1	↓			X	X	X				
BW10-2.5				1				X	X					One Week TAT
BW10-4				1					X					
BW10-6.5				1				X	X	X				Results to Jennifer
BW10-16.5				1				X	X	X				Beatty

RELINQUISHED BY: (Signature) William Madison	DATE 3/16/94	TIME 7:00p	RECEIVED BY: (Signature) Ken Stettler	DATE 3/17/94	TIME 10:20
RELINQUISHED BY: (Signature) Ken Stettler	DATE 3/17/94	TIME 12:25	RECEIVED BY: (Signature)	DATE	TIME
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
METHOD OF SHIPMENT:	DATE	TIME	LAB COMMENTS:		

Sample Collector:
LEVINE-FRICKE
1900 Powell Street, 12th Floor
Emeryville, California 94608
(510) 652-4500

Analytical Laboratory: Woodward Clyde, via AEN

Shipping Copy (White) Lab Copy (Green) File Copy (Yellow) Field Copy (Pink)

FORM NO. 86/COC/ARF

[redacted]
(415) 893-3600

EMERYVILLE, CA
94608

Chain of Custody Record

PROJECT NO. 1649.26

SAMPLERS: (Signature)

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 524	EPA Method 625	EPA Method 608	TOC						Number of Containers	REMARKS (Sample preservation, handling procedures, etc.)
3/16/94		BW10-6.5						X						1	
3/16/94		BW10-16.5						X						1	
3/16/94		BW32-11.5						X						1	RESULTS TO: JENIFER BEATTY 652-4500

TO: SEQUOIA ANALYTICAL

TOTAL NUMBER OF CONTAINERS

RELINQUISHED BY : (Signature)	DATE/TIME 3/17/94 3:00	RECEIVED BY : (Signature)	RELINQUISHED BY : (Signature)	DATE/TIME	RECEIVED BY : (Signature)
METHOD OF SHIPMENT :		SHIPPED BY : (Signature)	COURIER : (Signature)	RECEIVED FOR LAB BY : (Signature)	DATE/TIME

Sequoia Analytical

680 Chesapeake Drive Redwood City, CA 94063 (415) 364-9600 FAX (415) 364-9233
1900 Bates Avenue, Suite L Concord, CA 94520 (510) 686-9600 FAX (510) 686-9689
819 Striker Avenue, Suite 8 Sacramento, CA 95834 (916) 921-9600 FAX (916) 921-0100

Levine-Fricke
1900 Powell St., 12th Floor
Emeryville, CA 94608
Attention: Jenifer Beatty

Client Project ID: 1649.26
Sample Descript: Soil
Analysis for: Total Organic Carbon
First Sample #: 4CB8901

Sampled: Mar 16, 1994
Received: Mar 18, 1994

Analyzed: Mar 30, 1994
Reported: Apr 1, 1994

LABORATORY ANALYSIS FOR: Total Organic Carbon

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
4CB8901	BW10-6.5	1,000	1,600
4CB8902	BW10-16.5	500	700
4CB8903	BW32-11.5	500	670

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Vickie Tague Clark
Project Manager

Sequoia Analytical

680 Chesapeake Drive	Redwood City, CA 94063	(415) 364-9600	FAX (415) 364-9233
1900 Bates Avenue, Suite L	Concord, CA 94520	(510) 686-9600	FAX (510) 686-9689
819 Striker Avenue, Suite 8	Sacramento, CA 95834	(916) 921-9600	FAX (916) 921-0100

Levine-Fricke
1900 Powell St., 12th Floor
Emeryville, CA 94608
Attention: Jenifer Beatty

Client Project ID: 1649.26
Matrix: Solid
QC Sample Group: 4CB8901-03
Reported: Apr 1, 1994

QUALITY CONTROL DATA REPORT

ANALYTE Total Organic Carbon

Method: EPA 415.1
Analyst: K. Hynes

MS/MSD Batch#: 4C70404

Date Prepared: 3/29/94
Date Analyzed: 3/29/94
Instrument I.D.#: N.A.
Conc. Spiked: 5000 mg/kg

Matrix Spike % Recovery: 92

Matrix Spike Duplicate % Recovery: 102

Relative % Difference: 10

LCS Batch#: -

Date Prepared: -
Date Analyzed: -
Instrument I.D.#: -

LCS % Recovery: -

% Recovery Control Limits: 80-120

SEQUOIA ANALYTICAL

VMT Clark

Vickie Tague Clark
Project Manager

Please Note:
The LCS is a control sample of known, interferent free matrix that is analyzed using the same reagents, preparation, and analytical methods employed for the samples. The matrix spike is an aliquot of sample fortified with known quantities of specific compounds and subjected to the entire analytical procedure. If the recovery of analytes from the matrix spike does not fall within specified control limits due to matrix interference, the LCS recovery is to be used to validate the batch.

LEVINE FRICKE 1900 POWELL ST EMERYVILLE, CA 94608

Woodward-Clyde Consultants
500 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600

Chain of Custody Record

PROJECT NO. 1649.26

SAMPLERS: (Signature)

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 624	EPA Method 625	EPA Method 608	TOC						Number of Containers	REMARKS (Sample preservation, handling procedures, etc.) 9403B89	
3/16/94		BW10-6.5						X						1		-01
3/16/94		BW10-16.5						X						1	RESULTS TO: JENIFER BEATTY 652-4500	-02
3/16/94		BW32-11.5						X						1		-03

TOTAL NUMBER OF CONTAINERS

RELINQUISHED BY : (Signature)	DATE/TIME	RECEIVED BY : (Signature)	RELINQUISHED BY : (Signature)	DATE/TIME	RECEIVED BY : (Signature)
	3/17/94 3:00	3-17-94 1500		3/18/94 0930	D. Phillips

METHOD OF SHIPMENT :	SHIPPED BY : (Signature)	COURIER : (Signature)	RECEIVED FOR LAB BY : (Signature)	DATE/TIME
				3/18/94 1537

ENVIRONMENTAL ENGINEERING, INC.
155 Filbert Street, Suite 230, Oakland, CA 94607
TEL (510) 832-SOMA • FAX (510) 893-SOMA

APPENDIX A2

LABORATORY ANALYTICAL RESULTS FOR MARCH 1994 GROUNDWATER SAMPLING EVENT

Inchcape Testing Services
Anametrix Laboratories

1961 Concourse Drive
Suite E
San Jose, CA 95131
Tel: 408-432-8192
Fax: 408-432-8198

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403249
Date Received : 03/17/94
Project ID : 1649.06
Purchase Order: N/A

The following samples were received at Anametrix for analysis :

ANAMETRIX ID	CLIENT SAMPLE ID
9403249- 1	LF-11R
9403249- 2	LF-11RBB
9403249- 3	LF-10
9403249- 4	LF-13

This report is organized in sections according to the specific Anametrix laboratory group which performed the analysis(es) and generated the data.

The results contained within this report relate to only the sample(s) tested. Additionally, these data should be considered in their entirety and Anametrix cannot be responsible for the detachment, separation, or otherwise partial use of this report.

Anametrix is certified by the California Department of Health Services (DHS) to perform environmental testing under Certificate Number 1234.

If you have any further questions or comments on this report, please call us as soon as possible. Thank you for using Anametrix.

Corinne Pham for
Doug Robbins
Laboratory Director

03/30/94
Date

This report consists of 11 pages.

RECEIVED
MAR 3 1
LEVINE-FRICKE

ANAMETRIX REPORT DESCRIPTION
GC

Organic Analysis Data Sheets (OADS)

OADS forms contain tabulated results for target compounds. The OADS are grouped by method and, within each method, organized sequentially in order of increasing Anametrix ID number.

Surrogate Recovery Summary (SRS)

SRS forms contain quality assurance data. An SRS form will be printed for each method, _if_ the method requires surrogate compounds. They will list surrogate percent recoveries for all samples and any method blanks. Any surrogate recovery outside the established limits will be flagged with an "*", and the total number of surrogates outside the limits will be listed in the column labelled "Total Out".

Matrix Spike Recovery Form (MSR)

MSR forms contain quality assurance data. They summarize percent recovery and relative percent difference information for matrix spikes and matrix spike duplicates. This information is a statement of both accuracy and precision. Any percent recovery or relative percent difference outside established limits will be flagged with an "*", and the total number outside the limits will be listed at the bottom of the page. Not all reports will contain an MSR form.

Qualifiers

Anametrix uses several data qualifiers (Q) in its report forms. These qualifiers give additional information on the compounds reported. They should help a data reviewer to verify the integrity of the analytical results. The following is a list of qualifiers and their meanings:

U - Indicates that the compound was analyzed for, but was not detected at or above the specified reporting limit.

B - Indicates that the compound was detected in the associated method blank.

J - Indicates that the compound was detected at an amount below the specified reporting limit. Consequently, the amount should be considered an approximate value. Tentatively identified compounds will always have a "J" qualifier because they are not included in the instrument calibration.

E - Indicates that the reported amount exceeded the linear range of the instrument calibration.

D - Indicates that the compound was detected in an analysis performed at a secondary dilution.

Absence of a qualifier indicates that the compound was detected at a concentration at or above the specified reporting limit.

REPORTING CONVENTIONS

- Due to a size limitation in our data processing step, only the first eight (8) characters of your project ID and sample ID will be printed on the report forms. However, the report cover letter and report summary pages display up to twenty (20) characters of your project and sample IDs.
- Amounts reported are gross values, i.e., _not_ corrected for method blank contamination.

REPORT SUMMARY
ANAMETRIX, INC. (408)432-8192

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403249
Date Received : 03/17/94
Project ID : 1649.06
Purchase Order: N/A
Department : GC
Sub-Department: VOA

SAMPLE INFORMATION:

ANAMETRIX SAMPLE ID	CLIENT SAMPLE ID	MATRIX	DATE SAMPLED	METHOD
9403249- 1	LF-11R	WATER	03/16/94	8010
9403249- 3	LF-10	WATER	03/16/94	8010
9403249- 4	LF-13	WATER	03/16/94	8010

REPORT SUMMARY
ANAMETRIX, INC. (408)432-8192

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403249
Date Received : 03/17/94
Project ID : 1649.06
Purchase Order: N/A
Department : GC
Sub-Department: VOA

QA/QC SUMMARY :

- No QA/QC problems encountered for samples.

3/25/94
Department Supervisor Date

3/25/94
Chemist Date

ORGANIC ANALYSIS DATA SHEET -- EPA METHOD 8010
ANAMETRIX, INC. (408)432-8192

roject ID : 1649.06
ample ID : LF-11R
atrix : WATER
ate Sampled : 3/16/94
ate Analyzed : 3/18/94
nstrument ID : HP24

Anametrix ID : 9403249-01
Analyst :
Supervisor :

Dilution Factor : 5.0
Conc. Units : ug/L

CAS No.	COMPOUND NAME	REPORTING LIMIT	AMOUNT DETECTED	Q
75-71-8	Dichlorodifluoromethane	5.0	ND	U
74-87-3	Chloromethane	5.0	ND	U
75-01-4	Vinyl chloride	2.5	ND	U
74-83-9	Bromomethane	2.5	ND	U
75-00-3	Chloroethane	2.5	ND	U
75-69-4	Trichlorofluoromethane	2.5	ND	U
76-13-1	Trichlorotrifluoroethane	2.5	ND	U
75-35-4	1,1-Dichloroethene	2.5	ND	U
75-09-2	Methylene chloride	5.0	ND	U
156-60-5	trans-1,2-Dichloroethene	2.5	ND	U
75-34-3	1,1-Dichloroethane	2.5	ND	U
156-59-2	cis-1,2-Dichloroethene	2.5	16.	
67-66-3	Chloroform	2.5	ND	U
71-55-6	1,1,1-Trichloroethane	2.5	ND	U
56-23-5	Carbon tetrachloride	2.5	ND	U
107-06-2	1,2-Dichloroethane	2.5	ND	U
79-01-6	Trichloroethene	2.5	76.	
78-87-5	1,2-Dichloropropane	2.5	ND	U
75-27-4	Bromodichloromethane	2.5	ND	U
110-75-8	2-Chloroethylvinylether	5.0	ND	U
10061-01-5	cis-1,3-Dichloropropene	2.5	ND	U
10061-02-6	trans-1,3-Dichloropropene	2.5	ND	U
79-00-5	1,1,2-Trichloroethane	2.5	ND	U
127-18-4	Tetrachloroethene	2.5	ND	U
124-48-1	Dibromochloromethane	2.5	ND	U
108-90-7	Chlorobenzene	2.5	ND	U
75-25-2	Bromoform	2.5	ND	U
79-34-5	1,1,2,2-Tetrachloroethane	2.5	ND	U
541-73-1	1,3-Dichlorobenzene	2.5	ND	U
106-46-7	1,4-Dichlorobenzene	2.5	ND	U
95-50-1	1,2-Dichlorobenzene	2.5	ND	U

ORGANIC ANALYSIS DATA SHEET -- EPA METHOD 8010
ANAMETRIX, INC. (408)432-8192

oject ID : 1649.06
ample ID : LF-10
atrix : WATER
te Sampled : 3/16/94
te Analyzed : 3/18/94
nstrument ID : HP24

Anametrix ID : 9403249-03
Analyst :
Supervisor :

Dilution Factor : 100.0
Conc. Units : ug/L

CAS No.	COMPOUND NAME	REPORTING LIMIT	AMOUNT DETECTED	Q
75-71-8	Dichlorodifluoromethane	100.	ND	U
74-87-3	Chloromethane	100.	ND	U
75-01-4	Vinyl chloride	50.	120.	
74-83-9	Bromomethane	50.	ND	U
75-00-3	Chloroethane	50.	ND	U
75-69-4	Trichlorofluoromethane	50.	ND	U
76-13-1	Trichlorotrifluoroethane	50.	ND	U
75-35-4	1,1-Dichloroethene	50.	ND	U
75-09-2	Methylene chloride	100.	130.	
156-60-5	trans-1,2-Dichloroethene	50.	110.	
75-34-3	1,1-Dichloroethane	50.	ND	U
156-59-2	cis-1,2-Dichloroethene	50.	510.	
67-66-3	Chloroform	50.	ND	U
71-55-6	1,1,1-Trichloroethane	50.	ND	U
56-23-5	Carbon tetrachloride	50.	ND	U
107-06-2	1,2-Dichloroethane	50.	ND	U
79-01-6	Trichloroethene	50.	1800.	
78-87-5	1,2-Dichloropropane	50.	ND	U
75-27-4	Bromodichloromethane	50.	ND	U
110-75-8	2-Chloroethylvinylether	100.	ND	U
10061-01-5	cis-1,3-Dichloropropene	50.	ND	U
10061-02-6	trans-1,3-Dichloropropene	50.	ND	U
79-00-5	1,1,2-Trichloroethane	50.	ND	U
127-18-4	Tetrachloroethene	50.	ND	U
124-48-1	Dibromochloromethane	50.	ND	U
108-90-7	Chlorobenzene	50.	ND	U
75-25-2	Bromoform	50.	ND	U
79-34-5	1,1,2,2-Tetrachloroethane	50.	ND	U
541-73-1	1,3-Dichlorobenzene	50.	ND	U
106-46-7	1,4-Dichlorobenzene	50.	ND	U
95-50-1	1,2-Dichlorobenzene	50.	ND	U

ORGANIC ANALYSIS DATA SHEET -- EPA METHOD 8010
ANAMETRIX, INC. (408)432-8192

roject ID	: 1649.06	Anametrix ID	: 9403249-04
ample ID	: LF-13	Analyst	:
atrix	: WATER	Supervisor	:
ate Sampled	: 3/16/94		
ate Analyzed	: 3/18/94	Dilution Factor	: 1.0
nstrument ID	: HP24	Conc. Units	: ug/L

CAS No.	COMPOUND NAME	REPORTING LIMIT	AMOUNT DETECTED	Q
75-71-8	Dichlorodifluoromethane	1.0	ND	U
74-87-3	Chloromethane	1.0	ND	U
75-01-4	Vinyl chloride	.50	ND	U
74-83-9	Bromomethane	.50	ND	U
75-00-3	Chloroethane	.50	ND	U
75-69-4	Trichlorofluoromethane	.50	ND	U
76-13-1	Trichlorotrifluoroethane	.50	ND	U
75-35-4	1,1-Dichloroethene	.50	ND	U
75-09-2	Methylene chloride	1.0	ND	U
156-60-5	trans-1,2-Dichloroethene	.50	ND	U
75-34-3	1,1-Dichloroethane	.50	ND	U
156-59-2	cis-1,2-Dichloroethene	.50	ND	U
67-66-3	Chloroform	.50	ND	U
71-55-6	1,1,1-Trichloroethane	.50	.75	
56-23-5	Carbon tetrachloride	.50	ND	U
107-06-2	1,2-Dichloroethane	.50	ND	U
79-01-6	Trichloroethene	.50	20.	
78-87-5	1,2-Dichloropropane	.50	ND	U
75-27-4	Bromodichloromethane	.50	ND	U
110-75-8	2-Chloroethylvinylether	1.0	ND	U
10061-01-5	cis-1,3-Dichloropropene	.50	ND	U
10061-02-6	trans-1,3-Dichloropropene	.50	ND	U
79-00-5	1,1,2-Trichloroethane	.50	ND	U
127-18-4	Tetrachloroethene	.50	ND	U
124-48-1	Dibromochloromethane	.50	ND	U
108-90-7	Chlorobenzene	.50	ND	U
75-25-2	Bromoform	.50	ND	U
79-34-5	1,1,2,2-Tetrachloroethane	.50	ND	U
541-73-1	1,3-Dichlorobenzene	.50	ND	U
106-46-7	1,4-Dichlorobenzene	.50	ND	U
95-50-1	1,2-Dichlorobenzene	.50	ND	U

ORGANIC ANALYSIS DATA SHEET -- EPA METHOD 8010
ANAMETRIX, INC. (408)432-8192

oject ID : 1649.0
ample ID : VBLKA1
atrix : WATER
te Sampled : 0/ 0/ 0
te Analyzed : 3/18/94
nstrument ID : HP24

Anametrix ID : BM1802I1
Analyst :
Supervisor :

Dilution Factor : 1.0
Conc. Units : ug/L

CAS No.	COMPOUND NAME	REPORTING LIMIT	AMOUNT DETECTED	Q
75-71-8	Dichlorodifluoromethane	1.0	ND	U
74-87-3	Chloromethane	1.0	ND	U
75-01-4	Vinyl chloride	.50	ND	U
74-83-9	Bromomethane	.50	ND	U
75-00-3	Chloroethane	.50	ND	U
75-69-4	Trichlorofluoromethane	.50	ND	U
76-13-1	Trichlorotrifluoroethane	.50	ND	U
75-35-4	1,1-Dichloroethene	.50	ND	U
75-09-2	Methylene chloride	1.0	ND	U
156-60-5	trans-1,2-Dichloroethene	.50	ND	U
75-34-3	1,1-Dichloroethane	.50	ND	U
156-59-2	cis-1,2-Dichloroethene	.50	ND	U
67-66-3	Chloroform	.50	ND	U
71-55-6	1,1,1-Trichloroethane	.50	ND	U
56-23-5	Carbon tetrachloride	.50	ND	U
107-06-2	1,2-Dichloroethane	.50	ND	U
79-01-6	Trichloroethene	.50	ND	U
78-87-5	1,2-Dichloropropane	.50	ND	U
75-27-4	Bromodichloromethane	.50	ND	U
110-75-8	2-Chloroethylvinylether	1.0	ND	U
10061-01-5	cis-1,3-Dichloropropene	.50	ND	U
10061-02-6	trans-1,3-Dichloropropene	.50	ND	U
79-00-5	1,1,2-Trichloroethane	.50	ND	U
127-18-4	Tetrachloroethene	.50	ND	U
124-48-1	Dibromochloromethane	.50	ND	U
108-90-7	Chlorobenzene	.50	ND	U
75-25-2	Bromoform	.50	ND	U
79-34-5	1,1,2,2-Tetrachloroethane	.50	ND	U
541-73-1	1,3-Dichlorobenzene	.50	ND	U
106-46-7	1,4-Dichlorobenzene	.50	ND	U
95-50-1	1,2-Dichlorobenzene	.50	ND	U

SURROGATE RECOVERY SUMMARY -- EPA METHOD 8010
ANAMETRIX, INC. (408)432-8192

Project ID : 1649.06
Matrix : LIQUID

Anametrix ID : 9403249
Analyst :
Supervisor :

	SAMPLE ID	SU1	SU2	SU3
1	VBLKA1	80	91	92
2	LF-13	81	98	93
3	LF-11R	87	97	99
4	LF-10	87	98	94
5				
6				
7				
8				
9				
10				
11				
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28				
29				
30				

QC LIMITS

SU1 = Bromochloromethane (56- 99)
SU2 = 1-Chloro-2-fluorobenze (73-110)
SU3 = 2-Bromochlorobenzene (65-108)

* Values outside of Anametrix QC limits

LABORATORY CONTROL SAMPLE
EPA METHOD 601/8010
ANAMETRIX, INC. (408)432-8192

Sample I.D. : LABORATORY CONTROL SAMPLE
Matrix : WATER
SDG/Batch : 03249
Date analyzed : 03/18/94

Anametrix I.D. : MM1801I1
Analyst :
Supervisor :
Instrument I.D.: HP24

COMPOUND	SPIKE AMOUNT (ug/L)	AMOUNT RECOVERED (ug/L)	PERCENT RECOVERY	%RECOVERY LIMITS
Trichlorotrifluoroethane	10	10.2	102%	65 - 116
1,1-Dichloroethene	10	10.9	109%	64 - 125
trans-1,2-Dichloroethene	10	11.0	110%	77 - 113
1,1-Dichloroethane	10	10.9	109%	85 - 129
cis-1,2-Dichloroethene	10	11.1	111%	78 - 130
1,1,1-Trichloroethane	10	10.3	103%	83 - 125
Trichloroethene	10	10.3	103%	76 - 124
Tetrachloroethene	10	10.2	102%	80 - 118
Chlorobenzene	10	10.0	100%	81 - 130
1,3-Dichlorobenzene	10	9.5	95%	82 - 115
1,4-Dichlorobenzene	10	9.4	94%	85 - 122
1,2-Dichlorobenzene	10	9.7	97%	86 - 122

* Limits based on data generated by Anametrix, Inc., December, 1993.

#1 2 91403 9 (4)

CHAIN OF CUSTODY / ANALYSES REQUEST FORM

Project No.: 1649.06	Field Logbook No.:	Date: 3·17·94	Serial No.: № 12877
Project Name: Yerba Buena	Project Location: Emeryville, CA		
Sampler (Signature): Prescott C. Hold			Samplers: SCH

SAMPLES

SAMPLE NO.	DATE	TIME	LAB SAMPLE NO.	NO. OF CONTAINERS	SAMPLE TYPE	EPA 601/8010	EPA 624					HOLD	RUSH	REMARKS
① LF·11R	3·16·94	1245		2	H2O	X							X	48 Hr. TAT
② LF·11R·BB	↓	1240		2	↓	X						X		
③ LF·10		1410		2		X							X	Contact Jenifer Beatty
④ LF·13	↓	1745		2	↓	X							X	
														Results by AM ON 3/21.

RELINQUISHED BY: (Signature) Prescott C. Hold	DATE 3/17/94	TIME 0945	RECEIVED BY: (Signature) Benny S. Arrijosa	DATE 3/17/94	TIME 0945
RELINQUISHED BY: (Signature) Benny S. Arrijosa	DATE 3/17/94	TIME 1100	RECEIVED BY: (Signature) Nandy C. Falcon	DATE 3/17/94	TIME 11:00
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
METHOD OF SHIPMENT: Courier	DATE	TIME	LAB COMMENTS:		

Sample Collector: LEVINE-FRICKE
1900 Powell Street, 12th Floor
Emeryville, California 94608
(510) 652-4500

Analytical Laboratory: Anametrix, San Jose, CA

Shipping Copy (White) Lab Copy (Green) File Copy (Yellow) Field Copy (Pink)

FORM NO. 86/COC/ARF

Inchcape Testing Services
Anametrix Laboratories

1961 Concourse Drive
Suite E
San Jose, CA 95131
Tel: 408-432-8192
Fax: 408-432-8198

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403190
Date Received : 03/11/94
Project ID : 1649.10
Purchase Order: N/A

The following samples were received at Anametrix for analysis :

ANAMETRIX ID	CLIENT SAMPLE ID
9403190- 1	LF-31
9403190- 2	LF-131

This report is organized in sections according to the specific Anametrix laboratory group which performed the analysis(es) and generated the data.

The results contained within this report relate to only the sample(s) tested. Additionally, these data should be considered in their entirety and Anametrix cannot be responsible for the detachment, separation, or otherwise partial use of this report.

Anametrix is certified by the California Department of Health Services (DHS) to perform environmental testing under Certificate Number 1234.

If you have any further questions or comments on this report, please call us as soon as possible. Thank you for using Anametrix.

Todd Geringer for
Doug Robbins
Laboratory Director

3/22/94
Date

COPY

This report consists of ____ pages.

ANAMETRIX REPORT DESCRIPTION
GC

Organic Analysis Data Sheets (OADS)

OADS forms contain tabulated results for target compounds. The OADS are grouped by method and, within each method, organized sequentially in order of increasing Anametrix ID number.

Surrogate Recovery Summary (SRS)

SRS forms contain quality assurance data. An SRS form will be printed for each method, if the method requires surrogate compounds. They will list surrogate percent recoveries for all samples and any method blanks. Any surrogate recovery outside the established limits will be flagged with an "*", and the total number of surrogates outside the limits will be listed in the column labelled "Total Out".

Matrix Spike Recovery Form (MSR)

MSR forms contain quality assurance data. They summarize percent recovery and relative percent difference information for matrix spikes and matrix spike duplicates. This information is a statement of both accuracy and precision. Any percent recovery or relative percent difference outside established limits will be flagged with an "*", and the total number outside the limits will be listed at the bottom of the page. Not all reports will contain an MSR form.

Qualifiers

Anametrix uses several data qualifiers (Q) in its report forms. These qualifiers give additional information on the compounds reported. They should help a data reviewer to verify the integrity of the analytical results. The following is a list of qualifiers and their meanings:

U - Indicates that the compound was analyzed for, but was not detected at or above the specified reporting limit.

B - Indicates that the compound was detected in the associated method blank.

J - Indicates that the compound was detected at an amount below the specified reporting limit. Consequently, the amount should be considered an approximate value. Tentatively identified compounds will always have a "J" qualifier because they are not included in the instrument calibration.

E - Indicates that the reported amount exceeded the linear range of the instrument calibration.

D - Indicates that the compound was detected in an analysis performed at a secondary dilution.

Absence of a qualifier indicates that the compound was detected at a concentration at or above the specified reporting limit.

REPORTING CONVENTIONS

- Due to a size limitation in our data processing step, only the first eight (8) characters of your project ID and sample ID will be printed on the report forms. However, the report cover letter and report summary pages display up to twenty (20) characters of your project and sample IDs.
- Amounts reported are gross values, i.e., not corrected for method blank contamination.

REPORT SUMMARY
ANAMETRIX, INC. (408)432-8192

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403190
Date Received : 03/11/94
Project ID : 1649.10
Purchase Order: N/A
Department : GC
Sub-Department: VOA

SAMPLE INFORMATION:

ANAMETRIX SAMPLE ID	CLIENT SAMPLE ID	MATRIX	DATE SAMPLED	METHOD
9403190- 1	LF-31	WATER	03/11/94	601
9403190- 2	LF-131	WATER	03/11/94	601

REPORT SUMMARY
ANAMETRIX, INC. (408)432-8192

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403190
Date Received : 03/11/94
Project ID : 1649.10
Purchase Order: N/A
Department : GC
Sub-Department: VOA

QA/QC SUMMARY :

- No QA/QC problems encountered for samples.

M. Hassani 3/18/94
Department Supervisor Date

Taghi Memarzadeh 3/18/94
Chemist Date

ORGANIC ANALYSIS DATA SHEET -- EPA METHOD 601
ANAMETRIX, INC. (408)432-8192

oject ID : 1649.10
ample ID : LF-31
atrix : WATER
te Sampled : 3/11/94
te Analyzed : 3/17/94
nstrument ID : HP24

Anametrix ID : 9403190-01
Analyst :
Supervisor :

Dilution Factor : 1.0
Conc. Units : ug/L

CAS No.	COMPOUND NAME	REPORTING LIMIT	AMOUNT DETECTED	Q
75-71-8	Dichlorodifluoromethane	1.0	ND	U
74-87-3	Chloromethane	1.0	ND	U
75-01-4	Vinyl chloride	.50	ND	U
74-83-9	Bromomethane	.50	ND	U
75-00-3	Chloroethane	.50	ND	U
75-69-4	Trichlorofluoromethane	.50	ND	U
76-13-1	Trichlorotrifluoroethane	.50	ND	U
75-35-4	1,1-Dichloroethene	.50	ND	U
75-09-2	Methylene chloride	1.0	ND	U
156-60-5	trans-1,2-Dichloroethene	.50	ND	U
75-34-3	1,1-Dichloroethane	.50	ND	U
156-59-2	cis-1,2-Dichloroethene	.50	3.0	
67-66-3	Chloroform	.50	1.2	
71-55-6	1,1,1-Trichloroethane	.50	ND	U
56-23-5	Carbon tetrachloride	.50	ND	U
107-06-2	1,2-Dichloroethane	.50	ND	U
79-01-6	Trichloroethene	.50	5.4	
78-87-5	1,2-Dichloropropane	.50	ND	U
75-27-4	Bromodichloromethane	.50	ND	U
110-75-8	2-Chloroethylvinylether	1.0	ND	U
10061-01-5	cis-1,3-Dichloropropene	.50	ND	U
10061-02-6	trans-1,3-Dichloropropene	.50	ND	U
79-00-5	1,1,2-Trichloroethane	.50	ND	U
127-18-4	Tetrachloroethene	.50	ND	U
124-48-1	Dibromochloromethane	.50	ND	U
108-90-7	Chlorobenzene	.50	ND	U
75-25-2	Bromoform	.50	ND	U
79-34-5	1,1,2,2-Tetrachloroethane	.50	ND	U
541-73-1	1,3-Dichlorobenzene	.50	ND	U
106-46-7	1,4-Dichlorobenzene	.50	ND	U
95-50-1	1,2-Dichlorobenzene	.50	ND	U

ORGANIC ANALYSIS DATA SHEET -- EPA METHOD 601
ANAMETRIX, INC. (408)432-8192

oject ID : 1649.10
mple ID : LF-131
atrix : WATER
ate Sampled : 3/11/94
te Analyzed : 3/17/94
strument ID : HP24

Anametrix ID : 9403190-02
Analyst : TM
Supervisor : DL

Dilution Factor : 1.0
Conc. Units : ug/L

CAS No.	COMPOUND NAME	REPORTING LIMIT	AMOUNT DETECTED	Q
75-71-8	Dichlorodifluoromethane	1.0	ND	U
74-87-3	Chloromethane	1.0	ND	U
75-01-4	Vinyl chloride	.50	ND	U
74-83-9	Bromomethane	.50	ND	U
75-00-3	Chloroethane	.50	ND	U
75-69-4	Trichlorofluoromethane	.50	ND	U
76-13-1	Trichlorotrifluoroethane	.50	ND	U
75-35-4	1,1-Dichloroethene	.50	ND	U
75-09-2	Methylene chloride	1.0	ND	U
156-60-5	trans-1,2-Dichloroethene	.50	ND	U
75-34-3	1,1-Dichloroethane	.50	ND	U
156-59-2	cis-1,2-Dichloroethene	.50	3.4	
67-66-3	Chloroform	.50	1.4	
71-55-6	1,1,1-Trichloroethane	.50	ND	U
56-23-5	Carbon tetrachloride	.50	ND	U
107-06-2	1,2-Dichloroethane	.50	ND	U
79-01-6	Trichloroethene	.50	6.0	
78-87-5	1,2-Dichloropropane	.50	ND	U
75-27-4	Bromodichloromethane	.50	ND	U
110-75-8	2-Chloroethylvinylether	1.0	ND	U
10061-01-5	cis-1,3-Dichloropropene	.50	ND	U
10061-02-6	trans-1,3-Dichloropropene	.50	ND	U
79-00-5	1,1,2-Trichloroethane	.50	ND	U
127-18-4	Tetrachloroethene	.50	ND	U
124-48-1	Dibromochloromethane	.50	ND	U
108-90-7	Chlorobenzene	.50	ND	U
75-25-2	Bromoform	.50	ND	U
79-34-5	1,1,2,2-Tetrachloroethane	.50	ND	U
541-73-1	1,3-Dichlorobenzene	.50	ND	U
106-46-7	1,4-Dichlorobenzene	.50	ND	U
95-50-1	1,2-Dichlorobenzene	.50	ND	U

ORGANIC ANALYSIS DATA SHEET -- EPA METHOD 601
ANAMETRIX, INC. (408)432-8192

roject ID : 1649.1
ample ID : VBLKB1
Matrix : WATER
Date Sampled : 0/ 0/ 0
ate Analyzed : 3/17/94
nstrument ID : HP24

Anametrix ID : BM1702I1
Analyst : TM
Supervisor :

Dilution Factor : 1.0
Conc. Units : ug/L

CAS No.	COMPOUND NAME	REPORTING LIMIT	AMOUNT DETECTED	Q
75-71-8	Dichlorodifluoromethane	1.0	ND	U
74-87-3	Chloromethane	1.0	ND	U
75-01-4	Vinyl chloride	.50	ND	U
74-83-9	Bromomethane	.50	ND	U
75-00-3	Chloroethane	.50	ND	U
75-69-4	Trichlorofluoromethane	.50	ND	U
76-13-1	Trichlorotrifluoroethane	.50	ND	U
75-35-4	1,1-Dichloroethene	.50	ND	U
75-09-2	Methylene chloride	1.0	ND	U
156-60-5	trans-1,2-Dichloroethene	.50	ND	U
75-34-3	1,1-Dichloroethane	.50	ND	U
156-59-2	cis-1,2-Dichloroethene	.50	ND	U
67-66-3	Chloroform	.50	ND	U
71-55-6	1,1,1-Trichloroethane	.50	ND	U
56-23-5	Carbon tetrachloride	.50	ND	U
107-06-2	1,2-Dichloroethane	.50	ND	U
79-01-6	Trichloroethene	.50	ND	U
78-87-5	1,2-Dichloropropane	.50	ND	U
75-27-4	Bromodichloromethane	.50	ND	U
110-75-8	2-Chloroethylvinylether	1.0	ND	U
10061-01-5	cis-1,3-Dichloropropene	.50	ND	U
10061-02-6	trans-1,3-Dichloropropene	.50	ND	U
79-00-5	1,1,2-Trichloroethane	.50	ND	U
127-18-4	Tetrachloroethene	.50	ND	U
124-48-1	Dibromochloromethane	.50	ND	U
108-90-7	Chlorobenzene	.50	ND	U
75-25-2	Bromoform	.50	ND	U
79-34-5	1,1,2,2-Tetrachloroethane	.50	ND	U
541-73-1	1,3-Dichlorobenzene	.50	ND	U
106-46-7	1,4-Dichlorobenzene	.50	ND	U
95-50-1	1,2-Dichlorobenzene	.50	ND	U

SURROGATE RECOVERY SUMMARY -- EPA METHOD 601
ANAMETRIX, INC. (408)432-8192

Project ID : 1649.10
Matrix : LIQUID

Anametrix ID : 9403190
Analyst : TM
Supervisor :

	SAMPLE ID	SU1	SU2	SU3
1	VBLKB1	83	95	94
2	LF-31	89	96	94
3	LF-31MS	95	104	105
4	LF-31MSD	96	109	107
5	LF-131	93	99	105
6				
7				
8				
9				
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	QC LIMITS
SU1 = Bromochloromethane	(56- 99)
SU2 = 1-Chloro-2-fluorobenze	(73-110)
SU3 = 2-Bromochlorobenzene	(65-108)

* Values outside of Anametrix QC limits

MATRIX SPIKE RECOVERY FORM -- EPA METHOD 601
ANAMETRIX, INC. (408)432-8192

roject ID : 1649.10
ample ID : LF-31
atrix : WATER
ate Sampled : 3/11/94
ate Analyzed : 3/17/94
nstrument ID : HP24

Anametrix ID : 9403190-01
Analyst : TM
Supervisor :

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	MS CONCENTRATION (ug/L)	MS % REC	%REC LIMITS
Trichlorotrifluoroethan	10.0	.0	8.1	81	42-111
1,1-Dichloroethene	10.0	.0	9.1	91	47-128
trans-1,2-Dichloroethen	10.0	.0	9.8	98	63-110
1,1-Dichloroethane	10.0	.0	10.6	106	72-128
cis-1,2-Dichloroethene	10.0	3.0	12.2	92	62-126
1,1,1-Trichloroethane	10.0	.0	9.0	90	65-128
Trichloroethene	10.0	5.4	12.1	67	64-115
Tetrachloroethene	10.0	.0	8.5	85	64-111
Chlorobenzene	10.0	.0	9.1	91	75-124
1,3-Dichlorobenzene	10.0	.0	8.8	88	68-119
1,4-Dichlorobenzene	10.0	.0	8.9	89	72-125
1,2-Dichlorobenzene	10.0	.0	9.2	92	70-131

COMPOUND	SPIKE ADDED (ug/L)	MSD CONCENTRATION (ug/L)	MSD % REC	% RPD	RPD LIMITS	%REC LIMITS
Trichlorotrifluoroethan	10.0	7.9	79	3	25	42-111
1,1-Dichloroethene	10.0	9.0	90	1	25	47-128
trans-1,2-Dichloroethen	10.0	9.9	99	1	25	63-110
1,1-Dichloroethane	10.0	11.1	111	4	25	72-128
cis-1,2-Dichloroethene	10.0	12.6	96	4	25	62-126
1,1,1-Trichloroethane	10.0	9.2	92	2	25	65-128
Trichloroethene	10.0	12.8	75	11	25	64-115
Tetrachloroethene	10.0	8.8	88	4	25	64-111
Chlorobenzene	10.0	9.7	97	7	25	75-124
1,3-Dichlorobenzene	10.0	9.0	90	2	25	68-119
1,4-Dichlorobenzene	10.0	9.1	91	2	25	72-125
1,2-Dichlorobenzene	10.0	9.4	94	3	25	70-131

* Value is outside of Anametrix QC limits

RPD: 0 out of 12 outside limits
Spike Recovery: 0 out of 24 outside limits

LABORATORY CONTROL SAMPLE
EPA METHOD 601/8010
ANAMETRIX, INC. (408)432-8192

Sample I.D. : LABORATORY CONTROL SAMPLE
Matrix : WATER
SDG/Batch : 03190
Date analyzed : 03/17/94

Anametrix I.D. : MM1701I1
Analyst : TM
Supervisor :
Instrument I.D.: HP24

COMPOUND	SPIKE AMOUNT (ug/L)	AMOUNT RECOVERED (ug/L)	PERCENT RECOVERY	%RECOVERY LIMITS
Trichlorotrifluoroethane	10	10.1	101%	65 - 116
1,1-Dichloroethene	10	10.8	108%	64 - 125
trans-1,2-Dichloroethene	10	11.1	111%	77 - 113
1,1-Dichloroethane	10	11.5	115%	85 - 129
cis-1,2-Dichloroethene	10	11.0	110%	78 - 130
1,1,1-Trichloroethane	10	10.4	103%	83 - 125
Trichloroethene	10	10.0	100%	76 - 124
Tetrachloroethene	10	9.8	98%	80 - 118
Chlorobenzene	10	9.7	97%	81 - 130
1,3-Dichlorobenzene	10	9.6	96%	82 - 115
1,4-Dichlorobenzene	10	9.6	96%	85 - 122
1,2-Dichlorobenzene	10	9.7	97%	86 - 122

* Limits based on data generated by Anametrix, Inc., December, 1993.

REPORT SUMMARY
ANAMETRIX, INC. (408)432-8192

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403190
Date Received : 03/11/94
Project ID : 1649.10
Purchase Order: N/A
Department : GC
Sub-Department: TPH

SAMPLE INFORMATION:

ANAMETRIX SAMPLE ID	CLIENT SAMPLE ID	MATRIX	DATE SAMPLED	METHOD
9403190- 1	LF-31	WATER	03/11/94	TPHd

REPORT SUMMARY
ANAMETRIX, INC. (408)432-8192

MS. JENIFER BEATTY
LEVINE-FRICKE
1900 POWELL STREET 12TH FLOOR
EMERYVILLE, CA 94608

Workorder # : 9403190
Date Received : 03/11/94
Project ID : 1649.10
Purchase Order: N/A
Department : GC
Sub-Department: TPH

QA/QC SUMMARY :

- No QA/QC problems encountered for this sample.

Cheryl Balmer 3/21/94
Department Supervisor Date

03/21/94.
Chemist Date

ANALYSIS DATA SHEET - TOTAL PETROLEUM HYDROCARBONS AS DIESEL

ANAMETRIX, INC. (408) 432-8192

Anametrix W.O.: 9403190
Matrix : WATER
Date Sampled : 03/11/94
Date Extracted: 03/16/94

Project Number : 1649.10
Date Released : 03/21/94
Instrument I.D.: HP9

Anametrix I.D.	Client I.D.	Date Analyzed	Reporting Limit (ug/L)	Amount Found (ug/L)	Surrogate %Rec
9403190-01	LF-31	03/19/94	50	110	79%
BM1611F9	METHOD BLANK	03/18/94	50	ND	69%

Note : Reporting limit is obtained by multiplying the dilution factor times 50 ug/L.
The surrogate recovery limits for O-terphenyl are 30-130%.

ND - Not detected at or above the practical quantitation limit for the method.

TPHd - Total Petroleum Hydrocarbons as C12-C22 is determined by GCFID following sample extraction by EPA Method 3510.

All testing procedures follow California Department of Health Services (Cal-DHS) approved methods.

Tina Shor 3/22/94
Analyst Date

Cheryl Balmer 3/22/94
Supervisor Date

ANALYSIS DATA SHEET - TOTAL PETROLEUM HYDROCARBONS AS MOTOR OIL
ANAMETRIX, INC. (408) 432-8192

Anametrix W.O.:	9403190	Project Number :	1649.10
Matrix :	WATER	Date Released :	03/21/94
Date Sampled :	03/11/94	Instrument I.D.:	HP9
Date Extracted:	03/16/94		

Anametrix I.D.	Client I.D.	Date Analyzed	Reporting Limit (ug/L)	Amount Found (ug/L)	Surrogate %Rec
9403190-01	LF-31	03/19/94	50	210	79%
BM1611F9	METHOD BLANK	03/18/94	50	ND	69%

Note : Reporting limit is obtained by multiplying the dilution factor times 50 ug/L.
The surrogate recovery limits for O-terphenyl are 30-130%.

ND - Not detected at or above the practical quantitation limit for the method.

TPHd - Total Petroleum Hydrocarbons as C22-C36 is determined by GCFID following sample extraction by EPA Method 3510.

All testing procedures follow California Department of Health Services (Cal-DHS) approved methods.

3/22/94
Analyst Date

Cheryl Balmer 3/22/94
Supervisor Date

TOTAL EXTRACTABLE HYDROCARBON LABORATORY CONTROL SAMPLE REPORT
EPA METHOD 3510 WITH GC/FID
ANAMETRIX, INC. (408) 432-8192

Sample I.D. : LAB CONTROL SAMPLE
Matrix : WATER
Date Sampled : N/A
Date Extracted: 03/16/94
Date Analyzed : 03/18/94

Anametrix I.D. : MM1611F9
Analyst : JJ
Supervisor : cs
Date Released : 03/21/94
Instrument I.D.: HP9

COMPOUND	SPIKE AMT (ug/L)	LCS REC (ug/L)	% REC LCS	LCSD REC (ug/L)	% REC LCSD	RPD	% REC LIMITS
DIESEL	1250	980	78%	1000	80%	2%	47-130
SURROGATE			83%		85%		30-130

* Quality control limits established by Anametrix, Inc.

20:55 MB

CHAIN OF CUSTODY / ANALYSES REQUEST FORM

Project No.: 1649.10	Field Logbook No.:	Date: 3-11-94	Serial No.: № 12879
Project Name: Yerba Buena (Bashland)	Project Location: Emeryville, CA		
Sampler (Signature): Prescott C. Heald			Samplers: SCH

	SAMPLES					ANALYSES								
SAMPLE NO.	DATE	TIME	LAB SAMPLE NO.	NO. OF CON-TAINERS	SAMPLE TYPE	EPA 601	EPA 624	TPH diesel				HOLD	RUSH	REMARKS
① LF-31	3-11-94	1120		4	H2O	2		2						Normal TAT-
② LF-131	↓	1130		2	↓	2								
														Invoice Catellus.
														Fax/CC results to
														Jenifer Beatty.

RELINQUISHED BY: (Signature) Prescott C. Heald	DATE 3/11/94	TIME 1540	RECEIVED BY: (Signature) Benny S. Carrijoza	DATE 3/11/94	TIME 1540
RELINQUISHED BY: (Signature) Benny S. Carrijoza	DATE 3/11/94	TIME 1740	RECEIVED BY: (Signature)	DATE 3/11/94	TIME 17:40
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
METHOD OF SHIPMENT: Courier	DATE	TIME	LAB COMMENTS:		

Sample Collector: LEVINE-FRICKE 1900 Powell Street, 12th Floor Emeryville, California 94608 (510) 652-4500	Analytical Laboratory: Anametrix, San Jose, CA

Shipping Copy (White) Lab Copy (Green) File Copy (Yellow) Field Copy (Pink)

FORM NO. 86/COC/ARF

American Environmental Network

Certificate of Analysis

DOHS Certification: 1172 AIHA Accreditation: 11134

RECEIVED
APR - 1
LEVINE-FRICKE

LEVINE-FRICKE
1900 POWELL ST., 12TH FLOOR
EMERYVILLE, CA 94608

ATTN: JENIFER BEATTY

CLIENT PROJ. ID: 1649.06
C.O.C. SERIAL NO: 12878
PROJ. NAME: YERBA BUENA

REPORT DATE: 03/31/94

DATE SAMPLED: 03/16/94

DATE RECEIVED: 03/17/94

AEN JOB NO: 9403168

PROJECT SUMMARY

On March 17, 1994, this laboratory received four (4) water samples.

Client requested three (3) samples be analyzed for organic parameters. One (1) sample was placed on hold. Sample identification, methodology, results and dates analyzed are summarized on the following pages.

Please see quality control report for a summary of QC data pertaining to this project.

If you have any questions, please contact Client Services at (510) 930-9090.

Andrew Bradley for
Larry Klein
General Manager

LEVINE-FRICKE

SAMPLE ID: LF-111R
AEN LAB NO: 9403168-01
AEN WORK ORDER: 9403168
CLIENT PROJ. ID: 1649.06

DATE SAMPLED: 03/16/94
DATE RECEIVED: 03/17/94
REPORT DATE: 03/31/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
EPA 8010 - Water matrix	EPA 8010				
Bromodichloromethane	75-27-4	ND	0.5	ug/L	03/18/94
Bromoform	75-25-2	ND	0.5	ug/L	03/18/94
Bromomethane	74-83-9	ND	0.5	ug/L	03/18/94
Carbon Tetrachloride	56-23-5	ND	0.5	ug/L	03/18/94
Chlorobenzene	108-90-7	ND	0.5	ug/L	03/18/94
Chloroethane	75-00-3	ND	0.5	ug/L	03/18/94
2-Chloroethyl Vinyl Ether	110-75-8	ND	0.5	ug/L	03/18/94
Chloroform	67-66-3	ND	0.5	ug/L	03/18/94
Chloromethane	74-87-3	ND	0.5	ug/L	03/18/94
Dibromochloromethane	124-48-1	ND	0.5	ug/L	03/18/94
1,2-Dichlorobenzene	95-50-1	ND	0.5	ug/L	03/18/94
1,3-Dichlorobenzene	541-73-1	ND	0.5	ug/L	03/18/94
1,4-Dichlorobenzene	106-46-7	ND	0.5	ug/L	03/18/94
Dichlorodifluoromethane	75-71-8	ND	0 5	ug/L	03/18/94
1,1-Dichloroethane	75-34-3	ND	0.5	ug/L	03/18/94
1,2-Dichloroethane	107-06-2	ND	0.5	ug/L	03/18/94
1,1-Dichloroethene	75-35-4	ND	0.5	ug/L	03/18/94
cis-1,2-Dichloroethene	156-59-2	16 *	0.5	ug/L	03/18/94
trans-1,2-Dichloroethene	156-60-5	2 *	0.5	ug/L	03/18/94
1,2-Dichloropropane	78-87-5	ND	0.5	ug/L	03/18/94
cis-1,3-Dichloropropene	10061-01-5	ND	0.5	ug/L	03/18/94
trans-1,3-Dichloropropene	10061-02-6	ND	0.5	ug/L	03/18/94
Methylene Chloride	75-09-2	ND	0.5	ug/L	03/18/94
1,1,2,2-Tetrachloroethane	79-34-5	ND	0.5	ug/L	03/18/94
Tetrachloroethene	127-18-4	ND	0.5	ug/L	03/18/94
1,1,1-Trichloroethane	71-55-6	ND	0.5	ug/L	03/18/94
1,1,2-Trichloroethane	79-00-5	ND	0.5	ug/L	03/18/94
Trichloroethene	79-01-6	76 *	0.5	ug/L	03/18/94
Trichlorofluoromethane	75-69-4	ND	0.5	ug/L	03/18/94
1,1,2Trichlorotrifluoroethane	76-13-1	ND	0.5	ug/L	03/18/94
Vinyl Chloride	75-01-4	1 *	0.5	ug/L	03/21/94

ND = Not detected at or above the reporting limit
* = Value above reporting limit

LEVINE-FRICKE

SAMPLE ID: LF-110
AEN LAB NO: 9403168-03
AEN WORK ORDER: 9403168
CLIENT PROJ. ID: 1649.06

DATE SAMPLED: 03/16/94
DATE RECEIVED: 03/17/94
REPORT DATE: 03/31/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
EPA 8010 - Water matrix	EPA 8010				
Bromodichloromethane	75-27-4	ND	0.5	ug/L	03/18/94
Bromoform	75-25-2	ND	0.5	ug/L	03/18/94
Bromomethane	74-83-9	ND	0.5	ug/L	03/18/94
Carbon Tetrachloride	56-23-5	ND	0.5	ug/L	03/18/94
Chlorobenzene	108-90-7	3 *	0.5	ug/L	03/18/94
Chloroethane	75-00-3	ND	0.5	ug/L	03/18/94
2-Chloroethyl Vinyl Ether	110-75-8	ND	0.5	ug/L	03/18/94
Chloroform	67-66-3	ND	0.5	ug/L	03/18/94
Chloromethane	74-87-3	ND	0.5	ug/L	03/18/94
Dibromochloromethane	124-48-1	ND	0.5	ug/L	03/18/94
1,2-Dichlorobenzene	95-50-1	ND	0.5	ug/L	03/18/94
1,3-Dichlorobenzene	541-73-1	ND	0.5	ug/L	03/18/94
1,4-Dichlorobenzene	106-46-7	ND	0.5	ug/L	03/18/94
Dichlorodifluoromethane	75-71-8	ND	0.5	ug/L	03/18/94
1,1-Dichloroethane	75-34-3	2 *	0.5	ug/L	03/18/94
1,2-Dichloroethane	107-06-2	2 *	0.5	ug/L	03/18/94
1,1-Dichloroethene	75-35-4	5 *	0.5	ug/L	03/18/94
cis-1,2-Dichloroethene	156-59-2	360 *	0.5	ug/L	03/21/94
trans-1,2-Dichloroethene	156-60-5	90 *	0.5	ug/L	03/18/94
1,2-Dichloropropane	78-87-5	ND	0.5	ug/L	03/18/94
cis-1,3-Dichloropropene	10061-01-5	ND	0.5	ug/L	03/18/94
trans-1,3-Dichloropropene	10061-02-6	ND	0.5	ug/L	03/18/94
Methylene Chloride	75-09-2	ND	0.5	ug/L	03/18/94
1,1,2,2-Tetrachloroethane	79-34-5	ND	0.5	ug/L	03/18/94
Tetrachloroethene	127-18-4	15 *	0.5	ug/L	03/18/94
1,1,1-Trichloroethane	71-55-6	5 *	0.5	ug/L	03/18/94
1,1,2-Trichloroethane	79-00-5	2 *	0.5	ug/L	03/18/94
Trichloroethene	79-01-6	1,500 *	0.5	ug/L	03/18/94
Trichlorofluoromethane	75-69-4	ND	0.5	ug/L	03/18/94
1,1,2Trichlorotrifluoroethane	76-13-1	ND	0.5	ug/L	03/18/94
Vinyl Chloride	75-01-4	88 *	0.5	ug/L	03/21/94

ND = Not detected at or above the reporting limit
* = Value above reporting limit

LEVINE-FRICKE

SAMPLE ID: LF-113
AEN LAB NO: 9403168-04
AEN WORK ORDER: 9403168
CLIENT PROJ. ID: 1649.06

DATE SAMPLED: 03/16/94
DATE RECEIVED: 03/17/94
REPORT DATE: 03/31/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
EPA 8010 - Water matrix	EPA 8010				
Bromodichloromethane	75-27-4	ND	0.5	ug/L	03/18/94
Bromoform	75-25-2	ND	0.5	ug/L	03/18/94
Bromomethane	74-83-9	ND	0.5	ug/L	03/18/94
Carbon Tetrachloride	56-23-5	ND	0.5	ug/L	03/18/94
Chlorobenzene	108-90-7	ND	0.5	ug/L	03/18/94
Chloroethane	75-00-3	ND	0.5	ug/L	03/18/94
2-Chloroethyl Vinyl Ether	110-75-8	ND	0.5	ug/L	03/18/94
Chloroform	67-66-3	ND	0.5	ug/L	03/18/94
Chloromethane	74-87-3	ND	0.5	ug/L	03/18/94
Dibromochloromethane	124-48-1	ND	0.5	ug/L	03/18/94
1,2-Dichlorobenzene	95-50-1	ND	0.5	ug/L	03/18/94
1,3-Dichlorobenzene	541-73-1	ND	0.5	ug/L	03/18/94
1,4-Dichlorobenzene	106-46-7	ND	0.5	ug/L	03/18/94
Dichlorodifluoromethane	75-71-8	ND	0.5	ug/L	03/18/94
1,1-Dichloroethane	75-34-3	ND	0.5	ug/L	03/18/94
1,2-Dichloroethane	107-06-2	ND	0.5	ug/L	03/18/94
1,1-Dichloroethene	75-35-4	ND	0.5	ug/L	03/18/94
cis-1,2-Dichloroethene	156-59-2	ND	0.5	ug/L	03/18/94
trans-1,2-Dichloroethene	156-60-5	ND	0.5	ug/L	03/18/94
1,2-Dichloropropane	78-87-5	ND	0.5	ug/L	03/18/94
cis-1,3-Dichloropropene	10061-01-5	ND	0.5	ug/L	03/18/94
trans-1,3-Dichloropropene	10061-02-6	ND	0.5	ug/L	03/18/94
Methylene Chloride	75-09-2	ND	0.5	ug/L	03/18/94
1,1,2,2-Tetrachloroethane	79-34-5	ND	0.5	ug/L	03/18/94
Tetrachloroethene	127-18-4	ND	0.5	ug/L	03/18/94
1,1,1-Trichloroethane	71-55-6	0.8 *	0.5	ug/L	03/18/94
1,1,2-Trichloroethane	79-00-5	ND	0.5	ug/L	03/18/94
Trichloroethene	79-01-6	19 *	0.5	ug/L	03/18/94
Trichlorofluoromethane	75-69-4	ND	0.5	ug/L	03/18/94
1,1,2Trichlorotrifluoroethane	76-13-1	ND	0.5	ug/L	03/18/94
Vinyl Chloride	75-01-4	ND	0.5	ug/L	03/18/94

ND = Not detected at or above the reporting limit
* = Value above reporting limit

AEN (CALIFORNIA)
QUALITY CONTROL REPORT

AEN JOB NUMBER: 9403168

CLIENT PROJECT ID: 1649.06

Quality Control Summary

All laboratory quality control parameters were found to be within established limits.

Definitions

The following abbreviations are found throughout the QC report:

ND = Not Detected at or above the reporting limit
RPD = Relative Percent Difference
< = Less Than

QUALITY CONTROL DATA

INSTRUMENT: G

CLIENT PROJ. ID: 1649.06

AEN JOB NO: 9403168
AEN LAB NO: 0318-BLANK
DATE ANALYZED: 03/18/94

EPA METHOD 8010 (WATER MATRIX)
HALOGENATED VOLATILE ORGANICS

Compound	CAS #	Concentration (ug/L)	Reporting Limit (ug/L)
Bromodichloromethane	75-27-4	ND	0.5
Bromoform	75-25-2	ND	0.5
Bromomethane	74-83-9	ND	0.5
Carbon Tetrachloride	56-23-5	ND	0.5
Chlorobenzene	108-90-7	ND	0.5
Chloroethane	75-00-3	ND	0.5
2-Chloroethyl Vinyl Ether	110-75-8	ND	0.5
Chloroform	67-66-3	ND	0.5
Chloromethane	74-87-3	ND	0.5
Dibromochloromethane	124-48-1	ND	0.5
1,2-Dichlorobenzene	95-50-1	ND	0.5
1,3-Dichlorobenzene	541-73-1	ND	0.5
1,4-Dichlorobenzene	106-46-7	ND	0.5
Dichlorodifluoromethane	75-71-8	ND	0.5
1,1-Dichloroethane	75-34-3	ND	0.5
1,2-Dichloroethane	107-06-2	ND	0.5
1,1-Dichloroethene	75-35-4	ND	0.5
cis-1,2-Dichloroethene	156-59-2	ND	0.5
trans-1,2-Dichloroethene	156-60-5	ND	0.5
1,2-Dichloropropane	78-87-5	ND	0.5
cis-1,3-Dichloropropene	10061-01-5	ND	0.5
trans-1,3-Dichloropropene	10061-02-6	ND	0.5
Methylene Chloride	75-09-2	ND	0.5
1,1,2,2-Tetrachloroethane	79-34-5	ND	0.5
Tetrachloroethene	127-18-4	ND	0.5
1,1,1-Trichloroethane	71-55-6	ND	0.5
1,1,2-Trichloroethane	79-00-5	ND	0.5
Trichloroethene	79-01-6	ND	0.5
Trichlorofluoromethane	75-69-4	ND	0.5
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	ND	0.5
Vinyl Chloride	75-01-4	ND	0.5

QUALITY CONTROL DATA

INSTRUMENT: G

CLIENT PROJ. ID: 1649.06

AEN JOB NO: 9403168
AEN LAB NO: 0321-BLANK
DATE ANALYZED: 03/21/94

EPA METHOD 8010 (WATER MATRIX)
HALOGENATED VOLATILE ORGANICS

Compound	CAS #	Concentration (ug/L)	Reporting Limit (ug/L)
Bromodichloromethane	75-27-4	ND	0.5
Bromoform	75-25-2	ND	0.5
Bromomethane	74-83-9	ND	0.5
Carbon Tetrachloride	56-23-5	ND	0.5
Chlorobenzene	108-90-7	ND	0.5
Chloroethane	75-00-3	ND	0.5
2-Chloroethyl Vinyl Ether	110-75-8	ND	0.5
Chloroform	67-66-3	ND	0.5
Chloromethane	74-87-3	ND	0.5
Dibromochloromethane	124-48-1	ND	0.5
1,2-Dichlorobenzene	95-50-1	ND	0.5
1,3-Dichlorobenzene	541-73-1	ND	0.5
1,4-Dichlorobenzene	106-46-7	ND	0.5
Dichlorodifluoromethane	75-71-8	ND	0.5
1,1-Dichloroethane	75-34-3	ND	0.5
1,2-Dichloroethane	107-06-2	ND	0.5
1,1-Dichloroethene	75-35-4	ND	0.5
cis-1,2-Dichloroethene	156-59-2	ND	0.5
trans-1,2-Dichloroethene	156-60-5	ND	0.5
1,2-Dichloropropane	78-87-5	ND	0.5
cis-1,3-Dichloropropene	10061-01-5	ND	0.5
trans-1,3-Dichloropropene	10061-02-6	ND	0.5
Methylene Chloride	75-09-2	ND	0.5
1,1,2,2-Tetrachloroethane	79-34-5	ND	0.5
Tetrachloroethene	127-18-4	ND	0.5
1,1,1-Trichloroethane	71-55-6	ND	0.5
1,1,2-Trichloroethane	79-00-5	ND	0.5
Trichloroethene	79-01-6	ND	0.5
Trichlorofluoromethane	75-69-4	ND	0.5
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	ND	0.5
Vinyl Chloride	75-01-4	ND	0.5

QUALITY CONTROL DATA

INSTRUMENT: G

AEN JOB NO: 9403168

CLIENT PROJ. ID: 1649.06

SURROGATE STANDARD RECOVERY SUMMARY
METHOD: EPA 8010
(WATER MATRIX)

Date Analyzed	SAMPLE IDENTIFICATION		SURROGATE RECOVERY (PERCENT)	
	Client Id.	Lab Id.	Bromochloro-methane	1-Bromo-3-chloro-propane
03/18/94	LF-111R	01	105	94
03/18/94	LF-110	03	132	102
03/18/94	LF-113	04	86	80

CURRENT QC LIMITS

ANALYTE	PERCENT RECOVERY
Bromochloromethane	(78-153)
1-Bromo-3-chloropropane	(74-143)

QUALITY CONTROL DATA

DATE ANALYZED:	03/18/94	AEN JOB NO:	9403168
SAMPLE SPIKED:	LCS		
CLIENT PROJ. ID:	1649.06	INSTRUMENT:	G

LABORATORY CONTROL SAMPLE
METHOD: EPA 8010
(WATER MATRIX)

ANALYTE	Spike Added (ug/L)	Percent Recovery
1,1-Dichloroethene	50.0	82
Trichloroethene	50.0	93
Chlorobenzene	50.0	95

CURRENT QC LIMITS

Analyte	Percent Recovery
1,1-Dichloroethene	(37-156)
Trichloroethene	(54-122)
Chlorobenzene	(54-141)

*** END OF REPORT ***

R-3, 53

9403168

CHAIN OF CUSTODY / ANALYSES REQUEST FORM

Project No.: 1649.06
Field Logbook No.:
Date: 3.17.94
Serial No.: № 12878
Project Name: Yoba Buena
Project Location: Emeryville, CA
Sampler (Signature): Prescott C. Heald
Samplers: SCH

SAMPLE NO.	DATE	TIME	LAB SAMPLE NO.	NO. OF CON-TAINERS	SAMPLE TYPE	EPA ~~601~~ 8010 Rb	EPA 624					HOLD	RUSH	REMARKS
LF·111R	3·16·94	1250	01AB	2	H2O	X							X	48 Hr. TAT, Results
LF·110·BB	↓	1405	02AB	2	↓	X						X		by AM on 3/21.
LF·110	↓	1425	03AB	2	↓	X							X	Contact Jenifer Beatty
LF 113	↓	1820	04AB	2	↓	X							X	
														3/28/94 Per Scott Heald,
														please reference 8010
														on report. R. Byars

RELINQUISHED BY: (Signature) Prescott C. Heald	DATE 3/17/94	TIME 10:20	RECEIVED BY: (Signature) Ken S.	DATE 3/17/94	TIME 10:20
RELINQUISHED BY: (Signature) Ken S.	DATE 3/17/94	TIME 12:20	RECEIVED BY: (Signature) Ozina Gillespie	DATE 3-17-94	TIME 1220
RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)	DATE	TIME
METHOD OF SHIPMENT: Courier	DATE	TIME	LAB COMMENTS:		

Sample Collector:
LEVINE-FRICKE
1900 Powell Street, 12th Floor
Emeryville, California 94608
(510) 652-4500

Analytical Laboratory: AEN, Pleasant Hill, CA

Shipping Copy (White) Lab Copy (Green) File Copy (Yellow) Field Copy (Pink)

FORM NO. 86/COC/ARF

American Environmental Network

Certificate of Analysis

DOHS Certification: 1172 AIHA Accreditation: 11134

LEVINE-FRICKE
1900 POWELL ST., 12TH FLOOR
EMERYVILLE, CA 94608

ATTN: JENIFER BEATTY

REPORT DATE:	03/31/94
DATE SAMPLED:	03/18/94
DATE RECEIVED:	03/18/94
AEN JOB NO:	9403196

CLIENT PROJ. ID: 3145.00-04
C.O.C. SERIAL NO: 12682
PROJ. NAME: PSP

PROJECT SUMMARY:

On March 18, 1994, this laboratory received two (2) soil samples.

Client requested samples be analyzed for organic parameters. Sample identification, methodologies, results and dates analyzed are summarized on the following pages.

Please see quality control report for a summary of QC data pertaining to this project.

If you have any questions, please contact Client Services at (510) 930-9090.

RECEIVED
APR - 1
LEVINE-FRICKE

Larry Klein
Larry Klein
General Manager

LEVINE-FRICKE

SAMPLE ID: E5-15
AEN LAB NO: 9403196-01
AEN WORK ORDER: 9403196
CLIENT PROJ. ID: 3145.00-04

DATE SAMPLED: 03/18/94
DATE RECEIVED: 03/18/94
REPORT DATE: 03/31/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
#Extraction for Diesel/Oil	EPA 3550	-		Extrn Date	03/21/94
TPH as Diesel	GC-FID	ND	1	mg/kg	03/27/94

ND = Not detected at or above the reporting limit
* = Value above reporting limit

LEVINE-FRICKE

SAMPLE ID: E5-17.5
AEN LAB NO: 9403196-02
AEN WORK ORDER: 9403196
CLIENT PROJ. ID: 3145.00-04

DATE SAMPLED: 03/18/94
DATE RECEIVED: 03/18/94
REPORT DATE: 03/31/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
#Extraction for Diesel/Oil	EPA 3550	-		Extrn Date	03/21/94
TPH as Diesel	GC-FID	ND	1	mg/kg	03/27/94

ND = Not detected at or above the reporting limit
* = Value above reporting limit

AEN (CALIFORNIA)
QUALITY CONTROL REPORT

AEN JOB NUMBER: 9403196

CLIENT PROJECT ID: 3145.00-04

Quality Control Summary

All laboratory quality control parameters were found to be within established limits.

Definitions

The following abbreviations are found throughout the QC report:

ND = Not Detected at or above the reporting limit
RPD = Relative Percent Difference
< = Less Than

QUALITY CONTROL DATA

DATE EXTRACTED: 03/21/94
DATE ANALYZED: 03/22/94
CLIENT PROJ. ID: 3145.00-04

AEN JOB NO: 9403196
SAMPLE SPIKED: 9403209-02
INSTRUMENT: C

METHOD SPIKE RECOVERY SUMMARY
TPH EXTRACTABLE SOIL
METHOD: EPA 3550 GCFID

				QC Limits	
ANALYTE	Spike Added (mg/kg)	Average Percent Recovery	RPD	Percent Recovery	RPD
Diesel	41.9	68	4	44-105	18

METHOD BLANK RESULT

Lab Id.	Extractable Hydrocarbons as Diesel (mg/kg)
032194-METHOD BLANK	ND
Reporting Limit	1

*** END OF REPORT***

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APPENDIX B

CHEMICAL FATE AND TRANSPORT MODELING METHODOLOGY

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APPENDIX B

CHEMICAL FATE AND TRANSPORT MODELING METHODOLOGY

I. GROUNDWATER FLOW MODELING

I.1 Model Description

The U.S. Geological Survey (USGS) Modular Three-Dimensional Finite-Difference Ground-Water Flow Model (MODFLOW) (McDonald and Harbaugh, 1988) was used to simulate groundwater flow within the model domain beneath the Site. MODFLOW is a quasi-three-dimensional finite-difference flow model designed to simulate the response of a water-yielding unit to imposed stress conditions. MODFLOW may be used to simulate confined or unconfined (water table) conditions or a combination of both conditions. MODFLOW may also be used to simulate heterogeneous and anisotropic geologic units as well as geologic units with irregular boundaries.

MODFLOW was used to evaluate steady-state groundwater flow conditions at the Site under ambient conditions. The model domain, or the area in which groundwater flow was simulated, is shown in Figure 4.

I.2 Modeling Procedure

Groundwater flow modeling was accomplished through the following steps:

1) Conceptualize the hydrogeologic flow regime

2) Design a finite-difference grid system

3) Assign hydrogeologic parameter values

4) Assign model boundary conditions

5) Calibrate the computer model using field-measured data

These modeling steps are described in the following sections.

I.2.1 Conceptual Model

The hydrogeology of the Site, and it particular Area C, has been characterized by Levine·Fricke (1990, 1994) and is reviewed in Section 3.2.1. The depth to groundwater in Area C monitoring wells historically has ranged from approximately 4 to 8 feet below ground surface (bgs), while the depth to groundwater observed during excavation activities has been approximately 8 to 10 feet, indicating that shallow groundwater beneath Area C occurs under confined or semi-confined conditions (Levine·Fricke, 1994). This interpretation is supported by the well logs, which show an average of about 3½ feet of coarse-grained sediments (ranging from clayey sand to silty sandy gravel) in one or two layers between depths of about 10 and 20 feet bgs. These coarse-grained layers are over- and underlain by and interbedded with fine-grained sediments consisting primarily of silty clay with lesser amounts of clayey to sandy and/or gravelly silt.

Groundwater flows in a southwesterly direction beneath the Area C (Figure 2). This flow direction has been consistent over at least four sets of potentiometric (groundwater elevation) measurements obtained by Levine·Fricke since January 1992.

Based on a review of available well logs, it appears that the elevation of the aquifer decreases toward the west and south, similar to the slope of the land surface. In the model, the aquifer was approximated as a planar body with a slope of 0.006 ft/ft to the west and 0.0038 ft/ft to the south and a constant thickness of 3.7 feet.

I.2.2 Finite-Difference Grid System

The model domain is shown in Figure 4. It consists of a 700-foot by 1,800-foot area that includes the entirety of Area C and immediately adjacent areas. The model domain was subdivided into a finite-difference grid composed of 36 columns (oriented north-south) by 14 rows (oriented east-west) with a uniform grid spacing of 50 feet (Figure 4).

I.2.3 Hydrogeologic Properties

Hydrogeologic properties were assigned to saturated sediments beneath the Site. These hydrogeologic properties consisted of the following:

- Transmissivity (ft^2/day) of the shallow saturated coarse-grained sediments (shallow confined aquifer)
- Elevation of the bottom of shallow confined aquifer
- Thickness of the shallow confined aquifer
- Aquifer recharge rate

When running the model, a value must be specified for each of these parameters at every cell in the finite-difference grid.

Initial values of aquifer transmissivity used in the model were based on results of slug tests performed by Levine·Fricke personnel in March 1994 and the spacing of groundwater elevation contours (i.e., hydraulic gradients) on groundwater elevation contour maps prepared by Levine·Fricke from previous groundwater elevation monitoring data (Levine·Fricke, 1990, 1994). These initial values were adjusted during model calibration to achieve a good fit with measured potentiometric (groundwater elevation) data. A simplified zoning of transmissivity was used in the groundwater flow model as shown in Figure B-1. Following the calibration of the model, the final values of hydraulic conductivity in each zone were obtained. These values were between 0.9 and 90 ft^2/day, as shown in Figure B-1.

As described in Section I.2.1, the elevation of the top of the aquifer was approximated as a planar surface with a slope of 0.006 ft/ft to the west and 0.0038 ft/ft to the south, and a constant thickness of 3.7 feet was assigned throughout the model domain. A uniform aquifer recharge rate equivalent to 1 inch per year was assumed throughout the model domain.

I.2.4 Model Boundary Conditions

A second-order general head boundary (GHB) was used along the entire boundary of the model domain. This boundary condition specifies that ground water enters the model domain at a rate that is a function of the hydraulic conductivity of the sediments at the boundary, the cross-sectional area of the flow through the cell, and the hydraulic gradient at the edge of the model domain. Thus, flow conditions are considered to be continuous across the model boundary. The boundary heads rise and fall dependent on the flow conditions within the model domain. The GHB along the boundaries of the model domain specifies a hydraulic gradient across each boundary which remains constant. The northern and eastern boundaries of the model domain (Figure 4) were inflow boundaries (i.e., groundwater flows into the model domain), while the southern and western boundaries were outflow boundaries.

I.2.5 Model Calibration

Model calibration was performed to establish the model as adequately representing the groundwater flow system. The model was calibrated using water-level measurement data from individual monitoring wells. The July 9, 1993 water-level measurement data reported by Levine·Fricke were used as the reference values for model calibration. These data, obtained during the dry season when transient effects of precipitation and recharge are not present, were selected as representative of "steady-state" groundwater flow conditions.

Model calibration was achieved by repeatedly adjusting hydraulic input parameters (e.g., transmissivity, boundary conditions, recharge rate) and comparing the resulting simulated values with observed groundwater elevations at monitoring wells. Table 4-1 presents a comparison of simulated vs. measured groundwater elevations at Area C monitoring well locations. A very close calibration was achieved, as indicated by the average difference of only 0.06 feet between simulated and measured groundwater elevations.

II. GROUNDWATER CHEMICAL TRANSPORT MODELING

II.1 Model Description

Chemical transport in groundwater was simulated using MT3D, a modular three-dimensional transport model for simulation of advection, dispersion and chemical reactions of contaminants in groundwater systems developed by S.S. Papadopulos & Associates, Inc. (Zheng, 1992). MT3D is a finite-difference transport model that uses a mixed Eulerian-Lagrangian approach to the solution of the three-dimensional advective-dispersive-reactive equations in the method of characteristics, the modified method of characteristics, and a hybrid of the two methods, making it uniquely suitable for a wide range of field problems.

MT3D can be used in conjunction with any block-centered finite-difference flow model such as MODFLOW and is based on the assumption that the flow field is not measurably affected by any change in the concentration field, allowing separate conceptualization and calibration of a flow model.

Water-quality simulations were accomplished in two steps. In the first step, MODFLOW was run to generate the potentiometric head distribution for the single-layer system. The simulated hydraulic heads and other related flow terms for the layer were saved to a data file. In the second step, MT3D was run to simulate the chemical transport. MT3D retrieves the hydraulic heads and the flow and sink/source terms saved by the flow model, automatically incorporating the specified boundary conditions.

II.2 Chemical Transport Processes

Advection (flow with the ground water) is the dominant transport mechanism of dissolved chemicals in ground water. The two other primary processes that can influence the distribution of chemicals in groundwater are dispersion and sorption. Dispersion results from small-scale variations of groundwater flow velocity and causes spreading of chemicals in a transverse direction or in the direction of groundwater flow. The process of sorption of chemicals onto sediments impedes the transport of those chemicals through soil and groundwater. The effects of sorption were estimated using the retardation coefficient, which is the ratio between calculated groundwater velocity and the apparent chemical velocity in a particular porous medium. The following sections describe how dispersion and sorption processes were simulated in the chemical transport modeling.

II.2.1 Dispersion

The dispersion process in MT3D is considered as the spreading of contaminants over a greater region than would be predicted solely from the groundwater velocity vectors.

Dispersion occurs in both longitudinal and transverse directions to the flow direction. In the simulation, the porous medium was assumed to be isotropic, and molecular diffusion was considered to be negligible relative to dispersion. Input data that control the dispersion process include values of longitudinal and transverse dispersivity of the water-yielding sediments. Actual measurement of dispersivity values requires intensive field studies and such field data were not available. For modeling purposes, the saturated sediments beneath the Site were assigned values of 50 and 25 feet for longitudinal and transverse dispersivity, respectively.

II.2.2 Retardation

MT3D assumes that retardation of contaminant transport is mainly due to sorption which refers to the mass transfer process between the contaminants dissolved in groundwater (aqueous phase) and the contaminants sorbed on the porous medium (solid phase). The retardation of a concentration front in groundwater relative to the bulk mass of water is described by the retardation factor (R) in the following equation (Zheng, 1992):

$$R = 1 + \frac{\rho}{\eta} K_d \tag{1}$$

where

R = retardation factor (dimensionless)
ρ = bulk mass density (lb/ft^3)
η = effective porosity (dimensionless)
K_d = soil-water partition coefficient (ft^3/lb)

The functional relationship between sorbed and dissolved concentrations, called sorption isotherm, is classified in MT3D into three types: linear, Freundlich and Langmuir. Linear sorption was used in this simulation.

The linear sorption assumes that there is a linear relationship between the sorbed concentration and the dissolved concentration. The partition coefficients for each chemical were calculated from published values of the organic carbon-water partition coefficient using the following formula:

$$K_d = f_{oc} \times K_{oc} \qquad (2)$$

where

f_{oc} is the fraction of organic carbon content in the porous medium
K_{oc} is the organic carbon-water partition coefficient

This approach is based on the assumption that the sorption process is controlled by the organic carbon content of the porous medium.

The organic carbon content of the aquifer was determined by laboratory analysis of two soil samples collected from the saturated zone in Area C (Table 3-1). The average of the f_{oc} values for these samples was 0.069 percent. However, during the model calibration process, it was found that this value under-predicted chemical retardation and that a higher f_{oc} value was needed in order to achieve a reasonable fit between simulated and observed concentrations. An f_{oc} value of 0.35 percent was finally arrived at upon the conclusion of model calibration. This result suggests that other factors than organic carbon content, such as clay content, may be significant in determining chemical retardation in groundwater at the Site.

The K_{oc} and K_d values used in the model for each chemical are listed in Table B-2. The calculated retardation factors, R, are also listed in Table B-2. Parameter values for physical properties of the aquifer (e.g., effective porosity, bulk density, organic carbon content) used in the model are listed in Table B-1. The average effective porosity of saturated sediments was assumed to be 0.35 based on the calculated porosity of two samples of aquifer material obtained from boreholes drilled adjacent to Area C monitoring wells BW-10 and BW-32 (Table 3-1). This parameter was used in the retardation factor calculation and was also an important parameter in calculating groundwater flow velocity.

II.3 Calibration of the Transport Model

Because the source of VOCs detected in groundwater beneath Area C has not been characterized and lies outside the model domain to the north of Area C, entry of VOCs into the model domain was simulated in the contaminant transport model by assigning fixed chemical concentrations to selected finite-difference grid cells along the northern boundary of the model domain (Figures B-2 and B-3). The location(s) of chemical source areas and the source strength was determined during the model calibration process by varying source locations and strengths for each chemical to achieve the best fit with observed data using a trial-and-error process. The chemical concentration of VOCs in groundwater along this boundary was assumed to follow a nomral distribution. The resultant chemical "source areas" (i.e., boundary nodes assigned a constant chemical concentration in the simulations) and source strengths (concentrations) assumed in the model are shown in Figures B-2 and B-3 for TCE and 1,2-DCE, respectively. Due to its limited areal distribution in groundwater, vinyl chloride was assigned a fixed concentration (1100 ug/l) in only one grid cell (row 1, column 28) along the northern model boundary.

Groundwater sampling data for Electro-Coatings, Inc. (ECI) monitoring well MW-21, reportedly located near Area C monitoring well LF-10, indicate that significant TCE concentrations (2.2 mg/l) were present in groundwater at this location at least as early as June 1985 (American Environmental Management Corporation, 1992). Based on this information, a simulation period of 10 years was used for model calibration, assuming that VOCs began migrating into Area C across the northern property boundary by 1984.

The procedures of the calibration for the chemical transport model were similar to those for the flow model. Simulations were run repeatedly for each chemical. After each run, simulated chemical concentrations in groundwater at monitoring well locations were compared with observed concentrations from the March 1994 sampling data. In a trial-and-error process, chemical source locations and concentrations were adjusted until a satisfactory fit was obtained between simulated and observed chemical concentrations in groundwater at Area C monitoring well locations. Model calibration results are presented in Table 4-2.

II.4 Simulations of Chemical Transport

Following model calibration, MT3D was used to simulate future chemical concentrations in groundwater after 30 years assuming that concentrations of the chemicals of concern in groundwater entering Area C at the northern boundary of the model domain will remain constant. In view of the decreasing trends in VOC concentrations in Area C monitoring wells near the northern property boundary (e.g., wells LF-10 and LF-11, see Table 3-2), the use of a non-diminishing source term constitutes a conservative assumption which would be expected to result in an overestimation of future chemical concentrations in groundwater. Given this conservative assumption, the estimated future chemical concentrations in groundwater predicted by MT3D in the 30-year simulations represent a worst-case scenario which assumes that no future groundwater remediation or source removal actions will be implemented and neglects natural processes such as biodegradation and dilution which would tend to cause concentrations to decrease over time.

From the calibration simulations, the current concentration distribution of each chemical of concern was obtained. Using the calibration results as initial conditions and assuming that future VOC concentrations in groundwater flowing into Area C from the northeast would remain constant, future concentration distributions for each chemical were predicted by running MT3D for 30-year simulations. Due to the assumption of a non-diminishing source and the omission of biodegradation effects, the results of these simulations would be expected to conservatively over-estimate future chemical concentrations in groundwater.

III. ESTIMATION OF CHEMICAL EMISSION RATES FROM GROUNDWATER

Steady-state surface vapor emissions from shallow groundwater underlying the Site were estimated 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:

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

where

E_i = estimated emission rate of chemical i in mg/(m^2-sec)
D_{air} = chemical air diffusion coefficient in cm^2/sec
C_v = chemical concentration in vapor phase at depth L in mg/cm^3
C_i = gas phase chemical concentration immediately above the soil surface
L = the thickness of the overlying soil cover in cm
P_a = air-filled porosity of the soil cover in cm^3/cm^3
P_t = total porosity of the soil cover in cm^3/cm^3.

Soil property parameter values used in the calculation are listed in Table B-1, while chemical property values are listed in Table B-3. Based on the site-specific soil porosity and soil moisture values obtained from two soil borings drilled adjacent to Area C monitoring wells LF-10 and LF-32 (Table 3-1), a total porosity value of 0.42 was assumed for vadose zone soils in the calculations. The volumetric moisture content of vadose zone soils was assumed to be at field capacity. Based on the predominantly silty clay soil type for vadose zone soils in Area C, field capacity was assumed to be 80 percent saturation (EPA, 1988), or 0.336. Thus, a value of 0.084 (0.42 - 0.336) was assigned for the air-filled porosity in the emission rate calculations.

The thickness of the overlying soil cover, or the depth to the top of the aquifer (depth to groundwater), ranges from approximately 8 to 10 feet, as described in Section I.2.1. For simplicity, L was conservatively assumed to be 8 ft everywhere beneath the Site, except when calculating emission rates into excavated areas during on-site construction activities. For excavation emission rate calculations, L was assumed to be 3 feet, based on an assumed excavation depth of 5 feet.

In keeping with the conservative nature of this evaluation, it was assumed that C_1 was equal to zero. The vapor concentration of VOCs in the unsaturated soils above the capillary fringe, C_v, was estimated from groundwater concentration using Henry's Law:

$$C_V = H \times C_W \qquad (4)$$

where

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

Table B-3 lists Henry's Law and air diffusion coefficients for each of the chemicals of concern.

To facilitate chemical vapor emission rate calculations, SOMA developed a computer program to calculate emission rates using Farmers model for each cell in the finite-difference grid used in contaminant transport modeling. The program reads the groundwater chemical concentration calculated by MT3D for each cell in the finite difference grid, and can calculate and sum emission rates over any area(s) of interest (i.e., one or more specified blocks of finite-difference grid cells). This program was used to calculate the average emission rate for each VOC in the vicinity of Proposed Building No. 2 (shaded cells in Figure 4).

IV. ESTIMATION OF CHEMICAL CONCENTRATIONS IN ON-SITE INDOOR AIR

Estimated concentrations of COCs in on-site indoor air were calculated using the emission rates calculated for these chemicals as described in Section III. Indoor air concentrations were estimated using the methodology of the Orange County Public Health Care Agency's Simplified Vapor Pathway Evaluation (Daugherty, 1991). This model is based on the following assumptions:

- Vapor-phase chemical emission rates from soils are constant through time (steady-state assumption).
- Vapor-phase chemical emission rates from soils are not affected by the presence of buildings.
- Chemical vapors emitted from soil beneath a building are uniformly and instantaneously mixed within the entire air space within the building.

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

$$C_{in} = \frac{b \times E \times A}{Q} \tag{5}$$

where

C_{in} = chemical concentration in indoor air ($\mu g/m^3$)
b = attenuation factor (unitless)
E = chemical emission rate from soil ($\mu g/m^2 \cdot s$)
A = area covered by building (m^2)
Q = ventilation rate (m^3/s)

An attenuation factor of 0.1, representing an order-of-magnitude attenuation of chemical emission rates, was used due to the proposed concrete slab construction of the building. The ventilation rate, Q, was calculated assuming an exchange rate with outside air of 12 exchanges per day or 0.5 exchanges per hour:

$$Q = \frac{A \times h \times R}{C_f} \tag{6}$$

where

h = interior height of building (m)
R = exchange rate (hr^{-1})
C_f = unit conversion factor (3600 s/hr)

Note that the area covered by the building is unimportant, since the area divides out when the right-hand side of Equation 6 is substituted into Equation 5.

Building parameter values used in the indoor air concentration calculations are shown in Table B-4. Using the indicated values for the other variables, a value of 2.21 m^3/s was calculated for Q.

The approximate locations of three proposed buildings for retail use in Area C are shown in Figure 4. The location of Proposed Building No. 2 was selected for purposes of calculating VOC concentrations in indoor air since this location is the closest of the three to the area of maximum VOC concentrations in groundwater and thus represents a worst-case scenario. Information on the location and size of the proposed buildings was obtained from a letter from Kimberly Brandt of Catellus to Susan Hugo of the Alameda County Health Agency dated March 18, 1994.

Estimated indoor air concentrations at present time and after 30 years for Proposed Building No. 2 are presented in Table 4-3. These estimates are based on simulated chemical concentrations in groundwater at current time and after 30 years estimated using the MT3D model as described in Section II.

The same methodology described above was used to estimate chemical concentrations in air in hypothetical excavations during on-site construction. An attenuation factor of 1 (no attenuation) was used in these calculations, since the excavation was assumed to have a bare dirt floor. Also, because the excavation would have no ceiling, a higher exchange rate, equivalent to one complete air exchange per hour, was used for the excavation air concentration calculations. Groundwater chemical concentrations from MT3D simulations reflecting current conditions were used in estimating VOC concentrations in ambient air in the hypothetical on-site excavations. Table 4-4 presents the calculated air concentration values.

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Table B-1
Values of Aquifer and Vadose Zone Properties Used in Groundwater Flow and Chemical Transport Modeling
Yerba Buena Project Site, Area C

Parameter	Unit	Value
Porosity of Aquifer	Unitless	0.35
Porosity of Vadose Zone	Unitless	0.42
Volumetric Water Content of Vadose Zone	Unitless	0.336
Organic Carbon Content	%	0.35
Bulk Density of Aquifer	g/cm ^ 3	1.72
Bulk Density of Vadoe Zone	g/cm ^ 3	1.54
Density of Soil Particle	g/cm ^ 3	2.65

Table B-2
Chemical Retardation Coefficients Used in Groundwater and Vadose Zone Chemical Transport Modeling
Yerba Buena Project Site, Area C

Chemical Compounds	Koc* (cm ^ 3/g)	Kd		R (Unitless)
		(cm ^ 3/g)	(ft ^ 3/lb)	
Trichloroethene	1.06E+02	3.71E-01	5.94E-03	2.98E+00
1,2-Dichloroethene	4.90E+01	1.72E-01	2.74E-03	1.92E+00
Toluene	1.15E+02	4.03E-01	6.44E-03	3.15E+00
Vinyl chloride	2.45E+00	8.58E-03	1.37E-04	1.05E+00

Abbreviations:

Koc	Organic carbon-water partition coefficient
Kd	Soil-water partition coefficient
R	Retardatoin factor

* From Montgomery, J.H. and L.M. Welkom, 1989. Groundwater Chemical Desk Reference. Lewis Publisher.

Table B-3
Chemical Diffusion and Henry's Law Constants Used in Calculation of Vapor Emissions from Groundwater/Soil
Yerba Buena Project Site, Area C

Chemical Compounds	Diffusion Coefficient (2) (cm ^ 2/sec)	Henry's Law Coefficient (1) (atm-m ^ 3/mol)	Henry's Law Coefficient (Dimensionless)
Trichloroethene	0.06853	9.90E-03	4.13E-01
1,2-Dichloroethene	0.07979	7.56E-03	3.15E-01
Toluene	0.07834	6.70E-03	2.79E-01
Vinyl Chloride	0.10735	5.60E-03	2.33E-01

Notes: Values are for a temperature of 20 degrees C.

Sources: (1) Montgomery, J.H. and L.M. Welkom,1989. Groundwater Chemical Desk Reference. Lewis Publisher.

(2) U.S. Environmental Agency, Office of Remedial Response, Washington, April, 1984. Superfund Exposure Assessment Manual.

Table B-4
Building Parameters Used in Indoor Air Concentration Calculations
Yerba Buena Project Site, Area C

Parameter	Units	Value	Units	Value
Floor Area of Building	ft^2	51,200	m^2	4,756
Interior Height of Building	ft	11.0	m	3.4
Building Air Exchange Rate	1/hr	0.5	1/s	1.39E-04
Building Ventilation Rate, Q	ft^3/s	78.22	m^3/s	2.21
Attenuation Factor	Unitless	0.1	Unitless	0.1

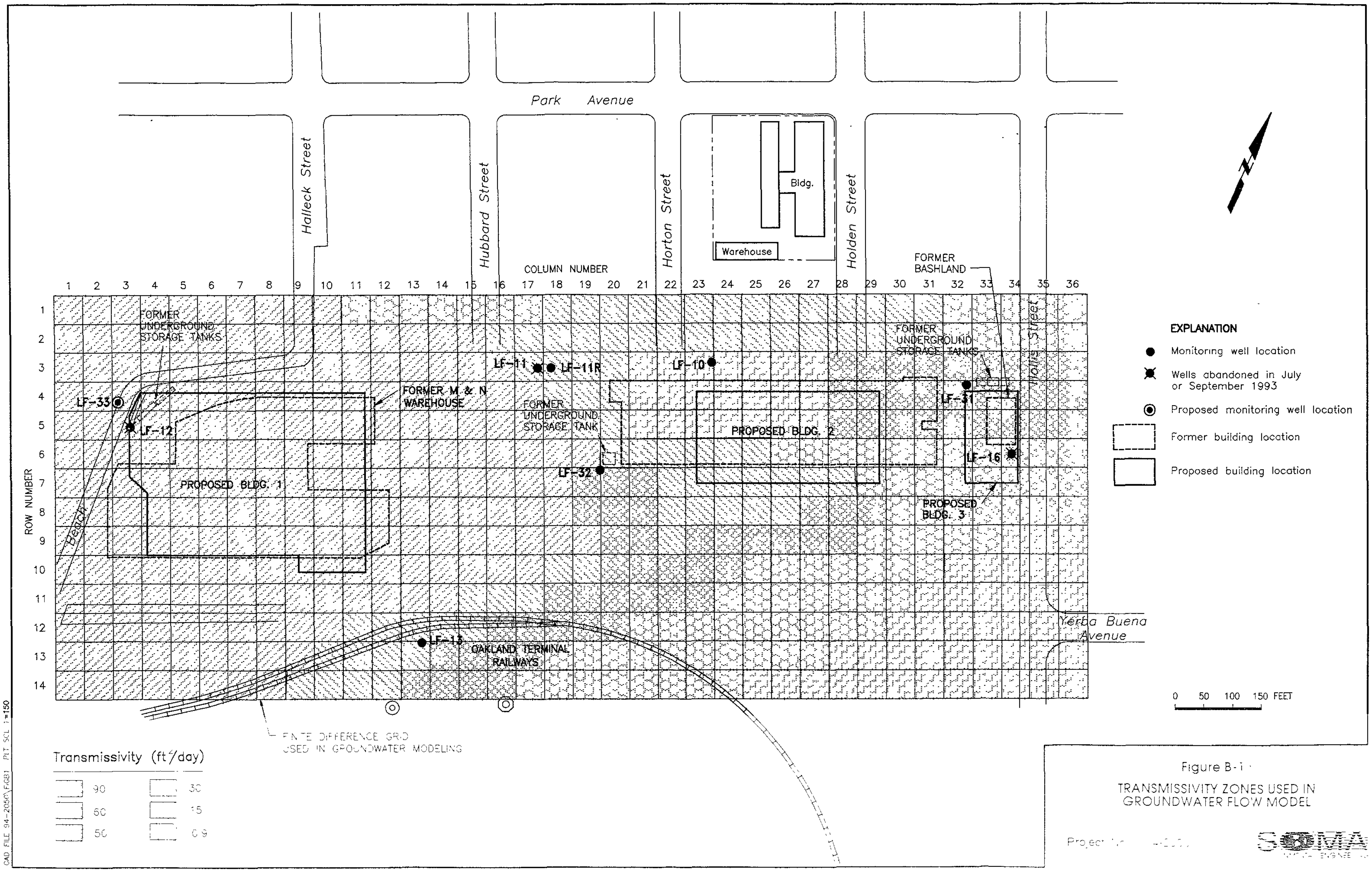

Figure B-1

TRANSMISSIVITY ZONES USED IN GROUNDWATER FLOW MODEL

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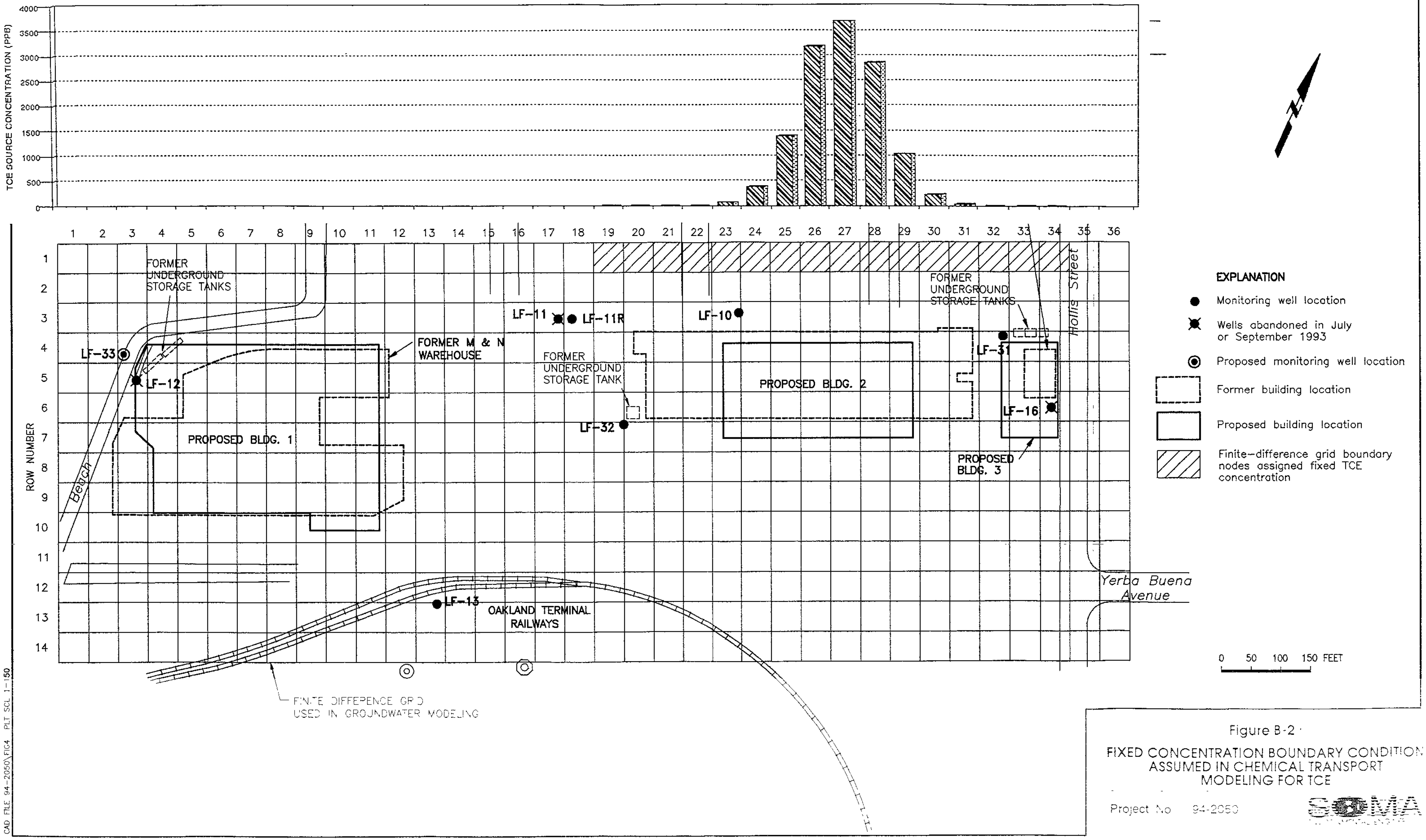

Figure B-2

FIXED CONCENTRATION BOUNDARY CONDITION ASSUMED IN CHEMICAL TRANSPORT MODELING FOR TCE

Project No 94-2050

SOMA

CAD FILE 94-2050\FIG4 PLT SCL 1=150

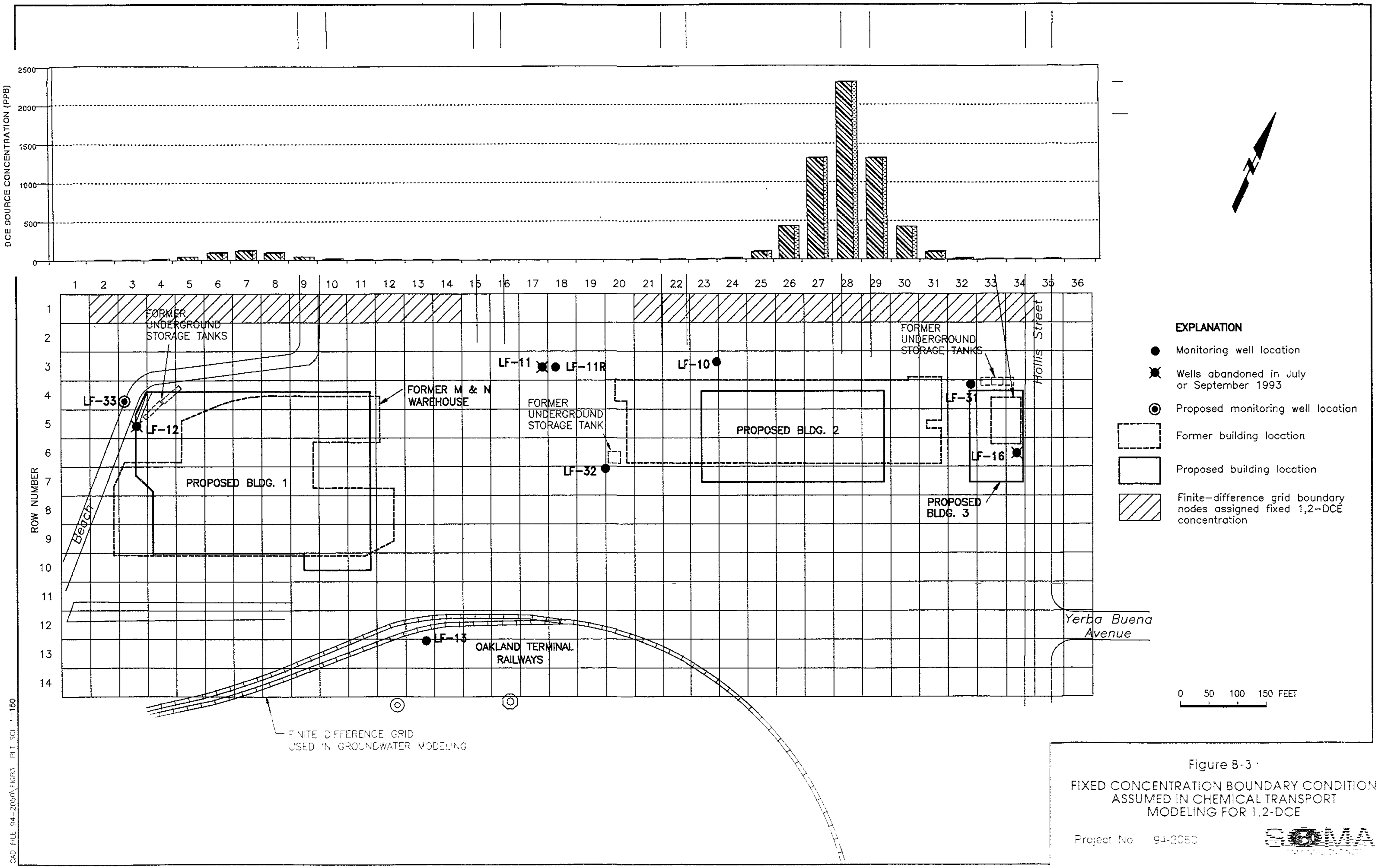

Figure B-3

FIXED CONCENTRATION BOUNDARY CONDITION ASSUMED IN CHEMICAL TRANSPORT MODELING FOR 1,2-DCE

Project No 94-2050

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APPENDIX C

LEADSPREAD BLOOD LEAD ESTIMATION MODEL INPUT AND RESULTS

Yerba Buena Site 95% UCL Lead Conc. in Soil

LEADSPREAD: A LEAD RISK ASSESSMENT SPREADSHEET

INPUT

MEDIUM	LEVEL
LEAD IN AIR (ug/m^3)	0.18
LEAD IN SOIL (ug/g)	32.4
LEAD IN WATER (ug/l)	15
SITE-GROWN PRODUCE? (1 = Yes; 0 = No)	0

OUTPUT

		percentiles 50th	90th	95th	98th	99th
BLOOD Pb, ADULT	(ug/dl)	2.04	3.19	3.62	4.18	4.6
BLOOD Pb, CHILD	(ug/dl)	3.52	5.5	6.2	7.2	8.0
BLOOD Pb, PICA CHILD	(ug/dl)	5.2	8.1	9.2	10.7	11.7

EQUATIONS, ADULTS

Blood Pb Pathway	ug/dl		Route-specific constant	concentration in medium	contact rate	percent of total
SOIL CONTACT:	0.01	=	1E-04 (ug/dl)/(ug/day) *	32 ug/g *	1.85 g soil/day (5 g/m^2 * 0.37 m^2)	0%
SOIL INGESTION:	0.01	=	0.018 (ug/dl)/(ug/day) *	32 ug/g *	0.03 g soil/day	1%
INHALATION:	0.30	=	1.64 (ug/dl)/(ug/m^3) *	0.18 ug/m^3		15%
WATER INGESTION:	0.84	=	0.04 (ug/dl)/(ug/day) *	15 ug/l *	1.4 l water/day	41%
FOOD INGESTION:	0.88	=	0.04 (ug/dl)/(ug/day) *	10.0 ug Pb/kg diet *	2.2 kg diet/day	43%

EQUATIONS, CHILDREN (TYPICAL)

Blood Pb Pathway	ug/dl		Route-specific constant	concentration in medium	contact rate	percent of total
SOIL CONTACT:	0.00	=	1E-04 (ug/dl)/(ug/day) *	32 ug/g *	1.4 g soil/day (5 g/m^2 * 0.28 m^2)	0%
SOIL INGESTION:	0.13	=	0.07 (ug/dl)/(ug/day) *	32 ug/g *	0.06 g soil/day	4%
INHALATION:	0.35	=	1.92 (ug/dl)/(ug/m^3) *	0.18 ug/m^3		10%
WATER INGESTION:	0.96	=	0.16 (ug/dl)/(ug/day) *	15 ug/l *	0.4 l water/day	27%
FOOD INGESTION:	2.08	=	0.16 (ug/dl)/(ug/day) *	10.0 ug Pb/kg diet *	1.3 kg diet/day	59%

EQUATIONS, CHILDREN (PICA) *

Blood Pb Pathway	ug/dl		Route-specific constant	concentration in medium	contact rate	percent of total
SOIL CONTACT:	0.00	=	1E-04 (ug/dl)/(ug/day) *	32 ug/g *	1.4 g soil/day (5 g/m^2 * 0.25 m^2)	0%
SOIL INGESTION:	1.79	=	0.07 (ug/dl)/(ug/day) *	32 ug/g *	0.79 g soil/day	35%
INHALATION:	0.35	=	1.92 (ug/dl)/(ug/m^3) *	0.18 ug/m^3		7%
WATER INGESTION:	0.96	=	0.16 (ug/dl)/(ug/day) *	15 ug/l *	0.4 l water/day	19%
FOOD INGESTION:	2.08	=	0.16 (ug/dl)/(ug/day) *	10.0 ug Pb/kg diet *	1.3 kg diet/day	40%

EQUATIONS, DIETARY LEAD

TOTAL DIETARY LEAD = 0 .945 * 10 + 0.055 * Pb in produce (ug/kg) = 10.0 ug/kg

LEAD IN PRODUCE = 10 ug/kg or 0.00045 * soil lead d = 10.0 ug/kg

LEADSPREAD: A LEAD RISK ASSESSMENT SPREADSHEET

INPUT

MEDIUM	LEVEL
LEAD IN AIR (ug/m^3)	0.18
LEAD IN SOIL (ug/g)	240
LEAD IN WATER (ug/l)	15
SITE-GROWN PRODUCE? (1 = Yes; 0 = No)	0

OUTPUT

		percentiles 50th	90th	95th	98th	99th
BLOOD Pb, ADULT	(ug/dl)	2.17	3.40	3.85	4.46	4.9
BLOOD Pb, CHILD	(ug/dl)	4.35	6.8	7.7	8.9	9.8
BLOOD Pb, PICA CHILD	(ug/dl)	16.7	26.2	29.7	34.3	37.8

EQUATIONS, ADULTS

Blood Pb Pathway	ug/dl		Route-specific constant	concentration in medium	contact rate	percent of total
SOIL CONTACT:	0.05	=	1E-04 (ug/dl)/(ug/day) *	240 ug/g *	1.85 g soil/day (5 g/m^2 * 0.37 m^2)	2%
SOIL INGESTION:	0.11	=	0.018 (ug/dl)/(ug/day) *	240 ug/g *	0.03 g soil/day	5%
INHALATION:	0.30	=	1.64 (ug/dl)/(ug/m^3) *	0.18 ug/m^3		14%
WATER INGESTION:	0.84	=	0.04 (ug/dl)/(ug/day) *	15 ug/l *	1.4 l water/day	39%
FOOD INGESTION:	0.88	=	0.04 (ug/dl)/(ug/day) *	10.0 ug Pb/kg diet *	2.2 kg diet/day	41%

EQUATIONS, CHILDREN (TYPICAL)

Blood Pb Pathway	ug/dl		Route-specific constant	concentration in medium	contact rate	percent of total
SOIL CONTACT:	0.04	=	1E-04 (ug/dl)/(ug/day) *	240 ug/g *	1.4 g soil/day (5 g/m^2 * 0.28 m^2)	1%
SOIL INGESTION:	0.93	=	0.07 (ug/dl)/(ug/day) *	240 ug/g *	0.06 g soil/day	21%
INHALATION:	0.35	=	1.92 (ug/dl)/(ug/m^3) *	0.18 ug/m^3		8%
WATER INGESTION:	0.96	=	0.16 (ug/dl)/(ug/day) *	15 ug/l *	0.4 l water/day	22%
FOOD INGESTION:	2.08	=	0.16 (ug/dl)/(ug/day) *	10.0 ug Pb/kg diet *	1.3 kg diet/day	48%

EQUATIONS, CHILDREN (PICA)

Blood Pb Pathway	ug/dl		Route-specific constant	concentration in medium	contact rate	percent of total
SOIL CONTACT:	0.04	=	1E-04 (ug/dl)/(ug/day) *	240 ug/g *	1.4 g soil/day (5 g/m^2 * 0.25 m^2)	0%
SOIL INGESTION:	13.28	=	0.07 (ug/dl)/(ug/day) *	240 ug/g *	0.79 g soil/day	80%
INHALATION:	0.35	=	1.92 (ug/dl)/(ug/m^3) *	0.18 ug/m^3		2%
WATER INGESTION:	0.96	=	0.16 (ug/dl)/(ug/day) *	15 ug/l *	0.4 l water/day	6%
FOOD INGESTION:	2.08	=	0.16 (ug/dl)/(ug/day) *	10.0 ug Pb/kg diet *	1.3 kg diet/day	12%

EQUATIONS, DIETARY LEAD

TOTAL DIETARY LEAD = 0 .945 * 10 + 0.055 * Pb in produce (ug/kg) = 10.0 ug/kg
LEAD IN PRODUCE = 10 ug/kg or 0.00045 * soil lead d = 10.0 ug/kg