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94-2050

March 24, 1994

Ms. Susan L. Hugo
Senior Hazardous Materials Specialist
Alameda County Health Agency
Division of Hazardous Materials
80 Swan Way, Room 350
Oakland, California 94621

Subject: Work Plan to Conduct a Baseline Health Risk Assessment for Area C at the Yerba Buena Project Site, Oakland and Emeryville, California

Dear Ms. Hugo:

Enclosed for your review and approval is our Work Plan to conduct a limited baseline health risk assessment (HRA) for the Area C at the Yerba Buena Project Site in Oakland and Emeryville, California, on behalf of Catellus Development Corporation and its consultant, Levine•Fricke, Inc. The scope of work included in this Proposal includes the following:

- Evaluation of risks to construction workers involved in construction of the proposed retail development at Area C due to potential exposures to hazardous chemicals in soil and groundwater via inhalation of chemical vapors and direct contact with contaminated soil and/or groundwater.

- Evaluation of risks to retail workers at the proposed development after construction due to potential exposures to chemical vapors from volatile contaminants in soil and groundwater.

Evaluation of potential risks associated with contamination outside of Area C is beyond the scope of this investigation. The Work Plan includes a discussion of the environmental fate and transport modeling methodology we propose to use to evaluate potential environmental pathways, including groundwater transport, volatilization from soil and groundwater, and dispersion in indoor and outdoor air.

Because development of the subject site, which could bring signficant economic benefits to the area, is contingent upon completion of the scope of work outlined above and detailed in the accompanying Work Plan, your prompt attention to this matter would be greatly appreciated. If you have any questions of comments regarding the Work Plan, please feel free to contact Dr. Mansour Sepehr or myself at (510) 832-7662.

Sincerely,

John M. Faustini

John M. Faustini, R.G. #5873
Senior Associate Hydrogeologist

enclosure

cc: Jenifer Beatty, Levine•Fricke, Inc.
Kim Brandt, Catellus Development Corp.

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WORK PLAN TO PERFORM A HEALTH RISK ASSESSMENT FOR THE YERBA BUENA PROJECT SITE, AREA C OAKLAND AND EMERYVILLE, CALIFORNIA

March 23, 1994

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

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March 23, 1994

WORK PLAN TO PERFORM A HEALTH RISK ASSESSMENT FOR THE YERBA BUENA PROJECT SITE, AREA C OAKLAND AND EMERYVILLE, 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 resulting from past activities at the Site. 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 Health Agency Division of Hazardous Materials (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 has 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) has prepared this Work Plan to conduct a baseline health risk assessment (HRA) for Area C.

1.2 Objectives and Scope

The primary objective of the HRA is 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 include 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 to be evaluated include inhalation of chemical vapors and direct contact with contaminated soil and/or groundwater.

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

The HRA will evaluate the potential human health risks associated with existing subsurface contamination beneath Area C (Figure 2) 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) is beyond the scope of this investigation.

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 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), 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) 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 3). Significant results of the environmental investigations conducted by Levine•Fricke are briefly summarized in the following section.

3.0 REVIEW OF EXISTING SITE CHARACTERIZATION DATA

This section presents a brief review of existing site characterization data based on a preliminary review of data provided to SOMA by Levine•Fricke. This data includes Levine•Fricke's March 9, 1994 report titled "Summary of Environmental Investigation Results for Area C of the Yerba Buena Project Site, Emeryville and Oakland, California," as well as additional data tables and figures provided to us by Levine•Fricke.

3.1 Site 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 these borings, 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 about 3 to 7 feet of clayey sand to silty sand and gravel are present between depths of 10 and 20 feet beneath most of Area C, with the exception of 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 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, near the center of 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. 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. The shallow groundwater flow direction appears to be influenced by a 54-inch diameter sewer line installed by the East Bay Municipal Utilities District (EBMUD), particularly near the southeastern corner of Area C. The sewer line, completed in 1992, runs beneath the right-of-way for Yerba Buena Avenue across the eastern half of the Site and continues across the Site along the southeastern edge of Area C. The trench for the 54-inch pipe was reportedly 16 feet deep and 6 feet wide. The bottom of the trench was backfilled with a sand-cement slurry to just below the top of the pipe. East of Hollis Street (which marks the northeastern boundary of Area C), within the jurisdiction of the City of Emeryville, the remainder of the trench (i.e., above a depth of approximately 12 feet) was backfilled with sand as required by the city. West of Hollis Street, within the jurisdiction of the City of Oakland, the portion of the excavation above the pipe was backfilled with native material (Ms. Jenifer Beatty, Levine•Fricke, Inc., personal communication). The portion of the sewer right-of-way backfilled with gravel appears to act as a preferential conduit for groundwater flow, as indicated by a trough in the potentiometric surface in this area in maps prepared by Levine•Fricke (for example, see Levine•Fricke, 1994, Figure 2). The portion of the sewer line right-of-way backfilled with native material (i.e., along the southeastern edge of Area C) appears to have less influence on the groundwater flow direction, although potentiometric data in this area are too sparse to be certain.

3.2 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.

3.2.1 VOCs in Soil

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 together were reported in only 8 of 44 samples analyzed for VOCs at maximum concentrations of 0.24 and 0.039 mg/kg respectively, were detected only in samples collected from depths ranging from 8 to 13 feet bgs, which is within the saturated zone. Because these chemicals were not detected in vadose zone samples, 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, has been reported in a majority of soil samples collected in Area C which have been analyzed for VOCs, including samples collected within the vadose zone. However, reported toluene concentrations in Area C soil samples may be wholly or partially due to the use electrical tape, which typically contains toluene, to secure plastic end caps to the brass tubes in which soil samples were collected. 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.

3.2.2 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 established in the Site Remedial Plan (SRP) (Levine•Fricke, 1991).

Metals concentrations reported for soil samples collected in Area C were generally within typical ranges of published values for uncontaminated soils (Levine•Fricke, 1994, Table 3A). 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, Figure 3). 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.

3.3 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. Elevated concentrations of TPH as oil (7.8 mg/l) were detected in a 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.

3.3.1 VOCs in Groundwater

The following VOCs have been detected in groundwater samples from Area C:

- 1,1-dichloroethene (DCE)
- 1,2-dichloroethene (1,2-DCE)
- trichloroethene (TCE)
- tetrachloroethene (PCE)
- 1,1,2-trichloroethane (1,1,2-TCA)
- vinyl chloride

However, 1,1-DCE, PCE, 1,1,2-TCA, and vinyl chloride have each only been reported in one or two samples collected from well LF-10 in two sampling events in 1990. These chemicals were not reported in samples collected during two subsequent sampling events in 1993. TCE and 1,2-DCE have consistently been detected in samples collected from monitoring wells LF-10, LF-11, and LF-12. The highest concentrations of TCE and 1,2-DCE were reported for well LF-10, at 7.6 and 3.2 mg/l respectively, in February 1990. TCE and 1,2-DCE concentrations detected at well LF-10 have consistently declined over time, to 1.5 and 0.322 mg/l respectively by July 1993.

TCE and 1,2-DCE have also been detected in samples collected from wells LF-12 and LF-31, as well as in a grab groundwater sample collected from boring C-15. The current distribution of TCE and 1,2-DCE in shallow groundwater in Area C is presented in Figure 3.

4.0 TECHNICAL APPROACH

4.1 Overview

The following scope of work for the Yerba Buena Project Site Area C human health risk assessment (HRA) is based on the following assumptions:

1) Based on our current knowledge, chemicals of concern in groundwater moving onto the property are:

   - 1,2-DCE
   - TCE

   Other volatile organic compounds (VOCs) have been detected in groundwater monitoring wells in Area C, including 1,1-DCE, PCE, 1,1,2-TCA and vinyl chloride. However, these compounds were each detected in only one or two samples collected in 1990 and have not been confirmed in two subsequent sampling events conducted in 1993.

2) Based on our current knowledge, toluene is the only potential chemical of concern in soil. However, reported toluene concentrations in Area C soil samples may be wholly or partially due to the use electrical tape, which typically contains toluene, to secure plastic end caps to the brass tubes in which soil samples were collected. Elevated concentrations of other chemicals (including lead, zinc, and total petroleum hydrocarbons as gasoline, diesel and oil) have also been reported in soil samples collected from Area C, but these issues have been addressed in a Site Remedial Plan (Levine•Fricke, 1991) approved by the County.

3) Exposure scenarios to be evaluated include:

   - On-site workers during construction/excavation activities;
   - On-site employees working in retail facilities.

4) The only complete exposure pathway to be evaluated for retail employees, both currently and in the future, is inhalation of volatile emissions from underlying soil and groundwater. For construction workers, pathways to be evaluated include inhalation of volatile emissions from groundwater and dermal contact with & incidental ingestion of contaminated groundwater and soil.

Environmental fate & transport modeling will be conducted to predict the future distribution of contaminants in groundwater based on projections of current environmental conditions and to estimate potential exposure point concentrations. Specifically, chemical fate and transport modeling will be conducted to estimate the following:

- present and future chemical concentrations in groundwater as a function of location and time,

- present and future chemical vapor emission rates from soil and groundwater in Area C, and

- maximum average chemical concentrations in outdoor and indoor air under present and future conditions likely to result from vapor emissions from contaminated soil and groundwater in Area C.

Calculations of estimated chemical vapor concentrations in indoor air in planned retail buildings will consider the effects of concrete slab foundations in reducing vapor emissions vs. bare soil.

The modeling results will be used, in conjunction with existing site soil and groundwater chemical data, to perform the health risk assessment for construction workers (during construction of the proposed development) and for retail workers (after completion of the project).

4.1.1 Data Requirements

In order to perform a realistic and technically defensible risk assessment, adequate site-specific data must be available to characterize the site in terms of physical setting and land use; historical chemical use and handling practices; hydrogeology; and the nature, extent and magnitude of contamination. Specifically, the data requirements for the proposed HRA include the following:

Data Available from Previous Site Investigations or Other Existing Sources

- site plan
- boring logs
- groundwater elevation data
- groundwater and soil chemical concentration data
- proposed site development plans

Data to be Obtained from Additional Site Investigation

The following additional data needed to conduct chemical fate and transport modeling for the HRA are currently being gathered by Levine•Fricke:

- moisture content, bulk density, and porosity of vadose zone soils
- total organic carbon (TOC) content of vadose zone soils
- hydraulic conductivity of shallow groundwater aquifer
- porosity and TOC content of saturated aquifer materials
- results from additional groundwater sampling in Area C

4.1.2 HRA Tasks

SOMA's proposed technical approach to the HRA investigation consists of the following tasks:

1. Compile and Evaluate Site Characterization Data and Identify Chemicals of Concern (COCs)

2. Perform Chemical Fate and Transport Modeling

3. Perform Exposure Assessment

4. Perform Toxicity Assessment

5. Perform Risk Evaluation

6. Prepare HRA Report

The following sections describe in detail how each of the above tasks will be accomplished.

4.2 Compile and Evaluate Site Characterization Data and Identify Chemicals of Concern (COCs)

This task involves a comprehensive review of all available site characterization data, as identified in Section 4.1.1. Analytical results for groundwater will be evaluated for usability in groundwater modeling and subsequent risk evaluations according to the guidance provided in USEPA Guidance for Data Usability in Risk Assessment (1992). Specifically, data evaluation will be comprised of the following steps:

1) Evaluate analytical methods used;

2) Evaluate the quality of the data with respect to sample quantitation limits;

3) Evaluate the quality of the data with respect to qualifiers and codes;

4) Evaluate the data with respect to analytical laboratory blanks; and

5) Compare the site-related contamination with regional background concentrations.

4.3 Perform Chemical Fate and Transport Modeling

Chemical fate & transport modeling will be performed to estimate exposure point concentrations of COCs. Modeling results will provide the following information:

- estimated current and future chemical concentrations in groundwater as a function of location and time,

- estimated chemical vapor emission rates from soil and groundwater, and
- estimated maximum average chemical concentrations in outdoor and indoor air likely to result from vapor emissions from contaminated soil and groundwater.

These data will be used, in conjunction with existing site soil and groundwater chemical data, to perform the health risk assessment.

The following sections describe the analytical and numerical models which will be used to estimate current and future exposure point concentrations in the different media (air, water and soil) in on-site areas.

4.3.1 Groundwater Flow and Contaminant Transport Modeling

SOMA will use the Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) of the U.S. Geological Survey (USGS, 1988) to evaluate groundwater flow conditions beneath the Site. MODFLOW is a versatile, widely used numerical model with broad regulatory acceptance which can simulate transient (time-varying) or steady-state groundwater flow in two- or quasi-three-dimensional systems.

We anticipate that the model domain will include the entirety of Area C and possibly adjacent portions of the Site. Due to inadequate potentiometric (groundwater elevation) data, we do not expect to include the adjacent off-site area north of Area C in the model domain. Potentiometric data from existing monitoring wells will be used to calibrate MODFLOW. The primary purpose of groundwater flow modeling will be to simulate groundwater flow conditions for use in contaminant transport modeling.

SOMA will use the MT3D groundwater chemical transport model (Papadopulos and Associates, 1992) to simulate groundwater quality conditions based on the groundwater flow velocity field calculated by MODFLOW. MT3D is a numerical finite-difference groundwater chemical transport code intended to be used in conjunction with a finite-difference groundwater flow model such as MODFLOW. MT3D retrieves the MODFLOW output, automatically incorporating the same hydrologic boundary conditions utilized in the groundwater flow model, and simulates chemical transport based on the groundwater flow field calculated by MODFLOW.

The simulated groundwater quality data will be compared against the historical groundwater quality data. The model will be calibrated by adjusting transport parameters such as dispersivity values (in both longitudinal and transverse directions) and effective aquifer porosity, and by varying the approximate chemical release times to achieve a good fit between simulated and observed groundwater quality data.

It is our understanding that groundwater contamination of concern at Area C is believed to emanate from an off-site source located to the northeast, and that only shallow groundwater is known or believed to be affected. Therefore, the groundwater flow system will be modeled as a single-layer (i.e., two-dimensional) system. Because it appears that insufficient data are available to incorporate the suspected upgradient chemical source area within the model directly, chemical transport will be simulated by specifying chemical concentrations in influent groundwater along a portion of the northern model boundary. Simulated influent chemical concentrations will be based on reported groundwater quality data for monitoring wells located near the Site boundary (i.e., LF-9/LF-31, LF-10, and LF-11/LF-11R).

SOMA will use the calibrated model to evaluate current groundwater quality in areas where no data are available (i.e., to interpolate and between and extrapolate from existing sampling locations), and to assess probable future groundwater quality under current conditions (i.e., without remediation).

4.3.2 Estimation of Chemical Vapor Emission Rates from Groundwater

SOMA will model the emission of chemicals from groundwater to the atmosphere using a semi-analytical approach. Henry's Law, an empirical relationship describing the partitioning of volatile chemicals between the aqueous and vapor phases, will be used to estimate concentrations of chemicals of concern in air-filled soil pores just above the saturated zone, and a modified application of Fick's Law described by Farmer et al. (1980) will be used to model steady-state diffusion of chemicals through the vadose zone to the atmosphere.

Because chemical concentrations of potential COCs in groundwater are only known at a limited number of sampling locations, the current as well as future spatial distribution of COCs in groundwater will be estimated using groundwater flow and transport modeling as described in Section 4.3.1. Then, after model calibration, SOMA will use the groundwater modeling results to calculate estimated vapor emissions from groundwater independently for each finite-difference grid cell within the groundwater modeling domain, both currently and in the future. Estimated chemical emission rates will then be summed over specific areas of interest, such as the locations of proposed retail buildings.

4.3.3 Estimation of Chemical Vapor Emission Rates from Soil

A preliminary review of soil chemical data for Area C suggests that toluene is present at low concentrations in vadose zone soils, while other VOCs are present, if at all, only within the saturated zone. Volatilization of toluene from contaminated vadose zone soils will be simulated using a transient analytical model developed by Jury et al. (1990). This model is recognized as an appropriate vadose zone transport model by the County. Emissions will be estimated based on the 95% Upper Confidence Limit (UCL) of the mean toluene concentration in soils as calculated from existing soil chemical data.

4.3.4 Estimation of Exposure Point Concentrations in Outdoor and Indoor Air

To estimate chemical concentrations in outdoor and indoor air associated with volatilization of chemicals from contaminated soil and groundwater based on the chemical emission rates calculated as described above, SOMA will use two different models. For outdoor air in on-site areas overlying contaminated soil and/or groundwater, we will use the "Box Model" described by Pasquill (1975), a steady-state analytical mass-balance model. To estimate chemical concentrations in on-site indoor air, we will use the methodology of the Orange County Public Health Care Agency's Simplified Vapor Pathway Evaluation (SVPE) (Daugherty, 1991). The SVPE methodology incorporates a building attenuation factor to account for a reduction in vapor emissions beneath the building vs. emissions from bare soil due to foundation materials (e.g., concrete slab construction). Both of the Box Model and the SVPE model are recognized by the County as appropriate models for use in risk assessments.

For calculating indoor air concentrations, SOMA will estimate emission rates at actual proposed building locations in the manner described in Section 4.3.2. In this way, the estimated exposure point concentrations should realistically reflect the potential future conditions under the proposed development scenario.

4.4 Perform Exposure Assessment

The principal elements of exposure assessment are as follows:

- identification of reasonable exposure scenarios
- identification of potential exposure pathways
- evaluation of the impacts of fate and transport processes
- estimation of concentrations at the points of exposure
- expected level of chemical intake

4.4.1 Exposure Scenarios

The overall risk estimate for this site will represent a reasonable maximum exposure (RME), as specified in the USEPA Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual Part A (1989). The RME is defined as "the highest exposure that is reasonably expected to occur at a site." Intake variables for a particular pathway will be chosen so that the combination of variables represents a reasonable maximum set of exposure parameters. Examples include:

1) The upper 95 percent confidence limit (95% UCL) of the mean contaminant concentration;

2) 90 to 95th percentile values for intake/contact rates;

3) Site or region-specific exposure frequencies and duration; and

4) Mean body weights.

4.4.2 Potential Exposure Pathways

In the near future, it is anticipated that Area C will be redeveloped into a shopping center containing a variety of retail stores. The potential exposure pathways to be evaluated at this site are as follows:

On-site workers during construction activities (current use)
- Inhalation of volatile emissions
- Dermal contact with contaminated soil and/or groundwater
- Incidental ingestion of contaminated soil and/or groundwater

On-site workers in retail stores (current/future)
- Inhalation of volatile emissions

In the case of retail workers, it is anticipated that potential chemical exposures due to inhalation of volatile emissions from soil and groundwater will be significantly reduced by concrete slabs beneath proposed buildings and asphalt paving over the majority of the remainder of Area C under current development plans.

Visitors to the site (e.g., shoppers) will not be explicitly considered as potential receptors, since the duration and frequency of potential exposure for site visitors would be much less than for on-site workers.

4.4.3 Evaluation of the Impacts of Fate and Transport Processes and Estimation of Exposure Point Concentrations

The impacts of fate and transport processes upon the movement and future distribution of COCs in the subsurface environment will be evaluated using chemical fate and transport modeling techniques as described in Section 4.3. As described in that section, modeling will also be used to estimate the concentrations of chemical contaminants at the point of receptor exposure (i.e., predicted ambient air concentrations due to emissions from groundwater and/or soil). For the inhalation pathway of exposure, these estimated concentrations, in conjunction with the appropriate exposure parameters, will determine the intake or dose of each chemical of concern.

4.4.4 Estimation of Chemical Intake (Dose)

The chemical contaminant intake will be estimated according to the following general equation, as specified in the USEPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual Part A (1989);

$$Intake(mg/kg\text{-}day) = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Where

CA	=	Predicted ambient air concentration (mg/m^3)
IR	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging time
	=	ED * 365 days/year for noncarcinogens
	=	30 years * 365 days/year for carcinogens

4.5 Perform Toxicity Assessment

A toxicity assessment is an evaluation of available evidence regarding the potential for a particular chemical to cause adverse health effects in exposed individuals. Toxicity assessment has two components; hazard identification and dose-response evaluation.

Hazard Identification is the process of establishing what adverse health effects can result from exposure to chemicals and whether the adverse health effect identified is likely to occur in humans.

Dose-response evaluation is the process of characterization the relationship between the dose of an agent and the anticipated incidence of an adverse health effect in an exposed population. This allows one to establish toxicity criteria (e.g., reference doses and slope factors).

For each established chemical of concern, a toxicity profile will be presented with the following components:

- Toxicokinetics
- Qualitative description of health effects
- Quantitative description of health effects, and
- Summary of health criteria.

4.6 Perform Risk Evaluation

This section of the risk assessment provides a quantitative and qualitative summary of the potential health risks posed to the populations of concern by the chemical contaminants at the site for each of the previously identified exposure pathways.

4.6.1 Noncarcinogenic Health Effects

In order to estimate the potential effects from exposure to multiple chemicals, the hazard index (HI) approach will be used. The HI is identified as:

$$HI = \frac{Predicted\ Dose_a}{RfD_a} + \frac{Predicted\ Dose_b}{RfD_b} + \ldots + \frac{Predicted\ Dose_i}{RfD_i}$$

A total HI less than or equal to unity is indicative of acceptable levels of exposure for chemicals exhibiting additive effects. Additivity is only assumed for chemicals that affect the same target organ system or that result in the same health endpoint.

4.6.2 Carcinogenic Health Effects

Quantitative estimates of upper bound cancer risk due to site-related contamination will be evaluated for each chemical according to the following equation:

$$R_i = q_i \bullet E_i$$

Where

R_i = Estimated incremental risk of cancer associated with the ith chemical

q_i = Cancer slope factor for the ith chemical $(mg/kg\text{-}day)^{-1}$

E_i = Exposure dose for the ith chemical (mg/kg/day)

Cumulative risk will then be estimated by summing the upper-limit risk for all chemical carcinogens and for all exposure pathways.

4.7 Prepare HRA Report

Upon completion of the project, SOMA will prepare a written health risk assessment report. The HRA report will describe the methodology and assumptions used in performing the risk evaluation and will include tabulations of the estimated carcinogenic or noncarcinogenic risk factor, as appropriate, associated with each COC for each exposure pathway evaluated. The report will also describe the environmental fate and transport models used, including the data requirements, assumptions and limitations of each, and will present the results of the groundwater, vadose zone, and air quality modeling upon which the risk evaluation is based.

The HRA report will also include an uncertainty analysis, which will discuss the uncertainties associated with site sampling and analysis, assessment of potential exposures, evaluation of chemical toxicity, and estimation of risks. The purpose of the uncertainty analysis is to provide a framework for interpreting the quantitative risk estimates.

Following review by Levine•Fricke and Catellus, the HRA report will be finalized for submittal to the County.

5.0 PROJECT PERSONNEL

5.1 Project Management

Mansour Sepehr, Ph.D., P.E.

Mansour Sepehr, Ph.D, P.E., will be Project Manager. As Project Manager, Dr. Sepehr will be responsible for managing all administrative and technical aspects of the project. Dr. Sepehr will serve as the primary contact person for Levine•Fricke and Catellus and, in conjunction with Jenifer Beatty or other designated Levine•Fricke personnel, will serve as the principal liaison with County and other regulatory agency personnel. In addition, he will be responsible for peer reviewing all chemical transport modeling performed for the risk assessment.

Dr. Sepehr is President and Principal Hydrogeologist at SOMA, and has over ten years experience in quantitative assessment of environmental contaminant transport, including groundwater flow and contaminant transport, vadose zone transport (leaching and volatilization), air dispersion of vapors and particulates, and surface water transport and mixing. He has worked on numerous public health and environmental risk assessments involving a wide variety of organic and inorganic chemicals. Prior to founding SOMA Environmental Engineering in 1991, Dr. Sepehr managed the quantitative modeling group at Levine•Fricke for over four years.

Dr. Sepehr has extensive experience working with state and local regulatory agencies, including the California Department of Health Services (DHS), the California Department of Toxic Substances Control (DTSC), the California Regional Water Quality Control Board (RWQCB), and the Alameda County Health Agency (County). He has presented technical workshops on contaminant fate and transport modeling and exposure/risk estimation to DHS personnel and has worked with the County to identify appropriate contaminant fate and transport models for use in site-specific quantitative exposure assessment and risk evaluation.

5.2 Project Technical Staff

William S. Bosan, Ph.D.

William S. Bosan, Ph.D., will be primarily responsible for performing the risk assessment and writing those sections of the HRA report pertaining to the risk evaluation. Dr. Bosan is Principal Toxicologist at SOMA and has eight years of experience in the field of environmental toxicology and risk assessment. In addition, Dr. Bosan brings with him the specialty of chemical carcinogenesis developed from laboratory experience in academia and a national research laboratory.

Dr. Bosan has performed numerous human health and environmental risk assessments, including several under RCRA. Among his many risk assessment projects, Dr. Bosan performed a human health and environmental risk assessment, under RCRA, for an active chemical manufacturing plant in southern California contaminated with VOCs and heavy metals, which was used to establish risk-based cleanup levels in soil and groundwater and to evaluate appropriate remedial alternatives.

Dr. Bosan has substantial experience in dealing with state and local regulatory agencies, including the U.S. EPA, DHS, RWQCB and DTSC. He is on the Integrated Site Mitigation Process Advisory Panel to the California Department of Health Services and is an Assistant Adjunct Professor of Environmental Toxicology in the Department of Community and Environmental Medicine at the University of California, Irvine.

John M. Faustini, R.G.

Mr. John Faustini, R.G., Senior Associate Hydrogeologist at SOMA, will be primarily responsible for compiling and evaluating site characterization data, supervising chemical fate and transport modeling, and overall preparation of the HRA report.

Mr. Faustini has over six years of experience in planning, conducting, and managing hydrogeologic and environmental investigations, including site characterization and remedial investigations, groundwater chemical plume definition, feasibility studies, remedial action plan development, and groundwater flow and contaminant transport modeling. He has extensive experience in analyzing and interpreting geologic, hydrologic, and soil and groundwater chemical data and has written numerous technical reports for clients and for submittal to state and local regulatory agencies.

Daiquong Yang

Mr. Daiquong Yang, Staff Hydrogeologist at SOMA, will assist with data compilation, computer modeling, and report preparation. Mr. Yang received Masters Degree in Civil and Environmental Engineering from Utah State University in 1993, where he developed a FORTRAN code to numerically solve groundwater flow and solute transport equations. Mr. Yang has worked on several contaminant fate and transport modeling and risk assessment projects since joining SOMA in October 1993.

6.0 PROJECT SCHEDULE

We anticipate that we can complete the scope of work described herein and submit the HRA report to the County within four weeks after approval of the Work Plan.

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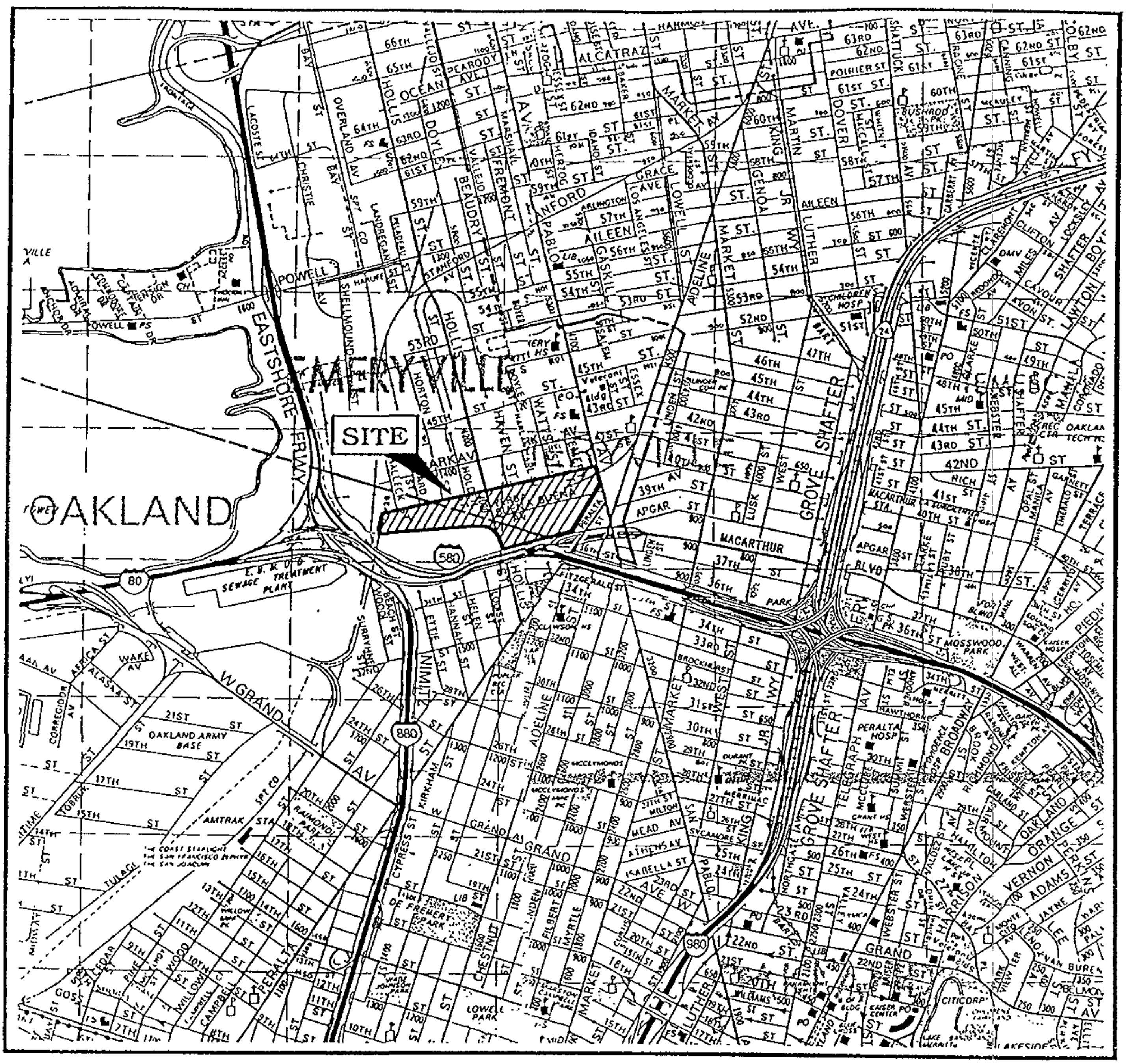

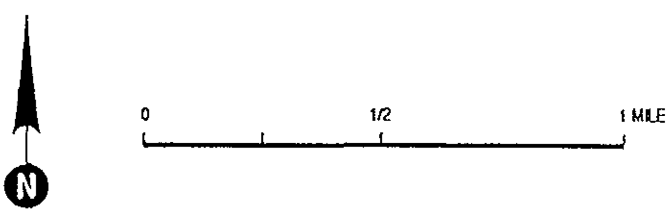

MAP SOURCE:
Alameda & Contra Costa Counties,
Thomas Bros. map, 1990 Edition

Figure 1 : SITE LOCATION MAP
YERBA BUENA PROJECT SITE

SOMA
ENVIRONMENTAL ENGINEERING

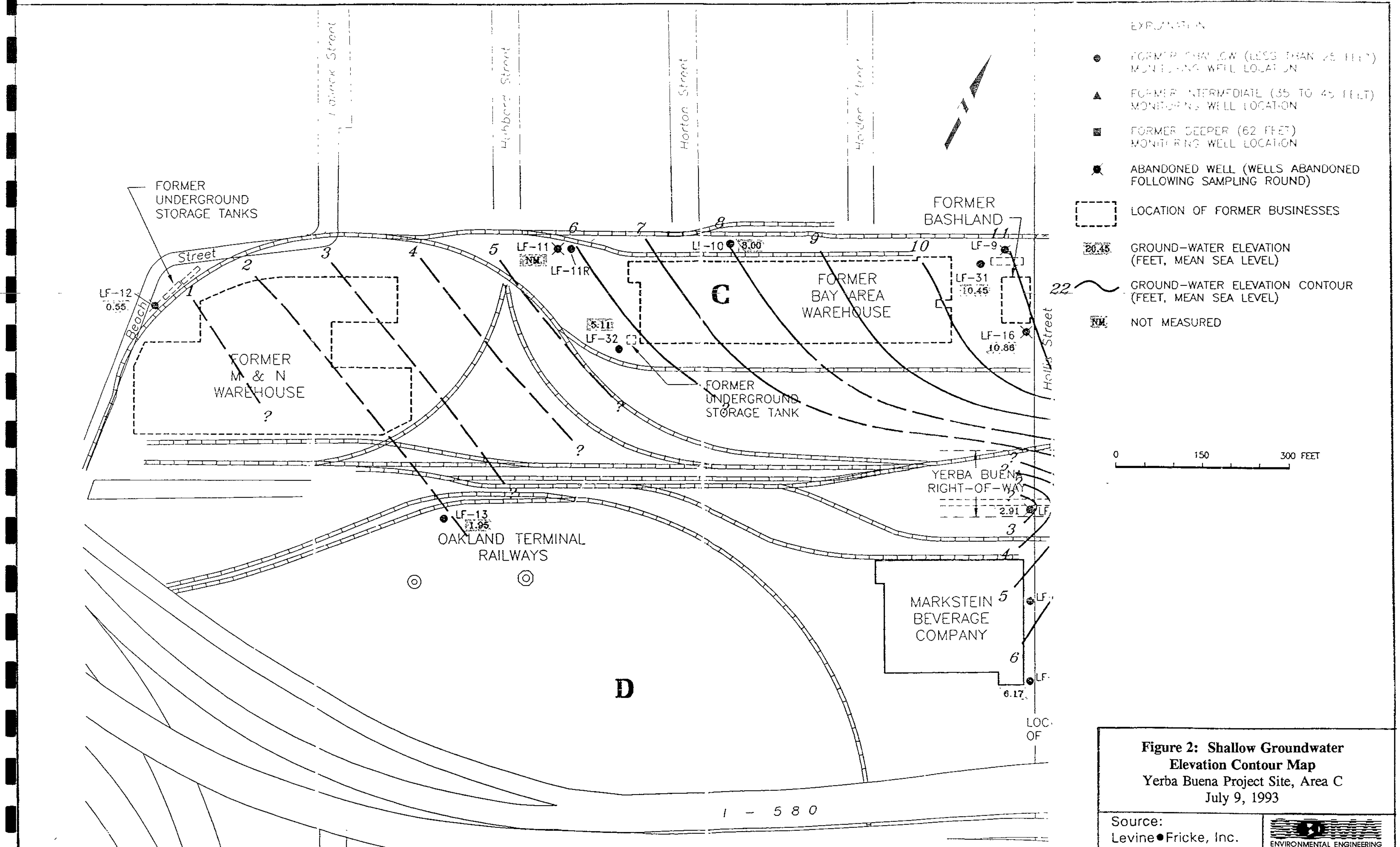

Figure 2: Shallow Groundwater Elevation Contour Map
Yerba Buena Project Site, Area C
July 9, 1993

Source:
Levine • Fricke, Inc.

ENVIRONMENTAL ENGINEERING

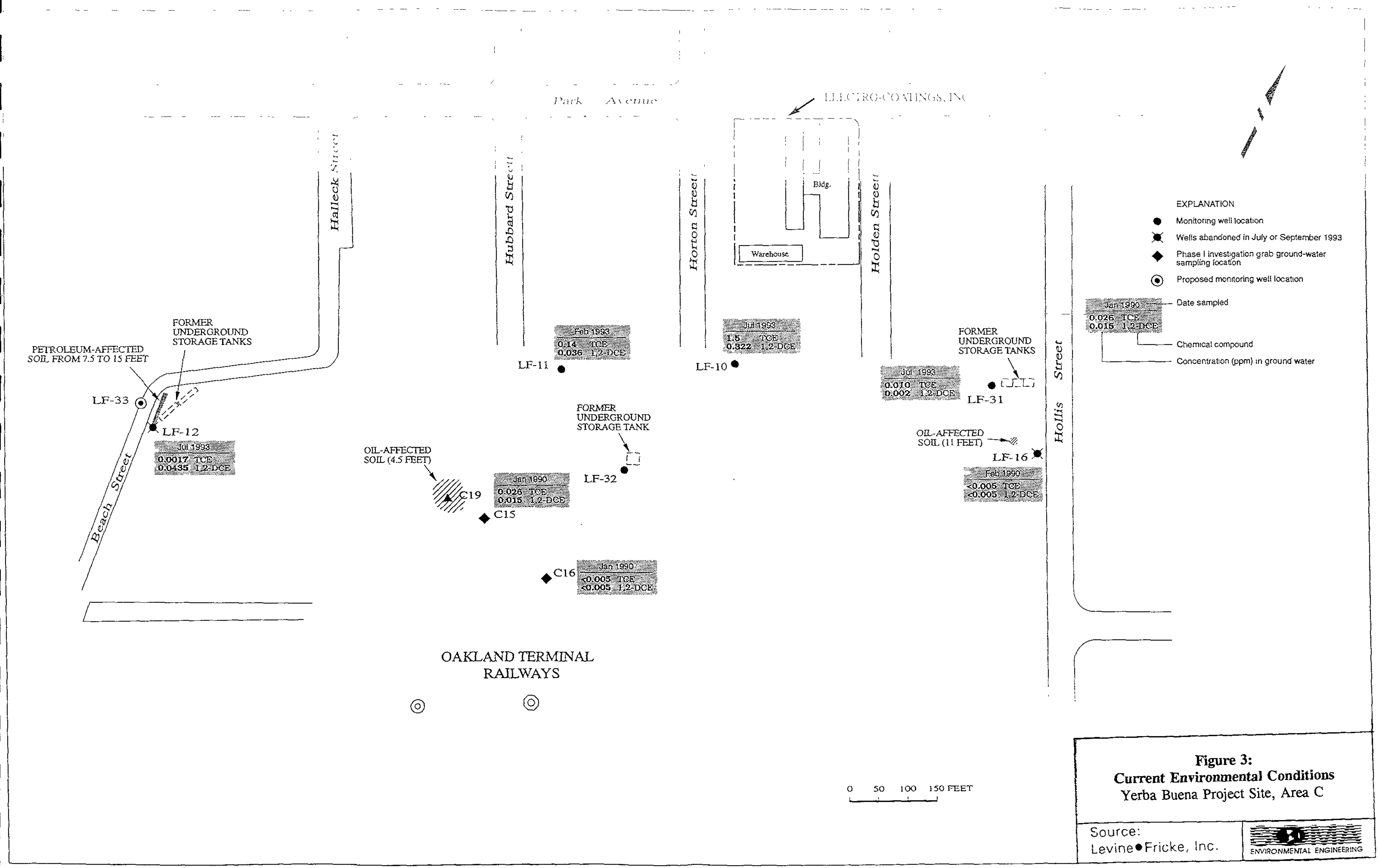

Figure 3:
Current Environmental Conditions
Yerba Buena Project Site, Area C

Source:
Levine●Fricke, Inc.