TERRA VAC

FINAL REMEDIATION STATUS REPORT AND REQUEST FOR NO FURTHER ACTION
FORMER CHEVRON STATION 9-4816
301 14TH STREET
OAKLAND, CALIFORNIA

PROJECT 30-0220

STID 478

TERRA VAC 1651 Alvarado Street, San Leandro, CA 94577-2636
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December 4, 1996

Ms. Jennifer Eberle
Alameda County Health Care Services
Department of Environmental Health
1131 Harbor Way Parkway, Suite 250
Alameda, CA 94502-6577

Subject: Former Chevron Service Stations #9-4587, 9-4816
609 Oak Street & 301 14th Street
Oakland, CA

Dear Ms. Eberle:

ENVIRONMENTAL PROTECTION
96 DEC 10 PM 3:23

Enclosed are Final Remediation Status Reports and Requests for No Further Action that Terra Vac has prepared for Chevron for the above referenced sites. Each report reviews background information, remediation activities and effectiveness, and evaluates site conditions in terms of human health risk with the conclusion that no further active remediation is warranted.

If you have any questions or comments, please call me at (510) 351-8900.

Sincerely,
Terra Vac Corporation

Robert A. Dahl
Senior Chemist

Mark Frye for
Project Manager

cc: Phil Briggs, Chevron
30-0219.20
30-0220.20

TERRA VAC

FINAL REMEDIATION STATUS REPORT AND REQUEST FOR NO FURTHER ACTION FORMER CHEVRON STATION 9-4816 301 14TH STREET OAKLAND, CALIFORNIA

Prepared For:

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November 14, 1996

FINAL REMEDIATION STATUS REPORT AND REQUEST FOR NO FURTHER ACTIVE REMEDIATION FORMER CHEVRON STATION 9-4816 301 14th Street OAKLAND, CALIFORNIA

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1.0 INTRODUCTION

At the request of Chevron Products Company (Chevron), Terra Vac Corporation (Terra Vac) is engaged in active remediation of the subject site. Alameda County Health Care Services, Department of Environmental Health (ACHCS) required that this work be performed in order to mitigate the impact of fuel hydrocarbons released during operation of a retail service station. The purpose of this report is to present the results of remediation work completed to date, and to request that no further active remediation be required at the site.

This report presents background information on environmental work completed at the site. A review of pre-remediation assessment data is made in order to define site specific environmental problems encountered. Next, implementation of active remediation and an evaluation of its effectiveness is discussed. Finally, current site conditions are evaluated on the basis of associated environmental and human health risks. The conclusion of this report is that no further active remediation is warranted. Additionally, a plan for managing future work at the site is presented.

2.0 BACKGROUND

The following background section provides a summary of work completed at the site. The summary is based on a review of documents provided to Terra Vac by Chevron which include copies of reports prepared by other consultants and previously submitted to ACHCS. The intent is to develop a timeline of site activities and to list sources of data pertinent to this report. In general, data used in this report are condensed from these sources and are not re-tabulated or appended.

The site is located at 301 14th Street, on the southwest corner of 14th and Harrison Streets in Oakland, California (Figure 1, Vicinity Map). This area of Oakland is located on the San Francisco Bay fringe approximately 1/4-mile east of San Francisco Bay. Lake Merritt is located approximately 1/4-mile east of the site. The site is underlain by unconsolidated, Pleistocene age silty and clayey sand of the Lake Merritt Formation. The Lake Merritt Formation is approximately 40 feet thick at this location. The Lake Merritt Formation overlies the Alameda Formation. The upper portion of the Alameda Formation is comprised of a sandy silty clay (*Radbruch, Areal and Engineering Geology of the Oakland West Quadrangle, California, 1957*).

A retail service station and car wash were operated at the site until August 1989. During a tank integrity test conducted in April 1988, the 10,000 gallon Unleaded Supreme underground storage tank was reported to have failed the test. And in August of that year a subsurface product line leading to the service islands failed at a joint. The leak was subsequently repaired. In August 1989, the service station was demolished (Figure 2, Site Plan). The site is currently a fenced vacant lot.

In June 1990, GeoStrategies Inc. (GSI) of Hayward, California, drilled eight exploratory soil borings, of which four were completed as groundwater monitoring wells, C-1 through C-4, (Figure 2) in order to assess potential sources of hydrocarbon impact at the site (*GeoStrategies Inc., Soil Boring and Well Installation Report, August 9, 1990*). Boring and well locations are illustrated on Figure 2, Site Plan. Sample results indicated that petroleum hydrocarbons were present in the area of the former USTs and easterly service island. Depth to water was reported as approximately 22 feet below grade (feet below grade) with groundwater flow to the southwest.

In October 1990, GSI drilled and installed one additional groundwater monitoring well, C-5, and a groundwater recovery well, CR-1 (Figure 2). The work further delineated the vertical and horizontal extent of hydrocarbon impact west of the former USTs and installed a remediation well at the site (*GeoStrategies Inc., Well Installation Report, December 5, 1990*). Depth to groundwater was reported to be approximately 22 feet below grade.

During February 1991, R.W. Johnston and Co. Of Oakland removed three USTs (2-10,000 gallon and 1-5,000 gallon) and the associated piping. Excavated soil (approximately 800 cubic yards) was stockpiled onsite and aerated to less than 10 parts per million (ppm) of total petroleum hydrocarbons calculated as gasoline (TPH-g). The stockpiled soil was used to backfill the excavations created during the UST removal project.

GSI returned to the site in April 1991 and drilled four additional soil borings which were completed as groundwater monitoring wells, C-6 through C-9 (Figure 2). This investigation further delineated hydrocarbon distributions in soil and groundwater in the apparent up-gradient direction from the site. Depth to groundwater was reported to be approximately 22 feet below grade with groundwater flow to the southwest. (*GeoStrategies Inc., Well Installation Report, June 13, 1991*).

In December 1991, Weiss Associates (Weiss) of Emeryville, California, submitted an application for an air permit to the Bay Area Air Quality Management District (BAAQMD). The permit was for Authority to Construct a soil vapor remediation system at the site (*Weiss Associates, December 6, 1991).*

In February 1992, Weiss developed a remediation work plan for the site. The work plan proposed the installation of a soil vapor extraction system which would utilize an internal combustion engine (ICE) operating on CR-1 and C-5 *(Weiss Associates, Remediation Work plan, February 10, 1992*). The work plan was approved by ACHCS and Weiss completed installation of utilities necessary for the operation of the system. Between March 12 and 16, 1992, Weiss conducted a Source Test for Authority to Construct No. 8272 *(letter to BAAQMD, April 17, 1992).* The VE system apparently was in operation until April 1994.

On June 11, 1992, Groundwater Technology, Inc. Drilled and constructed one offsite groundwater monitoring well, MW-10, and two vapor extraction wells, VEW-1 and VEW-2 (Figure 2) *(Groundwater Technology, Inc., Environmental Assessment Report, August 3, 1992).*

Chevron contracted Weiss to conduct an aquifer test at the site. The work was completed in late January, 1994 *(Weiss Associates, Hydraulic Test Results, February 24, 1994)*. Following the aquifer test, Weiss, acting as Chevrons agent, issued a request for bid for the construction of a groundwater extraction system at the site *(Weiss Associates, Request For Bid, Groundwater Extraction System, May 18, 1994)*. Groundwater extraction began in August of 1994. Available data indicates that the groundwater extraction system was in operation until April 1995.

Sierra Environmental Services (SES) was contracted by Chevron to drill two additional wells at the site, MW-11 and MW12 (Figure 2). Well MW-11 was drilled offsite, in the apparent down gradient direction at the time of drilling to further define the extent of hydrocarbon impact to groundwater. Well MW-12 was drilled on site and completed as an additional vapor extraction well *(Sierra Environmental Services, Subsurface Investigation Report, June 23, 1994)*.

In March 1995 Terra Vac submitted an addendum to the Weiss work plan. The work plan addendum revised remediation methodology and established clean-up goals for vadose zone soils and guidelines for achieving "no further active remediation" status for the site (*Terra Vac Corporation, Addendum Remediation Work Plan, March 28, 1995*). Terra Vac proposed the installation of a dual vapor extraction (DVE) system augmented by air sparging to enhance VOC partitioning and bio-activity. Subsequent to negotiations with ACHCS, the addendum to the work plan was approved and system modifications made. Operation of the system began on October 3, 1995. The system was operated until March 1996, during which time a significant mass of hydrocarbons was removed from the subsurface of the site (*Terra Vac Corporation, Remediation Status Report, March, 1996*).

Drilling and installation of wells to support remediation efforts were conducted during July 1995 (wells (SP-1, SP-2, VEW-4 and VEW-5) and September 1995 (SP-3 and SP-4). As proposed in the addendum work plan for the site, Terra Vac drilled four interim soil borings. These borings were completed as air sparge wells (SP-5 through SP-8) and subsequently incorporated into the sparging system (Figure 2).

3.0 EVALUATION OF PRE-REMEDIATION ASSESSMENT DATA

The following section develops an overall picture of site conditions prior to the start of Terra Vac's remediation work. For this report all previous remediation activities conducted at the site will be disregarded.

This section of the report defines the nature of the problem confronted at the site, develops a framework for understanding how the remedial action was implemented, and provides a basis for evaluating remedial effectiveness.

3.1 Lithology

Observed site lithology is characterized by laterally discontinuous units of sand, silty sands and clayey sands to approximately 35 feet below grade. However, an area of suspected gravel backfill was encountered in an area bounded by wells VEW-1, SP-1, VEW-5 and SP-3 and extends to a depth of approximately 18.5 feet below grade. The upper permeable zone is underlain by an apparent aquitard consisting of silt, clayey silt and clay units. This aquitard appears to be laterally continuous across the site. Borings drilled at the site have been advanced to depths varying from 25 to 45 feet below grade. Observed lithology beneath the study area appears to be consistent with previous surveys of regional lithology.

3.2 Hydrogeology

Groundwater is currently at a depth of approximately 20.5 feet below grade. Groundwater elevations beneath the site do not appear to vary significantly seasonally. However, groundwater elevations were shown to have rebounded due to the end of a multi-year draught. Groundwater elevations measured during the first quarter of 1993 are typically 3 to 3.5 feet higher than elevations measured in the fourth quarter of 1992. The potentiometric surface has not been observed to have returned to pre fourth quarter 1992 elevations. For the purpose of this report, soils encountered above 19 feet below grade are considered to be unsaturated vadose zone soils, soils encountered below 20.5 feet below grade are considered to be located within the water bearing zone. A capillary fringe of nominal thickness 1.5 feet is assumed to be present at the interface of the vadose and saturated zones.

The results of a seven hour aquifer test performed at CR-1 produced the following data *(Weiss Associates, Hydraulic Test Results, February 24, 1994)*; 1) The optimum pumping rate at CR-1 that sustains steady state flow was less than 2.5 gpm but greater than 2 gpm; 2) The radius of influence from CR-1 appeared to be greater than 70 feet to the east of CR-1, 50 feet to the southwest and 58 feet to the northwest; 3) Calculated transmissivity values ranged from 730 gallons per day per foot (gpd/ft) using the Theis recovery method to 1,100 gpd/ft using the Cooper/Jacob method; 4) Calculated conductivity (k) values ranged from 60 gpd/ft^2 (Theis recovery) to 92 gpd/ft^2 (Cooper/Jacob); 5) The calculated storativity was 0.06, which is indicative of an unconfined or slightly confined aquifer. This is consistent with the observed response of the potentiometric surface during drilling activities; 6) The maximum drawdown recorded was in well C-5, 58 feet from the pumping well, CR-1.

3.3 Distribution of Hydrocarbons

Prior to system startup in October 1995, twenty on-site exploratory soil borings, resulting in fifteen on-site groundwater monitoring and remediation wells, had been drilled at the site in order to define the vertical and horizontal distribution of fuel hydrocarbons in soil and groundwater. Soil samples were collected from each of the borings and analyzed by State-certified laboratories. A review of these data indicates that petroleum hydrocarbons calculated as gasoline were released into the subsurface during the operation of the service station. Evaluation of soil boring sample data has been made relative to clean-up goals established for vadose zone soil in the work plan addendum developed by Terra Vac. For the purpose of this report, samples with concentrations of total petroleum hydrocarbons as gasoline (TPHg) exceeding 100 part per million (ppm), and/or 1 ppm benzene are considered to be impacted. Samples having concentrations below these levels are not considered to be significantly impacted. These values are taken from the work plan developed for the site and represent the clean-up goals established for vadose zone soil.

date? author? 3-28-95 by Terra Vac

meaning DVE to 100+1 ppm then use AS. These are not cleanup goals per se, (only via DVE)

by County ok? Yes - letter 5-31-95

3.3.1 Point of Release

The approximate times and points of releases have been determined. Hydrocarbon releases have been associated with leaking distribution piping. Overfilling of the USTs, or the run-off of fuel spilled during dispensing may have resulted in additional fuel hydrocarbon impact beneath the site.

3.3.2 Horizontal Distribution in Unsaturated Soil

Borings were advanced to depths ranging from 25 to 46 feet below grade. Twenty soil borings were drilled on site prior to the start of remediation. Sixteen soil samples were collected and submitted for analysis from the unsaturated zone. The most shallow soil sample was collected at a depth of approximately 5 feet below grade and the deepest were from a depth of 15.5 feet. The results of laboratory analysis indicate that none of the soil samples were found to exceed the clean up goals stated in the work plan addendum (Figure 3, TPHg/Benzene in Vadose Zone Soil). As a result, it is assumed that vadose soils are not currently impacted by petroleum hydrocarbons.

3.3.3 Vertical Distribution in Saturated Soil

For an idealized site having a homogeneous lithology and a stable water table, free phase hydrocarbons released into shallow soils will migrate vertically through the vadose zone until they reach the saturated zone. The hydrocarbons will collect at the capillary fringe and migration becomes controlled by diffusion into the saturated zone. Due to the porous nature of the aquifer media, the highest concentrations of hydrocarbons would be in the capillary fringe and saturated zone. This would lead to high concentrations in dissolved phase hydrocarbons beneath the site. Assuming a depth to ground water of 20.5 feet below grade, it is possible that samples that were analyzed from 19 and 20.5 feet below grade are representative of impact to the capillary fringe. In fact samples having concentrations of fuel hydrocarbons exceeding the clean up goals for the site were present only in the capillary fringe interval (Figure 4, TPHg/Benzene in Saturated Soil). Samples collected from the saturated zone and submitted for analysis may not be representative of actual adsorbed hydrocarbons in the soil. As a result soil samples collected and analyzed from the saturated zone are not evaluated in this report. However the presence of hydrocarbons in saturated soil is evidenced in groundwater quality data. Dissolved phase concentrations could be considered a function of the concentration of hydrocarbons sorbed to saturated soils.

Historical fluctuation in the potentiometric surface and a rise in the water table due to the end of drought conditions could cause a smear zone as much as 3.5 feet thick. This smear zone would also account for continued concentrations of dissolved phase hydrocarbons.

3.4 Groundwater Flow Direction and Hydrocarbon Distribution in Groundwater

Seven groundwater monitoring wells were present on-site and six groundwater monitoring wells were off-site prior to the start of remediation in October 1995. Groundwater flow direction has fluctuated over time. Initial groundwater flow was shown to be in the southwesterly direction in 1990. Available illustrations indicate that the flow direction changed in 1992, since then (except during the groundwater extraction phase of remediation) groundwater flow has been to the north, and northeast.

During groundwater monitoring, free phase hydrocarbons were observed to be present in wells C-1, C-2, C-3, C-5, CR-1 and VEW-3. Approximately 11 gallons of free phase has been removed from the wells. The last reported free phase was December 27, 1995, in wells C-3, CR-1 and VEW-3.

Groundwater quality data for the third quarter of 1995, just prior to system startup in October 1995, showed detectable concentrations of TPHg ranging from a low of 12,000 parts per billion (ppb) in offsite well C-8 to a high of 280,000 ppb in on-site well C-3. Detectable concentrations of benzene ranged from less than 10 ppb (well C-8) to 27,000 ppb in well C-3. Wells C-4, C-6, C-7, MW-10 and MW-11 have not contained detectable levels of either TPHg or benzene since November 29, 1994. Well C-9 was not sampled during the third or fourth quarter of 1995, however, petroleum hydrocarbons have not been detected since May 6, 1992 . The groundwater plume has been defined in all but the easterly direction of the site (toward C-8). However, given the historical groundwater flow to the north, northeast, it is assumed that the plume has been defined down gradient of the site (Figure 5, TPHg/Benzene in Groundwater, 9/28/95). Hydrocarbons detected in well C-8 may or may not have originated at the Chevron site, given the known groundwater flow data.

4.0 ACTIVE REMEDIATION

This section describes active remediation work completed at the site. The goal of active remediation was to remove the bulk of hydrocarbon mass from beneath the site in a timely and economic manner. A period of passive bioremediation, effected by naturally occurring processes, will be required to completely restore soil and groundwater quality.

4.1 Remediation Work Plan

A remediation work plan was developed to outline steps that would be taken to implement active remediation of an estimated 20,000 lbs. of petroleum hydrocarbons in the subsurface at the site. The work plan proposed the use of dual vacuum extraction (DVE) and air sparging as the active remediation technology. At the end of DVE operation, air sparging will be used as a passive remediation technology. DVE is a technology proven to be effective in removing adsorbed and vapor phase hydrocarbons from vadose zone soils and the saturated smear zone. Air sparging is effective in partitioning hydrocarbons and enhancing bioremediation in the vadose and saturated zone.

Clean-up goals for vadose zone soils were established. The effectiveness of active remediation was to be evaluated using DVE operational data and documented by samples collected from confirmatory soil borings. The work plan predicated that concentrations of hydrocarbons in groundwater would be reduced through naturally occurring processes following the completion of active remediation. The work plan established that "No Further Active Remediation" status, based on Category II Non-Attainment Zone criteria, could be awarded following the submittal of a Management Plan for Residual Hydrocarbons (MPRH). The MPRH was to include a plan for on-going monitoring of the dissolved phase plume and an evaluation of human health risks associated with long term passive bioremediation of the plume.

The work plan was submitted to ACHCS for review in March 28, 1995. ACHCS approved the work plan in a letter dated May 31, 1995.

4.1.1 Goals for Vadose Zone Soil

The work plan established goals for vadose zone soil clean-up, utilizing DVE. A reduction in vadose zone soil concentrations was to be effect through the operation of the DVE. A reduction in concentration is required to insure that residual hydrocarbons will not leach out of the vadose and act as a continuing source of groundwater impact. The primary goals for soil boring samples were set at 100 ppm TPHg and 1 ppm benzene. A secondary method of validating the effectiveness of the DVE system was based on the system operational data. The rate at which hydrocarbons are removed from the subsurface tends to decrease over time and may ultimately level off at some point higher than zero pounds per day. When this occurs, the economic viability of operating the system is greatly reduced. Goals for DVE operations were set at an extraction rate below 50 pounds per day and the development of asymptotic extraction rates over time.

4.1.2 Goals for Groundwater

The work plan did not establish specific clean-up levels for groundwater as part of the active remediation goals. ACHCS maintained that groundwater must ultimately be remediated to concentrations below the Maximum Contaminant Levels (MCLs), specifically benzene concentrations must be below one part per billion (ppb). The benefit to groundwater quality achieved during active remediation of source contaminantes in the vadose zone soils will result in regression with no further associated health risks.

4.1.3 Interim and Confirmatory Borings

The work plan called for the installation of interim and confirmatory borings during active remediation of the site. Interim borings are used to enhance the assessment of the site and to evaluate the progress of site clean-up. Interim borings can be completed as extraction wells, expanding the capacity of the treatment system when necessary. Confirmatory borings are installed prior to the completion of active remediation in order to document achievement of clean-up goals. The work plan called for the installation of up to four interim borings after four weeks of active remediation and for two confirmatory borings when remediation appeared to be complete.

4.1.4 No Further Active Remediation Status

The work plan allowed for transitioning the site to "No Further Active Remediation." Residual hydrocarbons would remain in the subsurface, but passive bioremediation would continue to remove residual hydrocarbons without posing the threat of further groundwater quality degradation or adverse human health effects. Obtaining "No Further Active Remediation" status was to be based on achievement of the active remediation goals and the development of a MPRH. The MPRH was to include an assessment of post-remediation site conditions, projected passive bioremediation rates, a groundwater quality monitoring plan, a contingency plan in case of adverse changes in site conditions, and an evaluation of human health risks and possible institutional controls on exposures.

4.2 Remediation System

A dual vacuum extraction/air sparge system was installed and operated at the site in order to facilitate active and passive remediation. The basic system design was outlined in the work plan developed for the site by Terra Vac. Following acceptance of the work plan, Terra Vac installed and operated the system under contract to Chevron.

4.2.1 System Design

The vacuum portion of the system consisted of: a regenerative oxidizer bed, an extraction blower, a vapor/liquid separator, two-1,000 lb. activated carbon vessels, associated PVC piping and dual vacuum extraction wells. The air sparging system consisted of: an air injection blower, associated PVC piping and air sparge wells.

Wells VEW-1 through VEW-5, C-1 through C-3, C-5 and CR-1 were connected to the DVE system. The VEW wells had an effect on vadose zone soils from 9 to 20 feet below grade and the upper two to three feet of the saturated zone. The C-"X" wells had an effect on the vadose zone from 16 to 20 feet below grade and the upper two to three feet of the saturated zone. These intervals roughly correspond with the vertical extent of impacted soil. The air sparge wells were installed such that the screened interval extended from approximately 30 to 32.5 feet below grade.

4.2.2 System Operations

Operation of the DVE system began on October 3, 1995. The system was operated until March 9, 1996 when a total of 134.7 days of operation had been logged. During this time the system removed a calculated 19,481 pounds of petroleum hydrocarbons from the site subsurface. Current operations data indicates that the air sparge system is still in operation at the site.

Extraction flow rates averaged 334 standard cubic feet per minute. The highest observed mass extraction rate was approximately 661 pounds TPH per day, which occurred during the third day of operation. The lowest mass extraction rate of 0.8 pounds/day (lbs./day) occurred after approximately 45 days of operation. Adjustments were made to the system, at which point the mass extraction rate continued to increase to 353 lbs./day at the 80th run day. The mass extraction rate fell to 8.3 lbs./day at approximately 130 day of operation and remained at that level until system shutdown at 134.7 days (Table 1, Operations Summary).

5.0 EVALUATION OF REMEDIATION EFFECTIVENESS

Previous soil remediation activities by Weiss account for the remediation of approximately 13,000 lbs. of contaminant from the subsurface beneath the site. Approximately 19,500 lbs. of TPH have been removed from the subsurface during approximately 134 days of DVE system operation by Terra Vac. While hydrocarbons remain in soil and groundwater beneath the site, a majority of the petroleum hydrocarbons originally impacting the site have been removed and cost effective operation of the DVE system has been completed.

5.1 Operations Data

During operation of the DVE system, the maximum mass extraction rates were observed at the beginning of operations (Chart 1, Removal Rate). As significant amounts of TPH were removed from the subsurface, extracted soil vapor concentrations decreased while soil vapor extraction flow rates remained relatively constant. This caused an overall drop in mass extraction rates over time. Increases in the mass extraction rate occurred after periods of non-operation and/or system adjustments.

Cumulative hydrocarbon mass removed by the DVE has been plotted relative to days of operation (Chart 2, Cumulative Removal Rate). Chart 2 shows that 10,302 pounds TPH, or approximately 51 percent of the extractable mass present, was removed during the first 36 days of operation of the Terra Vac system. After 134 days of operation, 19,581 pounds TPH had been removed. This represents 98 percent of the 20,000 pound TPH estimated to be present at the start of remediation.

5.2 Results of Interim Soil Boring Installation

Four interim soil borings (SP-5 through SP-8) were drilled on December 20 and 21, 1995. The borings were subsequently completed as air sparging wells. Drilling of the borings occurred after approximately 78 days of system operations when a calculated 12,617 pounds TPH had been removed by the system. The borings were drilled to a depth of approximately 32 feet and samples were collected at five foot intervals. Since vadose zone is not considered to be impacted, soil samples collected ~~form~~ from the unsaturated zone were not analyzed from these borings.

5.3 Groundwater Quality Data

Groundwater quality data collected in June 1996 indicates that operation of the DVE has had a significant impact on dissolved phase hydrocarbon concentrations. Wells C-1 through C-3, C-5, C-8, CR-1 and MW-12 shows recorded reductions in TPHg concentrations ranging from 59.2 percent (C-8) to 99.7 percent (C-1). Reductions in benzene concentrations range from 50 percent (C-8) to 99.8 percent (C-1). Wells C-5 and MW-12 did not have detectable concentrations of either TPHg or benzene at the time of the second quarter 1996 sampling event. Figure 6 illustrates TPHg and benzene concentrations reported by Blaine Tech Services for second quarter 1996 sampling event.

6.0 REQUEST FOR NO FURTHER ACTIVE REMEDIATION

To date, work at the site has been guided by the remediation work plan. The work plan is a progressive document that embodies the concepts that the goal of active remediation is to remove a majority hydrocarbon mass in a cost effective manner; that residual hydrocarbons will be present in soil and groundwater at the end of active remediation, and that groundwater quality will ultimately be restored during a period of passive bioremediation effected by naturally occurring processes.

Since the development of the work plan two major changes have occurred within the regulatory frame work governing the site. First, the Lawrence Livermore Report, "Recommendations to Improve the Cleanup Process for California's Leaking Underground Fuel Tanks" was followed by Walt Pettit's December 8, 1996 letter, "Interim Guidance on Required Cleanup at Low-Risk Fuel Sites". The substance of these documents supports the efficacy of the basic concepts developed in the work plan. Second, the "Regional Board Supplemental Instructions to State Water Boards, January 5, 1996" letter developed a six point checklist for assigning low risk status to groundwater impacted sites. The supplemental instructions direct that "Passive bioremediation be the preferred remediation alternative unless there is a compelling reason to do otherwise." The subject site meets the definition of a low risk site and future remediation should be effected by passive bioremediation. The following is an evaluation of site conditions relative to the six points defining a low risk groundwater site.

6.1 On-Going Sources

All USTs and associated piping were removed from the site in February 1991. Cost effective removal of source hydrocarbons from the vadose zone has been completed. Free product has not been observed in groundwater monitoring wells since December 1995 and dissolved phase concentrations of TPHg are significantly below saturation levels.

6.2 Site Characterization

Significant assessment work has been completed at the site. Pre-remediation assessment data defined the source and extent of impacted soil. DVE operations data indicate that soil impact has been significantly reduced. The groundwater flow direction and extent of plume migration has been reasonably defined by off-site assessment.

6.3 Plume Stability

Groundwater quality data has been collected since the early 1990s. With the exception of C-8, perimeter wells have been reported as non detect for TPHg and benzene since their installation. While short-term variations occur over time, dissolved phase hydrocarbon concentrations remained fairly consistent in well C-8 prior to the start of active remediation.

6.4 Sensitive Receptors

Terra Vac conducted a 1/2 mile radius well survey. Three possible receptors were identified as a result of the survey. A domestic well located approximately 633 feet southeast of the site and two irrigation wells, one approximately 2000 feet northeast of the site. The other approximately 1/2 mile northeast of the site. An additional receptor is located east of the site, Lake Merritt, at a distance of approximately 1/2 mile. Given the historical groundwater flow data, generally north, northeast, only Lake Merritt and the irrigation wells could be considered as potential sensitive receptors.

6.5 Human Health Risks

The purpose of this section is to develop conservative models of exposures and health risks associated with residual hydrocarbon impacts and to show that no significant risk of adverse human health effects would be associated with long term passive bioremediation of the site. Evaluation of potential human health risks is made using Groundwater Services, Inc., ASTM Risk Based Corrective Action Software (GSI/RBCA). This risk assessment is based on current site conditions and uses. If the site use changes significantly in the future, the health risk assessment should be re-evaluated.

The GSI/RBCA evaluation begins with a defined target risk which is deemed to be protective of public health. This risk is the results a receptors exposure to constituents of concern (COC). The exposure is the results of transport of the COC from its source to the receptor. Each of these factors is modeled as being proportional to the concentrations of COCs in the source media. The GSI/RBCA works backwards from the acceptable risk to determine an acceptable concentration is the source media. This is the site specific threshold limit (SSTL) for concentrations of each COC in soil and groundwater. If existing soil or groundwater concentrations are below these limits, no significant health risk is present.

6.5.1 Assumptions and Defaults

A GSI/RBCA Tier Two assessment was performed for the site. Available site specific data was utilized in developing the risk models. Where site specific data was not available, conservative default variables were incorporated. Because benzene has the greatest toxicity of any gasoline constituent, it was the single COC used to drive the risk assessment. The California Environmental Protection Agency's toxicity value for benzene is more conservative than the default value used by GSI/ASTM. To reflect this, a factor of 0.29 was applied to the target risk for modeled exposures to benzene.

Other key assumptions made in developing the model were related to site use and exposure pathways. Since direct exposure to soil or groundwater is not possible given current site use, the air exposure pathway is the only complete exposure pathway for on-site receptors. Soil and air exposure pathways do not exist for off-site receptors. However, a complete groundwater pathway does exist for off-site receptors.

The site is currently zoned and developed for commercial use. On-site exposures and associated health risks are modeled accordingly. The exposure pathway for workers at the site is volatilization from soil and groundwater to outdoor and indoor air. Of the two, indoor air exposure is the critical pathway. Because the site use is commercial in nature, the OSHA Permissible Exposure Limit for benzene was applied. instead of 10-6.

Modeling of off-site groundwater exposure pathways assumed that any receptors are located within 2000 feet of the site. This distance is a conservative modeling of the distance to the irrigation well and Lake Merritt. The model assumes that these waters could be used as drinking water sources to which the MCL for benzene should be applied. A first order attenuation factor was applied to the groundwater model to reflect natural attenuation of hydrocarbons transported in the dissolved phase.

6.5.2 Data Set

Pre-remediation assessment data was used to develop the soil data set used in the risk assessment. These data were presented previously in Section 3.3.2. The groundwater data set is based on average of benzene concentrations in groundwater after remediation. An average benzene concentration of 13 ppb was calculated by the model from June 20, 1996 groundwater sampling data. This value is the representative concentration used by the model to calculate the Site Specific Target Level (SSTL) for each pathway. These data sets represent a conservative model of current site conditions.

how did they get 13 ppb?

6.5.4 Modeling Results

The SSTL from groundwater volatilization to indoor air for benzene was calculated by the model to be greater than solubility (free phase). The SSTL for benzene in groundwater at a sensitive receptor 2000 feet from the site is 580,000 ppb, almost 45,000 times greater than the average benzene concentration of 13 ppb used to evaluate the impact to groundwater. Worksheets produced by GSI/RBCA are presented in Appendix A.

The results of the conservative GSI/RBCA modeling indicate a significant margin between actual site conditions and conditions which would present a concern for adverse human health effects. This margin allows that site condition may vary somewhat over time but only a radical change in site conditions would raise a concern in the future.

6.6 Environmental Health Risks

Environmental impacts associated with the release of fuel hydrocarbons at the site is likely to be limited to subsurface soil and groundwater located within a few hundred feet of the site. Any surface waters, wetlands, or other sensitive environments are located well beyond this area of impact.

7.0 MANAGEMENT PLAN

Cost effective active remediation of the site has been completed. Major sources of petroleum hydrocarbon have been removed. Residual hydrocarbons do not present a significant threat to environmental quality or human health. The following is a plan for work to be completed at the site.

The DVE system was removed from the site with the approval of ACHCS. However the air sparge system is still in operation. Upon approval of this report the remaining system will be removed from the site. Removal of the remaining system components includes the destruction of all remediation wells per Zone 7 requirements.

Until such time as it is deemed no longer beneficial to monitor and sample, groundwater wells C-1 and C-2 will continue on a quarterly schedule. Wells C-4, C-6 through C-9, MW-10 and MW-11 will be sampled and monitored annually. If, during that time, a pattern of decreasing hydrocarbons concentrations is documented, the wells will be destroyed and the site will be closed to further environmental activity. If such a trend is not observed in the monitoring data, the need for additional work will be evaluated at that time.

During passive bioremediation, groundwater quality data will be evaluated to determine that adverse changes in site conditions have not occurred. Re-evaluation of site status would be required if dissolved phase concentrations of benzene increase above established Management Plan Threshold Limits (MPTL).

Initially, averaging benzene concentrations over the last four quarters (6/19/95 to 6/20/96) was thought to be the most efficient way to establish MPTLs for each of the monitored wells. However, the averaged values (Table 2) did not appear to be acceptable. As a result, the benzene concentration from the June 20, 1996 sampling event was increased ten fold. These values appear to be an acceptable indicator for further action, if required, at the site. The MPTL for each of the wells is presented in the attached table (Table 2, Management Plan Threshold Limits and Sampling Schedule).

If any of the threshold limits are exceeded in any given monitoring event, the site will be immediately re-sampled. If the existence of elevated concentrations is confirmed, the cause will be determined and appropriate steps taken to address the change in site conditions.

TABLES

Table 1
Operation Summary
Former Chevron Station 9-4816
301 14th Street
Oakland, CA

TERRA VAC

Date	Run Time (days)	Sample	Flow (scfm)	Extracted Conc. (mg/l)	Rate (lb/day)	Cumulative Extraction (lb)	Cumulative Water (gal)
10/03/95	0.0	start	558		0.0	0	
10/03/95	0.3	1	558	0.68	34.1	11	0
10/04/95	1.4	3	507	3.44	156.6	110	
10/05/95	2.3	5	596	12.36	661.4	481	4,270
10/05/95	2.3	stop	0		661.4	487	
10/06/95	2.3	start	487		661.4	487	4,412
10/06/95	2.4	7	467	13.30	557.6	545	4,412
10/09/95	5.5	9	306	7.56	207.5	1,760	16,360
10/10/95	6.3	11	358	5.73	183.9	1,915	22,264
10/16/95	12.5	nst	420		183.9	3,047	58,340
10/17/95	13.3	23	420	9.41	354.6	3,273	65,070
10/18/95	14.0	stop	0		354.6	3,508	
10/19/95	14.0	start	417		354.6	3,508	70,645
10/20/95	14.9	nst	401		354.6	3,840	75,215
10/31/95	25.9	nst	328		354.6	7,741	128,849
11/08/95	34.1	26	474	4.34	184.8	9,938	133,522
11/10/95	36.0	nst	402		184.8	10,302	141,028
11/15/95	40.8	38	459	0.20	8.2	10,761	161,110
11/20/95	45.8	50	461	0.02	0.8	10,784	177,738
11/27/95	53.0	nst	451		0.8	10,790	200,421
11/28/95	53.8	nst	302		0.8	10,791	203,113
11/29/95	55.0	54	311	2.00	55.9	10,826	211,866
12/06/95	62.0	nst	313		55.9	11,216	258,585
12/12/95	67.9	65	334	4.60	138.1	11,788	310,266
12/18/95	73.9	stop	0		138.1	12,617	
12/27/95	73.9	start	305		57.0	12,617	414,435
01/01/96	79.0	stop	305		57.0	12,907	
01/03/96	79.0	start	345		277.0	12,907	431,335
01/04/96	79.7	67	333	9.30	277.8	13,115	440,645
01/05/96	80.9	68	328	12.00	353.0	13,477	456,035
01/06/96	81.6	stop	0		353.0	13,727	
01/07/96	81.6	start	328		353.0	13,727	
01/08/96	82.7	69	348	9.30	290.9	14,076	480,784
01/12/96	86.9	70	352	7.90	249.9	15,219	523,918
01/18/96	92.8	nst	311		249.9	16,691	578,996
01/19/96	93.6	71	304	5.20	142.1	16,857	
01/22/96	96.9	72	302	4.40	119.4	17,282	619,317
01/26/96	100.7	73	299	3.60	96.8	17,690	655,448

TERRA VAC

Table 1
Operation Summary
Former Chevron Station 9-4816
301 14th Street
Oakland, CA

Date	Run Time (days)	Sample	Flow (scfm)	Extracted Conc. (mg/l)	Rate (lb/day)	Cumulative Extraction (lb)	Cumulative Water (gal)
02/02/96	107.7	74	275	3.45	85.3	18,326	724,129
02/09/96	114.8	75	289	2.30	59.6	18,842	793,548
02/11/96	116.9	stop	289		59.6	18,969	
02/14/96	116.9	start	287		59.6	18,969	818,038
02/15/96	117.9	86	291	1.11	29.0	19,012	828,787
02/16/96	118.9	87	308	1.67	46.2	19,050	842,387
02/23/96	125.8	stop	308		46.2	19,371	
02/25/96	125.8	start	302		46.2	19,371	911,570
02/26/96	126.7	98	324	0.57	16.6	19,398	920,135
03/01/96	130.7	109	317	0.29	8.3	19,447	958,235
03/02/96	131.6	stop	317		8.3	19,455	
03/05/96	131.6	start	291		8.3	19,455	989,335
03/07/96	133.6	stop	291		8.3	19,472	1,009,835
03/08/96	133.6	start	299		8.3	19,472	1,009,835
03/09/96	134.7	stop	299		8.3	19,481	1,019,529

Table 2
Management Plan Threshold Limits and Sampling Schedule
Former Chevron Station 9-4816
301 14th Street
Oakland, California

Well ID	Benzene Concentration Highest Observed (ppb)	Benzene Concentration 6/20/96 (ppb)	Average Benzene Concentrations Over The Last Four Qtrs. (ppb)	Benzene Concentration Threshold Limit (ppb)	Monitor & Sample	Sampling Interval
C-1	12,000	1	500	10	Yes	Quarterly
C-2	4,500	2	3,347	10	Yes	Quarterly
C-3	69,000	<25	9,018	-------	No	----
C-4	400.0	<0.5	<0.5	5	Yes	Annually
C-5	57,000	<0.5	925	-------	No	----
C-6	1	<0.5	<0.5	5	Yes	Annually
C-7	63	<0.5	<0.5	5	Yes	Annually
C-8	70	<5.0	102	10	Yes	Annually
C-9	<0.5	<0.5	<0.5	5	Yes	Annually
CR-1	50,000	570	4,283	-------	No	----
MW-10	2	<0.5	<0.5	5	Yes	Annually
MW-11	1.4	<0.5	<0.5	5	Yes	Annually
MW-12	26,000	<0.5	10,430	-------	No	----

?
5-10?

CHARTS

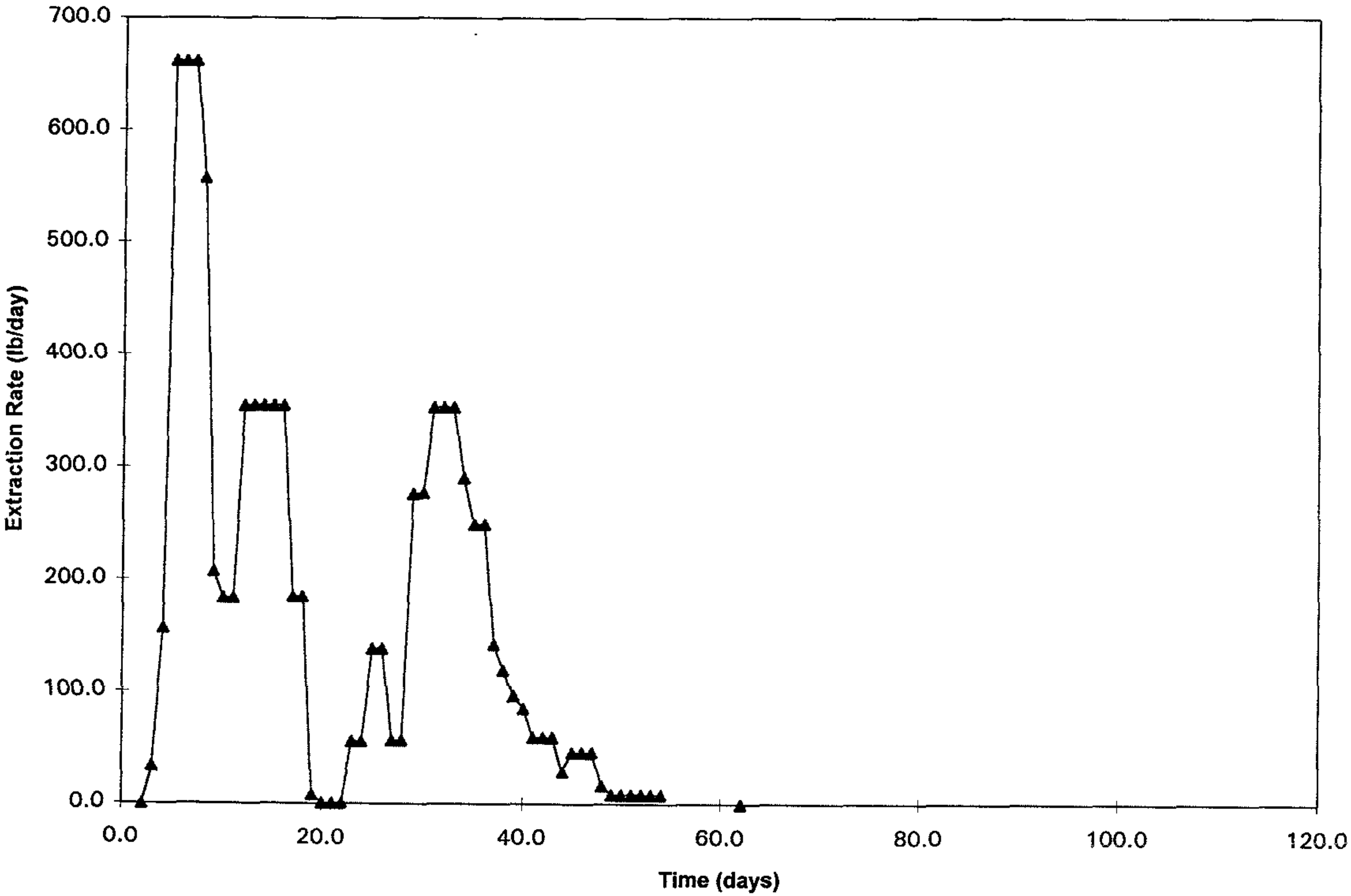
Chart 1

Removal Rate

Former Chevron Station 9-4816

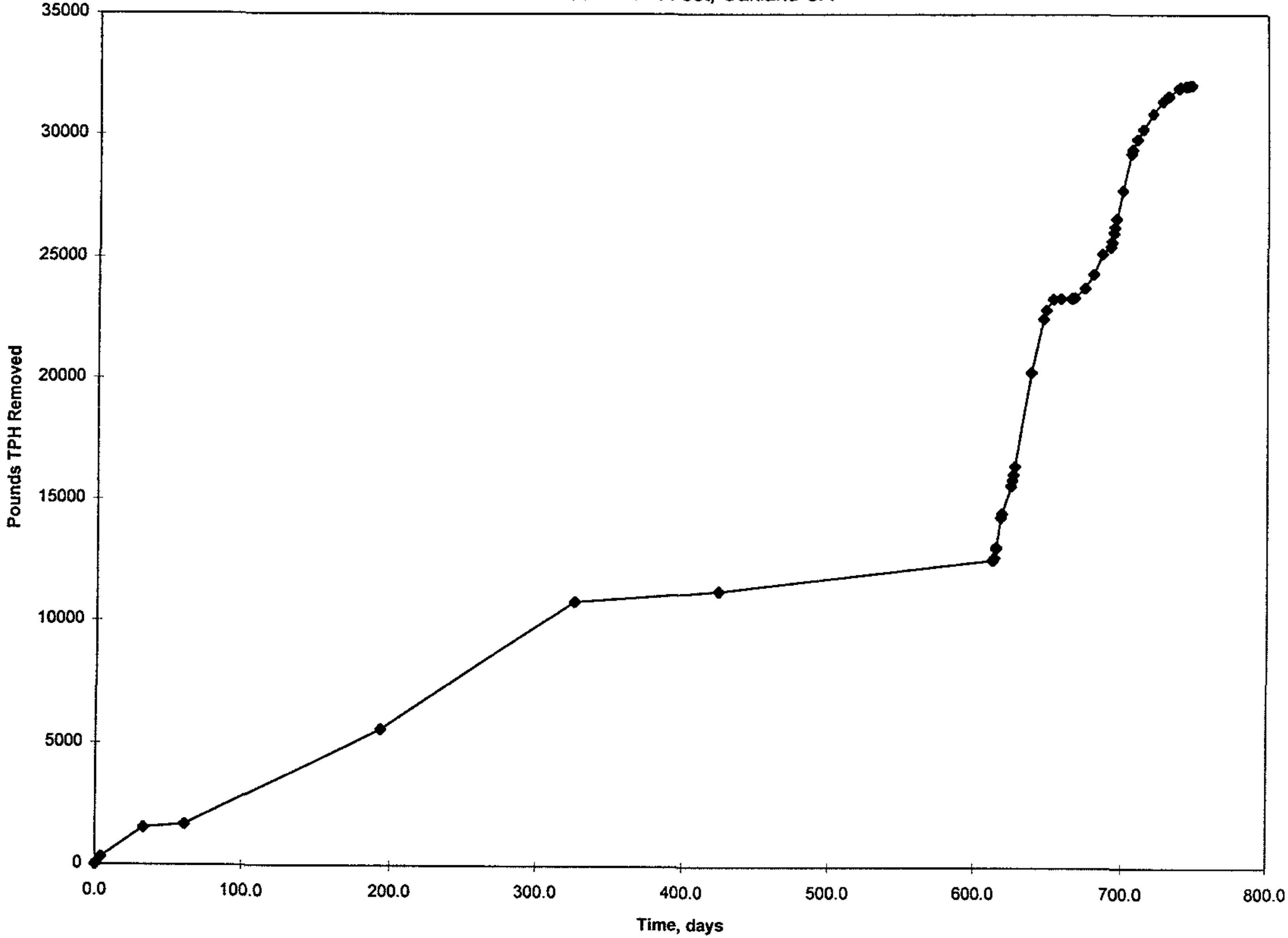
301 14th Street

Oakland, CA



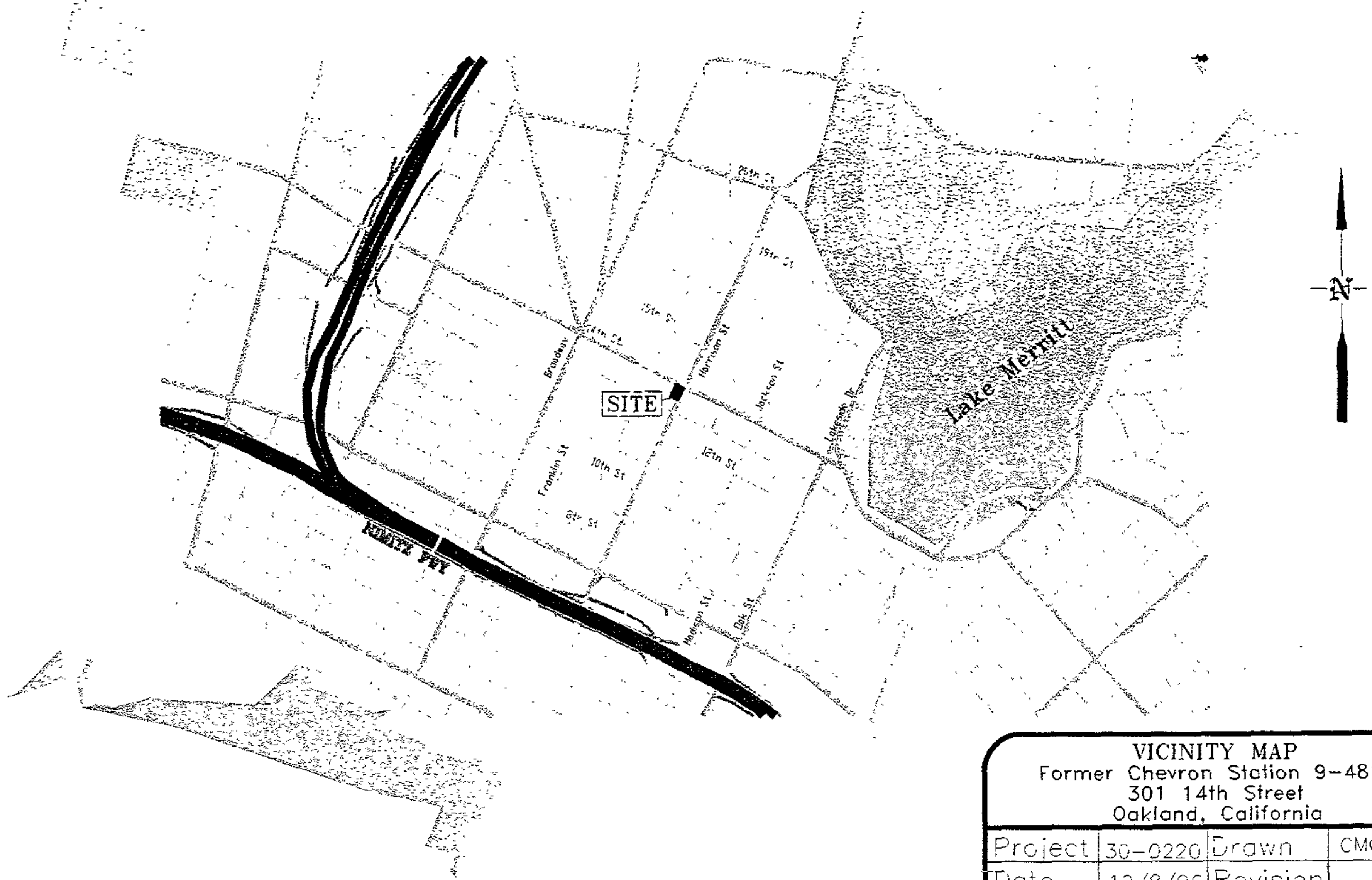
TERRA VAC

Chart 2
Cumulative Removal Rate
Former Chevron Station 9-4816
301 14th Street, Oakland CA



TERRA VAC

FIGURES

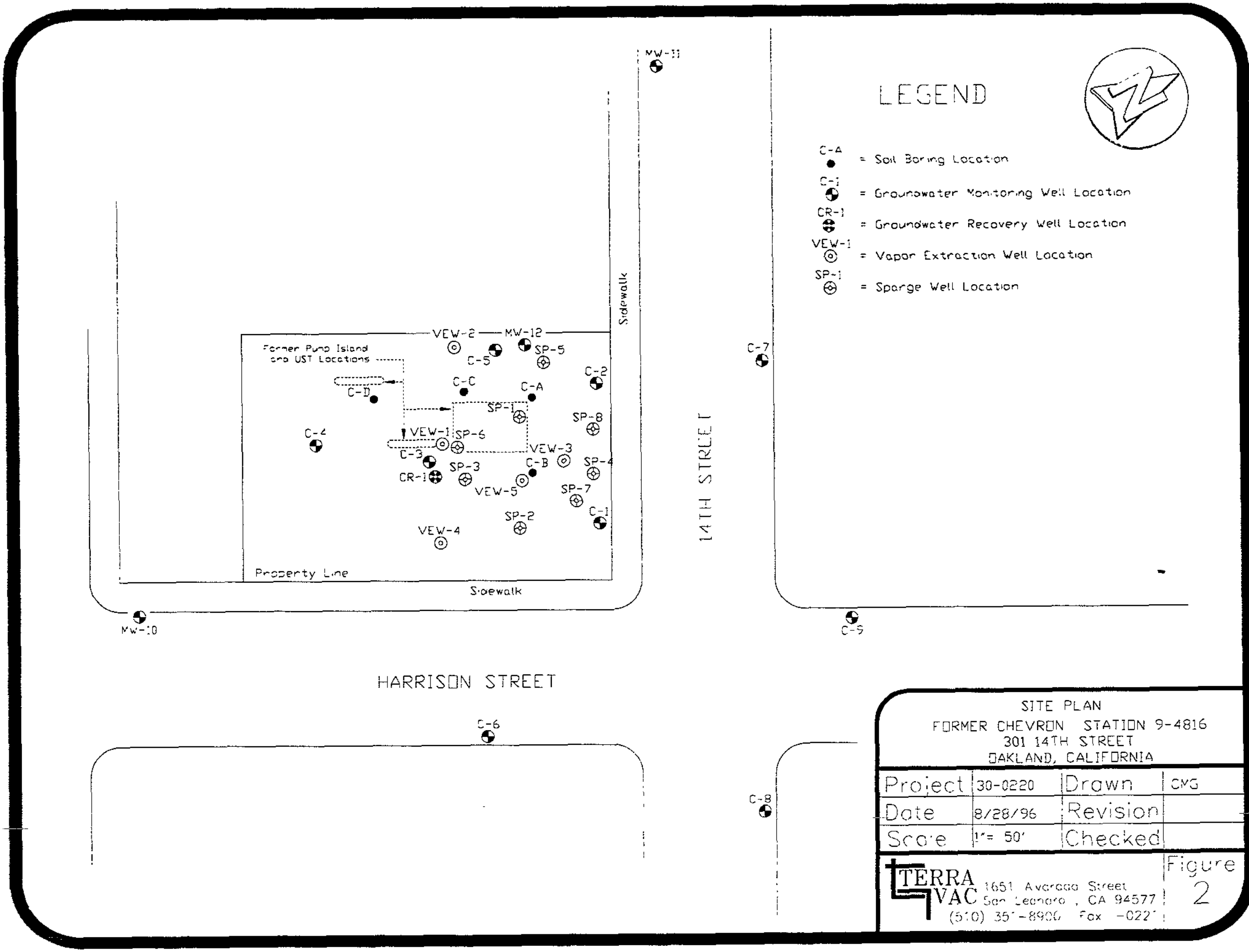


VICINITY MAP
Former Chevron Station 9-4816
301 14th Street
Oakland, California

Project	30-0220	Drawn	CMG
Date	10/8/96	Revision	
Scale	N.T.S.	Checked	

TERRA VAC 1651 Alvarado Street
San Leandro, CA 94577
(510) 351-8900 Fax -0221

Figure 1

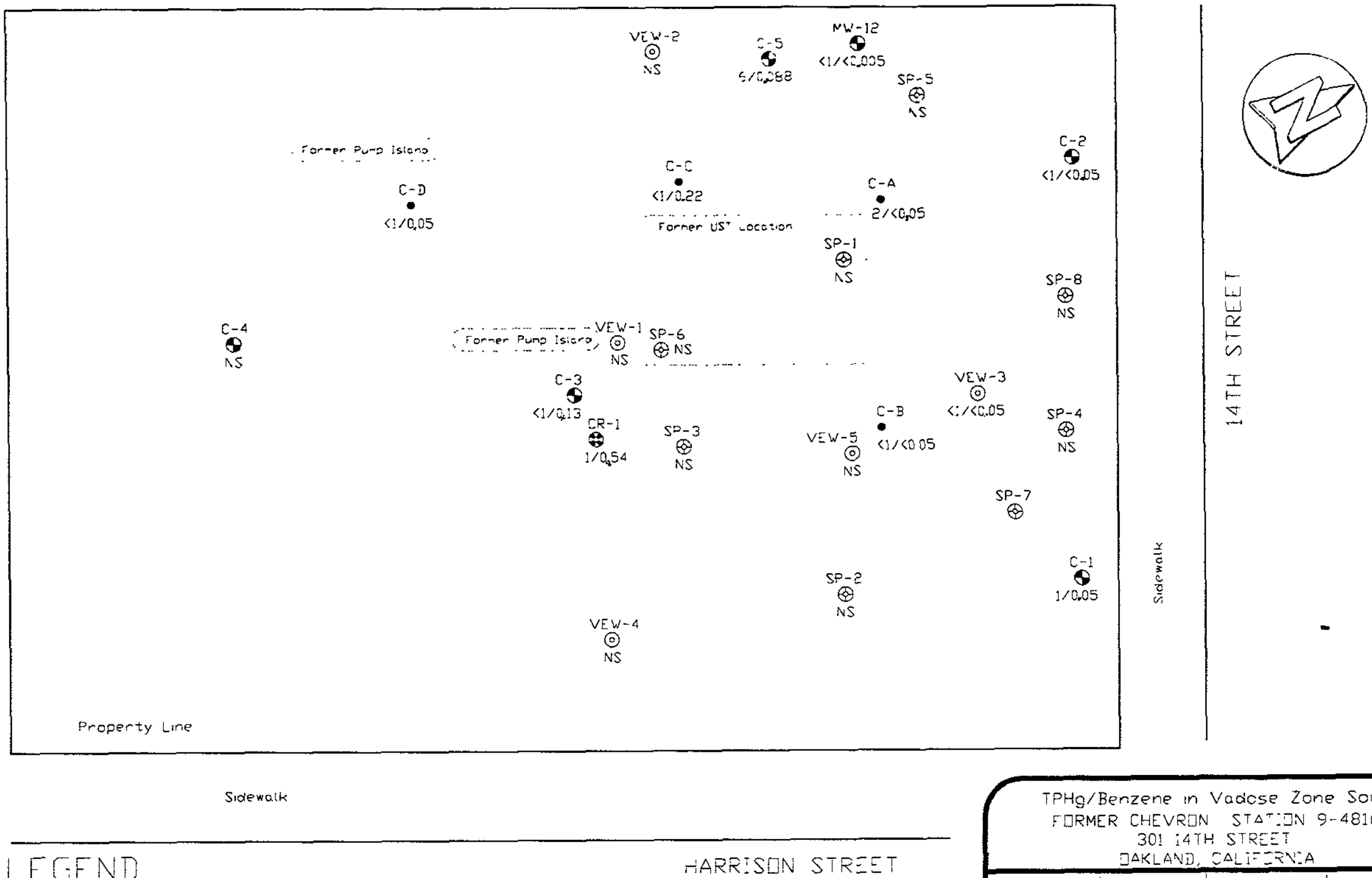


SITE PLAN
FORMER CHEVRON STATION 9-4816
301 14TH STREET
OAKLAND, CALIFORNIA

Project	30-0220	Drawn	CMG
Date	8/28/96	Revision	
Scale	1"= 50'	Checked	

TERRA VAC 1651 Alvarado Street, San Leandro, CA 94577 (510) 351-8900 Fax -0221

Figure 2



LEGEND

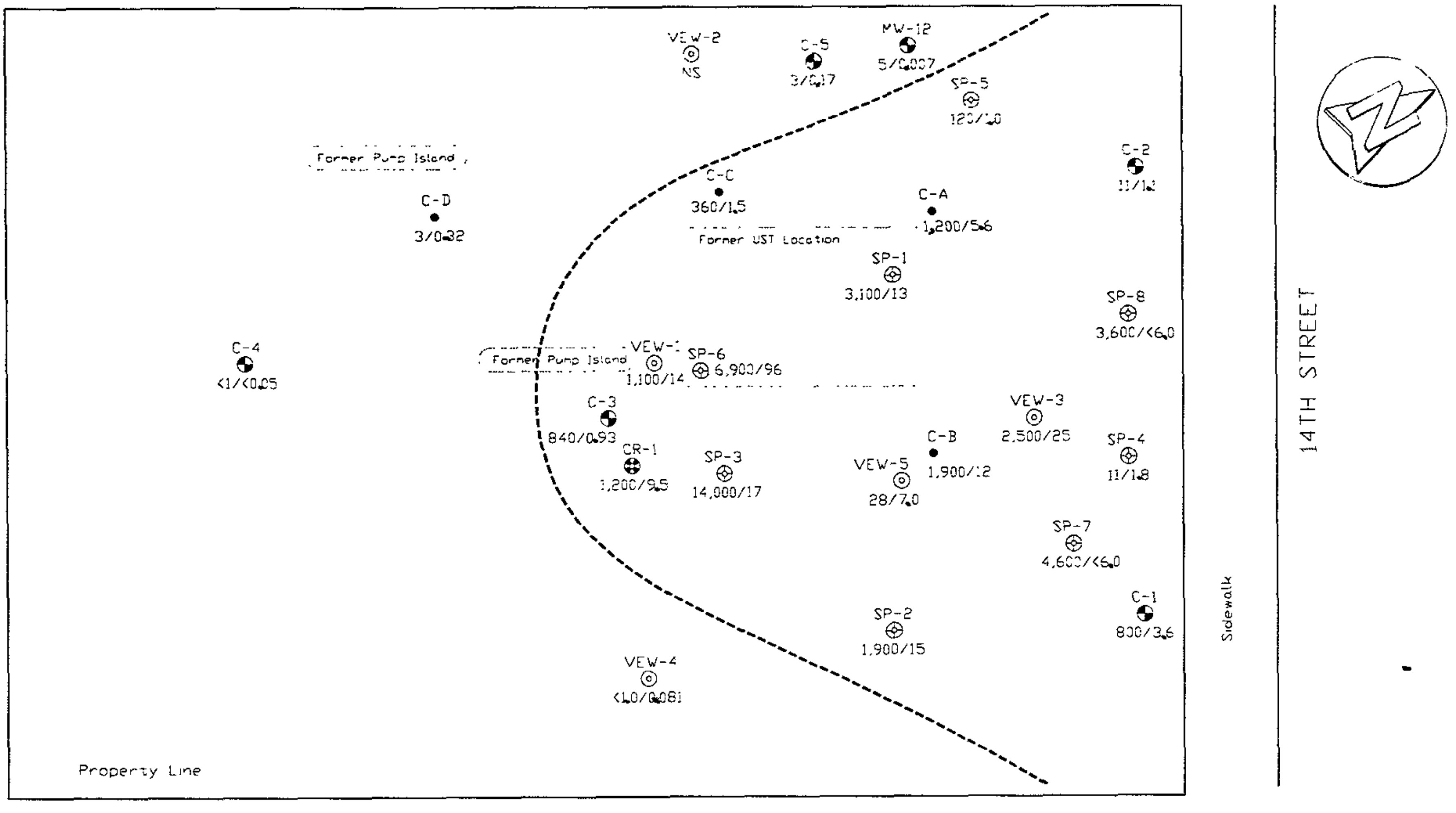
C-A ●	= Soil boring location	1,100/14	= Concentration of TPHg/Benzene in Soil mg/kg Sample depths less than 19 feet
C-1	= Groundwater monitoring well location	NS	= Not Samples
CR-1	= Groundwater recovery well location		
VEW-1	= Vapor extraction well location		
SP-1	= Sparge Well Location		

TPHg/Benzene in Vadose Zone Soil
FORMER CHEVRON STATION 9-4816
301 14TH STREET
OAKLAND, CALIFORNIA

Project	30-0220	Drawn	CMG
Date	8/29/96	Revision	
Scale	1"= 20'	Checked	

TERRA VAC 1651 Alvarado Street San Leandro, CA 94577 (510) 351-8900 Fax -0221

Figure 3



Sidewalk

HARRISON STREET

LEGEND

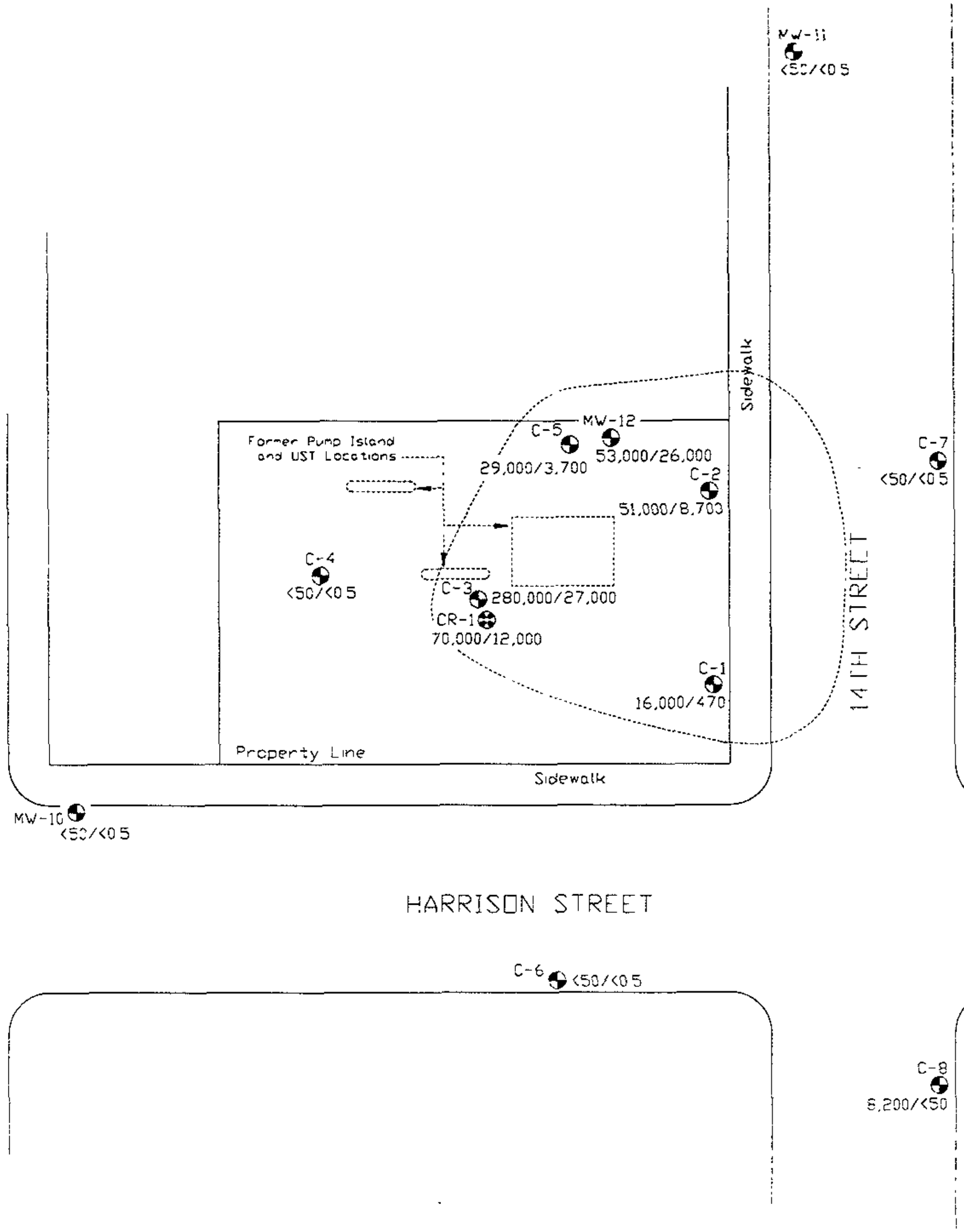
C-A ●	= Soil boring location	1,200/5.6	= Concentration of TPHg/Benzene in Soil, mg/kg. Sample depths greater than or equal to 19 feet
C-1	= Groundwater monitoring well location	NS	= Not Sampled
CR-1	= Groundwater recovery well location	- - -	= Estimated extent of soil concentrations exceeding 100 mg/kg TPHg or 1 mg/kg benzene
VEW-1	= Vapor extraction well location		
SP-1	= Sparge Well Location		

TPHg/Benzene in Saturated Soil
FORMER CHEVRON STATION 9-4816
301 14TH STREET
OAKLAND, CALIFORNIA

Project	30-0220	Drawn	CMG
Date	8/29/96	Revision	
Scale	1"= 20'	Checked	

TERRA VAC
1651 Alvarado Street
San Leandro, CA 94577
(510) 351-8900 Fax. -0221

Figure 4



LEGEND

C-1 = Groundwater Monitoring Well Location

CR-1 = Groundwater Recovery Well Location

19/0.012 = Concentration of TPHg/Benzene in Groundwater, ppb

NS = Not sampled

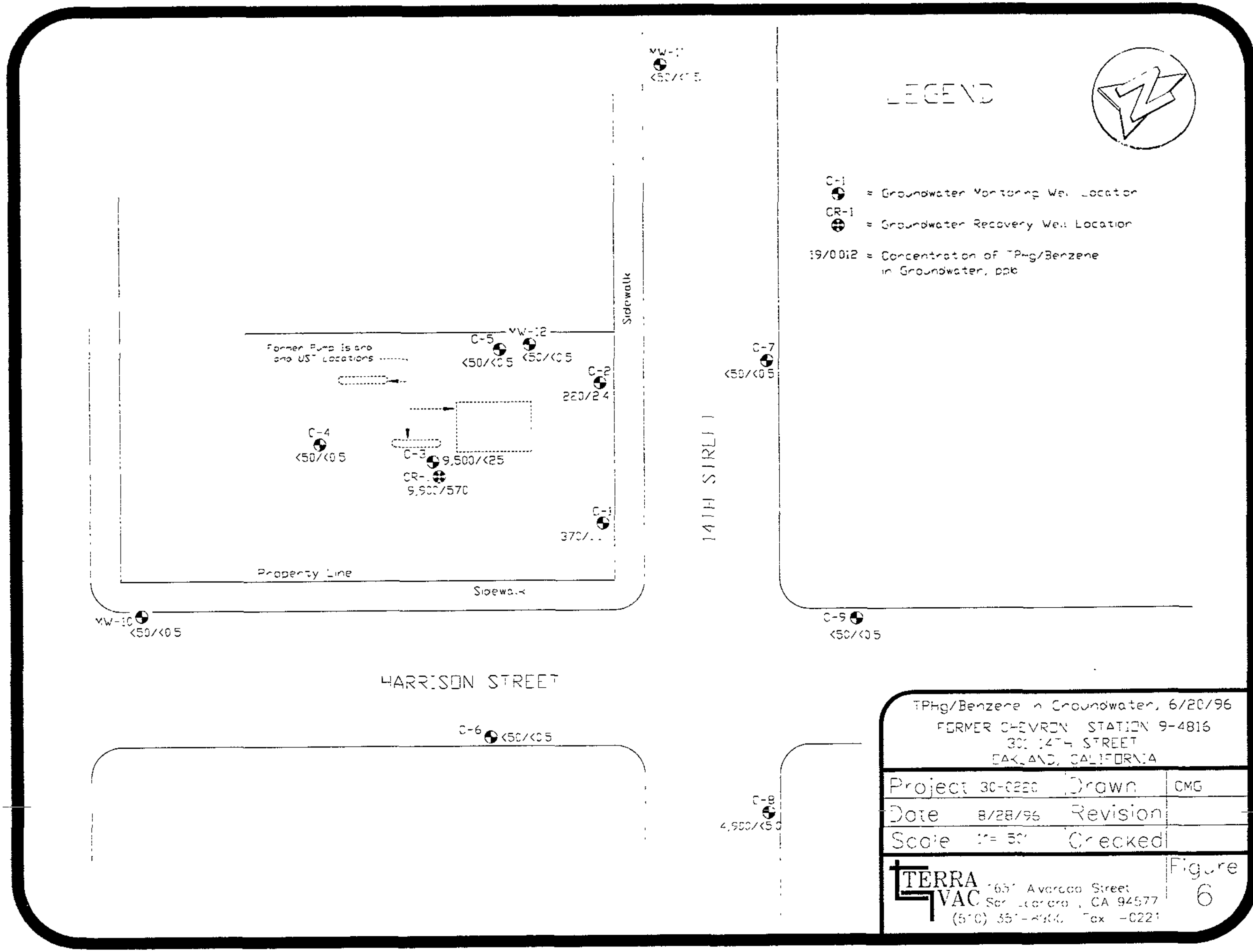
= Estimate extent of on-site groundwater exceeding 100 ppb benzene

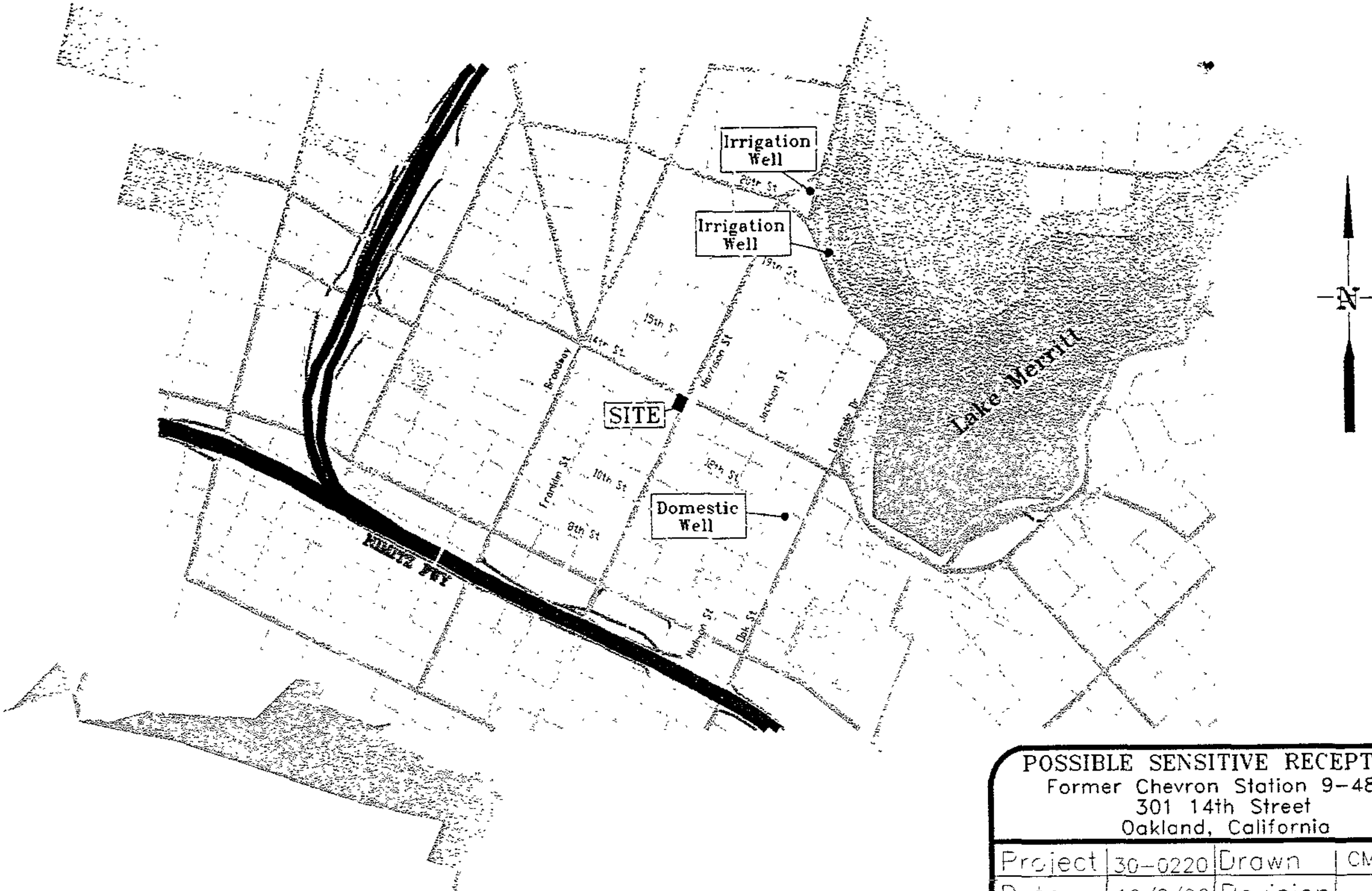
TPHg/Benzene in Groundwater, 9/28/95
FORMER CHEVRON STATION 9-4816
301 14TH STREET
OAKLAND, CALIFORNIA

Project	30-0220	Drawn	CMG
Date	8/28/96	Revision	
Scale	1" = 50'	Checked	

TERRA VAC 1651 Alvarado Street San Leandro, CA 94577 (510) 351-8900 Fax -0221

Figure 5


LEGEND
C-1 = Groundwater Monitoring Well Location
CR-1 = Groundwater Recovery Well Location
19/0.012 = Concentration of TPHg/Benzene in Groundwater, ppb
MW-11
MW-12 <50/<0.5
C-5 <50/<0.5
Former Pump Islands and UST Locations
C-2 220/2.4
C-4 <50/<0.5
C-3 9,500/<25
CR-1 9,900/570
C-1
Property Line
Sidewalk
C-7 <50/<0.5
14TH STREET
MW-10 <50/<0.5
C-9 <50/<0.5
HARRISON STREET
C-6 <50/<0.5
C-8 4,900/<50
TPHg/Benzene in Groundwater, 6/20/96
FORMER CHEVRON STATION 9-4816
OAKLAND, CALIFORNIA
Project 30-0220
Drawn CMG
Date 8/28/96
Revision
Scale 1"= 50'
Checked
Figure 6
TERRA VAC
Avocado Street
CA 94577



POSSIBLE SENSITIVE RECEPTORS

Former Chevron Station 9-4816
301 14th Street
Oakland, California

Project	30-0220	Drawn	CMG
Date	10/8/96	Revision	
Scale	N.T.S.	Checked	

TERRA VAC
1651 Alvarado Street
San Leandro, CA 94577
(510) 351-8900 Fax -0221

Figure 7

APPENDIX A

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Former Chevron Station 9-481 Job Identification: 30-0220
Site Location: 301 14th Street, Oakland, CA Date Completed: 8/28/96
Completed By: CMG

Software: GSI RBCA Spreadsheet
Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	5.8E+03		2.0E+03	5.8E+03	5.8E+03
SAadj	Adjusted dermal area (cm^2-yr/kg)	2.1E+03			1.7E+03	
M	Soil to Skin adherence factor	1				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	FALSE			FALSE	
tox	Use EPA tox data for air (or PEL based)	***<u>FALSE</u>***				
gwMCL?	Use MCL as exposure limit in groundwater?	TRUE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	TRUE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	TRUE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	FALSE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)	6.1E+04	FALSE	6.1E+04	FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	***<u>2.9E-07</u>***	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	***<u>2.9E-01</u>***	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)			
W	Length of affected soil parallel to wind (cm)			
W.gw	Length of affected soil parallel to groundwater (c			
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)			
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	2.0E+02
I	Groundwater infiltration rate (cm/yr)	3.0E+01
Ugw	Groundwater Darcy velocity (cm/yr)	***<u>1.8E+03</u>***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***<u>4.7E+03</u>***
Ks	Saturated Hydraulic Conductivity(cm/s)	2.8E-03
grad	Groundwater Gradient (cm/cm)	2.0E-02
Sw	Width of groundwater source zone (cm)	9.1E+02
Sd	Depth of groundwater source zone (cm)	1.5E+02
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	TRUE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	1.0E-03

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	***<u>4.6E+01</u>***		
hv	Vadose zone thickness (cm)	***<u>5.8E+02</u>***		
rho	Soil density (g/cm^3)	1.7		
foc	Fraction of organic carbon in vadose zone	0.01		
phi	Soil porosity in vadose zone	0.38		
Lgw	Depth to groundwater (cm)	***<u>6.2E+02</u>***		
Ls	Depth to top of affected soil (cm)			
Lsubs	Thickness of affected subsurface soils (cm)			
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	0.12	0.12
phi.a	Volumetric air content	0.038	0.26	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		6.1E+03
ay	Transverse dispersion coefficient (cm)		2.0E+03
az	Vertical dispersion coefficient (cm)		3.0E+02
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

RBCA SITE ASSESSMENT

Tier 2 Worksheet 9.3

Site Name: Former Chevron Station 9-4816
Site Location: 301 14th Street, Oakland, CA

Completed By: CMG
Date Completed: 8/28/1996

GROUNDWATER SSTL VALUES

Target Risk (Class A & B) 2.9E-7
Target Risk (Class C) 1.0E-5
Target Hazard Quotient 2.9E-1

■ MCL exposure limit?
■ PEL exposure limit?

Calculation Option: 2

SSTL Results For Complete Exposure Pathways ("x" if Complete)

CONSTITUENTS OF CONCERN		Representative Concentration	X Groundwater Ingestion			X Groundwater Volatilization to Indoor Air		Groundwater Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/L)	Residential: (on-site)	Commercial: 2000 feet	Regulatory(MCL): 2000 feet	Residential: (on-site)	Commercial: (on-site) (PEL)	Residential (on-site)	Commercial: (on-site) (PEL)	(mg/L	"■" if yes	Only if "yes" left
71-43-2	Benzene	1.3E-2	NA	5.8E+2	1.0E+3	NA	>Sol	NA	NA	1.0E+3	☐	<1

.013
= 13ppb

Software: GSI RBCA Spreadsheet
Version: v 1.0

Serial: g-337-yax-542

RBCA SITE ASSESSMENT | Tier 2 Worksheet 8.1

Site Name: Former Chevron Station 9-4816 | Site Location: 301 14th Street, Oakland, CA | Completed By: CMG | Date Completed: 8/28/1996 |

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER INGESTION

	Exposure Concentration										MAX. PATHWAY INTAKE (mg/kg-day) (*Maximum intake of active pathways soil leaching & groundwater routes.*)	
	1) Source Medium	2) NAF Value (dim) Receptor		3) Exposure Medium Groundwater POE Conc. (mg/L) (1)/(2)		4) Exposure Multiplier (IRxEFxED)/(BWxAT) (L/kg-day)		5) Average Daily Intake Rate (mg/kg-day)				
Constituents of Concern	Groundwater Concentration (mg/L)		Off-Site Commercial		Off-Site Commercial		Off-Site Commercial		Off-Site Commercial			Off-Site Commercial
Benzene	1.3E-2		2.0E+5		6.2E-8		3.5E-3		2.2E-10			2.2E-10

NOTE: AT = Averaging time (days) BW = Body Weight (kg) EF = Exposure frequencey (days/yr) POE = Point of exposure
CF = Units conversion factor *IR = Intake rate (L/day or mg/day)*
ED = Exp duration (yrs)

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RBCA SITE ASSESSMENT | **Tier 2 Worksheet 8.2**

Site Name: Former Chevron Station 9-4816 | Site Location: 301 14th Street, Oakland, C | Completed By: CMG | Date Completed: 8/28/1996

TIER 2 PATHWAY RISK CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ *(CHECKED IF PATHWAYS ARE ACTIVE)*

	CARCINOGENIC RISK						TOXIC EFFECTS				
Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Intake Rate (mg/kg/day)		(3) Oral Slope Factor	(4) Individual COC Risk (2) x (3)		(5) Total Toxicant Intake Rate (mg/kg/day)		(6) Oral Reference Dose	(7) Individual COC Hazard Quotient (5) / (6)	
			Off-Site Commercial	(mg/kg-day)^-1		Off-Site Commercial		Off-Site Commercial	(mg/kg-day)		Off-Site Commercial
Benzene	A		2.2E-10	2.9E-2		6.3E-12					
				Total Pathway Carcinogenic Risk =	0.0E+0	6.3E-12			***Total Pathway Hazard Index =***	0.0E+0	0.0E+0

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