Chevron

Chevron U.S.A. Products Company
6001 Bollinger Canyon Rd., Bldg. L
P.O. Box 5004
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Site Assessment & Remediation Group
Phone (510) 842-9500

May 8, 1995

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

Re: **Former Chevron Service Station #9-4587**
609 Oak Street, Oakland, CA

Dear Ms. Eberle:

Enclosed is the Addendum Remediation Work Plan dated April 26, 1995, prepared by our consultant Terra Vac for the above referenced site.

The work plan proposes to utilize dual vacuum extraction and air sparging remediation to reduce hydrocarbons in subsurface soils to 100 ppm TPH-G. Ground water will be remediated to remove separate phase hydrocarbons and decrease dissolved concentrations to levels conducive to biodegradation. Following active remediation, a management plan will be implemented to monitor decreasing levels of dissolved hydrocarbons in ground water.

We would like to schedule a meeting with yourself and any other individuals or agencies you feel appropriate to discuss the work plan. I will contact you by telephone during the next week to discuss possible meeting times and locations.

If you have any questions or comments, please feel free to contact me at (510) 842-8134.

Sincerely,
CHEVRON U.S.A. PRODUCTS COMPANY

Mark A. Miller
Site Assessment and Remediation Engineer

Enclosure

cc: Ms. B.C. Owen

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The Paris Company
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File: 94587WP1

TERRA VAC

ADDENDUM REMEDIATION WORK PLAN
DUAL VACUUM EXTRACTION
AIR SPARGING REMEDIATION
FORMER CHEVRON STATION 9-4587
609 OAK STREET
OAKLAND, CALIFORNIA

PROJECT 30-0219

TERRA VAC

ADDENDUM REMEDIATION WORK PLAN
DUAL VACUUM EXTRACTION
AIR SPARGING REMEDIATION
FORMER CHEVRON STATION 9-4587
609 OAK STREET
OAKLAND, CALIFORNIA

Prepared For:

Chevron U.S.A. Products Company
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San Ramon, California 94583-0804

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STATE OF CALIFORNIA

April 26, 1995

ADDENDUM REMEDIATION WORK PLAN
DUAL VACUUM EXTRACTION
AIR SPARGING REMEDIATION
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OAKLAND, CALIFORNIA

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April 26, 1995

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609 OAK STREET
OAKLAND, CALIFORNIA

1.0 INTRODUCTION

This remediation work plan was prepared at the request of Chevron U.S.A. Products Company (Chevron) for submittal to the Alameda County Health Services Department (ACHS). The work plan pertains to former Chevron Service Station 9-4587, located at 609 Oak Street, Oakland, California (Figures 1 and 2).

Background

The subject site was operated as a gasoline service station prior to the removal of underground storage tanks in October 1994. Subsurface investigation performed at the site since 1989 indicate that petroleum hydrocarbons are present in soil and groundwater beneath the site. A groundwater pump and treat system has been in operation at the site since November 1993. The site is currently developed as a car wash which is not currently operating. Re-development of the site as an active car wash may occur during the period of remediation activity outlined in this workplan. A fenced equipment compound houses the existing groundwater treatment system.

Terra Vac has reviewed available site information and has determined that the most feasible and cost effective approach for completing active remediation is to remove the source from beneath the former Chevron site. The removal of the source will improve the quality of the groundwater in the vicinity of the site. Once source removal has been completed in the vadose zone by active remediation, dissolved hydrocarbon levels will continue to be reduced by natural biodegradation and attenuation.

Terra Vac proposes that remediation goals for onsite vadose zone soils be established at an average of 100 parts per million (ppm) total petroleum hydrocarbons (TPH) and reducing the groundwater benzene concentration in onsite monitoring wells to a level conducive to natural attenuation. Once active remediation goals have been achieved, a Management Plan will be implemented to monitor the continued decrease of hydrocarbons levels in groundwater to MCLs for gasoline constituents. To attain these remediation goals, Terra Vac proposes to use a combination of dual vapor extraction and air sparging.

Dual vapor extraction (DVE), an effective technique for remediating hydrocarbon impacted soils, is proposed to remove a majority of the hydrocarbon mass. This technology recovers hydrocarbons from the subsurface which are present in the adsorbed and vapor phase.

Extraction wells are installed into the impacted area and screened to provide vacuum influence on the affected vadose zone. Air sparging will be used to remediate onsite groundwater. Air sparging is applicable as an enhancement for biodegradation of hydrocarbons in the saturated zone. Sparging involves the injection of clean air into the saturated zone. Elevated oxygen levels resulting from dispersion of injected air within the saturated zone enhance the natural biodegradation of hydrocarbons.

2.0 REMEDIAL DESIGN

Four primary factors were evaluated to prepare the remedial design for this site:

- Groundwater occurs at about 15 feet below grade.
- Subsurface soils consist of interbedded, poorly sorted, and clayey sands to a depth of at least 30 feet.
- The groundwater surface has been artificially lowered by the existing "pump and treat" system and has likely resulted in free-phase hydrocarbon sorbing onto soils below the static water level.
- An estimated 17,000 pounds of hydrocarbons remain in the subsurface.

Terra Vac and Chevron request that cost effective remediation goals and the conceptual Management Plan for addressing residual hydrocarbons be accepted by ACHS prior to the commencement of further remediation activities. Terra Vac maintains that attainable remediation levels be based on source removal and residual hydrocarbon levels in vadose zone soils. Proposed active remediation goals are an average of 100 ppm TPH or asymptotic vapor extraction rates for vadose zone soil and dissolved benzene levels in groundwater conducive to natural attenuation. This work plan will be implemented upon written acceptance of the proposed active remediation goals and conceptual Management Plan for residual hydrocarbon levels.

3.0 TECHNICAL APPROACH

The DVE system will simultaneously extract hydrocarbon impacted soil vapor and groundwater from beneath the site via existing and proposed extraction wells. A rotary lobe blower is used to create a vacuum in the subsurface and develop air flow through the impacted soils. Volatile hydrocarbons diffuse into the air stream which is then removed from the subsurface along with entrained groundwater. A vapor/liquid separator is then used to remove entrained groundwater from the vapor stream. The extracted air stream is processed through a thermal oxidizer and vented to the atmosphere under a Bay Area Air Quality Management District permit. Groundwater will be treated using activated carbon and discharged to the sanitary sewer system under a permit from the East Bay Municipal Utility District.

The air sparging system is designed to promote the natural biodegradation process. The air sparging system will utilize a rotary lobe blower to inject air into the groundwater through two proposed air sparging wells. As air bubbles up through the groundwater, oxygen delivered to the subsurface will promote aerobic biodegradation of hydrocarbons present in the groundwater.

If remediation proceeds as planned, the majority of the hydrocarbon mass will be removed from the vadose zone after 14 weeks of DVE system operation. Air sparging is projected to continue for an additional 28 weeks to complete active remediation of the onsite groundwater.

Extraction/Sparging Wells

The DVE system will incorporate an existing groundwater extraction well (CR-1) along with nine new DVE wells to be installed by Terra Vac. Terra Vac will also install five new air sparging wells, to be co-located with selected DVE wells, for use in the air sparging system.

Equipment

System components are as follows:

- Vapor/liquid separator - Centrifugal separator with a capacity of 200 gallons. The separator will have a low water level control that operates a water pump. A high-high level control will shut the system down in the event of a water pump failure.

- Vacuum extraction unit - A positive displacement blower (Duraflow 4509 or equivalent) with a 30 HP motor capable of 12 inches of mercury vacuum at 300 scfm. The unit will be equipped with explosion-proof motor and motor controls. The unit will be enclosed for noise suppression.

- Air injection blower - An air injection blower with a 10 HP motor capable of 10 psi at 30 scfm.

- Catalytic/Thermal oxidizer - In accordance with regulations of the Bay Area Air Quality Control District a catalytic or thermal oxidizer capable of 500 cfm will be used for vapor abatement.

Process Monitoring

During the first week of operation, vapor samples will be collected to optimize system operation and collect baseline data. In addition, a source test will be conducted within the first 10 days of operations to comply with air permit requirements. Once the system has stabilized, vapor samples will be collected at two week intervals for analysis. During typical monitoring events, the vapor treatment system will be monitored using vapor samples analyzed by a gas

chromatograph. Air samples will be collected in tedlar bags and analyzed in Terra Vac's laboratory. A modified EPA method 8015/8020 will be used to track total mass extraction, as well as specific compounds in the vapor stream. Flow rates (scfm) will be measured during each monitoring event so that emission rates (lbs/day) may be calculated.

Operations 14+28 = 42

Approximately 42 weeks of active remediation are estimated for this project. DVE will be conducted until vapor extraction rates are less than 50 pounds per day. The 42 week schedule includes one week of startup operations and optimization of system operations. Pending completion of active remediation a Management Plan will be implemented to address residual levels of hydrocarbon in the subsurface.

4.0 SCOPE OF WORK

Task 1: Engineering and Planning

Engineering and planning includes the drafting of this remediation work plan, review of previous work by other contractors, and subcontractor selection. It also includes the preparation of a site health and safety plan which includes site safety procedures, first aid procedures, and Material Safety Data Sheets for all site contaminants.

Task 2: Permitting

Permits will be obtained by Terra Vac for full scale operation of the system. Such permits include:

- An air permit from the Bay Area Air Quality Management District.
- Well construction permits from Zone 7 Water Resources Management.

Task 3: Drilling

Terra Vac proposes to install nine new DVE wells and five air sparging wells. Borings for the wells will be advanced to approximate depths of 15 and 25 feet using hollow-stem augers and completed as wells through the annulus of the auger. Variations in soil permeability, groundwater elevation, and hydrocarbon impact require the actual depth and screened interval of each well to be determined in the field by a Terra Vac geologist. Well materials will consist of two and four inch, flush-thread, schedule 40 PVC screen and riser. A filter pack consisting of silica sand will be placed to a maximum of two feet above the top of the screened portion of each casing. A one foot thick bentonite seal will be placed between the filter pack and the neat cement grout annular seal.

During drilling of the wells, soil samples will be collected at five foot intervals to confirm current lithologic data. Soil samples will be collected using a California-modified, split-spoon sampler containing clean brass sleeves. The sampler will be driven ahead of the auger by a standard 140 pound weight, repetitively dropped from a height of 30 inches, to advance the sampler eighteen inches. The number of blow counts for each six inch advancement will be recorded. Select soil samples will be collected and sent to a State-certified laboratory for analysis of total petroleum hydrocarbons as gas (TPHg) and benzene, toluene, ethylbenzene and xylene (BTEX) using EPA methods 8015M and 8020.

Soil samples collected in brass sleeves for laboratory analysis will be immediately removed from the split-spoon sampler, the exposed ends covered with Teflon sheets, capped with plastic caps, and taped with non-vinyl tape. The sample sleeve will then be labelled, placed in a ziplock plastic bag and held in a pre-cooled ice chest pending delivery to the laboratory following standard chain-of-custody procedures.

Decontamination of equipment will be performed onsite. Augers will be steam cleaned prior to each use. Split-spoon samplers will be decontaminated after each sample collected using an Alconox (or similar) wash and clean water rinse. All decontamination water will be placed in DOT approved 55-gallon drums, with proper labeling, for treatment through the groundwater treatment system. Soil cuttings obtained from drilling activities will also be stockpiled on plastic sheeting, composite sampled, and disposed of properly.

Task 4: Construction and Installation

The completed system will consist of the extraction blower, a vapor/liquid separator, an air injection blower, a PVC piping system, up to 10 DVE wells, and five air sparging wells. Each vacuum extraction well will be equipped with a flow monitoring port, a sample port and a well head vacuum gage. Branch piping to the wells will be 2 inch PVC. The thermal oxidizer will be equipped with vacuum gages, thermometers, flow monitoring ports, and sample ports. A generalized process flow diagram is shown as Figure 3.

The 10 DVE wells will be connected to the extraction system via an above-grade piping system, while the air sparge wells will be connected via a below-grade piping system to allow for development of the property.

A noise abatement system will be constructed around the equipment compound to protect the surrounding area from excessive noise. It will consist of a six foot high wall with sound insulation and a locking door.

Task 5: System startup

All equipment and control systems will be checked for proper operation prior to start-up. Testing shall include electrical continuity checks, tests of all safety shut-downs, verification of system set points, pressure testing of water line, and testing of the remote monitoring system. A sound survey will be performed to ensure that noise levels are below 70 Db at the boundary of the site.

Startup consists of the first week of operations. During this time the system will be closely monitored, as described in Section 3.0 (Process Monitoring). Each well will be brought on-line individually and evaluated for flow rate and hydrocarbon concentration in the extraction vapor stream. Individual sampling will identify areas of high hydrocarbon impact and of low permeability soils. The data collected will document initial conditions, determine mass extraction, overall system effectiveness, and air permit compliance. The system will then be optimized to effectively remediate the site. Standard operating procedures and quality assurance/control plan guidelines are included as Appendix A.

Task 6: Operations and Maintenance

Site visits will be performed once every two weeks during operations with the DVE system. During site visits, Terra Vac will collect vapor samples at the DVE system inlet and outlet for compliance purposes as well as to calculate the total mass extraction. Vapor samples from all operating wells will be collected monthly.

From the wellhead samples, Terra Vac will monitor the average vapor pressure of the extracted hydrocarbon vapors. From experience, Terra Vac has noted that the average extracted vapor pressure decreases as remediation progresses. If this decrease in vapor pressure is not noted, extraction is being controlled by a diffusion limited zone or vapor are being removed from a distant source. If this trend is seen in operating wells, Terra Vac will place an interim boring/well to address this problem. The well will be connected to the treatment system as necessary to improve removal rates.

The DVE system will be removed from the site after extracted hydrocarbon vapor concentrations are less than 50 pounds per day for two consecutive sampling events. When the system is removed, air sparging will continue at the site to promote remediation via biodegradation.

Task 7: Interim System Performance Evaluation

Groundwater quality at the site is currently monitored on a quarterly basis by another Chevron consultant. Terra Vac will carefully review data on groundwater quality to determine trends in the speed and effectiveness of groundwater remediation. Up to four interim borings will installed after about ten weeks of operation. The interim borings will be positioned on the basis of

operating and site characterization data. The borings will be completed as DVE wells and added to the DVE system to supplement extraction in selected areas. if < 100 TPH) they want < 1 benz) $Bs to be Conf borings

Soil samples will be collected at five-foot intervals from surface to depth using a California-modified, split-spoon sampler containing clean brass sleeves. Selected soil samples will be collected and sent to a State of California certified laboratory for analysis of TPHg and BTEX using EPA methods 8015M and 8020.

Task 8: Confirmatory Borings and Demobilization

Terra Vac proposes that two confirmatory borings to depths of up to 25 feet will be adequate to establish that remediation goals have been achieved for vadose zone soils. Terra Vac will confer with the lead regulatory agency for exact placement of the confirmatory borings. Soil samples will be collected every five feet. Two samples, a primary and a secondary, will be collected from each interval. Selected samples will be analyzed following the procedures described below:

- Each primary sample will be analyzed for TPHg. If primary samples have TPHg concentrations less than 100 ppm, the remediation objective in the soil will have been achieved.

- If the primary sample does not meet the clean-up goal, the secondary sample from the same sampling interval will be analyzed using the toxicity characteristic rules to demonstrate that benzene levels are less than 0.5 ppm in the deionized water leachate from the soil sample. This test result will provide evidence whether any residual hydrocarbons in the soil will impact groundwater.

- The primary results will be discounted if the secondary sample meets the remediation objective.

Upon confirmation that remediation goals have been achieved in groundwater, all equipment will be removed from the site and all wells not used in the Management Plan will be destroyed.

Task 9: Management Plan to Address Residual Hydrocarbons

Residual levels of hydrocarbon will remain in the vadose and saturated zones upon completion of active remediation. We anticipate that vadose zone soils will contain less than 100 ppm TPHg and groundwater will contain benzene concentrations on the order of 100 ppb. A Management Plan will be developed to address residual hydrocarbons.

A Management Plan for addressing residual hydrocarbons will be submitted to the ACHS upon completion of Phase II operations. Included in the Management Plan will be documentation of all active remediation operations. The Plan will include:

- o A summary of source removal through active remediation,
- o An estimate of residual hydrocarbon mass in soil and groundwater,
- o Monitoring procedures to document plume containment,
- o A projection of the rate of residual hydrocarbon reduction through natural biodegradation and attenuation,
- o A contingency plan that includes trigger levels for benzene levels in groundwater monitoring wells,
- o An evaluation of human health risks and institutional controls.

The Management Plan will include a program for monitoring the continued reduction of dissolved hydrocarbon levels in groundwater. All wells will be sampled on a quarterly basis for a period of one year. If benzene levels show a general decrease in most wells during the year, the sampling frequency will be ~~increased~~ decreased to once per year. If three consecutive years of reducing benzene levels are documented at the site, monitoring will be terminated and closure petitioned to the ACHS.

5.0 APPROXIMATE SCHEDULE / DELIVERABLES

The following table shows the approximated schedule and deliverables.

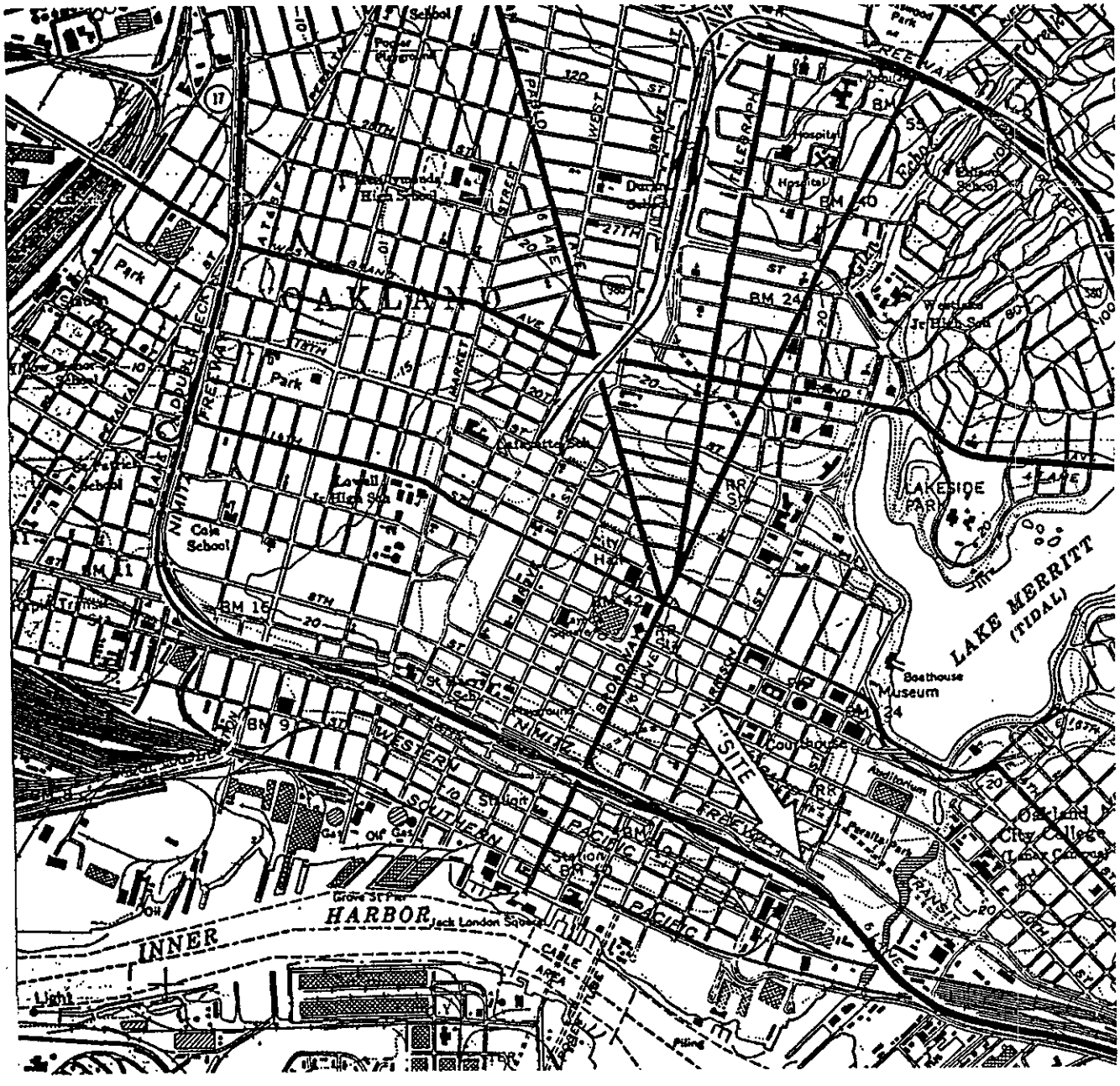
ITEM	SCHEDULE
Work Plan/ Health and Safety Plan	April 1995.
Air Permit Application	May 1995.
Well Permits	May 1995.
Construction	June 1995.
Start-Up	July 1995.
Final Report	July 1996.

6.0 COMPLIANCE WITH STANDARDS, SPECIFICATIONS, AND LAWS

Terra Vac will perform its contractual tasks in a professional manner and in compliance with all codes, standards, permits, regulations and laws applicable to the project. Terra Vac was selected by the United States Environmental Protection Agency to demonstrate vacuum extractIon for the Superfund Innovative Evaluation (SITE Program).

Remediation projects require safety and health measures to assure the protection of Terra Vac employees. All Terra Vac employees involved in remediation work undergo safety training which meets or exceeds the requirements of 29 CFR 1910.120. The Health and Safety Plan for this project is included as Appendix B.

FIGURES

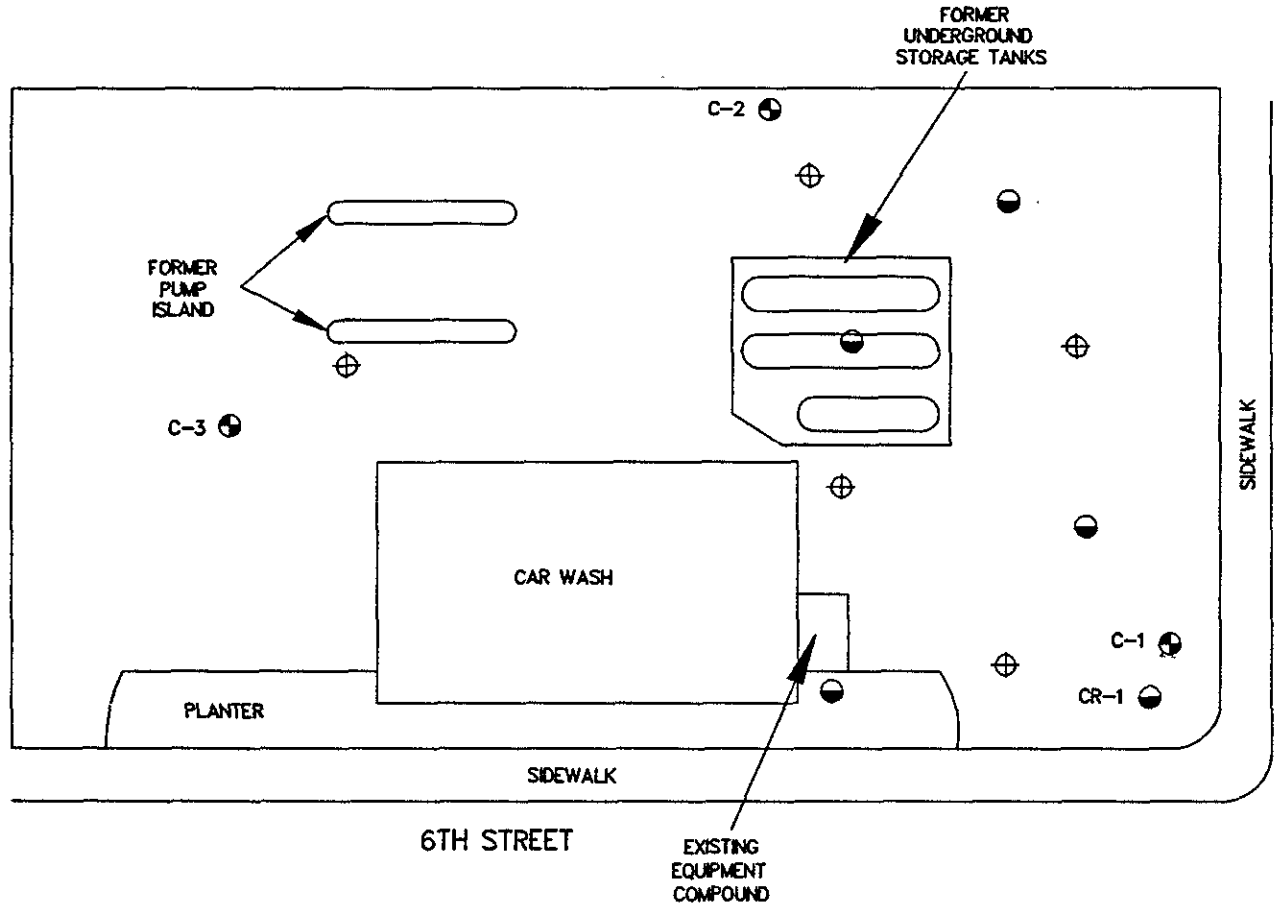


SITE VICINITY MAP
609 Oak Street
Oakland, California

Project	30-0219	Drawn by	APB
Date	4/14/95	Revision	
Scale	NTS	Checked	

TERRA VAC
14798 Wicks Boulevard
San Leandro, CA 94577
(510) 351-8900 fax: -0221

Figure 1



LEGEND

CR-1 = Groundwater monitoring well

= Dual completed well (5) air sparging + SVE

= Entainment extraction well (4) SVE

Approximate Scale

20 10 0 20

feet

Source: Modified from plan supplied by Touchstone Development

FIGURE 2

PROJECT 30-0219

PLOT PLAN
Chevron Station 9-4587
609 Oak Street
Oakland, California

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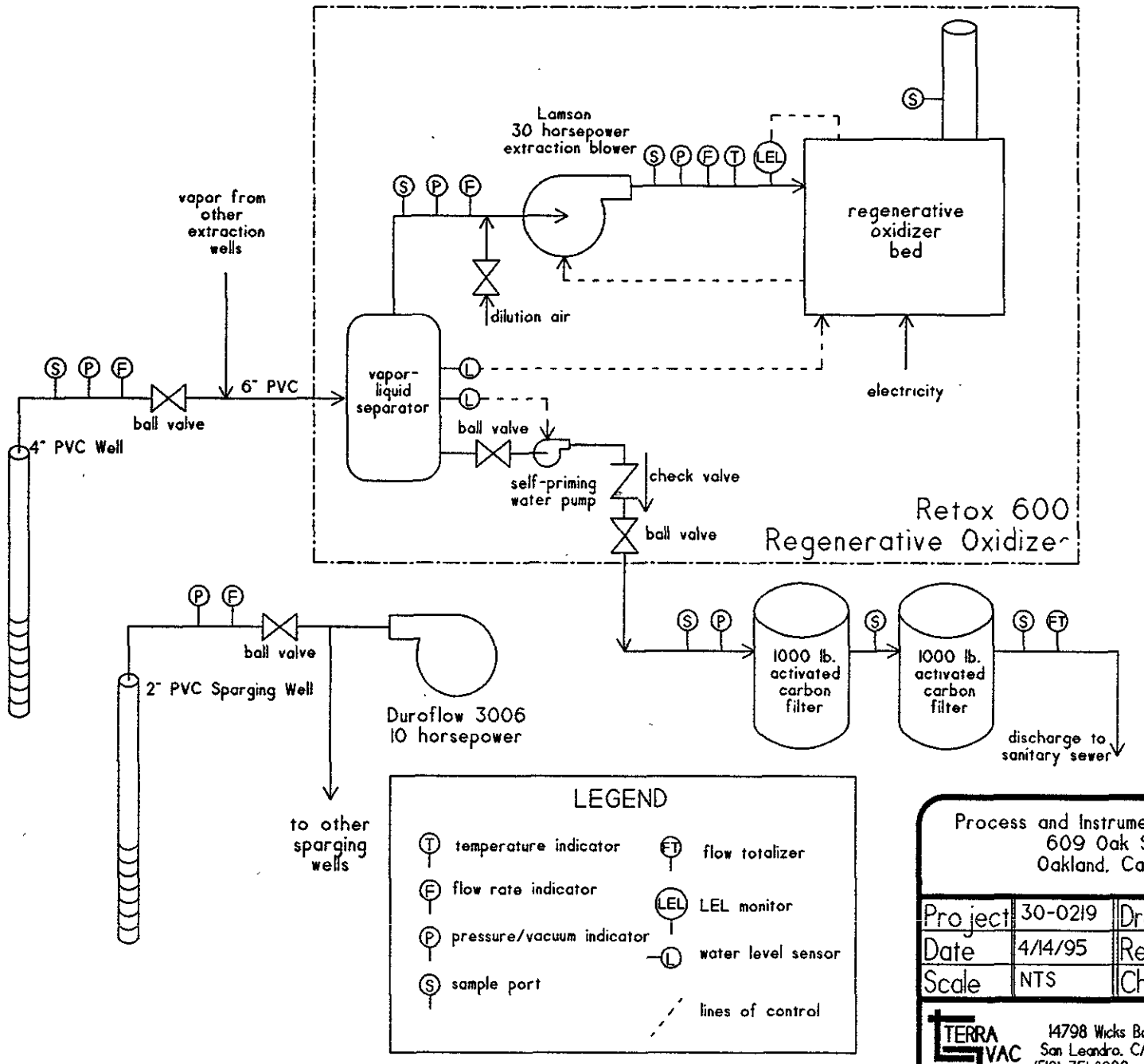

Process and Instrumentation Diagram
609 Oak Street
Oakland, California

Project	30-0219	Drawn by	APB
Date	4/14/95	Revision	1
Scale	NTS	Checked	

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14798 Wicks Boulevard
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(510) 351-8900 fax -0221

Figure 3

APPENDIX A

QUALITY ASSURANCE/CONTROL PLAN

Project 30-0219.17
April 26, 1995

QUALITY ASSURANCE OBJECTIVES

Operation and evaluation for the vacuum extraction process throughout the remediation period requires the collection of operating data. The data will be obtained from chemical analyses of vapor samples. Quality assurance objectives for these analyses are summarized in this section. Samples will be collected and then tested by protocol guidelines set forth in: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Volume IB, USEPA SW-846, Third Edition, 1986.

Precision, Accuracy and Representativeness:

Critical review of all data acquisition and analyses with respect to specific quality indicators will enable the QA/QC objectives to be achieved. These indicators are:

Precision: Precision normally measures the reproducibility of measurements under a given set of conditions.

Accuracy: Accuracy is a measurement of the standard error or bias that is inherent in the analytical process.

Representativeness: This is a function of the sampling method used and the procedures for processing the sample. The objective is to demonstrate the degree of quality of the data and the degree to which it represents the actual environmental condition. This can be determined by a comparison of the quality control data for samples analyzed against other data for similar samples under the same circumstances.

Every attempt will be made to validate all data generated. However, some samples may be lost in laboratory and field accidents and some may be deemed questionable based on internal QC procedures. Terra Vac anticipates that some 5 to 10 percent of the recovery values will be outside the QC limits owing to matrix interferences. In the event of gross matrix interferences, revised QA objectives will be developed by the QA officer. The objective is to have more than 90 percent valid data.

Completeness and Comparability:

It is recognized that the usefulness of the data is also contingent upon meeting the criteria for completeness and comparability. Wherever possible, reference methods and standard sampling procedures will be used. The QA objective is that all measurements be comparable to the media and operation being evaluated. These specific objectives are summarized below:

Comparability: This is an expression of the confidence with which one data set can be compared to another. By using standard methodology and QA/QC procedures, the results of the analyses can be compared to other analyses by other laboratories.

Completeness: The indicator for completeness is the percent of samples judged to be valid compared to the total number of samples collected.

PLACEMENT OF WELLS

Remediation systems will be designed with extraction wells placed where there are high degrees of contamination. Each well will be tested shortly after installation. The purpose of the well testing procedure is to quantify the radius of influence, flow rates of vapors, and Volatile Organic Compounds (VOC) concentration at each location. This information will be evaluated by Terra Vac to adjust the location of subsequent wells in the area so that the spacing of the wells is consistent with the radius of influence actually measured in the wells.

After the system begins full scale remediation, wells will be monitored regularly so as to quantify the extraction rate of VOCs from each well. This data will be used to establish initial conditions from which the effectiveness of the vacuum extraction remedy will be evaluated by Terra Vac throughout the proposed period of operation. The parameters to be measured include flow rate, vacuum levels, temperature, and VOC concentration. Normally these four vital measurements are taken at the same time from selected locations throughout the vacuum extraction system. In general, these locations are in the following process areas:

1. Vacuum extraction wells
2. Field piping
3. Separators and condensate collectors
4. Vacuum pumping inlet
5. Ambient air
6. Outlet after vapor treatment

This information will then be transferred to a data base to be used in analytical computations.

SPECIFIC QA MEASURES TO ASSESS DATA QUALITY

Process Gas:

Vapor samples will be compared with an independently prepared standard that is traceable to National Bureau of Standards. These will also be compared to standards prepared on site as a reference. Syringe blanks will be performed 1 in 20 samples as long as blanks show to be clean. If not, then more frequent blanks will be analyzed or a better purge method will be employed. Standards will be analyzed 1 in 20 samples (or at least daily). Duplicate vapor samples will be analyzed 1 in 20 samples. Detection limits for this analysis are anticipated to be in the range of 0.1 to 0.5 ppm.

Pressure, Temperature and Flow:

Pressure gauges, thermometers and flow devices will be routinely cross-checked with a calibrated gauge and thermometer. A field audit of gauges will be conducted as necessary. Any gauge or measuring device that is suspected or found to be out of the accuracy range of the manufacturer specifications will be calibrated or replaced if necessary.

SAMPLING PLAN AND PROCEDURES

Sampling Objectives:

The planned sampling procedures to be used during all phases of the vacuum extraction remediation activities will include the collection of process vapors, and specific process operating data. Attachments 1 and 2 detail sampling protocol and standardization procedures for use in the Terra Vac laboratory.

SAMPLE LOCATIONS AND FREQUENCY

Vapor Samples:

During the remediation process, vapor samples will be collected at various locations and analyzed on a gas chromatograph to determine mass flow rates to the vapor treatment system. Each extraction header will be analyzed for mass flux as determined by the contract.

CALIBRATION PROCEDURES

In order that QA/QC objectives can be achieved it is imperative that the response of all analytical equipment be calibrated to known standards.

Calibration will be achieved by using an independently prepared gas standard that is National Bureau of Standards traceable. Initial calibration of the gas chromatograph will be performed at least three times to assure consistency before standardization. A calibration test shall be performed at least every 20 samples, or daily, whichever is more conservative. Recalibration will occur if a standard is found to deviate more than 10 percent from the previous standard. No further samples will be analyzed until the instrument is calibrated.

The gas chromatograph and flame ionization detector (FID) will allow total petroleum hydrocarbon (TPH) and halogenated compounds to be analyzed. Typically the calibration is against propane.

DATA REPORTING, VALIDATION, AND REDUCTION

Analytical data are generated from two primary sources: field testing and laboratory testing. Terra Vac testing utilizes several instruments to obtain data. Field data is generated flow meter, temperature, pressure and vacuum gauges, and by gas chromatograph. Analytical data generated by the field gas chromatograph includes the chromatographic identification of compounds, concentrations, retention times and comparisons to standards.

Data production also includes internal records available for inspection during audits. These records include the following: laboratory notebooks, log book, worksheets, standards, records and associated quality control data. A complete record of each sample's history will be available to document the process from the field through the laboratory analysis.

Steps and checks used to validate the precision and accuracy of the analytical work performed and to support its representativeness, comparability and completeness include:

1. Documentation of analytical and QA/QC methodology.
2. Description of the controls for interfering contaminants (use of reference blanks and check standards for method accuracy and precision).
3. Description of the calibration of methods and instruments.

Validation of the analytical data will include review of the following:

1. Contaminants in syringe blanks and background analyses.
2. Agreement between samples and duplicates.
3. Agreement between calibration checks

Levels of contaminants in syringe blanks must be low enough so as not to have an impact on the validity of the data. If contaminants are found in significant levels in one of the field blanks, the sample data will be reviewed to determine if comparable levels are found in other samples obtained that same day.

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Sampling Techniques of Volatile Organic Compounds

I. SCOPE

Volatile Organic Compounds (VOC) are regulated, toxic chemicals and should be treated with care to avoid personal and environmental contamination. When sampling vapors from the vacuum system, it will be considered that the air stream is contaminated with VOC's. Care should be taken so that no contaminated air is discharged to atmosphere.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Hamilton Gastight Syringes 500μl size

III. PROCEDURE

1. Purge syringe with clean air
2. Insert syringe through sample port septum
3. Purge syringe with air stream to be sampled
4. Draw plunger back to desired volume
5. Withdraw needle from septum and stopper with a septum
6. Log time, location, wellhead vacuum and flow then return sample to GC

IV. PRECAUTIONS

Test syringe before use for leaking plunger and tight needle.

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Standards

I. SCOPE

The purpose of this procedure is to define the standardization of the gas chromatograph for reference in the quantitative analysis of samples containing unknown amounts of Volatile Organic Compounds. In this case, calibration is done with reference to site specific contaminants.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Gastight syringes 500 μl, 10 μl size
3. Pure liquid compounds (CAUTION: Some VOC's are known carcinogens and should be handled with care to avoid possible contamination or exposure.)
4. NBS traceable gas standards
5. Gas sampling bulb 500 ml size

III. PROCEDURES

For Liquid Standards

1. Run a blank of the syringe and gas sampling bulb to be used.
2. Inject a known volume (around 1 μl) of the standard into the 500 ml bulb (verify actual bulb volume beforehand).
3. Allow a few minutes for the liquid to disperse in the bulb. Warm gently, then allow to return to room temperature.
4. Using a gastight syringe, withdraw a 500 μl sample from the bulb and inject it into the GC. Volume utilized should approximate expected field concentrations.

5. Calculation of concentration at sea level:

$$mg/L = \frac{\text{vol. injected } (\mu l) * \text{spec gravity } (mg/\mu l)}{\text{bulb volume (L)}}$$

Note: Specific gravity for reagents are given in the Handbook of Environmental Data for Organic Chemicals, 2nd Ed.

6. If not within 10% of previous calibration, repeat steps 4&5, otherwise maintain calibration values established.

7. Calibration to new values when repeatability is shown. See precautions.

8. Establish retention times for indicator compounds by injecting headspace samples of pure compounds.

For NBS Traceable Gases

1. Run a blank of the syringe.

2. Using a gas tight syringe, withdraw a 500 μl sample directly from the gas cylinder of known concentration.

3. Inject immediately into GC.

4. Calculation of concentration at sea level:

mg/L = conc given (ppm) / conversion factor

Note: the conversion factor used will be air pollution factors from the Handbook of Environmental Data for Organic Chemicals, 2nd Ed., and are in units of ppm per mg/L.

5. If not within 10% of previous calibration, repeat steps 2&3, otherwise maintain calibration values established.

6. Calibrate to new values when repeatability is not shown, or a new cylinder of gas is used.

7. Establish retention times as needed by injecting headspace samples of pure compounds.

IV. PRECAUTIONS

1. In injecting headspace vapor from pure compound, care must be taken not to overload the column.

2. A wide change in calibration values indicates that troubleshooting of the system or procedures is necessary.

APPENDIX B

HEALTH AND SAFETY PLAN

Project 30-0219.17
April 26, 1995

TERRA VAC

HEALTH AND SAFETY PLAN
FORMER CHEVRON STATION 9-4587
609 OAK STREET
OAKLAND, CALIFORNIA

PROJECT 30-0219

Prepared For:

Chevron U.S.A. Products Company
6001 Bollinger Canyon Road
San Ramon, California 94583-0804

Prepared By:

Terra Vac Corporation
14798 Wicks Boulevard
San Leandro, California 94577

April 12, 1995

HEALTH AND SAFETY PLAN
FORMER CHEVRON STATION 9-4587
609 OAK STREET
OAKLAND, CALIFORNIA

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HEALTH AND SAFETY PLAN
FORMER CHEVRON STATION 9-4587
609 OAK STREET
OAKLAND, CALIFORNIA

1.00 INTRODUCTION

The purpose of this Health and Safety Plan is to provide a basic framework for the safe performance of all tasks that may occur onsite. The procedures contained in this plan will apply to all Terra Vac employees and subcontractors, as well as any visitors to the site.

1.10 Site Description

The subject property, located at 609 Oak Street in Oakland, California, is the site of the former Chevron Service Station 9-4587 (Figure 1 and Figure 2). The subject site was operated as a gasoline service station prior to the removal of underground storage tanks in October 1994. Subsurface investigation performed at the site since 1990 indicate that petroleum hydrocarbons are present in soil and groundwater beneath site. A groundwater pump and treat system has been operating at the site since November 1993. The site is developed as a car wash which is not currently in operation. A fenced equipment compound houses the existing groundwater treatment system.

1.20 Project Description

The overall objective of this project is to remediate the hydrocarbon impacted soils and groundwater beneath the site. Project tasks will include drilling, soil sampling, well installation, process piping installation, utility hook-up and dual vacuum extraction/ air sparging system operations. Throughout all on-site activities it is required that Terra Vac employees, subcontractors and visitors to the site review and adhere to the Health and Safety Plan (HSP). Soils and groundwater will be treated using dual extraction, a process in which both hydrocarbon impacted water and air are removed from the soil using a single well. The system is operated under a vacuum, therefore, any possible leakage in process piping will result in air entering the system, rather than hydrocarbon impacted air and water exiting. The process vapors will be treated using a thermal oxidizer and water collected will be treated using aqueous phase activated carbon. Figure 3 shows a typical process flow diagram for this type of remediation system.

2.00 ORGANIZATION AND COORDINATION

2.10 Project Manager

The Project Manager (Timothy Warner) of Terra Vac is responsible for directing, coordinating and controlling all site activities and is solely responsible for enforcing onsite compliance with the provisions of the Health and Safety Plan. The Project Manager has the authority to stop work at the site if unsafe conditions exist.

2.20 Site Safety Officer

A Site Safety Officer (SSO), Mark Frye, shall be designated to coordinate all aspects of site health and safety activities. The SSO will report directly to the Project Manager. In addition to ensuring the implementation and enforcement of the Site Health and Safety Plan, the SSO duties include:

- Monitoring for volatile hydrocarbon concentrations in the breathing zone of site personnel with a photoionization detector (PID) during soil drilling and intrusive work activities.
- Keeping a daily log of site activities, including type of activities, date, and location.
- Determining the level of respiratory protection required for the specific work activity.
- Conducting site safety meetings, which all onsite personnel shall be required to attend.
- Maintaining, inspecting and controlling an adequate inventory of safety equipment onsite.
- Monitoring all onsite hazards and conditions, including possible heat/cold stress situations.
- Monitoring any site decontamination procedures.

If Mr. Frye is unavailable to perform onsite duties, another duly trained individual will be appointed. When only one Terra Vac employee is onsite, that employee will be designated the SSO.

2.30 Team Members

Team members shall consist of all personnel involved in the project who will be allowed onsite. All team members will be responsible for understanding and complying with the HSP requirements.

2.40 Subcontractors

All subcontractors performing work for Terra Vac will be provided with a copy of the HSP and are required to attend all site safety meetings. It will be the responsibility of each subcontractor to ensure that their work is performed in a safe manner and in accordance with the HSP.

3.00 MEDICAL MONITORING/TRAINING REQUIREMENTS

Terra Vac has established a medical surveillance program designed to monitor and reduce health risks for its employees who have potential to be exposed to hazardous materials. This program is based on the Occupational Safety and Health Administration (OSHA) requirements under the U.S. Department of Labor (29 CFR 1910.120). Medical examinations are administered on an annual basis. Each employee is issued a certificate to certify him/her for respirator use upon completion of all requirements.

All Terra Vac activities will be performed in accordance with OSHA Standards and with properly trained employees who have passed all medical requirements of 29 CFR 1910.120. In addition, site specific training will be given to all personnel expected to perform activities onsite. This training will address any potential hazards and associated risks, site operating procedures and emergency response procedures.

All subcontractors of Terra Vac whose personnel may be exposed to health and safety hazards will be responsible to insure their employees have received the proper training and medical tests as required by OSHA (29 CFR 1910.120).

4.00 ONSITE HAZARDS

4.10 Chemical Hazards

The primary hazard to workers at the site is the potential for release of hazardous levels of volatile organic compounds (VOCs) from soils as the result of soil disturbance activities. Drilling, trenching, and utility installation are the only intrusive activities anticipated on site.

Common symptoms of overexposure to compounds (gasoline) at the site are headache, dizziness, weakness, loss of coordination or irritation of the eyes, nose or throat. Air monitoring and associated action levels will be based on the exposure limits of gasoline/benzene with a margin of safety built into the action level. The chemical and physical properties of these materials, including exposure limits, are listed in Attachment A. Material Safety Data Sheets (MSDSs) for the hazardous materials found onsite are included in Attachment B.

4.20 Physical Hazards

Physical hazards typically found at construction sites will be of concern at this site. These hazards include slippery ground surfaces, uneven terrain, holes/trenches, and operation of heavy equipment. The basic Level D safety apparel such as steel-toed shoes, hard hat and safety glasses will be worn during all onsite activities.

Noise is not expected to be above 80 decibels within the equipment compound and 70 decibels at the perimeter of the site. However, it is standard practice for workers to wear hearing protection while performing routine maintenance on the operating equipment.

4.30 Environmental Hazards

Environmental hazards may exist at the project site, such as exposure to heat, wind, rain and lightening. To avoid the possibility of heat stress, the work regime defined below will be followed. When weather conditions change, the Project Manager and the SSO will be responsible for determining if work procedures can be performed safely.

For workers not wearing protective clothing, the following applies:

Temperature*	Work	Rest	Comments
70-80° F	4.0 hr.	15 min.	Review heat stress symptoms in a safety meeting.
80-85° F	2.0 hr.	15 min.	Review heat stress in a safety meeting. Schedule a beverage break every 2 hours.
85-90° F	2.0 hr.	15 min.	Seated rest. Drink at least 8 ounces at each break.
Above 90° F	1.5 hr.	15 min.	As above. Rest area should be shaded.

For workers who are wearing protective clothing, pulse rate monitoring will be used to schedule work/rest in accordance with the following:

Temperature*	Action
72.5-77.5° F	Monitoring each 120 minutes of work
77.5-82.5° F	Monitoring each 90 minutes of work
82.5-87.5° F	Monitoring each 60 minutes of work
87.5-90.0° F	Monitoring each 30 minutes of work
90.0° F or above	Monitoring each 15 minutes of work

If pulse rates are above 110 beats per minute, the length of the next work period will be shortened by 1/3.

* Temperature measured with a thermometer in the work area.

5.00 RISK ASSESSMENT

Exposure to chemical/physical hazards vary depending upon the work activity. The following is a summary of work activities and related exposure risks.

Activity	Chemical/Physical Risks	Assessment
Drilling/well installation	possible exposure to contaminated soils,heavy lifting, rotating equipment, heat stress	moderate-high
Construction	heavy lifting, heat stress	low-moderate
Start-up/ operations	heat stress	low
Demobilization	heavy lifting, rotating equipment, heat stress	low-moderate

6.00 SITE MONITORING/ACTION LEVELS

Intrusive field activities associated with the installation and/or operation of the dual extraction remediation system may create potential hazardous conditions such as the release of hazardous substances, especially during drilling activities. Monitoring with a hand-held photoionization detector (PID) will be conducted in the work zone during intrusive work and sampling activities to ensure appropriate personal protective measures are employed. The PID will monitor total VOC levels and will be calibrated daily using 100 ppm Isobutylene.

6.10 Action Levels

During the course of any activity, if PID readings of 0 - 99 parts per million (ppm) are encountered in the breathing zone of the exclusion area, level D personal protective equipment shall be used. If concentrations exceed 100 ppm for a period of 5 minutes or longer, the level of PPE shall be upgraded to level C. These levels are based on the assumption that benzene is 1% of the volatiles encountered onsite. The action level for benzene shall be 1 ppm.

6.20 Personal Protective Equipment

Based on an evaluation of the hazards at the site, personal protective equipment (PPE) will be required for all personnel and visitors entering the controlled portion (exclusion zone) of the site. Protective clothing and respiratory protection for each level of protection are as follows:

Level D:

- Long trousers and shirt
- Steel-toed shoes
- Safety glasses (if necessary)
- Protective gloves (if necessary)

Level C:

- Level D PPE
- Full or half face air purifying, organic vapor cartridge equipped respirator
- Disposable chemical resistant one-piece suit (tyvek)
- Inner and outer chemical resistant gloves

The anticipated levels for the various work activities are as follows:

*	Drilling activities (well installation/soil sampling)	C or D
*	Installation of process piping and equipment	D
*	System operations	D
*	System sampling	D
*	Site demobilization	D

7.00 SITE CONTROL PLAN

The equipment compound will be fenced in and will not be accessible to the public. Site safety zones will be established during site activities. These zones will be dynamic and the size and function of each zone will depend on the type of activity taking place. Only authorized personnel who comply with the training and medical requirements of 29 CFR 1910.120 may enter the exclusion zone of the site. The exclusion zone will be established around any intrusive activity, such as drilling, and will also apply to the fenced equipment compound after operations have begun.

7.10 Exclusion Zone (EZ)

The controlled portion of the site will be delineated to identify the exclusion zone, wherein a higher level of personal protective equipment may be required for entry. An EZ will be designated during intrusive activities such as drilling and soil sampling. The limits of the EZ will be defined by caution tape and barricades.

All personnel entering the EZ will be required to wear the level of protection (D or C) which has been selected by the SSO.

7.20 Decontamination Zone (DZ)

The DZ will be located immediately outside of the exclusion zone. Upon leaving the EZ, all personnel and equipment must follow appropriate decontamination procedures depending on the level of protection used within the EZ. This zone will also be delineated using caution tape and barricades.

7.30 Support Zone (SZ)

The support zone is considered to be the areas at the site at background concentration of any volatiles. All equipment and materials are stored and maintained in this zone. During operations, this zone will include the equipment compound containing the remediation system. Access will be controlled to limit any potential dangers to untrained personnel.

8.00 EMERGENCY PROCEDURES

Emergency communications at the site will be by means of a mobile phone or onsite telephone. A list of emergency telephone numbers will be posted along with maps showing emergency evacuation routes from the site and the route to the nearest hospital (see Figure 4, Hospital Location Map and Table 1, Emergency Telephone Numbers). A first aid kit will be located at or near the equipment area.

All injuries occurring onsite, no matter how minor, will be immediately reported to the SSO. The SSO shall evaluate the extent of the injury, arrange for appropriate medical attention, and investigate the cause of the injury.

The SSO and/or Project Manager are directly responsible for locating all personnel. When the site is evacuated due to an onsite emergency, personnel shall not re-enter until:

1) The conditions resulting in the emergency have been corrected.
2) The hazards have been reassessed.
3) The Health and Safety Plan has been reviewed

4) Site personnel have been briefed on any changes in safe work procedures.
5) A Terra Vac representative gives the all clear.

9.00 HAZARD COMMUNICATION PROGRAM

A hazardous chemical is broadly defined as a chemical that is either a health hazard, a physical hazard, or both. To insure that all employees and subcontractors receive the necessary information regarding the safe handling of chemicals and other substances that are normally required in the execution of Terra Vac projects, a Hazard Communication Program has been established.

A list of hazardous chemicals will be maintained by the Project Manager or SSO. The master list will consist of all hazardous chemicals used or stored at the project site and will be updated whenever a new chemical is brought to the site. The Project Manager or SSO must be notified of any chemical substance being ordered for the first time so as to be able to add that chemical to the master list.

Material Safety Data Sheets (MSDSs) for each chemical used or stored at the site are found in Attachment B.

10.00 SITE RULES/PROHIBITIONS

The following is a list of rules and prohibitions required for Terra Vac job sites.

1. Personal protective equipment will be required for all onsite personnel dependent upon action level (Level D is required if no other level is specified).
2. Operating logs and health and safety logs will be onsite for review and daily entries beginning with the drilling activities.
3. Health and safety monitoring for chemical, physical and environmental risks will be performed as needed and by qualified personnel.
4. Workers will be properly trained for the various tasks performed during this project.
5. Personnel and equipment will be properly decontaminated prior to breaks and leaving the site.
6. All onsite personnel will review and understand the Health and Safety Plan.
7. All work will be performed in a professional and safe manner.
8. All accidents will be reported to the Project Manager and the SSO.
9. No smoking will be permitted in Terra Vac vehicles, offices or at job sites.
10. No Terra Vac employee will be under the influence of alcohol or controlled substances while conducting Terra Vac business.

TABLE 1

EMERGENCY TELEPHONE NUMBERS

Ambulance/Paramedics:	**emergency**	**911**
Nearest Hospital:		
Summit Medical Center 350 Hawthorn Avenue Oakland, CA		**(510) 655-4000**

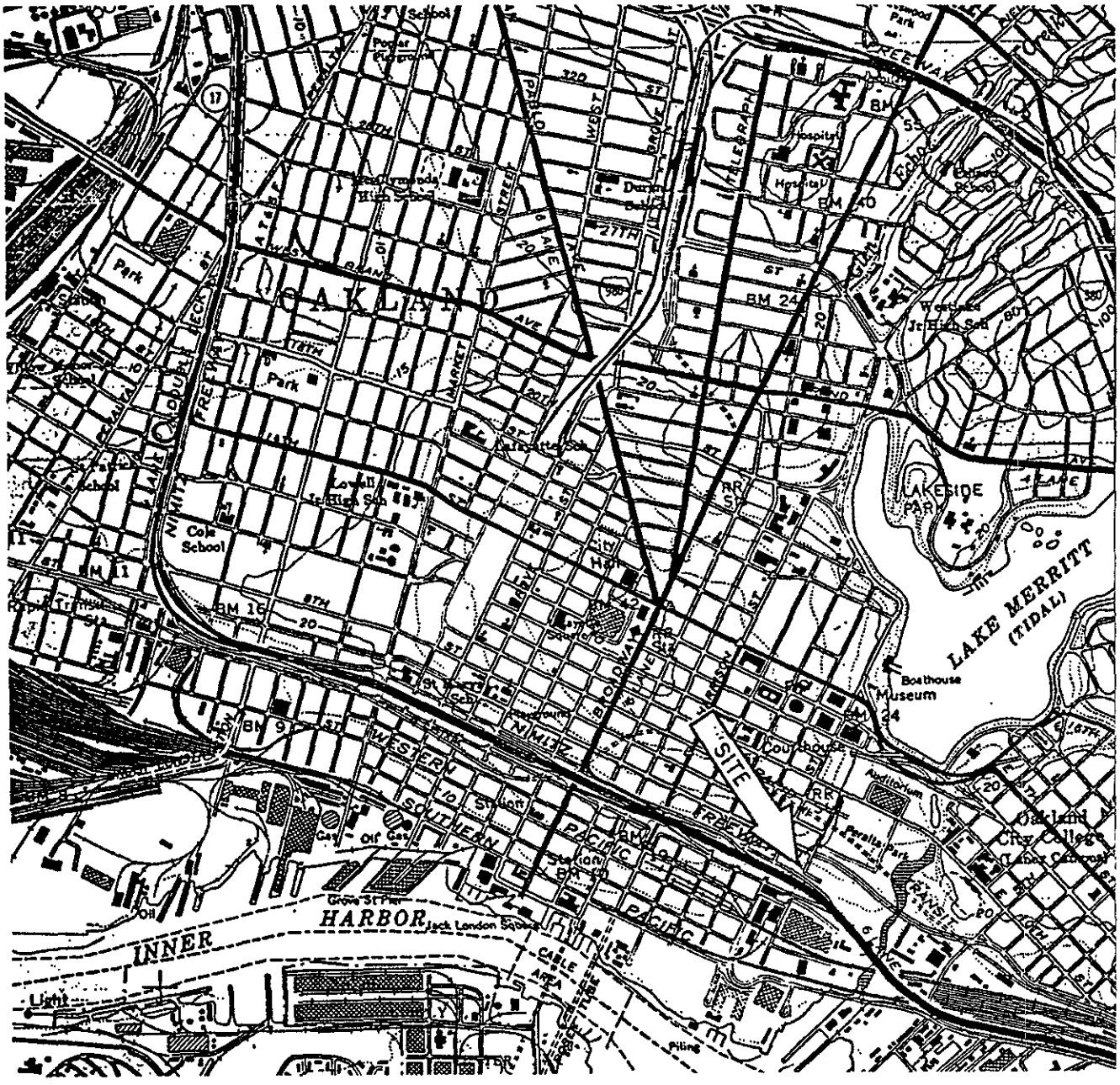
Directions to Summit Medical Center:

EXIT THE SITE HEADING WEST ON 6TH STREET. TURN RIGHT ONTO BROADWAY HEADING NORTH. DRIVE NORTH ON BROADWAY FOR APPROXIMATELY 3.0 MILES AND TURN LEFT ONTO HAWTHORN. TURN RIGHT INTO MEDICAL CENTER AND TAKE FIRST LEFT INTO EMERGENCY ROOM DROP-OFF AREA.

Oakland Fire Department: 1605 Martin Luther King Jr. Way	**emergency**	**911 or (510) 238-3856**
Oakland Police Department: 1455 7th Street	**emergency**	**911 or (510) 238-3481**
Poison Control Center:	24 Hours	(800) 523-2222
Terra Vac Office:		(510) 351-8900

Project 30-0219.18

FIGURES



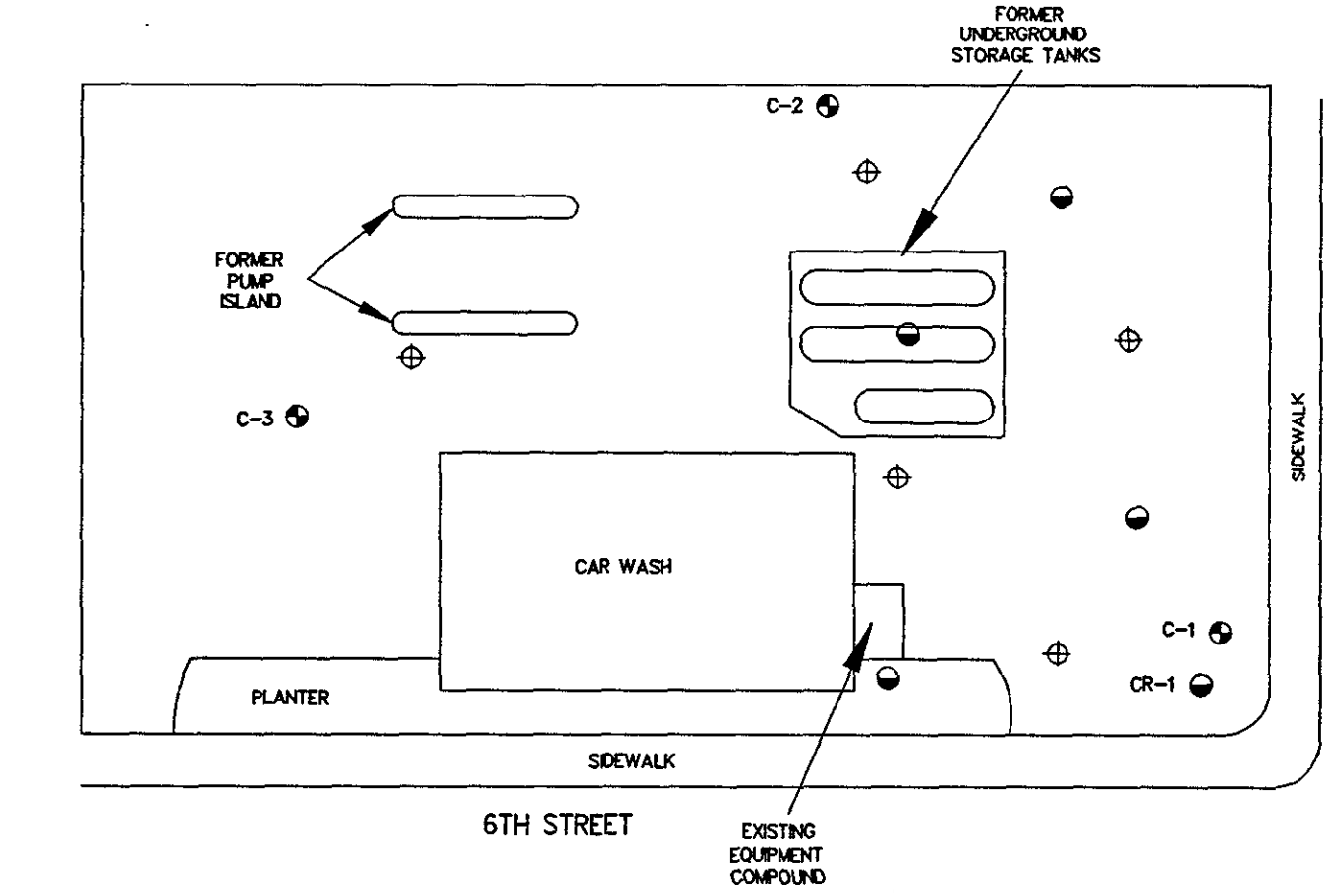
N

SITE VICINITY MAP
609 Oak Street
Oakland, California

Project	30-0219	Drawn by	APB
Date	4/14/95	Revision	
Scale	NTS	Checked	

TERRA VAC
14798 Wicks Boulevard
San Leandro, CA 94577
(510) 351-8900 fax: -0221

Figure 1



LEGEND

CR-1 = Groundwater monitoring well

= Dual completed well

= Entainment extraction well

Approximate Scale

20 10 0 20

feet

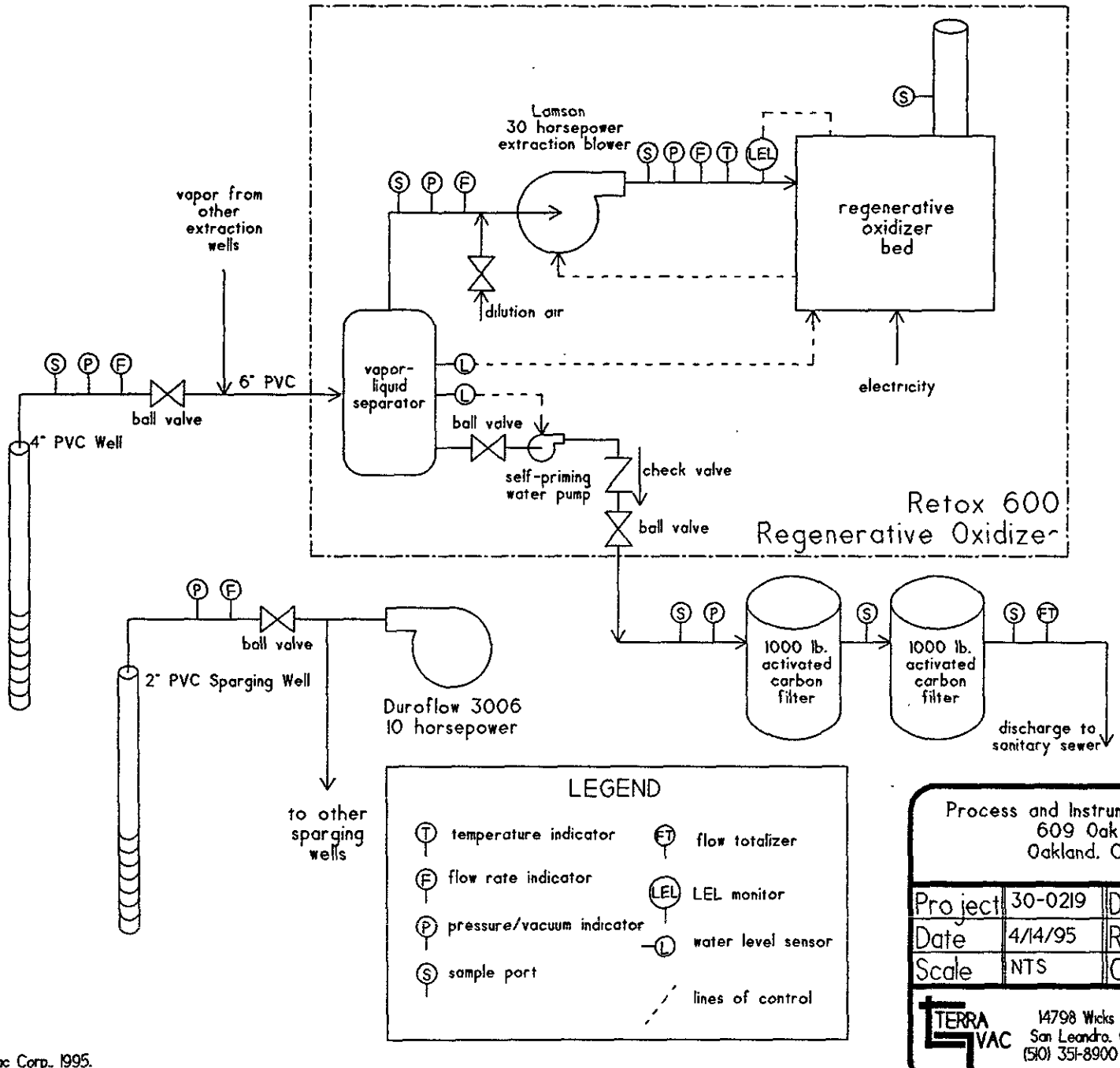
Source: Modified from plan supplied by Touchstone Development

FIGURE 2

PROJECT 30-0219

PLOT PLAN
Chevron Station 9-4587
609 Oak Street
Oakland, California

TERRA VAC

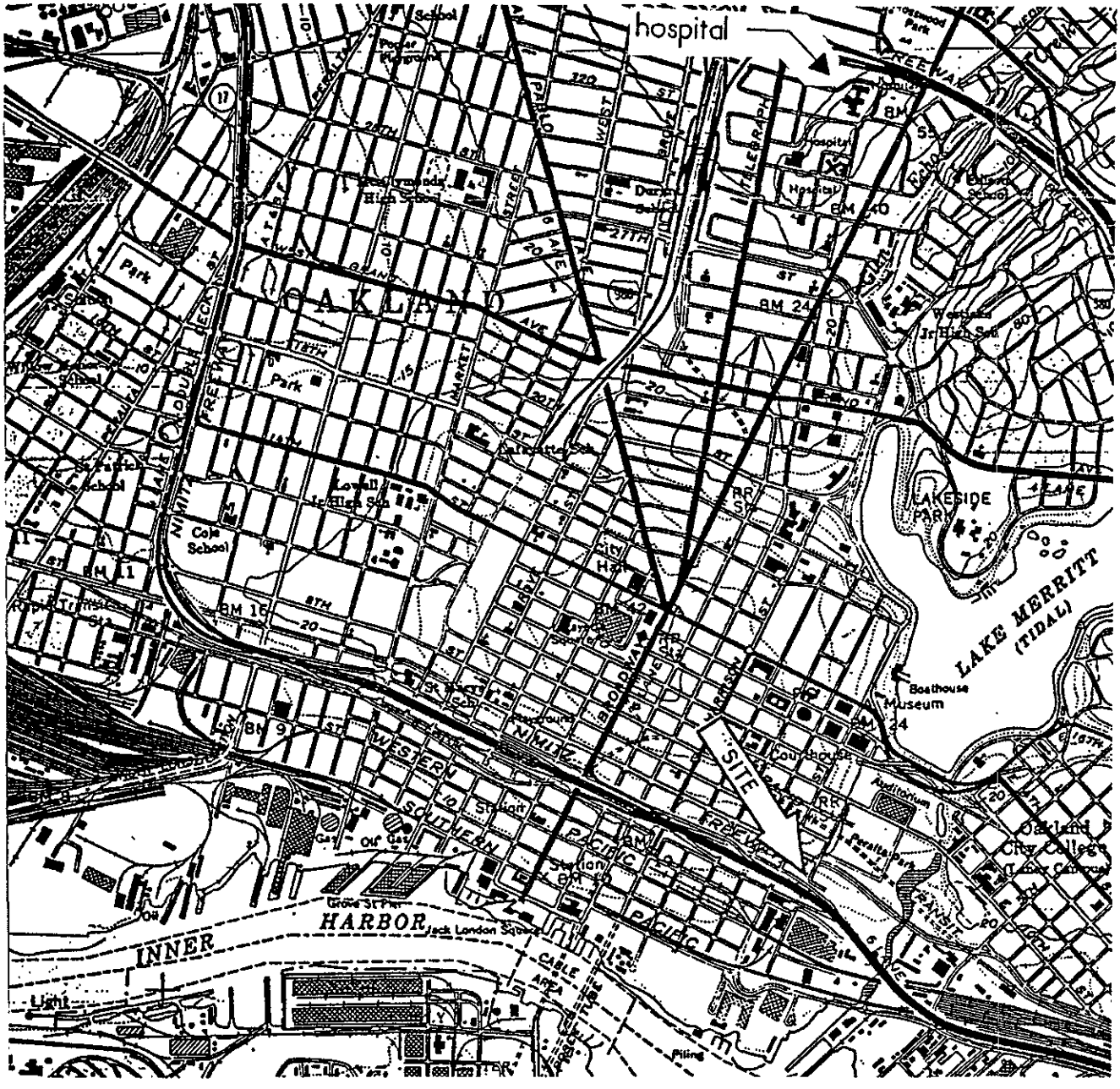


Process and Instrumentation Diagram
609 Oak Street
Oakland, California

Project	30-0219	Drawn by	APB
Date	4/14/95	Revision	1
Scale	NTS	Checked	

TERRA VAC
14798 Wicks Boulevard
San Leandro, CA 94577
(510) 351-8900 Fax -0221

Figure 3



ROUTE TO HOSPITAL
609 Oak Street
Oakland, California

Project	30-0219	Drawn by	APB
Date	4/14/95	Revision	
Scale	NTS	Checked	

TERRA VAC
14798 Wicks Boulevard
San Leandro, CA 94577
(510) 351-8900 fax: -0221

Figure 4

ATTACHMENT A

CHEMICAL AND PHYSICAL PROPERTIES OF CONTAMINANTS

PROJECT 30-0219

MUST ADHERE TO LOWEST VALUE

CONTAMINANT	EXPOSURE LIMIT	IDLH LEVEL	PROPERTIES	
Benzene	1 ppm PEL	2000 ppm	MW: 78 BP: 176 F SOL: 0.18% IP: 9.25ev Flash Point: 12 F	VP: 75 mm MP: 42 F UEL: 7.1% LEL: 1.3%
Gasoline (Regular)	300 ppm TLV		MW: n/a BP: 25-225 F SOL: insoluble IP: n/a Flash Point: <-49 F	VP: 5-15 PSI MP: n/a UEL: 7.6% LEL: 1.4%
Gasoline (Unleaded)	300 ppm TLV		MW: n/a BP: 25-225 F SOL: insoluble IP: n/a Flash Point: <-49 F	VP: 5-15 PSI MP: n/a UEL: 7.6% LEL: 1.4%

PEL (permissible exposure limit) **set by:** Cal OSHA
TLV (threshold limit values) **set by:** ACGIH
REL (time weighted average (TWA) concentration for up to 10hr workday during 40hr work-week) **set by:** NIOSH (10hr TWA)

ATTACHMENT B

MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheet

Prepared According to the OSHA Hazard Communication Standard (29 CFR 1910.1200).
(Formerly Called MATERIAL INFORMATION BULLETIN)

CHEVRON Unleaded Gasoline

CPS 201110

DANGER! HARMFUL OR FATAL IF SWALLOWED. VAPOR HARMFUL
LONG-TERM EXPOSURE TO VAPOR HAS CAUSED CANCER IN LABORATORY ANIMALS
MAY CAUSE EYE AND SKIN IRRITATION. EXTREMELY FLAMMABLE
KEEP OUT OF REACH OF CHILDREN

TYPICAL COMPOSITION

Blend of paraffins, naphthenes, aromatics and olefins including less than the percentages indicated for the following: 25% toluene (CAS 108-88-3), 20% xylenes (CAS 1330-20-7), 10% methyl tert butyl ether (MTBE) (CAS 1634-04-4), 5% benzene (CAS 71-43-2), 5% n-hexane (CAS 110-54-3), 5% cyclohexane (CAS 110-82-7), 5% ethyl benzene (CAS 100-41-4) and 5% naphthalene (CAS 91-20-3)

EXPOSURE STANDARD

The ACGIH (1985-86) TLV for gasoline is 300 ppm for a daily 8-hour exposure. No Federal OSHA exposure standard has been established for this material. See Additional Health Data for discussion of benzene exposure limits.

PHYSIOLOGICAL & HEALTH EFFECTS

Eye irritation may result from contact with the liquid or exposure to the vapor. The scientific literature warns that vapor concentrations above 500 ppm are irritating.

Prolonged or frequently repeated liquid contact may cause skin irritation or may cause the skin to become cracked or dry from the defatting action of this material. See Additional Health Data.

Prolonged or repeated breathing of gasoline vapor may be harmful. See Additional Health Data.

This material is expected to be only slightly toxic by ingestion. Note to Physician: See Additional Health Data.

EMERGENCY & FIRST AID PROCEDURES

Eyes

Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. If irritation persists, see a doctor.

Skin

Wash skin thoroughly with soap and water. See a doctor if any signs or symptoms described in this MSDS develop or if any skin irritation occurs. Launder contaminated clothing.

Inhalation

Move exposed person to fresh air. If breathing has stopped, apply artificial respiration. Call a doctor immediately. See Respiratory Protection, Page 2.

Ingestion

If swallowed, DO NOT make person vomit. Call a doctor immediately.

ADDITIONAL HEALTH DATA
See following pages

SPECIAL PROTECTIVE INFORMATION
Eye Protection: Keep away from eyes. Eye contact can be avoided by wearing chemical safety goggles.
Skin Protection: Keep away from skin. Skin contact can be minimized by wearing impervious protective clothing including gloves.
Respiratory Protection: Avoid prolonged breathing of vapor by using approved respiratory protection. In open areas, such as outdoor gasoline transfer areas, ventilation is usually adequate to prevent prolonged breathing of high gasoline vapor concentrations. See Additional Health Data.
Ventilation: Use this material only in well ventilated areas.
Comment: If you experience any of the signs or symptoms described in this MSDS, you may be exposed to harmful gasoline levels. Your exposure can be minimized if you follow the protective measures presented above.

FIRE PROTECTION
This product presents an extreme fire hazard. Liquid very quickly evaporates, even at low temperatures, and forms vapor (fumes) which can catch fire and burn with explosive violence. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches.
Flash Point: (P-M)<-49°F(-45°C)
Autoignition Temp.: NDA
Flammability Limits: 1.4-7.6%
Extinguishing Media: CO_2, Dry Chemical, Foam, Water Fog.
Special Fire Fighting Procedures: For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment. This may include self-contained breathing apparatus to protect against the hazardous effects of normal products of combustion or oxygen deficiency. Read the entire MSDS.

SPECIAL PRECAUTIONS
See last page of this MSDS.

X-INC031 (04-85)

ENVIRONMENTAL PROTECTION
Environmental Impact: Certain geographical areas have air pollution restrictions concerning the use of materials in work situations which may release volatile components to the atmosphere. Air pollution regulations should be studied to determine if this material is regulated in the area where it is to be used. This material is considered to be a water pollutant and releases of this product should be prevented from contaminating soil and water and from entering drainage and sewer systems.
Precautions if Material is Released or Spilled: Eliminate all sources of ignition in vicinity of spill or released vapor. Clean up small spills using appropriate techniques such as sorbent materials or pumping. Where feasible and appropriate, remove contaminated soil. Follow prescribed procedures for reporting and responding to larger releases.
Waste Disposal Methods: Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations. Contact local environmental or health authorities for approved disposal of this material.

REACTIVITY DATA
Stability (Thermal, Light, etc.): Stable.
Incompatibility (Materials to Avoid): May react with strong oxidizing materials.
Hazardous Decomposition Products: Normal combustion forms carbon dioxide and water vapor; incomplete combustion can produce carbon monoxide.
Hazardous Polymerization: Will not occur.

PHYSICAL PROPERTIES
Solubility: Soluble in hydrocarbons; insoluble in water.
Appearance (Color, Odor, etc.): Clear to yellow liquid.
Boiling Point: 25-225°C (Range)*
Melting Point: n/a
Specific Gravity: 0.7-0.8 (Range)
Vapor Pressure: 5-15 psi (max) @ 100°F(Range)*
Vapor Density (Air=1): 3-4(Range)
Percent Volatile (Volume %): 99+
Evaporation: NDA
*Variable with season and location.

n/a = Not Applicable
NDA = No Data Available

Material Safety Data Sheet

CHEVRON Unleaded Gasoline CPS 201110

ADDITIONAL HEALTH DATA

Ingestion of gasoline or inhalation of gasoline vapor at airborne concentrations exceeding 5000 ppm may cause signs and symptoms of central nervous system depression such as headache, dizziness, loss of appetite, weakness and loss of coordination. Vapor concentrations in excess of 5000 ppm may cause loss of consciousness, coma and death. Intentional exposures to excessively high concentrations (e.g., when used as a drug of abuse) have been reported to result in clinical manifestations that may include convulsions, delirium, and hallucinations. These manifestations are not known to occur following accidental inhalation of vapor or skin contact with gasolines during normal operations. Brief exposures to high vapor concentrations may also cause pulmonary edema and bronchitis. Note to Physician: Ingestion of this product or subsequent vomiting can result in aspiration of light hydrocarbon liquid which can cause pneumonitis.

This product may contain up to 4.9% benzene. Repeated or prolonged breathing of benzene vapors has been associated with the development of chromosomal damage in experimental animals and various blood diseases in humans ranging from aplastic anemia to leukemia (a form of cancer). All of these diseases can be fatal. Following a two-year cancer bioassay sponsored by the National Toxicology Program, NTP concluded that benzene is a carcinogen for rats and mice of both sexes. In its Monograph Supplement 4, the International Agency for Research on Cancer (IARC) listed *benzene in Group 1, chemicals carcinogenic to humans.* No teratogenic effects have been shown to occur in pregnant laboratory animals exposed to doses not acutely toxic to the mother. However, some evidence of fetotoxicity such as delayed physical development has been seen at such levels. The available information on the effects of benzene on human pregnancies is inadequate but it has been established that benzene can cross the human placenta. Note: Limiting the total hydrocarbon exposure to 300 ppm, the ACGIH TLV for gasoline, may not keep the benzene concentration below the 10 ppm Federal OSHA exposure standard and ACGIH TLV for benzene.

This product contains n-hexane. Prolonged or repeated contact with n-hexane may produce peripheral neuropathy characterized by progressive weakness and numbness in the extremities, loss of deep tendon reflexes and reduction of motor nerve conduction velocity. Recovery ranges from no recovery to complete recovery depending upon the duration of exposure and the severity of the nerve damage.

This product contains toluene. Toluene has been reported to decrease immunological responses in test animals. It has also been reported that when young rats were exposed to 1000 ppm toluene for 14 hours daily, for two weeks, irreversible hearing loss was detected. The same daily exposure to 700 ppm for as long as 16 weeks was without effect. Since the level necessary to produce hearing loss is greater than 7 times the 1985-86 ACGIH TLV for toluene, worker exposures at or below 100 ppm is not expected to cause any adverse effect. There are also reports that chronic abusers (glue sniffers, solvent huffers) of solvents containing toluene have suffered liver, kidney and brain damage. Scientific studies on toluene have failed to demonstrate teratogenicity in rats and mice. However, toluene has been shown to cause delayed growth and extra ribs in the offspring of rats and mice at inhaled doses (266-399 ppm) that were non-toxic to the mother. Toluene has not conclusively been shown to cause adverse reproductive effects in humans.

This product contains xylene. Xylene has been reported to be embryotoxic, teratogenic and to cause developmental disturbances in rats exposed in utero.

The American Petroleum Institute (API) sponsored a study where laboratory animals were exposed to 67, 292 and 2056 ppm unleaded gasoline vapor six hours/day, five days/week for approximately two years. Each exposure group consisted of 200 rats and 200 mice. During the course of the study, male rats had an increased incidence of kidney damage followed by repair and enlargement of the kidney tubules. At the end of the study, a dose-related incidence of microscopic kidney tumors was detected in the male rats; two tumors were found in the low exposure group, and five were found in the high exposure group. Female rats and both male and female mice did not show this type of lesion. It was noted in the study that the animals that were exposed to gasoline vapor lived longer than the control. Thus, the significance of the tumor findings is difficult to evaluate at this time. Additional findings in the API-sponsored study, which were observed only at the highest dose tested (2065 ppm), included (1) failure to gain body weight, (2) increased incidence of hepatocellular carcinomas (liver cancer) in female mice, and (3) lung inflammation in male and female rats. Subsequent testing has shown that the six to ten carbon isoparaffinic compounds in gasoline are apparently responsible for the early kidney damage seen in the male rat in the API study although the larger isoparaffins have not been individually tested. Information collected by the API and others indicates that the damage occurs only in the male rat, does not occur in female rats or mice and monkeys of either sex and may not occur in man. How this early kidney injury relates to the development of kidney tumors seen in the API study is currently unknown.

The significance to man of the results of the studies discussed above is not known. While we believe that low level or infrequent exposure to gasoline vapor is not likely to cause cancer or other serious disease, in light of the above information, the precautions outlined in this MSDS should be carefully observed. If strong odor of gasoline is present or if any irrritation occurs, individuals should leave the area or institute suitable protective measures (see page 2 - Special Protective Information).

SPECIAL PRECAUTIONS

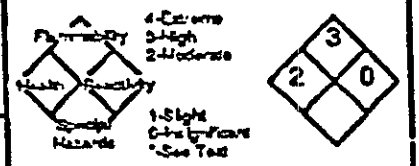
NEVER siphon gasoline by mouth. READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL.

Use only as a motor fuel. Do not use for cleaning, pressure appliance fuel, or any other such use. DO NOT USE OR STORE near flame, sparks or hot surfaces. USE AND STORE ONLY IN COOL, WELL VENTILATED AREA. Keep container closed. DO NOT TRANSFER LIQUID TO AN UNLABELED CONTAINER. DO NOT weld, heat or drill container. Replace cap or bung. Emptied container still contains hazardous or explosive vapor or liquid.

NFPA Hazard Rating:

Reactivity: 0, Flammability: 3, Health: 1* (*) Long-term exposure to vapor has caused cancer in laboratory animals.

BP CHEMICALS MATERIAL SAFETY DATA SHEET

24-HOUR EMERGENCY ASSISTANCE	GENERAL ASSISTANCE	NFPA FIRE HAZARD SYMBOL
BP America (In Ohio): 800-362-8059 (Outside Ohio): 800-321-8642 CHEMTREC Assist: 800-424-9300	Outside Ohio - 800-537-9720 Inside Ohio - 800-472-9922	
MSDS Number > 1027		

MANUFACTURER: BP Chemicals
ADDRESS: 200 Public Square, Cleveland, OH 44114-2375

PRODUCT IDENTIFICATION

TRADE NAME:
BENZENE

CAS NUMBER: 71-43-2
SYNONYM(S): BENZOL; BENZIN
CHEMICAL FAMILY: AROMATIC HYDROCARBON
MOLECULAR FORMULA: C6H6
MOLECULAR WEIGHT: 88.11
PRODUCT CODE: V 8135 HIERARCHY: 260.000

PRODUCT HAZARD SUMMARY

HEALTH
DANGER!
HARMFUL OR FATAL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN
ASPIRATION HAZARD
MAY BE IRRITATING TO THE SKIN, EYES AND RESPIRATORY TRACT
MAY CAUSE BLOOD DISORDERS
CANCER HAZARD

FLAMMABILITY
WARNING!
FLAMMABLE LIQUID & VAPOR

REACTIVITY
STABLE

PRODUCT HEALTH HAZARD INFORMATION

INGESTION:
SLIGHTLY TOXIC. Dog oral LDLo = 2,000 mg/kg. May cause harmful central nervous system effects. Effects may include excitation, euphoria, headache, dizziness, drowsiness, blurred vision, fatigue, tremors, convulsions, loss of consciousness, coma, respiratory

arrest and death. Aspiration into lungs may cause pneumonitis.

KI
MODERATELY IRRITATING. Repeated or prolonged contact may result in defatting, redness, itching, inflammation, cracking and possible secondary infection. May cause allergic reactions in some individuals.

YE:
SEVERELY IRRITATING. Direct contact may cause irritation, corneal edema and temporary corneal opacity. May also cause optic neuritis, atrophy and visual impairment.

INHALATION:
SLIGHTLY TOXIC. Rat LC50 = 10,000 ppm/7 hours. May cause respiratory tract irritation. Exposure may cause symptoms similar to those listed under "Ingestion" (see Ingestion section). Other effects may include loss of appetite, nervousness, pallor, anemia, bleeding under the skin and eyes and reduced clotting ability.

SPECIAL TOXIC EFFECTS:
Benzene is carcinogenic to laboratory animals when given by intubation or by inhalation. There is an association between occupational exposure to benzene and human leukemia. This association is based on limited information and is currently unresolved. Carcinogenic determinations: IARC--Human positive and Animal suspected carcinogen; NTP--Known carcinogen; ACGIH--Suspected carcinogen.

Acute benzene poisoning causes central nervous system depression. Chronic exposure affects the hematopoietic system causing blood disorders including anemia and pancytopenia. Mutagenic and clastogenic in mammalian and non-mammalian test systems. Reproductive toxicant only at doses that are maternally toxic, based on tests with animals.

FIRST AID

INGESTION:
DO NOT INDUCE VOMITING BECAUSE OF DANGER OF ASPIRATING LIQUID INTO LUNGS. Keep affected person warm and at rest. Get immediate medical attention.

SKIN CONTACT:
Wash area of contact thoroughly with soap and water. Get medical attention if irritation persists. Remove contaminated clothing immediately. Place contaminated clothing in closed container for storage until laundered or discarded. If clothing is to be laundered, inform person performing operation of contaminant's hazardous properties. Discard contaminated leather goods.

EYE CONTACT:
Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Get medical attention if irritation persists.

INHALATION:
Remove affected person from source of exposure. If not breathing, ensure open airway and institute cardiopulmonary resuscitation (CPR). If breathing is difficult, administer oxygen if available. Keep affected person warm and at rest. Get immediate medical attention.

NOTES TO PHYSICIAN

In cases of acute poisoning, artificial respiration with administration of oxygen is useful for support. Ingested benzene should be removed by gastric lavage, with care to avoid aspiration of liquid into the lungs, which may induce severe chemical pneumonitis. Vomiting should not be induced and consideration should be given to endotracheal intubation, especially for an unconscious patient. If spontaneous vomiting has occurred, the patient should be monitored for symptoms of pneumonitis, as this effect may be delayed up to 48 hours.

Seizure or convulsions may be controlled with diazepam, 0.1 mg/kg administered slowly intravenously. Keep patient at complete bed rest. DO NOT GIVE EPINEPHRINE, EPHEDRINE, OR SIMILAR ADRENERGIC DRUGS. THEY MAY INDUCE FATAL VENTRICULAR FIBRILLATION. Electrocardiographic monitoring should be carried out with severely ill patients to anticipate possible cardiac arrest.

Anemia may require the usual supportive measures. Medical evaluation of acute overexposure should include urinary phenol determinations and hematological determinations until stable. If recovery does not appear to progress, consideration of blood transfusions may be indicated.

In severe acute and chronic poisoning, both renal and hepatic damage may occur and should be anticipated in such cases. Respiratory and pulmonary problems may require special attention. After severe acute symptoms have been alleviated, it may be advisable to consider periodic monitoring of the patient until such time as the likelihood of other adverse effects can be discounted.

PERSONAL PROTECTION INFORMATION

EYE PROTECTION:
Wear safety glasses or chemical goggles to prevent eye contact. Have eye washing facilities readily available where eye contact can occur.

SKIN PROTECTION:
Wear appropriate impervious gloves and protective clothing to prevent skin contact. Suggested protective materials are: Viton and polyvinyl alcohol. Provide safety showers at any location where skin contact can occur.

RESPIRATORY PROTECTION:
Use NIOSH or MSEA approved equipment when airborne exposure limits are exceeded. Ventilation may be used to control or reduce airborne concentrations. NIOSH/MSHA approved breathing equipment may be required for non-routine and emergency use.

PHYSICAL PROPERTIES

BOILING POINT:	80.0 C (176 F)
SPECIFIC GRAVITY:	0.88
MELTING POINT:	5.5 C (42 F)
% VOLATILE:	100.0
VAPOR PRESSURE:	75.00 MM HG @ 20 C (68 F)
EVAPORATION RATE (WATER=1):	ND
VAPOR DENSITY (AIR=1):	2.8

ND = No Data
NA = Not Applicable

VISCOSITY: ND
% SOLUBILITY IN WATER: 0 2 @ 20 C (68 F)
POUR POINT: 5.5 C (42 F)
pH: NA
APPEARANCE/ODOR: COLORLESS FREE-FLOWING LIQUID WITH SWEET AROMATIC ODOR

FIRE AND EXPLOSION DATA

FLASH POINT: -11.00 C (12 F) TCC
AUTOIGNITION TEMPERATURE: 560.00 C (1044 F)
FLAMMABILITY LIMITS IN AIR (% BY VOL.) LOWER: 1.3 UPPER: 7.1

BASIC FIREFIGHTING PROCEDURES:
Use dry chemical, foam or carbon dioxide to extinguish fire. Water may be ineffective but should be used to cool fire-exposed containers, structures and to protect personnel. If leak or spill has not ignited, ventilate area and use water spray to disperse gas or vapor and to protect personnel attempting to stop a leak. Use water to flush spills away from sources of ignition. Do not flush down public severs.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Vapors form flammable or explosive mixtures with air at room temperature. Vapor or gas may spread to distant ignition sources and flash back. Containers may explode in heat of fire. Runoff to sever may cause fire or explosion hazard. Exposed firefighters should wear MSEA/NIOSH approved self-contained breathing apparatus with full face mask and full protective equipment. Dangerous when exposed to heat or flame.

REACTIVITY DATA

STABILITY/INCOMPATIBILTY:
Stable under normal conditions of use. Avoid contact with strong oxidizers.

HAZARDOUS REACTIONS/DECOMPOSITION PRODUCTS:
Combustion may produce CO, CO2 and reactive hydrocarbons.

ENVIRONMENTAL INFORMATION

SPILL OR RELEASE TO THE ENVIRONMENT:
If your facility or operation has an "Oil or Hazardous Substance Contingency Plan", activate its procedures.

-- Take immediate steps to stop and contain the spill. Caution should be exercised regarding personnel safety and exposure to the spilled material.

-- For technical advice and assistance related to chemicals, contact CHEMTREC (800/424-9300) and your local fire department.

-- Notify the National Response Center, if required.

Emergency Action:
Keep unnecessary people away. Stay upwind; keep out of low areas. Isolate hazard area and deny entry. (Also see Personal Protection Information section.) Isolate for 1/2 mile in all directions if tank or tankcar is involved in fire.

ND = No Data
NA = Not Applicable

Spill or Leak Procedure:
No flares, smoking or flames in hazard area. Stop leak if you can do it without risk. Use water spray to reduce vapors. Small Spills: Take up with sand or other noncombustible absorbent material or other sorbent known to be compatible, then flush area with water. Large Spills: Dike far ahead of spill for later disposal.

Notification:
The reportable quantity for this material is 10 pound(s).

Any spill or other release, or substantial threat of release, of this material to the air, water, or land (unless entirely contained in the workplace) equal to or in excess of the reportable quantity must be reported immediately to the National Response Center (800/424-8802) as required by U.S. Federal Law. Failure to report may result in substantial civil and criminal penalties.

WASTE DISPOSAL:
This substance, when discarded or disposed of, is a hazardous waste according to Federal regulations (40 CFR 261). It is listed as Hazardous Waste Number U019, so listed due to its toxicity.

The transportation, storage, treatment, and disposal of this waste material must be conducted in compliance with 40 CFR 262, 263, and 264. Disposal can occur only in properly permitted facilities. Check state and local regulations for any additional requirements.

SARA TITLE III INFORMATION:
Listed below are the hazard categories for the Superfund Amendments and Reauthorization Act (SARA) Section 311/312 (40 CFR 370):
Immediate Hazard: X Delayed Hazard: X Fire Hazard: X Pressure Hazard: - Reactivity Hazard: -

The product contains the following toxic chemical(s) subject to the reporting requirements of the Superfund Amendments and Reauthorization Act (SARA) Section 313 (40 CFR 372):

Component:	CAS Number:	Maximum %
Benzene	71-43-2	100.0

ADDITIONAL ENVIRONMENTAL REGULATORY INFORMATION:
This material is listed as a hazardous air pollutant under U.S. Federal regulations. See 40 CFR Part 61 for restrictions which may apply to its use.

This substance is listed as a toxic pollutant pursuant to 40 CFR 122.21, Appendix D, Table II/III. Any unusual introduction of this substance into the facility's process streams, stormwater and/or wastewater could result in the violation of U.S. Federal Law. Facilities must notify the USEPA as soon as they know, or have reason to believe, that any activity has occurred, or will occur, which would result in the discharge of a toxic pollutant which is not regulated in the facility's NPDES permit. Notification levels are described in 40 CFR 122.42(a)(1) and 122.42(a)(2). Refer to spill section for additional regulations.

There may be specific regulations at the local, regional or state level that pertain to this material.

REGULATORY INFORMATION

This product contains ingredient(s) known to the State of California to cause cancer, birth defects or other reproductive harm. All components of this product are listed on the TSCA inventory.

Contains Benzene. Consult OSHA Standard 1910.1028. Initial air monitoring should be conducted to determine if exposures are above 0.5 ppm action limit or 1 ppm PEL. If exposures are above, OSHA requirements apply for training, medical surveillance, personal/protective equipment, regulated areas, etc.

SPECIAL PRECAUTIONS/SUPPLEMENTAL INFORMATION

HANDLING/STORAGE:
Store in tightly closed containers in cool, dry, isolated, well-ventilated area away from heat, sources of ignition and incompatibles. Ground lines and equipment used during transfer to reduce the possibility of static spark-initiated fire or explosion. Do not eat, drink or smoke in areas of use or storage.

Empty containers may contain flammable/combustible or explosive residue or vapors. Do not cut, grind, drill, weld or reuse containers unless adequate precautions are taken against these hazards.

TRANSPORTATION REQUIREMENTS

D.O.T. HAZARD CLASS (49 CFR 172.101): FLAMMABLE LIQUID
D.O.T. PROPER SHIPPING NAME (49 CFR 172.101): BENZENE (BENZOL)
D.O.T. LABELS REQUIRED (49 CFR 172.101): FLAMMABLE LIQUID
D.O.T. PLACARDS REQUIRED: FLAMMABLE LIQUID
BILL OF LADING DESCRIPTION: BENZENE - FLAMMABLE LIQUID, UN 1114, "RQ"
UN/NA CODE: UN 1114

INGREDIENTS/HEALTH HAZARD INFORMATION

COMPONENT	CAS NO.	%	EXPOSURE LIMITS - REF.
Benzene	71-43-2	99-100	10 ppm (32 mg/M3) TLV (ACGIH 1989-90) 1 ppm 8-hour TWA; 5 ppm STEL (OSEA) 1 ppm 60-minute CEIL (NIOSH)
Remaining components not determined hazardous and/or hazardous components present at less than 1.0% (0.1% for carcinogens).	NA	Trace	NA

ND = No Data
NA = Not Applicable