BACE Environmental
A Division Of
Brunsing Associates, Inc.

November 18, 1992 29.6

Ms. Jennifer Eberle
Alameda County Health Services
Department of Environmental Health
80 Swan Way, Room 200
Oakland, CA 94621 11/18/92

RE; REPORT OF FINDINGS-VAPOR EXTRACTION PILOT STUDY
PACIFIC SUPPLY COMPANY
OAKLAND, CALIFORNIA

Dear Ms. Eberle:

Enclosed please find one copy of the Report of Findings for the Vapor Extraction Pilot Study performed by Brunsing Associates, Inc. (BAI) at the Pacific Supply Company, located at 1735 24TH Street, Oakland, California. Please refer all technical questions and comments to myself at BAI's Redwood City office, phone 415-364 - 9031, or Normita Callison at Pacific Coast Building Products, phone (916) 486-4094.6

Sincerely,

Michael E Velzy
Project Engineer

Enclosure

cc: Normita Callison, Pacific Coast Building Products
Jim Anderson, Pacific Supply Company
Tom Brunsing, BAI

1735 E. Bayshore Road, Suite 2A, Redwood City, CA 94063 Phone (415) 364-9030, Fax (415) 364-9032

REPORT OF FINDINGS
VAPOR EXTRACTION PILOT STUDY

Nov 1992

PACIFIC SUPPLY COMPANY
OAKLAND, CALIFORNIA

1735 24TH STREET
OAKLAND, CALIFORNIA 94623

NOVEMBER 18, 1992

REPORT OF FINDINGS
VAPOR EXTRACTION PILOT STUDY

PACIFIC SUPPLY COMPANY
1735 24TH STREET
OAKLAND, CALIFORNIA 94623

NOVEMBER 18, 1992

submitted to

ALAMEDA COUNTY HEALTH CARE SERVICES
DEPARTMENT OF ENVIRONMENTAL HEALTH
HAZARDOUS MATERIALS PROGRAM
80 Swan Way, Room 200
Oakland, California 94621

prepared for

PACIFIC COAST BUILDING PRODUCTS
3001 I Street
Sacramento, California 94002

prepared by

BRUNSING ASSOCIATES, INC.
1735 East Bayshore Road, Suite 2A
Redwood City, California 94063

Author: _____
Michael E. Velzy
Project Engineer

Reviewer: _____
Thomas P. Brunsing, Ph.D., P.E.
Principal

Acad? exp. date?

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1.0 INTRODUCTION

This Report of Findings (ROF) has been prepared by Brunsing Associates, Inc. (BAI) on behalf of the Pacific Supply Company, a subsidiary of Pacific Coast Building Products, in accordance with the Interim Remedial Action Workplan (Workplan), dated January 6, 1992 for the project site located at 1735 24th Street, Oakland, California. The site location is shown on Figure 1. The Workplan was reviewed and approved by the Alameda County Health Care Services, Department of Environmental Health - Hazardous Materials Division (DEH-HMD) in correspondence dated April 24, 1992.

The pilot study was performed with the approval of the Bay Area Air Quality Management District (BAAQMD). The BAAQMD was notified through correspondence dated June 18, 1992 from BAI under policy set forth in a BAAQMD Internal Memo, dated April 11, 1992 entitled "Gas Characterization Tests for On-Site Soil Decontamination Projects". Adherence to this policy is in lieu of performing a short term vapor extraction pilot study under BAAQMD permit.

This ROF presents the field methods, results, and design recommendations as part of the stated Workplan objectives for the vapor extraction pilot study.

2.0 VAPOR EXTRACTION PILOT STUDY FIELD METHODS

The intent of the pilot study was to determine the feasibility of using vapor extraction as an in-situ corrective action to reduce volatile hydrocarbon concentrations in the soil. One primary goal of this pilot study was to determine the radius of influence of the vapor extraction well in subsurface soils to eight feet below grade. Groundwater at the time the study started was approximately eight feet in depth.

A vapor extraction pilot study was conducted over a three day period during the week of June 23, 1992. Prior to implementing the pilot study, BAI installed one vapor extraction well (VEW-1) and five monitoring probes (P-5, P-10, P-15, P-20 and P-25). The extraction well VEW-1 was placed approximately 15 feet south of the former gasoline underground storage tank (UST) as shown on Figure 2. The locations of the monitoring probes are also indicated on Figure 2.

The vapor extraction system consisted of a trailer mounted internal combustion engine which powered the vacuum pump and standard catalytic converter which produced vacuum pressures at VEW-1 significantly high to induce an inward air flow into extraction well VEW-1.

2.1 Installation of the Vapor Extraction Well

A single two-inch diameter PVC extraction well (VEW-1) was installed on June 6, 1992 by Bay Land Drilling, Inc. with supervision provided by BAI. The extraction

well VEW-1 was constructed in accordance with the Workplan specifications. The soil boring VEW-1 was drilled to a depth of 8.5 feet below grade with an eight-inch (nominal) diameter hollow-stem auger. The well was screened to a depth of between 4.0 feet and 8.0 feet below grade. The screen slot size is 0.02 inches. As shown in Appendix A, a bentonite pellet seal was placed above the filter pack of coarse aquarium sand. A neat cement grout containing five percent (by volume) bentonite powder was placed above the bentonite seal to within six inches of existing grade. Extraction well VEW-1 was secured with an expandable locking well cap and traffic rated Christy box. The completion details of well VEW-1 are provided in Appendix A.

The soils generated from the drilling of boring VEW-1 was containerized in one 55-gallon and stored on-site. No purge water was generated from the installation of the extraction well. Rinseate water was added to an existing 55-gallon drum and left on-site.

to follow up

2.1.1 Soil Boring VEW-1

Soil boring VEW-1 was drilled to a depth of 8.5 feet below grade. Soils were observed to be medium stiff to very stiff clays to 5.5 feet below grade. Soils between 5.5 and 8.3 feet below grade were observed to be a loose silty sand. At 8.3 feet soils were reported to be a soft black clay. Soil samples were collected every one to two feet in depth. All soil samples indicated a petroleum odor. The strongest odors were detected at a depth of 8.3 feet below existing grade at the groundwater surface. The sample collected below 8.3 feet into the black clay had the strongest petroleum odor. Soil samples were collected between 4.5 and 5.0 feet and 8.0 and 8.5 feet below grade for chemical analyses. The sample between 8.0 and 8.5 feet was saturated indicating that this sample was collected at or near the groundwater surface. This was confirmed by measuring the depth to groundwater at well MW-3 which indicated groundwater to be 8.5 feet below grade prior to installation of well VEW-1. As shown on Figure 2 well MW-3 is approximately 32 feet south of well VEW-1. The boring log of well VEW-1 is provided in Appendix A.

2.1.2 Analytical Soil Test Methods and Results

Soil samples collected for analytical testing were tested for petroleum hydrocarbons using the following analytical methods:

- Total Petroleum Hydrocarbons as gasoline (TPHg), GCFID/EPA 8015;
- Benzene, Toluene, Ethylbenzene, Xylene (BTEX), EPA 5030/8020.

The analytical testing of the two soil samples from extraction well VEW-1 was performed by BACE Analytical & Field Services, Inc. Copies of the laboratory data and Chain-of-Custody Records are provided in Appendix B.

The results of the soil analytical testing are summarized on Table 1. The results of

the TPHg analyses reported that hydrocarbon concentrations increased from 100 mg/kg to 780 mg/kg between 4.5 feet and 8.0 feet below grade, respectively. All BTEX constituent concentrations increased between 4.5 feet and 8.0 feet below grade.

2.2 Installation of Vapor Monitoring Probes

Five vapor monitoring probes were installed during the week of June 15, 1992. These probes were installed by BAI staff to a depth of approximately six feet.

Installation of the monitoring probes was performed with a hand operated 110 volt rotary impact hammer which advanced 3/8-inch hollow steel rods into the subsurface soils. The steel rods were three feet in length. The rods were attached to a dedicated steel perforated tip which was pushed to the desired depth. Teflon tubing was joined to the perforated probe and threaded up through the hollow rods. The connection between the rods and the hammer was fabricated to permit the tubing to pass through the connection. The rotary impact hammer and machined components (rods, probes, impact bit, etc.) allowed the teflon tubing to connect the probes at depth to above ground monitoring instrumentation.

Upon achieving the desired probe depth of six feet, the hammer was disconnected from the rods, and the rods were pulled up approximately one to two inches which disconnect the probe from the rod. The probe was connected to the rod by way of a non-threaded slip collar. The rods wire extracted with the use of a jack, leaving in place the probe and tubing.

The five monitoring probes were positioned radially around well VEW-1 at distances of 5, 10, 15, 20, and 25 feet as shown on Figure 2. Installation of the monitoring probes did not permit the collection of soil samples for logging or analytical purposes.

2.3 Vapor Extraction System

Extraction of subsurface hydrocarbon vapors was performed using a commercially available vapor extraction system manufactured by Remediation Services International (RSI). The Spray Aeration Vacuum Extraction (S.A.V.E.) system consisted of an internal combustion engine which provided power to a vacuum pump, water pump, and air compressor. The vacuum pressures induced at the extraction well promote volatization of hydrocarbons which flow under pressure into the extraction system through the vacuum pump. These vapors are then directed to the engine intake when they are burned as part of the normal combustion process. The system also has the capability of separating hydrocarbons in the groundwater as vapor.

Emissions from the engine are passed through a standard catalytic converter to further enhance hydrocarbon destruction. The engine's fuel to air ratio is adjusted to maintain an efficient combustion.

The RSI system was set up at the Pacific Supply Company site with two 25-gallon propane tanks to be used as supplemental fuel sources. The pilot study focused on soil vapor extraction. The groundwater remediation component incorporated into the vapor extraction system, which consists of a type of sparging tank operated at moderately elevated temperatures, was not in operation during the course of the vapor extraction pilot study. No groundwater was intensionally extracted.

2.4 Field Monitoring

The primary goal of the pilot study was to monitor and quantify the effects of vapor extraction on each of the five monitoring probes such that depth was held constant and the distance from extraction well VEW-1 could be the dependent variable. From each probe differential pressure, measured in inches of water (accuracy approximately 0.02 inches), was recorded periodically during the test period. Differential pressure at each probe was measured with a Dwyer Series 2000 megnahelic gauge (Model 2000-00, 0.00 to 0.25 inches of water and Model 2001, 0.00 to 1.00 inches of water).

Organic vapor and differential pressure were measured at extraction well VEW-1. Organic vapor was monitored with a Foxboro Organic Vapor Analyzer (OVA) and a Horiba automotive emissions analyzer (Horiba) in parts per million (ppm). Vapor from well VEW-1 exceeded the upper limits of both the OVA (10,000 ppm) and the Horiba (13,400 ppm) for total organic vapors. Vapor monitoring was maintained at well VEW-1 during the course of the testing period with the OVA. The Horiba was used only once on June 17, 1992. OVA readings were recorded once each day during the vapor extraction pilot study.

3.0 TEST OPERATIONS

The RSI extraction system arrived at the site on June 22, 1992. The extraction system was set up for operation on June 23, 1992. The extraction system was connected to well VEW-1 through a two-inch flexible hose. The initial test was started at approximately 10:53 a.m. on June 23, 1992 and allowed to run while adjustments were made to fuel, air and well flow. Differential pressures were continuously monitored at each monitoring probe and the extraction well. Flow was measured in standard cubic feet per minute (SCFM) and pressure in inches of water.

Differential pressure was recorded at each monitoring probe every minute for the first 10 minutes, and every 10 minutes thereafter until the system was shut down at 11:25 a.m. when groundwater was pumped into the system's vacuum pump. Initial vacuum pressures were maintained at well VEW-1 above 150 inches of water. The test was terminated when groundwater was pumped into the system's vacuum pump. The remainder of the initial day of testing was spent varying with engine speed, well flow, fuel flow and air flow to develop an efficient combustion and an optional vacuum pressure that would not pump groundwater.

On the second day of test operations, it was speculated that probes P-5, P-15, and P-25 were clogged based on data obtained from probes P-10 and P-20 the previous day. The probes were replaced on June 24, 1992 near their original locations. Test operations resumed in the afternoon until groundwater pumping terminated the test after approximately 3.0 hours. It was determined that vacuum pressure at well VEW-1 was approximately 50 inches of water. At 50 inches of water the extraction system ran uninterrupted for 2.5 hours without pumping groundwater. Responses at probes P-15 and P-25 were observed to be significantly less than responses observed at probes -10 and P-20. No response was observed at probe P-5.

A continuous 24-hour pilot study was initiated on June 25, 1992 based on the subsurface and mechanical data obtained over the previous two days. This test started on 9:46 a.m. and ended at 10:00 a.m. on June 26, 1992. Operational parameters remained relatively constant over the 24 hour test period. These parameters are summarized below:

- Engine Revolutions Per Minute (RPM): 1200 - 1500
- Fuel Flow: zero
- Air Flow: 2.0 - 4.0 SCFM
- Well Flow: 4.0 SCFM
- Vacuum Extraction Well Pressure: 45 - 50 inches of water

During the 24 hour test period differential pressures at each monitoring probe were recorded every five minutes for the first 30 minutes then periodically thereafter as indicated on Table 2.

4.0 PILOT STUDY RESULTS

The results of the vapor extraction pilot study indicate that vapor extraction of volatile hydrocarbons can be an effective remediation option at the Pacific Supply Company site. The results of the field monitoring during the pilot study are presented below.

4.1 Organic Vapor Monitoring

Total hydrocarbon concentration of the gas vapors from well VEW-1 were monitored daily, but as previously discussed, gas vapor concentration levels exceeded the upper limits of both monitoring devices (OVA: 10,000 ppm; Horiba: 13,400 ppm). Hydrocarbon vapor concentration levels were recorded once each day. Based on the fuel consumption requirements of the internal combustion engine operating at approximately 1,300 RPM, it is estimated that hydrocarbon vapor concentrations extracted from well VEW-1 exceeded 100,000 ppm.

4.2 Differential Pressure Monitoring

During the course of the entire four day pilot study, all monitoring probes indicated

differential pressures from below 0.01 to 0.75 (excluding P-5) inches of water. As discussed above, monitoring probe P-5 was believed to be submerged during most of the test as a result of its close proximity to the extraction well. Monitoring probes P-15 and P-25 also experienced moderate amounts of occlusion. Differential pressures recorded at these probe locations appeared depressed compared to data from probes P-10 and P-20. Differential pressure data recorded at P-10 and P-20 are similar. Each of these two probes responded to the vapor extraction treatment in a similar fashion. Differential pressures from probes P-10 and P-20 increased slowly at the start of each operations period and eventually leveled off near equilibrium.

Based on the monitoring data from probes P-10 and P-20, it is estimated that for design purposes an effective radius of influence would be approximately 25 feet. Empirically, this value is based on the fact that P-20 experienced slightly higher differential pressures than those observed at probe P-10 which strongly suggests that differential pressures at a radius of 25 feet (minimum) from an extraction well under test conditions would be sufficiently strong to induce inward vapor flow. Analytically, this estimate of the radius of influence was verified using a mathematical solution. The steady-state radial pressure distribution equation was used to solve for the radius of influence. The results of this calculation indicated that the radius of influence was approximately 22 feet which is a conservative estimate based on actual field data. This calculation, input data and assumptions are provided in Appendix C.

4.3 Estimated Product Removed

Calculations were performed to estimate the total hydrocarbon product removed during the course of the 24 hour uninterrupted pilot test. Based on an average air flow of 21.2 SCFM, an average engine speed of approximately 1,360 RPM, and three estimated hydrocarbon vapor concentrations ranging from 80,000 to 125,000 ppm, the amount of product removed over the course of the 24 hour pilot test period varied from 15.8 to 19.8 gallons, respectively. The estimated hydrocarbon vapor concentrations were based on the known engine fuel/air ratio requirements and the fact that the engine ran continuously during the 24 hour test period without supplemental fuel. These computer generated calculations are provided in Appendix D.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the data collected during the four day long vapor extraction pilot study, the following conclusions have been prepared:

- Vapor extraction is a viable remediation option to reduce volatile hydrocarbons in the shallow subsurface soils. The lithology of the shallow subsurface fill soils at the Pacific Supply Company site permit the flow of air through the subsurface such that vapor extraction wells can be placed at approximately 50 feet on center. This spacing can be reduced to increase vapor extraction efficiency. Moreover, groundwater can be treated through an atomizing oil/water separator

component which is incorporated into the RSI S.A.V.E system used at the Pacific Supply Company site during the pilot study.

- The initial start of a vapor extraction remediation program would not require a supplemental fuel source as demonstrated by this study. For planning purposes it is estimated that this condition would persist two to four weeks, thereafter, propane or natural gas may be required to supplement the reduced hydrocarbon vapor supply extracted from the subsurface.

- The RSI S.A.V.E. system is recommended on the basis of its dual capability of extracting and treating groundwater and soil vapor simultaneously. Pumping groundwater from the same well that soil vapor is extracted from would off set rises in groundwater levels as a result of high vacuum pressures in the well. This combination of groundwater and soil extraction within the same well would affectively increase efficiency of the soil vapor component by maximizing the length of exposed well screen above the groundwater surface to reduce or eliminate the problems associated with a shallow groundwater surface and high vacuum extraction pressures.

- It is recommended that a groundwater pump test be performed at the site to determine the design groundwater flow rate. Additionally, a shallow subsurface soils investigation should be implemented to determine the lateral extent of the soil hydrocarbon plume. Once the lateral extent of the soil hydrocarbon plume is defined, a system of vapor extraction wells can then be developed for the site.

6.0 CERTIFICATION

The field and analytical methods, and preparation of this ROF has been performed for the Pacific Supply Company by BAI under the direct supervision of Michael Velzy and Dr. Thomas Brunsing. This ROF and associated activities has been developed to be consistent with acceptable regulatory guidelines and practices and sound engineering principles. Dr. Brunsing is a Registered Professional Engineer (Civil) in the state of California and certifies that the information contained in this ROF is accurate and complete to the best of his knowledge.

TABLES

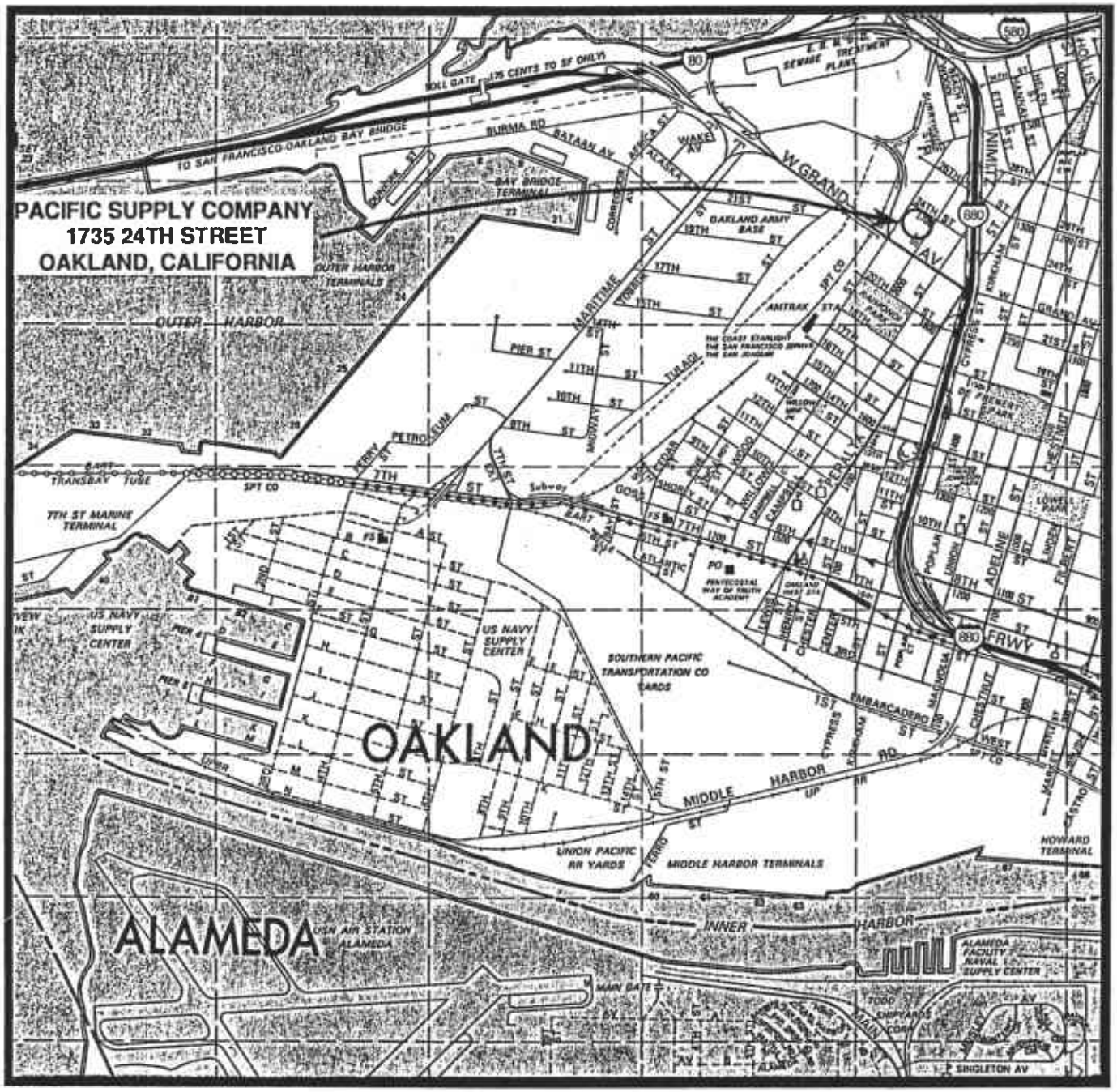
TABLE 1
SUMMARY OF SOIL ANALYTICAL RESULTS
PACIFIC SUPPLY COMPANY
OAKLAND, CALIFORNIA

Sampling Date	Description	TPH-G (mg/kg)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Xylene (µg/kg)
6/6/92	VEW-1 @ 4.5'	100	9,100	830	~~1,300~~ 1500	21,000
6/6/92	VEW-1 @ 8'	780	23,000	93,000	60,000	170,000

TABLE 2
VAPOR EXTRACTION MONITORING DATA
PACIFIC SUPPLY COMPANY
OAKLAND, CALIFORNIA

DATE TIME	ENGINE (RPM)	FUEL FLOW (CFM)	AIR FLOW (CFM)	WELL FLOW (CFM)	VAC @ EXTRACTION WELL (Inches H2O)	VAC MEASUREMENTS AT MONITORING PROBES (Inches H2O)					OVA MONITORING AT VEW-1 (PPM)	COMMENTS
						P-5	P-10	P-15	P-20	P-25		
6/24/92												Start of 24-hour continuous test
9:47	1500	0	3.00	4.50	49	0.00	0.00	0.00	0.00	0.00		
9:55	1300	0	3.00	4.50	49	0.00	0.05	0.00	0.04	0.00		
10:00	1250	0	2.50	4.50	50	0.00	0.10	0.01	0.10	0.00		
10:07	1250	0	2.00	4.00	49	0.00	0.13	0.01	0.30	0.01		
10:30	1200	0	2.00	4.00	46	0.00	0.13	0.01	0.50	<0.01		
10:45	1200	0	2.00	4.00	46	0.00	0.13	0.01	0.50	0.01		
11:00	1250	0	2.00	4.00	46	0.00	0.13	0.01	0.50	0.01	10,000+	OVA reading off scale
11:15	1250	0	2.00	4.00	45	0.00	0.12	<0.01	0.50	0.01		
11:35	1200	0	2.00	4.00	45	0.00	0.10	0.00	0.50	0.01		
12:40	1250	0	2.00	4.00	45	0.00	0.20	0.00	0.50	<0.01		
13:00	1250	0	2.00	4.00	46	0.00	0.40	0.00	0.55	0.01		
14:00	1250	0	2.00	4.00	47	0.00	0.60	0.00	0.50	0.01		
15:00	1300	0	2.00	4.00	47	0.00	0.70	0.00	0.60	0.01		
16:00	1300	0	2.00	4.00	48	0.00	0.70	0.00	0.75	0.01		
17:00	1300	0	2.00	4.00	48	0.00	0.70	0.00	0.75	0.01		System to remain on over night
6/25/92												
7:20	1300	0	3.00	4.00	50+	0.00	0.60	0.00	0.70	<0.01		
8:00	1300	0	2.90	4.00	50+	0.00	0.60	0.00	0.70	<0.01		
9:00	1300	0	2.90	4.00	50	0.00	0.60	0.00	0.70	<0.01	10,000+	OVA reading off scale
10:00	1300	0	2.90	4.00	49	0.00	0.60	0.00	0.70	<0.01		End of test, elapsed time 24 hours, 13 minutes, SAVE system ran uninterrupted for entire test period with supplemental propane fuel at low vacuum pressure and RPM

FIGURES



REFERENCE: Thomas Brothers Map, Alameda County, 1989

NORTH

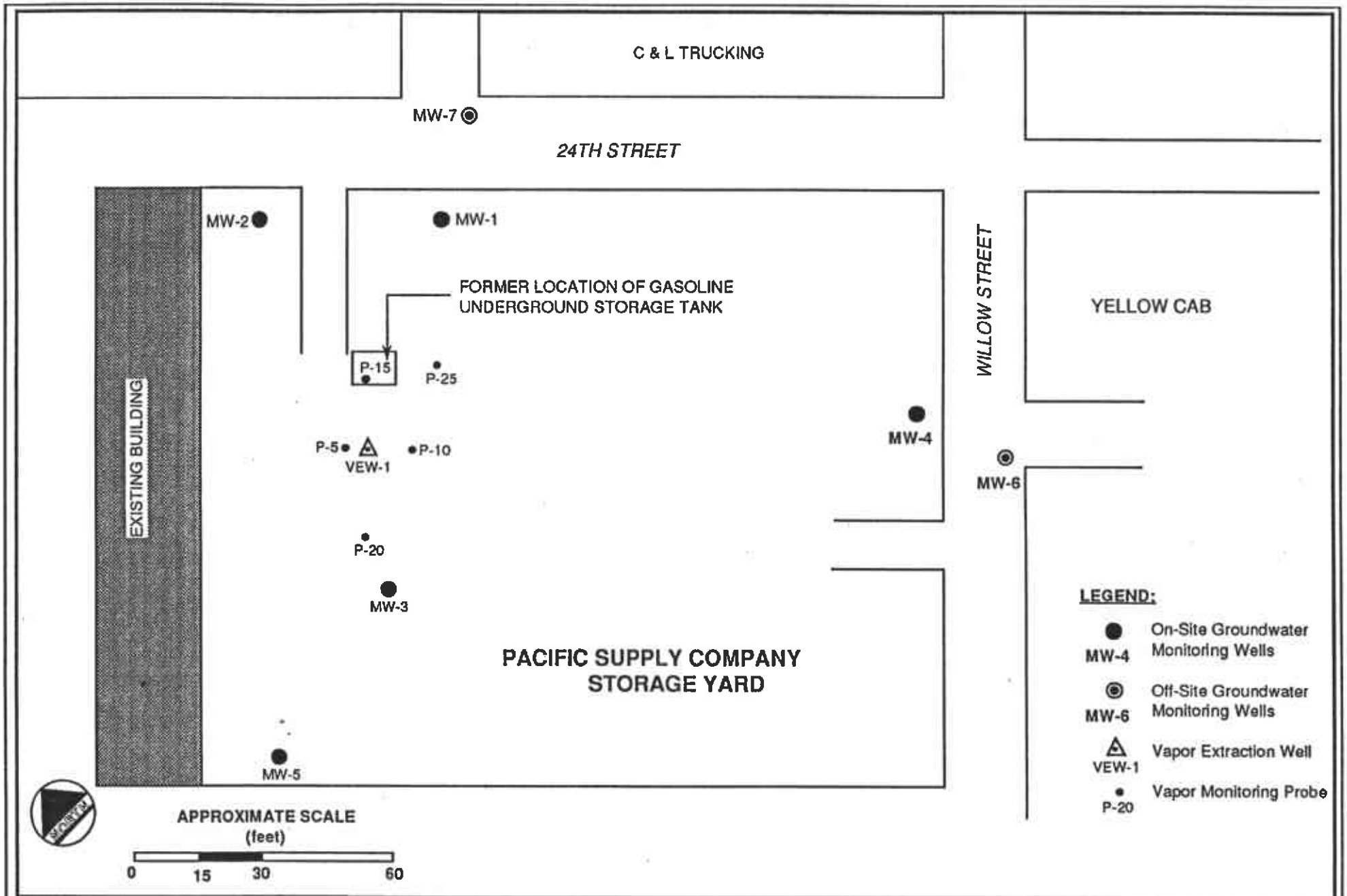
APPROXIMATE SCALE
(feet)

0 1100 2200 4400

PROJECT NO.:	29.6	
DRAWN BY:	JG	8/13/92
CHECKED BY:	MEV	8/13/92
APPROVED BY:	MEV	8/13/92

BRUNSING ASSOCIATES, INC.

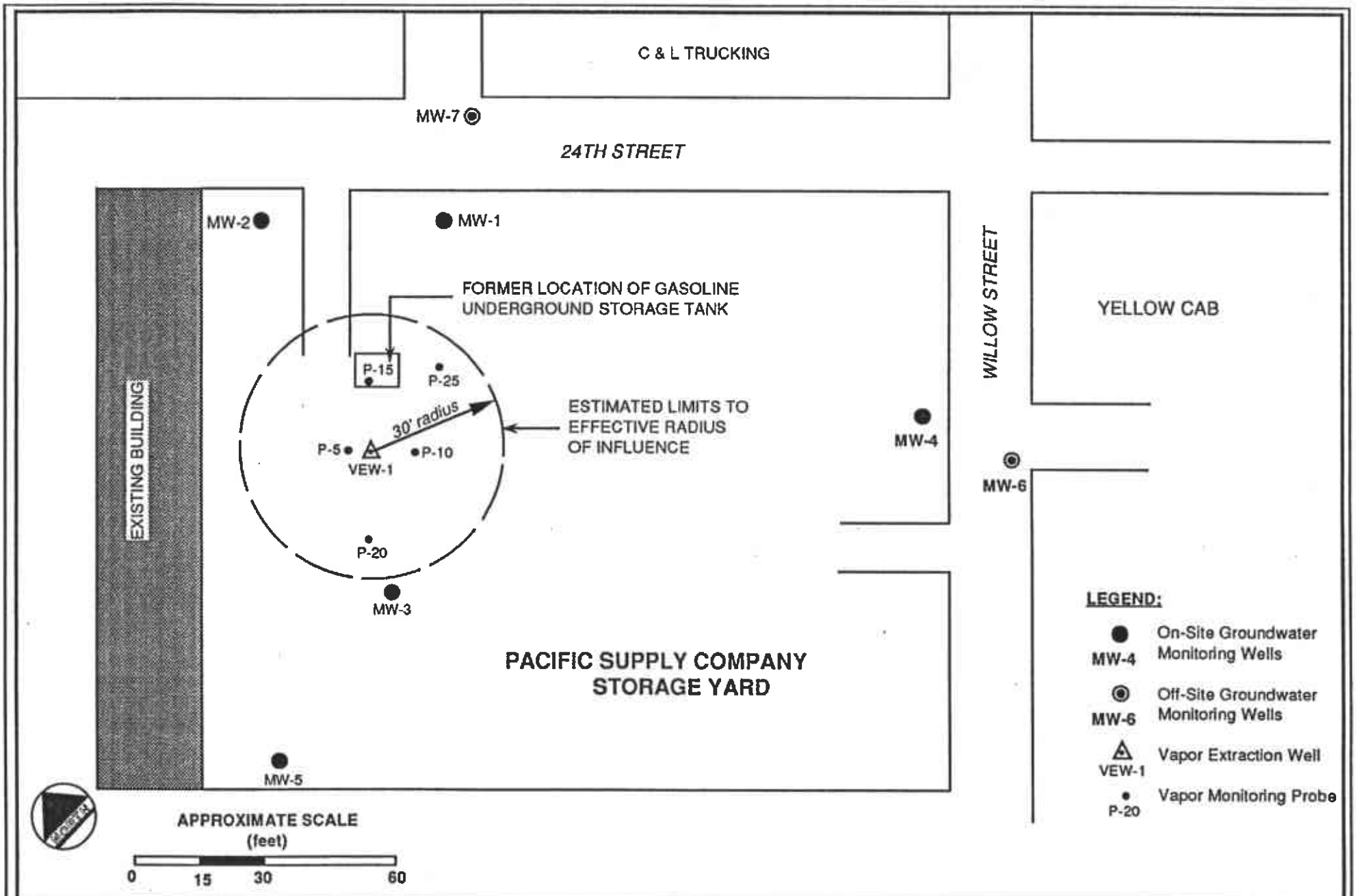
FIGURE 1
SITE VICINITY MAP
Pacific Supply Company
Oakland, California



PROJECT NO.:	29.6	
DRAWN BY:	JG	8/12/92
APPROVED BY:	MV	8/13/92
REVISION NO.:		

BRUNSING ASSOCIATES, INC.

FIGURE 2
SITE PLAN
Pacific Supply Company
Oakland, California



PROJECT NO.:	29.6	
DRAWN BY:	JG	8/12/92
APPROVED BY:	MV	8/13/92
REVISION NO.:		

BRUNSING ASSOCIATES, INC.

FIGURE 3
ESTIMATED RADIUS OF INFLUENCE
Pacific Supply Company
Oakland, California

APPENDICES

APPENDIX A

Boring Log and Completion Details of Vapor Extraction Well VEW-1

BRUNSING ASSOCIATES, INC.

Project Name: Pacific Supply Company

Project No.: 29.6

Boring Location: 65' northing and 185' westing of the north and east property lines

Surface Elevation: ~10 feet Driller: Bayland Drilling Date: 6/6/92

Depth	SOIL DESCRIPTION AND REMARKS	Lithology	U.S.C.S Soil Type	qu TSF	Contact Depth	SAMPLE No.	SAMPLE Type	SAMPLE Interval From	SAMPLE Interval To	BLOW COUNT 0–6	BLOW COUNT 6–12	BLOW COUNT 12–18	BLOW COUNT 18–24	Recovery In Inches
0'0"	Asphalt surface cover				0'									
0'6"	Base rock													
1'0"	Medium stiff green clay, moist, slight petroleum odor		CL		1'	1	SS	1'0"	1'9"	6	6	6	-	9
					2'									
2'6"	Medium stiff green clay, moist, slight petroleum odor					2	SS	2'6"	3'6"	4	5	7	-	12
					3'									
4'0"	Medium stiff green clay, moist, slight petroleum odor				4'									
5'0"	Very stiff black clay, moist, slight petroleum odor					3	SS	4'6"	5'0"	5	16	14	-	16
					5'									
5'6"	Loose green silty sand, moist, slight petroleum odor		SM			4	SS	5'6"	6'6"	5	4	5	-	12
					6'									
7'0"	Loose green silty sand, wet, slight petroleum odor				7'									
					▼ 8'	5	SS	8'0"	8'6"	2	2	2	-	2
8'4"	Soft black and green mottled clay, saturated, strong petroleum odor		CL		8'3"									
8'6"	Bottom of Boring				9'									
	Note: Converted into Vapor Extraction Well VEW-1													

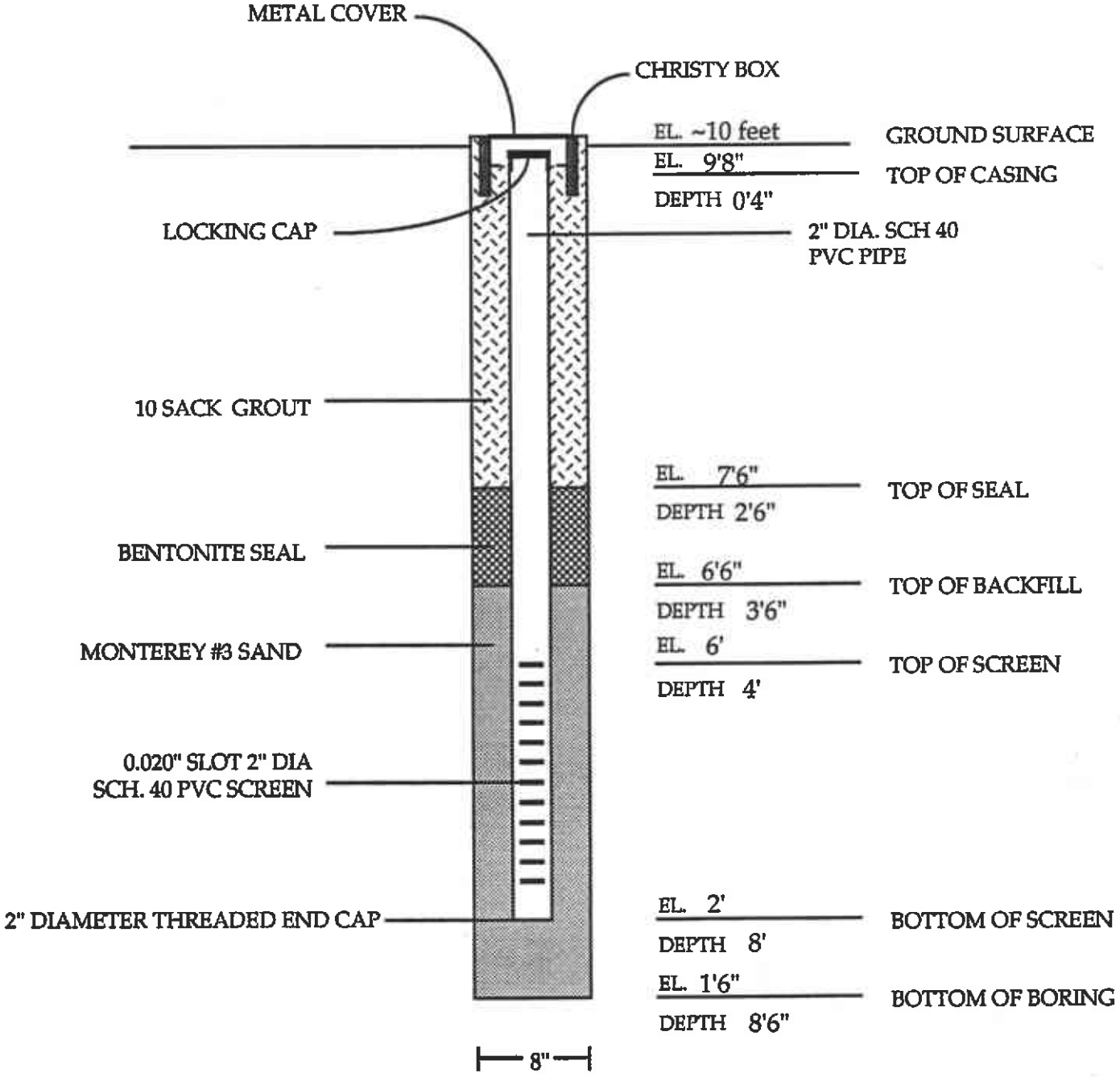
Field Log of Boring No.: VEW-1 By: Jeff Stivers Page 1 of 1

WELL COMPLETION DETAIL

PROJECT NAME: Pacific Supply Company PROJECT NO. 29.6

BORING LOCATION: 65' northing and 185' westing of the north & east property lines

WELL NUMBER: VEW-1 DATE: 6/6/92 BY: Jeff Stivers



APPENDIX B

Soil Analytical Results From Soil Boring VEW-1

BACE Analytical & Field Services, Inc.

P. O. Box 838, Windsor, CA 95492
707-838-8338 FAX 707-838-4420

Sonoma County

June 22, 1992
Log No: 1518

Brunsing Associates, Inc.
1607 Industrial Way
Belmont, California 94002

ATTN: Jeff Stivers

RE: Results of the analyses of soil samples obtained for project number 29.6 on June 6, 1992.

Dear Mr. Stivers,

This letter serves to confirm the analytical results previously communicated to you. Should any questions arise concerning procedure or results, please feel free to contact us.

Sincerely,

William G. Rotz
Director, Mobile Analytical Services

Tami Hucke Norgrove
Laboratory Manager

Client: Brunsing Associates, Inc.
Client Contact: Jeff Stivers

Sample Date: 6/6/92
Analysis Date: 6/19/92

BAFS Log No: 1518

METHOD: EPA 5030/8020

Matrix: Soil

Parameter	Reporting Limit µg/kg	Lab No: Descriptor:	Results - µg/kg 1518-1 (VEW-1, 4.5')	1518-2 (VEW-1, 8')
Benzene	5.0		9100 (9.1 ppm)	23000 (23 ppm)
Toluene	5.0		830	93000
Ethylbenzene	5.0		1500	60000
Xylene (total)	5.0		21000	170000
Dilution Factor:			10	100

METHOD: 5030 / GC FID

Parameter	Reporting Limit mg/kg	Lab No: Descriptor:	Results - mg/kg 1518-1 (VEW-1, 4.5')	1518-2 (VEW-1, 8')
TPH - gasoline	1.0		100	780
Dilution Factor:			10	100

NOTE: ND = not detected.
nr = not requested.

BACE Analytical
& Field Services, Inc.

SUMMARY OF LABORATORY RESULTS *

Pacific Supply - Project No. 29.6

Sampling Date	Lab Number	Descriptor	TPH (gas) mg/kg	Benzene ug/kg	Toluene ug/kg	Ethylbenzene ug/kg	Xylene ug/kg
6/6/92	1518-1	VEW-1, 4.5'	100 <	9100	830 <	1500 <	21000 <
6/6/92	1518-2	VEW-1, 8'	780 <	23000 <	93000 <	60000 <	170000 <

** See original laboratory report dated 6/22/92 for complete results.*

PROJ. NO.	PROJECT NAME
29.6	Pacific Supply
L.P. NO.	SAMPLERS: (Signature)

DATE	SAMPLE I.D	TYPE	NO. OF CONTAINERS	ANALYSIS: TPH-gas w/BTEX	REMARKS
6/6/92	VEW-1 4.5'	Soil	one	X	1518-1
6/6/92	VEW-1 8'	Soil	one	X	-2

LABORATORY: BAES

Relinquished by: (Signature)	Date/Time	Received by: (Signature)
	6/16/92 9:40	
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)

Remarks

TAT according to SB 2004 / 10 day price

Analysis per Tri-Regional Reqs

BRUNSING ASSOCIATES, INC.

Main office:
P. O. Box 588
Windsor, CA 95492
707-838-3027

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1607 Industrial Drive
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APPENDIX C

Analytical Determination of Radius of Influence

BRUNSING ASSOCIATES, INC.

By MEV Date 8/25/92 Subject PACIFIC SUPPLY CO. OAKLAND Sheet No. 1 of 3

Chkd By TPB Date 9-16-92 ANALYTICAL DETERMINATION OF RADIUS OF INFLUENCE Project No. 29.6

ESTIMATE LENGTH OF RADIUS OF INFLUENCE (R_I) FROM STEADY-STATE RADIAL PRESSURE DISTRIBUTION EQUATION:

$$P(r) = P_W \left[1 + \left(1 - \left(\frac{P_{atm}}{P_W}\right)^2\right) \frac{\ln (r/P_W)}{\ln (P_W/R_I)} \right]^{1/2}$$

WHERE:

$P(r)$ = ABSOLUTE PRESSURE MEASURED @ A DISTANCE r FROM THE EXTRACTION WELL VEW-1

P_{atm} = ABSOLUTE AMBIENT PRESSURE

P_W = ABSOLUTE PRESSURE APPLIED TO VAPOR EXTRACTION WELL VEW-1

R_W = RADIUS OF VEW-1 CASING

VALUES FOR $P(r)$, P_{atm}, P_W, R_W and r WERE MEASURED IN THE FIELD DURING THE EXECUTION OF THE VAPOR EXTRACTION PILOT TEST.

MATHEMATICAL ARRANGEMENT OF EQUATION TO SOLVE FOR R_I:

$$\left(\frac{P(r)}{P_W}\right)^2 = 1 + \left(1 - \left(\frac{P_{atm}}{P_W}\right)^2\right) \frac{\ln (r/P_W)}{\ln (P_W/R_I)}$$

$$\frac{\left(\frac{P(r)}{P_W}\right)^2 - 1}{1 - \left(\frac{P_{atm}}{P_W}\right)^2} = \frac{\ln (r/P_W)}{\ln (P_W/R_I)}$$

$$\ln (P_W/R_I) = \frac{\ln (r/P_W)\left[1 - \left(\frac{P_{atm}}{P_W}\right)^2\right]}{\left(\frac{P(r)}{P_W}\right)^2 - 1}$$

VARIABLE VALUES INCLUDE:

$$P(r) = 1.0 \text{ atm} - 0.70 \text{ in } H_2O \left(\frac{2.454 \times 10^{-3} \text{ atm}}{1.0 \text{ in } H_2O}\right) = 0.998 \text{ atm}$$

$P_{atm} \approx 1.0$ atm

$$P_W = 1.0 \text{ atm} - 50 \text{ m } H_2O \left(\frac{2.454 \times 10^{-3} \text{ atm}}{1.0 \text{ in } H_2O}\right) = 0.877 \text{ atm}$$

$R_W = 2.54$ cm

$r = 610$ cm

SOLVING FOR R_I:

$$\ln\left(\frac{R_W}{R_I}\right) = \frac{\ln\left(r/R_W\right)\left[1-\left(\frac{P_{atm}}{P_W}\right)^2\right]}{\left(\frac{P(r)}{P_W}\right)^2 - 1}$$

$$= \frac{\ln\left(\frac{610 \text{ cm}}{2.54 \text{ cm}}\right)\left[1-\left(\frac{1.00 \text{ atm}}{0.877 \text{ atm}}\right)^2\right]}{\left(\frac{0.998 \text{ atm}}{0.877 \text{ atm}}\right)^2 - 1} = -5.58$$

$$\ln\left(\frac{R_W}{R_I}\right) = -5.58$$

$$\frac{R_W}{R_I} = e^{-5.58}$$

$$R_I = R_W / e^{-5.58} = 2.54 \text{ cm} / e^{-5.58}$$

$$\therefore R_I = 673 \text{ cm} = 22.1 \text{ feet}$$

BRUNSING ASSOCIATES, INC.

By MEV Date 8-25-92 Subject PACIFIC STEEL CO. / OAKLAND Sheet No. 3 of 3

Chkd By TPB Date 9-16-92 ANALYTICAL DETERMINATION OF RADIUS OF INFLUENCE Project No. 29.6

REFERENCES:

1.) JOHNSON, P.C., STANELY, C.C., KEMBLOWSKI, M.W., BYERS, D.L. & COLTHART, J.D., SPRING 1990, "A PRACTICAL APPROACH TO THE DESIGN, OPERATION, AND MONITORING OF IN SITU SOIL-VENTING SYSTEMS," GROUNDWATER MONITORING REVIEW.

2.) JOHNSON, P.C., KEMBLOWSKI, M.W. & COLTHART, J.D., DATE UNKNOWN, "PRACTICAL SCREENING MODELS FOR SOIL VENTING APPLICATIONS," SHELL DEVELOPMENT, HOUSTON, TEXAS.

APPENDIX D

S.A.V.E. System Performance Data

S.A.V.E. SYSTEM PERFORMANCE DATA
TABLE VI
Explanation for Table I

GROUNDWATER	SPRAY AERATOR WATER IN	GALLONS	1. Monthly total of contaminated water remediated: table IV, col 10.
		TPH-PPM*	2. Average concentration of TPH in the contaminated water: table II, col 2.
	SPRAY AERATOR WATER OUT	GALLONS	3. Monthly total of remediated water: table IV, col 10.
		TPH-PPM*	4. Average concentration of TPH in the remediated water: table II, col 3.
VAPOR	RECOVERED VAPORS FROM WELLS	SCFM*	5. Conversion of cfm to scfm; see calculation 1, table VII.
		TPH-PPM*	6. Average concentration of TPH in the extracted vapor: table II, col 4.
	TOTAL VAPORS TO ENGINE	SCF	7. Weighted average for vapor and air in scf; see calculation 2, table VII.
		TPH-PPM*	8. Same as #6. Auxiliary fuel not included in calculation for TPH value.
AIR	TO SPRAY AERATOR	SCFM	9. Conversion of cfm to scfm; see calculation 3, table VII.
	TO ENGINE	SCFM	10. Same as #9. Air goes directly to engine from aerator tank.
FREE PRODUCT	RECOVERED FROM WELLS	GALLONS	11. Free product skimmed or bailed from wells.
ENGINE	EXHAUST	TPH-PPM*	12. Average concentration of TPH in the exhaust: table II, col 5.
		CO-%*	13. Average concentration of CO in the exhaust: table V, col 3.
	OPERATION	HOURS	14. Monthly total of the operating hours: table III, col 3.
	SPEED	RPM	15. Average RPMs: table III, col 4.
TOTAL CONTAMINANT REMOVED	FROM THE PROJECT LOCATION	GALLONS	16. See calculation 4, table VII.

* DENOTES AVERAGE CONCENTRATIONS.

S.A.V.E. SYSTEM PERFORMANCE DATA
TABLE VII
Calculations

Calculation 1:	A = weighted average for extracted vapor (cfm); table IV, col 8.	4.1
	B = weighted average for vacuum at extraction manifold (in H_2O); table III, col 5.	50.0
	C = average ambient air temperature (degree Farenheit); table IV, col 2.	70.0
	D = standard temperature (68 degree Farenheit); table IV, col 3.	
	E = contaminated vapor recovered (scfm)= A cfm * (384 in H_2O - B in H_2O) * (460 deg R/deg F + D deg F) / ((460 deg R/deg F + C deg F) * 384 in H_2O)	3.6
Calculation 2:	E = contaminated vapor recovered - Calculation 1 (scfm).	3.6
	G = air to spray aerator - Calculation 3 (scfm).	21.2
	H = total run time (hours); table III, col 3.	24.1
	I = total vapors to engine (scf)= (E scfm + G scfm) * H hr * 60 hr/min.	35860.8
Calculation 3:	J = average air flow to spray tank (cfm); table IV, col 7.	21.2
	C = average ambient air temperature (degree Farenheit); table IV, col 2.	70.0
	D = standard temperature (68 degree Farenheit); table IV, col 3.	70.0
	G = air to spray aerator (scfm) = J cfm * (460 deg R/deg F+ C deg F) / (460 deg R/deg F + D deg F)	21.2
Calculation 4.	E = vapor recovered - Calculation 1 (scfm).	3.6
	K = average TPH concentration extracted vapor from wells (ppmv); table II, col 4.	125000.0
	H = total run time (hours); table III, col 3.	24.1
	P = average TPH concentration in extracted H_2O (mg/L); table II, col 2.	0.0
	M = average TPH concentration in discharged H_2O (mg/L); table II, col 3.	0.0
	N = total discharge water (gallons); table IV, col 10.	0.0
	O = free product recovered (gallons); #11 on previous page.	0.0
#	S = contaminant removed from vapor (gallons) = 1.557 * 10-7 lb mole min/cu ft hr * E scfm * K ppmv * 86 lb/lb mole * 7.4805 gal/cu ft * H hr / 43.9 lb cu ft	24.7
	T = contaminant removed from groundwater (gallons) = (P mg/L - M mg/L) * 3.785 L/gal * N gal * 2.2046 * 10-6 lb/mg * 0.1325 gal/lb	0.0
	TOTAL CONTAMINANT REMOVED = S gal + T gal + O gal	24.7

See FUEL CONVERSION CALCULATION sheet for explanation of 1.557 * 10-7 lb mole min/cu ft hr.

S.A.V.E. SYSTEM PERFORMANCE DATA

TABLE I

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

MONTH			JUN 92					
GROUNDWATER	SPRAY AERATOR WATER IN	GALLONS						
		TPH-PPM*						
	SPRAY AERATOR WATER OUT	GALLONS						
		TPH-PPM*						
VAPOR	RECOVERED VAPORS FROM WELLS	SCFM*	3.6					
		TPH-PPM*	80000.0					
	TOTAL VAPORS TO ENGINE	SCF	35860.8					
		TPH-PPM*	80000.0					
AIR	TO SPRAY AERATOR	SCFM	21.2					
	TO ENGINE	SCFM	21.2					
FREE PRODUCT	RECOVERED FROM WELLS	GALLONS						
ENGINE	EXHAUST	TPH-PPM*						
		CO-PPM*						
	OPERATION	HOURS	24.1					
	SPEED	RPM	1358.1					
TOTAL CONTAMINANT REMOVED	FROM THE PROJECT LOCATION	GALLONS	15.8					

* DENOTES AVERAGE CONCENTRATIONS.

S.A.V.E. SYSTEM
SUMMARY OF LABORATORY RESULTS FOR JUN 92
TABLE II

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	EXTRACTED H_2O TO AERATOR (mg/l)	DISCHARGED H_2O FROM AERATOR (mg/l)	EXTRACTED VAPOR FROM WELLS (ppmv)	ENGINE EXHAUST (ppmv)
25	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: 18:00 by: DA TPH 80000. B. T. EB. X.	time: by: TPH. B. T. EB. X.
	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.
	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.

ND - Not Detected

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE III

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

	DATE	TIME	ENGINE OPERATION DATA		PRESSURE READINGS AT				
			RUNNING TIME (HOURS)	SPEED (RPM)	EXTRACTION MANIFOLD (INCH H_2O)	EXTRACTION WELL (INCH H_2O)	EXTRACTION WELL (INCH H_2O)	SPRAY AERATOR (INCH Hg)	RECIRC WATER (PSI)
BEGIN	25	9:47	0.1	1500.0	>50.0				
	25	17:00	7.1	1300.0	>50.0				
	26	7:20	21.2	1300.0	>50.0				
	26	10:00	24.2	1300.0	>50.0				
END	06/26/92	10:00	24.2						

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE IV

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	TEMPERATURE READINGS AT					FLOW READING AT			
	AMBIENT AIR (F)	EXTRACTED VAPOR (F)	ENGINE OUTLET (F)	CATALYST OUTLET (F)	RECIRC WATER (F)	AIR TO SPRAY TANK (CFM)	EXTRACTED VAPORS (CFM)	AUXILIARY FUEL (CFH)	DISCHARGE WATER (GALS)
25	70.0	70.0				20.0	4.5	0.0	
25	70.0	70.0				20.0	4.0	0.0	
26	70.0	70.0				30.0	4.0	0.0	
26	70.0	70.0				29.0	4.0	0.0	

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE V

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	EXHAUST GAS COMPONENTS				
	H-C	CO	CO_2	O_2	NOx
25					
25					
26					
26					

NOTES:

S.A.V.E. SYSTEM PERFORMANCE DATA

TABLE I

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

MONTH			JUN 92					
GROUNDWATER	SPRAY AERATOR WATER IN	GALLONS						
		TPH-PPM*						
	SPRAY AERATOR WATER OUT	GALLONS						
		TPH-PPM*						
VAPOR	RECOVERED VAPORS FROM WELLS	SCFM*	3.6					
		TPH-PPM*	125000.0					
	TOTAL VAPORS TO ENGINE	SCF	35860.8					
		TPH-PPM*	125000.0					
AIR	TO SPRAY AERATOR	SCFM	21.2					
	TO ENGINE	SCFM	21.2					
FREE PRODUCT	RECOVERED FROM WELLS	GALLONS						
ENGINE	EXHAUST	TPH-PPM*						
		CO-PPM*						
	OPERATION	HOURS	24.1					
	SPEED	RPM	1358.1					
TOTAL CONTAMINANT REMOVED	FROM THE PROJECT LOCATION	GALLONS	24.7					

* DENOTES AVERAGE CONCENTRATIONS.

S.A.V.E. SYSTEM
SUMMARY OF LABORATORY RESULTS FOR JUN 92
TABLE II

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	EXTRACTED H_2O TO AERATOR (mg/l)	DISCHARGED H_2O FROM AERATOR (mg/l)	EXTRACTED VAPOR FROM WELLS (ppmv)	ENGINE EXHAUST (ppmv)
25	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: 18:00 by: DA TPH 125000. B. T. EB. X.	time: by: TPH. B. T. EB. X.
	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.
	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.	time: by: TPH. B. T. EB. X.

ND - Not Detected

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE III

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

	DATE	TIME	ENGINE OPERATION DATA		PRESSURE READINGS AT				
			RUNNING TIME (HOURS)	SPEED (RPM)	EXTRACTION MANIFOLD (INCH H_2O)	EXTRACTION WELL (INCH H_2O)	EXTRACTION WELL (INCH H_2O)	SPRAY AERATOR (INCH Hg)	RECIRC WATER (PSI)
BEGIN	25	9:47	0.1	1500.0	>50.0				
	25	17:00	7.1	1300.0	>50.0				
	26	7:20	21.2	1300.0	>50.0				
	26	10:00	24.2	1300.0	>50.0				
END	06/26/92	10:00	24.2						

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE IV

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	TEMPERATURE READINGS AT					FLOW READING AT			
	AMBIENT AIR (F)	EXTRACTED VAPOR (F)	ENGINE OUTLET (F)	CATALYST OUTLET (F)	RECIRC WATER (F)	AIR TO SPRAY TANK (CFM)	EXTRACTED VAPORS (CFM)	AUXILIARY FUEL (CFH)	DISCHARGE WATER (GALS)
25	70.0	70.0				20.0	4.5	0.0	
25	70.0	70.0				20.0	4.0	0.0	
26	70.0	70.0				30.0	4.0	0.0	
26	70.0	70.0				29.0	4.0	0.0	

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE V

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	EXHAUST GAS COMPONENTS				
	H-C	CO	CO_2	O_2	NOx
25					
25					
26					
26					

NOTES:

S.A.V.E. SYSTEM PERFORMANCE DATA

TABLE I

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

MONTH			JUN 92					
GROUNDWATER	SPRAY AERATOR WATER IN	GALLONS						
		TPH-PPM*						
	SPRAY AERATOR WATER OUT	GALLONS						
		TPH-PPM*						
VAPOR	RECOVERED VAPORS FROM WELLS	SCFM*	3.6					
		TPH-PPM*	100000.0					
	TOTAL VAPORS TO ENGINE	SCF	35860.8					
		TPH-PPM*	100000.0					
AIR	TO SPRAY AERATOR	SCFM	21.2					
	TO ENGINE	SCFM	21.2					
FREE PRODUCT	RECOVERED FROM WELLS	GALLONS						
ENGINE	EXHAUST	TPH-PPM*						
		CO-PPM*						
	OPERATION	HOURS	24.1					
	SPEED	RPM	1358.1					
TOTAL CONTAMINANT REMOVED	FROM THE PROJECT LOCATION	GALLONS	19.8					

* DENOTES AVERAGE CONCENTRATIONS.

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE III

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

	DATE	TIME	ENGINE OPERATION DATA		PRESSURE READINGS AT				
			RUNNING TIME (HOURS)	SPEED (RPM)	EXTRACTION MANIFOLD (INCH H_2O)	EXTRACTION WELL (INCH H_2O)	EXTRACTION WELL (INCH H_2O)	SPRAY AERATOR (INCH Hg)	RECIRC WATER (PSI)
BEGIN	25	9:47	0.1	1500.0	>50.0				
	25	17:00	7.1	1300.0	>50.0				
	26	7:20	21.2	1300.0	>50.0				
	26	10:00	24.2	1300.0	>50.0				
END	06/26/92	10:00	24.2						

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE IV

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	TEMPERATURE READINGS AT					FLOW READING AT			
	AMBIENT AIR (F)	EXTRACTED VAPOR (F)	ENGINE OUTLET (F)	CATALYST OUTLET (F)	RECIRC WATER (F)	AIR TO SPRAY TANK (CFM)	EXTRACTED VAPORS (CFM)	AUXILIARY FUEL (CFH)	DISCHARGE WATER (GALS)
25	70.0	70.0				20.0	4.5	0.0	
25	70.0	70.0				20.0	4.0	0.0	
26	70.0	70.0				30.0	4.0	0.0	
26	70.0	70.0				29.0	4.0	0.0	

NOTES:

S.A.V.E. SYSTEM
MONITORING DATA LOG FOR JUN 92
TABLE V

PROJECT LOCATION: BRUNSING ASSOCIATES PACIFIC SUPPLY CO.

DATE	EXHAUST GAS COMPONENTS				
	H-C	CO	CO_2	O_2	NOx
25					
25					
26					
26					

NOTES: