PES Environmental, Inc.
Engineering & Environmental Services

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September 28, 1994

131.0100.003

Alameda County Environmental Health Services
Hazardous Materials Division
1131 Harbor Bay Parkway
Alameda, California 94502

Attention: Ms. Susan Hugo

QUARTERLY GROUNDWATER MONITORING REPORT
AUGUST 1994 SAMPLING EVENT
EMERY BAY PLAZA
1650 65TH STREET
EMERYVILLE, CALIFORNIA

Dear Ms. Hugo:

This letter presents data collected by PES Environmental, Inc. (PES) during the August 10, 1994 quarterly groundwater monitoring conducted at Emery Bay Plaza, located at 1650 65th Street in Emeryville, California (Plate 1). PES has been retained by Emery Bay Plaza to conduct groundwater monitoring at the site.

The purpose of the groundwater monitoring program at this site is to: (1) evaluate the presence of hydrocarbons in groundwater; (2) provide data to assess the performance and effectiveness of the groundwater remedial program; and (3) monitor seasonal water level variations at the site. The monitoring is performed in accordance with California Regional Water Quality Control Board (RWQCB) guidelines and the approved remedial action plan for this site.

BACKGROUND

Six monitoring wells and one extraction well were installed at the site (Plate 2) following removal of an onsite underground storage tank (UST) in July 1987 and several offsite USTs in September and October 1989. Groundwater monitoring has been conducted at this facility since November 1989. An activated carbon groundwater treatment system was installed and its operation was begun in December 1990. Discharges of treated groundwater were conducted under the authority of an East Bay Municipal Utility District wastewater discharge permit (Permit # 502-45131). Groundwater extraction was discontinued on October 25, 1993 pending startup of a passive in-situ bioremediation pilot program. The present sampling is the twentieth consecutive sampling event since groundwater monitoring was initiated, and the twelfth to be conducted by PES.

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GROUNDWATER ELEVATIONS

Water-Level Measurement Procedures

Prior to sampling, the groundwater level in each of the six monitoring wells was measured to a precision of 0.01 feet using an electronic water-level indicator. Prior to each measurement, the portion of the water-level indicator that was submerged in the well was cleaned with a mild detergent solution and rinsed with de-ionized water.

Results

Water-level data were converted to water-level elevations referenced to mean sea level (MSL). A groundwater elevation map constructed from the data is presented on Plate 3. An historical summary of groundwater elevations for wells at the site is presented in Table 1.

Groundwater elevations have remained approximately the same in MW-2 and MW-4, and decreased in the remaining wells (MW-3, MW-5, MW-6 , and MW-7) since the prior May 17, 1994 sampling event. Based on measured water levels on August 10, 1994, groundwater flow direction at the site was calculated to be toward the southwest, with an approximate gradient of 0.007 foot per foot. This is generally consistent with historical groundwater flow direction and gradient.

GROUNDWATER SAMPLING AND ANALYTICAL TESTING

Sampling Protocol

Groundwater samples were collected on August 10 and 12, 1994 by Blaine Tech Services, Inc. (Blaine Tech). Monitoring Wells MW-2, MW-3, MW-4, MW-6, MW-7, and EW-1 were sampled on August 10; MW-5 was inaccessible for sampling on August 10 due to the presence of a parked car over the well, and therefore sampling was performed on August 12. Prior to sampling, the groundwater was visually inspected to assess the presence of floating product. A minimum of three well volumes were evacuated prior to sampling using a teflon bladder pump. During pumping the discharge water was measured for pH, temperature, electrical conductivity, and turbidity. Groundwater samples were collected with a clean teflon bailer and decanted into clean 40-milliliter glass vials with teflon lined caps.

Samples were immediately labeled to designate sample number, time and date collected, and analysis requested, and stored in a chilled, thermally-insulated cooler for transport to the analytical laboratory. The information collected during the groundwater sampling and the chain of custody records are presented in a groundwater sampling report prepared by Blaine Tech, provided in Appendix A.

Analytical Program

Groundwater samples from all wells including the extraction well were analyzed by American Environmental Network (AEN), a State-certified laboratory located in Pleasant Hill, California. Samples were analyzed for total petroleum hydrocarbons quantified as gasoline (TPH-gas) and benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Test Method 8015M/8020.

Analytical Results

Consistent with historical monitoring data, TPH-gas was detected in Wells MW-2, MW-3, MW-5, MW-7, and EW-1. Detectable concentrations of BTEX were found in MW-2, MW-5, and EW-1; benzene, toluene and/or total xylenes were also detected in MW-3, MW-4, and MW-7. No TPH-gas or BTEX was detected in MW-6. Consistent with previous analytical results, Well MW-2, located within the backfill of the former UST excavation, exhibited the highest levels of dissolved hydrocarbons (TPH-gas and BTEX).

Analytical results for all wells, including historical monitoring results for the previous sampling events and relevant federal and state standards, are presented in Table 2. Laboratory reports and chain of custody records are provided in Appendix B. The distribution of hydrocarbons in groundwater at the site on August 10 and 12, 1994 is presented on Plate 4.

SUMMARY

Groundwater elevations have remained approximately the same or decreased since the May 17, 1994 sampling event. As with prior monitoring events, the groundwater flow direction continues to be toward the southwest.

Concentrations of dissolved hydrocarbons have generally decreased or remained approximately the same since the prior quarterly monitoring event. Detected concentrations of TPH-gas, toluene, ethylbenzene, and xylenes have increased slightly in Well MW-5.

If you have any questions or comments, please do not hesitate to call either of the undersigned.

Yours very truly,

PES ENVIRONMENTAL, INC.

Mary E. William for
Jenny F. Han
Staff Geologist

Andrew A. Briefer, P. E.
Associate Engineer

REGISTERED PROFESSIONAL ENGINEER
ANDREW A. BRIEFER
No. 046518
Exp 6-30-95
CIVIL
STATE OF CALIFORNIA

Attachments:

Table 1	Summary of Groundwater Elevations Through August 1994
Table 2	Summary of Analytical Results for Groundwater Samples Through August 1994
Plate 1	Site Location Map
Plate 2	Well Location Map
Plate 3	Groundwater Elevation Contours on August 10, 1994
Plate 4	Dissolved Hydrocarbons in Groundwater on August 10 and 12, 1994
Appendix A	Groundwater Sampling Report
Appendix B	Analytical Laboratory Reports

pc: Mr. Thomas Gram - P. O. Partners
Ms. Lynn Tolin - Emery Bay Plaza
Mr. Matt Dulka - Hanson, Bridgett, Marcus, Vlahos & Rudy

Table 1. **Summary of Groundwater Elevations Through August 1994**
Emery Bay Plaza
1650 65th Street, Emeryville, California

Well Number	Date	Measured by	Top of Casing (feet MSL)	Depth to Water (feet)	Groundwater Elevations (feet MSL)
MW-2	21-Feb-90	ES	15.75	11.72	4.03
	25-May-90	ES	15.75	11.83	3.92
	29-Aug-90	ES	15.75	11.72	4.03
	29-Nov-90	ES	15.75	11.99	3.76
	1-Mar-91	ES	15.79	12.87	2.92
	28-May-91	ES	15.79	12.21	3.58
	1-Aug-91	ES	15.79	NA	NA
	27-Jan-92	PES	15.79	11.78	4.01
	28-Feb-92	PES	15.79	11.70	4.09
	28-May-92	PES	15.79	11.83	3.96
	27-Aug-92	PES	15.79	12.28	3.51
	10-Nov-92	PES	15.79	12.40	3.39
	18-Feb-93	PES	15.79	12.00	3.79
	20-May-93	PES	15.79	12.00	3.79
	19-Aug-93	PES	15.79	12.11	3.68
	15-Nov-93	PES	15.79	11.64	4.15
	14-Feb-94	PES	15.79	11.45	4.34
	16-May-94	PES	15.79	11.25	4.54
	10-Aug-94	**PES**	**15.79**	**11.22**	**4.57**
MW-3	21-Feb-90	ES	12.45	9.18	3.27
	25-May-90	ES	12.45	9.25	3.20
	29-Aug-90	ES	12.45	9.50	2.95
	29-Nov-90	ES	12.45	9.80	2.65
	1-Mar-91	ES	12.43	9.51	2.92
	28-May-91	ES	12.43	9.03	3.40
	1-Aug-91	ES	12.43	NA	NA
	27-Jan-92	PES	12.43	9.44	2.99
	28-Feb-92	PES	12.43	8.80	3.63
	28-May-92	PES	12.43	8.80	3.63
	27-Aug-92	PES	12.43	9.18	3.25
	10-Nov-92	PES	12.43	9.44	2.99
	18-Feb-93	PES	12.43	7.59	4.84
	20-May-93	PES	12.43	8.21	4.22
	19-Aug-93	PES	12.43	8.71	3.72
	15-Nov-93	PES	12.43	9.09	3.34
	14-Feb-94	PES	12.43	8.84	3.59
	16-May-94	PES	12.43	8.18	4.25
	10-Aug-94	**PES**	**12.43**	**8.72**	**3.71**

Table 1. **Summary of Groundwater Elevations Through August 1994**
Emery Bay Plaza
1650 65th Street, Emeryville, California

Well Number	Date	Measured by	Top of Casing (feet MSL)	Depth to Water (feet)	Groundwater Elevations (feet MSL)
MW-4	21-Feb-90	ES	12.24	8.63	3.61
	25-May-90	ES	12.24	8.58	3.66
	29-Aug-90	ES	12.24	8.50	3.74
	29-Nov-90	ES	12.24	8.74	3.50
	1-Mar-91	ES	12.24	8.65	3.59
	28-May-91	ES	12.24	8.57	3.67
	1-Aug-91	ES	12.24	NA	NA
	27-Jan-92	PES	12.24	8.62	3.62
	28-Feb-92	PES	12.24	8.52	3.72
	28-May-92	PES	12.94	8.35	3.89
	27-Aug-92	PES	12.24	9.00	3.24
	10-Nov-92	PES	12.24	8.85	3.39
	18-Feb-93	PES	12.24	8.17	4.07
	20-May-93	PES	12.24	8.21	4.03
	19-Aug-93	PES	12.24	8.20	4.04
	15-Nov-93	PES	12.24	8.33	3.91
	14-Feb-94	PES	12.24	8.30	3.94
	16-May-94	PES	12.24	8.20	4.04
	10-Aug-94	**PES**	**12.24**	**8.14**	**4.10**
MW-5	21-Feb-90	ES	12.81	6.91	5.90
	25-May-90	ES	12.81	7.58	5.23
	29-Aug-90	ES	12.81	7.75	5.06
	29-Nov-90	ES	12.81	8.17	4.64
	1-Mar-91	ES	12.82	8.11	4.71
	28-May-91	ES	12.82	7.39	5.43
	1-Aug-91	ES	12.82	NA	NA
	27-Jan-92	PES	12.82	7.90	4.92
	28-Feb-92	PES	12.82	7.73	5.09
	28-May-92	PES	12.82	7.18	5.64
	27-Aug-92	PES	12.82	7.54	5.28
	10-Nov-92	PES	12.82	7.90	4.92
	18-Feb-93	PES	12.82	6.58	6.24
	20-May-93	PES	12.82	6.29	6.53
	19-Aug-93	PES	12.82	6.89	5.93
	15-Nov-93	PES	12.82	7.43	5.39
	14-Feb-94	PES	12.82	7.16	5.66
	16-May-94	PES	12.82	6.50	6.32
	10-Aug-94	**PES**	**12.82**	**6.98**	**5.84**

Table 1. Summary of Groundwater Elevations Through August 1994
Emery Bay Plaza
1650 65th Street, Emeryville, California

Well Number	Date	Measured by	Top of Casing (feet MSL)	Depth to Water (feet)	Groundwater Elevations (feet MSL)
MW-6	1-Mar-91	ES	12.03	8.59	3.44
	28-May-91	ES	12.03	8.35	3.68
	1-Aug-91	ES	12.03	NA	NA
	27-Jan-92	PES	12.03	8.32	3.71
	28-Feb-92	PES	12.03	8.08	3.95
	28-May-92	PES	12.03	8.04	3.99
	27-Aug-92	PES	12.03	8.48	3.55
	10-Nov-92	PES	12.03	8.52	3.51
	18-Feb-93	PES	12.03	8.14	3.89
	20-May-93	PES	12.03	8.46	3.57
	19-Aug-93	PES	12.03	8.61	3.42
	15-Nov-93	PES	12.03	8.30	3.73
	14-Feb-94	PES	12.03	8.09	3.94
	16-May-94	PES	12.03	7.82	4.21
	10-Aug-94	**PES**	**12.03**	**8.46**	**3.57**
MW-7	1-Mar-91	ES	12.9	7.51	5.39
	28-May-91	ES	12.9	7.07	5.83
	1-Aug-91	ES	12.9	NA	NA
	27-Jan-92	PES	12.9	7.28	5.62
	28-Feb-92	PES	12.9	7.04	5.86
	28-May-92	PES	12.9	6.81	6.09
	27-Aug-92	PES	12.9	7.12	5.78
	10-Nov-92	PES	12.9	7.80	5.10
	18-Feb-93	PES	12.9	6.54	6.36
	20-May-93	PES	12.9	6.17	6.73
	19-Aug-93	PES	12.9	6.60	6.30
	15-Nov-93	PES	12.9	6.89	6.01
	14-Feb-94	PES	12.9	6.50	6.40
	17-May-94	PES	12.9	6.07	6.83
	10-Aug-94	**PES**	**12.9**	**6.34**	**6.56**

NOTES:

Ft MSL = feet above Mean Sea Level
ES = Engineering-Science, Inc.
PES = PES Environmental, Inc.
NA = Information not available at this date.

Table 2. Summary of Analytical Results for Groundwater Samples Through August 1994
Emery Bay Plaza
1650 65th Street, Emeryville, California

Concentrations expressed in milligrams per liter (mg/l) - equivalent to parts per million (ppm)

Well Number	Sample Date	Sampled by	TPH as Gasoline	TPH as Diesel	Benzene MCL = 0.001	Toluene DAL = 0.1	Ethyl-Benzene MCL = 0.68	Total Xylenes MCL = 1.75	Purgeable Halocarbons	Lead MCL = 0.005
MW-2	Nov-89	ES	100	NA	8.4	7.4	2.4	13	0.015 *	0.05
	Feb-90	ES	54	NA	7.8	5.6	1.6	8.4	0.032 *	0.021
	May-90	ES	40	NA	7.8	7.5	1.6	7.6	0.076 *	0.025
	Aug-90	ES	49	4.6	9	8	ND	8.9	0.040 *	0.0059
	Nov-90	ES	73	3.5	6.9	5.9	1.4	7.4	NA	NA
	Mar-91	ES	72	1.8	5.5	6.6	1	7.7	NA	NA
	May-91	ES	31	ND	8.4	4.7	1.7	6.3	NA	NA
	Aug-91	ES	47	ND	7.6	1.6	7.3	7.8	NA	NA
	29-Jan-92	PES	77.000	NA	10.000	8.700	2.000	7.600	NA	NA
	28-Feb-92	PES	70.000	NA	9.100	6.400	0.530	7.400	NA	NA
	28-May-92	PES	54.000	NA	8.000	4.800	2.400	6.200	NA	NA
	27-Aug-92	PES	47.000	NA	2.700	2.900	3.400	9.200	NA	NA
	10-Nov-92	PES	45.000	<20.000	6.600	4.000	2.000	5.800	<0.050	NA
	18-Feb-93	PES	14.000	NA	2.300	0.810	0.670	1.400	NA	NA
	20-May-93	PES	43.000	NA	7.300	5.200	1.500	5.500	NA	NA
	19-Aug-93	PES	45.000	NA	4.900	3.700	1.300	3.400	NA	NA
	15-Nov-93	PES	97.000	NA	6.100	1.700	1.700	4.100	NA	NA
	14-Feb-94	PES	27.000	NA	5.000	0.830	1.200	3.100	NA	NA
	16-May-94	PES	77.000	NA	6.800	1.100	1.400	3.300	NA	NA
	10-Aug-94	**PES**	**25**	**NA**	**5.600**	**0.750**	**1.400**	**1.700**	**NA**	**NA**
MW-3	Nov-89	ES	0.13	NA	0.0022	ND	ND	0.003	ND	ND
	Feb-90	ES	ND	NA	0.0025	ND	ND	ND	NA	0.011
	May-90	ES	ND	ND	0.002	ND	ND	ND	ND	NA
	Aug-90	ES	ND	0.8	0.0044	0.0029	ND	0.0054	NA	NA
	Nov-90	ES	0.9	0.8	0.0034	ND	ND	ND	NA	NA
	Mar-91	ES	ND	ND	0.025	0.025	0.0053	0.32	NA	NA
	May-91	ES	ND	ND	0.0026	ND	ND	ND	NA	NA
	Aug-91	ES	ND	ND	0.0019	ND	ND	ND	NA	NA

Table 2. Summary of Analytical Results for Groundwater Samples Through August 1994

Emery Bay Plaza
1650 65th Street, Emeryville, California

Concentrations expressed in milligrams per liter (mg/l) - equivalent to parts per million (ppm)

Well Number	Sample Date	Sampled by	TPH as Gasoline	TPH as Diesel	Benzene MCL = 0.001	Toluene DAL = 0.1	Ethyl-Benzene MCL = 0.68	Total Xylenes MCL = 1.75	Purgeable Halocarbons	Lead MCL = 0.005
MW-3	29-Jan-92	PES	0.092	NA	0.0024	<0.0003	0.0006	<0.0003	NA	NA
	28-Feb-92	PES	0.160***	NA	0.0028	<0.0003	0.0007	0.0005	NA	NA
	28-May-92	PES	<0.050	NA	0.0025	<0.0005	<0.0005	<0.0005	NA	NA
	27-Aug-92	PES	0.370	NA	0.0040	<0.001	<0.0005	<0.0005	NA	NA
	10-Nov-92	PES	0.240	<0.100	0.0042	<0.0003	<0.0003	<0.0006	<0.0003	NA
	18-Feb-93	PES	0.140	NA	0.0018	<0.0005	<0.0005	<0.0005	NA	NA
	20-May-93	PES	0.072	NA	0.0031	<0.0005	<0.0005	<0.0005	NA	NA
	19-Aug-93	PES	<0.050	NA	0.0032	<0.0005	<0.0005	0.0007	NA	NA
	15-Nov-93	PES	0.070	NA	0.0023	0.0007	<0.0005	0.0015	NA	NA
	14-Feb-94	PES	0.120	NA	0.0053	0.0023	0.0012	0.0042	NA	NA
	16-May-94	PES	0.120	NA	0.0031	<0.0005	<0.0005	0.0017	NA	NA
	10-Aug-94	**PES**	**0.1**	**NA**	**0.003**	**< 0.0005**	**<0.0005**	**<0.002**	**NA**	**NA**
MW-4	Nov-89	ES	0.2	NA	0.0023	ND	ND	ND	ND	ND
	Feb-90	ES	ND	NA	ND	ND	ND	ND	NA	0.006
	May-90	ES	ND	ND	0.001	ND	ND	ND	ND	NA
	Aug-90	ES	ND	0.8	0.0089	0.0071	ND	0.0094	NA	NA
	Nov-90	ES	ND	0.7	0.0027	ND	ND	ND	NA	NA
	Mar-91	ES	NA	ND	0.003	ND	ND	ND	NA	NA
	May-91	ES	NA	ND	0.0024	ND	ND	ND	NA	NA
	Aug-91	ES	NA	ND	0.0015	ND	ND	ND	NA	NA
	29-Jan-92	PES	<0.050	NA	0.0022	0.0004	<0.0003	0.0007	NA	NA
	28-Feb-92	PES	<0.050	NA	0.0016	<0.0003	<0.0003	0.0003	NA	NA
	28-May-92	PES	<0.050	NA	0.0015	<0.0005	<0.0005	<0.0005	NA	NA
	27-Aug-92	PES	0.080	NA	0.003	<0.001	<0.0005	0.0005	NA	NA

Table 2. Summary of Analytical Results for Groundwater Samples Through August 1994
Emery Bay Plaza
1650 65th Street, Emeryville, California

Concentrations expressed in milligrams per liter (mg/l) - equivalent to parts per million (ppm)

Well Number	Sample Date	Sampled by	TPH as Gasoline	TPH as Diesel	Benzene MCL = 0.001	Toluene DAL = 0.1	Ethyl-Benzene MCL = 0.68	Total Xylenes MCL = 1.75	Purgeable Halocarbons	Lead MCL = 0.005
MW-4	10-Nov-92	PES	0.180	<0.100	0.060	0.0009	<0.0003	<0.0006	<0.0003	NA
	18-Feb-93	PES	0.060	NA	0.0017	<0.0005	<0.0005	<0.0005	NA	NA
	20-May-93	PES	<0.050	NA	0.0022	<0.0005	<0.0005	<0.0005	NA	NA
	19-Aug-93	PES	<0.050	NA	0.0020	0.0006	<0.0005	0.0005	NA	NA
	15-Nov-93	PES	<0.050	NA	0.0020	0.0005	<0.0005	0.0009	NA	NA
	14-Feb-94	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	16-May-94	PES	<0.050	NA	0.0017	0.0009	<0.0005	0.0011	NA	NA
	10-Aug-94	**PES**	**<0.05**	**NA**	**0.002**	**<0.0005**	**<0.0005**	**<0.002**	**NA**	**NA**
MW-5	Nov-89	ES	ND	NA	0.074	ND	ND	0.0042	ND	ND
	Feb-90	ES	ND	NA	0.2	ND	ND	ND	NA	0.012
	May-90	ES	ND	ND	0.11	ND	ND	ND	ND	NA
	Aug-90	ES	ND	0.7	0.066	0.0022	ND	0.0038	NA	NA
	Nov-90	ES	0.6	0.9	0.069	ND	ND	ND	NA	NA
	Mar-91	ES	ND	1.1	0.066	0.0023	ND	ND	NA	NA
	May-91	ES	ND	ND	0.11	ND	ND	ND	NA	NA
	Aug-91	ES	ND	ND	0.078	0.0021	ND	ND	NA	NA
	29-Jan-92	PES	0.190	NA	0.090	0.0005	<0.0003	0.0006	NA	NA
	28-Feb-92	PES	0.230***	NA	0.110	0.0009	<0.0003	0.0005	NA	NA
	28-May-92	PES	0.130	NA	0.100	<0.0005	<0.0005	<0.0005	NA	NA
	27-Aug-92	PES	0.520	NA	0.083	0.002	<0.0005	<0.0005	NA	NA
	10-Nov-92	PES	0.240	<0.100	0.074	0.0010	<0.0003	<0.0006	<0.0003	NA
	18-Feb-93	PES	0.190	NA	0.056	0.0006	<0.0005	<0.0005	NA	NA
	20-May-93	PES	<0.200	NA	0.056	<0.002	<0.002	<0.002	NA	NA
	19-Aug-93	PES	0.170	NA	0.050	0.0007	<0.0005	<0.0005	NA	NA
	15-Nov-93	PES	0.220	NA	0.049	0.001	<0.001	<0.001	NA	NA
	14-Feb-94	PES	0.140	NA	0.062	<0.0005	<0.0005	<0.0005	NA	NA
	16-May-94	PES	0.310	NA	0.140	0.003	<0.003	<0.003	NA	NA
	12-Aug-94	**PES**	**0.5**	**NA**	**0.095**	**0.034**	**0.004**	**0.014**	**NA**	**NA**

Table 2. Summary of Analytical Results for Groundwater Samples Through August 1994

Emery Bay Plaza
1650 65th Street, Emeryville, California

Concentrations expressed in milligrams per liter (mg/l) - equivalent to parts per million (ppm)

Well Number	Sample Date	Sampled by	TPH as Gasoline	TPH as Diesel	Benzene MCL = 0.001	Toluene DAL = 0.1	Ethyl-Benzene MCL = 0.68	Total Xylenes MCL = 1.75	Purgeable Halocarbons	Lead MCL = 0.005
MW-6	May-90	ES	NA	ND	ND	ND	ND	ND	ND	ND**
	Aug-90	ES	NA	ND	NA	NA	NA	NA	NA	ND**
	Nov-90	ES	1.2	1.4	0.0012	ND	ND	ND	0.0012	NA
	Mar-91	ES	ND	ND	ND	ND	ND	ND	NA	NA
	May-91	ES	ND	ND	ND	ND	ND	ND	NA	NA
	Aug-91	ES	ND	ND	ND	ND	ND	ND	NA	NA
	29-Jan-92	PES	<0.050	NA	<0.0003	<0.0003	<0.0003	<0.0003	NA	NA
	28-Feb-92	PES	<0.050	NA	<0.0003	<0.0003	<0.0003	<0.0003	NA	NA
	28-May-92	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	27-Aug-92	PES	0.050***	NA	<0.0005	<0.001	<0.0005	<0.0005	NA	NA
	10-Nov-92	PES	<0.050	<0.100	<0.0003	<0.0003	<0.0003	<0.0006	<0.0003	NA
	18-Feb-93	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	20-May-93	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	19-Aug-93	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	15-Nov-93	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	14-Feb-94	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	16-May-94	PES	<0.050	NA	<0.0005	<0.0005	<0.0005	<0.0005	NA	NA
	10-Aug-94	**PES**	**<0.05**	**NA**	**<0.0005**	**<0.0005**	**<0.0005**	**<0.002**	**NA**	**NA**
MW-7	May-90	ES	NA	0.6	0.24	ND	ND	ND	0.24	ND**
	Aug-90	ES	ND	ND	0.081	0.0018	ND	ND	0.0844	ND**
	Nov-90	ES	ND	0.8	0.054	ND	ND	ND	0.054	NA
	Mar-91	ES	ND	ND	0.1	0.0036	ND	ND	NA	NA
	May-91	ES	ND	ND	0.12	0.0027	ND	ND	NA	NA
	Aug-91	ES	ND	ND	0.074	0.0033	ND	ND	NA	NA
	29-Jan-92	PES	0.270	NA	0.025	0.0005	<0.0003	0.0008	NA	NA
	28-Feb-92	PES	0.100***	NA	0.033	0.0007	<0.0003	0.0007	NA	NA
	28-May-92	PES	0.150	NA	0.021	<0.0005	<0.0005	<0.0005	NA	NA
	27-Aug-92	PES	0.440	NA	0.011	0.001	<0.0005	<0.0005	NA	NA

Table 2. Summary of Analytical Results for Groundwater Samples Through August 1994

Emery Bay Plaza
1650 65th Street, Emeryville, California

Concentrations expressed in milligrams per liter (mg/l) - equivalent to parts per million (ppm)

Well Number	Sample Date	Sampled by	TPH as Gasoline	TPH as Diesel	Benzene	Toluene	Ethyl-Benzene	Total Xylenes	Purgeable Halocarbons	Lead
					MCL = 0.001	DAL = 0.1	MCL = 0.68	MCL = 1.75		MCL = 0.005
MW-7	10-Nov-92	PES	0.370	<0.100	0.031	0.0012	<0.0003	0.0012	<0.0003	NA
	18-Feb-93	PES	0.270	NA	0.077	0.0013	<0.0005	0.0014	NA	NA
	20-May-93	PES	0.300	NA	0.150	0.003	<0.002	0.003	NA	NA
	19-Aug-93	PES	0.110	NA	0.040	0.0010	<0.0005	0.0011	NA	NA
	15-Nov-93	PES	0.120	NA	0.015	0.0006	<0.0005	0.0023	NA	NA
	14-Feb-94	PES	0.120	NA	0.038	<0.0005	<0.0005	<0.0005	NA	NA
	17-May-94	PES	<0.300	NA	0.061	<0.003	<0.003	<0.003	NA	NA
	10-Aug-94	**PES**	**0.1**	**NA**	**0.009**	**<0.0005**	**<0.0005**	**<0.002**	**NA**	**NA**
EW-1	May-90	ES	20	ND	7.5	4.5	1	6.3	0.068	ND**
	Aug-90	ES	NA	3.5	6	4.2	ND	4.6	0.016 *	ND**
	Nov-90	ES	47	3.1	6	3.4	1	4.7	NA	NA
	17-Dec-90	ES	NA	NA	11	7.9	2.2	10	NA	NA
	19-Dec-90	ES	NA	NA	3.7	2.5	ND	2.3	NA	NA
	21-Dec-90	ES	NA	NA	3.2	2.2	ND	1.7	NA	NA
	27-Dec-90	ES	NA	NA	2.9	2.1	0.16	1.5	NA	NA
	4-Jan-91	ES	NA	NA	3.2	2.8	ND	ND	NA	NA
	11-Jan-91	ES	NA	NA	3	2.4	0.2	1.8	NA	NA
	6-Feb-91	ES	NA	NA	0.47	0.23	0.011	0.39	NA	NA
	13-Feb-91	ES	NA	NA	1.2	0.28	ND	0.36	NA	NA
	15-Mar-91	ES	NA	NA	0.13	0.085	0.006	0.17	NA	NA
	3-Jul-91	ES	NA	NA	1.3	0.95	0.22	1.4	NA	NA
	1-Aug-91	ES	NA	NA	0.22	0.19	0.013	0.27	NA	NA
	16-Aug-91	ES	NA	NA	0.17	0.16	0.013	0.19	NA	NA
	13-Nov-91	ES	NA	NA	3.1	0.27	0.04	0.22	NA	NA
	29-Jan-92	PES	2.700	NA	0.570	0.150	0.0070	0.260	NA	NA
	26-Mar-92	PES	25.000	NA	3.600	2.600	0.530	2.600	NA	NA
	28-May-92	PES	16.000	NA	3.300	3.200	0.750	2.600	NA	NA
	29-Jun-92	PES	7.000	NA	2.200	3.100	0.270	1.400	NA	NA

Table 2. Summary of Analytical Results for Groundwater Samples Through August 1994

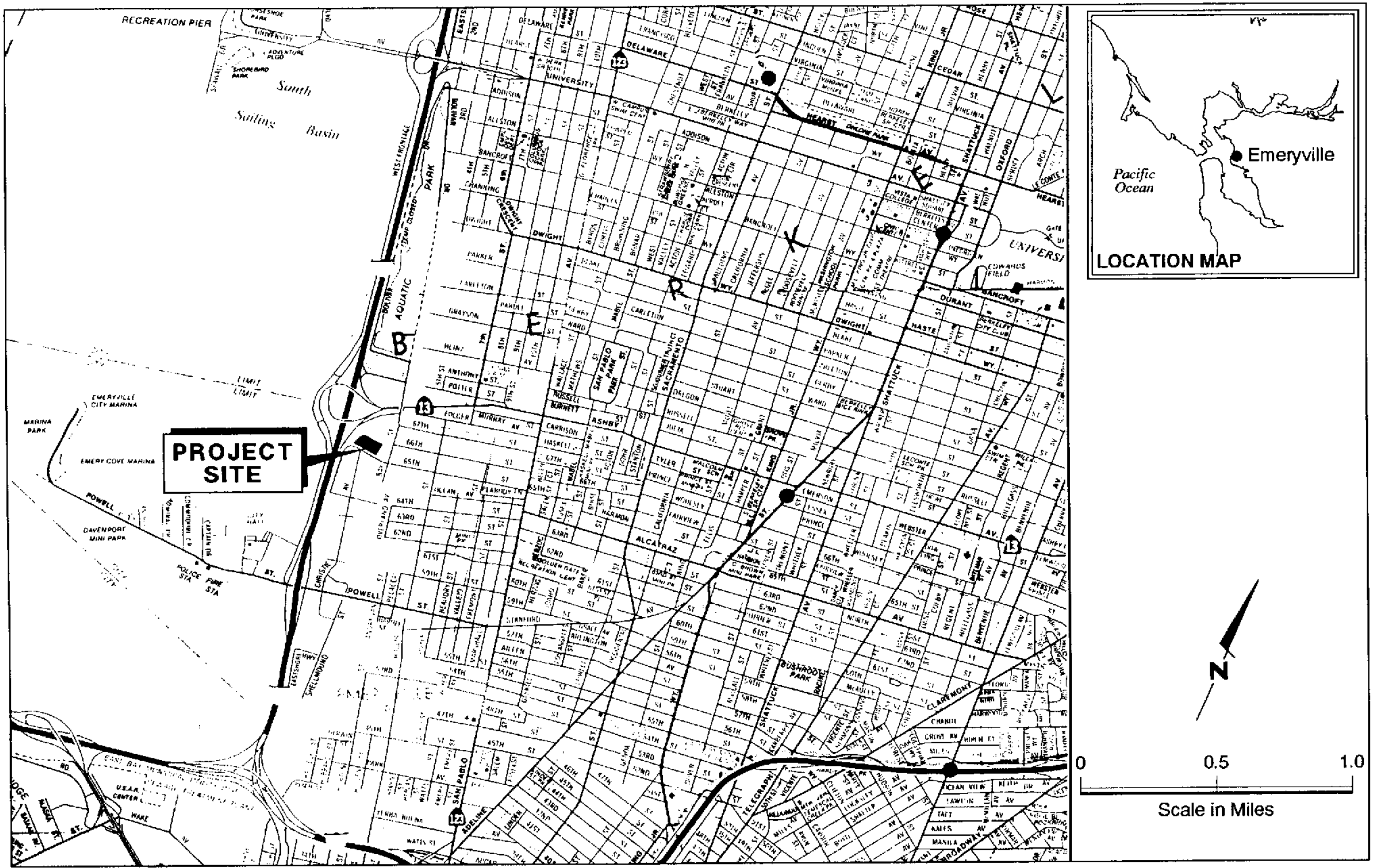
Emery Bay Plaza
1650 65th Street, Emeryville, California

Concentrations expressed in milligrams per liter (mg/l) - equivalent to parts per million (ppm)

Well Number	Sample Date	Sampled by	TPH as Gasoline	TPH as Diesel	Benzene MCL = 0.001	Toluene DAL = 0.1	Ethyl-Benzene MCL = 0.68	Total Xylenes MCL = 1.75	Purgeable Halocarbons	Lead MCL = 0.005
EW-1	21-Jul-92	PES	1.600	NA	0.220	0.017	<0.0005	0.100	NA	NA
	27-Aug-92	PES	NS	NS	NS	NS	NS	NS	NS	NS
	23-Sep-92	PES	5.200	NA	1.100	0.590	0.100	1.000	NA	NA
	27-Oct-92	PES	1.300	NA	0.220	0.061	0.0053	0.110	NA	NA
	24-Nov-92	PES	7.100	NA	1.400	1.100	0.120	0.890	NA	NA
	18-Feb-93	PES	7.200	NA	1.400	0.930	0.210	1.000	NA	NA
	09-Mar-93	PES	4.600	NA	0.990	0.750	0.062	0.840	NA	NA
	21-Apr-93	PES	4.900	NA	0.270	0.180	0.020	0.190	NA	NA
	13-May-93	PES	2.600	NA	0.520	0.110	0.023	0.330	NA	NA
	28-Jun-93	PES	9.500	NA	1.900	0.460	0.230	1.000	NA	NA
	11-Aug-93	PES	1.300	NA	<0.002	<0.002	<0.002	0.400	NA	NA
	15-Nov-93	PES	46.000	NA	2.900	0.380	0.500	1.700	NA	NA
	14-Feb-94	PES	21.000	NA	4.500	0.860	1.000	2.800	NA	NA
	16-May-94	PES	19.000	NA	7.300	0.930	1.300	3.300	NA	NA
	10-Aug-94	**PES**	**19**	**NA**	**4.200**	**0.490**	**1.100**	**1.500**	**NA**	**NA**

NOTES:

* = 1,2-Dichlorethane concentration (only 1,2-Dichloroethane detected).
** = Organic Lead
*** = TPH quantified as gasoline but chromatogram pattern was not typical of gasoline.
**** = Small amount of Diesel 2 was detected in sample.
ES = Engineering-Science, Inc.
PES = PES Environmental, Inc.
NA = Not analyzed
ND = Not detected above method detection limit.
NS = Not sampled.
<0.0005 = Not detected above indicated laboratory reporting limit.
MCL = California Maximum Contaminant level, current as of January 1991.
DAL = Department of Health Services Action Levels, current as of January 1991.
TPH = Total Petroleum Hydrocarbons

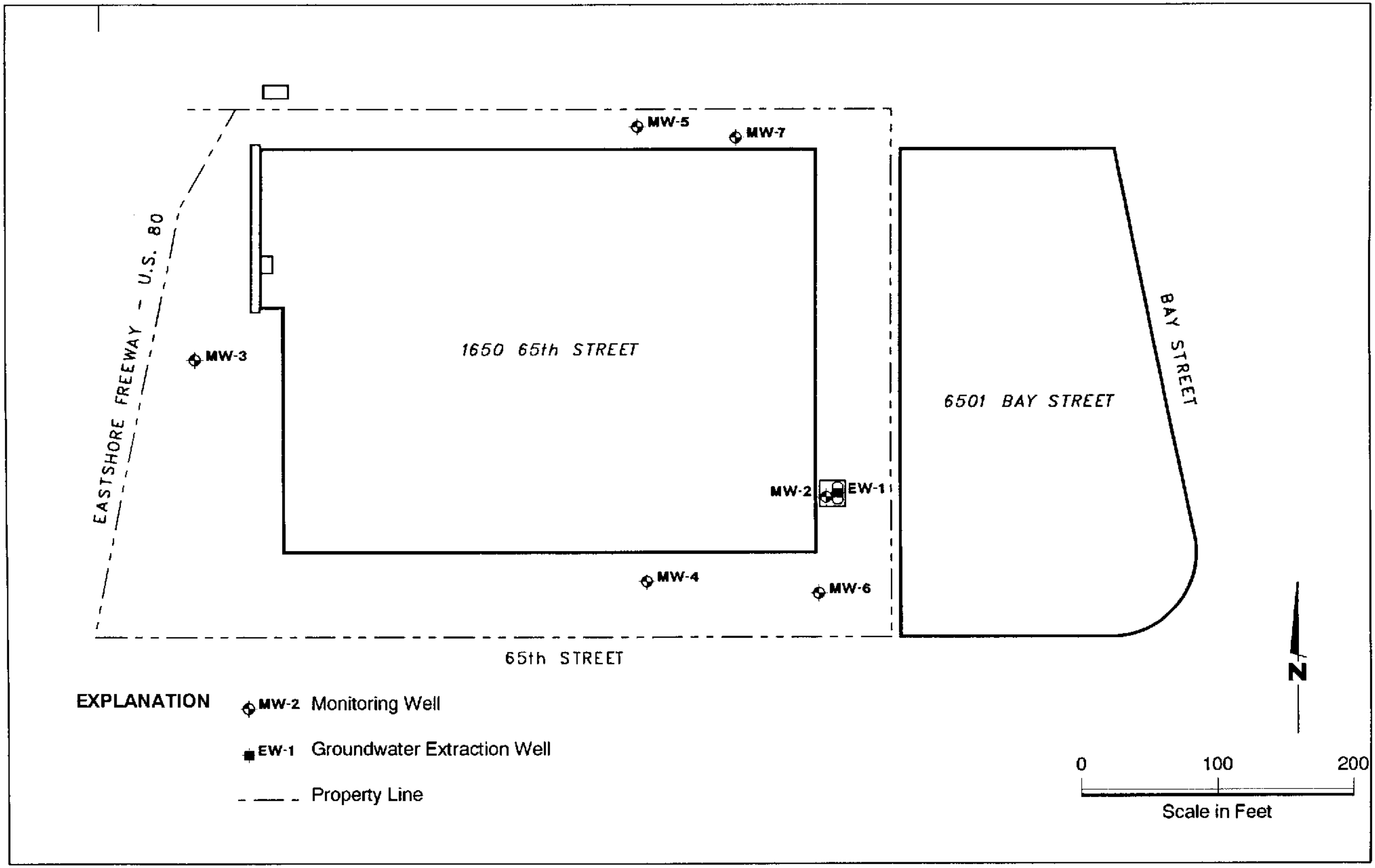


PES Environmental, Inc.
Engineering & Environmental Services

Site Location Map
1650 65th Street
Emeryville, California

PLATE
1

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE	REVISED DATE
131.01.003	MW	9/94		



PES Environmental, Inc.
Engineering & Environmental Services

Well Location Map
1650 65th Street
Emeryville, California

PLATE
2

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE	REVISED DATE
131.01.003	MW	9/94		

United States
Environmental Protection
Agency

Solid Waste and
Emergency Response
5403W

EPA 510-F-93-018
October 1993

EPA

Groundwater Remediation For UST Sites

In Situ Bioremediation

In situ ***bioremediation*** *is a technique for removing biodegradable contaminants from groundwater. The technique relies on microorganisms and supplemental oxygen and nutrients to break down petroleum products in the groundwater.*

In situ bioremediation offers the advantage of being able to treat contamination in place, without the need for pumping or the subsequent treatment of pumped groundwater. The technique is most effective in permeable aquifers.

Petroleum Types And Constituents

- Fresh or weathered gasoline, diesel, jet fuel, kerosene, motor oil, heavy fuel oil, lubricating oils, and crude oils
- Volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylene (BTEX); residual semivolatile organic compounds (SVOCs) such as polynuclear aromatic hydrocarbons; and nonvolatile constituents

In Situ Bioremediation

Advantages	• Degrades contaminants in place • Achieves lower concentration levels than pump and treat
Limitations	• Effectiveness is limited in low permeability or heterogeneous media • Ability to transport nutrients and oxygen might be limited by soil and groundwater mineral content or pH • Targets only biodegradable constituents
System Components	• Groundwater containment system • Oxygen delivery equipment • Nutrient delivery equipment • Injection trenches • Recovery walls or trenches • Pumps • Monitoring points

Wastestream Treatment	• Recirculated groundwater treatment options:
	  • *Air stripping*
	  • *Granulated activated carbon*
	  • *Bioreactors*

Parameters to Monitor[1]	• Constituent concentrations in groundwater • Microbial population in aquifer • pH and total organic carbon • Dissolved oxygen • Nutrient concentration • Flow rates
Cleanup Levels and Timing[2]	• Generally, can achieve maximum contaminant levels (MCLs) • Achieves ≥ 90% reduction of biodegradable constituents • For an ideal site[3], ~90% in 6 months to 1 year • For an average site[4], ~90% in 6 months to 4 years • Longer time required to degrade heavier hydrocarbons
Costs[5]	• For an ideal site[3], $150,000 to $250,000 • For an average site[4], $200,000 to $500,000

[1] "Parameters to monitor" are for performance purposes only; compliance monitoring parameters vary by state.
[2] Cleanup standards are determined by the state.
[3] An "ideal site" assumes no delays in corrective action and a relatively homogeneous, permeable subsurface.
[4] An "average site" assumes minimal delays in corrective action and a moderately heterogeneous and permeable surface.
[5] Costs include equipment, and operation and maintenance.

(oxygen, nitrate, and sometimes sulfate) and release of waste products (carbon dioxide and sometimes reduced iron and methane) in areas where microorganisms are most active. If field monitoring indicates that oxygen, nitrate and/or sulfate is being depleted (or carbon dioxide, soluble iron, or methane is being produced) within the plume, this is a good indication that one or more of the contaminants are being biodegraded. The major limitation of this approach is that it is not possible to determine which specific compounds are being degraded.

A second method that can be used to determine if individual compounds are being biodegraded is to examine changes in the ratio of different contaminants along the flow path. If one contaminant declines more rapidly than another, this suggests that some process is removing that contaminant. Field monitoring at several hydrocarbon plumes (Jasiorkowski and Robbins, 1991) and a sanitary landfill leachate plume (Barker et al., 1986) has shown a more rapid downgradient decline in *o*-xylene concentrations than *m*- or *p*-xylene. Since all of the xylene isomers should sorb to the aquifer equally, the only explanation for this pattern would be biodegradation of the *o*-xylene.

9.5.3. Are Environmental Conditions Appropriate for Biodegradation?

As previously discussed, virtually all hydrocarbons are biodegradable. Yet extensive plumes of dissolved hydrocarbons persist in some aquifers. Why does this apparent contradiction occur? The answer lies with the environmental conditions in the specific aquifer.

Virtually all hydrocarbons biodegrade more rapidly in the presence of dissolved oxygen. If dissolved oxygen concentrations are low in a specific aquifer, the rate of natural biodegradation will be lower. Also, the pH of the aquifer should be near neutrality, adequate inorganic nutrients should be present (nitrogen, phosphorus, and trace minerals), and no toxicants should be present that could inhibit microbial growth.

In most cases, it is not necessary to perform extensive investigations to precisely determine the concentrations of nitrogen, phosphorus, trace minerals, and potential toxicants. Past studies have shown that most aquifers do not contain toxicants and do contain adequate levels of inorganic nutrients to support moderate levels of microbial growth (Lee, 1986). If field monitoring indicates that biodegradation is occurring, it can reasonably be assumed that aquifer conditions are appropriate for microbial growth. Where field monitoring data suggest that biodegradation is being inhibited, additional laboratory studies may be needed to identify those factors that are limiting biodegradation. When performing laboratory studies, it is very important to design the experiment to simulate actual conditions within the aquifer. For example, if the oxygen supply in the aquifer is limiting, laboratory studies conducted with an excess of oxygen (or nitrogen, phosphorus, etc.) will overestimate the actual extent of biodegradation and lead to erroneous conclusions.

9.5.4. If the Waste Doesn't Completely Biodegrade, Where Will It Go?

Natural bioremediation, like other available techniques, is not foolproof. Instances arise where for some unforeseen reason, the contaminant plume does not biodegrade as expected. In order to adequately manage a natural remediation system, it is first necessary to evaluate the consequences of a system failure. In most cases, the primary consequences of a failure will be: (1) contamination of water supply wells; or (2) contamination of surface water. Appropriate controls should be incorporated into a natural remediation system to identify a failure and eliminate it.

9.6. MONITORING NATURAL BIOREMEDIATION SYSTEMS

One of the most important factors to consider in planning a natural bioremediation system is monitoring system performance. The monitoring system typically includes: (1) interior wells to monitor the actual plume distribution and indicator parameters; and (2) guardian wells at the outside edge of the area of contamination to monitor potential offsite migration and determine if additional remedial measures are required.

Interior wells may be monitored to evaluate the overall system performance. Parameters to be monitored typically include: (1) individual hydrocarbon components; (2) dissolved oxygen; (3) nitrate; (4) dissolved iron; (5) redox potential; (6) carbon dioxide; (7) pH; and (8) total organic carbon. Monitoring of individual hydrocarbon components can be performed using standard techniques and provides an indication of the treatment effectiveness.

Dissolved oxygen is monitored to determine if one or more of the organics are biodegrading and as an aid in defining the contaminant plume. Typically, both dissolved oxygen and hydrocarbon concentrations will be reduced at the margins of the plume. Dissolved oxygen can be measured in the field using electrodes or field test kits. Collection of accurate data on dissolved oxygen concentrations in ground water is difficult because of problems with aerating the samples during collection. One to two mg/l of oxygen may be added to the sample during collection unless special precautions are taken to prevent aeration. The extent of aeration can be reduced by using special pumps and filling the well casing with argon gas, but in most cases aeration cannot be completely eliminated.

Nitrate and iron may be monitored to determine the extent of anaerobic biodegradation of the hydrocarbons and any bacterial waste products. Nitrate can be monitored by collecting samples using conventional techniques and then transporting to the laboratory for analysis. Collection of samples for iron analysis is more difficult because of problems with iron present in suspended solids and precipitation of dissolved iron during transport. One method that may be used is to filter samples in the field during collection, preserve them with a concentrated acid and then analyze for total iron. While this procedure does not differentiate between dissolved ferric and ferrous iron, in most cases essentially all iron in excess of 0.5 mg/l will be in the reduced ferrous form (Hem, 1989).

Measurement of redox potential is relatively simple and can provide a good qualitative indicator of the overall oxidation-reduction status of the aquifer. Redox potential can be measured using a platinum electrode and a standard pH meter. In locations where the redox potential is negative, the ground water is strongly reduced, indicating significant bacterial decomposition. In areas where the redox potential is positive, the ground water is oxidizing, indicating that the contaminant plume has not reached this point or that bacterial degradation has not occurred. In most cases, redox potentials should not be used for precise calculations but as a qualitative indicator of environmental conditions within and outside the contaminant plume (Barcelona et al., 1989).

Carbon dioxide and pH can be monitored to evaluate the extent of bacterial respiration and determine if conditions are suitable for biodegradation. If the pH falls outside of a specified range (typically 5 to 9), biodegradation may be inhibited. Accumulation of carbon dioxide within and adjoining the contaminant plume is indicative of bacterial respiration. Direct interpretation of carbon dioxide concentrations is sometimes difficult because of shifts in the dominant form of inorganic carbon with pH and release of inorganic carbon during dissolution of certain minerals.

Individual hydrocarbon components can be monitored to determine the extent of the contaminant plume and any organic waste products produced during biodegradation of the dissolved hydrocarbons. In some cases, dissolved hydrocarbons will not be completely biodegraded but will be converted to nontoxic organic waste products. Monitoring total organic carbon (TOC) will provide some indication of the total oxygen demand exerted by the contaminant plume.

Guardian wells may be installed at the outside edge of the contamination area to monitor system performance, evaluate the potential for offsite migration and determine if additional remedial measures are required. In most cases, these wells are used for regulatory purposes and are only monitored for compounds of regulatory concern. These wells may also be monitored occasionally for indicator parameters (oxygen, nitrate, etc.) to confirm that the wells do in fact intercept the 'plume' of ground water that has undergone biodegradation.

9.7. PERFORMANCE OF NATURAL BIOREMEDIATION SYSTEMS

Under optimal conditions, natural bioremediation should be capable of completely containing a dissolved hydrocarbon plume. While there are few well-documented cases where this has occurred, there is a great deal of anecdotal evidence that suggests that natural bioremediation can be effective in containing dissolved hydrocarbon plumes. Typically greater than 90% of all underground tanks are used to store gasoline and other petroleum fuels. Yet a study by the California Department of Health Services (Hadley and Armstrong, 1991) found that by far the most common ground-water contaminants were chlorinated solvents, not petroleum constituents. These results suggest that the petroleum contaminants are being removed to below detection limits before reaching water supply wells.

In many aquifers, conditions will not be perfect for natural bioremediation and less than optimal biodegradation will occur. The extent of aerobic biodegradation will be controlled by the amount of contamination released, the rate of oxygen transfer into the subsurface, and the background oxygen content of the aquifer. When large amounts of contamination enter the subsurface, they overwhelm the capacity of an aquifer to assimilate them. As a result, extensive contamination may persist for long distances. When hydrogeologic conditions such as clayey, confining layers or naturally occurring organic deposits reduce the rate of oxygen transfer into the subsurface, the assimilative capacity of the aquifer will be lower. Anaerobic biodegradation may be inhibited by low pH, low buffering capacity, or absence of appropriate electron acceptors (nitrate, iron, etc.). Heterogeneous conditions within the aquifer may prevent mixing and allow a portion of the plume to migrate rapidly. If this occurs, the extent of biodegradation may be less than would be expected for more uniform conditions.

9.8. PREDICTING THE EXTENT OF NATURAL BIOREMEDIATION

One of the most frequently asked questions is "How far will the plume migrate before it biodegrades?" Unfortunately, this is a very difficult question to answer.

To predict the maximum extent of plume migration, it is necessary to estimate: (1) the rate of migration; and (2) the rate of biodegradation. The rate of contaminant migration can be estimated by measuring the hydraulic gradient and permeability of the aquifer. Accurate estimation of the biodegradation rate within an aquifer is much more difficult. Results from laboratory studies may significantly over- or underestimate biodegradation rates if environmental conditions in the laboratory differ from conditions in the field.

Computer models may be used to combine the results of field and laboratory investigations and to predict the actual extent of biodegradation in an aquifer. At present, there are a number of computer models that have been developed to simulate contaminant biodegradation (Molz et al., 1986; Odencrantz et al., 1989; MacQuarrie et al., 1990). Two of the most commonly used models for simulating hydrocarbon biodegradation are: (1) first-order decay models; or (2) BIOPLUME II.

Kemblowski et al. (1987) describe the use of a first order decay model to simulate hydrocarbon biodegradation at several sites. Their results show that this simple approach can adequately match the observed hydrocarbon distribution in the aquifers studied. The major limitation of this method is in estimating the first-order decay rate before extensive data are collected. Once the contaminant plume is properly delineated and shown to be biodegrading, it is possible to match the field data to a first-order decay equation and estimate the decay rate.

Hydrocarbon biodegradation may also be simulated using the computer model BIOPLUME II (Rifai et al., 1989). BIOPLUME II is based on the U.S.G.S. Method of Characteristics model (Konikow and Bredehoeft, 1978) and includes advection, dispersion, oxygen-limited biodegradation, and first-order decay in a two-dimensional aquifer. Oxygen-limited biodegradation is simulated as an instantaneous reaction between oxygen and hydrocarbon. Calibration of BIOPLUME II is relatively simple because the only data required are the aquifer hydrogeology, background oxygen concentrations and contaminant source concentrations.

The major limitations of BIOPLUME II are the inability to accurately simulate dissolution of residual hydrocarbons and anaerobic biodegradation of hydrocarbons or bacterial waste products. BIOPLUME II assumes that all contaminants are converted directly to carbon dioxide and water using 3 mg of oxygen for every mg of hydrocarbon degraded. In many cases, this significantly underestimates the amount of biodegradation (Chiang et al., 1989) and leads to a conservative prediction. This error is presumably due to anaerobic degradation of bacterial waste products and certain hydrocarbons. Anaerobic decay can be simulated in BIOPLUME II using a first-order decay rate, but this approach suffers from the same limitation as the simple first-order decay models. There are no accurate methods available to estimate these decay rates without first collecting extensive field data.

In summary, there are no good methods available at this time for predicting the extent of hydrocarbon biodegradation without first characterizing the contaminant plume. Once the contaminant plume is defined, there are several methods that can be used to analyze the available data and evaluate the effect of different alternatives on contaminant migration. As additional field data becomes available from different sites, it may become possible to estimate the decay rate by extrapolating results from similar aquifers and avoid extensive field data collection.

9.9. ISSUES THAT MAY AFFECT THE COSTS OF THIS TECHNOLOGY

One of the major factors controlling the costs of natural bioremediation is acceptance of this approach by regulators, environmental groups and the public. At sites where natural bioremediation is strongly opposed, the costs of implementation may actually be higher than conventional remediation technologies (e.g. pump and treat). In North Carolina, regulations have been in place for five years that allow responsible parties to request a reclassification of contaminated ground water to a nonwater supply use. Once reclassified, the responsible party would not be required to actively remediate the site. At present there are over 2,000 sites under investigation, with over 100 pump-and-treat systems in operation. Yet no one has ever filed a request for reclassification. The apparent cause is a perception by the responsible parties that the legal, administrative and site characterization costs for reclassification would be excessive, and the probability of success would be low.

The second major issue limiting application of natural bioremediation is third party liability. A hydrocarbon plume that is left in place to naturally biodegrade may migrate under an adjoining property, posing a potential risk to public health and the environment. Even when public health is not at risk, adjoining property owners may have strong concerns about a contaminant plume migrating under their property and the potential impact on property values. In such cases, natural bioremediation could be coupled with active plume management technology, such as purge wells, to prevent undesirable impact to third parties.

9.10. KNOWLEDGE GAPS AND RESEARCH OPPORTUNITIES

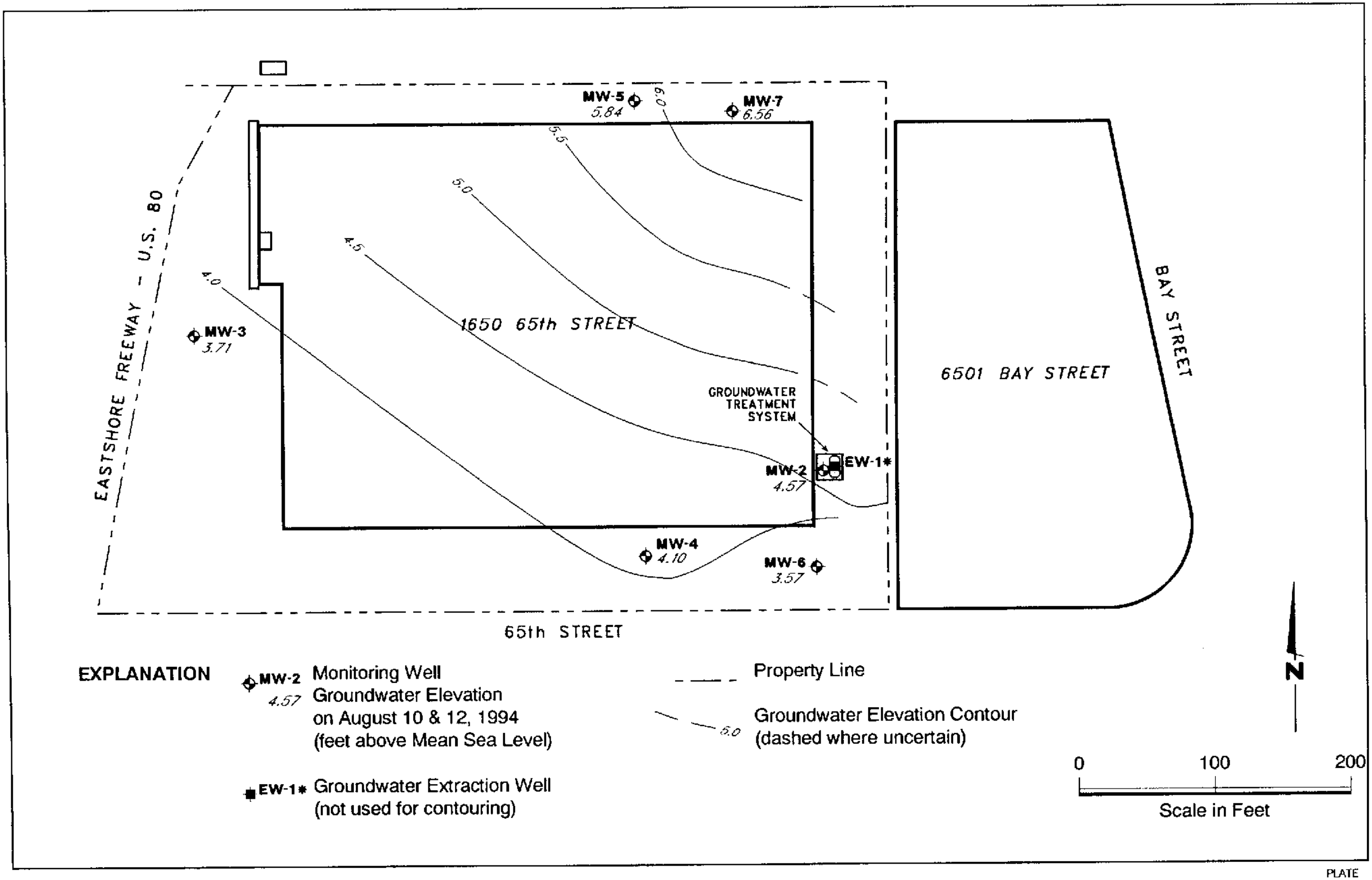
Currently, there are no reliable methods for predicting the effectiveness of natural bioremediation without first conducting extensive field work. Existing mathematical models cannot be used in a predictive mode because they either: (1) require extensive field data for calibration; or (2) greatly underestimate the extent of anaerobic biodegradation. This is often the primary reason why natural bioremediation is not seriously considered when evaluating remedial alternatives. Without some reasonable assurance of success, responsible parties are not willing to risk the large sums of money required for legal, administrative and site characterization costs.

Over the next several years, there is potential to dramatically improve our ability to predict the extent of natural bioremediation. Several organizations [U.S. EPA, American Petroleum Institute (API), Electric Power Research Institute (EPRI)] are funding extensive field studies to characterize dissolved hydrocarbon plumes undergoing natural bioremediation. These studies will generate an extensive database that will be used to improve our understanding of the basic processes that control natural biodegradation and to develop more accurate models for predicting the extent of natural bioremediation. In order to use this database effectively, additional research is needed in two general areas: (1) anaerobic hydrocarbon biodegradation; and (2) biodegradation modeling.

We now know that many hydrocarbons can be biodegraded under anaerobic conditions using nitrate, iron, sulfate, water and carbon dioxide as terminal electron acceptors. What we do not know is what factors control the rate of anaerobic hydrocarbon biodegradation and why anaerobic hydrocarbon biodegradation occurs in some locations and not in others. Detailed laboratory studies are needed to resolve these questions.

Primary emphasis should be placed on coordinating these laboratory studies with the ongoing field work to maximize benefits.

Existing models of hydrocarbon biodegradation do not adequately represent anaerobic biodegradation. Consequently, these models grossly under-predict the extent of biodegradation at many sites. Until this problem is resolved, natural bioremediation will not be seriously considered at many sites where it is a reasonable alternative. The extensive field database being collected by EPA, API and EPRI provides an outstanding opportunity to resolve this problem. By coordinating model development with the field data collection in the next few years we can significantly improve our ability to predict the extent of natural bioremediation.

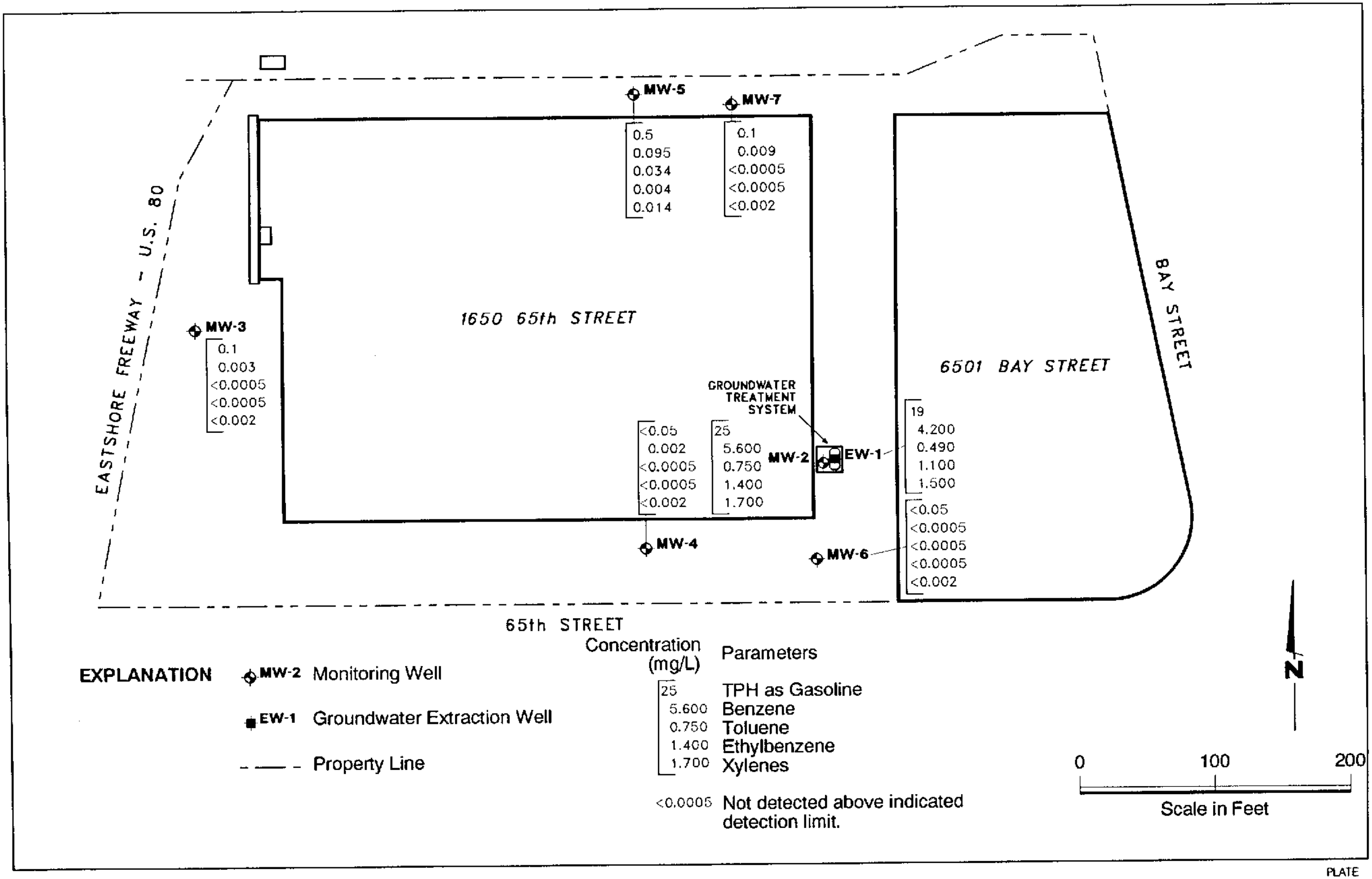


PES Environmental, Inc.
Engineering & Environmental Services

Groundwater Elevation Contours on August 10, 1994
1650 65th Street
Emeryville, California

PLATE
3

JOB NUMBER 131.03.001	REVIEWED BY MW	DATE 9/94	REVISED DATE	REVISED DATE



PES Environmental, Inc.
Engineering & Environmental Services

Dissolved Hydrocarbons in Groundwater on August 10 and 12, 1994
1650 65th Street
Emeryville, California

PLATE
4

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE	REVISED DATE
131.0100.003	MW	9/94		

BLAINE
TECH SERVICES INC.

985 TIMOTHY DRIVE
SAN JOSE, CA 95133
(408) 995-5535
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August 25, 1994

PES Environmental, Inc.
1682 Novato Blvd., Suite 100
Novato, CA 94947

Attn: Mary Williams

SITE:
P.O. Partners
1650 65th Street
Emeryville, California

DATE:
August 10 & 12, 1994

GROUNDWATER SAMPLING REPORT 940810-J-1

Blaine Tech Services, Inc. perform specialized environmental sampling and documentation as an independent third party. In order to avoid compromising the objectivity necessary for the proper and disinterested performance of this work, Blaine Tech Services, Inc. does not participate in the interpretation of analytical results or become involved with the marketing or installation of remedial systems.

This report deals with the groundwater well sampling performed by our firm on August 10, 1994, in response to your request. Data collected in the course of our work at the site are presented in the TABLE OF WELL MONITORING DATA. This information was collected during our inspection, well evacuation, and sample collection. Measurements include the total depth of the well and depth to water. Water surfaces were further inspected for the presence of immiscibles. A series of electrical conductivity, pH, and temperature readings were obtained during well evacuation and at the time of sample collection.

TABLE OF WELL MONITORING DATA

Well I.D.	MW-2	MW-3	MW-4	MW-5
Date Sampled	08/10/94	08/10/94	08/10/94	08/12/94
Well Diameter (in.)	2	4	4	4
Total Well Depth (ft.)	25.72	18.26	15.96	18.04
Depth To Water (ft.)	11.22	8.72	8.14	6.98
Free Product (in.)	NONE	NONE	NONE	NONE
Reason If Not Sampled	--	--	--	--
1 Case Volume (gal.)	2.3	6.2	5.1	7.2
Did Well Dewater?	NO	NO	NO	NO
Gallons Actually Evacuated	7.0	19.0	16.0	22.0
Purging Device	BAILER	ELECTRIC SUBMERSIBLE	ELECTRIC SUBMERSIBLE	ELECTRIC SUBMERSIBLE
Sampling Device	BAILER	BAILER	BAILER	BAILER
Time	13:56 13:59 14:03	12:52 12:54 12:56	12:09 12:11 12:13	16:47 16:49 16:54
Temperature (Fahrenheit)	75.1 74.9 74.3	69.4 69.1 68.4	69.8 70.8 71.4	76.4 74.4 74.6
pH	7.2 7.4 7.4	7.5 7.5 7.5	7.2 7.4 7.5	7.2 7.2 7.2
Conductivity (micromhos/cm)	1540 1500 1460	1600 1530 1560	3630 3560 3580	2800 2600 2600
Nephelometric Turbidity Units	>200 >200 >200	25 15 7	>200 13 11	15.6 10.3 11.6
BTS Chain of Custody	940810-J-1	940810-J-1	940810-J-1	940810-J-1
BTS Sample I.D.	MW-2	MW-3	MW-4	MW-5
DHS HMTL Laboratory	AEN	AEN	AEN	AEN
Analysis	TPH (GAS), BTEX	TPH (GAS), BTEX	TPH (GAS), BTEX	TPH (GAS), BTEX

TABLE OF WELL MONITORING DATA

Well I.D.	MW-6			MW-7			EW-1		
Date Sampled	08/10/94			08/10/94			08/10/94		
Well Diameter (in.)	4			4			4		
Total Well Depth (ft.)	18.82			18.78			28.04		
Depth To Water (ft.)	8.46			6.34			11.18		
Free Product (in.)	NONE			NONE			NONE		
Reason If Not Sampled	--			--			--		
1 Case Volume (gal.)	6.7			8.0			10.9		
Did Well Dewater?	NO			NO			NO		
Gallons Actually Evacuated	21.0			24.0			33.0		
Purging Device	ELECTRIC SUBMERSIBLE			ELECTRIC SUBMERSIBLE			ELECTRIC SUBMERSIBLE		
Sampling Device	BAILER			BAILER			BAILER		
Time	11:40	11:43	11:45	13:21	13:23	13:26	14:26	14:29	14:32
Temperature (Fahrenheit)	76.4	73.9	72.3	71.5	69.5	67.6	74.7	71.7	71.8
pH	6.7	6.5	6.5	7.4	7.4	7.3	7.2	7.3	7.2
Conductivity (micromhos/cm)	2930	5780	4360	1000	870	840	1780	1760	1780
Nephelometric Turbidity Units	33	139	43	13	9	12	>200	>200	>200
BTS Chain of Custody	940810-J-1			940810-J-1			940810-J-1		
BTS Sample I.D.	MW-6			MW-7			EW-1		
DHS HMTL Laboratory	AEN			AEN			AEN		
Analysis	TPH (GAS), BTEX			TPH (GAS), BTEX			TPH (GAS), BTEX		

Evacuation and Sampling Equipment

As shown in the TABLE OF MONITORING DATA the wells at this site were evacuated according to a protocol requirement for three case volumes. The wells were evacuated using either bailers or electric submersible pumps.

Samples were collected using stainless steel bailers.

Bailers: A bailer, in its simplest form, is a hollow tube which has been fitted with a check valve at the lower end. The device can be lowered into a well by means of a cord. When the bailer enters the water, the check valve opens and liquid flows into the interior of the bailer. The bottom check valve prevents water from escaping when the bailer is drawn up out of the well.

Two types of bailers are used in groundwater wells at sites where fuel hydrocarbons are of concern. The first type of bailer is made of a clear material such as acrylic plastic and is used to obtain a sample of the surface and the near surface liquids in order to detect the presence of visible or measurable fuel hydrocarbon floating on the surface. The second type of bailer is made of Teflon or stainless steel and is used as an evacuation and/or sampling device.

Bailers are inexpensive and relatively easy to clean. Because they are manually operated, variations in operator technique may have a greater influence than would be found with more automated sampling equipment. Also where fuel hydrocarbons are involved, the bailer may include near surface contaminants that are not representative of water deeper in the well.

Electric Submersible Pumps: Electric submersible pumps are appropriate for the high volume evacuation of wells of any depth provided the well diameter is large enough to admit the pump. Four inch and three inch diameter wells will readily accept electric submersible pumps, while two inch wells do not. In operation, the pump is lowered into the well with a pipe train above it. A checkvalve immediately above the pump and below the first section of pipe prevents water that has entered the pipe from flowing back into the well. Electricity is provided to the pump via an electrical cable and the action of the pump is to push water up out of the well.

Electric submersible pumps are often used as well evacuation devices, which are then supplanted with a more specialized sample collection device (such as a bailer) at the time of sampling. An alternative is to use the pump for both evacuation and sampling. When a bailer is used to collect the sample, interpretation of results by the consultant should allow for variations attributable to near surface contamination entering the bailer. When the electric submersible is, itself, used for sample collection it should be operated with the output restricted to a point where the loss of volatiles becomes indistinguishable from the level obtained with true sampling pumps.

It should be noted that when the pump is used for both evacuation and sample collection that it is possible to perform these operation as an uninterrupted continuum. This contrasts with the variations in elapsed time between evacuation and sample collection that occur when field personnel cease one mode of operation and must bring other apparatus into use.

Decontamination

All apparatus is brought to the site in clean and serviceable condition. The equipment is decontaminated after each use and before leaving the site.

Effluent Materials

The evacuation process creates a volume of effluent water which must be contained. Purge water from this sampling event was discharged through the carbon filtration system on site.

Sampling Methodology

Samples were obtained by standardized sampling procedures that follow an evacuation and sample collection protocol. The sampling methodology conforms both State and Regional Water Quality Control Board standards and specifically adheres to EPA requirements for apparatus, sample containers and sample handling as specified in publication SW 846 and the T.E.G.D. which is published separately.

Sample Containers

Sample containers are supplied by the laboratory performing the analyses.

Sample Handling Procedures

Following collection, samples are promptly placed in an ice chest containing prefrozen blocks of an inert ice substitute such as Blue Ice or Super Ice.

Sample Designations

All sample containers are identified with both a sampling event number and a discrete sample identification number. Please note that the sampling event number is the number that appears on our chain of custody. It is roughly equivalent to a job number, but applies only to work done on a particular day of the year rather than spanning several days as jobs and projects often do.

Chain of Custody

Samples are continuously maintained in an appropriate cooled container while in our custody and until delivered to the laboratory under our standard chain of custody. If the samples are taken charge of by a different party (such as another person from our office, a courier, etc.) prior to being delivered to the laboratory, appropriate release and acceptance records are made on the chain of custody (time, date, and signature of person releasing the samples followed by the time, date and signature of the person accepting custody of the samples).

Hazardous Materials Testing Laboratory

After completion of the field work, the sample containers were delivered to American Environemental Network in Pleasant Hill, California. American Environmental Network is certified by the California Department of Health Services as a Hazardous Materials Testing Laboratory and is listed as DOHS HMTL #1172.

Personnel

All Blaine Tech Services, Inc. personnel receive 29 CFR 1910.120(e)(2) training as soon after being hired as is practical. In addition, many of our personnel have additional certifications that include specialized training in level B supplied air apparatus and the supervision of employees working on hazardous materials sites. Employees are not sent to a site unless we are confident they can adhere to any site safety provisions in force at the site and unless we know that they can follow the written provisions of an SSP and the verbal directions of an SSO.

In general, employees sent to a site to perform groundwater well sampling will assume an OSHA level D (wet) environment exists unless otherwise informed. The use of gloves and double glove protocols protects both our employees and the integrity of the samples being collected. Additional protective gear and procedures for higher OSHA levels of protection are available.

Please call if we can be of any further assistance.

James Keller for

Richard C. Blaine

RCB/dk

attachments: chain of custody

BLAINE
TECH SERVICES INC.

985 TIMOTHY DRIVE
SAN JOSE, CA 95133
(408) 995-5535
FAX (408) 293-8773

CHAIN OF CUSTODY

CLIENT PES Environmental

SITE P.O. Partners
1650 65th St.
Emeryville CA

LAB AEN   DHS #

ALL ANALYSES MUST MEET SPECIFICATIONS AND DETECTION LIMITS SET BY CALIFORNIA DHS AND

☐ EPA
☐ LIA
☐ OTHER
☐ RWQCB REGION

SPECIAL INSTRUCTIONS
Invoice + Report to:
PES Environmental
Attn: Andrew Briefer
PES Job# 131.0100.003
cc report to BTS

CONDUCT ANALYSIS TO DETECT

SAMPLE I.D.	MATRIX S = SOIL W = H2O	CONTAINERS TOTAL	C = COMPOSITE ALL CONTAINERS	TPHg (8015)/BTEX (8020)	ADD'L INFORMATION	STATUS	CONDITION	LAB SAMPLE #
MW-3	W	3		X				
MW-3	↓	3		↓				
MW-4		3						
MW-6		3						
MW-7		3						
EW-1		3						
T.B.		2						

SAMPLING COMPLETED DATE 8/10/94 TIME 16:15

SAMPLING PERFORMED BY JEAN GATINEAU

RESULTS NEEDED NO LATER THAN Routine - As Contracted

RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME
Jean Gatineau	8/12/94	14:45	Michael E. [illegible]	8/12/94	14:45

SHIPPED VIA	DATE SENT	TIME SENT	COOLER #	

BLAINE
TECH SERVICES INC.

985 TIMOTHY DRIVE
SAN JOSE, CA 95133
(408) 995-5535
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CHAIN OF CUSTODY

CLIENT PES Environmental

SITE PO Partners
1650 65th St
Emeryville

LAB AEN DHS #

ALL ANALYSES MUST MEET SPECIFICATIONS AND DETECTION LIMITS SET BY CALIFORNIA DHS AND

☐ EPA
☐ LIA
☐ OTHER
☐ RWQCB REGION

SPECIAL INSTRUCTIONS
Invoice & Report to
PES Environmental
Attn: Andrew Briefer
PES Job# 131.0100.003
cc report to BTS

CONDUCT ANALYSIS TO DETECT

SAMPLE I.D.			MATRIX S = SOIL W = H2O	CONTAINERS TOTAL		C = COMPOSITE ALL CONTAINERS	TPHg/BTEX								ADD'L INFORMATION	STATUS	CONDITION	LAB SAMPLE #
MW-5	8/12	1700	W	3	VOAs		X											

SAMPLING COMPLETED	DATE 8/12	TIME 1700	SAMPLING PERFORMED BY Brett Blean / GRANT MOHR	RESULTS NEEDED NO LATER THAN	As Contracted - Routine

RELEASED BY	DATE 8/15/94	TIME 1100.	RECEIVED BY	DATE 8/15/94	TIME 11:00
RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME
RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME

SHIPPED VIA	DATE SENT	TIME SENT	COOLER #	

American Environmental Network

Certificate of Analysis

DOHS Certification: 1172

AIHA Accreditation: 11134

PES ENVIRONMENTAL, INC.
1682 NOVATO BLVD.
SUITE 100
NOVATO, CA 94947

ATTN: ANDREW BRIEFER
CLIENT PROJ. ID: 131.0100.003

REPORT DATE: 09/06/94

DATE(S) SAMPLED: 08/10/94

DATE RECEIVED: 08/12/94

AEN WORK ORDER: 9408191

PROJECT SUMMARY:

On August 12, 1994, this laboratory received 7 water sample(s).

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

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

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

Larry Klein

Larry Klein
Laboratory Director

cc: Blaine Tech Services

PES ENVIRONMENTAL, INC.

SAMPLE ID: MW-2
AEN LAB NO: 9408191-01
AEN WORK ORDER: 9408191
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED: 08/10/94
DATE RECEIVED: 08/12/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	**EPA 8020**				
Benzene	71-43-2	5,600 *	10	ug/L	08/23/94
Toluene	108-88-3	750 *	10	ug/L	08/23/94
Ethylbenzene	100-41-4	1,400 *	10	ug/L	08/23/94
Xylenes, Total	1330-20-7	1,700 *	40	ug/L	08/23/94
Purgeable HCs as Gasoline	5030/GCFID	25 *	1	mg/L	08/23/94

Reporting limits elevated due to high levels of target compounds. Sample run at dilution.

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

PES ENVIRONMENTAL, INC.

SAMPLE ID: MW-3
AEN LAB NO: 9408191-02
AEN WORK ORDER: 9408191
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED: 08/10/94
DATE RECEIVED: 08/12/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	EPA 8020				
Benzene	71-43-2	3 *	0.5	ug/L	08/23/94
Toluene	108-88-3	ND	0.5	ug/L	08/23/94
Ethylbenzene	100-41-4	ND	0.5	ug/L	08/23/94
Xylenes, Total	1330-20-7	ND	2	ug/L	08/23/94
Purgeable HCs as Gasoline	5030/GCFID	0.1 *	0.05	mg/L	08/23/94

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

PES ENVIRONMENTAL, INC.

SAMPLE ID: MW-4
AEN LAB NO: 9408191-03
AEN WORK ORDER: 9408191
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED: 08/10/94
DATE RECEIVED: 08/12/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	**EPA 8020**				
Benzene	71-43-2	2 *	0.5	ug/L	08/23/94
Toluene	108-88-3	ND	0.5	ug/L	08/23/94
Ethylbenzene	100-41-4	ND	0.5	ug/L	08/23/94
Xylenes, Total	1330-20-7	ND	2	ug/L	08/23/94
Purgeable HCs as Gasoline	5030/GCFID	ND	0.05	mg/L	08/23/94

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

PES ENVIRONMENTAL, INC.

SAMPLE ID: MW-6
AEN LAB NO: 9408191-04
AEN WORK ORDER: 9408191
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED: 08/10/94
DATE RECEIVED: 08/12/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	**EPA 8020**				
Benzene	71-43-2	ND	0.5	ug/L	08/19/94
Toluene	108-88-3	ND	0.5	ug/L	08/19/94
Ethylbenzene	100-41-4	ND	0.5	ug/L	08/19/94
Xylenes, Total	1330-20-7	ND	2	ug/L	08/19/94
Purgeable HCs as Gasoline	5030/GCFID	ND	0.05	mg/L	08/19/94

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

PES ENVIRONMENTAL, INC.

SAMPLE ID: MW-7
AEN LAB NO: 9408191-05
AEN WORK ORDER: 9408191
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED: 08/10/94
DATE RECEIVED: 08/12/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	**EPA 8020**				
Benzene	71-43-2	9 *	0.5	ug/L	08/19/94
Toluene	108-88-3	ND	0.5	ug/L	08/19/94
Ethylbenzene	100-41-4	ND	0.5	ug/L	08/19/94
Xylenes, Total	1330-20-7	ND	2	ug/L	08/19/94
Purgeable HCs as Gasoline	5030/GCFID	0.1 *	0.05	mg/L	08/19/94

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

PES ENVIRONMENTAL, INC.

SAMPLE ID: EW-1
AEN LAB NO: 9408191-06
AEN WORK ORDER: 9408191
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED: 08/10/94
DATE RECEIVED: 08/12/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	**EPA 8020**				
Benzene	71-43-2	4,200 *	10	ug/L	08/23/94
Toluene	108-88-3	490 *	10	ug/L	08/23/94
Ethylbenzene	100-41-4	1,100 *	10	ug/L	08/23/94
Xylenes, Total	1330-20-7	1,500 *	40	ug/L	08/23/94
Purgeable HCs as Gasoline	5030/GCFID	19 *	1	mg/L	08/23/94

Reporting limits elevated due to high levels of target compounds. Sample run at dilution.

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

PES ENVIRONMENTAL, INC.

SAMPLE ID: T.B.
AEN LAB NO: 9408191-07
AEN WORK ORDER: 9408191
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED:
DATE RECEIVED: 08/12/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	EPA 8020				
Benzene	71-43-2	ND	0.5	ug/L	08/19/94
Toluene	108-88-3	ND	0.5	ug/L	08/19/94
Ethylbenzene	100-41-4	ND	0.5	ug/L	08/19/94
Xylenes, Total	1330-20-7	ND	2	ug/L	08/19/94
Purgeable HCs as Gasoline	5030/GCFID	ND	0.05	mg/L	08/19/94

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

AEN (CALIFORNIA)
QUALITY CONTROL REPORT

AEN JOB NUMBER: 9408191

CLIENT PROJECT ID: 131.0100.003

Quality Control and Project Summary

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

Definitions

Laboratory Control Sample (LCS)/Method Spike(s): Control samples of known composition. LCS and Method Spike data are used to validate batch analytical results.

Matrix Spike(s): Aliquot of a sample (aqueous or solid) with added quantities of specific compounds and subjected to the entire analytical procedure. Matrix spike and matrix spike duplicate QC data are advisory.

Method Blank: An analytical control consisting of all reagents, internal standards, and surrogate standards carried through the entire analytical process. Used to monitor laboratory background and reagent contamination.

Not Detected (ND): Not detected at or above the reporting limit.

Relative Percent Difference (RPD): An indication of method precision based on duplicate analysis.

Reporting Limit (RL): The lowest concentration that can reliably be determined during routine laboratory operations. The RL is generally 1 to 10 times the Method Detection Limit (MDL). Reporting limits are matrix and method dependent and take into account any dilutions performed as part of the analysis.

Surrogates: Organic compounds which are similar to analytes of interest in chemical behavior, but are not found in environmental samples. Surrogates are added to all blanks, calibration and check standards, samples, and spiked samples. Surrogate recovery is monitored as an indication of acceptable sample preparation and instrumental performance.

D: Surrogates diluted out.

#: Indicates result outside of established laboratory QC limits.

QUALITY CONTROL DATA

AEN JOB NO: 9408191
INSTRUMENT: F
MATRIX: WATER

Surrogate Standard Recovery Summary
Method: EPA 8020, 5030 GCFID

Date Analyzed	Client Id.	Lab Id.	Percent Recovery Fluorobenzene
08/23/94	MW-2	01	106
08/23/94	MW-3	02	94
08/23/94	MW-4	03	96
08/19/94	MW-6	04	99
08/19/94	MW-7	05	97
08/23/94	EW-1	06	103
08/19/94	T.B.	07	98

Current QC Limits

Surrogate	Percent Recovery
Fluorobenzene	70-115

QUALITY CONTROL DATA

AEN JOB NO: 9408191
DATE ANALYZED: 08/22/94
SAMPLE SPIKED: LCS
INSTRUMENT: F
MATRIX: WATER

Laboratory Control Sample
Method: EPA 8020, 5030 GCFID

Analyte	Spike Added (ug/L)	Percent Recovery
Benzene	8.5	87
Toluene	32.2	79
Hydrocarbons as Gasoline	500	86

Current QC Limits

Analyte	Percent Recovery
Benzene	65-122
Toluene	67-124
Gasoline	60-125

Daily method blanks for all associated analytical runs showed no contamination over the reporting limit.

*** END OF REPORT ***

American Environmental Network

Certificate of Analysis

DOHS Certification: 1172

AIHA Accreditation: 11134

PES ENVIRONMENTAL, INC.
1682 NOVATO BLVD.
SUITE 100
NOVATO, CA 94947

ATTN: ANDREW BRIEFER
CLIENT PROJ. ID: 131.0100.003
CLIENT PROJ. NAME: PO PARTNERS

REPORT DATE: 09/06/94

DATE(S) SAMPLED: 08/12/94

DATE RECEIVED: 08/15/94

AEN WORK ORDER: 9408201

PROJECT SUMMARY:

On August 15, 1994, this laboratory received 1 water sample(s).

Client requested the sample be analyzed for organic parameters. Results of analysis are summarized on the following page.

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

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

Larry Klein

Larry Klein
Laboratory Director

cc: Blaine Tech Services

PES ENVIRONMENTAL, INC.

SAMPLE ID: MW-5
AEN LAB NO: 9408201-01
AEN WORK ORDER: 9408201
CLIENT PROJ. ID: 131.0100.003

DATE SAMPLED: 08/12/94
DATE RECEIVED: 08/15/94
REPORT DATE: 09/06/94

ANALYTE	METHOD/ CAS#	RESULT	REPORTING LIMIT	UNITS	DATE ANALYZED
BTEX & Gasoline HCs	EPA 8020				
Benzene	71-43-2	95 *	0.5	ug/L	08/19/94
Toluene	108-88-3	34 *	0.5	ug/L	08/19/94
Ethylbenzene	100-41-4	4 *	0.5	ug/L	08/19/94
Xylenes, Total	1330-20-7	14 *	2	ug/L	08/19/94
Purgeable HCs as Gasoline	5030/GCFID	0.5 *	0.05	mg/L	08/19/94

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

AEN (CALIFORNIA)
QUALITY CONTROL REPORT

AEN JOB NUMBER: 9408201

CLIENT PROJECT ID: 131.0100.003

Quality Control and Project Summary

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

Definitions

Laboratory Control Sample (LCS)/Method Spike(s): Control samples of known composition. LCS and Method Spike data are used to validate batch analytical results.

Matrix Spike(s): Aliquot of a sample (aqueous or solid) with added quantities of specific compounds and subjected to the entire analytical procedure. Matrix spike and matrix spike duplicate QC data are advisory.

Method Blank: An analytical control consisting of all reagents, internal standards, and surrogate standards carried through the entire analytical process. Used to monitor laboratory background and reagent contamination.

Not Detected (ND): Not detected at or above the reporting limit.

Relative Percent Difference (RPD): An indication of method precision based on duplicate analysis.

Reporting Limit (RL): The lowest concentration that can reliably be determined during routine laboratory operations. The RL is generally 1 to 10 times the Method Detection Limit (MDL). Reporting limits are matrix and method dependent and take into account any dilutions performed as part of the analysis.

Surrogates: Organic compounds which are similar to analytes of interest in chemical behavior, but are not found in environmental samples. Surrogates are added to all blanks, calibration and check standards, samples, and spiked samples. Surrogate recovery is monitored as an indication of acceptable sample preparation and instrumental performance.

D: Surrogates diluted out.

#: Indicates result outside of established laboratory QC limits.

QUALITY CONTROL DATA

AEN JOB NO: 9408201
INSTRUMENT: F
MATRIX: WATER

Surrogate Standard Recovery Summary
Method: EPA 8020, 5030 GCFID

Date Analyzed	Client Id.	Lab Id.	Percent Recovery Fluorobenzene
08/19/94	MW-5	01	100

Current QC Limits

Surrogate	Percent Recovery
Fluorobenzene	70-115

QUALITY CONTROL DATA

AEN JOB NO: 9408201
DATE ANALYZED: 08/18/94
SAMPLE SPIKED: LCS
INSTRUMENT: F
MATRIX: WATER

Laboratory Control Sample
Method: EPA 8020, 5030 GCFID

Analyte	Spike Added (ug/L)	Percent Recovery
Benzene	8.5	94
Toluene	32.2	87
Hydrocarbons as Gasoline	500	99

Current QC Limits

Analyte	Percent Recovery
Benzene	65-122
Toluene	67-124
Gasoline	60-125

Daily method blanks for all associated analytical runs showed no contamination over the reporting limit.

*** END OF REPORT ***

K-3,5-1

BLAINE
TECH SERVICES INC.

985 TIMOTHY DRIVE
SAN JOSE, CA 95133
(408) 995-5535
FAX (408) 293-8773

CHAIN OF CUSTODY

CLIENT PES Environmental

SITE PO Partners
1650 65th St
Emeryville

LAB AEN 9408201

DHS #

ALL ANALYSES MUST MEET SPECIFICATIONS AND DETECTION LIMITS SET BY CALIFORNIA DHS AND

☐ EPA
☐ LIA
☐ OTHER
☐ RWQCB REGION ____

SPECIAL INSTRUCTIONS
Invoice & Report to
PES Environmental
Attn: Andrew Briefer
PES Job# 131.0100.003
cc report to BTS

SAMPLE I.D.			MATRIX S = SOIL W = H2O	CONTAINERS TOTAL		C = COMPOSITE ALL CONTAINERS	CONDUCT ANALYSIS TO DETECT TPHg/BTEX							ADD'L INFORMATION	STATUS	CONDITION	LAB SAMPLE #
MW-5	8/12	1700	W	3	VOAs		X							01A-C			

SAMPLING COMPLETED DATE 8/12 TIME 1700
SAMPLING PERFORMED BY Brett Blean / GRANT MOHR
RESULTS NEEDED NO LATER THAN As Contracted - Routine

RELEASED BY	DATE 8/15/94	TIME 1100.	RECEIVED BY	DATE 8/15/94	TIME 11:00
RELEASED BY	DATE 8-15-94	TIME 13:00	RECEIVED BY Arine Gillespie	DATE 8-15-94	TIME 1300
RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME

SHIPPED VIA	DATE SENT	TIME SENT	COOLER #	

BLAINE
TECH SERVICES INC

985 TIMOTHY DRIVE
SAN JOSE, CA 95133
(408) 995-5535
FAX (408) 293-8773

CONDUCT ANALYSIS TO DETECT

LAB AEN 9408191 DHS #

ALL ANALYSES MUST MEET SPECIFICATIONS AND DETECTION LIMITS SET BY CALIFORNIA DHS AND

☐ EPA ☐ RWQCB REGION ______
☐ LIA
☐ OTHER

CHAIN OF CUSTODY

CLIENT PES Environmental

SITE P.O. Partners
1650 65th St.
Emeryville CA

SPECIAL INSTRUCTIONS
Invoice + Report to:
PES Environmental
Attn. Andrew Briefer
PES Job# 131.0100.003
cc report to BTS

SAMPLE I.D.		MATRIX S = SOIL W = H2O	CONTAINERS TOTAL		C = COMPOSITE ALL CONTAINERS	TPHg(8015)/BTEX (8020)							ADD'L INFORMATION	STATUS	CONDITION	LAB SAMPLE #
MW-2	01A-C	W	3			X										
MW-3	02A-C	↓	3			↓										
MW-4	03A-C		3													
MW-6	04A-C		3													
MW-7	05A C		3													
EW-1	06AC		3													
T.B.	07AB	↓	2			↓										

SAMPLING COMPLETED DATE 8/10/94 TIME 16:15
SAMPLING PERFORMED BY JEAN GATINEAU
RESULTS NEEDED NO LATER THAN Routine - As Contracted

RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME
Jean Gatineau	8/12/94	14:15	Michael E. McNulty	8/12/94	14:45
Michael E. McNulty	8/12	17:15	Emily H	8/12/94	1715

SHIPPED VIA	DATE SENT	TIME SENT	COOLER #	