CAMBRIA

ENVIRONMENTAL PROTECTION
98 NOV 31 AM 9:39

November 24, 1998

Barney Chan
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway, 2nd Floor
Alameda, CA 94502-6577

Re: **Response to Information Request**
Shell-branded Service Station
285 Hegenberger Rd.
Oakland, California
WIC # 204-5508-5504
Cambria Project # 240-734

Dear Mr. Chan:

Cambria Environmental Technology (Cambria), on behalf of Equilon Enterprises LLC (Equilon), has prepared this response to information requested in your May 11, 1998 Alameda County Department of Environmental Health (ACDEH) letter to Shell Oil Products Company (Shell). In the letter to Shell, earlier submittals by Pacific Environmental Group (PEG) and recent ground water monitoring reports were referenced. Specifically, an evaluation of the soil vapor extraction (SVE) system a review of possibly restarting the SVE system was requested. A proposal to determine the potential use of enhanced bioremediation and an investigation of preferential pathways of ground water in the site vicinity was also requested.

Cambria evaluated the operation of the SVE system and determined that restarting the SVE system would be ineffective at further decreasing total petroleum hydrocarbons as gasoline (TPHg), benzene and methyl tert butyl ether (MTBE) in ground water. As discussed below, influent SVE concentrations of TPHg and benzene had reached asymptotic levels prior to system shutdown, and wells screens are typically submerged due to shallow ground water, thus limiting the operation of the SVE system.

Cambria also evaluated the groundwater concentrations for TPHg and benzene in monitoring wells MW-1, MW-9 and MW-10. The concentrations in those wells show a negative linear trend that can be expected to continue as natural biodegradation is occurring at this site. Presented below is an evaluation of groundwater concentrations and the potential for enhanced biodegradation.

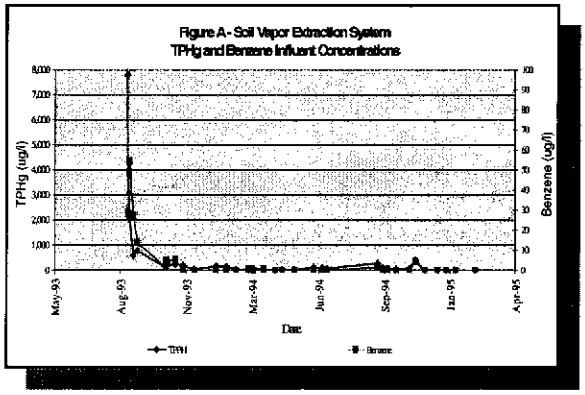
Additionally, Cambria located underground utilities to identify potential preferential migration pathways of ground water in the site vicinity. Presented below is an evaluation of the potential preferential pathways.

Oakland, CA
Sonoma, CA
Portland, OR
Seattle, WA

Cambria Environmental Technology, Inc.

1144 65th Street
Suite B
Oakland, CA 94608
Tel (510) 420-0700
Fax (510) 420-9170

Soil Vapor Extraction System: The operation of the soil vapor extraction (SVE) system began on August 30, 1993 and was discontinued in February 1995 after influent concentrations of TPHg and benzene reached asymptotic levels corresponding to negligible hydrocarbon removal as shown in Figure A. A February 9, 1995 letter from Pacific Environmental Group, Inc. (PEG) states that the SVE system was shut down due to low influent concentrations and high ground water conditions, and PEG's June 20, 1995 Quarterly report states that the system would remain shut down until the ground water elevations decreased to approximately 5 to 6 feet below ground surface.

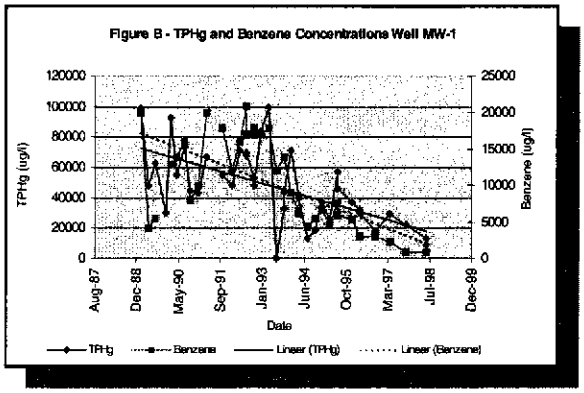


- There are no current estimate for SVE are
- New releases have occurred and/or caused by MTBE conc. can't they do dual phase extr.?

The vapor extraction wells were screened from approximately 3.5 to 9 ft below grade, and ground water depths in the wells closest to the vapor extraction wells (MW-1, MW-9 and MW-10) have generally been between 2.0 and 6.0 ft since 1995. With extraction well screens totally or partially submerged, the amount of soil available for soil vapor extraction treatment is minimized, and it is not likely that a significant amount of additional hydrocarbons would be removed by restarting the SVE system. Installation of SVE wells with shallow screen intervals is not practical due to the need to provide a seal between the top of the well screen and ground surface to eliminate short circuiting of air flow.

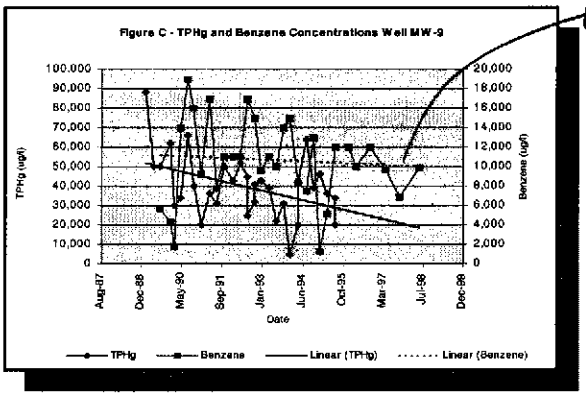
MW-1, MW-9 and MW-10 Ground Water Concentrations: Your May 11, 1998 letter mentioned that comparing the 1995 and 1997 ground water concentrations of TPHg and benzene in wells MW-1, MW-9, and MW-10 shows only a partial decrease. – Should also look @ current levels based on health risks.

From July 1995 to June 1998, TPHg concentrations in well MW-1 have dropped from 57,000 µg/L to 13,000 µg/L and benzene has dropped from 7,500 µg/L to 870 µg/L as shown in Figure B. The linear trend for TPHg and Benzene in well MW-1 show a negative slope indicating that TPHg and benzene are decreasing over time.

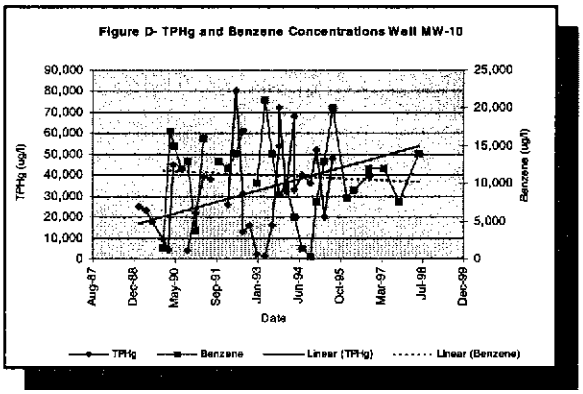


[Benz] is not decreasing

During the same period, TPHg concentrations in well MW-9 have dropped from 43,000 µg/L to 20,000 µg/L, and benzene has dropped from 12,000 µg/L to 9,900 µg/L as shown in Figure C. Again, the linear trend for TPHg and Benzene in well MW-9 show a negative slope indicating that TPHg and Benzene are decreasing over time



Concentrations of TPHg in well MW-10 dropped from 72,000 µg/L to 48,000 µg/L, and benzene dropped from 20,000 µg/L to 14,000 µg/L from July 1995 to June 1998. There is a positive linear trend for TPHg and a negative linear trend for Benzene which might suggest that TPHg is increasing in well MW-10. However, the negative linear trend for benzene is an indicator that TPHg will eventually decrease over time since the estimated half-lives for benzene and TPHg are estimated at only about 1.2 and 1.4 years, respectively. Based on steadily decreasing benzene concentrations in well MW-10 it can be expected that TPHg concentrations will eventually decrease over time. (no !)

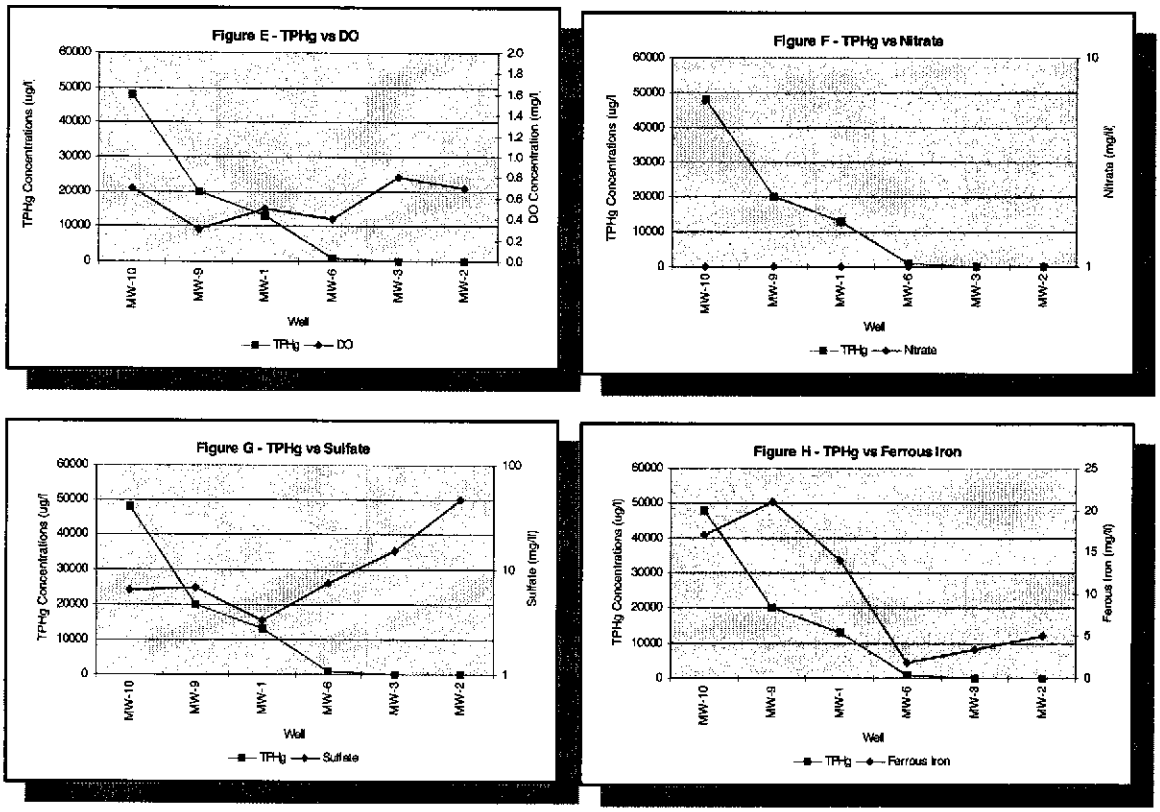


Enhanced Bioremediation Program: The ACDEH May 11, 1998 letter indicated that in the Third Quarter 1995 Report, PEG recommended implementing an enhanced bioremediation program at the site but did not submit a proposal for the program. The following is an evaluation of the potential for enhanced bioremediation at this site.

During the second quarter 1998 ground water sampling event, selected wells were sampled for dissolved oxygen (DO), oxidation-reduction potential (ORP), nitrate, sulfate, and ferrous iron to determine existing parameter concentrations and to evaluate further actions.

The results of the bioattentuation parameters are presented in Table 1. To summarize parameter relationships, active biodegradation is indicated by *inverse* relationships between hydrocarbon concentrations and DO, nitrate and sulfate concentrations, and *direct* relationships between hydrocarbon concentrations and alkalinity and ferrous iron concentrations. To facilitate comparison of the intrinsic bioremediation parameters sampled on June 10, 1998, between hydrocarbon-impacted

and non-hydrocarbon-impacted wells, we plotted some of the measured parameters versus the TPHg concentrations for each of the wells.



The plots above demonstrate that intrinsic biodegradation is occurring at this site. At this site, the primary biodegradation mechanism is likely to be anaerobic. DO concentration are less than 1 mg/l in the selected wells (Figure E). For natural attenuation to occur by aerobic processes, a minimum of about 1 mg/l DO is required. Under anaerobic processes, sulfates, nitrates and iron act as electron receptors. After DO has been depleted in the ground water or under anaerobic conditions, nitrate may be used as an electron acceptor for anaerobic biodegradation. In this denitrification process, nitrate is reduced to nitrite. If nitrate concentrations vary inversely with hydrocarbon concentrations, anaerobic biodegradation of fuel hydrocarbons is probably occurring. At this site nitrates have been depleted to less than 1 mg/l indicating denitrification is occurring (Figure F).

After DO and nitrate have been depleted in the ground water, sulfate may be used as an electron acceptor for anaerobic biodegradation. If sulfate concentrations vary inversely with hydrocarbon

concentrations, anaerobic biodegradation of fuel hydrocarbons is probably occurring as demonstrated in Figure G.

Ferric iron also acts as an electron acceptor during anaerobic biodegradation of petroleum hydrocarbons. In this process, ferric iron is reduced to ferrous iron, which may be soluble in water. Therefore, if the ferrous iron concentrations vary directly with hydrocarbon concentration, anaerobic biodegradation may be occurring. A direct relationship of ferrous iron and TPHg concentrations is demonstrated in Figure H.

Proposal For Enhanced Bioremediation: **Because there is evidence of naturally occurring anaerobic biodegradation at this site, enhanced biodegradation, i.e. introducing oxygen to the ground water, is not necessary.** Natural attenuation of hydrocarbons is occurring as demonstrated in Figures A, B, and C and intrinsic anaerobic biodegradation is occurring as demonstrated in Figures E, F, G and H. However, the introduction of oxygen into the ground water would serve to accelerate the natural biodegradation processes. Cambria proposes introducing Oxygen Release Copmounds into source wells to increase the potential for aerobic biodegradation.

no ! it too slow.

ORCs release DO into ground water to stimulate and accelerate naturally occurring aerobic hydrocarbon biodegradation. ORCs are capable of elevating DO concentrations up to 40 mg/l, while DO concentrations from air injection techniques such as air sparging can typically only achieve up to about 10 mg/l. Unlike air injection techniques, ORCs oxygenate ground water without the potential for causing hydrocarbon vapor migration. ORCs are a solid magnesium peroxide compound that is activated by moisture. ORCs release oxygen slowly to the ground water and are environmentally safe to use. The byproducts of the ORC reaction with water are oxygen and magnesium hydroxide. ORCs can be installed in existing ground water monitoring wells or installed as a slurry in borings drilled below the water table. Using ORCs to remediate the hydrocarbons in ground water typically requires 1 or more years, and depends on site conditions and water quality objectives.

Preferential Pathways: As shown in Figure 1, sewer trenches run across the site and storm drains run along the south of the property in the down gradient direction. Because of the shallow depth to water at the site, it is possible that these trenches are acting as ground water conduits and diverting water away from offsite wells MW-11, MW-12, and MW-13, which could explain the absence of petroleum hydrocarbons and MTBE in those wells. However, geologic cross-sections prepared by PEG (Attachment A) show that the soils beneath the site consist of artificial fill, fine grained deposits, and seams of coarse grained deposits within 10 ft of the surface. A thin seam of sand and gravel intersects the screen of well MW-11, while MW-12 is screened within the low permeability

silts and clays. Therefore, ground water beneath the site may be partially perched within the fill and high permeability materials.

Conclusions: Because our objective is to safely and cost-effectively decrease hydrocarbon concentrations in ground water, oxygenation using ORCs appears to be a cost-effective and appropriate remedial technique for this site. With the SVE well screens totally or partially submerged, the amount of soil available for soil vapor extraction treatment is minimized, and it is not likely that a significant amount of additional hydrocarbons would be removed by restarting the SVE system. The offsite migration of hydrocarbons should be monitored by continued ground water sampling of the offsite wells.

CLOSING

We appreciate your continued assistance with this project. Please call Darryk Ataide at (510) 420-0700 if you have any questions or comments.

Sincerely,
Cambria Environmental Technology, Inc.

Darryk Ataide
Project Environmental Scientist

Diane Lundquist, P.E.
Principal Engineer

Attachments: A - Geologic Cross Section Prepared by Previous Consultants

cc: Karen E. Petryna, Equiva Services LLC, P.O. Box 6249 Carson, California 90749-6249

G:\OAK285\ACDEHAugust 10Response.wpd

Table 1. **Ground Water Analytical Data - Bioattenuation Parameters** - Shell-branded Service Station WIC #204-5508-5504, 285 Hegenberger Road, Oakland, California

Well ID	Date	DO (mg/L)	ORP (millivolts)	Ferrous Iron	Nitrate as Nitrate (Concentrations in mg/L)	Sulfate
MW-1	06/10/98	0.5/0.5	-163/-178	14	<1.0	3.3
	06/10/98[dup]	0.5/0.5	-163/-178	14	<1.0	5.1
MW-2	06/10/98	0.7/0.6	-155/-161	5.1	<1.0	47
MW-3	06/10/98	0.8/0.9	-101/-149	3.5	<1.0	15
MW-6	06/10/98	0.4/0.4	-159/-155	1.8	<1.0	7.4
MW-9	06/10/98	0.3/0.4	-169/-188	21	<1.0	6.6
MW-10	06/10/98	0.7/0.5	-149/-162	17	<1.0	6.3

Notes and Abbreviations:

ft = Feet
mg/L = Milligrams per liter
DO = Dissolved oxygen, reported as pre-purge/post-purge
ORP = Oxidation reduction potential, reported as pre-purge/post-purge
dup = Duplicate sample
Ferrous iron by EPA Method 200.7
Nitrate as nitrate and sulfate by EPA Method 300.0
<n = Below detection limit of n mg/L

Attachment A
Geologic Cross Section Prepared by Previous Consultants

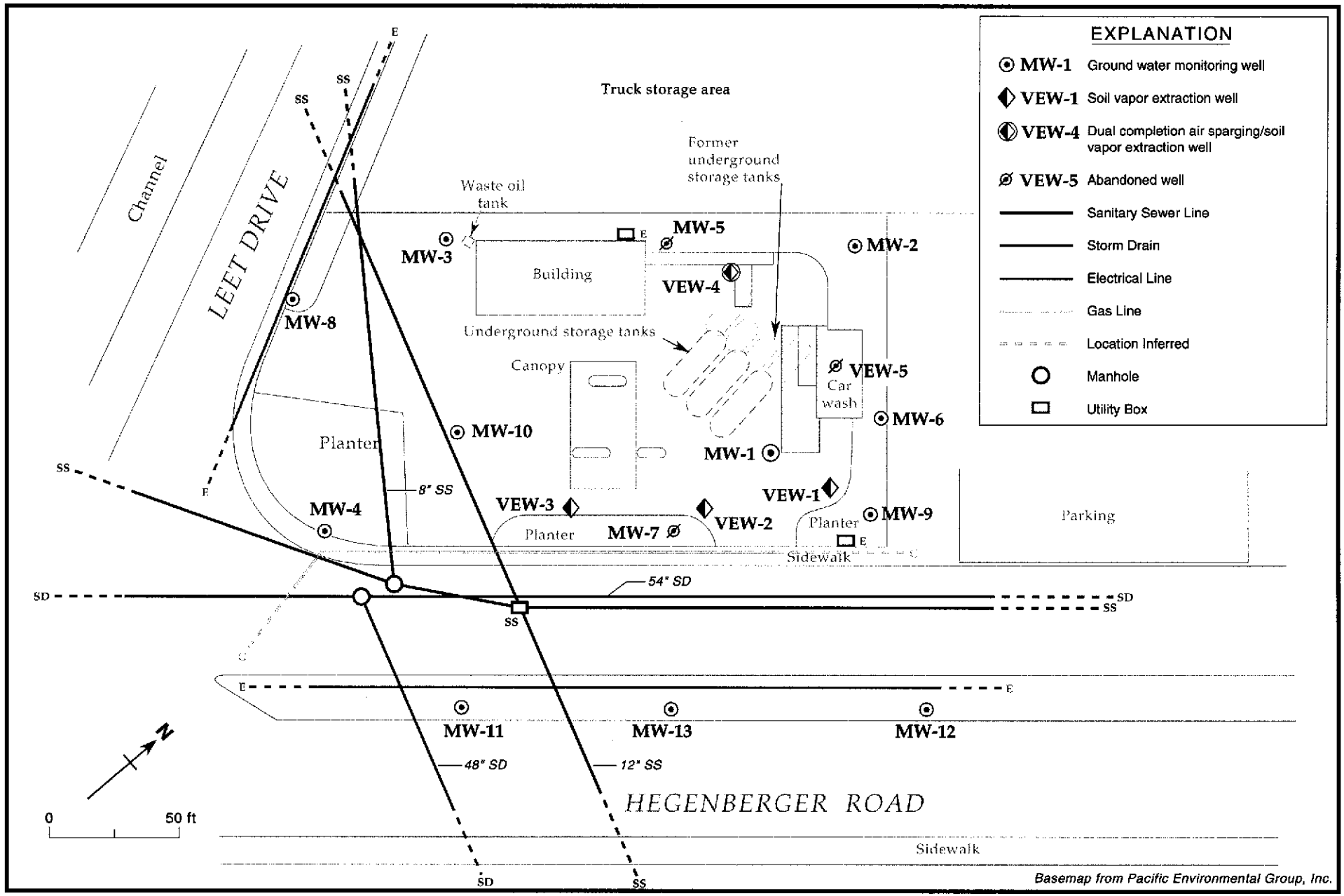
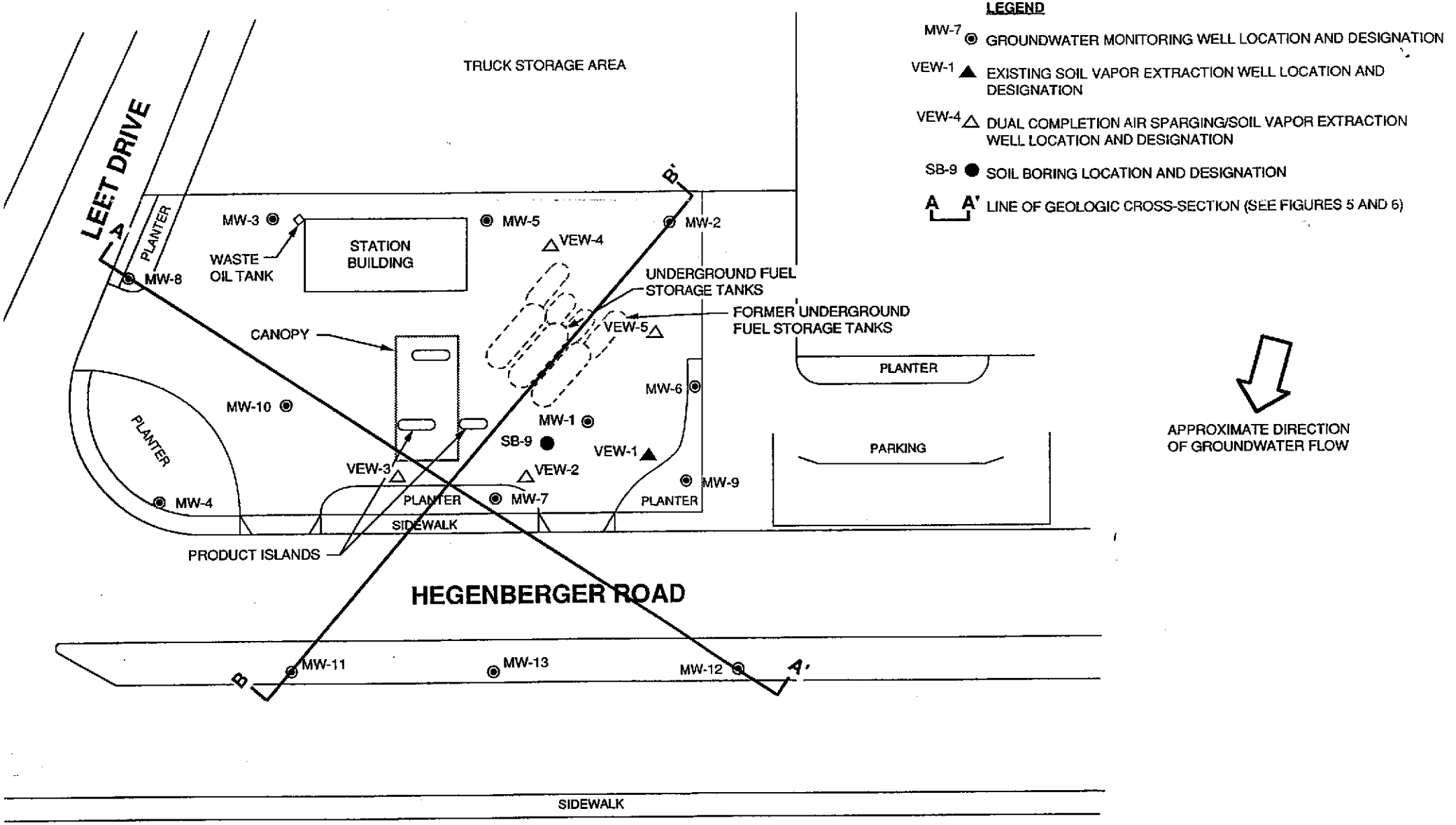
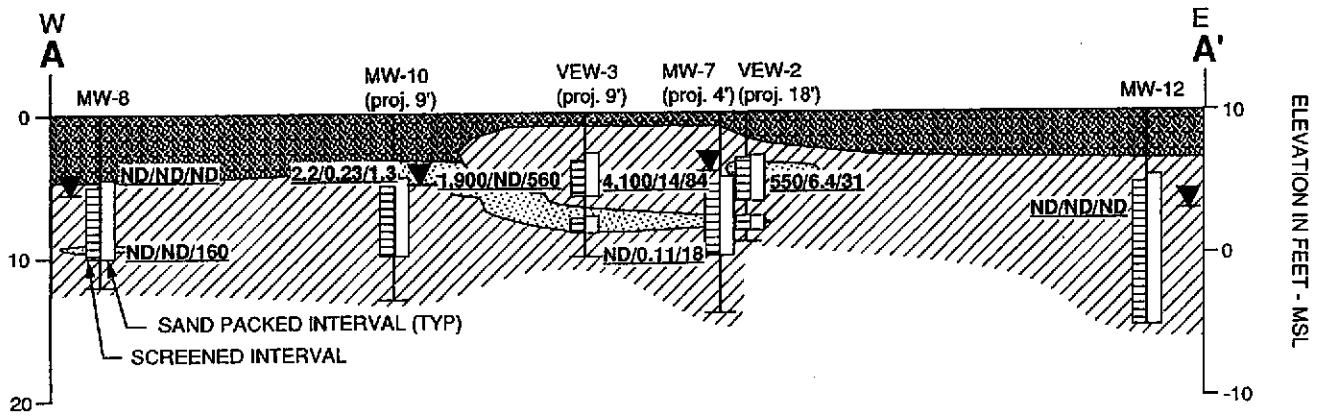


Figure 1. Underground Utility Locations - Shell-branded Service Station, 285 Hegenberger Road, Oakland, California



PACIFIC ENVIRONMENTAL GROUP, INC.	SCALE 0 40 80 FEET	**SHELL SERVICE STATION** 285 Hegenberger Road at Leet Drive Oakland, California **SITE MAP**	FIGURE: **2** PROJECT: 305-79.01

11/03/9

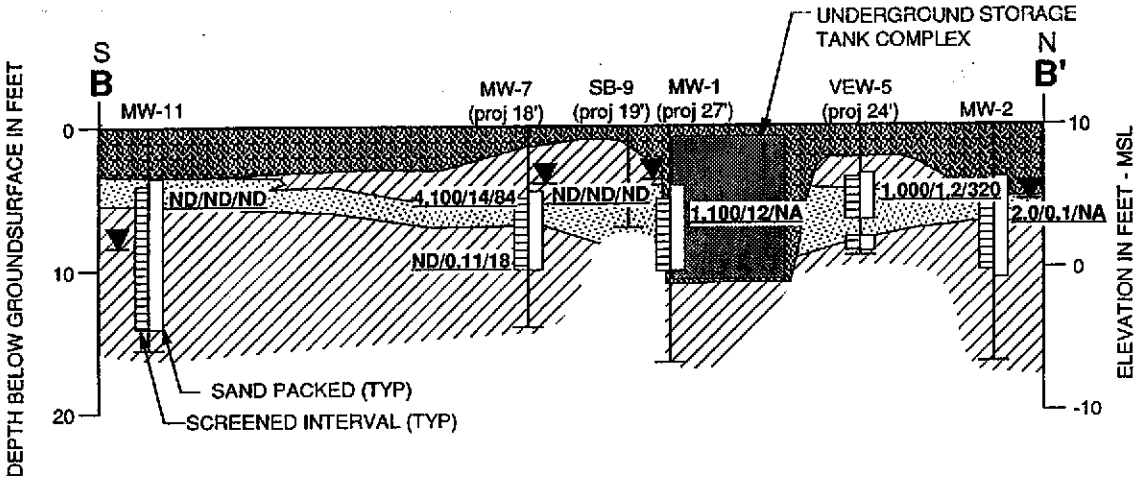


LEGEND

- ARTIFICIAL FILL
- PRIMARILY FINE GRAINED DEPOSITS - SILTS AND CLAYS
- PRIMARILY COARSE GRAINED DEPOSITS - SANDS AND GRAVELS
- MW-8 GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- VEW-2 DUAL COMPLETION AIR SPARGING/SOIL VAPOR EXTRACTION WELL LOCATION AND DESIGNATION
- proj PROJECTED ONTO LINE OF SECTION IN FEET
- ▼ STATIC WATER LEVEL, 7-20-93
- 550/6.4/31 TPH-g/BENZENE/TPH-d CONCENTRATION IN SOIL, IN PARTS PER MILLION, 7-13-89 to 6-10-93
- ND NOT DETECTED
- NA NOT ANALYZED

PACIFIC ENVIRONMENTAL GROUP, INC.	**SCALE** HORIZONTAL : 1" = 40' VERTICAL : 1" = 10'	**SHELL SERVICE STATION** 285 Hegenberger Road at Leet Drive Oakland, California **GEOLOGIC CROSS-SECTION A-A"**	FIGURE: 3 PROJECT: 305-79.01

11/03/93



LEGEND

- ARTIFICIAL FILL
- PRIMARILY FINE GRAINED DEPOSITS - SILTS AND CLAYS
- PRIMARILY COARSE GRAINED DEPOSITS - SANDS AND GRAVELS
- MW-2 GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- SB-9 SOIL BORING LOCATION AND DESIGNATION
- VEW-5 DUAL COMPLETION AIR SPARGING/SOIL VAPOR EXTRACTION WELL LOCATION AND DESIGNATION
- proj PROJECTED ONTO LINE OF SECTION IN FEET
- ▼ STATIC WATER LEVEL, 7-20-93
- 2.0/0.1/NA TPH-g/BENZENE/TPH-d CONCENTRATION IN SOIL, IN PARTS PER MILLION, 7-13-89 to 6-10-93
- ND NOT DETECTED
- NA NOT ANALYZED

PACIFIC ENVIRONMENTAL GROUP, INC.	**SCALE** HORIZONTAL : 1" = 40' VERTICAL : 1" = 10'	**SHELL SERVICE STATION** 285 Hegenberger Road at Leet Drive Oakland, California **GEOLOGIC CROSS-SECTION B-B'**	FIGURE: **4** PROJECT: 305-79.01

11/03/92