PACIFIC
ENVIRONMENTAL
GROUP, INC.

September 27, 1994
Project 310-058.3A

Ms. Tina Berry
Unocal Corporation
2000 Crow Canyon Place, Suite 400
San Ramon, California 94583

Re: Remedial Action Implementation Plan
Unocal Service Station 5760
376 Lewelling Boulevard
San Lorenzo, California

Dear Ms. Berry:

This letter, prepared by Pacific Environmental Group, Inc. (PACIFIC), presents a response to the letter (dated August 24, 1994) issued by the Alameda County Health Care Services Agency (ACHCSA) regarding the referenced site-specific topic. Each comment provided by the ACHCSA is paraphrased below, followed by a response.

1. *The RAP mentions.....*: Design specifications will be submitted to the ACHCSA before beginning construction and operation of the proposed remedial system.

2. *Additionally, Pacific states.....*: A sample of a quarterly performance evaluation prepared by PACIFIC is presented as Attachment A. PACIFIC recognizes that changes in soil vapor hydrocarbon concentration occur due to several factors. Primary factors that induce concentration change over time include changes in soil vapor flow rate, residual composition, residual mass levels, and increased diffusional resistances. Monitoring the cumulative residual amount removed, extraction well vapor concentrations, and extraction well vapor composition (parameters considered in generating the performance evaluation) allow evaluation of soil vapor extraction (SVE) effectiveness and insight into what factors are responsible for concentration changes. Finally, it is common practice to pulse SVE system operation when a concentration plateau (or removal rate plateau) is reached. This is done to maintain operational efficiency and document the concentration rebound associated with successive

Also, include as part of letter & present results.

operational pulses. Pulse data are also included in the performance evaluation.

3. *The RAP should address*.....: The proposed use of SVE and bioreclamation was specified to address the entire aqueous-phase hydrocarbon plume, as well as impacted soil. SVE will be used to remove the bulk of hydrocarbon mass beneath the site that would otherwise act as a secondary source. Reduction of this secondary source will limit the availability of hydrocarbons that maintain the dissolved hydrocarbon plume. As a result, hydrocarbon concentrations throughout the dissolved plume will begin to attenuate more rapidly. The mechanism described does not rely on an effective radius for SVE that encompasses the entire dissolved hydrocarbon plume (references 1 through 4). It is probable the ACHCSA case files contain examples of the aforementioned phenomenon.

   Bioreclamation will be relied upon to address the entire dissolved hydrocarbon plume by enhancing biodegradation of soil-bound and dissolved hydrocarbons. Primarily, enhancement will be accomplished by the subsurface infiltration of aerobic and anaerobic electron acceptors. From the infiltration point(s), electron acceptors will be distributed throughout the impacted media via vapor and liquid-phase advection and diffusion.

4. *This office is concerned*.....: Use of diffusers in wells whose screened section intercepts the groundwater table is proposed for subsurface air injection. The injection flow rate, and thus pressure, will be well below that which would encourage dissolved plume migration (the aim is oxygen injection, not dissolved hydrocarbon stripping). Additionally, the path of least resistance to air flow will likely route injected air up through the well sand pack, so that air will enter the vadose zone near the bottom of the well seal. Finally, it has been shown that groundwater movement is promoted only under certain injection circumstances (high pressure and/or injection into a confined permeable layer). In most cases, low flow injection (through sparge wells) locally displaces groundwater from pore spaces and does not significantly promote groundwater movement (references 7, 8, and 12).

5. *Based on the fact*.....: To the extent possible, delineation of the dissolved hydrocarbon plume will be completed downgradient from Well U-9. With respect to biodegradation and plume stabilization, first consider that a preponderance of data show

So will another well be installed?

1st identify Constituents

petroleum hydrocarbons have a high tendency to biodegrade in the subsurface environment. For example, Borden (Borden et al., 1993) states that almost all petroleum hydrocarbons are subject to biodegradation in shallow aerobic groundwaters. Additionally, Borden points out that biodegradation of petroleum hydrocarbons also takes place under anaerobic conditions, where nitrate, sulfate, and ferric iron are utilized as electron acceptors.

With respect to dissolved petroleum hydrocarbon migration, Borden, Salanitro (Salanitro, 1993) and others have described the role of biodegradation in stabilizing dissolved hydrocarbon plumes, showing that an aerobic groundwater zone typically surrounds the hydrocarbon plume. It has also been shown that nitrification at the plume fringes also contributes to biodegradation at the plume edge. For the situation described, the long-term rate of hydrocarbon dissolution is equal to the rate of biodegradation, and a quasi-steady state condition is established.

For the site, trends in existing groundwater monitoring data, with respect to time and space, suggest that the phenomenon outlined above is occurring at the site. Dissolved hydrocarbon concentrations appear to attenuate with time and downgradient distance from the suspected source areas beneath the site.

6. *Page 2 of the plan*.....: Concentrations of oxygen and carbon dioxide in soil vapor collected from hydrocarbon-affected areas are typically low for oxygen and high for carbon dioxide (references 5, 11, and 18). For ambient air, this situation is reversed; this is also true for soil vapor collected from areas not affected by a biodegradable substrate. Based on preliminary data, it was stated that oxygen and carbon dioxide in soil vapor samples collected during the SVE test indicated biodegradation was occurring. This observation was based on the carbon dioxide and oxygen levels identified in a soil vapor sample (6.0 percent carbon dioxide, 15 oxygen). Since the time the Remedial Action Plan (RAP) was issued, it was discovered that soil vapor samples collected before the last test day were diluted with ambient air prior to sampling. It is probable that ambient air dilution decreased the true carbon dioxide levels and increased the true oxygen levels contained in extracted soil vapor. Given the circumstances, it is probable the true concentrations would have strongly indicated biodegradation is occurring. This will be verified as part of the remedial system operation, as stated in the RAP.

If you have any questions, please call.

Sincerely,

Pacific Environmental Group, Inc.

Robert L. Giattino
Project Engineer

Joseph Muzzio
Project Geologist
CEG 1672

REFERENCES

1. Bird, R. B., Stewart, W.E., and Lightfoot, E.N., *Transport Phenomena,* Wiley and Sons, 1960.

2. Brown, R.A., Hoag, G.E., and Norris, R.D., *The Remediation Game: Pump, Dig, or Treat*, Water Pollution Control Federation Conference, 1987.

3. Clayton, W.S., Brody, K.L., and Brown, R.A., *The Deduction of Groundwater Contamination by Vapor Extraction of Volatile Organics from the Vadose Zone*, 1989.

4. Hoag, G.E., Marley, M.C., Cliff, B.L., and Nangeroni, P., *Soil Vapor Extraction Research Developments*, 1990.

5. Hoeppel, R.E., Hinchee R.E., and Arthur, M.F., *Bioventing Soils Contaminated with Petroleum Hydrocarbons*, J. Indust. Microbiol., 1991.

6. Howard, P., *Handbook of Environmental Fate and Exposure Data for Organic Chemical*, 1991.

7. Ji, W., Dahmani, A., Ahlfeld, D.P., Lin, J.D., and Hill, E., *Laboratory Study of Air Sparging: Air Flow Visualization*, Groundwater Monitoring and Remediation, Fall 1993.

8. Johnson, R.L., Johnson, P.C., McWhorter, D.B., Hinchee, R.E., and Goodman, I., *An Overview of In Situ Air Sparging*, Groundwater Monitoring and Remediation, Fall 1993.

9. Leeson, A., Hinchee, R.E., Kittle, J., Sayles, C.M., Vogel, and Miller, R.N., *Optimizing bioventing in shallow vadose zones and cold climates*, Hydrological Sci., 1993, 38(4):283-295.

10. Miller, R.N., Hinchee, R.E., and Vogel, C.M., *A field-scale investigation of petroleum hydrocarbon biodegradation in the vadose zone enhanced by soil venting at Tyndall AFB, Florida*. In: Hinchee, R.E., and Oflenbuttel, R.F., eds. *In Situ Bioreclamation*. Boston, MA: Butterworth-Heinemann, 1991, pp. 283-302.

11. Norris, Borden, et al., *In-Situ Bioremediation of Groundwater and Geological Material: A Review of Technologies*, Robert S. Kerr Environmental Research Laboratory, July 1993.

12. Nyer, E.K. and Suthersan, S., *Air Sparging: Savior of Ground Water Remediations or just Blowing Bubbles in the Bath Tub?*, Groundwater Monitoring and Remediation, Fall 1993.

13. Ong, S.K., Hinchee, R.E., Hoeppel, R., and Schultz, R., *In situ respirometry for determining aerobic degradation rates*. In: Hinchee, R.E., and R.F. Olfenbuttel, eds. In situ bioreclamation. Boston, MA: Butterworth-Heinemann, 1991, pp. 541-545.

14. Ong, S.K., Leeson, A., Hinchee, R.E., Kittel, J., Vogel, C.M., Sayles, G.D., an Miller, R.N., *Cold climate applications of bioventing*. In: Hinchee, R.E., et al., eds. Hydrocarbon bioremediation. CRC Press, 1994, pp. 444-453.

15. Salanitro, J., *The role of Bioattenuation of Aromatic Hydrocarbon Plumes in Aquifers*, Groundwater Monitoring and Remediation, Fall 1993.

16. San Francisco Bay Regional Water Quality Control Board, *Groundwater Basin Plan Amendments*, August 1994.

17. Sayles, G.D., Brenner, R.C., Hinchee, R.E., Vogel, C.M., and Miller, R.N., *Optimizing bioventing in shallow vadose zones and cold climates: Eielson AFB bioremediation of a JP-4 spill*. In: U.S. EPA. Symposium on bioremedation of hazardous wastes (abstracts). EPA/600/R-92/126. Washington, DC (May), 1992, pp. 31-35.

18. Vance, D.B., *Remediation by In-Situ Aeration: The Power of Volatilization and Bio-Oxidation*, The National Environmental Journal, July/August 1993.

Attachments: Attachment A - Remedial Action Performance Summary

cc: Ms. Juliet Shin, Alameda County Health Care Services

ATTACHMENT A
REMEDIAL ACTION PERFORMANCE SUMMARY: FIRST QUARTER 1993
SOIL-BASED REMEDIAL SYSTEM

Client / Station I.D.
Station Address
City, State

REMEDIAL OBJECTIVES

- o Mass Removal
- o Regulatory Compliance

REMEDIAL SYSTEM PROCESS AND INSTURMENTATION DIAGRAM — Not Available

OPERATIONAL DATA (First Quarter 1993)

Treatment System Data	January	February	March
Operational Status	Operational	Operational	Operational
Average System Flow Rate (scfm)	75	75	75
Well Flow Rate Range (scfm)	8-15	8-15	8-15

Treatment System Analytical Results Summary	INFLUENT	EFFLUENT	
EPA Method 8015 Analyses	Detected	ND	Table 10 Page A-12
EPA Method 8020 Analyses	Detected	ND	Table 11 Page A-13

TPH-g and Benzene Summary	January	February	March		
Influent TPH-gasoline (ug/L air)	3,500	4,200	3,600		
Influent Benzene (ug/L air)	2	4	2		
Effluent TPH-gasoline (ug/L air)	ND	ND	ND		
Effluent Benzene (ug/L air)	ND	ND	ND	Cumulative	
Mass TPH Removed (lbm)	1,890.0	2,953.1	837.0	10,351.8	Table 12 Page A-14
Mass Benzene Removed (lbm)	0.2	0.4	0.3	16.3	Table 12 Page A-14

Air Sparging System Summary	January	February	March
Operational Status	Operational	Shutdown	Operational
Average System Flow Rate (scfm)	30	NA	28
Well Flow Rate Range (scfm)	1-3	NA	1-3
Average System Pressure (psi)	2	NA	<2
Well Average Pressure Range (psi)	1-3	NA	1-2

REMEDIAL ACTION PERFORMANCE EVALUATION

Mass Removal — Brief description of progress toward mass removal, with estimated time to complete site remediation and site closure.

Regulatory Compliance — Brief description of regulatory compliance (regarding all permits, orders, schedules, etc.).

RECOMMENDATIONS

- o Continue operation of the remedial system.
- o Install second water-knockout drum to further reduce water content of influent stream.
- o Begin closure liaison with lead agency.

Table 10
Summary of EPA Method 8015 Analytical Results
Soil Vapor Extraction System

Client / Station I.D.
Station Address
City, State

Sample Date	TPH-g (ug/L air) Influent	TPH-g (ug/L air) Effluent	TPH-d (ug/L air) Influent	TPH-d (ug/L air) Effluent
10/23/92	8,000	ND	6,000	ND
11/27/92	7,000	ND	5,500	ND
12/09/92*	NS	NS	NS	NS
01/10/93	3,500	ND	2,000	ND
02/24/93	4,200	ND	2,500	ND
03/16/93	3,600	ND	2,000	ND

TPH-g	= Total petroleum hydrocarbons, calculated as gasoline
TPH-d	= Total petroleum hydrocarbons, calculated as diesel
ug/L air	= Micrograms per liter of air
ND	= Not detected above detection limits
NS	= Not sampled
*	= Treatment system deactivated

Graphical Summary of EPA Method 8015 Analytical Results

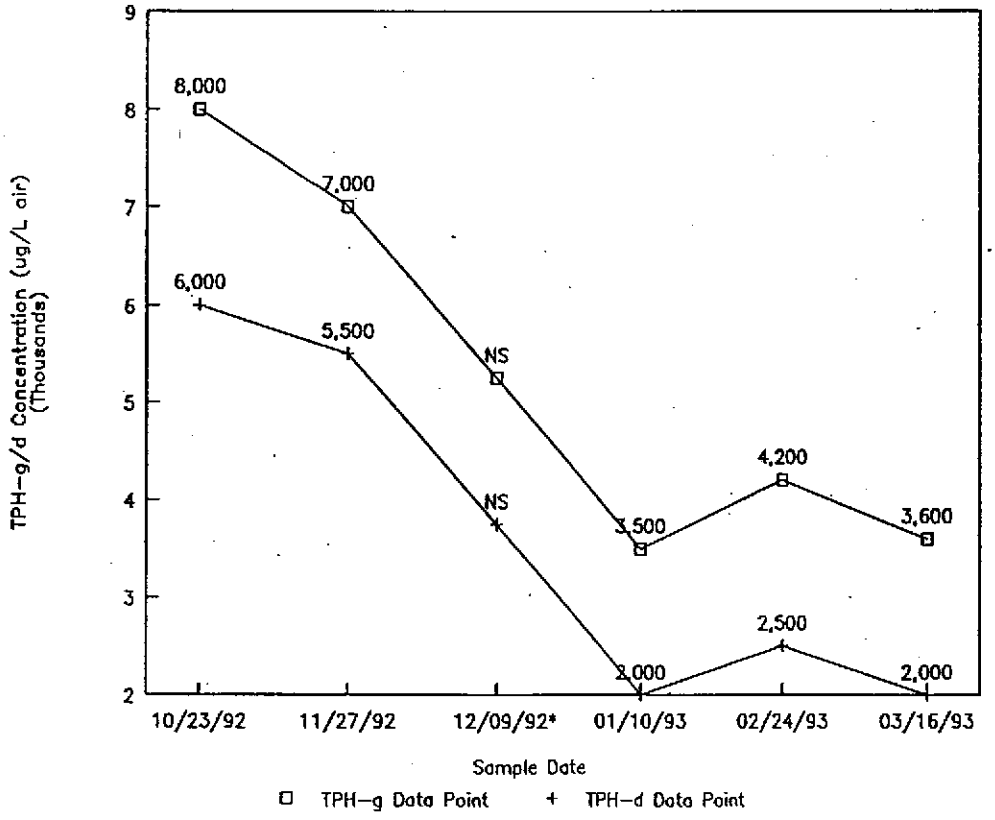

Table 11
Summary of EPA Method 8020 Analytical Results
Soil Vapor Extraction System

Client / Station I.D.
Station Address
City, State

Sample Date	Benzene (ug/L air)		Toluene (ug/L air)		Ethylbenzene (ug/L air)		Total Xylenes (ug/L air)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
10/23/92	1.0	ND	10.0	ND	ND	ND	19.0	ND
11/27/92	2.0	ND	ND	ND	30.0	ND	24.0	ND
12/09/92	NS	NS	NS	NS	NS	NS	NS	NS
01/10/93	2.0	ND	16.0	ND	ND	ND	25.0	ND
02/24/93	4.0	ND	6.0	ND	ND	ND	67.0	ND
03/16/93	2.0	ND	ND	ND	35.0	ND	10.0	ND

ug/L air = Micrograms per liter in air
ND = Not detected
NS = Not sampled
NA = Not available or not applicable
* = Treatment system deactivated

Table 12
Soil Vapor Extraction Data Evaluation

Client / Station I.D.
Station Address
City, State

Sample Date	Operating Period (days)	Period Down Time (days)	Influent Concentration (ug/L) TVH	Benzene	Flow Rate (scfm) Total	Well	TVH Removed Rate (lb/day)	For Period (lbm)	Total (lbm)	Benzene Removed Rate (lb/day)	For Period (lbm)	Total (lbm)
10/23/92	30	0	14,000	1.0	50	50	63.0	1,890.0	3,338.5	0.0	0.1	13.9
11/27/92	35	0	12,500	2.0	75	75	84.4	2,953.1	6,291.6	0.0	0.5	14.4
12/09/92*	12	12	NS	NS	NA	NA	0.0	0.0	6,291.6	0.0	0.0	14.4
01/10/93	32	0	5,500	2.0	75	75	37.1	1,188.0	7,479.6	0.0	0.4	14.8
02/24/93	45	0	6,700	4.0	75	75	45.2	2,035.1	9,514.8	0.0	1.2	16.0
03/16/93	20	0	6,200	2.0	75	75	41.9	837.0	10,351.8	0.0	0.3	16.3
TOTAL POUNDS REMOVED:									10,351.8			16.3
TOTAL GALLONS REMOVED:									1,551.2			2.4
PERCENT OPERABLE FOR PERIOD:												100%
PERCENT OPERABLE SINCE START-UP:												93%

TVH = Total volatile hydrocarbons (calculated as gasoline and diesel)
ug/L = Micrograms per liter of air
scfm = Standard cubic feet per minute
NA = Not available
lb/day = Pounds per day
lbm = Pounds per day
* = Treatment system deactivated

Table 12 (continued)
Soil Vapor Extraction Data Evaluation

Client / Station I.D.
Station Address
City, State

Graphical Summary of Soil Vapor Extraction Data