PACIFIC
ENVIRONMENTAL
GROUP, INC.

AN ITT COMPANY

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ENVIRONMENTAL
PROTECTION

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Date: April 7, 1999
Project: 330-006.2Q

STID
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To: Mr. Amir K. Gholami, REHS
Alameda County Health Care
Services Agency
1131 Harbor Bay Parkway
Alameda, CA 94502

We have enclosed:

Copies	Description
1	Addendum to Modified Health Risk Assessment for ARCO 608
1	ACHCSA Letter dated July 21,1995

For your:
- X Use
- ___ Approval
- ___ Review
- ___ Information

Comments: Dear Mr. Gholami,
In response to your February 24, 1999 letter, we have enclosed copies of the documents that you requested. Please call if you have questions. Thank you.

Shaw Garakani

2025 Gateway Place, Suite 440 • San Jose, California 95110-1014 (408) 441-7500 FAX (408) 441-7539

PACIFIC
ENVIRONMENTAL
GROUP INC.

March 10, 1998
Project 330-006.3E

Dr. Ravi Arulanantham
Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, California 94612

Re: Addendum to Modified Health Risk Assessment
ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Dear Dr. Arulanantham:

On behalf of ARCO Products Company (ARCO), Pacific Environmental Group, Inc. (PEG) is pleased to present this Addendum to the *Modified Health Risk Assessment* (PEG, October 5, 1993) for the site referenced above. This addendum has been prepared to assess health risks associated with the presence of dissolved methyl tert-butyl ether (MtBE) in groundwater at the site referenced above.

BACKGROUND

As part of the case closure requirements for the site referenced above, the Alameda County Health Care Services Agency (ACHCSA) requested that a supplemental health risk assessment for MtBE be conducted. During an August 18, 1997 meeting, representatives from ARCO, ACHCSA, Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), and PEG agreed that the MtBE health risk assessment would be based on the "children playing in sprinklers" scenario. The scenario assumes that children playing under an active sprinkler from a domestic irrigation well in a backyard could potentially be exposed to MtBE. This scenario was also considered during the 1993 modified health risk assessment for benzene, toluene, ethylbenzene, and xylenes (BTEX compounds).

PURPOSE

The purpose of this addendum to the health risk assessment was to 1) determine the hazard quotients for the above scenario based on the historical maximum MtBE concentration from the site, and 2) define Risk-Based Screening Levels (RBSLs) for the site

which are protective of human health under the above described scenario.

EXPOSURE ROUTES

With the sprinkler scenario, three potential routes of exposure to MtBE were determined: (1) dermal contact with groundwater, (2) ingestion of groundwater, and (3) inhalation of volatilized MtBE from groundwater. Therefore, three hazard quotients and three RBSLs for MtBE were calculated, one for each pathway. In addition, the three hazard quotients were added together to calculate the overall risk (hazard quotient) posed to children playing in sprinklers.

MODEL VARIABLES

As discussed and agreed upon during the August 18,1997 meeting, most of the model variables used in the calculation of the hazard quotients and RBSLs for MtBE are the same as previously established for the BTEX risk calculations. Please refer to the *Modified Health Risk Assessment* (PEG, October 5, 1993) for a detailed listing of model variables. Variables used in the calculation of the MtBE RBSLs and hazard quotients which were different from those previously used are presented below:

- **Henry's Law Constant: 0.024 (unitless)**

  For calculations concerning MtBE volatilization to the air, the Henry's Law constant of 0.024 was used. For calculations concerning residual dissolved phase MtBE, 0.976 was used (1 - 0.024). The Henry's Law constant for MtBE was obtained from Groundwater Service's Inc.'s (GSI) *RBCA Tool Kit.*

- **Exposure Frequency: 183 (days/year)**

  Due to weather conditions in the San Francisco Bay Region, it is possible that children may play in sprinklers approximately 6 months of the year. Therefore, one-half of the year, or 183 days, was used as a conservative exposure frequency value. This value is within the range of values used for various wells during the BTEX compounds risk assessment.

- **Exposure Time: 1 (hour/day)**

  The average exposure time was estimated to be 1 hour per event for this risk assessment.

- **MtBE Reference Doses: Inhalation = 0.857 (mg/kg-day)**
  Oral = 0.005 (mg/kg-day)

  The reference doses obtained from GSI's *RBCA Tool Kit* were used in each calculation. The MtBE oral reference dose was used in the calculation of the dermal and ingestion hazard quotients and RBSLs, while the inhalation reference dose was used for the calculation of the inhalation hazard quotient and RBSL.

- **MtBE Dermal Permeability Constant: 0.00463 (cm/hour)**

  This value was obtained from the University of California Extension text for the *Site-Specific Application of the Risk and Decision-Making Process for Petroleum-Impacted Sites: An Advanced Workshop* (San Diego, June 12 and 13, 1997).

RESULTS

Hazard Quotients

Table 1 presents the overall risk posed by the maximum historical MtBE concentration in groundwater (380 micrograms per liter [µg/L], PEG, *Fourth Quarter 1997 Groundwater Monitoring Report*, March 10, 1998). The overall risk was calculated by adding the individual hazard quotients together. Since the individual hazard quotients and the total hazard quotient all are below 1, then MtBE in groundwater at 380 µg/L does not pose a risk to children playing in sprinklers. The results of the individual hazard quotients for ingestion, dermal contact, and inhalation of volatilized MtBE from groundwater are presented in Tables 2-A, 3-A, and 4-A. Groundwater monitoring results are presented as Attachment A.

Risk-Based Screening Levels

Tables 2-B, 3-B, and 4-B present the models used to calculate the MtBE RBSLs; the results are also presented on these tables. The MtBE dermal RBSL was the lowest value modeled at 11.52 milligrams per liter (mg/L), the MtBE ingestion RBSL was 17.50 mg/L, and the MtBE inhalation RBSL modeled was 5,947 mg/L. Thus, the lowest MtBE RBSL of 11.52 mg/L, should be set as the screening level for off-site groundwater.

CONCLUSIONS

To date, the highest MtBE concentration collected from the site (including on- and off-site monitored wells) was 380 µg/L. This concentration is far below the lowest RBSL of 11.52 mg/L and this concentration has been proven through a risk assessment to not pose a risk to children playing in a sprinkler. Based on the above, PEG concludes

that the human health risk for the scenario and exposure routes described above is within acceptable levels.

If you have any questions or comments regarding the contents of this letter, please call.

Sincerely,

Pacific Environmental Group, Inc.

Shaw Garakani
Project Engineer

Debra J. Moser
Project Manager
CEG 1293

REGISTERED GEOLOGIST
DEBRA J. MOSER
No. 1293
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA
DM 9/98

Attachments:
- Table 1 - Total MtBE Hazard Quotient by Children Playing in a Sprinkler
- Table 2-A - Hazard Quotient for Inhalation of MtBE by Children Playing in a Sprinkler
- Table 2-B - RBSL for Inhalation of MtBE by Children Playing in a Sprinkler
- Table 3-A - Hazard Quotient for Ingestion of MtBE by Children Playing in a Sprinkler
- Table 3-B - RBSL for Ingestion of MtBE by Children Playing in a Sprinkler
- Table 4-A - Hazard Quotient for Dermal Contact of MtBE by Children Playing in a Sprinkler
- Table 4-B - RBSL for Dermal Contact of MtBE by Children Playing in a Sprinkler
- Attachment A - Groundwater Monitoring Results

cc: Mr. Michael Whelan, ARCO Products Company
Ms. Madhulla Logan, M.S., Alameda County Health Care Services Agency
Mr. Ron Sykora/Mr. Robert L. Webster, David D. Bohannon Organization
Dr. Charles Lapin, ARCO Products Company

Table 1
Total MtBE Hazard Quotient
by Children Playing in a Sprinkler

ARCO Service Station 0608
17601 Hesperian Boulevard
San Lorenzo, California

Pathway	Hazard Quotient
Inhalation	6.40E-05
Ingestion	0.02
Dermal Contact	0.03
Total	**0.056**

Table 2-A
Hazard Quotient for Inhalation of MtBE
by Children Playing in a Sprinkler

ARCO Service Station 0608
17601 Hesperian Boulevard
San Lorenzo, California

					Reference:
To Calculate the MtBE concentration in air from a sprinkler:					
Equation:	$CA = \frac{CW \times Q \times T \times HL}{V + (v \times H \times W \times T)}$				
Where:	CA =	MtBE Concentration in Air	1.37E-04	[mg/m^3]	
	CW =	MtBE concentration in water	0.380	[mg/L]	a
	Q =	Flow rate of extracted groundwater	0.63	[L/sec]	b
	T =	Time (normalized to hourly-basis)	3,600	[sec]	b
	HL =	MtBE Henry's Law constant	0.024	[unitless]	c
	V =	Volume of air surrounding the Irrigation Well	293	[m^3]	b
	v =	Wind velocity	2.0	[m/sec]	b
	h =	Dispersion height	1.5	[m]	b
	W =	Width of backyard	14	[m]	b
Determining MtBE reference concentration from exposure parameters:					
Equation:	$RfC = \frac{RfD*BW*AT*365\ d/yr}{IR*EF*ED}$				
Where:	RfC =	MtBE Reference Concentration	2.14	[mg/m^3]	
	RfD =	MtBE Reference dose (inhalation)	0.857	[mg/kg-day]	c
	BW =	Body weight	25	[kg]	b
	AT =	Averaging time	9	[years]	b
	IR =	Inhalation rate	20	[m^3/day]	b
	EF =	Exposure frequency	183	[days/year]	d
	ED =	Exposure duration	9	[years]	b
Determine the hazard quotient for MtBE inhalation:					
Equation:	$HQ = \frac{CA}{RfC}$				
Where:	HQ =	Hazard Quotient	6.40E-05		
	CA =	Modeled MtBE concentration in air	1.37E-04	[mg/m^3]	
	RfC =	MtBE Reference Concentration	2.14	[mg/m^3]	

MtBE = Methyl tert-butyl ether
mg/kg-day = Milligrams per kilogram - day
m3 = Cubic meters
mg/m3 = Milligrams per cubic meter
L/sec = Liters per second

a. PACIFIC, *Fourth Quarter 1997 Groundwater Monitoring Report*, date?
b. PACIFIC, Letter to Alameda County Health Care Services Division, October 5, 1993.
c. Groundwater Services, Inc., *RBCA Tool Kit*, 1997.
d. PACIFIC, estimated values developed for this risk assessment.

Table 2-B
RBSL for Inhalation of MtBE
by Children Playing in a Sprinkler

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

$$CA\ (\mu g/m^3) = \frac{HQ*RfD_i*BW*AT*365days/year*1000\ \mu g/mg}{IR_{air}*EF*ED}$$

Where:

			Reference:
CA =	Allowable Concentration of MtBE in Air =	2,137 ($\mu g/m^3$)	
HQ =	Hazard Quotient =	1 (unitless)	a
RfD_i =	MtBE Reference Dose (Inhalation) =	0.857 (mg/kg-day)	b
BW =	Body weight =	25 (kg)	c
AT =	Averaging time =	9 (years)	c
IR_{air} =	Inhalation rate =	20 (m^3/day)	c
EF =	Exposure frequency =	183 (days/year)	d
ED =	Exposure duration =	9 (years)	c

$$RBSL\ or\ CW\ (\mu g/L) = \frac{[V+(v*h*W*T)]CA}{Q*T*HL}$$

Where:

CW =	Corresponding concentration of MtBE in water =	5,947 (mg/L) 5,946,630 ($\mu g/L$)	
V =	Volume of air surrounding the extraction well =	293 (m^3)	c
v =	Wind velocity =	2 (m/sec)	c
h =	Dispersion height =	1.5 (m)	c
W =	Width of backyard =	14 (m)	c
T =	Time =	3,600 (sec)	c
CA =	Concentration of MtBE in air =	2,137 ($\mu g/m^3$)	
Q =	Flow rate of extracted groundwater =	0.63 (L/sec)	c
HL =	MtBE Henry's Law constant =	0.024 (unitless)	b

MtBE = Methyl tert-butyl ether
RBSL = Risk-Based Screening Level
$\mu g/L$ = Micrograms per liter
mg/L = Milligrams per liter
m = Meter
kg = Kilogram
m^3 = Cubic meter
L = Liter

a. ASTM, *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, E 1739-95
b. Groundwater Services, Inc., *RBCA Tool Kit*, 1997.
c. PACIFIC, Letter to Alameda County Health Care Services Division, October 5, 1993.
d. PACIFIC, estimated values developed for this risk assessment.

Table 3-A
Hazard Quotient for Ingestion of MtBE
by Children Playing in a Sprinkler

ARCO Service Station 0608
17601 Hesperian Boulevard
San Lorenzo, California

Equation:

$$HQ = \frac{CW \times IIR \times HL \times ET \times ED \times EF}{BW \times AT \times RfD}$$

Where:

				Reference:
HQ =	Hazard Quotient	0.02		
CW =	MtBE concentration in water (historical maximum)	0.38	[mg/L]	a
ET =	Exposure time	1	[hours/day]	b
ED =	Exposure duration	9	[years]	c
EF =	Exposure frequency	183	(days/year]	b
IIR =	Incidental ingestion rate	0.0145	[L/hour]	c
HL =	1 - Henry's Law constant for MtBE =	0.976	(unitless)	d
BW =	Body weight	25	[kg]	c
RfD =	MtBE Reference Dose (oral)	0.005	(mg/kg - day)	d
AT =	Averaging time	3285	[days]	c

MtBE = Methyl tert-butyl ether
L = Liter
mg/kg-day = Milligrams per kilogram-day

a. PACIFIC, *Fourth Quarter 1997 Groundwater Monitoring Report*, date?
b. PACIFIC, estimated values developed for this risk assessment.
c. PACIFIC, Letter to Alameda County Health Care Services Division, October 5, 1993.
d. Groundwater Services, Inc., *RBCA Tool Kit*, 1997.

Table 3-B
RBSL for Ingestion of MtBE
by Children Playing in a Sprinkler

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

$$RBSL \text{ or } CW\ (mg/L) = \frac{HQ * RfD_o * BW * AT * 365\ days/year}{ET * ED * EF * IIR * HL} * CF$$

Where:

				Reference:
r CW =	Allowable MtBE concentration in groundwater	17.50	(mg/L)	
		17,500	(µg/L)	
HQ =	Hazard Quotient =	1	(unitless)	a
RfD_o =	MtBE Reference Dose (oral) =	0.005	(mg/kg - day)	b
BW =	Body weight =	25	(kg)	c
AT =	Averaging time =	9	(years)	c
ET =	Exposure time =	1	(hours/day)	d
ED =	Exposure duration =	9	(years)	c
EF =	Exposure frequency =	183	(days/year)	d
IIR =	Incidental ingestion rate =	14.6	(ml/hour)	c
HL =	1 - Henry's Law constant for MtBE =	0.976	(unitless)	b
CF =	Conversion factor =	0.001	$(L/ml)^{-1}$	

MtBE = Methyl tert-butyl ether
RBSL = Risk-Based Screening Level
µg/L = Micrograms per liter
mg/L = Milligrams per liter
kg = Kilogram
ml = Milliliter
L = Liter

a. ASTM, *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, E 1739-95
b. Groundwater Services, Inc., *RBCA Tool Kit*, 1997.
c. PACIFIC, Letter to Alameda County Health Care Services Division, October 5, 1993.
d. PACIFIC, estimated values developed for this risk assessment.

Table 4-A
Hazard Quotient for Dermal Contact with MtBE
by Children Playing in a Sprinkler

ARCO Service Station 0608
17601 Hesperian Boulevard
San Lorenzo, California

Equation:

$$HQ = \frac{W \times SA \times DP \times ET \times EF \times ED \times CF \times HL}{BW \times AT \times RfD}$$

Where:

				Reference:
HQ =	Hazard Quotient	0.03		
CW =	MtBE concentration in water (historical maximum)	0.38	[mg/L]	a
SA =	Skin surface area available for contact	4,970	[cm^2]	b
DP =	Dermal Permeability constant	0.00463	[cm/hour]	c
ET =	Exposure time	1	[hours/day]	d
EF =	Exposure frequency	183	(days/year)	d
ED =	Exposure duration	9	(years)	b
HL =	1 - Henry's Law constant for MtBE =	0.976	[unitless]	e
BW =	Body weight	25	[kg]	b
CF =	Conversion factor	0.001	[L/cm^3]	
RfD =	MtBE Reference Dose (oral)	0.005	[mg/kg-day]	e
AT =	Averaging time	3285	[days]	b

MtBE = Methyl tert-butyl ether
mg/L = Milligrams per liter
kg = Kilogram
cm^3 = Cubic centimeters
L = Liter

a. PACIFIC, *Fourth Quarter 1997 Groundwater Monitoring Report*, date?
b. PACIFIC, Letter to Alameda County Health Care Services Division, October 5, 1993.
c. UC Extension, *Site-Specific Application of the Risk and Decision-Making Process for Petroleum-Impacted Sites*
d. PACIFIC, estimated values developed for this risk assessment.
e. Groundwater Services, Inc., *RBCA Tool Kit*, 1997.

Table 4-B
RBSL for Dermal Contact with MtBE
by Children Playing in a Sprinkler

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

$$\text{RBSL or CW (mg/L)} = \frac{HI*RfD_o*BW*AT*CF}{SA*HL*DPC*ET*EF*ED}$$

Where:

				Reference:
RBSL or CW =	Concentration of MtBE Allowable in Groundwater =	11.52 (mg/L) 11,518 (µg/L)		
HI =	Hazard Index =	1 (unitless)		a
RfD_o =	MtBE Reference Dose (oral) =	0.005 (mg/kg-day)		b
BW =	Body weight =	25 (kg)		c
AT =	Averaging time =	9 (years) or	3,285 (days	c
CF =	Conversion factor =	1,000 (cm^3/L)		
SA =	Skin absorption factor =	4,790 (cm^2)		c
HL =	1 - Henry's Law constant for MtBE =	0.976 (unitless)		b
MtBE DPC =	Dermal Permeablity constant =	0.00463 (cm/hour)		d
ET =	Exposure time =	1 (hours/day)		e
EF =	Exposure frequency =	183 (days/year)		e
ED =	Exposure duration =	9 (years)		c

MtBE = Methyl tert-butyl ether
RBSL = Risk-Based Screening Level
µg/L = Micrograms per liter
mg/L = Milligrams per liter
kg = Kilograms
cm^3 = Cubic centimeters
cm^2 = Square centimeters
L = Liter

a. ASTM, *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, E 1739-95
b. Groundwater Services, Inc., *RBCA Tool Kit*, 1997.
c. PACIFIC, Letter to Alameda County Health Care Services Division, October 5, 1993.
e. UC Extension, *Site-Specific Application of the Risk and Decision-Making Process for Petroleum-Impacted Sites*
d. PACIFIC, estimated values developed for this risk assessment.

ATTACHMENT A

GROUNDWATER MONITORING RESULTS

Table 1 (continued)
Groundwater Elevation and Analytical Data
Groundwater Monitoring Wells
Total Purgeable Petroleum Hydrocarbons
(TPPH as Gasoline, BTEX Compounds, and MtBE)

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Well Number	Date Sampled	Well Elevation (feet, MSL)	Depth to Water (feet, TOB)	Groundwater Elevation (feet, MSL)	TPPH as Gasoline (ppb)	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Xylenes (ppb)	MtBE (ppb)
MW-11	11/25/96		11.00	21.54	<50	<0.50	<0.50	<0.50	<0.50	<2.5
(cont.)	04/01/97 f		10.88	21.66	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97		11.65	20.89	<50	<0.50	<0.50	<0.50	<0.50	<2.5
E-1A ††	03/14/96 a	33.06	10.35	22.71	2,700	38	<5.0	130	6.2	NA
(MW-12)	05/29/96 b		11.50	21.56	1,400	410	18	55	5.5	NA
	08/28/96		11.70	21.36	NS	NS	NS	NS	NS	NS
	11/25/96 d		11.18	21.88	4,300	13	<5.0	100	20	220
	03/31/97 †		12.65	20.41	1,900	7.9	<2.0	62	3.5	140
	06/25/97		11.82	21.24	4,900	21	<5.0	53	6.8	160
MW-13	03/15/96 a	35.42	10.90	24.52	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/29/96 b		12.90	22.52	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		13.89	21.53	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96		13.41	22.01	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97 f		13.11	22.31	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97		13.98	21.44	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-14	03/15/96 a	30.46	6.63	23.83	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96 b		8.83	21.63	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		9.83	20.63	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96		9.33	21.13	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97 f		9.04	21.42	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97		9.94	20.52	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-15	03/13/96 a	31.41	8.13	23.28	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/29/96 b		10.30	21.11	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		11.30	20.11	<50	<0.50	<0.50	<0.50	<0.50	5.3
	11/25/96		10.83	20.58	<50	<0.50	<0.50	<0.50	<0.50	12
	04/01/97 f		10.45	20.58	<50	<0.50	<0.50	<0.50	<0.50	7.2
	06/25/97		11.39	20.02	<50	<0.50	<0.50	<0.50	<0.50	7.0
MW-16	03/13/96 a	31.39	8.62	22.77	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96 b		10.90	20.49	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		11.84	19.55	<50	<0.50	<0.50	<0.50	<0.50	89
	11/25/96		11.32	20.07	<50	<0.50	<0.50	<0.50	<0.50	66
	04/01/97 f		11.06	20.33	<50	<0.50	<0.50	<0.50	<0.50	49
	06/25/97		11.92	19.47	<50	<0.50	<0.50	<0.50	<0.50	59

Table 1 (continued)
Groundwater Elevation and Analytical Data
Groundwater Monitoring Wells
Total Purgeable Petroleum Hydrocarbons
(TPPH as Gasoline, BTEX Compounds, and MtBE)

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Well Number	Date Sampled	Well Elevation (feet, MSL)	Depth to Water (feet, TOB)	Groundwater Elevation (feet, MSL)	TPPH as Gasoline (ppb)	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Xylenes (ppb)	MtBE (ppb)
MW-11	11/25/96		11.00	21.54	<50	<0.50	<0.50	<0.50	<0.50	<2.5
(cont.)	04/01/97 f		10.88	21.66	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97		11.65	20.89	<50	<0.50	<0.50	<0.50	<0.50	<2.5
E-1A ††	03/14/96 a	33.06	10.35	22.71	2,700	38	<5.0	130	6.2	NA
(MW-12)	05/29/96 b		11.50	21.56	1,400	410	18	55	5.5	NA
	08/28/96		11.70	21.36	NS	NS	NS	NS	NS	NS
	11/25/96 d		11.18	21.88	4,300	13	<5.0	100	20	220
	03/31/97 †		12.65	20.41	1,900	7.9	<2.0	62	3.5	140
	06/25/97		11.82	21.24	4,900	21	<5.0	53	6.8	160
MW-13	03/15/96 a	35.42	10.90	24.52	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/29/96 b		12.90	22.52	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		13.89	21.53	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96		13.41	22.01	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97 f		13.11	22.31	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97		13.98	21.44	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-14	03/15/96 a	30.46	6.63	23.83	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96 b		8.83	21.63	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		9.83	20.63	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96		9.33	21.13	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97 f		9.04	21.42	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97		9.94	20.52	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-15	03/13/96 a	31.41	8.13	23.28	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/29/96 b		10.30	21.11	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		11.30	20.11	<50	<0.50	<0.50	<0.50	<0.50	5.3
	11/25/96		10.83	20.58	<50	<0.50	<0.50	<0.50	<0.50	12
	04/01/97 f		10.45	20.58	<50	<0.50	<0.50	<0.50	<0.50	7.2
	06/25/97		11.39	20.02	<50	<0.50	<0.50	<0.50	<0.50	7.0
MW-16	03/13/96 a	31.39	8.62	22.77	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96 b		10.90	20.49	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96		11.84	19.55	<50	<0.50	<0.50	<0.50	<0.50	89
	11/25/96		11.32	20.07	<50	<0.50	<0.50	<0.50	<0.50	66
	04/01/97 f		11.06	20.33	<50	<0.50	<0.50	<0.50	<0.50	49
	06/25/97		11.92	19.47	<50	<0.50	<0.50	<0.50	<0.50	59

Table 1 (continued)
Groundwater Elevation and Analytical Data
Groundwater Monitoring Wells
Total Purgeable Petroleum Hydrocarbons
(TPPH as Gasoline, BTEX Compounds, and MtBE)

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Well Number	Date Sampled		Well Elevation (feet, MSL)	Depth to Water (feet, TOB)	Groundwater Elevation (feet, MSL)	TPPH as Gasoline (ppb)	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Xylenes (ppb)	MtBE (ppb)
MW-17	Well Destroyed										
MW-18	03/13/96	a	29.70	7.53	22.17	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96	b		9.88	19.82	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96			10.82	18.88	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96			10.18	19.52	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97	f		10.14	19.56	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97			10.94	18.76	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-19	03/13/96	a	29.02	7.06	21.96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96	b		9.42	19.60	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96			10.33	18.69	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96			9.67	19.35	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97	f		9.65	19.37	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97			10.41	18.61	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-20	Well Destroyed										
MW-21	03/13/96	a	28.72	7.58	21.14	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/29/96	b		9.85	18.87	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96			10.75	17.97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96			10.00	18.72	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97	f		10.03	18.69	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97			10.83	17.89	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-22	03/13/96	a	29.29	7.83	21.46	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96	b		10.33	18.96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96			11.28	18.01	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96			10.61	18.68	<50	<0.50	<0.50	<0.50	<0.50	3
	12/30/96			10.61	18.68	NA	NA	NA	NA	NA	3.3
	04/01/97	f		10.56	18.73	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97			11.51	17.78	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-23	03/13/96	a	30.99	9.13	21.86	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96	b		11.37	19.62	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96			12.31	18.68	<50	<0.50	<0.50	<0.50	<0.50	<2.5

Table 1 (continued)
Groundwater Elevation and Analytical Data
Groundwater Monitoring Wells
Total Purgeable Petroleum Hydrocarbons
(TPPH as Gasoline, BTEX Compounds, and MtBE)

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Well Number	Date Sampled		Well Elevation (feet, MSL)	Depth to Water (feet, TOB)	Groundwater Elevation (feet, MSL)	TPPH as Gasoline (ppb)	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Xylenes (ppb)	MtBE (ppb)
MW-23	11/25/96			11.76	19.23	<50	<0.50	<0.50	<0.50	<0.50	<2.5
(cont.)	04/01/97	f		11.56	19.43	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97			12.39	18.60	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-24	01/15/96	a	34.38	10.10	24.28	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96	b		12.25	22.13	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96			13.28	21.10	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96			12.71	21.67	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97	f		12.50	21.88	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97			13.38	21.00	<50	<0.50	<0.50	<0.50	<0.50	<2.5
MW-25	03/14/96	a	34.12	9.61	24.51	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/29/96	b		11.30	22.82	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96	c		12.32	21.80	<50	<0.50	<0.50	<0.50	<0.50	51
	11/25/96			11.83	22.29	<50	<0.50	<0.50	<0.50	<0.50	110
	04/01/97	f		11.55	22.57	<50	<0.50	<0.50	<0.50	<0.50	39
	06/25/97			14.57	19.55	<50	<0.50	<0.50	<0.50	<0.50	49
MW-26	03/15/96	a	33.71	9.38	24.33	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/28/96	b		11.57	22.14	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/28/96	c		12.55	21.16	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	11/25/96			12.03	21.68	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	04/01/97	f		11.84	21.87	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97			12.94	20.77	<50	<0.50	<0.50	<0.50	<0.50	<2.5

MtBE = Methyl tert-butyl ether
MSL = Mean sea level
TOB = Top of box
ppb = Parts per billion
a. All wells gauged on March 13, 1996.
b. All wells gauged on May 28, 1996.
c. Well sampled on August 29, 1996.
d. Well sampled on November 26, 1996.
e. MtBE result confirmed by EPA Method 8260.
f. Wells gauged on March 31, 1997.
< = Less than laboratory detection limit.
NA = Not analyzed
NS = Not sampled
† = Well sampled without purging.
†† = ORC program at well was initiated on September 21, 1995 and discontinued on May 15, 1997.

Table 2
Groundwater Analytical Data
Domestic Irrigation Wells
Total Purgeable Petroleum Hydrocarbons
(TPPH as Gasoline, BTEX Compounds, and MtBE)

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Well Address	Date Sampled	TPPH as Gasoline (ppb)	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Xylenes (ppb)	MtBE (ppb)
590 H	03/14/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96 a	NS	NS	NS	NS	NS	NA
	11/26/96	NS	NS	NS	NS	NS	NS
	03/31/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97 a	NS	NS	NS	NS	NS	NS
633 H	03/14/96	480	10	11	1.8	140	NA
	05/13/96 b	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	11/26/96	<50	<0.50	<0.50	<0.50	<0.50	3.70
	12/30/96	NA	NA	NA	NA	NA	4.9 c
	03/31/97	NS	NS	NS	NS	NS	NS
	06/25/97 a	NS	NS	NS	NS	NS	NS
634 H	03/13/96 a	NS	NS	NS	NS	NS	NA
	05/27/96 a	NS	NS	NS	NS	NS	NA
	08/29/96 a	NS	NS	NS	NS	NS	NA
	11/26/96	NS	NS	NS	NS	NS	NS
	03/31/97	NS	NS	NS	NS	NS	NS
	06/25/97 a	NS	NS	NS	NS	NS	NS
642 H	03/15/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	11/26/96	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	03/31/97	NS	NS	NS	NS	NS	NS
	06/25/97	NS	NS	NS	NS	NS	NS
675 H	03/13/96 a	NS	NS	NS	NS	NS	NA
	05/27/96 a	NS	NS	NS	NS	NS	NA
	08/29/96 d	NS	NS	NS	NS	NS	NA
	11/26/96	NS	NS	NS	NS	NS	NS
	03/31/97	NS	NS	NS	NS	NS	NS
	06/25/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
17197 VM	03/15/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	11/26/96	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	03/31/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
17200 VM	03/15/96	730	<1.0	<1.0	1.5	1.7	NA
	05/27/96	200	<0.50	<0.50	1.4	1.8	NA
	08/29/96		Well Destroyed				
17203 VM	03/15/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA

Table 2 (continued)
Groundwater Analytical Data
Domestic Irrigation Wells
Total Purgeable Petroleum Hydrocarbons
(TPPH as Gasoline, BTEX Compounds, and MtBE)

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Well Address	Date Sampled	TPPH as Gasoline (ppb)	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Xylenes (ppb)	MtBE (ppb)
17203 VM	11/26/96	<50	<0.50	<0.50	<0.50	<0.50	<2.5
(cont.)	03/31/97 f	NS	NS	NS	NS	NS	NS
	06/25/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
17302 VM	03/15/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	11/26/96	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	03/31/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97 f	NS	NS	NS	NS	NS	NS
17348 VE	03/13/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96		Well Dry				
	08/29/96		Well Dry				
	11/26/96		Well Dry				
	03/31/97		Well Dry				
	06/25/97		Well Inaccessible				
17349 VM	03/15/96	1,700	<2.0	<2.0	2.5	13	NA
	05/27/96	320	4.2	1.3	0.95	0.71	NA
	08/29/96	410	7.5	<0.50	<0.50	1.1	NA
	11/26/96	300	<1.0	1.7	<1.0	2.1	55 *
	03/31/97	430	<1.0	2.7	<1.0	1.0	57 c
	06/25/97 **	2,100	30	<5.0	<5.0	6.7	140
	08/18/97	320	2.0	<0.5	<0.5	<0.5	34
	08/18/97	–	–	–	–	–	31 c
17371 VM	03/13/96 e	NS	NS	NS	NS	NS	NA
	05/27/96 e	NS	NS	NS	NS	NS	NA
	08/29/96 e	NS	NS	NS	NS	NS	NA
	11/26/96 e	NS	NS	NS	NS	NS	NS
	03/31/97 e	NS	NS	NS	NS	NS	NS
	06/25/97 e	NS	NS	NS	NS	NS	NS
17372 VM	03/14/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	11/26/96	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	03/31/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
	06/25/97	<50	<0.50	<0.50	<0.50	<0.50	<2.5
17393 VM	03/14/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	05/27/96	<50	<0.50	<0.50	<0.50	<0.50	NA
	08/29/96	<50	<0.50	<0.50	<0.50	<0.50	NA

Table 2 (continued)
Groundwater Analytical Data
Domestic Irrigation Wells
Total Purgeable Petroleum Hydrocarbons
(TPPH as Gasoline, BTEX Compounds, and MtBE)

ARCO Service Station 0608
17601 Hesperian Boulevard at Hacienda Avenue
San Lorenzo, California

Well Address	Date Sampled	TPPH as Gasoline (ppb)	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Xylenes (ppb)	MtBE (ppb)
17393 VM	11/26/96	<50	<0.50	<0.50	<0.50	<0.50	<2.5
(cont.)	03/31/97 a	NS	NS	NS	NS	NS	NS
	06/25/97	---------- Well Destroyed ----------					

TPPH = Total purgeable petroleum hydrocarbons
MtBE = Methyl tert-butyl ether
ppb = Parts ber billion
H = Hacienda Avenue
< = Less than laboratory detection limit stated at right.
NA = Not analyzed
NS = Not sampled
a. Owner not available to approve sampling access; well not sampled.
b. Well resampled to confirm data of March 14, 1996.
c. MtBE result confirmed by EPA Method 8260.
d. Pumping equipment obstructing sampling access; well not sampled.
e. Access denied by owner; well not sampled.
f. Pump on well does not work.
VM = Via Magdalena
VE = Via Encinas
* = MtBE data maybe anamolous; unable to confirm with EPA Method 8260.
** = Concentration data are suspect due to inadequate purging. Well resampled on August 18, 1997 for confirmation purposes.
Homeowners are contacted 1 week prior to sampling event.