

Robert Elbert & Associates

18 Anacapa Street, Second Floor
Santa Barbara, California 93101

P. O. Box 40180, Santa Barbara CA 93140-0180

TELEPHONE (805) 963-1808

FEDERAL EXPRESS

April 14, 1988

Mr. Larry Seto
Alameda County Health Care Services
470 27th Street
3rd Floor
Oakland, CA 94612

Re: Thrifty Oil Company
Station No. 054
2504 Castro Valley Blvd.
Castro Valley, CA

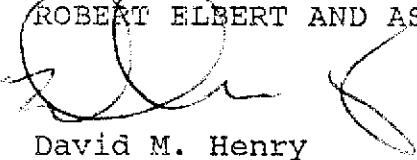
Dear Mr. Seto:

Robert Elbert and Associates on behalf of Thrifty Oil Company hereby submits the Report of Subsurface Investigation for the above referenced facility. This report is also submitted to Mr. Thomas J. Callaghan at the California Regional Water Quality Control Board.

Please feel free to call if you have any questions or comments.

Sincerely;

ROBERT ELBERT AND ASSOCIATES



David M. Henry

cc Mr. Darrell Fah, Thrifty Oil Company
Mr. P. D'Amico, Thrifty Oil Company

Report of Subsurface Investigation
for
THRIFTY OIL COMPANY
Station No. 054
2504 Castro Valley Boulevard
Castro Valley, California

prepared for
THRIFTY OIL COMPANY
10000 Lakewood Blvd.
Downey, CA 90240

by
ROBERT ELBERT AND ASSOCIATES
P.O. Box 40180
Santa Barbara, CA 93140-0180
(805)963-1808

April 11, 1988

TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	2
1.1 Site Description	2
1.2 Scope of Investigation	2
2.0 PREVIOUS INVESTIGATIONS	3
3.0 HYDROGEOLOGIC SETTING	4
4.0 INVESTIGATIVE PROCEDURES	4
4.1 Drilling and Soil Sampling	4
4.2 Groundwater Monitoring Well Construction	5
4.3 Groundwater/Free Product Measurements and Corrections	5
4.4 Laboratory Soil Analysis	6
4.5 Laboratory Analysis of Water Samples	7
5.0 FINDINGS	7
5.1 Subsurface Soil Conditions	8
5.2 Groundwater Conditions	9
6.0 LIMITATIONS OF INVESTIGATION	9

1.0 INTRODUCTION

This report presents the result of a subsurface investigation conducted by Robert Elbert and Associates for Thrifty Oil Company Station No 054, at 2504 Castro Valley Boulevard, Castro Valley, California. A location map is provided as Figure 1. This study was performed in order to define the extent of hydrocarbon contamination found during a previous site assessment made using the drilling and sampling method.

1.1 Site Description

The site is located in the Castro Valley, which is an approximately mile and one half wide valley lying at the base of the U-shaped surrounding San Leandro Hills. The valley itself has a rather shallow slope and drains to the south by way of Cull and Crow Creeks and several other small drainages, that all join San Lorenzo Creek.

The site is found on Castro Valley Boulevard, in Alameda County, Castro Valley, California. On the location is an operating retail gasoline station with three underground tanks for leaded, unleaded and premium gasolines. Figure 2 is a site plan showing the location of buildings, storage tanks and other relevant features.

1.2 Scope of Investigation

Our services for this investigation were performed to further define the degree and extent of contamination of petroleum hydrocarbon contaminants in the soil at station No. 054. Our investigation consisted of:

- o Advancing seven (7) borings to depths of 15 to 26 feet;

- o Soil sampling at 5 foot intervals from grade to total depth;
- o Field analysis of soil samples with an HNU Photoionization Detector when possible;
- o Permitting and arranging for construction of a 4 inch PVC water monitoring well in each of the borings;
- o Surveying the wells and a nearby benchmark in order to get true elevations for the wells;
- o Laboratory analysis of two (2) soil samples and one water sample from each well (exception RE-2);
- o Evaluation of field and laboratory data; and
- o Preparation of this report which summarizes our investigation methodologies and findings.

2.0 PREVIOUS INVESTIGATIONS

Four (4) 20 foot deep borings were completed on December 17, 1987 by Interstate Soils Sampling under the observation of an engineering geologist from Hydrotech. The borings show that the site is underlain by 12 to 15 feet of clayey soil overlying shale bedrock. None of the borings encountered groundwater.

Hydrocarbon contamination was found in all of the wells with the maximum contamination occurring between the five and 10 foot depths. Contamination decreases with depth thereafter as determined both by Gastechtor readings and laboratory analysis. Only boring B-1 showed any significant

contamination below 15 feet with 420 parts per million (ppm) of Total Petroleum Hydrocarbons (EPA method 418.1) at a total depth of 20 feet.

3.0 HYDROLOGIC SETTING

The site is in the San Francisco Bay structural depression of the Coast Range Physiographic Province. Bedrock beneath the site is shale and is found at about 15 feet below grade.

Groundwater was found at approximately seven (7) feet below ground surface (bgs) and was held in a gravelly (shale gravels) clay just above the shale. The direction of flow is generally to the south-southeast and is mapped on Figure 3. Ground surface in the area is about 165 feet above sea level according to RE&A's survey of the wells which tied into a nearby bench mark (see Section 4.2).

4.0 INVESTIGATIVE PROCEDURES

4.1 Drilling and Soil Sampling

From February 14, 1988 to February 17, 1988 seven borings were drilled to 15 to 25 foot depths, the limitation of depth being shale bedrock. Exact depth measurements are listed on Table 1, Monitoring Well Construction Data. Borings RE-1,2,3,4 and 5 surround the underground tanks in a somewhat circular shape and are all within 30 feet of the cluster. RE-6 and 7 are located on the southern boundary of the station. Figure 2 is a site plan showing the location of the borings. The borings were advanced by five foot long, four inch diameter auger flights with 1.5 foot soil samples taken or attempted at five foot intervals.

One soil sample tube from each sampled interval was sealed and retained in cold storage for possible laboratory analysis. The soil from another sample tube from the same sampled interval was put in a ziplock bag and tested onsite for hydrocarbon contamination by taking an HNU Photoionization Dector (PID) reading, then the remaining sample was used for a soil description. The boring logs and a detailed account of the drilling methodology and sampling procedures is presented in Appendix A.

4.2 Groundwater Monitoring Well Construction

All seven borings were reamed out to an 11 inch diameter and were completed as groundwater monitoring wells. The wells are constructed with schedule 40, four inch PVC casing with threaded flush joints. Blank casing was used for the upper five feet, and .020 inch slot sized casing was used from five feet to depth in each well. The wells were capped and finished with a metal traffic cover.

The mounted portion of the traffic cover of each of the RE&A wells and the remaining, previously built wells, PW-1 and PW-2, were surveyed for their elevations. The well survey was tied into a nearby benchmark with an elevation of 165.891 feet asl. Data for the benchmark was provided by the County of Alameda. Elevation measurements and construction specifications are listed in Table 1, and surveying notes are included in Appendix B.

4.3 Groundwater/Free Product Measurements and Corrections

The wells, except for RE-2, were measured on February 16 and 18, 1988 with an interface probe for the depths to groundwater and free product. There was no measurable amount of free product floating on the water in any of the RE&A wells, however PW-1 had 0.07 feet and PW-2 had .03 feet

of product. The product in these wells was thick and dark brown-black. Neither of these wells, which are located downhill from the pump islands, are capped, but are only covered with a loose fitting traffic cover.

The wells were remeasured March 29 and 30, 1988. On this date only a thin film of free product was found in MW-3. The water table data is presented in Tables 2-A and 2-B, and Figures #A and 3B. *missing*

To find the groundwater elevation in the wells that contain free product a calculation must be made. Because of the density difference between gasoline and water, the top of the gasoline is higher than an equivalent column of water and therefore needs to be corrected in order to get the water table elevation. This is done by multiplying the gasoline thickness by its specific gravity and adding that thickness to the measured water level elevation. A specific gravity of 0.755 g/l was used for the gasoline. Appendix E describes the theory behind making this correction. The water levels for the RE&A wells, and the corrected water levels and free product measurements from the previous wells are listed in Tables 2-A and 2-B.

4.4 Laboratory Soil Analysis

The field logs for the completed borings were reviewed and two samples from each RE&A well were submitted for laboratory analysis for fuel fingerprinting. The samples chosen from each boring were one at the top of the water table and possibly one just above that, one sample from a shallower depth. By testing these samples it can be determined whether the upper layers are contaminated, and if contamination has reached the groundwater. No samples were taken below groundwater because it acts as a barrier to downward movement of possible hydrocarbons. Fuel

Fingerprint tests were done by Central Coast Analytical Services, a State of California licenced hazardous waste testing laboratory. The test used is the modified EPA method 8240, and concentrations of Benzene, Toluene, Ethylbenzene, Xylenes, 1,2-Dichlorethane, Ethylene Dibromide, Naphthalene, and Total Purgeable Petroleum Hydrocarbons are reported. The detection limit is 1 ppb. The results are summarized in Table 3, and official results and a detailed discussion of the Analytical method are included in Appendix C.

4.5 Laboratory Analysis of Water Samples

After the wells were built and groundwater levels stabilized, two water samples were taken from each well. Before sampling, the wells were bailed of five casing volumes of water or until dry. The wells were allowed to recharge, and samples were taken using a Teflon bailer and glass vials. These, like the soil samples, were submitted to Central Coast Analytical Services for fuel fingerprints using the same analysis as described above.

5.0 FINDINGS

The soils found during drilling were fairly uniform across the site. Ten to 15 feet of clay or clay with quartzite and sandstone gravels and/or evaporite deposits overlies clay with abundant shale gravel. Beneath this at 15 feet or deeper is shale bedrock. A contour map of the elevation of the top of the shale is included as Figure 4. The exceptions to the above sequence are in RE-3 which had black clay with fill material from the surface to seven (7) feet deep and in RE-1 which was drilled to 25 feet without encountering bedrock.

MISSING

On February 17, 1988 groundwater was measured in all of the wells and varied from 4.8 to 11.8 feet below surface. The 11.8 foot depth was in RE-7 which may not have fully stabilized at that time. Tables 2-A and 2-B shows the measured depths with the final water elevations after correcting for elevation differences in each well.

5.1 Subsurface Soil Conditions

During drilling water was found at approximately 7 to 10 feet below ground surface. After the wells were built and bailed the water level stabilized and was accurately measured (see tables 2-A and 2-B).

Laboratory analyses showed that in all samples except for RE-2 and RE-7 the hydrocarbon contamination is restricted to at or above 10 feet. The greatest concentrations of Total Purgeable Petroleum Hydrocarbons (TPPH) are found in a zone running northwest - southeast and under the underground tank area; RE-4 had 1900.0 ppm of TPPH at 5 feet which dropped to 7.7 ppm at 10 feet. RE-1 had 1000.0 ppm of TPPH at 5 feet and <0.1 ppm at 10 feet. RE-3, northeast of the tanks, had the next highest measurement of 490 ppm at 5 feet and 0.1 ppm at 10 feet. At the southeastern end of this hydrocarbon belt, RE-7 had 50 ppm at 5 feet which increased to 110.0 ppm at 10 feet. Surprisingly RE-5, which is closest to and south of the tanks, had only 17.0 ppm of TPPH at 5 feet and 13.0 ppm at 10 feet. Further south than RE-5, RE-2 showed an increase in TPPH from 1.1 ppm at 5 feet to 130.0 ppm at 10 feet. RE-6 had minimal amounts of TPPH, 1.2 ppm at 5 feet, 0.6 ppm at 10 feet,

A summary of laboratory results are in Table 3 and official results are in Appendix C.

5.2. Groundwater Conditions

Laboratory results of water samples from RE-1,3,4,5,6, and RE-7 show there are significant amounts of hydrocarbons in all of the samples. RE-2 was not sampled. Similar to the soil samples, RE-5 and 6 have the lowest concentrations with 14 ppm of TPPH in the former and 6.0 ppm in the latter. RE-1 and RE-7 are the next lowest with 37.0 ppm and less than 50.0 ppm of TPPH respectively. In the northwest - southeast trending zone of highest concentration are RE-3, 70 ppm, and RE-4, 150 pp, of TPPH.

Upon examination of the laboratory results for water samples, RE&A noticed that the measurements for Benzene were unusually high for the expected contaminant of gasoline. Consequently a full scan laboratory analysis was ordered on RE-7 which had the highest Benzene measurement (17.0 ppm). The results of this test are pending.

A summary of the laboratory results is given in Table 4, and the official results are in Appendix C.

6.0 LIMITATIONS OF INVESTIGATION

Soil and groundwater conditions can vary significantly between borings. Samples taken are believed to be representative of the site.

The investigation and interpretations presented herein were performed to meet current professional standards. No other guarantee is expressed or implied regarding the conclusions or recommendations in this report.

Written By

Donnette Dunaway-Kammer
Donnette Dunaway-Kammer
Staff Geologist

Reviewed by

Diane Kasari Henry
Diane Kasari Henry
CA Registered Geologist No. 4342

Table 2-A

Depth to Groundwater
 Thrifty Oil Station No. 054 - Castro Valley
 February 16-18, 1988

WELL NUMBER	RE-1	RE-2	RE-3	RE-4	RE-5	RE-6	RE-7	PW-1	PW-2
DEPTH TO FREE PRODUCT FROM GROUND LEVEL	N	N	N	N	N	N	N	4.74	6.53
DEPTH TO WATER TABLE FROM GROUND LEVEL	6.11		7.23	7.45	6.80	8.08	11.83	4.81	6.56
THICKNESS OF FREE PRODUCT	N	N	N	N	N	N	N	0.07	0.03
ELEVATION OF WATER LEVEL	160.81	N	160.24	159.74	160.34	158.46	154.05	161.6*	159.52*
GROUND LEVEL ELEVATION	166.92	167.09	167.47	166.89	167.10	166.54	165.88	166.36	166.06

N - No measurable amount

* See Appendix G

All measurements in feet

Flow to the SE

Table 2-B

Depth to Groundwater
Thrifty Oil Station No. 054 - Castro Valley
March 30, 1988

WELL NUMBER	RE-1	RE-2	RE-3	RE-4	RE-5	RE-6	RE-7	PW-1	PW-2
DEPTH TO FREE PRODUCT FROM GROUND LEVEL	N	N	7.42	N	N	N	N	N	N
DEPTH TO WATER TABLE FROM GROUND LEVEL	6.24	6.22	7.43	6.80	6.40	7.20	7.27	5.25	6.45
THICKNESS OF FREE PRODUCT	N	N	0.01	N	N	N	N	0.07	0.03
ELEVATION OF WATER LEVEL	160.68	161.87	160.04	160.09	160.70	159.34	158.61	161.11	159.61
GROUND LEVEL ELEVATION	166.92	167.09	167.47	166.89	167.10	166.54	165.88	166.36	166.06

N - No measuable amount

* See Appendix G

All measurements in feet

Table 3

Laboratory Results of Soil Samples
Thrifty Station No. 054 - Castro Valley

WELL NUMBER WELL DEPTH	RE-1		RE-2		RE-3		RE-4	
	5'	10'	5'	10'	5'	10'	5'	10'
BENZENE	10.0	0.016	0.004	0.02	5.3	0.014	13.0	0.057
TOLUENE	92.0	0.003	0.001	0.02	22.0	0.010	120.0	0.0
ETHYLBENZENE	27.0	BD	BD	0.75	7.8	BD	44.0	0.013
XYLENES	180.0	0.005	BD	0.14	82.0	0.013	410.0	0.13
EDC	BD	BD	BD	BD	BD	BD	BD	BD
EDB	BD	BD	BD	BD	BD	BD	BD	BD
NAPHTHALENE	1.4	BD	BD	0.03	1.1	0.003	7.0	0.009
TOTAL PURGEABLE PETROLEUM HYDROCARBON	1000.0	<0.1	1.1	130.0	490.0	0.1	1900.0	7.7

Measurements are in parts per million (ppm)

BD - Below Detection

Table 3
Continued
Laboratory Results of Soil Samples
Thrifty Station No. 054 - Castro Valley

WELL NUMBER WELL DEPTH	RE-5		RE-6		RE-7	
	5'	10'	5'	10'	10'	25'
BENZENE	0.36	0.008	0.033	0.025	1.3	0.57
TOLUENE	0.036	BD	0.003	0.002	2.9	0.05
ETHYLBENZENE	0.029	0.007	0.010	0.004	0.6	0.08
XYLENES	0.14	0.017	0.025	0.005	7.0	0.37
EDC	BD	BD	BD	BD	BD	BD
EDB	BD	BD	BD	BD	BD	BD
NAPHTHALENE	0.001	0.019	0.002	0.003	0.3	BD
TOTAL PURGEABLE PETROLEUM HYDROCARBON	17.0	13.0	1.2	0.6	50.0	110.0

Measurements are in parts per million (ppm)

BD - Below Detection

Table 4

Laboratory Results of Water Samples
Thrifty Station No. 054 - Castro Valley

WELL NUMBER	RE-1	RE-3	RE-4	RE-5	RE-6	RE-7
BENZENE	1.9	6.6	12.0	1.3	3.0	17.0 ppm
TOLUENE	8.4	5.3	8.0	1.1	0.04	4.4
ETHYLBENZENE	1.2	0.8	1.0	0.1	0.08	0.6
XYLENES	15.0	13.0	27.0	2.6	0.14	8.4
EDC	BD	BD	BD	BD	BD	BD
EDB	BD	BD	BD	BD	BD	BD
NAPHTHALENE	BD	0.7	3.0	0.1	0.02	BD
TOTAL PURGEABLE PETROLEUM HYDROCARBON	37.0	70.0	150.0	14.0	6.0	<50.0

Measurements are in parts per million (ppm)

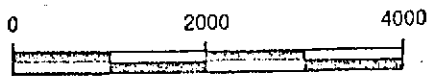
BD - Below Detection

benzene 0.7 ppm



A PORTION OF THE U.S.G.S. HAYWARD 7.5' QUADRANGLE

LOCATION MAP
THRIFTY OIL STATION NO. 054
CASTRO VALLEY, CALIFORNIA
 Prepared for
THRIFTY OIL COMPANY
DOWNY, CALIFORNIA

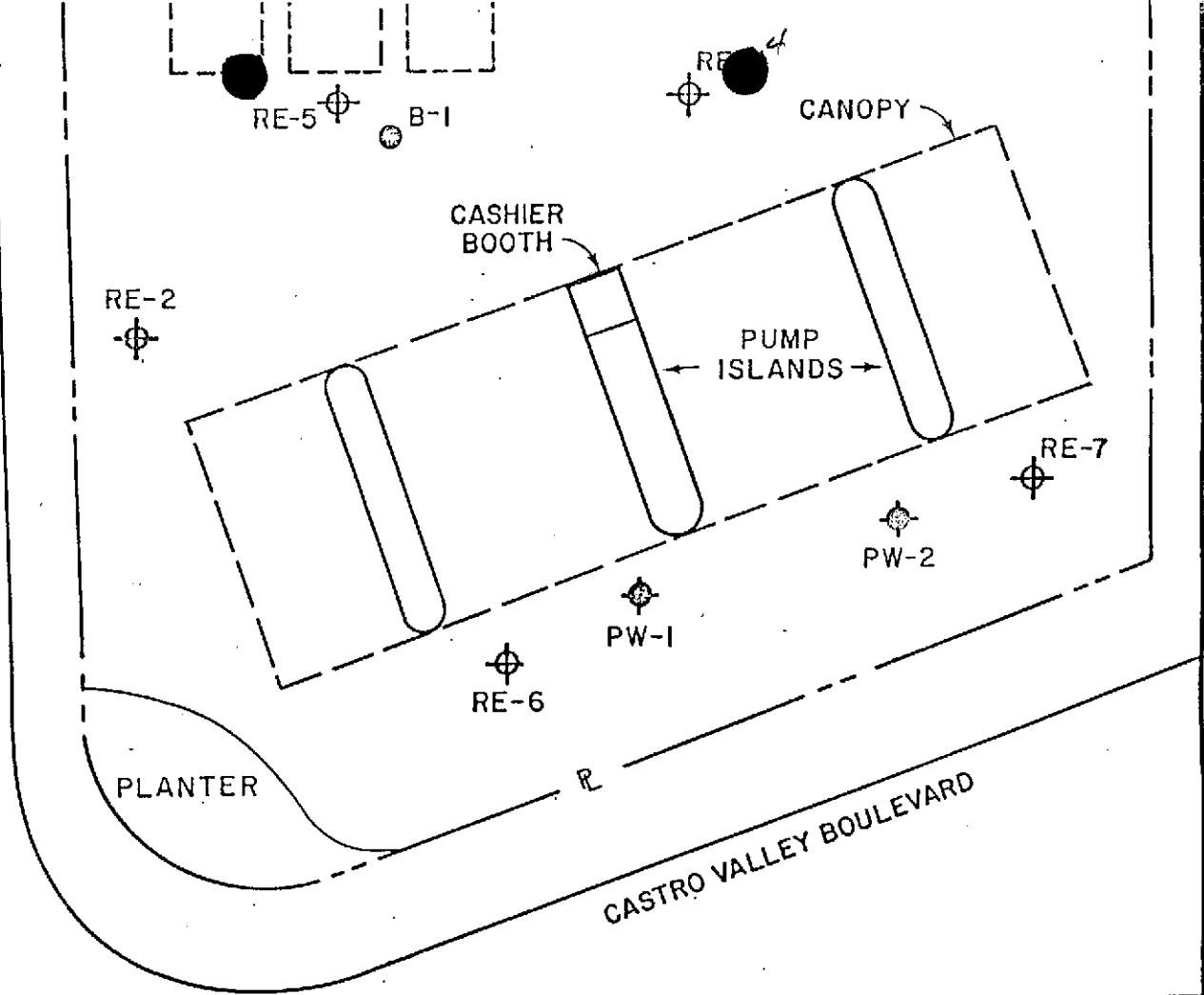


SCALE IN FEET

RE & A
 Santa Barbara
 California

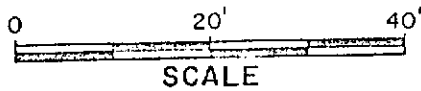
Figure 1

STANTON AVENUE



EXPLANATION:

- B-4 ● Exploratory Boring
- RE-7 ⊕ Monitoring Well
- PW-1 ⊕ Pre-existing Well



SITE PLAN
 THRIFTY OIL STATION NO.054
 CASTRO VALLEY, CALIFORNIA
 Prepared for
 THRIFTY OIL COMPANY
 DOWNEY, CALIFORNIA

FEB 1988
 RE & A
 Santa Barbara
 California

Figure 2

of Flow

EXPLANATION:

- B-4 ● Exploratory Boring
- RE-7 ⊕ Monitoring Well
- PW-1 ⊕ Pre-existing Well



WATER TABLE ELEVATION 2/16/88
 THRIFTY OIL STATION NO.054
 CASTRO VALLEY, CALIFORNIA
 Prepared for
 THRIFTY OIL COMPANY
 DOWNEY, CALIFORNIA

RE & A
 Santa Barbara
 California

Figure 3A

APPENDIX A

Boring Logs and Sampling Notes

THRIFTY OIL COMPANY MONITORING WELL LOG DATE: 2-15-88
 054 Castro Valley CA 2504 Castro Valley Logged By: DD
 Drilling Contractor: BEYLIK DRILLING COMPANY Rig Type: HOLLOW STEM AUGER
 Time Started: 1:11 Boring/Well #: RE-1 Elevation:
 Sampling Method: DRIVE Casing Size: 4" Screen Type: PVC Filter Pack: #3 SAND

DEPTH (FEET)	SAMP INT	PID ppm	BPF*	WELL DETAILS	USCS	SOIL DESCRIPTION AND NOTES
5	X	140	7, 8, 12			GRAY CLAY WITH GRAVEL, MOIST, STRONG HYDROCARBON ODOR.
10	X	2	13, 14, 16		CL	MOTTLED BROWN AND GRAY CLAY WITH GRAVEL AT BASE, WET, SLIGHT HYDROCARBON ODOR.
15	X	<1	21, 37, 39			LIGHT BROWN SLIGHTLY GRAVELLY (SHALE) CLAY, MOIST - NOT WET, NO HYDROCARBON ODOR.
20	X	<1	16, 21, 27			BLACK WEATHERED SHALE, DRY, NO HYDROCARBON ODOR.
25	X	<1	37, 65			BLACK CLAY WITH SHALE, MOIST, NO HYDROCARBON ODOR.
30						TD AT 26 FEET. 2-15-88
35						GROUNDWATER AT 10 FEET
40						
45						
50						

Eric A. G. ... 4342

*BLOWS PER HALF FOOT

REDA

THRIFTY OIL COMPANY MONITORING WELL LOG DATE: 2-16-88
 054 Castro Valley CA 2504 Castro Valley Logged By: DD
 Drilling Contractor: BEYLIK DRILLING COMPANY Rig Type: HOLLOW STEM AUGER
 Time Started: 9:30 Boring/Well #: RE-2 Elevation:
 Sampling Method: DRIVE Casing Size: 4" Screen Type: PVC Filter Pack: #3 SAND

DEPTH (FEET)	SAMP INT	PID ppm	BPF*	WELL DETAILS	USCS	SOIL DESCRIPTION AND NOTES
5	X	7	4, 16, 14		CL	GRAY-GREEN CLAY WITH SOME GRAVEL, VERY MOIST, SLIGHT HYDROCARBON ODOR.
10	X	110	13, 19, 18		CL	GREEN GRAVELLY (QUARTZITE) CLAY, VERY MOIST, STRONG HYDROCARBON ODOR. PERCHED GROUNDWATER.
15	X	50	8, 18, 37			GREEN CLAY, MOIST, WITH EVAPORITE CRYSTALS, VERY SLIGHT HYDROCARBON ODOR. REFUSAL AT 17 FEET ON GRAVELLY CLAYEY SHALE WITH PLAGIOCLASE VEINS. T.D. AT 17 FEET. GROUNDWATER AT APPROXIMATELY 13 FEET. 2-16-88
20						
25						
30						
35						
40						
45						
50						

Steve ...
 ... 4342

*BLOWS PER HALF FOOT

THRIFTY OIL COMPANY MONITORING WELL LOG DATE: 2-14-88
 054 Castro Valley CA 2504 Castro Valley Logged By: DD
 Drilling Contractor: BEYLIK DRILLING COMPANY Rig Type: HOLLOW STEM AUGER
 Time Started: 12:30 Boring/Well #: RE-3 Elevation:
 Sampling Method: DRIVE Casing Size: 4" Screen Type: PVC Filter Pack: #3 SAND

DEPTH (FEET)	SAMP INT	PID ppm	BPF*	WELL DETAILS	USCS	SOIL DESCRIPTION AND NOTES
5	X	140	17, 14, 21			ASPHALT DARK GRAY-BLACK CLAY WITH WOOD, FILL MATERIAL.
10	X	140	13, 21, 33		CL	BLACK ORGANIC CLAY, VERY MOIST, STRONG HYDROCARBON ODOR. GREEN-BROWN GRAVELLY CLAY, WEATHERED QUARTZITE GRAVEL WITH SAND AND CLAY, CLUMPS, MOIST, STRONG HYDROCARBON ODOR
15	X	<5	9, 11, 17			DARK OLIVE-BROWN GRAVELLY CLAY, GRAVEL IS SHALE, WITH SAND, ROOTS, MOIST, NO HYDROCARBON ODOR. REFUSAL ON SHALE BEDROCK.
20						T.D. AT 19 FEET. NO GROUNDWATER 2-14-88.
25						NOTE: AFTER WAITING OVERNIGHT, THE BORING (NOT SET AS A WELL YET) HAD WATER AT APPROXIMATELY 7 FEET. THE BORING WAS THEN REAMED, AND A 4 INCH WATER WELL WAS BUILT 2-15-88.
30						
35						
40						
45						
50						

Alan R. Henry S.E. 4342

*BLOWS PER HALF FOOT

THRIFTY OIL COMPANY MONITORING WELL LOG DATE: 2-14-88
 054 Castro Valley CA 2504 Castro Valley Logged By: DD
 Drilling Contractor: BEYLIK DRILLING COMPANY Rig Type: HOLLOW STEM AUGER
 Time Started: 2:00 Boring/Well #: RE-4 Elevation:
 Sampling Method: DRIVE Casing Size: 4" Screen Type: PVC Filter Pack: #3 SAND

DEPTH (FEET)	SAMP INT	PID ppm	BPF*	WELL DETAILS	USCS	SOIL DESCRIPTION AND NOTES
5		125	6, 8, 17			GREEN GRAVELLY CLAY OVER BLACK CLAY, VERY MOIST, STRONG HYDROCARBON ODOR.
10		25	16, 17, 16		CL	GREEN GRAVELLY CLAY, WET, MODERATE HYDROCARBON ODOR.
15		<1	12, 50/2"			REFUSAL ON WEATHERED SHALE. SAMPLE IS GRAVELLY (SHALE) CLAY, WET, OVER DRY SHALE BEDROCK.
15.5						T.D. AT 15.5 FEET.
20						GROUNDWATER AT 10 FEET 2-16-88
25						
30						
35						
40						
45						
50						

Alvin K. Y... R.A. 4342

*BLOWS PER HALF FOOT

THRIFTY OIL COMPANY MONITORING WELL LOG DATE: 2-17-88
 054 Castro Valley CA 2504 Castro Valley Logged By: DD
 Drilling Contractor: BEYLIK DRILLING COMPANY Rig Type: HOLLOW STEM AUGER
 Time Started: 7:40 Boring/Well #: RE-5 Elevation:
 Sampling Method: DRIVE Casing Size: 4" Screen Type: PVC Filter Pack: #3 SAND

DEPTH (FEET)	SAMP INT	PID ppm	BPF*	WELL DETAILS	USCS	SOIL DESCRIPTION AND NOTES
5		130	7, 12, 19			GREEN AND GRAY CLAY WITH GRAVEL (SANDSTONE) AT TOP, VERY MOIST, MODERATE HYDROCARBON ODOR.
10		120	12, 15, 21		CL	GREEN-BROWN CLAY WITH SOME GRAVELS AND WHITE EVAPORITE DEPOSITS, VERY MOIST, STRONG HYDROCARBON ODOR.
15		4	22, 43, 49			GREEN-BROWN WEATHERED SHALE, NO HYDROCARBON ODOR, WET.
20			50/6"			GREEN-BROWN SHALE, REFUSAL.
						T.D. AT 20.5 FEET.
						GROUNDWATER AT 10 FEET 2-17-88
25						
30						
35						
40						
45						
50						

Clare A. Henry R.G. 4342

*BLOWS PER HALF FOOT

THRIFTY OIL COMPANY MONITORING WELL LOG DATE: 2-17-88
 054 Castro Valley CA 2504 Castro Valley Logged By: DD
 Drilling Contractor: BEYLIK DRILLING COMPANY Rig Type: HOLLOW STEM AUGER
 Time Started: 1:10 Boring/Well #: RE-6 Elevation:
 Sampling Method: DRIVE Casing Size: 4" Screen Type: PVC Filter Pack: #3 SAND

DEPTH (FEET)	SAMP INT'	PID ppm	BPF*	WELL DETAILS	USCS	SOIL DESCRIPTION AND NOTES
5	X	20	21, 22, 27	[Patterned]	CL	GRAY CLAY WITH WHITE EVAPORITE DEPOSITS, VERY MOIST, NO HYDROCARBON ODOR.
10	X	50	9, 17, 36	[Patterned]	*	MOTTLED GRAY AND GREEN-BROWN GRAVELLY CLAY WITH EVAPORITE DEPOSITS, MORE GRAVEL AT BASE, VERY MOIST, NO HYDROCARBON ODOR.
15	—	5	50/3"	[Patterned]		SHALE - REFUSAL. T.D. AT 15 FEET. NO GROUNDWATER FOUND DURING DRILLING 2-17-88. *AFTER BUILDING THE WELL AND WAITING SEVERAL HOURS, GROUNDWATER FILLED THE WELL TO 8 FEET.
20						
25						
30						
35						
40						
45						
50						

Beylek Drilling Co. 4242

*BLOWS PER HALF FOOT

REGA

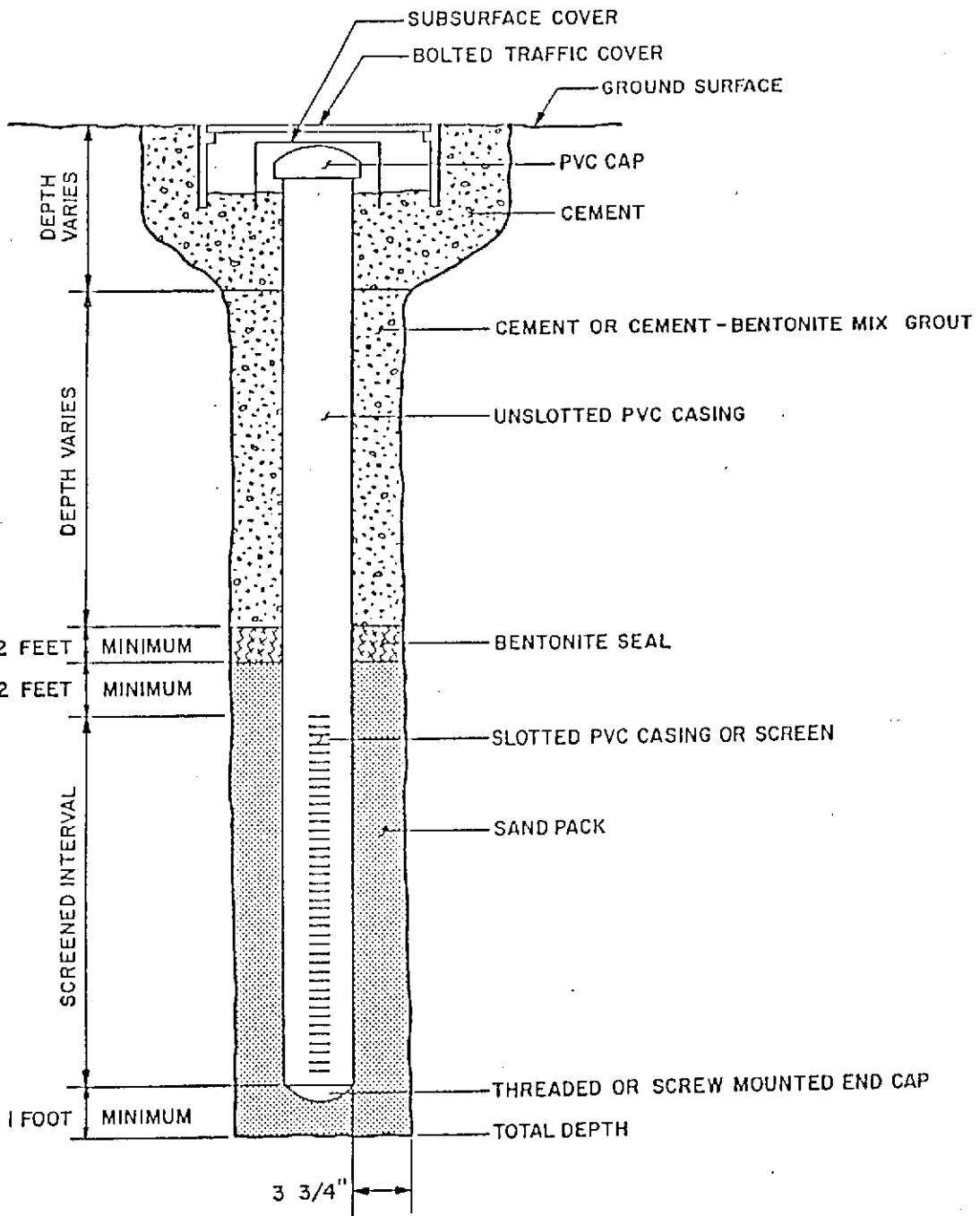
THRIFTY OIL COMPANY MONITORING WELL LOG DATE: 2-17-88
 054 Castro Valley CA 2504 Castro Valley Logged By: DD
 Drilling Contractor: BEYLIK DRILLING COMPANY Rig Type: HOLLOW STEM AUGER
 Time Started: 10:00 Boring/Well #: RE-7 Elevation:
 Sampling Method: DRIVE Casing Size: 4" Screen Type: PVC Filter Pack: #3 SAND

DEPTH (FEET)	SAMP INT	PID ppm	BPF*	WELL DETAILS	USCS	SOIL DESCRIPTION AND NOTES
5	X	110	6, 9, 14			BLACK CLAY OVER GREEN CLAY WITH EVAPORITE DEPOSITS, VERY MOIST, STRONG HYDROCARBON ODOR.
10	X	150	12, 16, 19			GREEN GRAVELLY (SHALE) AND CLAY, WET, STRONG HYDROCARBON ODOR.
15	X	18	43, 65/6"			SHALE - REFUSAL. T.D. AT 15 FEET. GROUNDWATER AT 10 FEET 2-17-88
20						
25						
30						
35						
40						
45						
50						

Done K. H. 2.6 439?

*BLOWS PER HALF FOOT

RE&A







NO SCALE
TYPICAL ONLY








TYPICAL MONITORING WELL
CONSTRUCTION

LEGEND SHEET FOR BORING LOGS



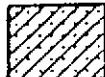











BORING LOG SYMBOLS

-  Modified California Sampler (blow-count)
-  No Sample Recovered
-  First Water Encountered
-  Measured Water Level

MONITORING WELL SYMBOLS

-  Concrete Seal
-  Bentonite Seal
-  Sand Pack
-  Native Backfill
-  Slotted Section of Casing
-  Blank Section of Casing
-  Measured Water Level

LITHOLOGIES

- | | | | | | | | |
|---|-------------|---|--------------------------------|--|-----------------------------|---|-------------|
|  | CLAY |  | Silty CLAY |  | Sandy CLAY |  | SILT |
|  | Clayey SILT |  | Sandy SILT |  | SAND |  | Clayey SAND |
|  | Silty SAND |  | Gravels & Gravel-Sand Mixtures |  | All Silty or Clayey Gravels |  | Bedrock |
|  | Fill |  | Asphalt/Concrete | | | | |

DEFINITION OF TERMS USCS CLASSIFICATION FOR SOILS

PRIMARY DIVISIONS		SYM-BOLS	SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO.200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO.4 SIEVE SIZE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW Well graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	GP Poorly graded gravels or gravel-sand mixtures, little or no fines
			GM Silty gravels, gravel-sand-silt mixtures, non-plastic fines
		SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO.4 SIEVE SIZE	CLEAN SANDS (LESS THAN 5% FINES)
	SP Poorly graded sands, gravelly sands, little or no fines		
	SANDS WITH FINES		SM Silty sands, sand-silt mixtures, non-plastic fines
			SC Clayey sands, sand-clay mixtures, plastic fines
	FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO.200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50%	ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays			
OL Organic silts and organic silty clays of low plasticity			
SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50%		MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		CH Inorganic clays of high plasticity, fat clays	
		OH Organic clays of medium to high plasticity, organic silts	
HIGHLY ORGANIC SOILS		Pt Peat and other highly organic soils	

DESCRIPTION OF BORING TECHNIQUES AND SAMPLING PROCEDURES

Under the supervision of a Robert Elbert and Associates, Inc. geologist the soil borings are advanced using a truck mounted hollow-stem auger. Each auger flight is 5 feet in length with an inner diameter of 3.5 inches and an outer diameter of 8 inches. A pilot assembly, consisting of a drill bit and center plug, is lowered through the hollow-stem auger via the center rod. This assembly, in conjunction with the auger head which is fitted with cutting blades, helps advance the auger through the soil and prevents soil from entering the hollow-stem portion of the auger. The hollow auger acts as a "temporary casing" preventing collapse of the bore hole wall. Soil cuttings are lifted up to the surface via the auger flights.

When the desired sample depth is reached, the drill bit and plug are removed from the center rod and replaced with a Modified California Split Spoon sampler. Usually, sampling is done at the end of each 5 foot auger flight. This sampler consists of an outer "split barrel" sampler in which a thin-walled set of rings is inserted. These rings are brass or stainless steel cylinders, each 3.25 inches in diameter and 3 to 6 inches long, totaling 16 or 18 inches in length.

A 140 pound hammer is used to drive the sampler into the formation below the bottom of the auger flight, thereby filling all of the sampling rings with soil. This method allows for collection of an undisturbed soil sample preventing introduction of overburden soil by the drilling process. The number of hammer blows (blows per foot, BPF) to advance the sampler a given distance is recorded on the boring log. This gives an indication of the amount of force required to recover the sample.

After retrieving and dismantling the sampler, all the thin tube rings are removed. The bottom ring is immediately sealed for laboratory analysis by covering both ends with teflon sheeting, plastic caps and securing the caps with tape. If some of the soil in the bottom ring has fallen out or appears to have been disturbed during the recovery operation, the second to last ring is used. This ring is labeled and placed in an ice chest for cold storage pending transportation to the laboratory. This packaging protocol is designed to prevent loss of volatiles from the soil sample, and to prevent any cross contamination. Standard chain of custody procedures are followed for all samples.

Soil from the second ring is used for field analysis of possible hydrocarbon contamination. The sample is placed in a ziplock bag, sealed and allowed to volatilize for a HNU Photoionization Analyzer (PID) measurement. A head-space measurement is taken by breaking the seal just enough to insert the probe. The highest reading is recorded. However, if the reading stabilizes at a significantly different level, this also is noted. The PID has a detection range from 0.1 ppm to 2000 ppm for hydrocarbon vapors, when calibrated with a benzene standard.

Soils in the remaining rings are examined to complete the field descriptions. This data includes a written soil description, the Unified Soil Classification code, and any notable odors, staining or contamination. Also noted are unusual drilling conditions, equipment malfunctions or other observations of field conditions for future reference. All data are recorded on the boring logs.

To prevent any cross contamination the augers are steam cleaned prior to drilling each boring. The split spoon sampler is cleaned using a three step process commonly referred to as a "three bucket wash". This consists of

first a trisodium phosphate wash, followed by a tap water rinse and finally a deionized water rinse. This process is completed between each sample run.

All cuttings and excess sample material recovered during the drilling operations are placed in 55 gallon DOT hazardous waste drums pending laboratory analysis results. The drums are sealed, labeled and left on site. Proper disposal is the client's responsibility.

GROUNDWATER SAMPLE
FIELD LOG

PROJECT NAME Thimble 1254
LOCATION Castro Valley
WELL NUMBER RE 1

SAMPLE: ✓
WELL _____
SURFACE WATER _____
SEEP _____
OTHER (DESCRIBE) _____

SAMPLER Dorothy Dunning
DATE OF SAMPLING 2-16-88
WEATHER CONDITIONS Sunny
DEPTH TO FREE PRODUCT 0
DEPTH TO WATER 6.11'
DATUM ELEVATION (msl) _____
GROUNDWATER ELEVATION (msl) _____
TOTAL WELL DEPTH 17 feet

WATER LEVEL MEASURING EQUIPMENT interface probe
FREE PRODUCT LEVEL MEASURING EQUIPMENT " "
EVACUATION EQUIPMENT PVC A-Bailer
GALLONS TO BE EVACUATED (4 casing vols.) 28
TIME OF EVACUATION START 12:20 FINISH 12:22
TOTAL GALLONS EVACUATED 25

SAMPLING EQUIPMENT Teflon bailer
SAMPLING TIME START 4:35 FINISH 4:36
SAMPLING RATE (ml/min.) _____
APPEARANCE OF SAMPLE (clear water w/ very thin film of gas)

FIELD OBSERVATIONS AND/OR PROBLEMS ENCOUNTERED _____

EQUIPMENT DECONTAMINATION 3 bucket wash - TSP, tap water, distilled water

SAMPLES HAND CARRIED/SHIPPED ON 2-19-88 AT _____
(date) (time)

VIA _____ TO Central Coast analytical
(carrier and shipper's number) laboratory

FOR ANALYSIS OF FF.

GROUNDWATER SAMPLE
FIELD LOG

PROJECT NAME Thrifty Oil #54
LOCATION Castro Valley
WELL NUMBER RF 3

SAMPLE:
WELL RF 3
SURFACE WATER _____
SEEP _____
OTHER (DESCRIBE) _____

SAMPLER Duette Dunaway

DATE OF SAMPLING 2-16-88
WEATHER CONDITIONS Sunny
DEPTH TO FREE PRODUCT 2'
DEPTH TO WATER 7.23'
DATUM ELEVATION (msl) _____
GROUNDWATER ELEVATION (msl) _____
TOTAL WELL DEPTH 20 feet

WATER LEVEL MEASURING EQUIPMENT interface probe

FREE PRODUCT LEVEL MEASURING EQUIPMENT "

EVACUATION EQUIPMENT pvc Bailer

GALLONS TO BE EVACUATED (4 casing vols.) 33.6

TIME OF EVACUATION START 11:58 FINISH 12:08

TOTAL GALLONS EVACUATED 25 (23 casing volumes)

SAMPLING EQUIPMENT teflon Bailer

SAMPLING TIME START 3:28 p FINISH 3:29 p

SAMPLING RATE (ml/min.) _____

APPEARANCE OF SAMPLE clear

FIELD OBSERVATIONS AND/OR PROBLEMS ENCOUNTERED _____

EQUIPMENT DECONTAMINATION 3 buckets wash - TSP, trip into tank, flushed water

SAMPLES HAND CARRIED/SHIPPED ON 2-19-88 AT _____
(date) (time)

VIA _____ TO Central Coast analytical
(carrier and shipper's number) laboratory

FOR ANALYSIS OF Fuel Fingerprint

GROUNDWATER SAMPLE
FIELD LOG

PROJECT NAME Thrifty Oil #54
LOCATION Castro Valley
WELL NUMBER RB. 4

SAMPLE:
WELL RB 4
SURFACE WATER _____
SEEP _____
OTHER (DESCRIBE) _____

SAMPLER Dorette Runaway

DATE OF SAMPLING 2-18-88
WEATHER CONDITIONS Sunny
DEPTH TO FREE PRODUCT 0
DEPTH TO WATER 7.15
DATUM ELEVATION (msl) _____
GROUNDWATER ELEVATION (msl) _____
TOTAL WELL DEPTH 15'

WATER LEVEL MEASURING EQUIPMENT interface probe
FREE PRODUCT LEVEL MEASURING EQUIPMENT " "
EVACUATION EQUIPMENT PVC bailer
GALLONS TO BE EVACUATED (4 casing vols.) 21
TIME OF EVACUATION START 2:40 FINISH 2:45
TOTAL GALLONS EVACUATED 20 gals

SAMPLING EQUIPMENT teflon bailer
SAMPLING TIME START 9:59 FINISH 10:00
SAMPLING RATE (ml/min.) _____
APPEARANCE OF SAMPLE Very clear

FIELD OBSERVATIONS AND/OR PROBLEMS ENCOUNTERED _____

EQUIPMENT DECONTAMINATION 3-bucket wash - TSP, tap water, distilled water

SAMPLES HAND CARRIED/SHIPPED ON 2-19-88 AT _____
(date) (time)

VIA _____ TO Central Coast Analytical
(carrier and shipper's number) laboratory

FOR ANALYSIS OF P.F.

GROUNDWATER SAMPLE
FIELD LOG

PROJECT NAME Thrifty Oil #54
LOCATION Castro Valley
WELL NUMBER RG 5

SAMPLE:
WELL RG 5
SURFACE WATER _____
SEEP _____
OTHER (DESCRIBE) _____

SAMPLER Donette Dunning
DATE OF SAMPLING 2-18-88
WEATHER CONDITIONS Sunny
DEPTH TO FREE PRODUCT 20
DEPTH TO WATER 6' 80"
DATUM ELEVATION (msl) _____
GROUNDWATER ELEVATION (msl) _____
TOTAL WELL DEPTH 20'

WATER LEVEL MEASURING EQUIPMENT interface probe
FREE PRODUCT LEVEL MEASURING EQUIPMENT _____
EVACUATION EQUIPMENT PVC bailer
GALLONS TO BE EVACUATED (4 casing vols.) 35
TIME OF EVACUATION START 2:50 FINISH 2:55
TOTAL GALLONS EVACUATED 20 gals (22% casing volumes)

SAMPLING EQUIPMENT teflon bailer
SAMPLING TIME START 9:53 FINISH 9:54
SAMPLING RATE (ml/min.) _____
APPEARANCE OF SAMPLE very clear

FIELD OBSERVATIONS AND/OR PROBLEMS ENCOUNTERED _____

EQUIPMENT DECONTAMINATION: 3 bucket wash - TSP, tap water, distilled water

SAMPLES HAND CARRIED / SHIPPED ON 2-19-88 AT _____
(date) (time)

VIA _____ TO Central Coast analytical
(carrier and shipper's number) laboratory

FOR ANALYSIS OF FF

GROUNDWATER SAMPLE
FIELD LOG

PROJECT NAME Thifty 54
LOCATION Castro Valley
WELL NUMBER RE 6

SAMPLE:
WELL RE 6
SURFACE WATER _____
SEEP _____
OTHER (DESCRIBE) _____

SAMPLER Don. the Dunaway

DATE OF SAMPLING 2-18-88
WEATHER CONDITIONS Sunny
DEPTH TO FREE PRODUCT 0
DEPTH TO WATER 8.08
DATUM ELEVATION (msl) _____
GROUNDWATER ELEVATION (msl) _____
TOTAL WELL DEPTH 13' 8" - was built (supposedly) 15'

WATER LEVEL MEASURING EQUIPMENT interface probe

FREE PRODUCT LEVEL MEASURING EQUIPMENT " "

EVACUATION EQUIPMENT PVC bailer

GALLONS TO BE EVACUATED (4 casing vols.) 15

TIME OF EVACUATION START 8:35 FINISH 8:40

TOTAL GALLONS EVACUATED 10 gals (- 2 2/3 casing volumes)

SAMPLING EQUIPMENT tepton bailer

SAMPLING TIME START 2:00 FINISH 2:01

SAMPLING RATE (ml/min.) _____

APPEARANCE OF SAMPLE very clear

FIELD OBSERVATIONS AND/OR PROBLEMS ENCOUNTERED _____

EQUIPMENT DECONTAMINATION 3 bucket wash - TSP, ~~dist~~ tap water, distilled water

SAMPLES HAND CARRIED SHIPPED ON 2-19-88 AT _____
(date) (time)

VIA _____ TO Central Coast analyst.
(carrier and shipper's number) laboratory

FOR ANALYSIS OF FF

GROUNDWATER SAMPLE
FIELD LOG

PROJECT NAME Thimble # 54
LOCATION Castro Valley
WELL NUMBER RE 7

SAMPLE:
WELL RE 7
SURFACE WATER _____
SEEP _____
OTHER (DESCRIBE) _____

SAMPLER D. D. Duran

DATE OF SAMPLING 2-18-88
WEATHER CONDITIONS Sunny
DEPTH TO FREE PRODUCT _____
DEPTH TO WATER 11.83
DATUM ELEVATION (msl) _____
GROUNDWATER ELEVATION (msl) _____
TOTAL WELL DEPTH Built 15' - is 13.5' deep now

WATER LEVEL MEASURING EQUIPMENT interface probe
FREE PRODUCT LEVEL MEASURING EQUIPMENT _____
EVACUATION EQUIPMENT PVC bailer
GALLONS TO BE EVACUATED (4 casing vols.) 8.13
TIME OF EVACUATION START 8:25 FINISH 8:30
TOTAL GALLONS EVACUATED 5 gals. (2 1/2 casing volumes)

SAMPLING EQUIPMENT teflon bailer
SAMPLING TIME START 1:55 FINISH 1:58
SAMPLING RATE (ml/min.) _____
APPEARANCE OF SAMPLE clear (very clear)

FIELD OBSERVATIONS AND/OR PROBLEMS ENCOUNTERED _____

EQUIPMENT DECONTAMINATION 3 bucket wash - TSP, tap water, distilled water

SAMPLES HAND CARRIED/SHIPPED ON 2-19-88 AT _____
(date) (time)

VIA _____ TO Central Coast analyt.
(carrier and shipper's number) laboratory

FOR ANALYSIS OF FF

True Elevation Survey

Thrifty Oil Station No. 054 - Castro Valley
February 16, 1988

Elevation		1st	2nd	Difference
165.89'	Surveying Point*	6.005	5.96	
166.92'	RE-1	4.978	4.93	+1.03
167.09'	RE-2	4.809	4.78	+1.2
167.47'	RE-3	4.429	4.39	+1.58
166.89'	RE-4	5.012	4.95	+1.0
167.10'	RE-5	4.800	4.79	+1.21
166.54'	RE-6	5.359	5.31	+0.65
165.88'	RE-7	6.015	5.97	-0.01
166.36'	PW-1	5.540	5.50	+0.47
166.06'	PW-2	5.842	5.78	+0.17

APPENDIX C

Official Laboratory Results and
Discussion of Analytical Methods

RECEIVED MAR 24 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0627
Collected: 02/15/88
Received: 02/19/88 @ 1500
Tested: 02/22/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-1 @ 5 Feet,
Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.1	10.
Toluene	0.1	92.
Ethylbenzene	0.1	27.
Xylenes	0.1	180.
1,2-Dichloroethane (EDC)	0.1	not found
Ethylene Dibromide (EDB)	0.1	not found
Naphthalene	0.1	1.4
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		1000.
BTX as a Percent of Fuel		28.
Percent Surrogate Recovery		102.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD #2
GB0627fd.wr1/204
MH/t1/vg/sc

RECEIVED MAR 24 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0628
Collected: 02/16/88
Received: 02/19/88 @ 1500
Tested: 02/22/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-1 @ 10 Feet,
Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.001	0.016
Toluene	0.001	0.003
Ethylbenzene	0.001	not found
Xylenes	0.001	0.005
1,2-Dichloroethane (EDC)	0.001	not found
Ethylene Dibromide (EDB)	0.001	not found
Naphthalene	0.001	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		<0.1
BTX as a Percent of Fuel		not applicable
Percent Surrogate Recovery		87.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD #2
GB0628f.wr1/204
MH/sw/vg/sc

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0630
Collected: 02/16/88
Received: 02/19/88 @ 1500
Tested: 02/25/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/0240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-2 at 10.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.01	0.02
Toluene	0.01	0.02
Ethylbenzene	0.01	0.75
Xylenes	0.01	0.14
1,2-Dichloroethane (EDC)	0.01	not found
Ethylene Dibromide (EDB)	0.01	not found
Naphthalene	0.01	0.03
TOTAL PURGEABLE PETROLEUM HYDROCARBONS 1. (WEATHERED GASOLINE)		130.
BTX as a Percent of Fuel		0.1
Percent Surrogate Recovery		85.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
GB0630f.wr1/206
MH/gh/ec/vg/rh

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GD-0631
Collected: 02/14/88
Received: 02/19/88 @ 1500
Tested: 02/22/88
Collected by: D. Dunaway

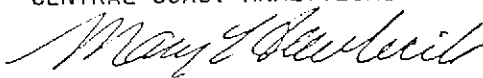
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-3 at 5.0'
Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.5	5.3
Toluene	0.5	22.
Ethylbenzene	0.5	7.8
Xylenes	0.5	82.
1,2-Dichloroethane (EDC)	0.5	not found
Ethylene Dibromide (EDB)	0.5	not found
Naphthalene	0.5	1.1
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	50.	490.
BTX as a Percent of Fuel		22.
Percent Surrogate Recovery		74.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES



Mary Havlicek, Ph.D.
President

MSD#3
GB0631f.wr1/203
MH/sw/vg/rh

RECEIVED Feb 24 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0631dup
Collected: 02/14/88
Received: 02/19/88 @ 1500
Tested: 02/22/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-3 at 5.0'
Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.1	3.3
Toluene	0.1	13.
Ethylbenzene	0.1	4.7
Xylenes	0.1	48.
1,2-Dichloroethane (EDC)	0.1	not found
Ethylene Dibromide (EDB)	0.1	not found
Naphthalene	0.1	0.6
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		260.
BTX as a Percent of Fuel		25.
Percent Surrogate Recovery		97.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
GB0631fd.wr1/203
MH/tl/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0632
Collected: 02/14/88
Received: 02/19/88 @ 1500
Tested: 02/22/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/B240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-3 at 10.0'
Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.001	0.014
Toluene	0.001	0.010
Ethylbenzene	0.001	not found
Xylenes	0.001	0.013
1,2-Dichloroethane (EDC)	0.001	not found
Ethylene Dibromide (EDB)	0.001	not found
Naphthalene	0.001	0.003
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	0.1	0.1
BTX as a Percent of Fuel		37.
Percent Surrogate Recovery		93.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
GB0632f.wr1/203
MH/tl/vg/rh

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0633
Collected: 02/16/88
Received: 02/19/88 @ 1500
Tested: 02/25/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-4 at 5.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	1.	13.
Toluene	1.	120.
Ethylbenzene	1.	44.
Xylenes	1.	410.
1,2-Dichloroethane (EDC)	1.	not found
Ethylene Dibromide (EDB)	1.	not found
Naphthalene	1.	7.
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		1900.
BTX as a Percent of Fuel		29.
Percent Surrogate Recovery		101.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#2
03-02-88
GB0633f.wr1/207
MH/gh/vg/rh

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0634
Collected: 02/16/88
Received: 02/19/88 @ 1500
Tested: 02/25/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/0240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-4 at 10.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.005	0.057
Toluene	0.005	0.020
Ethylbenzene	0.005	0.013
Xylenes	0.005	0.13
1,2-Dichloroethane (EDC)	0.005	not found
Ethylene Dibromide (EDB)	0.005	not found
Naphthalene	0.005	0.009
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (WEATHERED GASOLINE)	0.1	7.7
BTX as a Percent of Fuel		2.7
Percent Surrogate Recovery		87.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0634f.wr1/206
MH/gh/ec/vg/rh

RECEIVED MAR 24 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0635
Collected: 02/17/88
Received: 02/19/88 @ 1500
Tested: 03/04/88
Collected by: D. Dunaway

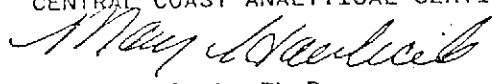
Fuel Fingerprint Analysis - EPA Method 524.2/0240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-5 at 5.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.001	0.36
Toluene	0.001	0.036
Ethylbenzene	0.001	0.029
Xylenes	0.001	0.14
1,2-Dichloroethane (EDC)	0.001	not found
Ethylene Dibromide (EDB)	0.001	not found
Naphthalene	0.001	0.001
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		17.
BTX as a Percent of Fuel		3.2
Percent Surrogate Recovery		86.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES



Mary Havlicek, Ph.D.
President

MSD#3
GB0635f.wr1/207
MH/gh/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0636
Collected: 02/17/88
Received: 02/19/88 @ 1500
Tested: 02/25/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/0240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-5 at 10.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.005	0.008
Toluene	0.005	not found
Ethylbenzene	0.005	0.007
Xylenes	0.005	0.017
1,2-Dichloroethane (EDC)	0.005	not found
Ethylene Dibromide (EDB)	0.005	not found
Naphthalene	0.005	0.019
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (WEATHERED GASOLINE)		13.
BTX as a Percent of Fuel		0.2
Percent Surrogate Recovery		96.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0636f.wr1/206
MH/tl/vg/rh

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0637
Collected: 02/17/88
Received: 02/19/88 @ 1500
Tested: 03/04/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-6 at 5.0', Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.001	0.033
Toluene	0.001	0.003
Ethylbenzene	0.001	0.010
Xylenes	0.001	0.025
1,2-Dichloroethane (EDC)	0.001	not found
Ethylene Dibromide (EDB)	0.001	not found
Naphthalene	0.001	0.002
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		1.2
BTX as a Percent of Fuel		5.1
Percent Surrogate Recovery		98.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
GB0637f.wr1/209
MH/jk/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0638
Collected: 02/17/88
Received: 02/19/88 @ 1500
Tested: 02/25/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-6 at 10.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.001	0.025
Toluene	0.001	0.002
Ethylbenzene	0.001	0.004
Xylenes	0.001	0.005
1,2-Dichloroethane (EDC)	0.001	not found
Ethylene Dibromide (EDB)	0.001	not found
Naphthalene	0.001	0.003
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (WEATHERED GAS)		0.6
BTX as a Percent of Fuel		5.3
Percent Surrogate Recovery		101.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
GB0638f.wr1/206
MH/tl/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0638dup
Collected: 02/17/88
Received: 02/19/88 @ 1500
Tested: 03/01/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-6 at 10.0' Soil
Duplicate

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.001	0.011
Toluene	0.001	0.001
Ethylbenzene	0.001	0.003
Xylenes	0.001	0.005
1,2-Dichloroethane (EDC)	0.001	not found
Ethylene Dibromide (EDB)	0.001	not found
Naphthalene	0.001	0.002
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (WEATHERED GASOLINE)		0.5
BTX as a Percent of Fuel		3.4
Percent Surrogate Recovery		91.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
GB0638f.wr1/208
MH/tl/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0640
Collected: 02/17/88
Received: 02/19/88 @ 1500
Tested: 02/25/88
Collected by:

Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-7 at 5.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.1	1.3
Toluene	0.1	2.9
Ethylbenzene	0.1	0.6
Xylenes	0.1	7.0
1,2-Dichloroethane (EDC)	0.1	not found
Ethylene Dibromide (EDB)	0.1	not found
Naphthalene	0.1	0.3
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		50.
BTX as a Percent of Fuel		22.
Percent Surrogate Recovery		98.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0640f.wr1/206
MH/sw/vg/rh

RECEIVED MAR 24 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0639
Collected: 02/17/88
Received: 02/19/88 @ 1500
Tested: 02/25/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-7 at 10.0' Soil

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.01	0.57
Toluene	0.01	0.05
Ethylbenzene	0.01	0.08
Xylenes	0.01	0.37
1,2-Dichloroethane (EDC)	0.01	not found
Ethylene Dibromide (EDB)	0.01	not found
Naphthalene	0.01	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (WEATHERED GASOLINE)	1.	110.
BTX as a Percent of Fuel		0.9
Percent Surrogate Recovery		97.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#2
03-02-88
GB0639f.wr1/207
MH/t1/vg/rh

RECEIVED 02/24/88

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0641
Collected: 02/16/88
Received: 02/19/88 @ 1500
Tested: 02/24/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-1, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.05	1.9
Toluene	0.05	8.4
Ethylbenzene	0.05	1.2
Xylenes	0.05	15.
1,2-Dichloroethane (EDC)	0.05	not found
Ethylene Dibromide (EDB)	0.05	not found
Naphthalene	0.05	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	5.	37.
BTX as a Percent of Fuel		68.
Percent Surrogate Recovery		89.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0641f.wr1/205
MH/gh/vg/rh

RECEIVED MAR 24 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0642
Collected: 02/16/88
Received: 02/19/88 @ 1500
Tested: 02/24/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/0240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-3, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.5	6.6
Toluene	0.5	5.3
Ethylbenzene	0.5	0.8
Xylenes	0.5	13.
1,2-Dichloroethane (EDC)	0.5	not found
Ethylene Dibromide (EDB)	0.5	not found
Naphthalene	0.5	0.7
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	50.	70.
BTX as a Percent of Fuel		36.
Percent Surrogate Recovery		95.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0642f.wr1/205
MH/jc/vg/rh

RECEIVED Jan 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0641
Collected: 02/18/88
Received: 02/19/88 @ 1500
Tested: 02/24/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-4, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	1.	12.
Toluene	1.	8.
Ethylbenzene	1.	1.
Xylenes	1.	27.
1,2-Dichloroethane (EDC)	1.	not found
Ethylene Dibromide (EDB)	1.	not found
Naphthalene	1.	3.
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	50.	150.
BTX as a Percent of Fuel		31.
Percent Surrogate Recovery		107.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0643fd.wr1/205
MH/gh/vg/rh

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0643
Collected: 02/18/88
Received: 02/19/88 @ 1500
Tested: 03/08/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-4, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.5	8.7
Toluene	0.5	5.9
Ethylbenzene	0.5	1.1
Xylenes	0.5	10.
1,2-Dichloroethane (EDC)	0.5	not found
Ethylene Dibromide (EDB)	0.5	not found
Naphthalene	0.5	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		70.
BTX as a Percent of Fuel		35.
Percent Surrogate Recovery		127.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0643f.wr1/210
MH/sw/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0644
Collected: 02/18/88
Received: 02/19/88 @ 1500
Tested: 02/24/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/0240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-5, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.1	1.3
Toluene	0.1	1.1
Ethylbenzene	0.1	0.1
Xylenes	0.1	2.6
1,2-Dichloroethane (EDC)	0.1	not found
Ethylene Dibromide (EDB)	0.1	not found
Naphthalene	0.1	0.1
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	5.	14.
BTX as a Percent of Fuel		36.
Percent Surrogate Recovery		95.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
GB0644f.wr1/205
MH/tl/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0645
Collected: 02/18/88
Received: 02/19/88 @ 1500
Tested: 02/24/88
Collected by: D. Dunaway
Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-6, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.05	2.6
Toluene	0.05	0.05
Ethylbenzene	0.05	0.05
Xylenes	0.05	0.25
1,2-Dichloroethane (EDC)	0.05	not found
Ethylene Dibromide (EDB)	0.05	not found
Naphthalene	0.05	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS 5. (GASOLINE)		<5.
BTX as a Percent of Fuel		not applicable
Percent Surrogate Recovery		101.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0645f.wr1/206
MH/jc/vg/rh

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0645dup
Collected: 02/18/88
Received: 02/19/88 @ 1500
Tested: 02/24/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-6, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.01	3.0
Toluene	0.01	0.04
Ethylbenzene	0.01	0.08
Xylenes	0.01	0.14
1,2-Dichloroethane (EDC)	0.01	not found
Ethylene Dibromide (EDB)	0.01	not found
Naphthalene	0.01	0.02
TOTAL PURGEABLE PETROLEUM HYDROCARBONS 1. (GASOLINE)		6.
BTX as a Percent of Fuel		53.
Percent Surrogate Recovery		94.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0645fd.wr1/206
MH/jc/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: GB-0646
Collected: 02/18/88
Received: 02/19/88 @ 1500
Tested: 02/24/88
Collected by: D. Dunaway

Fuel Fingerprint Analysis - EPA Method 524.2/8240

Robert Elbert & Associates
P.O. Box 40180
Santa Barbara, CA 93140-0180

SAMPLE DESCRIPTION:
Thrifty Oil #54, RE-7, Water

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.5	17.
Toluene	0.5	4.4
Ethylbenzene	0.5	0.6
Xylenes	0.5	8.4
1,2-Dichloroethane (EDC)	0.5	not found
Ethylene Dibromide (EDB)	0.5	not found
Naphthalene	0.5	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	50.	<50.
BTX as a Percent of Fuel		not applicable
Percent Surrogate Recovery		117.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
GB0646f.wr1/206
MH/jc/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: B-02228-2
Collected:
Received:
Tested: 02/22/88
Collected by:
Fuel Fingerprint Analysis - EPA Method 524.2/0240

CCAS

SAMPLE DESCRIPTION:
INSTRUMENT BLANK

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.0001	not found
Toluene	0.001	not found
Ethylbenzene	0.001	not found
Xylenes	0.001	not found
1,2-Dichloroethane (EDC)	0.0001	not found
Ethylene Dibromide (EDB)	0.0001	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		<0.05
BTX as a Percent of Fuel		not applicable
Percent Surrogate Recovery		106.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
B02228f2.wr1/203
MH/gh/vg/rh

RECEIVED MAR 2 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: S-02228-5
Collected:
Received:
Tested: 02/22/88
Collected by:

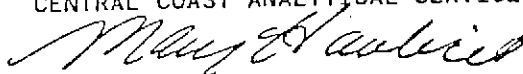
Fuel Fingerprint Analysis - EPA Method 524.2/8240

CCAS

SAMPLE DESCRIPTION:
STD.1/2X (#022288-4) BTE & EDC @ 0.020 ppm
Xylenes @ 0.060 ppm

Compound Analyzed	Detection Limit in ppm	Concentration w/spike in ppm	Percent Recovery
Benzene	0.001	0.017	85.
Toluene	0.001	0.016	80.
Ethylbenzene	0.001	0.015	75.
Xylenes	0.001	0.045	75.
1,2-Dichloroethane (EDC)	0.001	0.013	65.
Ethylene Dibromide (EDB)	0.001	not spiked	
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE) 0.1			not applicable
BTX as a Percent of Fuel			not applicable
Percent Surrogate Recovery			111.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES



Mary Havlicek, Ph.D.
President

MSD#3
S02228f5.wr1/203
MH/tl/vg/rh

Central Coast Analytical Services, Inc.
 141 Suburban Road, Suite C-4
 San Luis Obispo, California 93401
 (805) 543-2553

Lab Number : B-02258
 Collected :
 Received :
 Tested : 02/25/88
 Collected by:

CCAS

EPA METHOD 524.2
 Sample Description:
 INSTRUMENT BLANK @ 10:26 a.m.

Compound Analyzed	Detection Limit (ug/l)	Concentration (ug/l)
Benzene	0.1	not found
Bromodichloromethane	0.1	not found
Bromoform	0.2	not found
Carbon Tetrachloride	0.1	not found
Chlorobenzene	0.1	not found
2-Chloroethyl Vinyl Ether	1.	not found
Chloroform	0.5	not found
Dibromochloromethane	0.1	not found
1,2-Dichlorobenzene	0.1	not found
1,3-Dichlorobenzene	0.1	not found
1,4-Dichlorobenzene	0.1	not found
1,1-Dichloroethane	0.1	not found
1,2-Dichloroethane (EDC)	0.1	not found
1,1-Dichloroethene	0.1	not found
c-1,2-Dichloroethene	0.1	not found
t-1,2-Dichloroethene	0.1	not found
1,2-Dichloropropane	0.1	not found
c-1,3-Dichloropropene	0.1	not found
t-1,3-Dichloropropene	0.1	not found
Ethylbenzene	0.1	not found
Ethyl Chloride	0.1	not found
Methyl Bromide	0.1	not found
Methyl Chloride	0.1	not found
Methylene Chloride	1.	not found
1,1,2,2-Tetrachloroethane	0.5	not found
Tetrachloroethylene (PCE)	0.1	not found
Toluene	0.1	not found
1,1,1-Trichloroethane (TCA)	0.1	not found
1,1,2-Trichloroethane	0.1	not found
Trichloroethene (TCE)	0.1	not found
Trichlorotrifluoroethane (f113)	0.1	not found
Trichlorofluoromethane(F-11)	0.5	not found
Vinyl Chloride	0.1	not found
Xylenes	0.2	not found

Percent Recoveries of Sample-Specific Quality Assurance Spikes are: 103/97/78.

MSD#2
 03-02-88
 B02258v.wr1/255
 MH/gh/vg/rh

Respectfully submitted,
 CENTRAL COAST ANALYTICAL SERVICES
Mary D. Havlicek
 Mary D. Havlicek, Ph.D., President

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: S-02248-2
Collected by:
Received:
Tested: 02/24/88
Collected by:

Fuel Fingerprint Analysis - EPA Method 524.2/8240

CCAS

SAMPLE DESCRIPTION:
STD.1/2X (#022488-5) BTE & EDC @ 0.020 ppm
Xylenes @ 0.060 ppm

Compound Analyzed	Detection Limit in ppm	Concentration in ppm	Percent Recovery
Benzene	0.001	0.018	90.
Toluene	0.001	0.014	70.
Ethylbenzene	0.001	0.015	75.
Xylenes	0.001	0.062	103.
1,2-Dichloroethane (EDC)	0.001	0.017	85.
Ethylene Dibromide (EDB)	0.001	not spiked	--

TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)	0.1	not applicable	

BTX as a Percent of Fuel		not applicable	
Percent Surrogate Recovery		106.	
=====			

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
S02248f2.wr1/205
MH/jc/vg/rh

RECEIVED MAR 2 1 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: S-03088-2
Collected:
Received:
Tested: 03/08/88
Collected by:
Fuel Fingerprint Analysis - EPA Method 524.2/8240

CCAS

SAMPLE DESCRIPTION:
STD.1/2X (#030888-9) BTE & EDC @ 0.020 ppm
Xylenes @ 0.060 ppm

Compound Analyzed	Detection Limit in ppm	Concentration w/spike in ppm	Percent Recovery
Benzene	0.001	0.022	110.
Toluene	0.001	0.019	95.
Ethylbenzene	0.001	0.018	90.
Xylenes	0.001	0.053	88.
1,2-Dichloroethane (EDC)	0.001	0.020	100.
Ethylene Dibromide (EDB)	0.001	not spiked	
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		0.1	not applicable
BTX as a Percent of Fuel			not applicable
Percent Surrogate Recovery			110.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES
Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
S03088f2.wr1/209
MH/sw/vg/rh

RECEIVED MAR 21 1988

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: B-03008
Collected:
Received:
Tested: 03/08/88
Collected by:
Fuel Fingerprint Analysis - EPA Method 524.2/8240

CCAS

SAMPLE DESCRIPTION:
INSTRUMENT BLANK

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.0001	not found
Toluene	0.001	not found
Ethylbenzene	0.001	not found
Xylenes	0.001	not found
1,2-Dichloroethane (EDC)	0.0001	not found
Ethylene Dibromide (EDB)	0.0001	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (GASOLINE)		<0.05
BTX as a Percent of Fuel		not applicable
Percent Surrogate Recovery		130.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek

Mary Havlicek, Ph.D.
President

MSD#3
B03088f.wr1/209
MH/gh/vg/rh

Central
Coast
Analytical
Services

Central Coast
Analytical Services, Inc.
141 Suburban Road, Suite C-4
San Luis Obispo, California 93401
(805) 543-2553

Lab Number: S-03088-4
Collected:
Received:
Tested: 03/08/88
Collected by:
Fuel Fingerprint Analysis - EPA Method 524.2/8240

CCAS

SAMPLE DESCRIPTION:
DIESEL #2 STD. (#030888-12)

Compound Analyzed	Detection Limit in ppm	Concentration in ppm
Benzene	0.0001	not found
Toluene	0.001	not found
Ethylbenzene	0.001	not found
Xylenes	0.001	0.002
1,2-Dichloroethane (EDC)	0.0001	not found
Ethylene Dibromide (EDB)	0.0001	not found
TOTAL PURGEABLE PETROLEUM HYDROCARBONS (DIESEL #2)	0.05	0.78
BTX as a Percent of Fuel		0.3
Percent Surrogate Recovery		104.

Respectfully submitted,
CENTRAL COAST ANALYTICAL SERVICES

Mary Havlicek
Mary Havlicek, Ph.D.
President

MSD#3
S03088f4.wr1/210
MH/sw/vg/rh

Central
Coast
Analytical
Services

Air, Water, & Hazardous Waste
Sampling, Analysis, & Consultation
State Certified Hazardous Waste,
Chemistry, & Bacteriology Laboratory

RECEIVED JAN 19 1988

141 Suburban Road, Suite C-4
San Luis Obispo, Ca 93401
(805) 543-2553 Fax (805) 543-2685

6483-D Calle Real
Goleta, CA 93117
(805) 964-7838

CHARACTERIZATION OF FUEL SPILLS

STEPHEN C. HAVLICEK, Ph.D.,
VICE PRESIDENT
CENTRAL COAST ANALYTICAL SERVICES, INC.

Fuels are highly complex mixtures of hydrocarbons which often contain more than a hundred identifiable components. Gasolines are characterized by their lower boiling range and by their aliphatic and aromatic hydrocarbon distributions. These, together with the presence or absence of lead and ethylene dibromide serve to distinguish between leaded and unleaded gasoline. CENTRAL COAST ANALYTICAL SERVICES, INC., has modern instrumentation which can even distinguish between different brands of leaded or unleaded gasoline PROVIDING the samples have not been extensively weathered. The term "weathered" pertains to exposure to ground, water, or the atmosphere.

Spilled gasoline will undergo changes in its component distribution pattern of "fuel fingerprint" as it moves through the soil. Volatiles may be preferentially lost near the surface. Aromatics and lower molecular weight hydrocarbons will travel further through the soil than higher molecular weight, less soluble components. Soil microorganisms degrade aliphatics, aromatics and alicyclics at different rates, thereby further altering the fingerprints. If the gasoline should come in contact with groundwater, additional fractionation based on solubility differences will take place.

Diesel fuel, kerosene, aviation fuel and related materials also exhibit characteristic fuel fingerprints. These undergo similar changes in their distribution of components as the fuels migrate through the soil following a spill.

CENTRAL COAST ANALYTICAL SERVICES, INC., provides septum sealed vials free of charge to clients interested in collecting their own samples for fuel fingerprint analysis. Soils may be sampled by immediately transferring about 1/4 vial of soil to the vial as it is collected, sealing the cap and refrigerating in the field. Another technique which works well is the collection of soil cores in metallic Shelby tubes or brass rings and covering the ends with Teflon sheeting prior to emplacing a snugly-fitting plastic cap. The whole core is frozen or refrigerated in the field. Once in the laboratory, subsamples may be removed and analyzed by a variation of the purge-and-trap gas chromatographic technique.

Water samples are collected by completely filling the vials which contain an acid preservative, sealing, checking for bubbles and refilling and resealing if bubbles are present, then placing the filled vials into plastic guard bottles which contain activated charcoal. The guard bottles which contain the filled vials are then refrigerated (NOT FROZEN) in the field. Analysis is performed using EPA Method 624/8240 and compared to a standard containing an appropriate fuel.

When free product is available, some of that should be sampled and submitted in a septum-sealed vial which is then placed in a guard bottle. The laboratory should be instructed to use the free product for the standard used to quantitate the fuel in the samples.

During the initial stages of an investigation, it is recommended that samples be taken at several depths to groundwater. If it is unclear whether or not groundwater has been contaminated, we recommend drilling be stopped if strong petroleum odors are encountered. In the later stages of an investigation, drilling may be continued in such cases PROVIDING that precautions are taken to ensure that contamination will not follow the path of the drill as it passed through the contaminated zone.

Oversampling followed by selected sample analysis is recommended. This strategy allows the laboratory to zero in on meaningful samples while avoiding costly resampling. CENTRAL COAST ANALYTICAL SERVICES, INC. employs both flame ionization (FID) gas chromatography and selected ion GC/MS to obtain fuel fingerprints. We prefer the latter since it gives information about the distribution of aliphatic and aromatic hydrocarbons which is not available by FID. Both techniques are sufficiently sensitive to detect spilled fuels at sub part per million levels.

COMMENTS REGARDING EPA METHODS 8015, 8020, 8240 & 8270

EPA apparently has included this method in SW-846 to provide guidance for the determination of potentially hazardous materials which do not respond well to electron-capture detection (ECD), photoionization detection (PID) or halogen-selective detection (HALL). Since the flame ionization detector (FID) employed by EPA 8015 is both sensitive and non-selective, most organic compounds listed will produce a strong signal. Therefore, acrylamide, carbon disulfide, diethyl ether, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), and paraldehyde which are the compounds listed in EPA 8015 can readily be detected using this method. Furthermore, the FID is sufficiently nonselective to permit extension of the method to a host of other materials.

In many commercial laboratories, fuels are determined by pattern comparison using gas chromatography with flame ionization detection (GC/FID) using an adaptation of EPA Method 8015. Samples containing volatile analytes may be introduced to the gas chromatograph by direct injection, headspace (EPA Method 5020) or purge-and-trap (EPA Method 5030). When used in this way, EPA Method 8015 can be used to characterize gasoline, diesel #2, jet fuel, aviation gas, Stoddard solvent and other volatile hydrocarbon distillates. The results may be expressed in terms of "ppm gasoline", "ppm total petroleum hydrocarbon (TPH)" or some other

appropriate description. The analysis is described as a "TPH", a "fuel characterization analysis", or a "fuel fingerprint". A column substitution is usually made as even the volatile fuels contain some components requiring temperatures beyond the maxima permitted for the columns specified in EPA Method 8015.

When semivolatile fuels or analytes are to be determined, the FID and EPA Method 8015 may still be employed. In such cases, the sample may be introduced by direct injection, prepared for analysis by liquid-liquid extraction (EPA Method 3510), sonication (EPA Method 3550) or Soxhlet extraction (EPA Method 3540). Following extract concentration, an aliquot of the concentrate is subjected to gas chromatographic separation followed by flame ionization detection. This variation of EPA Method 8015 is often used for the analysis of diesel #4, crude oil, bunker fuel and fuel oil #6. It is sometimes used for the analysis of diesel #2 and even gasoline, although much of the gasoline components are lost during the concentration step. This type of analysis is often described as a TPH (Total Petroleum Hydrocarbon) analysis. When doing this type of analysis, CCAS refers to the results as Total Semivolatile Petroleum Hydrocarbons and lists the fuel used as a standard for quantifying the material. CCAS uses standards which are provided by the client or which resemble the samples' chromatographic pattern.

While CCAS is capable of performing all of the aforementioned variations of EPA 8015, our recommended approaches to the analysis of nonhalogenated volatile organics, volatile fuels and in some cases, even semivolatile fuels are based upon GC/MS as outlined in EPA Methods 8240 and 8270. If techniques such as cryogenic focussing, selected ion monitoring, capillary column chromatography and direct column-to-mass spectrometer source interfacing are incorporated into the basic 8240/8270 protocols, the required 1 ppb sensitivities can be reached easily. Since the mass spectrometer is the most selective detector available, interferences and misassignments are reduced dramatically. Of the six compounds listed in EPA Method 8015, CCAS has applied GC/MS successfully to all of them. Detection limits of 0.1 ppb have been obtained without using selective ion monitoring. These results are on file with the California Department of Health Services (Hazardous Waste Certification and Drinking Water Certification Branches).

At the time at which EPA methods were being developed, economical, automated GC/MS instrumentation was not widely available. For this reason, GC/MS was considered to be too costly to serve as a practical alternative to EPA Method 8015 and such selective detector methods and EPA 8010 and 8020. Recently instrument costs have fallen to the point that a GC/MS system can be purchased for little more than double that of a comparable gas chromatograph. Moreover, positive results obtained using selective detection gas chromatography are subject to confirmation using another column (rerunning the test again) or by using GC/MS. (See letter written by Dr. Fred Seto of the California Department of Health Services dated June 8, 1987, which is attached.) Practical improvements in automation have further improved the cost-effectiveness of GC/MS so that some jobs can now be done more economically by GC/MS than by GC, particularly when confirmation is necessary.

For example, the analysis of soils adjacent to a leaking gasoline tank should include a fuel fingerprint to determine the fuel type and the total petroleum hydrocarbons (TPH) and EPA Method 8020 to quantify the benzene, toluene, and xylene (BTX) levels. Furthermore, if leaded fuel is suspected, ethylene dibromide (EDB) should be determined as this compound is often added to gasoline to promote the removal of lead from the engine following combustion. EDB is a priority pollutant which is analyzed by EPA Method 8080.1. CCAS has selected those ions which are characteristic of the aforementioned components from among ions available in the full scan EPA Methods 624/8240. In this way we are able to determine simultaneously the most commonly requested information concerning volatile hydrocarbons in the environment. Furthermore, the cost for this analysis at \$120 in water and \$140 in soil is substantially below the sum of the three separate analyses which would otherwise be required, namely, EPA 8015 @ \$75/100, EPA 8020 @ \$90/120 and EPA 8080.1 @ \$75/100. Moreover, confirmation testing is not required when using GC/MS since it is the method recommended by EPA for confirmation. Thus GC/MS provides better information at a lower overall price.

The GC/MS fuel fingerprint method has been shown to provide even more detailed information in cases in which depth and/or area profiles are involved. Typically one sees a distribution of fuel components with depth which reverses itself once groundwater is reached. EDB, for example, may be found only at the groundwater interface due to its preferential solubility in water. Heavier, biorefractory components are retained by the soil nearer the surface while more mobile components are found at depth. Information of this type serves to validate all sample results obtained in the course of a major investigation using GC/MS methods, yet it is very difficult to obtain all of these data using only EPA Method 8015.

If a gasoline spill is suspected, we recommend analysis for total lead as well as the fuel fingerprint. High levels of lead compared to a background samples, even in the absence of a fuel fingerprint, may indicate that gasoline was spilled in the area but has become degraded by soil microorganisms. This phenomenon is sometimes noted in nearsurface samples.

DEPARTMENT OF HEALTH SERVICES

2151 BERKELEY WAY
BERKELEY, CA 94704

(415) 540-3003



June 8, 1987

Dr. Stephen Havlicek Ph.D.
Central Coast Analytical Services
141 Suburban Road C-4
San Luis Obispo, CA 93401

Dear Dr. Havlicek:

This is to inform you that all laboratories certified by the Department under Health and Safety Code Section 25198 to perform hazardous waste testing are required to use second column or GC/MS confirmation for all positive results in gas chromatographic organic analysis. The only exception is the analysis of Polychlorinated Biphenyls (PCBs).

Except PCBs, all positive results of organic analysis by gas chromatography without confirmation are not acceptable. The department may suspend or revoke a certificate for hazardous waste testing if a laboratory failed to comply with this confirmation requirement.

Sincerely,

Robert D. Stephens
for

Robert D. Stephens, Ph.D., Chief
Hazardous Materials Laboratory

CORRECTION OF WATER TABLE MEASUREMENTS
FOR PRESENCE OF FREE PRODUCT

When free product (gasoline or oil) accumulates in a groundwater well, the measured water level needs to be corrected in order to determine the true water table elevation. The difference in specific gravity between water and the free product causes the water level in the well to be depressed, and the top of the free product to be elevated relative to the true water table elevation.

In addition to determining the depth to water and depth to free product, the specific gravity (SG) of the free product must be measured. Gasoline we have measured usually has a SG of 0.755. The formula for correcting the depth to water is:

$$\text{CDTW} = \text{DTW} - (\text{DFP} - \text{DTW}) (\text{SG})$$

or:

$$\text{CDTW} = \text{DTW} - (\text{T}) (\text{SG})$$

Where:

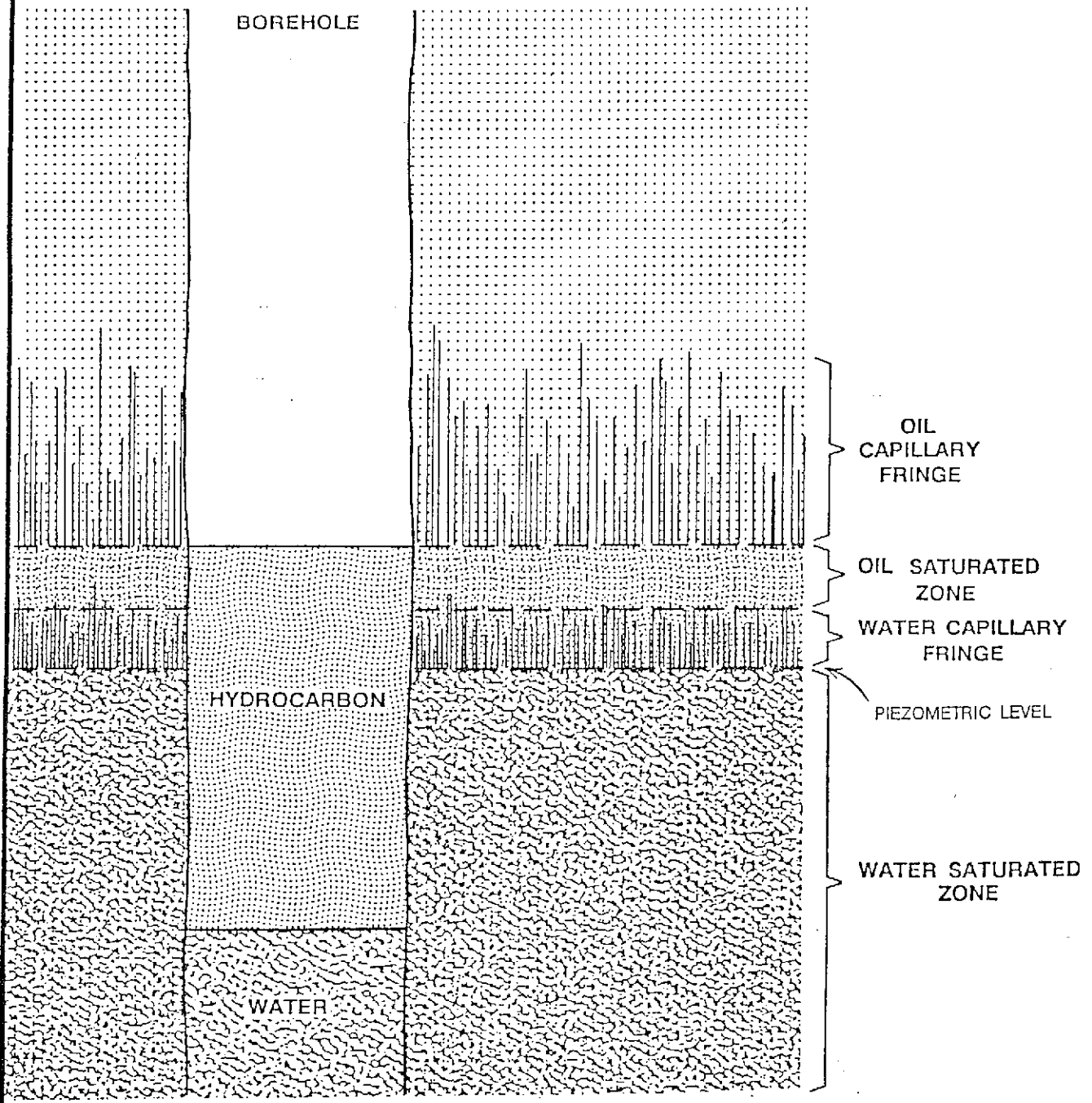
CDTW = Corrected Depth to Water
DFP = Measured Depth to Free Product
DTW = Measured Depth to Water
T = Product Thickness (DFP - DTW)
SG = Specific Gravity

The corrected water table elevation is obtained by subtracting the corrected depth to water from the measuring point elevation.

The hydrocarbon thickness measured in the well does not represent the actual thickness that is present in the formation. In most cases, the thickness of the free product layer in the formation is much smaller than that which accumulates in the well (Blake and Hall, 1984).

This difference is thought to be due to the effect of the interaction of the well with the capillary fringe of the water in the formation. Research has indicated that the free product in the formation is supported by the capillary fringe above the water table due to the immiscibility of oil and water. Installation of a monitoring well, however, destroys the capillary fringe of the water table and essentially creates a macropore in the formation (see figure).

Because the capillary fringe of the water table no longer exists, it doesn't support the free product and the oil or gasoline begins to migrate into the well. As free product depresses the water level in the well, it continues to flow into the well until equilibrium is established. Thus, a greater thickness of free product is measured in the well than actually exists in the formation. The finer grained the sediments, the greater the discrepancy between product thickness in the well and in the formation due to a thicker capillary fringe in finer sediments (Blake and Hall, 1984).



HYDROCARBON THICKNESS IN WELLS