

**A TEST TO ILLUSTRATE THE EFFECTS OF
ECOSAFE™ ON THE MOVEMENT OF OIL IN
CONTAMINATED SOILS**

February 25 - March 1, 2002

Date Published: March 4, 2002

Approved by:



RMOTC Manager

3/4/02
Date

L.M. Jackson

**PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY/ROCKY MOUNTAIN
OILFIELD TESTING CENTER**

**Work Performed Under Rocky Mountain Oilfield
Testing Center (RMOTC) CRADA No. 2002-007**

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Introduction

Petroleum Environmental Technologies, LLC, a Floridian Corporation relocating to Casper, Wyoming, contracted with the Rocky Mountain Oilfield Testing Center (RMOTC) of Casper, Wyoming to conduct a leachate recovery bench test. The test was intended to illustrate the decreased movement of crude oil in soils on which ECOSAFE™ was applied to enhance the degradation of hydrocarbons in contaminated soil and water.

The data presented in this report was collected from February 26, 2002 to March 1, 2002. This report will detail the materials and methods used to conduct the test, test procedures, laboratory results, and conclusions.

Materials and Methods Experimental Design

The procedures detailed in this report were based on earlier bench testing conducted by RMOTC at Naval Petroleum Reserve No. 3 (NPR-3).

To simulate the flow of fluid through the soil, columns were used to hold soil and liquid. Each column was assembled from a 36-inch length of 4-inch diameter clear Schedule 40 PVC pipe. One-half inch holes were drilled at six-inch intervals along each length of pipe; one-half inch pipe plugs were installed in the holes. A one-half inch outlet valve was inserted at the bottom of each column. A PVC cap perforated by two one-half inch holes was placed atop each column.

The columns were set into specially constructed stands and loaded with eight inches of medium grain clean sand covered with twenty-four inches of clean clay-loam dirt. Four inches of headspace was left at the top of each column to allow addition of water and ECOSAFE™ solution. A 1,000-milliliter glass jar was placed below the outlet valve of each column.

Unrefined sweet crude oil (36° API) was collected from an onsite battery at NPR-3.

Experimental Procedure

February 26, 2002

First, a bulk density test was executed on the topsoil to determine its porosity. Bulk density is expressed in grams of soil mass per cubic centimeter of soil volume. This value is used in the equation to calculate the volume of oil to soil ratio to achieve a particular hydrocarbon loading rate.

For each column a 20% total petroleum hydrocarbon loading rate was desired. Therefore, 301.4 in³ of clay-loam soil, with a bulk density of 1.39g/cm³, the volume of oil needed to achieve this loading rate was 1,562 milliliters. The oil and soil mixture was homogenized thoroughly. The equation used to achieve this loading rate is shown below.

$$.20\text{mg/kg} = \frac{x/\text{ml (volume of oil)} \times 315 \text{ lbs/bbl}}{301.4\text{in}^3 \times 1.39 \text{ g/cm}^3 \text{ (bulk density)}}$$

Next, two columns were set side by side. Each column was loaded with 8-inches of fine to medium grain, clean sand followed by 24-inches of the crude oil and clay-loam soil mixture.

Finally, it was determined that each column would receive a liquid addition to the soil matrix in 1,000-milliliter increments. The Control Column would receive additions of de-ionized water only. The Test Column would receive a solution of ECOSAFE™ mixed at a ratio of 1 part product to 100 parts de-ionized water.

The output fluid would be collected in 1,000-milliliter glass jars. The first 2,000 milliliters collected from each column would be analyzed for Total Petroleum Hydrocarbon content using EPA Method 1664 and Diesel Range Organics using EPA Method 8015 Modified.

Finally, the air injection procedure would begin. A one-quarter inch stainless-steel pipe perforated at four-inch spacing was inserted into the center of each column to a depth of approximately 35-inches. Air would be injected into each column at an average rate of 2.5 cfm at 10 psi. Liquid additions would be made to each column following the same procedure and leachate collection would continue.

At the conclusion of the test, three soil samples would be collected from each soil column and analyzed for Total Petroleum Hydrocarbon content using EPA Method 1664 and Diesel Range Organics using EPA Method 8015 Modified.

Discussion

February 26, 2002, Control Column #1

The temperature of the soil and oil mixture was 12°C. Temperature of the unrefined crude oil ranged between 12°–17°C. 1,562 milliliters of unrefined sweet crude oil (36° API) was homogenized with 301.4 in³ of clay-loam soil. This mixture was added to the column, followed by 1,000 milliliters of de-ionized water at 9.0°C.

The water was absorbed and approximately 7 minutes later, leachate began draining from the valve at the base of the column. Six hundred milliliters of de-ionized water was added to the column. This liquid was absorbed. Eighteen minutes later, 400 more milliliters of water was introduced to the column. The column continued to leach during this procedure.

Forty minutes passed as most of this liquid was taken up in the soil matrix. Six hundred milliliters of de-ionized water was added. Fifteen minutes later most of this liquid had been absorbed and an additional 150 milliliters of de-ionized water was added to the

column. A final supplement of 250 milliliters of de-ionized water was added 25 minutes later. Over two hours, a total of 3,000 milliliters of de-ionized water was added to the Control Column. The column was allowed to drain overnight.

February 27, 2002, Control Column #1

The following morning approximately 2,200 milliliters of output fluid was recovered over 18 hours. The output was a mixture of de-ionized water and free oil product. This fluid was taken to the laboratory for analyses.

Continuing the test, an additional 1,000 milliliters of de-ionized water at 10.8°C was added to the Control Column. This water was absorbed in two and one-half hours. An additional 250 milliliters of de-ionized water was added and air injection commenced. Two and one-half hours later, 250 milliliters of water was added to the column. Air injection continued for the next 16 hours.

February 28, 2002, Control Column #1

From 1600 the previous day, to 0700 Thursday, approximately 200 milliliters of a mixture of de-ionized water and crude oil had collected in the leachate jar. The procedure continued with additions of 250 milliliters of water at one-hour intervals for the next three hours. The air injection continued as well.

A change of procedure was made at the next scheduled fluid addition. Due to the small volume of leachate recovery, the air injection would be turned off to prevent overspray and 1,000 milliliters of de-ionized water would be introduced to the soil column.

The column could only hold 900 milliliters of water. Within two and one-half hours, most of the liquid had been absorbed and air injection could continue. Over the next five hours, only 200 additional milliliters of leachate was collected.

February 26, 2002, Test Column #2

The temperature of the soil and oil mixture was 12°C. Temperature of the unrefined crude oil ranged between 12°-17°C. 1,562 milliliters of unrefined sweet crude oil was homogenized with 301.4 in³ of clay-loam soil. This mixture was added to the column, followed by 1,000 milliliters of ECOSAFE™ solution at 9.0°C. The solution was absorbed.

Approximately 31 minutes later leachate began draining from the valve at the base of the column. Simultaneously, an addition of 1,000 milliliters of ECOSAFE™ solution was introduced to the Test Column. Most of this solution was absorbed into the soil matrix.

Forty-two minutes later, 850 milliliters of ECOSAFE™ solution was added to the column. This liquid was absorbed and a final addition of 150 milliliters of ECOSAFE™ solution was added. The column continued to leach during this procedure. A total of 3,000

milliliters of ECOSAFE™ solution was introduced to the soil column over two hours. The column was allowed to drain overnight.

February 27, 2002, Test Column #2

The following morning approximately 1,850 milliliters of output fluid was recovered over an 18-hour period. A slight skim of crude oil was visible on top of the leachate. This sample was taken to the laboratory for analyses.

Continuing the test, an additional 1,000 milliliters of ECOSAFE™ solution at 11.3°C was added to the Test Column. This solution was absorbed in two and one-half hours. An additional 250 milliliters of ECOSAFE™ solution was added and air injection commenced. Two and one-half hours later, 250 milliliters of water was added to the column. Air injection continued for the next 16 hours.

February 28, 2002, Test Column #2

From 1600 the previous day, to 0700 Thursday, only 100 milliliters of output fluid had collected in the leachate jar. No oil was visible on top of the leachate. The procedure continued with additions of 250 milliliters of water at one-hour intervals for the next three hours. The air injection continued as well.

A change of procedure was made at the next scheduled fluid addition. Due to the small volume of leachate recovery, the air injection would be turned off and 1,000 milliliters of de-ionized water would be introduced to the soil column.

The column could only take 600 milliliters of water. Within two and one-half hours, it appeared most of the liquid had been absorbed and air injection could continue. Over the next five hours, only 125 additional milliliters of water and oil was collected.

March 1, 2002, Soil Samples

Two and one-half days after the test began, the plugs were removed from both columns to obtain soil samples. Samples were taken from the top layer, 18" into each soil column and the bottom (36" depth) of each column. The 18-inch and bottom grab samples were extracted by removing the plug and retrieving the soil using a 1 gram soil scoop. The grab sample collected from top of the column was taken by removing the cap and inserting a 3 gram soil scoop into the top of the column to remove the soil. The samples were analyzed for Total Petroleum Hydrocarbon content using EPA Method 1664 and Diesel Range Organics using EPA Method 8015 Modified.

The results of laboratory analyses are summarized in Table 2 contained at the end of this report. Full laboratory reports are contained in Appendix A.

Summary

An ECOSAFE™ solution was tested at 1 part to 100 milliliters of de-ionized water against a control set using de-ionized water only. Each soil column received five and one-quarter treatments of either ECOSAFE™ solution or de-ionized water over two and one-half days.

Air was injected following saturation of the columns and leachate recovery. Soil samples were collected from each column on the final day.

The total volume of water added to the Control Column was 6,150 milliliters. The laboratory homogenized 2500 ml of water and removed 75 ml of free crude oil product before analysis. Of that, 1,000 milliliters was analyzed for TPH content and 1,000 milliliters was analyzed for Diesel Range Organics using EPA Method 1664 and 8015 Modified, respectively. The sample contained 17 mg/L of TPH and 34 mg/L of Diesel Range Organics.

The total volume of water added to the Test Column was 5,850 milliliters. The samples were analyzed for TPH content and Diesel Range Organics using EPA Method 1664 and 8015 Modified, respectively. The sample contained 15 mg/L of TPH and 500 mg/L of Diesel Range Organics.

Time lines are summarized in Table 1 at the end of this report. The results of laboratory analyses are summarized in Table 2 contained at the end of this report. Full laboratory reports are contained in Appendix A.

Conclusions

Tests demonstrated that the presence of ECOSAFE™ appeared to retard the rate of saturation and fluid movement through the soil columns as compared to fluid flow rates in the untreated columns.

Table 1					
Control Column	Day	Time	Concentrations	De-Ionized Water Volume (ml)	Comments
1	2/26/02	13:15	NA	1,000	Column began leaching at 13:22
2		13:22	NA	600	
3		13:40	NA	400	
4		14:20	NA	600	
5		14:34	NA	150	
6		15:00	NA	250	
Total Volume for 2/26/02				3000	
7	2/27/02	07:55	NA	1,000	Oil has begun leaching from column
8	2/27/02	11:30	NA	250	Turned on air compressor
9	2/27/02	16:00	NA	250	Dan Kelly added
Total Volume for 2/27/02				1,500	More than 2,000 ml of oil and water (3 jars) was delivered to the laboratory for analyses.
10	2/28/02	07:20	NA	250	Free product on top of water layer, 200 ml total volume collected overnight, air compressor ran overnight
11	2/28/02	08:20	NA	250	No additional leachate collected
12	2/28/02	9:20	NA	250	No additional leachate collected
13	2/28/02	10:00	NA	900	Turned air compressor off, column full, will not accept any more water.
Total Volume for 2/28/02				1,650	375 ml of leachate recovered, 150 ml of oil
Total Volume for Test				6,150	

Table 1					
Test Column	Day	Time	Concentrations	ECOSAFE™ Solution Volume (ml)	Comments
1	2/26/02	13:12	NA	1,000	Column began leaching at 13:43
2	2/26/02	13:43	NA	1,000	
3	2/26/02	13:25	NA	850	
4	2/26/02	1500	NA	150	
Total Volume for 2/26/02				3000	
5	2/27/02	07:58	NA	1,000	
6	2/27/02	11:30	NA	250	Turned on air compressor
7	2/27/02	16:00	NA	250	Dan Kelly added
Total Volume for 2/27/02				1,500	More than 2,000 ml of fluid was delivered to the laboratory for analyses.
8	2/28/02	07:20	NA	250	Free product on top of water layer, 100 ml total volume collected overnight, air compressor ran overnight
9	2/28/02	08:20	NA	250	No additional leachate collected
10	2/28/02	9:20	NA	250	No additional leachate collected
11	2/28/02	10:15	NA	600	Turned air compressor off, column full, will not accept any more water.
Total Volume for 2/28/02				1,650	200 ml of leachate recovered, 25 ml of oil
Total Volume for Test				5,850	

**Table 2
Lab Analyses Results for Leachate Recovery Test**

Soil		
Baseline Sample	TPH Method 1664 mg/kg	TPH, Diesel Range Organics mg/kg
Control Column	45000	110000
Test Column	37000	101000
Leachate		
	TPH Method 1664 mg/L	TPH, Diesel Range Organics mg/L
Control Column #1	17	34
Test Column #2	15	500
Soil		
Control Column #1	TPH Method 1664 mg/kg	TPH, Diesel Range Organics mg/kg
Top	10000	7800
18"	14000	40000
Bottom	3800	8000
Soil		
Test Column #2	TPH Method 1664 mg/kg	TPH, Diesel Range Organics mg/kg
Top	15000	35000
18"	13000	31000
Bottom	6000	7500

APPENDIX A

Enviro-Test Laboratories LLC.
Chemical Analysis Report

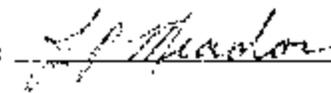
US DEPT. OF ENERGY EML
Attn: LORRI JACKSON
907 N POPLAR STE 150
CASPER WY 82601

Date: 02 MAR 2002

Lab Work Order #: L4701
Project P.O. #:
Project Reference: PET
Comments:

Date Received: 01 MAR 2002

APPROVED BY: _____



Project Manager



Enviro • Test
LABORATORIES LLC.
200 West 1st Street, Casper, Wyoming 82601

Phone: (307) 235-5741 Fax: (307) 266-1676
Toll Free 1(800)668-3300

Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to the analysis at our expense or refunding the analytical costs charged for the work performed.



March 2, 2002

Customer: U.S. Dept. Of Energy EML

ETL LLC Job Number: L4701

The following information is pertinent to the interpretation of the gamma spectroscopy data.

Due to high levels of TPH/DRO in these samples there was significant interference with the surrogates for DRO and the matrix spikes for both DRO and TPH.

If you have any questions regarding the analysis of these samples, please call us at (307) 235-5741 or (800) 666-0306.



Paul Reeks
Organics Supervisor



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Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis or our expense of refunding the analysis costs charged for the work performed.



Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 NORTH POPLAR
 CASPER WY 82601
 ATTN: U.S. DEPT. OF ENERGY
 Project:
 Purchase Order:

Page: 2 of 4
 Report Date: 02-MAR-02
 Work Order: L46B5
 Lab Sample ID: L46B5-1
 Client Sample ID: CONTROL
 Date Collected: 26-FEB-02
 Sampled By: CLIENT
 Date Received: 26-FEB-02
 Matrix: SOIL

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Run ID	Analyzed	By
Misc									
SGT-HEM (TPH)	45000		200	200	mg/kg		R16361	26-FEB-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	110,000		9330	9990	mg/kg	993	R16349	26-FEB-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		67-126		%		R16349	26-FEB-02 00:00	SWD



Enviro • Test
 LABORATORIES, LLC

126 West 1st Street, Casper, Wyoming 82601
 Phone: (307) 235-5741 Fax: (307) 266-1076
 Toll Free: 1(800)366-0504

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Chemical Analysis Report

US DEPT. OF ENERGY EML
907 NORTH POPLAR
CASPER WY 82601

ATTN: U.S. DEPT. OF ENERGY

Project:
Purchase Order:

Page: 3 of 4

Report Date: 02-MAR-02
Work Order: L4685
Lab Sample ID: L4685-2
Client Sample ID: TEST
Date Collected: 26-FEB-02
Sampled By: CLIENT
Date Received: 26-FEB-02
Matrix: SO-L

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Rpt ID	Analyzed	By
Misc									
SGT-HEM (TPH)	37000		200	200	mg/kg		R16361	28-FEB-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	101,000		3330	9990	mg/kg	333	R16349	28-FEB-02 00:00	SWD
Surrogate o-Terphenyl	Diluted out of Range		67-126		%		R16349	28-FEB-02 00:00	SWD



Enviro • Test
LABORATORIES LLC

328 West 1st Street Casper, Wyoming 82601
Phone: (307) 235-5741 Fax: (307) 286-1876
Toll Free 1(800)856-0396

Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to the analysis at our expense or refunding the analytical costs charged for the work performed.



Reference Information

Page: 4 of 4
Report Date: 02-MAR-02
Work Order: L4685

The following is the Description of sample Qualifiers where applicable:

The following Preparation/Extraction Methods were performed:

<u>ETL Test Code and Matrix</u>	<u>Test Description</u>	<u>Methodology Reference (Based On)</u>
TEPH-DRO-CA Soil	Total Extractable Hydrocarbons as Diesel	SW-846 3540C
TPH-CA Soil	SGT-HEM EPA Method 1634	

The following Analytical Methods were performed:

<u>ETL Test Code and Matrix</u>	<u>Test Description</u>	<u>Methodology Reference (Based On)</u>
TEPH-DRO-CA Soil	Total Extractable Hydrocarbons as Diesel	SW846-8015 Modified
TPH-CA Soil	SGT-HEM EPA Method 1634	SGT-HEM EPA Method 1634



Results are only applicable to samples submitted for analysis.
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ance of our services, our liability in all cases is limited to re-analysis at our
expense or refunding the analytical costs charged for the work performed.



ENVIRO-TEST QC REPORT

Client: US DEPT. OF ENERGY EML
 907 NORTH POPLAR
 CASPER WY 82601

Contact: U.S. DEPT. OF ENERGY

Page 1 of 2
 Report Date: Mar. 02, 2002
 Workorder: L4685

Test	Matrix	Reference	Result	Qualifier	Units	Limit	Analyzed
TEPH-DRO-CA Soil							
Batch R16349							
WG12725-1	BLANK		<10		mg/kg		28-FEB-02
Total Extractable Hydrocarbon:							
WG12725-2	BS		110		%	Amount 500	28-FEB-02
Total Extractable Hydrocarbon:							
WG12725-3	BSD	WG12725-2	117		%	RPD 6.2	28-FEB-02
Total Extractable Hydrocarbon:							
WG12725-4	MS	L4685-1	1620		%	Amount 5	28-FEB-02
Total Extractable Hydrocarbon:							
WG12725-5	MSD	WG12725-4	-1060		%	RPD 957	28-FEB-02
Total Extractable Hydrocarbon:							
TPH-CA Soil							
Batch R16361							
WG12732-1	BLANK		<200		mg/kg		28-FEB-02
SGT-HEM (TPH)							
WG12732-2	BLANK		<200		mg/kg		01-MAR-02
SGT-HEM (TPH)							
WG12732-3	LCS		108		%	Amount N/A	28-FEB-02
SGT-HEM (TPH)							
WG12732-4	LCS		83		%	Amount N/A	01-MAR-02
SGT-HEM (TPH)							
WG12732-5	MS		142		%	Amount N/A	01-MAR-02
SGT-HEM (TPH)							
WG12732-6	MSD	WG12732-5	170		%	RPD 20	01-MAR-02
SGT-HEM (TPH)							

Product - Batch and Sample Number Relations:

Product	Batch	Sample Number	Reference
TEPH-DRO-CA	R16349	2	L4685-1
			L4685-2
TPH-CA	R16361	2	L4685-1
			L4685-2



Enviro • Test
LABORATORIES LLC

420 West 1st Street Casper, Wyoming 82601
 Phone: (307) 235-5741 Fax: (307) 236-1871
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Reference Information

Page 2 of 2
Report Date: Mar. 02, 2002
Work Order L4685

The following is a description of Sample types that where applicable:

BLANK Laboratory Blank
BS Blank Spike
BSD Blank Spike Duplicate
LCS Laboratory Control Spike
MS Matrix Spike
MSD Matrix Spike Duplicate

The following is a description of sample Qualifiers that where applicable:



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Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



March 2, 2002

Customer: U.S. Dept. Of Energy EML

ETL LLC Job Number: L4690

The following information is pertinent to the interpretation of the gamma spectroscopy data.

Sample L4690-1 (Control) was received in 3 glass jars and was composited into 1 glass jar. There was a significant amount of free product (75 mL) floating on the top of the water. The sample was shaken and sonicated then separated from the free product for analysis.

If you have any questions regarding the analysis of these samples, please call us at (307) 235-5741 or (800) 666-0306.



Paul Reeks
Organics Supervisor



Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR ST
 STE 150
 CASPER WY 82501
 ATTN: LORRI JACKSON

Project: PET
 Purchase Order:

Page: 2 of 4
 Report Date: 02-MAR-02
 Work Order: L4890
 Lab Sample ID: L4890-1
 Client Sample ID: CONTRCL
 Date Collected: 27-FEB-02
 Sampled By: LORRI JACKSON
 Date Received: 27-FEB-02
 Matrix: WATER/OIL

Parameter	Result	Qualifier	MDL	PCL	Units	DF	Run ID	Analyzed	By
Misc									
SGT-HEM (TP-I)	17		5	5	mg/L		R16962	28-FEB-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	15		5	15	mg/L	10	R16948	28-FEB-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		52-153		%		R16948	28-FEB-02 00:00	SWD



Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR ST
 STE 150
 CASPER WY 82601
 ATTN: LORRI JACKSON

Project: PET
 Purchase Order:

Page: 3 of 4
 Report Date: 02-MAR-02
 Work Order: L4690
 Lab Sample ID: L4690-2
 Client Sample ID: TEST
 Date Collected: 27-FEB-02
 Sampled By: LORRI JACKSON
 Date Received: 27-FEB-02
 Matrix: WATER/OIL

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Run ID	Analyzed	By
Misc									
SGT-HEM (TPH)	94		5	5	mg/L		R16362	28-FEB-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	500		50	150	mg/L	100	R16348	28-FEB-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		52-133		%		R16348	28-FEB-02 00:00	SWD



Reference Information

Page: 4 of 4
Report Date: 02-MAR-02
Work Order: L4690

The following is the Description of sample Qualifiers where applicable:

The following Preparation/Extraction Methods were performed:

ETL Test Code and Matrix	Test Description	Methodology Reference (Based On)
TEPH-DRO-CA Water	Total Extractable Hydrocarbons as Diesel	SW-846 3510C
TPH-CA Water	SGT-HEM EPA Method 1664	

The following Analytical Methods were performed:

ETL Test Code and Matrix	Test Description	Methodology Reference (Based On)
TEPH-DRO-CA Water	Total Extractable Hydrocarbons as Diesel	SW846-3510/8015B Modified
TPH-CA Water	SGT-HEM EPA Method 1664	SGT-HEM EPA Method 1664



Results are only applicable to samples submitted for analysis.
Limit of Liability: A though care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



ENVIRO-TEST QC REPORT

Client: US DEPT. OF ENERGY EML
 907 N POPLAR ST STE 150
 CASPER WY 82601

Page 1 of 2
 Report Date: Mar. 02, 2002
 Workorder: L4890

Contact: LORRI JACKSON

Test	Matrix	Reference	Result	Qualifier	Units	Limit	Analyzed
TEPH-DRO-CA <u>Water</u>							
Batch	R16348						
WG12724-1	BLANK						
Total Extractable Hydrocarbon:			<0.5		mg/L		28-FEB-02
WG12724-2	BS						
Total Extractable Hydrocarbon:			1.09		%	Amount 500 70-130	28-FEB-02
WG12724-3	BSD	WG12724-2	1.06		%	RPD 2.8 20	28-FEB-02
Total Extractable Hydrocarbon:							
TPH-CA <u>Water</u>							
Batch	R16352						
WG12733-1	BLANK						
SGT-HEM (TPH)			<5		mg/L		28-FEB-02
WG12733-2	LCS						
SGT-HEM (TPH)			1.00		%	Amount N/A 2-1	28-FEB-02
WG12733-3	LCS	WG12733-2	91		%	10 2	28-FEB-02
SGT-HEM (TPH)							

Product - Batch and Sample Number Relations:

TEPH-DRO-CA	R16348	1	L4890-1	L4890-2
TPH-CA	R16352	1	L4890-1	L4890-2



Reference Information

Page 2 of 2
Report Date: Mar. 02, 2002
Work Order L4690

The following is a description of Sample types that where applicable:

BLANK Laboratory Blank
BS Blank Spike
BSD Blank Spike Duplicate
LCS Laboratory Control Spike
LCSD Lab Control Spike Duplicate

The following is a description of sample Qualifiers that where applicable:



Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and diligence is taken in the performance of our services, our liability in all cases is limited to the analysis at our expense or refunding the analysis costs charged for the work performed.



Enviro-Test Laboratories LLC.
Chemical Analysis Report

US DEPT. OF ENERGY EML
Attn: U.S. DEPT. OF ENERGY
907 NORTH POPLAR
CASPER WY 82601

Date: 02 MAR 2002

Lab Work Order #: L4686
Project P.O. #:
Project Reference:
Comments:

Date Received: 26 FEB 2002

APPROVED BY: _____

[Signature]
Project Manager



Enviro • Test
LABORATORIES, LLC

100 West Lincoln Casper, Wyoming 82601
Phone: (307) 235-5711 Fax: (307) 266-1676
1-811-FRAC 1(800)686-0606

Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



March 2, 2002

Customer: U.S. Dept. Of Energy EML

ETL LLC Job Number: 14685

The following information is pertinent to the interpretation of the gamma spectroscopy data.

Due to high levels of TPH/DRO in these samples there was significant interference with the surrogates for DRO and the matrix spikes for both DRO and TPH.

If you have any questions regarding the analysis of these samples, please call us at (307) 235-5741 or (800) 666-0306.



Paul Reeks
Organics Supervisor



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Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR
 STE 150
 CASPER WY 82601
 ATTN: LORRI JACKSON
 Project: PET
 Purchase Order:

Page: 6 of 8
 Report Date: 02-MAR-02
 Work Order: L4701
 Lab Sample ID: L4701-5
 Client Sample ID: TEST 18
 Date Collected: 01-MAR-01
 Sampled By: CLIENT
 Date Received: 01-MAR-02
 Matrix: SOIL

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Run ID	Analyzed	By
Misc									
SGT-HEM (TPH)	13000		200	200	mg/kg		R16361	01-MAR-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	31,000		3330	9900	mg/kg	333	R16360	01-MAR-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		67-128		%		R16360	01-MAR-02 00:00	SWD

Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR
 STE 150
 CASPER WY 82601
 ATTN: LORRI JACKSON
 Project: PET
 Purchase Order:

Page: 7 of 8
 Report Date: 02-MAR-02
 Work Order: L4701
 Lab Sample ID: L4701-6
 Client Sample ID: TEST BOTTOM
 Date Collected: 01-MAR-01
 Sampled By: CLIENT
 Date Received: 01-MAR-02
 Matrix: SOIL

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Run #	Analyzed	By
Misc									
SGT-HEM (TPH)	6000		200	200	mg/kg		R16981	01-MAR-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	7.500		3330	9990	mg/kg	393	R16360	01-MAR-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		67-126		%		R16360	01-MAR-02 00:00	SWD



Enviro • Test
LABORATORIES, LLC

480 West 1st Street, Casper, Wyoming 82601
 Phone: (307) 235-5711 Fax: (307) 266-1676
 Toll Free: 1(800)866-3266

Results are only applicable to samples submitted for analysis.
 Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to the analysis at our expense or refunding the analysis costs charged for the work performed.



Reference Information

Page: 8 of 8
Report Date: 02-MAR-02
Work Order: L4701

The following is the Description of sample Qualifiers where applicable:

The following Preparation/Extraction Methods were performed:

ETL Test Code and Matrix	Test Description	Methodology Reference (Based On)
TEP--DRO-CA Soil	Total Extractable Hydrocarbons as Diesel	SW-846-3540C
TPH-CA Soil	SGT-HEM EPA Method 1664	

The following Analytical Methods were performed:

ETL Test Code and Matrix	Test Description	Methodology Reference (Based On)
TEP--DRO-CA Soil	Total Extractable Hydrocarbons as Diesel	SW846-BD15 Modified
TPH-CA Soil	SGT-HEM EPA Method 1664	SGT-HEM EPA Method 1664



Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



ENVIRO-TEST QC REPORT

Client: US DEPT. OF ENERGY EML
 907 N POPLAR STE 160
 CASPER WY 82601

Contact: LORRI JACKSON

Page 1 of 2
 Report Date: Mar. 02, 2002
 Workorder: L4701

Test	Matrix	Reference	Result	Qualifier	Units	Limit	Analyzed
TEPH-DRO-CA Soil							
Batch R16360							
WG12731-1	BLANK		<10		mg/kg		01-MAR-02
Total Extractable Hydrocarbon:							
WG12731-2	BS		105		%	Amount 500 70-130	01-MAR-02
Total Extractable Hydrocarbon:							
WG12731-3	BSD	WG12731-2	107		%	RPD 1.9 20	01-MAR-02
Total Extractable Hydrocarbon:							
WG12731-4	MS	L4701-1	-640		%	Amount 500 70-130	01-MAR-02
Total Extractable Hydrocarbon:							
WG12731-5	MSD	WG12731-4	-440		%	RPD -37 20	01-MAR-02
Total Extractable Hydrocarbon:							
TPH-CA Soil							
Batch R16361							
WG12732-1	BLANK		<200		mg/kg		28-FEB-02
SGT-HEM (TPH):							
WG12732-2	BLANK		<200		mg/kg		01-MAR-02
SGT-HEM (TPH):							
WG12732-3	LCS		108		%	Amount N/A 2-2	28-FEB-02
SGT-HEM (TPH):							
WG12732-4	LCS		83		%	Amount N/A 2-2	01-MAR-02
SGT-HEM (TPH):							
WG12732-5	MS		142		%	Amount N/A 2-2	01-MAR-02
SGT-HEM (TPH):							
WG12732-6	MSD	WG12732-5	170		%	RPD 20 2	01-MAR-02
SGT-HEM (TPH):							

Product - Batch and Sample Number Relations

Product	Batch	Sample Number					
TEPH-DRO-CA	R16360	2	14701-1	14701-2	14701-5	14701-4	14701-6
TPH-CA	R16361	2	14701-1	14701-2	14701-5	14701-4	14701-6



Enviro • Test
LABORATORIES LLC.

420 West 1st Street Casper Wyoming 82601
 Phone: (307) 235-5741 Fax: (307) 260-1071
 Toll Free: 1-800-855-1308

Results are only applicable to samples specifically listed for analysis.
 Limit of Liability: Although care and diligence is taken in the perform-
 ance of our services, our liability in all cases is limited to an analysis of our
 expense or refunding the analytical costs charged for the work performed.



Reference Information

Page 2 of 2
Report Date: Mar. 02, 2002
Work Order L4701

The following is a description of Sample types that where applicable:

BLANK Laboratory Blank
BS Blank Spike
BSD Blank Spike Duplicate
LCS Laboratory Control Spike
MS Matrix Spike
MSD Matrix Spike Duplicate

The following is a description of sample Qualifiers that where applicable:



Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



Enviro-Test Laboratories LLC.

Chemical Analysis Report

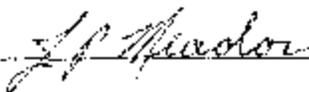
US DEPT. OF ENERGY EML
Attn: LORRI JACKSON
807 N POPLAR ST STE 150
CASPER WY 82601

Date: 02 MAR 2002

Lab Work Order #: L4690
Project P.O. #:
Project Reference: PET
Comments:

Date Received: 27 FEB 2002

APPROVED BY: _____



Project Manager



Enviro • Test
LABORATORIES LLC.

420 West 1st Street Casper, Wyoming 82601
Phone: (307) 235-5741 Fax: (307) 268-1571
Toll Free 1 (800) 666-4304

Results are only applicable to samples submitted for analysis.
Limit of Liability: Although care and due diligence is taken in the perform-
ance of our services, our liability in all cases is limited to re-analysis at our
expense or refunding the analytical costs charged for the work performed.



Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR
 STE 150
 CASPER WY 82601
 ATTN: LORRI JACKSON

Page: 2 of 8
 Report Date: 02-MAR-02
 Work Order: L4701
 Lab Sample ID: L4701-1
 Client Sample ID: CONTROL TOP
 Date Collected: 01-MAR-01
 Sampled By: CLIENT
 Date Received: 01-MAR-02
 Matrix: SOIL

Project: PET
 Purchase Order:

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Run ID	Analyzed	By
Misc									
SQT-HEM (TPH)	10000		200	200	mg/kg		R18361	01-MAR-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	7,800		3330	9990	mg/kg	353	R18360	01-MAR-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		67-125		%		R18360	01-MAR-02 00:00	SWD



Enviro • Test
 LABORATORIES LLC

420 West 10th Street, Casper, Wyoming 82601
 Phone: (307) 239-5741 Fax: (307) 239-1676
 Toll Free 1(800)866-0304

Results are only applicable to samples submitted for analysis.
 Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR
 STE 150
 CASPER WY 82601
 ATTN: LORRI JACKSON

Project: PET
 Purchase Order:

Page: 3 of 8
 Report Date: 02-MAR-02
 Work Order: L4701
 Lab Sample ID: L4701-2
 Client Sample ID: CONTROL 18*
 Date Collected: 01-MAR-01
 Sampled By: CLIENT
 Date Received: 01-MAR-02
 Matrix: SOIL

Parameter	Result	Qualifier	MDE	PQL	Units	DF	Run ID	Analyzed	By
Misc									
SGT-HEM (TPH)	14000		200	200	mg/kg		R16361	01-MAR-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	40,000		3350	9990	mg/kg	335	F16360	01-MAR-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		87-126		%		F16360	01-MAR-02 00:00	SWD



Results are only applicable to samples submitted for analysis under a contract. Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to the analysis of our expense or refunding the analytical costs charged for the work performed.



Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR
 STE 150
 CASPER WY 82601
 ATTN: LORRI JACKSON

Page: 4 of 8
 Report Date: 02-MAR-02
 Work Order: L4701
 Lab Sample ID: L4701-3
 Client Sample ID: CONTROL BOTTOM
 Date Collected: 01-MAR-01
 Sampled By: CLIENT
 Date Received: 01-MAR-02
 Matrix: SOIL

Project: PET
 Purchase Order:

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Run ID	Analyzed	By
Misc									
SGT-HEM (TPH)	3300		200	200	mg/kg		R16861	01-MAR-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	8.000		3330	9590	mg/kg	393	R16360	01-MAR-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		67-126		%		R16360	01-MAR-02 00:00	SWD



Enviro • Test
 LABORATORIES, LLC

30 West 3rd Street, Casper, Wyoming 82601
 Phone (307) 255-5741 Fax (307) 266-1676
 Toll Free 1-800-688-0301

Results are only applicable to samples submitted for analysis.
 Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to re-analysis at our expense or refunding the analytical costs charged for the work performed.



Chemical Analysis Report

US DEPT. OF ENERGY EML
 907 N POPLAR
 STE 150
 CASPER WY 82601
 ATTN: LORRI JACKSON

Page: 5 of 8

Report Date: 02 MAR 02
 Work Order: L4701
 Lab Sample ID: L4701-4
 Client Sample ID: TEST TOP
 Date Collected: 01-MAR-01
 Sampled By: CLIENT
 Date Received: 01-MAR-02
 Matrix: SOIL

Project: PET
 Purchase Order:

Parameter	Result	Qualifier	MDL	PQL	Units	DF	Run ID	Analyzed	By
Misc									
SGT-HEM (TPH)	15000		200	200	mg/kg		R16361	01-MAR-02 00:00	FT
Total Extractable Hydrocarbons as Diesel									
Total Extractable Hydrocarbons	35,000		3330	9990	mg/kg	333	R16360	01-MAR-02 00:00	SWD
Surrogate: o-Terphenyl	Diluted out of Range		67-126		%		R16360	01-MAR-02 00:00	SWD



Enviro • Test
 LABORATORIES, LLC

120 West 18th Street Casper, Wyoming 82601
 Phone (307) 266-5741 Fax (307) 266-1676
 Toll Free 1(800)568-0300

Results are only applicable to samples submitted for analysis.
 Limit of Liability: Although care and due diligence is taken in the performance of our services, our liability in all cases is limited to the analysis of our expense or refunding the analytical costs charged for the work performed.

