REMEDIATION
PLAN

Chaparral Energy

Monarch White "A" State # 1 Remediation Project

RECEIVED

JUN 25 1998

ENVIRONMENTAL BUREAU
OIL CONSERVATION DIVISION

Whole Earth Environmental
19606 San Gabriel
Houston, Tx. 77084

Chaparral Energy, Inc. (405) 478-8770 • FAX (405) 478-1947

701 Cedar Lake Blvd. • Oklahoma City, OK 73114

23 June 1998

State of New Mexico
Oil Conservation Division
Attn: Bill Olsen
2040 South Pacheco Street
Santa Fe, New Mexico 87504

Re: Monarch Corporation
White "A" State #1
Sec. 15-T10S-R32E
Lea County, New Mexico

Dear Sir:

Enclosed is a copy of the report Chaparral Energy, Inc. received from Whole Earth Environmental, Inc. The report consists of a site profile, laboratory reports from the testing performed, a requested cleanup protocol for the sludge pit, procedures for the project, and VADSAT modeling results for the hydrocarbon and the brine water.

Based on the laboratory results and the modeling, it appears this hydrocarbon has an extremely low leachability such that migration of any hydrocarbon plume to ground water is essentially nil. Due to the physical characteristics of the contaminate, the distance to ground water, and the physical characteristics of the rock between the two, Whole Earth Environmental, Inc. and Chaparral Energy, Inc., on behalf of Monarch Corporation, request a closure concentration of <100,000 ppm TPH, <10 ppm benzene, and <50 ppm BTEX (see "Protocols" paragraph 8.0). The closure, as recommended in this report, should isolate the contamination and achieve the desired results of protecting the local environment.

After you have had a chance to review this submission, please contact the undersigned should you have any questions or comments.

Sincerely,

Robert C. Lang IV, REM, CEA
Environmental & Special Projects Engineer

cc: Hobbs, NM Office, NMOCD

Site Profile

The site is situated approximately 5.5 miles north of the intersection of U.S. Highway 380 and New Mexico State Highway 156. The pit lies approximately 150 yards west of Hwy. 156 on gently rolling hills. The surrounding land is classified as semi-arid and is principally used for grazing cattle. There is no agricultural development within five miles of the pit.

The pit area is approximately 210' north to south and 125' east to west. The pit is surrounded with a well-maintained four-strand barbed wire fence. Access to the pit is through an unsecured gate at the southern perimeter. The pit topography is slightly indented to the surrounding terrain and appears to adequately contain any storm water runoff. There is no sign of recently stressed vegetation around the pit area.

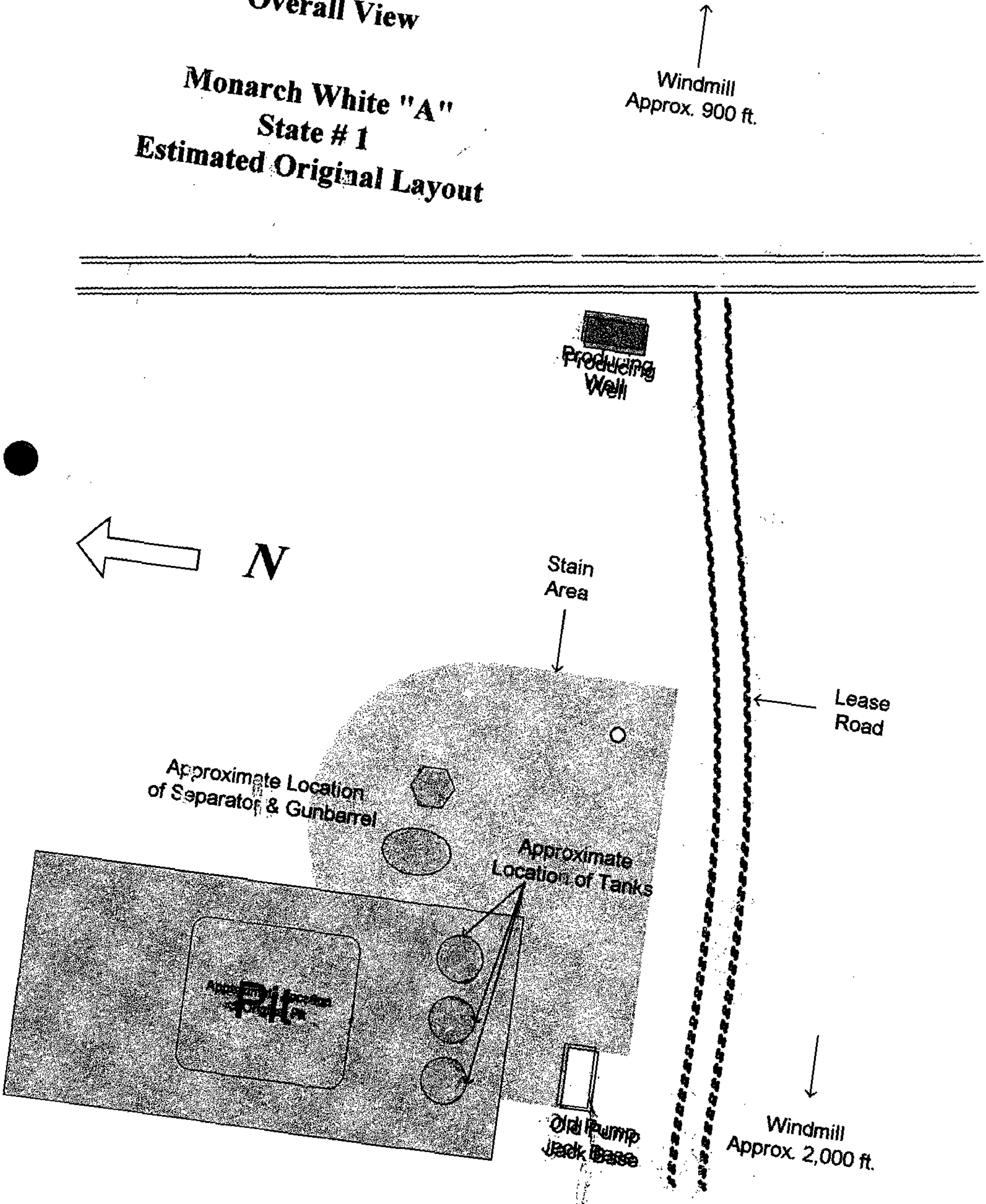
There is an area of "hard pack" centered at the southeast corner of the pit. The surface contamination appears as patchy areas covered with a highly weathered, asphalt-like surface coating ranging in thickness from 2-8 cm. There is an abandoned steel reinforced cement pump jack base to the south of the pit and a cement separator base to the southeast of the location.

The pit appears to be uniformly covered with a mixture of "gin trash" and manure to a depth of at least 2' bgl. This mixture is quite "spongy" and is likely to bog down any non-tracked equipment brought onto the location. Several surface seeps were observed ranging in size from 1-6 sq. ft. The seeps reveal an extremely viscous (almost brittle in 36^{0}F temperatures) asphaltine compound to be emerging from the pit.

There are no power lines within the immediate area and no posted pipeline crossings within 200 feet of the location.

Monarch White "A"
State # 1
Overall View

Monarch White "A"
State # 1
Estimated Original Layout



Detail of Abandoned
Pump Jack Base


Detail Showing Relative
Location of MW #1

Detail of MW #1
Showing Completion Detail


Detail of Pit Showing
Vapor Extraction System

Detail of Pit Perimeter
Showing Plugged Well & Jack Base

Laboratory Analyses

This section contains copies of the analytical testing done both in the field and at Environmental Labs of Texas.

ENVIRONMENTAL
LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

WHOLE EARTH ENVIRONMENTAL
ATTN: MR. MIKE GRIFFIN
19606 SAN GABRIEL
HOUSTON, TEXAS 77084
FAX: 281-464-8996

Receiving Date: 06/08/98
Sample Type: SOLID
Project : MONARCH ENERGY WHITE "A" STATE #1
Project Location: NEAR TATUM, NM

Analysis Date: 06/08/98
Sampling Date: NONE GIVEN
Sample Condition: Intact

ELT#	FIELD CODE	C6-C10 mg/kg	>C10-C28 mg/kg	TPH C6-C28 mg/kg
14540	PIT SURFACE	9,373	111,533	120,906
	REPORTING LIMIT	100	100	100
	% IA	84	82	83
	% EA	117	70	94
	BLANK	<100	<100	<100

METHODS: SW 846-8015 GRO,DRO

Raland K. Tuttle

6-10-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

WHOLE EARTH ENVIRONMENTAL
ATTN: MR. MIKE GRIFFIN
19606 SAN GABRIEL
HOUSTON, TEXAS 77084
FAX: 281-464-8996

Receiving Date: 06/08/98
Sample Type: SOLID
Project : MONARCH ENERGY WHITE "A" STATE #1
Project Location: NEAR TATUM, NM

Analysis Date: 06/09/98
Sampling Date: NONE GIVEN
Sample Condition: Intact

ELT#	FIELD CODE	TCLP C6-C10 mg/l	TCLP >C10-C28 mg/l	TCLP TPH C6-C28 mg/l
14540	PIT SURFACE	<3	<3	<3
	REPORTING LIMIT	3	3	3
% IA		96	97	96
% EA		101	109	105
RPD		1	1	1

METHODS: SW 846-8015M GRO,DRO, 1311

Raland K Tuttle
Raland K. Tuttle

6-10-98
Date

ENVIRONMENTAL
LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

WHOLE EARTH ENVIRONMENTAL
ATTN: MR. MIKE GRIFFIN
19606 SAN GABRIEL
HOUSTON, TEXAS 77084
FAX: 1-281-646-8996

Receiving Date: 06/08/98
Sample Type: SOLID
Project : MONARCH ENERGY
Project #: WHITE "A" STATE #1
Project Location: NEAR TATUM, NM

Analysis Date: 06/08/98
Sampling Date: NONE GIVEN
Sample Condition: Intact

ELT#	FIELD CODE	TCLP BENZENE mg/l	TCLP TOLUENE mg/l	TCLP ETHYLBENZENE mg/l	TCLP m,p-XYLENE mg/l	TCLP o-XYLENE mg/l
14540	PIT SURFACE	0.763	0.741	0.199	0.064	0.033

% IA	93	96	95	93	98
% EA**	58	99	132	113	115
RPD	<1	<1	2	6	4

**Note: Matrix interference due to elevated hydrocarbon levels.
METHODS: SW 846-8020,5030,1311

Raland K. Tuttle

6-10-98
Date

Environmental Lab of Texas, Inc. 12600 West I-20 East Odessa, Texas 79763
(915) 563-1800 FAX (915) 563-1713

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: Mike Griffin / Bob Lang Chaparral Energy
Phone #: 281-646-8996
FAX #: Whole Earth

Company Name & Address: Whole Earth Environmental

Project #: Monarch Energy - New-Tatum NM
Project Name :

Project Location: Monarch Energy White "A" State #1
Sampler Signature:

ANALYSIS REQUEST

LAB # (LAB USE ONLY)	FIELD CODE	# CONTAINERS	Volume/Amount	MATRIX					PRESERVATIVE METHOD					SAMPLING		BTEX 8020/5030	TPH ~~418.1~~ GRO, DRO 8015	TCLP Metals Ag As Ba Cd Cr Pb Hg Se	Total Metals Ag As Ba Cd Cr Pb Hg Se	TCLP Volatiles	TCLP Semi Volatiles	TDS	RCI	BTEX TPH [illegible] (TCLP)
				WATER	SOIL	AIR	SLUDGE	OTHER	HCL	HNO3	ICE	NONE	OTHER	DATE	TIME									
14540	Pit Surface	2	Qut				✓										✓							✓

Relinquished by: UPS	**Date:** 6-8-98	**Times:** 1240	**Received by:**	**REMARKS**
Relinquished by:	**Date:**	**Times:**	**Received by:**	
Relinquished by:	**Date:**	**Times:**	**Received by Laboratory:**	

ENVIRONMENTAL
LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

WHOLE EARTH ENVIRONMENTAL
ATTN: MR. MIKE GRIFFIN
19606 SAN GABRIEL
HOUSTON, TEXAS 77084
FAX: 281-646-8996

RECEIVING DATE: 04/28/98
SAMPLE TYPE: Water
PROJECT #: White A State #1
PROJECT NAME: Chaparral Energy
PROJECT LOCATION: Tatum, New Mexico

ANALYSIS DATE: 04/28/98
SAMPLING DATE: 04/27/98
SAMPLE CONDITION: INTACT

ELT#	FIELD CODE	Chloride mg/L
14288	1	2,765
	QUALITY CONTROL	4,998
	TRUE VALUE	5,000
	% PRECISION	100

Methods: SW 846-9252

Michael R. Fowler

4-29-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

WHOLE EARTH ENVIRONMENTAL
ATTN: MR. MIKE GRIFFIN
19606 SAN GABRIEL
HOUSTON, TEXAS 77084
FAX: 1-281-646-8996

Receiving Date: 04/28/98	Analysis Date: 04/28/98
Sample Type: Water	Sampling Date: 04/27/98
Project : Chaparral Energy	Sample Condition: Intact
Project #: White A State #1	
Project Location: Tatum, New Mexico	

ELT#	FIELD CODE	BENZENE mg/L	TOLUENE mg/L	ETHYLBENZENE mg/L	m,p-XYLENE mg/L	o-XYLENE mg/L	DRO C10-C28 mg/L
14288	1	0.002	0.002	<0.001	<0.001	<0.001	<3
% IA		101	100	99	99	103	103
% EA		102	100	98	97	101	**
BLANK		<0.001	<0.001	<0.001	<0.001	<0.001	<3

METHODS: SW 846-8020,5030,8015

Michael R. Fowler

4-29-98
Date

Environmental Lab of Texas, Inc.

12600 West I-20 East Odessa, Texas 79763
(915) 563-1800 FAX (915) 563-1713

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: Mike Griffin

Phone #: (800) 354-1358

FAX #: (281) 646-8996

Company Name & Address: Chaparral Energy

Project #: White A State #1

Project Name :

Project Location: Tatum, N.M.

Sampler Signature: M. Griffin

LAB # (LAB USE ONLY)	FIELD CODE	# CONTAINERS	Volume/Amount	MATRIX					PRESERVATIVE METHOD					SAMPLING		ANALYSIS REQUEST								
				WATER	SOIL	AIR	SLUDGE	OTHER	HCL	HNO3	ICE	NONE	OTHER	DATE	TIME	BTEX 8020/5030	TPH ~~418.1~~ 8015 DRO	TCLP Metals Ag As Ba Cd Cr Pb Hg Se	Total Metals Ag As Ba Cd Cr Pb Hg Se	TCLP Volatiles	TCLP Semi Volatiles	TDS	RCI	Chlorides
14288	1	1		✓										4-27	6:30P	✓	✓							✓
~~14289~~	~~2~~	~~2~~		✓												~~✓~~								
~~14290~~	~~3~~	~~3~~		✓																				

Relinquished by:	Date:	Times:	Received by:
M. Griffin	4-28-98	800	Roland K. [illegible]

Relinquished by:	Date:	Times:	Received by Laboratory:

REMARKS

Whole Earth Environmental
Field Test
Analytical Results

Facility Name	White "A" State # 1	**Date of Collection**	4/27/98
Pit Type	Emergency Overflow	**Date of Analysis**	4/27/98
Client	Chaparral Energy	**Analysisist**	M. Griffin
TPH Analyzer S/N	01152	**VOC Analyzer S/N**	N/A
Chromatograph S/N	3714	**E.C. Analyzer S/N**	3659251

Analysis: TPH (418.1)
Analysis: BTEX
Analysis: Chlorides
Analysis:

Sample Location: Pit # 2 (Described further on plat map)

	5' bgl	10' bgl	15' bgl	20' bgl	25' bgl	30' bgl	Water
T.P.H(1)	56	12	22	ND	ND	ND	N / A
E.C(2)	N/A	N/A	N/A	N/A	N/A	N/A	28.8
V.O.C(1)	N/A	N/A	N/A	N/A	N/A	N/A	16,300
Benzene(1)	ND	0.5	1.2	ND	0.5	ND	N/A
Toluene(1)	ND	ND	0.7	0.6	ND	0.3	N/A
Ethylbenzene(1)	ND	ND	ND	ND	ND	ND	N/A
Xylene(1)	ND	ND	ND	ND	ND	ND	N/A

Notes:
1. Results shown in mg / L (ppm)
2. Results Shown in mmhos / cm

Technician: ______________________

Protocol

This section contains copies of the detailed protocol we plan to employ on this project.

Pit Remediation Protocol
Chaparral Energy
Tatum Pit Closure Project

1.0 Purpose

This protocol is provide a detailed outline of the steps to be employed in the remediation and final closure of the Chaparral Energy White "A" State # 1 pit.

2.0 Scope

This protocol is site specific for the above stated site.

3.0 Preliminary

Prior to any field operations, Whole Earth Environmental shall conduct the following activities:

3.1 Client Review

3.1.1 Whole Earth shall meet with cognizant personnel within Chaparral to review this protocol and make any requested modifications or alterations prior to submittal to the State of New Mexico Oil Conservation Division.

3.1.2 Changes to this protocol will be documented and submitted for final review by Chaparral prior to submittal to the Oil Conservation Division.

3.2 Oil Conservation Division Review

3.2.1 Upon client approval, this protocol and associated modeling results will be submitted to the New Mexico Oil Conservation Division for review and comment. Recommended changes will be reviewed by the client prior to implementation.

3.2.2 Any recommended changes effecting costs will require a revised quotation to be issued to the client for approval prior to the commencement of any on-site remediation activity.

4.0 Safety

4.1 Prior to work on the site, Whole Earth shall obtain the location and phone numbers of the nearest emergency medical treatment facility. We will review all safety-related issues with the appropriate Chaparral personnel, sub-contractors and exchange phone numbers.

4.2 A tailgate safety meeting shall be held and documented each day. All sub-contractors must attend and sign the daily log-in sheet.

4.3 Anyone allowed on to location must be wearing sleeved shirts, steel-toed boots, and long pants. Each vehicle must be equipped with two-way communication capabilities.

4.4 Prior to any excavation, the area shall be surveyed with a line finder. If lines are discovered within the area to be excavated, they shall be marked with pin flags on either side of the line at maximum five-foot intervals. The area will be photographed prior to any excavation or fluid removal.

4.5 Each pit area will be swept with a Ludlam 2350 to determine if NORM is present in concentrations greater than 40μr / hr.

5.0 Fluid Removal

Prior to any excavation, the pit fluids shall be removed by vacuum truck and transported to the Gandy / Marley, Inc. Landfarm. A shipping manifest and O.C.D. Form C-117-A shall be prepared for each waste load.

6.0 Compaction & Coring

6.1 Soils which are highly saturated with hydrocarbons, (>20% generally), will be excavated and transported to the Gandy / Marley, Inc. Landfarm. A shipping manifest and O.C.D. Form C-117-A shall be prepared for each waste load. Care will be taken to insure that these soils remain within the truck during transport.

6.2 Atkins Engineering Associates, Inc. will drill a monitor well immediately adjacent to the southeast corner of the pit center using a continuous core sampler. The monitor well will be cased and screened in accordance with OCD guidelines. Whole Earth will collect water samples in accordance with our procedures WEQP-76 & WEQP-77. Confirmation samples will be analyzed by Environmental Labs of Texas for BTEX and DRO using EPA Methods 8020, 5030 and 8015m.

6.3 If the monitor well indicates the presence of "free product', two additional monitor wells will be drilled, cased and sampled in accordance with paragraph 6.2 of this protocol. The location of the two additional wells will be a minimum distance of 100' down gradient from the initial monitoring well and at a lateral distance of 50' from a continuation of the initial monitoring well and pit center.

6.4 If free product is discovered within the initial monitoring well, a recovery well will be drilled and developed in the approximate pit center at the completion of all remediation and surface reclamation activities.

7.0 Modeling

7.1 Whole Earth will model the migration potential of the plume on VADSAT using the results of the field screen analyses. If the results reflect a zero percentage probability of the plume impacting ground water, the OCD will be immediately notified and excavation operations begun.

7.2 The confirmation samples will be modeled upon receipt to verify a zero percentage probability. All modeling data will be included within the final closure documentation.

8.0 Excavation & Remediation

8.1 The site shall be excavated to the maximum contaminant concentrations specified in paragraph 8.2 of this protocol. All excavated material will be deposited immediately adjacent to the pit site.

8.2 The bottom of the pit and all four side walls will be tested for TPH and Benzene concentrations using WEQP-06 and WEQP-19. Excavation will continue until such concentrations are <100,000 ppm TPH, <10 ppm benzene and <50 ppm total BTEX. Confirmation samples will be collected and analyzed as described in 6.3 of this protocol.

8.3 Upon reaching the required depth and side wall concentrations, the bottom of the pit will be made as smooth as possible with excavation equipment. Sand will be deposited in the bottom of the pit to a minimum thickness of 6".

8.4 A polyethylene liner of a minimum thickness of 30 mils will be spread atop the sand to the pit edge and an additional 6" of sand deposited above it.

8.5 The excavated materials will be mixed and blended with additional topsoils obtained from the area immediately adjacent to the pit until the hydrocarbon concentrations fall below the maximum limits as described in Paragraph 8.2 of this protocol. The remediated materials will then be replaced into the excavated area, compacted and the surface contoured to provide for positive drainage.

8.6 The top two feet of the excavation shall be covered in remediated materials having a maximum TPH concentration of <100 ppm and benzene concentrations of <2 ppm. The area will be seeded with a mixture of local grasses.

7.0 Documentation & Reporting

7.1 At the conclusion of the pit remediation project, Whole Earth will prepare a closure report to include the following information:

- A plat map of the location showing the exact location of the pit, the dimensions prior to excavation and the actual excavated dimensions.
- Photographs of the pit prior to excavation, at the point of maximum excavation and after final closure
- Field Sampling Report to include the side wall and pit bottom TPH, BTEX and chloride concentrations after excavation.
- Field Sampling Report to include TPH, BTEX and chloride concentrations of all remediated materials deposited into the pit.
- Daily calibration records of each testing instrument
- Shipping manifests and OCD Form C-117-A
- Risk assessment model and supporting documentation
- M.S.D.S. and permeability certification of liner materials

Procedures

This section contains copies of all testing procedures planned for this project.

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Conducting Field TPH Analysis

Completed By: Approved By: Effective Date: 02/15/97

1.0 Purpose

To define the procedure to be used in conducting total percentage hydrocarbon testing in accordance with EPA Method 418.1 (modified) using the "MEGA" TPH Analyzer.

2.0 Scope

This procedure is to be used for field testing and on site remediation information.

3.0 Procedure

3.1 The G.A.C. "MEGA" TPH analyzer is an instrument that measures concentrations of aliphatic hydrocarbons by means of infra-red spectrometry. It is manufactured to our specifications and can accurately measure concentrations from two parts per million through 100,000 parts per million. The unit is factory calibrated however minor calibration adjustments may be made in the field. Quality Procedure 25 defines the field calibration methods to be employed.

3.2 Prior to taking the machine into the field, insert a 500 ppm and 5,000 ppm calibration standard into the sample port of the machine. Zero out the Range dial until the instrument records the exact standard reading.

3.3 Once in the field, insert a large and small cuvette filled with clean Freon 113 into the sample port of the machine. Use the range dial to zero in the reading. If the machine does not zero, do not attempt to adjust the span dial. Immediately implement Quality Procedure 25 .

3.4 Place a 100 g. weight standard on the field scale to insure accuracy. Zero out the scale as necessary.

3.5 Tare a clean 100 ml. sample vial with the Teflon cap removed. Add 10 g. (+/- .01 g), of sample soil into the vial taking care to remove rocks or vegetable matter from the sample to be tested. If the sample is wet, add up to 5 g. silica gel or anhydrous sodium sulfate to the sample after weighing.

3.6 Dispense 10 ml. Freon 113 into the sample vial.

3.7 Cap the vial and shake for five minutes.

3.8 Carefully decant the liquid contents of the vial into a filter/desiccant cartridge and affix the cartridge cap. Recap the sample vial and set aside.

3.9 Insert the metal tip of the pressure syringe into the cap opening and slowly pressurize. **WARNING: APPLY ONLY ENOUGH PRESSURE ON THE SYRINGE TO EFFECT FLOW THROUGH THE FILTERS. TOO MUCH PRESSURE MAY CAUSE THE CAP TO SEPARATE FROM THE BODY OF THE CARTRIDGE.** Once flow is established through the cartridge direct the flow into the 5 cm. cuvette until the cuvette is full. Reverse the pressure on the syringe and remove the syringe tip from the cartridge cap. Set the cartridge aside in vertical position.

3.10 The cuvette has two clear and two frosted sides. Hold the cuvette by the frosted sides and carefully insert into the sample port of the machine. Read the right hand digital read-out of the instrument. If the reading is less than 1,000 ppm. the results shall be recorded in the field Soil Analysis Report. If the result is higher than 1,000 ppm, continue with the dilution procedure.

4.0 Dilution Procedure

4.1 When initial readings are greater than 1,000 ppm using the 5 cm. cuvette, pour the contents of the 5 cm. cuvette into a 1 cm. cuvette. Insert the 1. cm cuvette into the metal holder and insert into the test port of the instrument.

4.1 Read the left hand digital read-out of the machine. If the results are less than 10,000 ppm, record the results into the field Soil Analysis Report. If greater than 10,000 ppm, continue the dilution process. **Concentrations >10,000 ppm are to be used for field screen purposes only.**

4.2 Pour the contents of the small cuvette into a graduated glass pipette. Add 10 ml. pure Freon 113 into the pipette. Shake the contents and pour into the 1cm. cuvette. Repeat step 4.2. adding two zeros to the end of the displayed number. If the reported result is greater than 100,000 ppm. the accuracy of further readings through additional dilutions is extremely questionable. **Do not use for reporting purposes.**

4.4 **Pour all sample Freon into the recycling container**.

5.0 Split Samples

5.1 Each tenth test sample shall be a split sample. Decant approximately one half of the extraction solvent through a filter cartridge and insert into the instrument to obtain a concentration reading. Clean and rinse the cuvette and decant the remainder of the fluid to obtain a second concentration reading from the same sample. If the second reading varies by more than 1% from the original, it will be necessary to completely recalibrate the instrument.

QP-13

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Preparing a Paste Extraction

Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure defines the methods to be employed in preparing a paste extraction to be analyzed for conductivity and exchangeable cations.

2.0 Scope

This procedure shall be used in all electrical Conductivity (EC) and Cation Exchange Capacity (CEC) tests.

3.0 Procedure

3.1 All samples shall be prepared in accordance with QP-12.

3.2 Weigh 100 +/- 0.1g soil sample into tared sample reservoir of filter assembly. Add deionized reagent water to fill pores, stirring gently with plastic stirrer to achieve saturation. The solid/water mixture is consolidated occasionally by tapping the container on the workbench. At saturation the surface of the mixture glistens and flows slightly when tipped. Let stand for one hour. The mixture should not stiffen or puddle; add more sample or water as required and allow to stand for one additional hour.

3.3 Analyze paste extract directly for EC and pH.

3.4 Connect filter assembly to vacuum assembly and filter extract until air begins to pass through filter. Analyze directly for Na, Ca, Mg, K.

QP-14

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Conducting Sodium Adsorption Ratio (SAR) Testing

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Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure defines the methods to be employed when conducting sodium adsorption ratio testing from paste extract samples.

2.0 Scope

This procedure shall be used in all SAR's obtained from sample paste extracts.

3.0 Procedure

3.1 All samples shall be prepared in accordance with QP-12 and 13.

3.2 Calibration of the equipment shall be performed daily. Calibrate using a 5 point series of standards. The range of standards must include a blank, and should span the range of expected concentrations of the samples. The following concentrations are appropriate:

Low Range: 0, 1.0, 3.0, 5.0, 10.0 ppm
High Range: 0, 10.0, 20.0, 50.0, 100 ppm

With the instrument on, inject standard mixture with 10 µL syringe and start data collection. Store calibration data under the date of generation for use in subsequent analyses.

3.3 Calibrate instrument in accordance with 3.2. Dilute aqueous extract volumetrically so that sample concentrations fall within the working range of the instrument. Enter sample I.D. and operator name into data collection system. Inject 10 µL sample and start data collection.

3.4 Report cation concentrations to three significant digits. Milliequivilents conversions are automatically performed in the calculation for SAR as follows:

$$\text{soluble cations (meq/100g)} = \left(\left\{\frac{[Na]}{23.0} + \frac{[Ca]}{20.0} + \frac{[Mg]}{12.2} + \frac{[K]}{39.1}\right\} \text{ X SP}\right) / 1000$$

$$SAR = \frac{[Na]}{23.0} / \left(0.5\left\{\frac{[Ca]}{20.0} + \frac{[Mg]}{12.2}\right\}\right)^{-1/2}$$

Where [ ] = concentration in ppm

QP-15

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Determining Distribution of Exchangeable Cations

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Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure defines the methods to be employed when determining the distribution of cations adsorbed on the solid phase.

2.0 Scope

This procedure shall be used in all exchangeable cation distribution testing.

3.0 Procedure

3.1 All samples shall be prepared in accordance with QP-12 and 13.

3.2 Calibration of the equipment shall be performed daily. Calibrate using a 5 point series of standards. The range of standards must include a blank, and should span the range of expected concentrations of the samples. The following concentrations are appropriate:

Low Range: 0, 1.0, 3.0, 5.0, 10.0 ppm
High Range: 0, 10.0, 20.0, 50.0, 100 ppm

With the instrument on, inject standard mixture with 10 μL syringe and start data collection. Store calibration data under the date of generation for use in subsequent analyses.

3.3 Weigh 5 +/- 0.01g sample into fritted extraction tube. Add 20 mL ammonium acetate, cap and shake for 5 minutes. Connect tube into filtration apparatus and collect extract. Repeat three times. Enter sample I.D. and operator name in data collection system. Inject 10 µL into 100mL container of deionized water and shake. Extract 10 µL of dilute sample and inject into sampling port of the ion Chromatograph.

3.4 Report cation concentrations to three significant digits. Milliequivilents conversions are automatically performed in the calculation for SAR as follows:

$$\text{extractable cations} = \left(\left\{\frac{[\mathrm{Na}]}{23.0} + \frac{[\mathrm{Ca}]}{20.0} + \frac{[\mathrm{Mg}]}{12.2} + \frac{[\mathrm{K}]}{39.1}\right\} \ \mathrm{X}\ 10\right) / W$$

soluble cations = (SC X SP) / 1000

EC = extractable cations - soluble cations

Where [ ] = concentration in ppm
W = sample weight, grams

3.5 References:
Methods for Chemical analysis of Water and Wastes; USEPA; EMSL, Cincinnati, OH 1979

Deuel and Holliday, Soil Remediation for the Petroleum Extraction Industry; Houston, Tx., 1993

QP-16

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Determining Cation Exchange Capacity (CEC)

Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure defines the methods to be employed when determining the cation exchange capacity of soils.

2.0 Scope

This procedure shall be used in all CEC testing.

3.0 Procedure

3.1 All samples shall be prepared in accordance with QP-12 and 13.

3.2 Calibration of the equipment shall be performed daily. Calibrate using a 5 point series of standards. The range of standards must include a blank, and should span the range of expected concentrations of the samples. The following concentrations are appropriate:

Low Range: 0, 1.0, 3.0, 5.0, 10.0 ppm
High Range: 0, 10.0, 20.0, 50.0, 100 ppm

With the instrument on, inject standard mixture with 10 µL syringe and start data collection. Store calibration data under the date of generation for use in subsequent analyses.

3.3 Weigh 5 +/- 0.01g sample into fritted extraction tube. Add 30 mL sodium acetate, cap and shake for 5 minutes. Connect tube into filtration apparatus and discard extract. Repeat three times. Rinse sample with 30 mL iso-propyl alcohol, shaken and filtered as above. Add 30 mL ammonium acetate, shake and collect filtrate as in above.Inject 10 µL into 100mL container of deionized water and shake. Extract 10 µL of dilute sample and inject into sampling port of the ion Chromatograph.

3.4 Report cation concentrations to three significant digits. Milliequivilents conversions are automatically performed in the calculation for SAR as follows:

CEC = 10 [Na] / 23.0 W

Where [ ] = concentration in ppm
W = sample weight, grams

3.5 References:

Methods for Chemical analysis of Water and Wastes; USEPA; EMSL, Cincinnati, OH 1979

Deuel and Holliday, Soil Remediation for the Petroleum Extraction Industry; Houston, Tx., 1993

QP-19

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Sampling and Testing Protocol
BTEX Speciation in Soil

Completed By:
Approved By:
Effective Date: / /

1.0 Purpose

This procedure is to be used to determine the concentrations of Benzene, Toluene, Ethyl-Benzene and Xylene (BTEX) in soils.

2.0 Scope

This procedure is to be used as the standard field measurement for soil BTEX concentrations. It is not to be used as a substitute for full spectrographic speciation of organic compounds.

3.0 Procedure

3.1 Sample Collection and Preparation

3.1.1 Collect at least 500 g. of soil from the sample collection point. Take care to insure that the sample is representative of the general background to include visible concentrations of hydrocarbons and soil types. If necessary, prepare a composite sample of soils obtained at several points in the sample area. Take care to insure that no loose vegetation, rocks or liquids are included in the sample(s).

3.1.2 The soil sample(s) shall be immediately inserted into a one quart or larger polyethylene freezer bag and sealed. When sealed, the bag should contain a nearly equal space between the soil sample and trapped air.

3.1.3 The sealed samples shall be allowed to set for a minimum of five minutes at a minimum temperature of 70°F.

3.1.4 The sealed sample bag should be massaged to break up any clods, and to provide the soil sample with as much exposed surface area as practically possible.

3.2 Sampling Procedure

3.2.1 The instrument to be used in conducting VOC concentration testing shall be a Photovac Ion-chromatograph with BTEX Module. Prior to use the instrument shall be zeroed out in accordance with QP-55.

3.2.2 Carefully open one end of the collection bag and insert the probe tip into the bag taking care that the probe tip not touch the soil sample or the side walls of the bag. If VOC analysis was conducted on the sample prior to BTEX analysis, care should be taken to insure that a sufficient air volume exists in the bag to provide accurate results. **If the available air space within the bag is insufficient to run a full analysis, the sample shall be discarded.**

3.2.3 Set the instrument to retain the highest result reading value. Record the reading onto the Field Analytical Report Form and additionally enter the location code into the instrument data logger.

4.0 After testing, the soil samples shall be returned to the sampling location, and the bags collected for off-site disposal. **IN NO CASE SHALL THE SAME BAG BE USED TWICE. EACH SAMPLE CONTAINER MUST BE DISCARDED AFTER EACH USE.**

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Obtaining Water Samples (Cased Wells) Using One Liter Bailer

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Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure outlines the methods to be employed in obtaining water samples from cased monitoring wells.

2.0 Scope

This procedure shall be used for developed, cased water monitoring wells. It is not to be used for standing water samples such as ponds or streams.

3.0 Preliminary

3.1 Obtain sterile sampling containers from the testing laboratory designated to conduct analyses of the water. The shipment should include a Certificate of Compliance from the manufacturer of the collection bottle or vial and a Serial Number for the lot of containers. Retain this Certificate for future documentation purposes.

3.2 The following table shall be used to select the appropriate sampling container, preservative method and holding times for the various elements and compounds to be analyzed.

Compound to be Analyzed	Sample Container Size	Sample Container Description	Cap Requirements	Preservative	Maximum Hold Time
BTEX	40 ml.	VOA Container	Teflon Lined	HCl	7 days
TPH	1 liter	clear glass	Teflon Lined	HCl	28 days
PAH	1 liter	clear glass	Teflon Lined	Ice	7 days
Cation / Anion	1 liter	clear glass	Teflon Lined	None	48 Hrs.
Metals	1 liter	HD polyethylene	Any Plastic	Ice / HNO_3	28 Days
TDS	300 ml.	clear glass	Any Plastic	Ice	7 Days

4.0 Chain of Custody

4.1 Prepare a Sample Plan. The plan will list the well identification and the individual tests to be performed at that location. The sampler will check the list against the available inventory of appropriate sample collection bottles to insure against shortage.

4.2 Transfer the data to the Laboratory Chain of Custody Form. Complete all sections of the form except those that relate to the time of delivery of the samples to the laboratory.

4.3 Pre-label the sample collection jars. Include all requested information except time of collection. (Use a fine point Sharpie to insure that the ink remains on the label). Affix the labels to the jars.

5.0 Bailing Procedure

5.1 Identify the well from the site schematics. Place pre-labeled jar(s) next to the well. Remove the bolts from the well cover and place the cover with the bolts nearby. Remove the plastic cap from the well bore by first lifting the metal lever and then unscrewing the entire assembly.

5.2 The well may be equipped with an individual 1 liter bailing tube. If so, use the tube to bail a volume of water from the well bore equal to 10 liters for each 5' of well bore in the water table. (This assumes a 2" dia. Well bore).

5.3 Take care to insure that the bailing device and string do not become cross-contaminated. A clean pair of rubber gloves should be used when handling either the retrieval string or bailer. The retrieval string should not be allowed to come into contact with the ground.

6.0 Sampling Procedure

6.1 Once the well has been bailed in accordance with 5.2 of this procedure, a sample may be decanted into the appropriate sample collection jar directly from the bailer. The collection jar should be filled to the brim. Once the jar is sealed, turn the jar over to detect any bubbles that may be present. Add additional water to remove all bubbles from the sample container.

6.2 Note the time of collection on the sample collection jar with a fine Sharpie.

6.3 Place the sample directly on ice for transport to the laboratory. The preceding table shows the maximum hold times between collection and testing for the various analyses.

6.4 Complete the Chain of Custody form to include the collection times for each sample. Deliver all samples to the laboratory.

7.0 Documentation

7.1 The testing laboratory shall provide the following minimum information:

A. Client, Project and sample name.
B. Signed copy of the original Chain of Custody Form including data on the time the sample was received by the lab.
C. Results of the requested analyses
D. Test Methods employed
E. Quality Control methods and results

QP-77

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Obtaining Soil Samples for Transportation to a Laboratory

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Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure outlines the methods to be employed when obtaining soil samples to be taken to a laboratory for analysis.

2.0 Scope

This procedure shall be used for developed, cased water monitoring wells. It is not to be used for standing water samples such as ponds or streams.

3.0 Preliminary

3.1 Obtain sterile sampling containers from the testing laboratory designated to conduct analyses of the soil. The shipment should include a Certificate of Compliance from the manufacturer of the collection bottle or vial and a Serial Number for the lot of containers. Retain this Certificate for future documentation purposes.

3.2 If collecting TPH, BTEX, RCRA 8 metals, cation / anions or O&G, the sample jar may be a clear 4 oz. container with Teflon lid. If collecting PAH's, use an amber 4 oz. container with Teflon lid.

4.0 Chain of Custody

4.1 Prepare a Sample Plan. The plan will list the number, location and designation of each planned sample and the individual tests to be performed on the sample. The sampler will check the list against the available inventory of appropriate sample collection bottles to insure against shortage.

4.2 Transfer the data to the Laboratory Chain of Custody Form. Complete all sections of the form except those that relate to the time of delivery of the samples to the laboratory.

4.3 Pre-label the sample collection jars. Include all requested information except time of collection. (Use a fine point Sharpie to insure that the ink remains on the label). Affix the labels to the jars.

5.0 Sampling Procedure

5.1 Go to the sampling point with the sample container. If not analyzing for ions or metals, use a trowel to obtain the soil. Do not touch the soil with your bare hands. Use new latex gloves with each sample to help minimize any cross-contamination.

5.2 Pack the soil tightly into the container leaving the top slightly domed. Screw the lid down tightly. Enter the time of collection onto the sample collection jar label.

5.3 Place the sample directly on ice for transport to the laboratory.

5.4 Complete the Chain of Custody form to include the collection times for each sample. Deliver all samples to the laboratory.

7.0 Documentation

7.1 The testing laboratory shall provide the following minimum information:

A. Client, Project and sample name.
B. Signed copy of the original Chain of Custody Form including data on the time the sample was received by the lab.
C. Results of the requested analyses
D. Test Methods employed
E. Quality Control methods and results

QP-78

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Obtaining Water Samples (Cased Wells) Using Enviro-Tech ES-60 Pump

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Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure outlines the methods to be employed in obtaining water samples from cased monitoring wells.

2.0 Scope

This procedure shall be used for developed, cased water monitoring wells. It is not to be used for standing water samples such as ponds or streams.

3.0 Preliminary

3.1 Obtain sterile sampling containers from the testing laboratory designated to conduct analyses of the water. The shipment should include a Certificate of Compliance from the manufacturer of the collection bottle or vial and a Serial Number for the lot of containers. Retain this Certificate for future documentation purposes.

3.2 The following table shall be used to select the appropriate sampling container, preservative method and holding times for the various elements and compounds to be analyzed.

Compound to be Analyzed	Sample Container Size	Sample Container Description	Cap Requirements	Preservative	Maximum Hold Time
BTEX	40 ml.	VOA Container	Teflon Lined	HCl	7 days
TPH	1 liter	clear glass	Teflon Lined	HCl	28 days
PAH	1 liter	clear glass	Teflon Lined	Ice	7 days
Cation / Anion	1 liter	clear glass	Teflon Lined	None	48 Hrs.
Metals	1 liter	HD polyethylene	Any Plastic	Ice / HNO_3	28 Days
TDS	300 ml.	clear glass	Any Plastic	Ice	7 Days

4.0 Chain of Custody

4.1 Prepare a Sample Plan. The plan will list the well identification and the individual tests to be performed at that location. The sampler will check the list against the available inventory of appropriate sample collection bottles to insure against shortage.

4.2 Transfer the data to the Laboratory Chain of Custody Form. Complete all sections of the form except those that relate to the time of delivery of the samples to the laboratory.

4.3 Pre-label the sample collection jars. Include all requested information except time of collection. (Use a fine point Sharpie to insure that the ink remains on the label). Affix the labels to the jars.

5.0 Bailing Procedure

5.1 Identify the well from the site schematics. Place pre-labeled jar(s) next to the well. Remove the bolts from the well cover and place the cover with the bolts nearby. Remove the plastic cap from the well bore by first lifting the metal lever and then unscrewing the entire assembly.

5.2 Lower the ES-60 pump into the monitor well bore taking care to insure that the pump and first 10' of hose and cable does not touch the ground or become cross-contaminated by contact with anything containing hydrocarbon residues. When the pump reaches the bottom of the well bore you will feel the hose and cable assembly go slack. Lift the pump a minimum distance of 18" above the bottom of the well bore and clamp the hose assembly to the top of the well bore by means of vice grips. (Take care to insure that the vice grips are adjusted so as not to "choke" the hose.

5.3 Attach the electrical cable leads to an automobile battery and begin pumping the well bore. If the pump does not bring fluid to the surface within one minute, disconnect the electrical leads, and re-connect for four seconds three times to remove air cavitation.

5.4 The pump has a minimum volume of 2.8 gallons per minute at 60'. Purge the well by pumping for a minimum of 10 minutes before taking a sample.

6.0 Sampling Procedure

6.1 Once the well has been bailed in accordance with 5.2 of this procedure, a sample may be decanted into the appropriate sample collection jar directly from the bailer. The collection jar should be filled to the brim. Once the jar is sealed, turn the jar over to detect any bubbles that may be present. Add additional water to remove all bubbles from the sample container.

6.2 Note the time of collection on the sample collection jar with a fine Sharpie.
6.3 Place the sample directly on ice for transport to the laboratory. The preceding table shows the maximum hold times between collection and testing for the various analyses.
6.4 Complete the Chain of Custody form to include the collection times for each sample. Deliver all samples to the laboratory.

7.0 Decontamination

7.1 After removing the pump from the well, use an aerosol spray pump bottle filled with denatured isopropyl alcohol to clean the pump and first 10' of the cable and hose assembly. Rinse the sprayed portion with distilled water to remove the alcohol and dry with a clean rag. Discard the rag after each use. During transport, the pump assembly should be carried in a 2" PVC protective sleeve.

8.0 Documentation

8.1 The testing laboratory shall provide the following minimum information:

A. Client, Project and sample name.
B. Signed copy of the original Chain of Custody Form including data on the time the sample was received by the lab.
C. Results of the requested analyses
D. Test Methods employed
E. Quality Control methods and results

VADSAT Modeling

This section contains copies of the data input sheets and results of migration models for hydrocarbon and brine at the White "A" State # 1 site.

Modeling Data Entry
Chaparral White "A" State # 1

Control Data	Entry	U / M
Deterministic	Yes	
Monte Carlo	No	
Evaporation	No	
Biodecay	No	
Low Permeability Layer Below Contamination	No	

Source Data		
Waste Zone Thickness	5	meters
Waste Zone Area	433	sq. meters
Ratio of Length to Width	1:1	
Soil Thickness Above Waste Zone	1	meter
Contaminant Concentration in Soil / Waste Zone	100,000	ppm
Hydrocarbon Concentration in Soil / Waste Zone	100,000	ppm

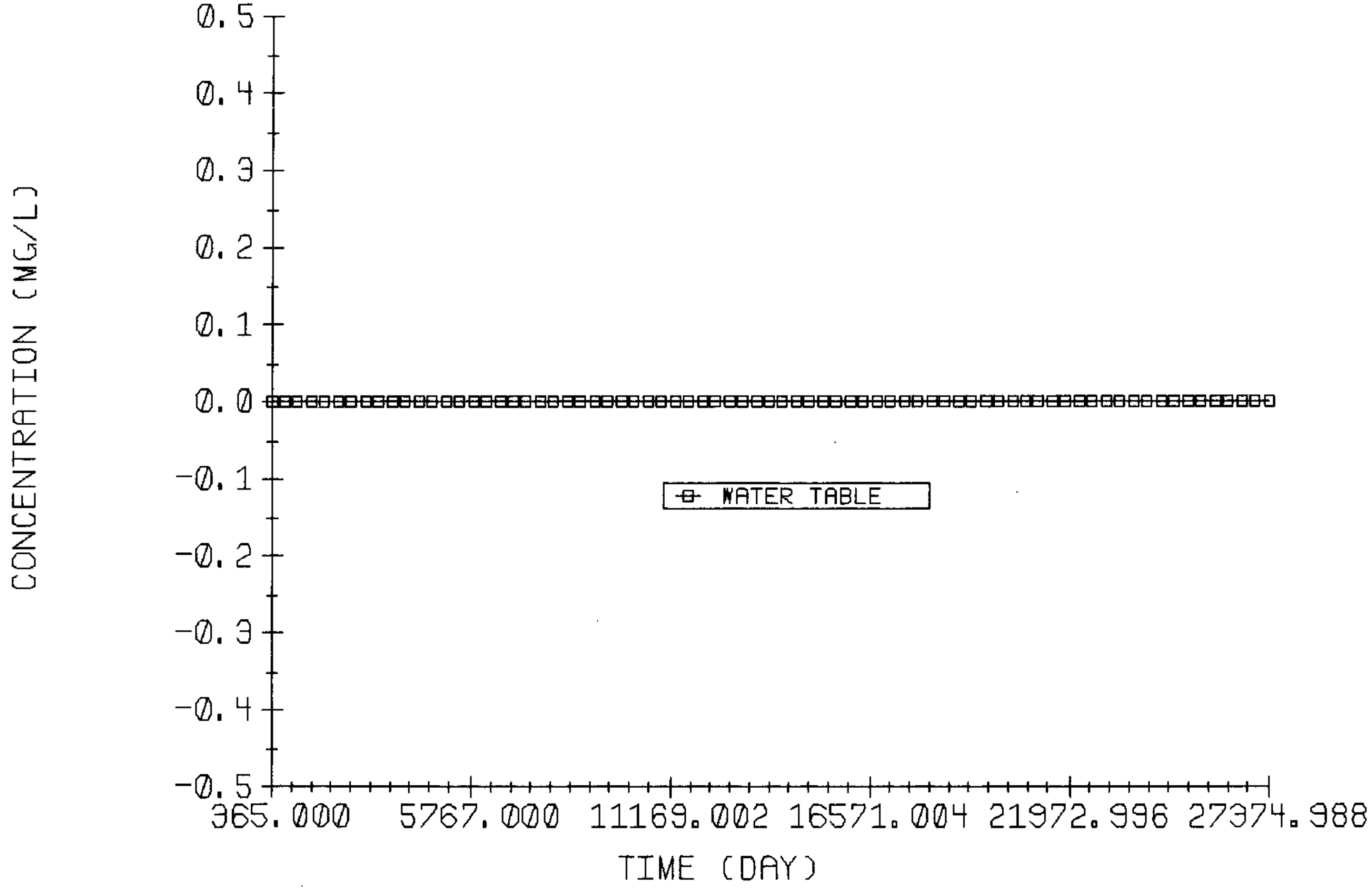
Chemical Data	
Benzene	Yes

Unsaturated Zone		
Biodecay Cooefficient	0	
Organic Carbon Fraction	0	
Soil Database	**Clay**	
Hydrological Database	Sedimentary	
Unsaturated Zone Thickness	40	meter
Soil Database	**Clay**	
van Genuchten n	1.09	(Default)
Residual Water Content	0.01001	
Unsaturated Zone Dispersivity	0	Internally

Saturated Zone		
Biodecay Cooefficient	0	
Aquifer Porosity	0.2	(Default)
Organic Carbon Fraction	0	Internally
Longitudinal Dispersivity	0	Internally
Ratio of Long. / Trans. Dispersivities	3	
Ratio of Trans. / Vert. Dispersivities	3	
Hydrological Database	Sedimentary	
Aquifer Thickness	10	meters / day
Aquifer Gradient	0.00357	
Saturated Hydraulic Conductivity	0.13	meters / day

Net Infiltration Rate	0.00001	ft. / day

CONCENTRATION VS. TIME



Modeling Data Entry
Chaparrel White "A" State # 1
NaCl

Control Data	Entry	U / M
Deteministic	Yes	
Monte Carlo	No	
Evaporation	No	
Biodecay	No	
Low Permeability Layer Below Contamination	No	

Source Data		
Waste Zone Thickness	5	meters
Waste Zone Area	433	sq. meters
Ratio of Length to Width	1:1	
Soil Thickness Above Waste Zone	1	meter
Contaminant Concentration in Soil / Waste Zone	10,000	ppm
Soluable Concentration in Soil / Waste Zone	10,000	ppm

Chemical Data	
NaCl	Yes

Unsaturated Zone		
Biodecay Cooefficient	0	
Organic Carbon Fraction	0	
Soil Database	**Clay**	
Hydrological Database	Sedimentary	
Unsaturated Zone Thickness	20	feet
Soil Database	**Clay**	
van Genuchten n	1.09	(Default)
Residual Water Content	0.01001	
Unsaturated Zone Dispersivity	0	Internally

Saturated Zone		
Biodecay Cooefficient	0	
Aquifer Porosity	0.2	(Default)
Organic Carbon Fraction	0	Internally
Longitudinal Dispersivity	0	Internally
Ratio of Long. / Trans. Dispersivities	3	
Ratio of Trans. / Vert. Dispersivities	3	
Hydrological Database	Sedimentary	
Aquifer Thickness	10	meters
Aquifer Gradient	0.00357	
Saturated Hydraulic Conductivity	0.13	meters / day

Net Infiltration Rate	0.00001	ft. / day

CONCENTRATION VS. TIME