1R - 0432

REPORTS

DATE:

2005

Whole Earth Environmental, Inc.
2103 Arbor Cove
Katy, Tx. 77494
281.394.2050
whearth@msn.com

IR 432

November 2, 2005

NMOCD
1220 South Saint Francis Dr.
Sante Fe, NM 87505

Attn: Wayne Price

Dear Wayne:
Enclosed, please find a copy of the closure report for the Devon Dickinson Project. Additional copies of the report are being forwarded to your Hobbs office and to the landowner, Darr Angell.

Thank you again for all of your guidance and quick responses throughout the project. It was sincerely appreciated.

Warmest personal regards,

Mike Griffin
President
Whole Earth Environmental, Inc.

devon
ENERGY CORPORATION

B.C. Dickinson Remediation Project Closure Report

Whole Earth Environmental
2103 Arbor Cove
Katy, TX 77494
281.394.2050
whearth@msn.com

Executive Summary

Location

The site is located approximately nine miles northwest of the City of Lovington, Lea County, New Mexico on fee lands. The primary land use is grazing of cattle however extensive oil and gas operations are prevalent in the area. The area is semi-arid with a net precipitation / evaporation amount of –73” per year. The legal description of the site is the NW 1/4 of the SW ¼ Section 1, Township 15 South, Range 37East. at an approximate elevation of 3,800 feet above mean sea level. (See exhibits 1-2)

Setting

A thin veneer of windblown sand covers the site and overlies the Ogallala formation. The Ogallala formation consists of poorly to well-cemented sand and sandstone, interbedded with clay, silt and gravel. The Ogallala overlies the Triassic age Chinle formation consisting chiefly of mudstone, shale and sandstone. Groundwater is found at a depth of approximately 60’ below ground surface.

Site History

We’ve little history of the location however from the surface features and aerial photography, it appears that the site was used as a bulk storage and processing point for crude oil and natural gas. A production pit appears to have been in use as a repository for tank bottoms and the storage of contaminated soils. (See exhibits 3-4)

Previous Investigations

The site was characterized by the presence of two plumes of hydrocarbon contamination and one of chlorides. The first appears to be centered within the production pit having TPH concentrations of 1,798 ppm extending to a depth of 60’ below ground surface (soil boring # 6). This contaminant plumes appear to consist mainly of aliphatic fractions with a minor BTEX component. The BTEX appeared to drop to acceptable levels at a depth of 55’ bgs.

One significant chloride reading (874 ppm) was discovered at the southeast corner of the pit at a depth of 40’ below ground surface. There is no data regarding the chloride concentrations within the vertical soil profile of the monitor well situated approximately 10’ down-gradient of the anomaly however the chloride concentrations within this monitor well (MW-1) are 363 ppm.

The second area of concern centered around soil boring # 4 in which TPH concentrations of 4,420 ppm are found at a depth of 10' below ground surface and extend to a minimum depth of 55' bgs at a concentration of 242 ppm. Again, the plume appeared to be aliphatic in makeup as the BTEX component cleans up at a depth of approximately 15' bgs.

The final area of concern was the comparatively high chloride concentrations contained within monitor well no. 2. Though no BTEX component was discovered, the groundwater chloride concentrations within this well are 1,360 ppm.

The soil morphology is initially sandy to a depth of approximately 5-7' followed by a 12-15' band of soft caliche underlain by yet another 20' sand lens atop a denser caliche layer. The bulk of the hydrocarbon plume was situated between the caliche bands.

A series of seven monitor wells were advanced prior to remediation activities at the location and the analytical results were used to prepare a preliminary contaminant migration model. (See exhibits 5-7)

Two additional monitor wells were advanced to the south and east of the facility to fully define the lateral extent of contamination. Both wells were found to have non-detectable concentrations of BTEX and nominal chlorides.

Preliminary Modeling

Based on the previous site borings, a comprehensive contaminant migration model was prepared by Dr. Jan M.H. Hendrickx of New Mexico State University. The model data indicated that the contaminant migration from the main plume may be effectively retarded by excavating the extensive surface contamination and placing a one foot layer of compacted clay atop the remaining minor concentrations. Our protocol doubled the thickness of the clay cap to twenty-four inches.

Remediation Activities

Surface Preparation

Prior to major excavation activities, the fence line was extended approximately 100' north and 250' west of the original location. All surface and buried flowlines, metal structures and steel barrels were tested for the presence and concentration of naturally occurring radioactivity materials (NORM), and removed for commercial disposal. (See exhibits 8-9)

Well Plugging

Monitor well no. 2 was situated within the battery area had to be plugged and removed prior to excavation activities. The metal surface box and all accessible plastic casing were removed. The bore hole was then grouted from bottom to surface with cement. (See exhibits 10-11)

Excavation – Battery Area

The plume source centered at the battery area was excavated to an average depth of 5' below ground level with the salt contaminated soils stockpiled for subsequent dilution and re-burial. Approximately 3,500 cubic yards of materials were excavated within the battery area. (See exhibit 12)

Excavation – Pit Area

The excavation of the pit area proved to be especially difficult due to the presence of dozens of large, extremely hard boulders found generally at a depth of 10-15' bgs. (See exhibit 13). An examination of these indurated sandstone formations indicated that despite being in an environment saturated with hydrocarbons and brine for extended periods, the fluid penetration extended only fractions of an inch. (See exhibit 14).

The site was excavated to a total depth of 25' below ground surface at which point we encountered another solid layer of dense sandstone making further excavation impossible without extraordinary efforts such as blasting. The layer is at least five feet thick and extends well outside the project area evidenced by our inability to even drill through it using a conventional auger rig. Each side-wall and the bottom of the excavation was composited and forwarded to Environmental Lab of Texas for confirmation testing. (See the Laboratory Analytical section of this report.). A total of approximately 26,000 cubic yards were excavated within the pit area. Final excavation is illustrated by exhibit 15.

Clay Liner

A two foot layer of clay was placed within the excavation and compacted to achieve a coefficient of permeability of 1.7 X 10-7. (See exhibits 16-18).

Dilution and Backfill

All hydrocarbon and brine contaminated soils were mixed and blended with additional materials located immediately west of the main excavations. Each lift batch (generally measuring approximately 1-2,000 cubic yards), was field tested for the presence and concentrations of hydrocarbons and brine prior to being replaced within the excavations. (See exhibit 19) Each 3' lift was composited and forwarded to Environmental Lab of Texas for confirmation testing. (See the Laboratory Analytical section of this report.).

Each backfill lift was watered and compacted to achieve high density and eliminate the "fluffing" phenomenon normally associated with excavated calichi. The locations and dimensions of each excavated area are described within exhibit 20.

Re-vegetation

The surface of the work zone was contoured to match background elevations and provide positive drainage, hydro-mulched with a combination of 13-13-13 fertilizer, winter oats and rye to provide organic cover over the first winter and a mixture of 70% Loving Blue Gramma and 30% Sideoats Gramma per the landowner's request.

Exhibits Index

1. Satellite Photo of Location (Zoom Out)
2. Satellite Photo of Location (Zoom In)
3. USGS 7.5' Map (Zoom Out)
4. USGS 7.5' Map (Zoom In)
5. Plat Map of Excavated Areas
6. Overall View of Location Prior to Remediation
7. Pipe Removal Detail
8. Well Plugging Detail
9. Boring Log of Plugged Well
10. Initial Excavation of Battery Area
11. Detail of Typical Boulder Situated Within Excavation
12. Detail of Fluid Penetration Within Indurated Sandstone
13. Detail of Main Pit Area at Point of Maximum Excavation
14. Detail of Clay Compaction
15. Detail of Backfilling Operations
16. Gradient Chart
17. Monitor Well Geocoordinates
18. Clay Proctor
19. Clay Compaction Test Certificate
20. Excavation Depth Chart

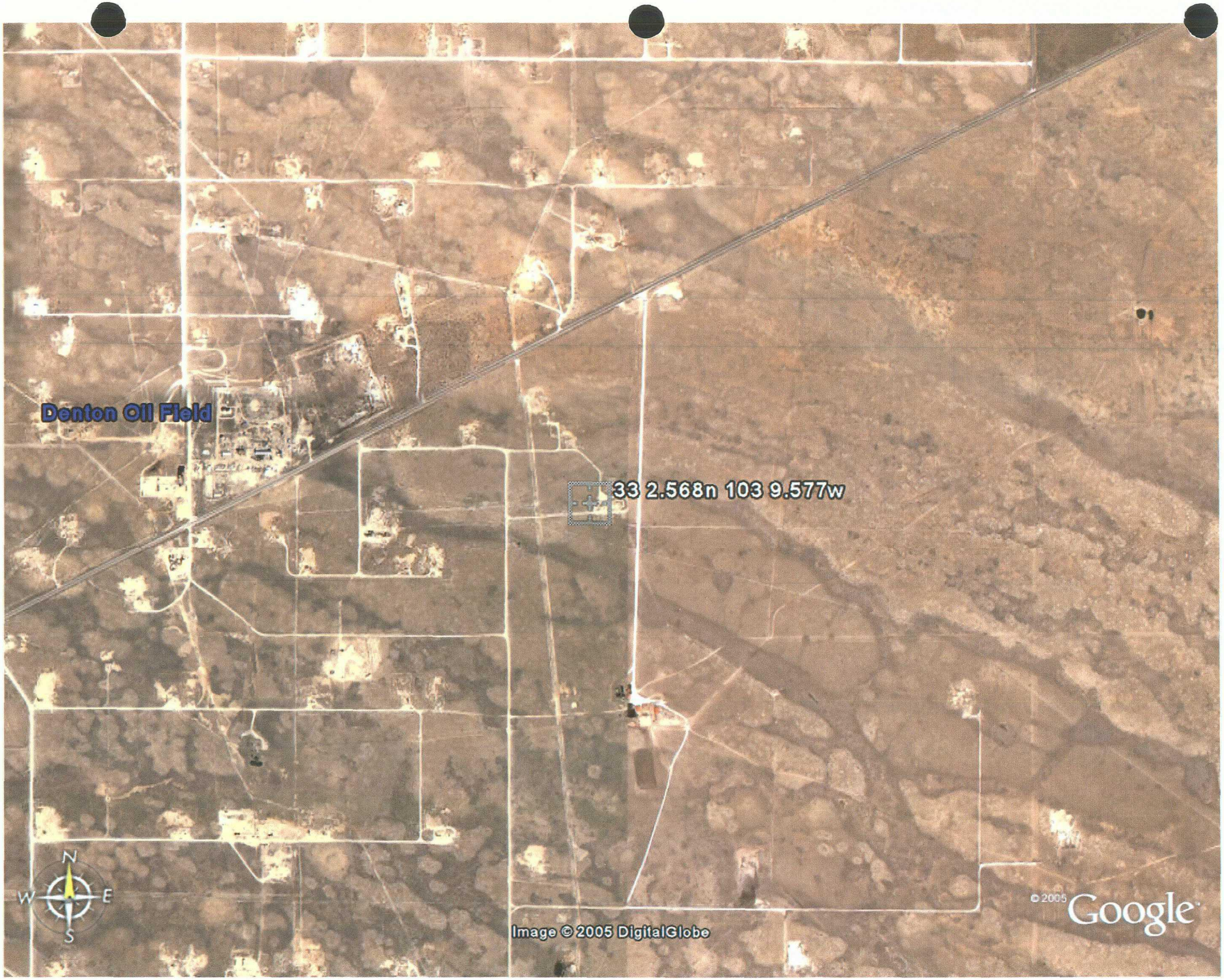
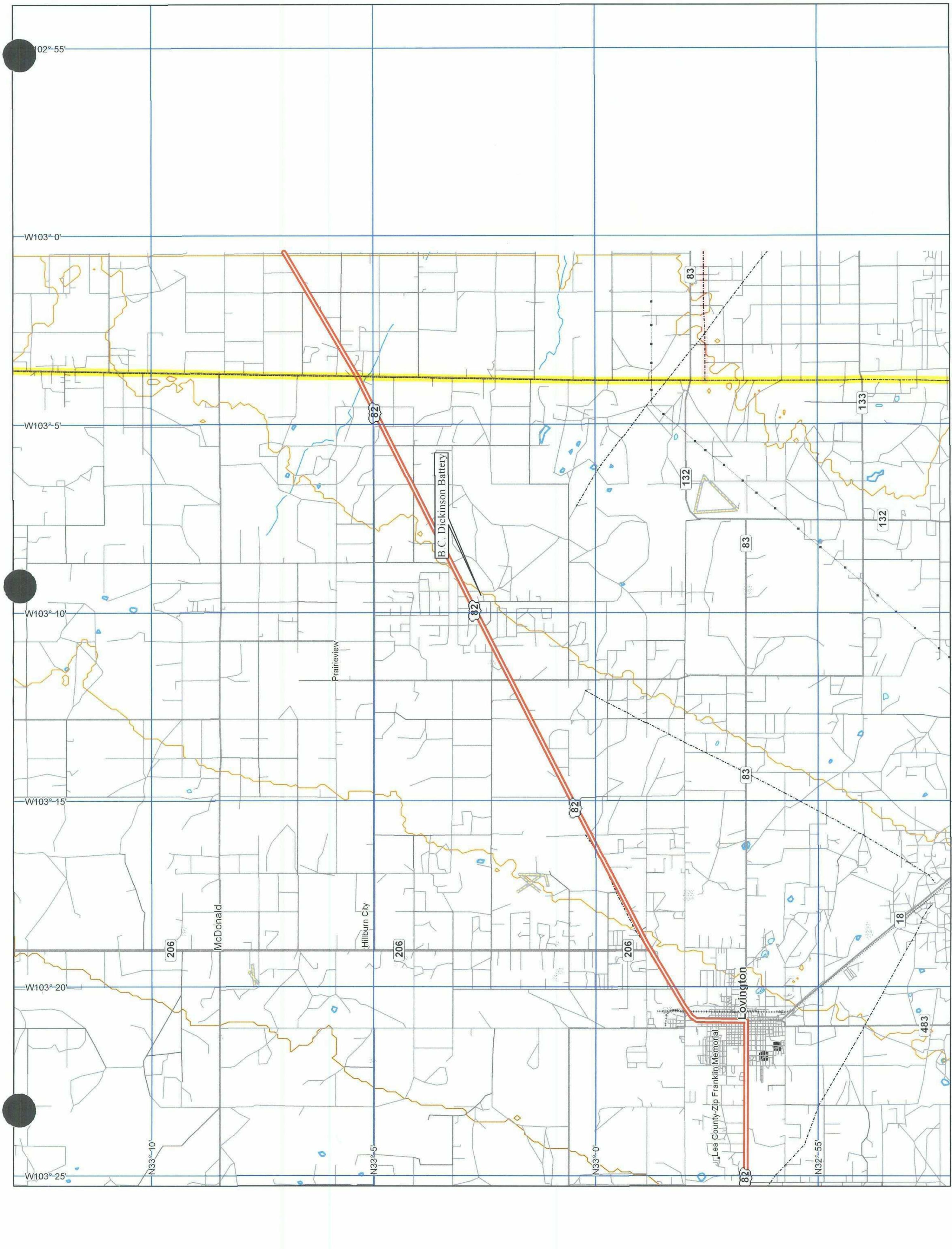


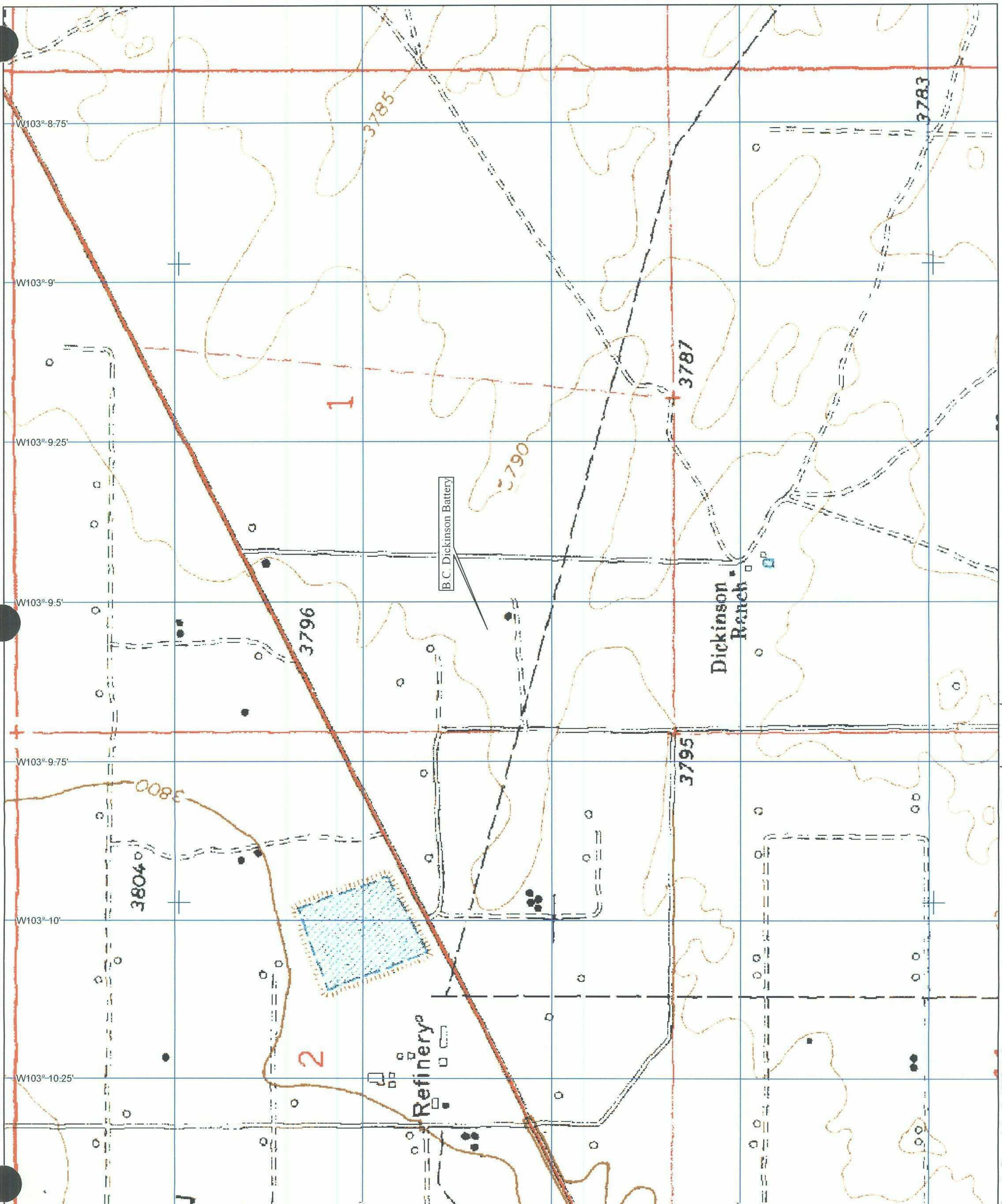
Image © 2005 DigitalGlobe

© 2005 Google


33 2.568n 103 9.577w
N
W
E
S
Image © 2005 DigitalGlobe
© 2005 Google

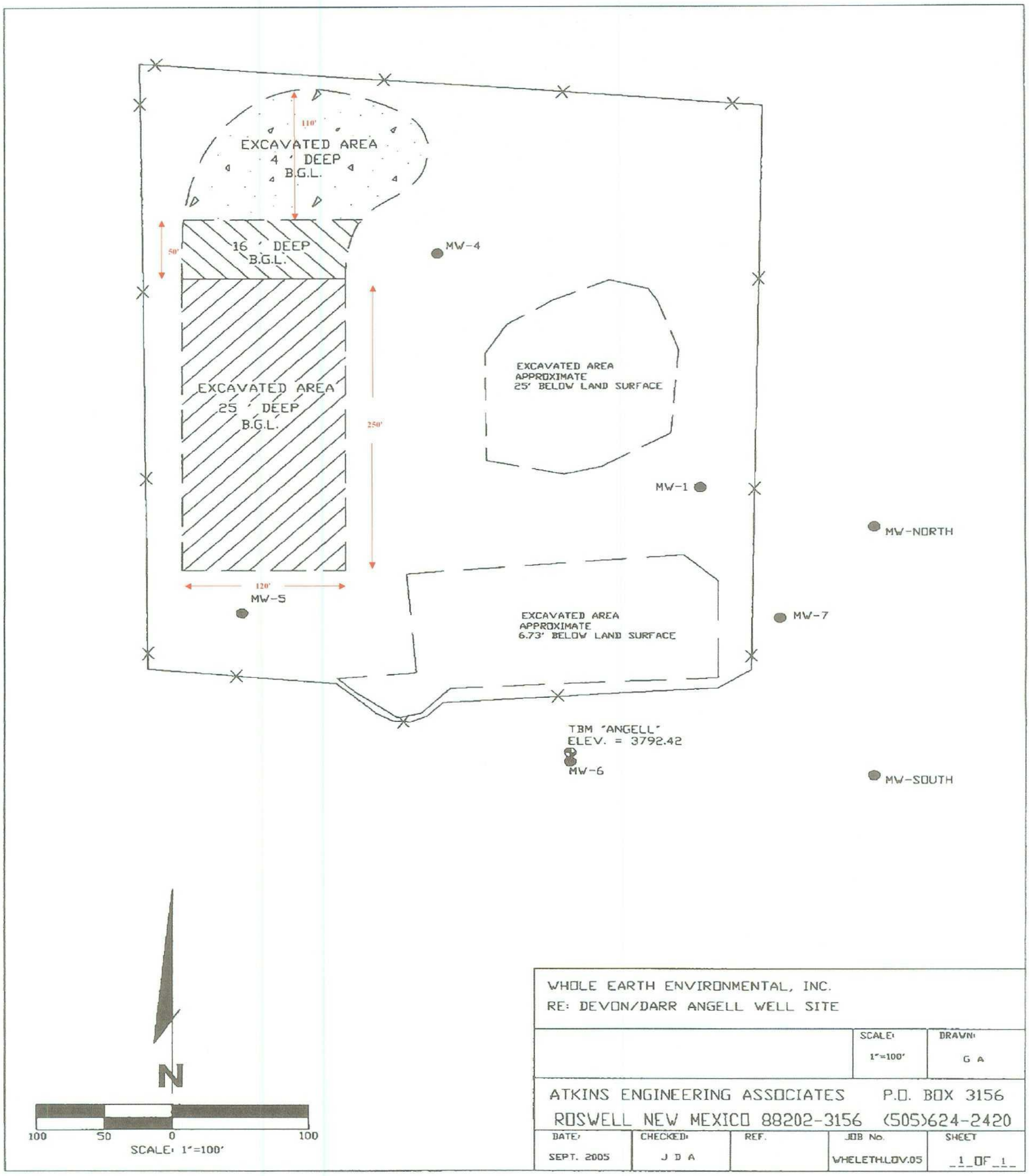


3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 1 mi Scale: 1 : 200,000 Detail: 10-0 Datum: NAD27



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS

500 ft Scale: 1 : 12,800 Detail: 14-0 Datum: NAD27



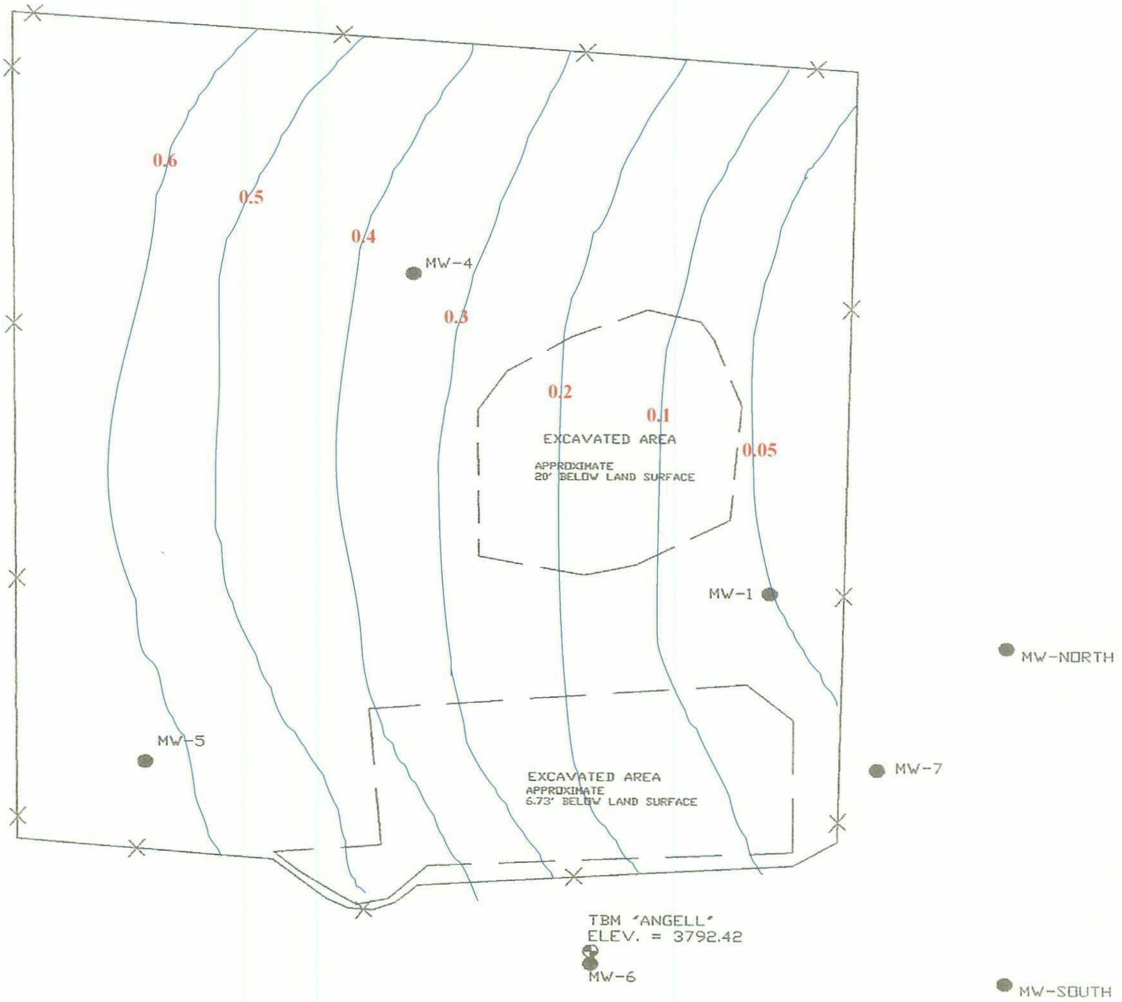
WHOLE EARTH ENVIRONMENTAL, INC.
RE: DEVON/DARR ANGELL WELL SITE

	SCALE:	DRAWN:
	1"=100'	G A

ATKINS ENGINEERING ASSOCIATES P.O. BOX 3156
ROSWELL NEW MEXICO 88202-3156 (505)624-2420

DATE:	CHECKED:	REF.	JOB No.	SHEET
SEPT. 2005	J D A		WHELETH.LOV.05	1 OF 1

Devon Energy Corporation
B.C. Dickinson Remediation Project
Hydrostatic Gradient



Whole Earth Environmental,Inc.
Devon/Darr Angell Site

Well #	State Plane Northing	State Plane Easting	Land Surface Northing	Land Surface Easting	M.S.L. Elevation
MW-1	745232.03	901340.68	745232.06	901340.69	3792.79
MW-4	745432.03	901147.63	745432.08	901147.61	3793.41
MW-5	745124.35	901004.03	745124.37	901004.00	3792.86
MW-6	744996.87	901245.15	744996.87	901245.15	3792.52
MW-7	745120.57	901399.10	745120.58	901399.12	3792.80
MW-South	744985.34	901468.30	744985.34	901468.33	3792.48
MW-North	745198.28	901468.49	745198.30	901468.52	3793.45
TBM	745000.81	901244.20	745000.81	901244.20	3792.42

Notes:

1.Horizontal coordinates are State Plane NAVD 83 datum referenced to USCGS Triangulation Station named “CREAK”.

2.Elevations are NAVD 88 datum referenced to USCGS Bench Mark named “G-35".

3. Elevations on monitor wells are taken on top of 2'x2' cement pad as requested by Mike Griffin in field 4-12-05.

4. TBM is ½" reinforcing bar with aluminum cap marked “ANGELL” located on the north side of the cement 2'x2' pad of monitor well 6.


10.02.2004 10:35


IW
Transportation
03 . 29 . 2005 15:00


03.28.2005 11:35

ATKINS ENGINEERING ASSOCIATES, INC.
Professional Engineering / Land Surveying
Water Resources Environmental Science

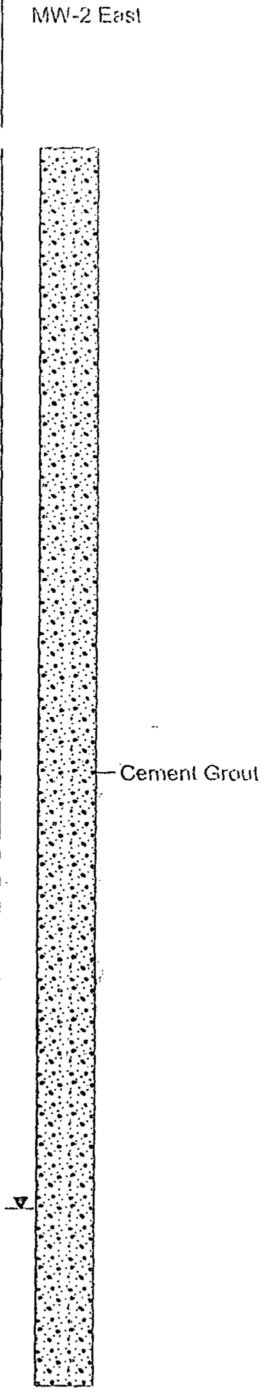
Log of Boring Monitor Well 2 East

Whole Earth Environmental
2103 Arbor Cove
Katy, TX 77494

Contact: Mike Griffin
Job#: WHELETH.LOV.05

Date : 03-28-05
Boring Location : Southeast corner of site
Site Location : Dickerson Lease, Lovington, NM

Depth in Feet	GRAPHIC	USCS	Sample	DESCRIPTION
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75				Plug and abandon Monitor Well #2 East located on Devon/Darr Angell Ranch at the Dickerson Lease, Lovington, NM. Water Level 62.0' ground level Total Depth 72.48' ground level Was not able to pull the casing from well. Grouted well through the casing. 47 gallons of grout used at ±10 lbs. per gallon.



03-29-2005 C:\Program Files\mtech2002\whole1\2east.bor


CATERPILLAR
CAT
CATERPILLAR
CAT
CATERPILLAR
04.07.2005 10:11


03.24.2005 15:20
MSA

03.24.2005 14:22


05.16.2005 09:37


INGERSOLL-RAND
05.18.2005 09:35


05.20.2005 10:17

Quality Control Engineering, Inc.

1136 W. Hobbs Roswell, NM 88203
505-625-0005 Fax: 625-0555

700 E. First #725C, Alamogordo, NM 88310
505-439-1285 Fax: 439-1283

SOIL REPORT

ASTM D75, D698/1557, C127, C136, C117, D854, D2216, D2487, D4318, D4718

Project Marley Ranch, clay **Job #** 322 **Lab #** A19 **Sample #** 1

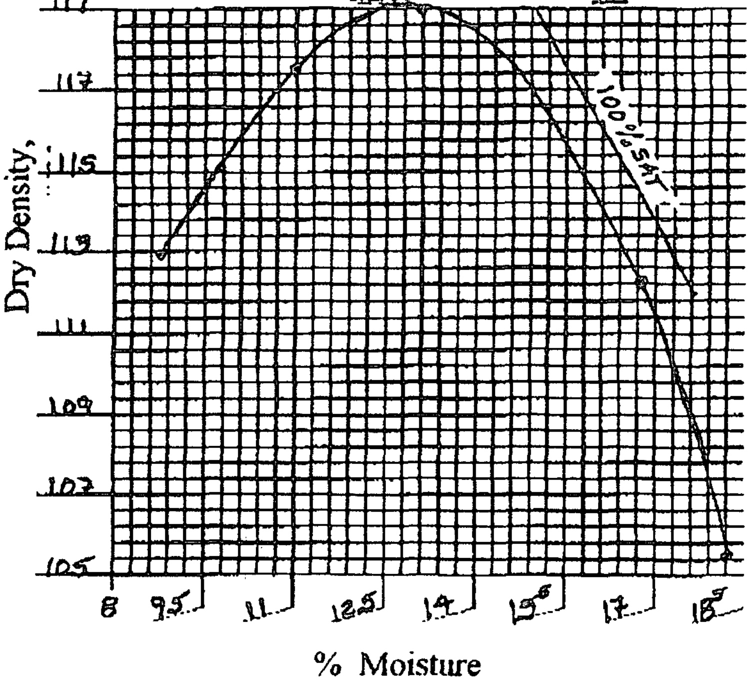
Client name & address Gandy Marley, Inc., P.O. Box 827, Tatum, NM 88267 Phone: 505-398-4960 Fax: 396-6887

Material source Marley Ranch, clay **Contractor** NA

Date sampled 2/15/05 **By** JT (client) **Rec'd** 2/15/05 **Tested** 2/16-18/05 **By** GH

3/2/05 GH

U.S. Standard Sieve No.	Cumulative % Retained	Cumulative % Passing	Specs
3"	0%	100%	
1 1/2"	0%	100%	
1"	0%	100%	
3/4"	0%	100%	
3/8"	0%	100%	
#4	0%	100%	
#10	9%	91%	
#40	19%	81%	
#200	44.7%	55.3%	



Material Classification (field) Sandy Clay

0% Gravel
45% Sand
55% Fines

LL=30 PI=15

Coefficient of Permeability=1.7X10-7
(@ 89.5% compaction of D698A)
(See attached)

Test Method ASTM Manual	Max. Dry Density	Optimum Moisture
D698 Method A	118.4 pcf uncorrected	13.3% uncorrected
Nat'l moist 11%		G_S= 2.659

Submitted by: K Byrd Humphreys 3/2/05
K. Byrd-Humphreys

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

Flexible Wall Hydraulic Conductivity
Falling Head

ATTN: Ms. Katy Byrd-Humphreys, PE
Quality Control Engineering, Inc.
1136 W. Hobbs St.
Roswell, NM 88203

Project: QCE Contract Testing File No.: 05-022
Soil Type: Clay Date March 1, 2005 Lab No.: 46894
Sampled From: Marley Ranch; Job# 322, Lab# A19, Sample# 1 Performed By: GWG

TEST SPECIMEN CONDITIONS AT BEGINING OF TEST:

Wet Unit Weight: 122.1 pcf
Dry Unit Weight: 106.3 pcf

% Moisture: 14.9
% Compaction: 89.5
% Compaction Requested: 90.0

PROCTOR INFORMATION:

Proctor Method: ASTM D-698-A
Maximum Dry Density: 118.8 pcf
Optimum Moisture Content: 13.1 %

Coefficient of Permeability, k_{20}: 1.7×10^{-7} cm/sec.

Remarks: Sample compacted at 2.0% above optimum moisture content.

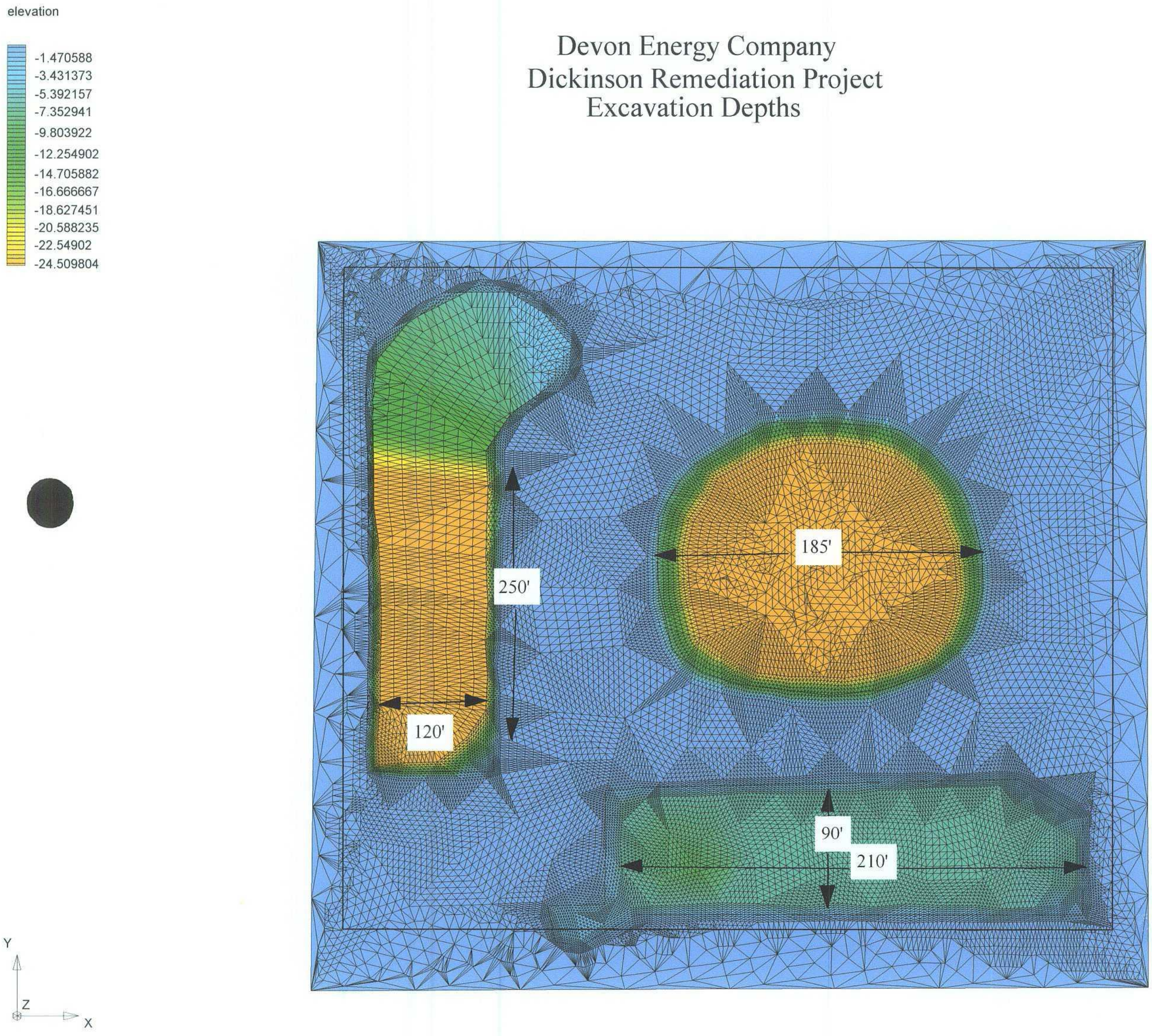
Reviewed By:
BWB

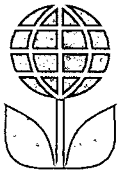
Reviewed By:

Certified By:

C:\Documents and Settings\Owner\My Documents\APE\Files\Form Masters\Excel Test Reports Master\[46894 Permeability.xls]Report

Devon Energy Company
Dickinson Remediation Project
Excavation Depths





Protocol

This section contains a copy of PR-57D, the final remediation protocol employed on this project.

PR-57D

Remediation Protocol
Devon Energy Corporation
B.C. Dickinson Battery

1.0 Purpose

This protocol is to provide a detailed outline of the steps to be employed in the remediation and closure of the B.C. Dickenson Battery located east of Lovington, New Mexico.

2.0 Scope

This protocol is site specific for the Devon Energy B.C. Dickenson remediation project.

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 Devon, the NMOCD and the landowner to review and approve this protocol.

3.1.2 Changes to this protocol will be documented and submitted for final review by all parties prior to the initiation of actual field work.

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 Client 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, New Mexico One Call will be notified. 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.

4.5 Prior to any field operations, Whole Earth will prepare and submit to Devon Energy a detailed site Health and Safety Plan.

5.0 Preliminary Activities

5.1 All barrels, trash and piping will be scanned for the presence and concentration of naturally occurring radioactive materials (NORM). Any component containing radiation reading exceeding 10 μrems above background will be segregated for further inspection by a third party certified to work in New Mexico on radioactive materials.

5.2 All clean trash will be collected and sent to a commercial disposal facility. A manifest will be generated and signed by the disposal company. All such manifests shall be collected and included within the final closure report.

5.3 All cement shall be collected and deep buried on-site. The top of the cement shall be a minimum distance of 5' below ground level.

5.4 Monitor well no. 2 will be grouted to surface prior to excavation and replaced if required at the conclusion of the project.

6.0 Remediation

6.1 All berms and assorted piles of contaminated soils will be spread to a maximum depth of 6 inches on the surface of the site. The contaminated soils shall be set aside of the excavation but within the fence perimeter.

6.2 The side walls and bottom of each excavated area shall be field screened for the presence and concentration of TPH by means of EPA method 418.1 (modified). Excavation of each site shall continue until the TPH concentrations are <1,000 ppm. Prior to backfill, laboratory confirmation samples shall be taken from each side-wall and bottom. The Hobbs office of the NMOCD will be given a minimum of forty-eight hours notification of the intended sampling event.

6.3 Upon approval by the NMOCD, Whole Earth will install a clay liner in the bottom of the excavation having a minimum thickness of 18". All clay layers will be watered and compacted to 100% density.

6.4 The material originally excavated from the pit shall be replaced within the excavations. Care shall be taken to ensure that the soils coming into direct contact with the clay liner should be finely textured and free of large rocks or sharp edged stones. The soils being replaced within the excavation shall be watered and compacted as required to minimize pore spaces within the cell. Large boulders will be set aside for later disposal or other potentially beneficial use at the conclusion of the project.

6.5 Remediated soils having a maximum chloride concentration of <250 ppm and a maximum TPH concentration of <100 ppm will be placed atop the clay liner. A composite sample of this final backfill material will be submitted to an independent laboratory for analysis of chlorides, TPH and BTEX.

6.6 The land surface shall be re-contoured to match the surrounding topography, seeded with a selection of grasses selected by the landowner.

7.0 Monitoring

The monitor wells will be tested on an annual basis for the presence and concentration of BTEX, and chlorides for a minimum period of five years. If the well shows criteria contaminant concentrations within NMWQCC standards for a minimum of the last three of five years, Devon will request final site closure to include plugging the remaining well.

8.0 Closure Report

8.1 At the conclusion of the project, Whole Earth shall prepare a closure report that contains the following minimum information:

- Photographs of the location prior to remediation
- Photographs of the site at the point of maximum excavation
- Detail photographs of the liner installation
- Photographs of the location at time of final closure
- Lab analysis and related chain of custody for THP, BTEX and chloride testing of each side-wall and excavation bottom
- Lab analysis and related chain of custody for chloride testing of each 3'lift composite
- Procter analysis of the clay
- Clay compaction test report

- Copies of this protocol and all testing procedures
- Shipping manifests for all materials taken to disposal
- Laboratory analysis of water samples obtained from each monitoring well
- Boring logs of any new monitor wells installed at the location

Procedures

This section contains copies of the individual field testing and sample collection procedures employed on this project.

QP-76 (Rev. A)

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

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

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

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 is to be used when collecting soil samples intended for ultimate transfer to a testing laboratory.

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. Try to avoid collecting rocks or vegetation.

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.

6.0 Documentation

6.1 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-96

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Sampling and Testing Protocol
Chloride Titration Using .1 Normal
Silver Nitrate Solution

Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure is to be used to determine the concentrations of chlorides in soils.

2.0 Scope

This procedure is to be used as the standard field measurement for soil chloride concentrations.

3.0 Sample Collection and Preparation

3.1 Collect at least 80 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).

3.2 The soil sample(s) shall be immediately inserted into a one quart or larger polyethylene freezer bag. Care should be taken to insure that no cross-contamination occur between the soil sample and the collection tools or sample processing equipment.

3.3 The sealed sample bag should be massaged to break up any clods.

4.0 Sample Preparation

4.1 Tare a plastic cup having a minimum six-ounce capacity. Add between 80-120 grams of the soil sample and record the weight.

4.2 Add the same weight of distilled water to the soil sample and stir thoroughly using a glass or plastic stir stick.

4.3 Allow the sample to set for a period of thirty minutes. The sample should be stirred at least three times before fluid extraction.

4.4 Carefully pour off the free liquid from the sample through a paper filter into a clean plastic cup.

5.0 Titration Procedure

5.1 Using a graduated pipette, remove 10 ml extract and dispense into a clean plastic cup.

5.2 Add 2-3 drops potassium chromate (K_2CrO_4) to mixture.

5.3 If the sample contains any sulfides (hydrogen or iron sulfides are common to oilfield soil samples) add 2-3 drops of hydrogen peroxide (H_2O_2) to mixture. Allow the mixture to set for a minimum of five minutes.

5.4 Using a 1 ml pipette, carefully add .1 normal silver nitrate solution to sample until solution turns salmon red when viewed with yellow goggles. Be consistent with endpoint recognition.

6.0 Calculation

Multiply the amount of silver nitrate used in step 5.4 by 354.5 to obtain the chloride concentration in mg/L.

QP-06 Rev. C

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-28

WHOLE EARTH ENVIRONMENTAL
QUALITY PROCEDURE

Procedure for Developing Cased Water Monitoring Wells

Completed By: Approved By: Effective Date: / /

1.0 Purpose

This procedure outlines the methods to be employed to develop 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 Prior to development, the static water level and height of the water column within the well casing will be measured with the use of an electric D.C. probe or a steel engineer's tape and water sensitive paste.

3.2 All measurements will be recorded within a field log notebook and subsequently reported within the driller's boring log report.

3.3 All equipment used to measure the static water level will be decontaminated after each use by means of Alconox, a phosphate free laboratory detergent, and water to reduce the possibility of cross-contamination. The volume of water in each well casing will be calculated.

4.0 Purging

4.1 Wells will be purged by removing a minimum of three well casing volumes by using a 2" decontaminated submersible pump or dedicated one liter Teflon bailer.

4.2 If a submersible is used the pump will be decontaminated prior to use by scrubbing the outside surface of tubing and wiring with an Alconox-water mixture, pumping an Alconox-water mixture through the pump, and a final flush with fresh water.

5.0 Water Disposal

5.1 All purge and decontamination water will be temporarily stored within a 60 gallon portable tank and then pumped into a permanent storage tank to be later disposed of in an appropriate manner.

6.0 Records

6.1 Whole Earth will record the amount of water removed from the well during development procedures. The purge volume will be reported to the appropriate regulatory authority when filing the closure report.

Hydrus 2-D Contaminant Migration Modeling

This section contains a copy the contaminant migration model for the B.C. Dickinson site prepared by Dr. Jan Hendrickx of New Mexico State University.

SIMULATION OF OPTIMAL REMEDIATION STRATEGY AT THE B.C. DICKINSON A-1 FORMER TANK BATTERY SITE

A Report Prepared for
Whole Earth Environmental, Inc.
Phone: 281-394-2050
Houston, TX 77084
whearth@msn.com

By

Jan M.H. Hendrickx, Ph.D., Ir.
PO Box 897
Los Lunas, NM 87031
Pone: 505-565-9211
JanGraHendrickx@aol.com

September 2005

EXECUTIVE SUMMARY

Whole Earth Environmental, Inc. (WEE) has developed a remediation strategy for the Devon Energy B.C. Dickenson A-1 former tank battery site in Lea County, New Mexico. The selected strategy is technically feasible for a reasonable expenditure. The purpose of this study is to conduct computer simulations for evaluation of the selected optimal remediation strategy.

The remediation plan is to excavate the contaminated site to a depth of approximately 25 feet. The impaired geological layers below 25 feet will be left in place since removal will be cost prohibitive. The impaired excavated soil will be mixed with uncontaminated soil to prepare fill material with a soil chloride concentration of 250 ppm. A 2 feet thick clay cap will be placed on the bottom of the pit to prevent recharge water to enter the impaired soil volume below. The pit will be filled with half the volume of fill material, the other half will be buried around the site to a maximum depth of 10 feet.

In this report we will answer four important questions that determine the effectiveness of the remediation plan. The questions are: (1) It there evidence of lateral brine movement at the site? (2) Will water seep around the clay cap and enter the impaired soil volume underneath? (3) How much chloride may seep out of the impaired volume underneath the clay cap after its installation? (4) Will "wicking" or a sudden rise of ground water level into the impaired sand layer impact future ground water quality at the site?

On the basis of field observations, soil bore logs, and literature reports we conclude that no lateral brine movement has occurred at the site. Therefore, only the soil volume below the excavated pit remains impaired with higher (unknown) chloride concentrations. The impaired soil volume will be isolated from the environment by installation of a clay cap.

On the basis of our field observations, soil physics theory and experiments, and our HYDRUS2D modeling results we conclude that no or very little water will seep around the clay cap and enter the impaired soil volume.

We conclude that the clay cap effectively eliminates the driving force for chloride seepage from the impaired soil volume. As a result the chloride concentrations in the monitoring well are expected to decrease below 250 ppm within a few years.

After simulations with HYDRUS2D we conclude that a sudden rise of ground water level will affect the concentrations in the monitoring well but these effects will be mitigated within only a few years.

The evaluation of the four critical questions clearly has shown that installation of the clay cap is a cost-effective restoration technique at Dickenson tank battery. The clay cap will all but eliminate seepage of chloride from the impaired soil volume into the ground water. The chloride concentrations in the monitoring well are expected to decrease within a few years to less than 250 ppm.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	ii
TABLE OF CONTENTS	iv
LIST OF TABLES	v
LIST OF FIGURES	v
Purpose	1
Site Description	2
Remediation Approach	3
Input Parameters for Models	5
Question One: Is there evidence of lateral brine movement?	8
Question Two: Will water seep around the clay cap and enter the impaired volume underneath?	9
Question Three: Will chloride seep out of the impaired volume underneath the clay cap after its installation?	10
Question Four: What is the effect of "wicking" or a sudden rise in ground water level?	15
Conclusion	17
References	19

LIST OF TABLES

Page

Table 1 Van Genuchten parameters that describe the hydraulic properties of the soil materials in, around, and below the restored pit. 8

LIST OF FIGURES

Page

Figure 1 Diagram of distribution of soil materials after remediation of the pit. The vertical cross section represents a slice of the circular pit and surroundings with a radius of 165 feet and a depth of 62 feet. Soil surface at top, ground water at bottom. Material 1 (red) is the top soil; material 2 (dark blue) is the calcic horizon; material 3 (green) is the sand; material 4 (pink) is the sandstone; material 5 (light blue) is the clay cap. 4

Figure 2 Limiting soil water content profiles as time goes to infinity during infiltration from a line source. Numbers on the curves represent values of degree of saturation. (After Jury & Horton, 2004). 11

Figure 3 Soil profile inside the excavated pit. The dark area to the right has been darkened due to infiltration of BTEX and brines; the light area at the left has not been affected. The sharp vertical boundary between the dark and light areas is evidence of the limiting soil water content profiles typical for sand soils during three-dimensional infiltration from the tank battery. 12

Figure 4 Soil water content distribution at the remediated site ten years after installation of the clay cap. The elongated shape with higher water contents is a result of infiltration from the edge of the clay cap. The impaired soil volume to the left of the infiltrating water is not affected by the higher water contents. See also detail in Figure 5. 13

Figure 5 Water flow velocity vectors near the edge of the clay pan simulated with HYDRUS2D ten years after installation of the clay pan. The larger the vector, the more water flow. Note (i) the lateral flow on top of the clay cap and (ii) the absence of vectors inside the impaired soil volume with chloride contamination. 14

Figure 6 The chloride concentration in a down-gradient monitoring well as a function of time after clay cap installation. 16

Figure 7 The chloride concentration in a down-gradient monitoring well as a function of time after a sudden 4 feet rise of ground water level immediately after installation of the clay cap. 18

SIMULATION OF OPTIMAL REMEDIATION STRATEGY AT THE B.C. DICKINSON A-1 FORMER TANK BATTERY SITE

Purpose

Whole Earth Environmental, Inc. (WEE) has developed a remediation strategy for the Devon Energy B.C. Dickenson A-1 former tank battery site in Lea County, New Mexico, taking into account –among other information– a previous simulation study at the site[1]. The selected strategy is technically feasible for a reasonable expenditure. The purpose of this study is to conduct computer simulations for evaluation of the selected optimal remediation strategy.

The remediation plan is to excavate the contaminated site to a depth of approximately 25 feet. The impaired geological layers below 25 feet will be left in place since removal will be cost prohibitive. The impaired excavated soil will be mixed with uncontaminated soil to prepare fill material with a soil chloride concentration of 250 ppm, i.e. 250 mg chloride per 1 kg of moist soil. A 2 feet thick clay cap will be placed on the bottom of the pit in order to prevent recharge water to enter the impaired soil volume below. The pit will be filled with half the volume of fill material, the other half will be buried around the site to a maximum depth of 10 feet.

In this report we will answer four important questions that determine the effectiveness of the remediation plan. The questions are: (1) It there evidence of lateral brine movement at the site? (2) Will water seep around the clay cap and enter the impaired soil volume underneath? (3) How much chloride may seep out of the impaired volume underneath the clay cap after its installation? (4) Will "wicking" or a sudden rise of ground water level into the impaired sand layer impact future ground water quality at the site? The study will be conducted on the basis of information provided by Whole Earth Environmental, Inc. as well as data gathered during a one-day field visit.

Site Description

The B.C. Dickenson Battery is located in Lea County, New Mexico, South of US 182 on fee land. WEE has provided us with (1) a map of the site and the locations of boreholes for soil sampling and the installation of monitoring wells, (2) laboratory analyses of soil and water samples, (3) logs of soil borings, and (4) a copy of a preliminary site investigation report and remediation work plan dated December 2002. Ground water table depth measurements in May 2002 are all around 60 feet. The direction of flow is from the NW to the SE following the topography. The aquifer is unconfined and, thus, exposed to recharge and solutes leaving the vadose zone at the phreatic level.

On March 30, 2005, the excavated pit was inspected and sampled. The pit is located at UTM coordinates 671980 East and 3657376 North (Zone 13 North, datum WGS84). The soil profile in the pit consists of 3 feet of a silty clay loam topsoil underlain by a caliche layer of 4 feet. The caliche layer is fractured and full of fine roots. Beneath the caliche layer a 17 feet thick sand layer rests on 6 feet of indurated sandstone. The sand layer consists of fine sand with some one to two inch diameter stones. The bottom of the pit was located on the indurated sandstone. The soil bore logs presented in a report by Environmental Technology Group, Inc.[2] clearly indicate that the sand layers underneath the sandstone are very similar to the one above the sandstone. This finding is corroborated by several geological reports on the Ogallala Aquifer in Eastern New Mexico[3, 4].

The pink-tan colored sandstone layer shows grey patches. Many of the grey patches in the sandstone contain hydrocarbons which is an indication that these patches are flow paths for hydrocarbons and brine through the sandstone. There are reports[5, 6] that organic acids –such as may be present in the leachate under the Dickenson site– can dissolve quartz and, thus, create flow paths through sandstone layers. Another report[7] presents measurements of the saturated hydraulic conductivity of sandstone taken along trenches with a total length of approximately 3 km. Saturated hydraulic conductivity values of weathered and non-weathered sandstone are similar and range from 1 to 42 cm/day, with geometric means of 17 and 10 cm/day.

The aquifer underneath the B.C. Dickenson site is part of the Ogallala aquifer. In 1967, the saturated thickness at the site is estimated as approximately 125 feet[8]. Taking into account some decline of the water-level in the aquifer near the site[9] the current saturated thickness is taken as 100 feet in this study. The ground water flux in the aquifer at the site is not known. However, ground water velocities are estimated from 2 to a little less than 5 inches per day[10, 11] in the Ogallala Formation. If we multiply these velocities by the average porosity of 35 percent[9] assumed for the Ogallala aquifer in Lea county, we arrive at ground water fluxes varying between 1.8 and 4.4 cm/day. Information from another source [12] yields a typical average ground water flux of 2.1 cm/day. In this study we will use the average value of 2.8 cm/day.

Remediation Approach

In this report we evaluate the optimal remediation strategy as designed by WEE. The contaminated site has been excavated to a depth of approximately 25 feet. The impaired geological layers below 25 feet have been left in place. The impaired excavated soil has been mixed with uncontaminated soil to prepare fill material with a soil chloride concentration not higher than the legal limit of 250 ppm, i.e. 250 mg of chloride per 1 kg of moist soil. A 2 feet thick clay cap has been placed on the bottom of the pit in order to prevent deep percolation water to enter the impaired formations below. The pit has been filled with approximately half the volume of fill material, the remaining fill material has been buried around the site to a maximum depth of 10 feet. Figure 1 shows all soil materials after completion of the remediation project.

Presently, after remediation there remains one major source of chloride at the site, i.e. the chloride stored below the clay barrier. As a worst-case scenario we assume that the soil chloride content below the clay cap is 874 ppm, i.e. the highest chloride content measured at the site in SB7 at a depth of 40 feet in May 2002. However, due to the clay cap the water flux infiltrating into the impaired soil volume will become very small and –as a consequence– the amount of chloride released will sharply decrease.

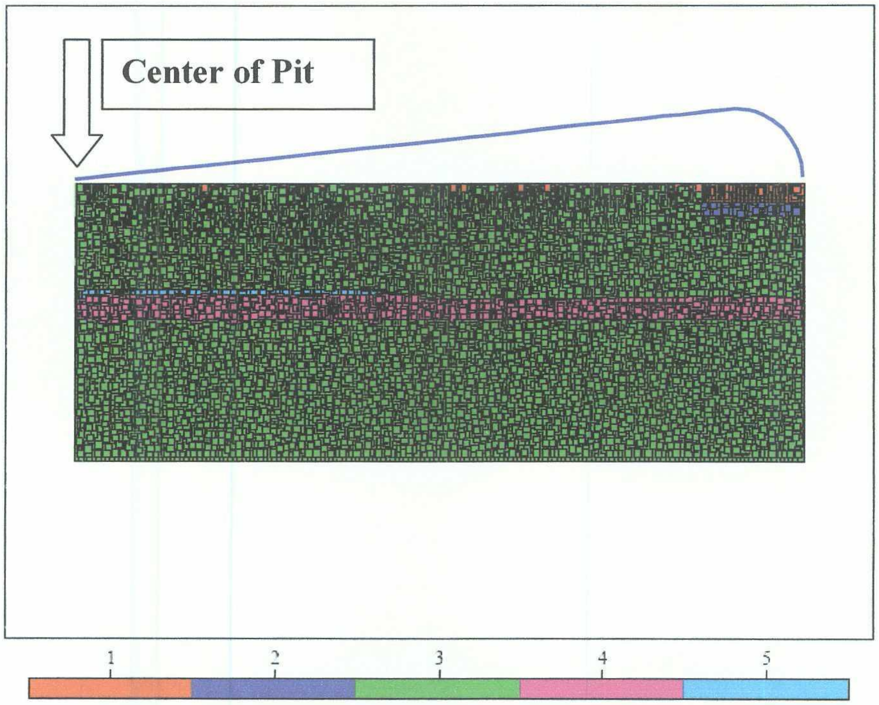


Figure 1. Diagram of distribution of soil materials after remediation of the pit. The vertical cross section represents a slice of the circular pit and surroundings with a radius of 165 feet and a depth of 62 feet. Soil surface at top, ground water at bottom. Material 1 (red) is the top soil; material 2 (dark blue) is the calcic horizon; material 3 (green) is the sand; material 4 (pink) is the sandstone; material 5 (light blue) is the clay cap.

To evaluate the effectiveness of the economically optimal remediation strategy designed by WEE we will answer the four critical questions presented in the section "*Purpose*" using field observations, information from the literature, and modeling. The modeling will be conducted using the models HYDRUS1D[13] and HYDRUS2D[14] for simulating water movement and chloride transport through the vadose zone. In addition, two models will be coupled: (1) the model HYDRUS1D for simulating vertical water movement and chloride transport through the vadose zone and (2) a simple spreadsheet model to simulate horizontal movement of chloride in the aquifer and to predict the chloride concentration in a down gradient monitoring well. These models are fully described in API Publication Number 4734 "Modeling Study of Produced Water Release Scenarios"[15] that was co-authored by Dr. Hendrickx.

Input Parameters for Models

The models need a number of input parameters: concentration of released brine waters, amount of brine water infiltrated, i.e the height of the spill, site lithology, hydraulic properties of each soil and geological layer, depth of ground water table, thickness of underlying aquifer, porosity of underlying aquifer, chloride content in aquifer, ground water flux in aquifer, daily precipitation rates, daily potential evapotranspiration rates, and initial soil moisture and chloride distributions in the vadose zone. For most brine releases many of these input parameters are not readily available. Therefore, it is necessary to use a combination of forward modeling, pseudo inverse modeling, and expert judgments for evaluation of different remediation strategies. For the B.C. Dickenson site we will not simulate the history of the spill since too few data are available. Instead we will evaluate the effects of the optimal remediation strategy using our knowledge of the conditions that prevail after completion of the remediation project.

Known Input Parameters: At the B.C. Dickenson site information is available for several parameters. Climate data for 47 recent years were obtained for Lea County, NM from the National Climatic Data Center (NCDC, www.ncdc.noaa.gov). The data consisted of historical daily temperature and **precipitation** measurements collected at specific weather stations identified by a NCDC Coop identification number. Data for Lea County were collected at the

Pearl, NM weather station (Coop # 296659). **Potential evapotranspiration** (PET) was calculated from daily temperature observations using the method of Samani and Pessarakli[16]. When a HYDRUS simulation was performed for a longer time period than the period of record for the weather station, the climate data was repeated for as many years as was necessary. The thickness of the vadose zone or **ground water table depth** is 62 ft (18.6 m).

Input Parameters with Approximately Known Values. It would take much effort to measure the characteristics of the Ogalla aquifer underlying the B.C. Dickenson site and to exactly determine the size of the release. However, often it is possible to determine reasonable values for these parameters based on literature reports and/or field observations. In this study typical Ogalalla aquifer values will be used as described in the section "*Site Description*". The **groundwater flux** represents the rate of groundwater movement and effects the ability of an aquifer to dilute chloride of a produced water release. A large groundwater flux produces greater dilution. As explained above for this study we will use 2.8 cm/day (about 0.1 foot/day). The **porosity** of the aquifer is estimated as 35 volume percent[9]. The **ambient chloride concentration** in the Ogalalla aquifer is typically 100 ppm or less[17] with a characteristic minimum value of 10 ppm. The measurements at the site indicate an ambient chloride concentration of 56 ppm[1]. The thicker the aquifer, the more opportunity for mixing (dilution), and the lower the predicted chloride concentration will be in the aquifer. In this study we use 100 ft (30 m). In many places the Ogalalla Aquifer and other unconfined, alluvial aquifers are thicker than 100 ft.

The **diameter of the release area** and the **location of the monitoring well** also influence the chloride concentration measured in the monitoring well. Based on the data presented by WEE the diameter of the area affected by chloride underneath the clay barrier is about 120 feet. A suitable location for the monitoring well would be at the downstream edge of the remediated site about 140 ft (42 m) away from the center of the pith.

The **dispersion length** of the chloride inside the vadose zone has also an impact on the chloride concentration at the bottom of the vadose zone where the chloride flux enters the aquifer. The higher the dispersion length the more dilute the chloride concentration will become at the bottom of the vadose zone. The dispersion length depends on a large number of factors; a rule of thumb is to take the dispersion length equal to one-tenth of the scale of the simulation. For the 62 ft (18.6 m) vadose zone at the site we have selected a dispersion length of 180 cm.

Unknown Input Parameters. Generally no quantitative information is available on (i) the **amount of produced water** that has infiltrated into the vadose zone, (ii) the **chloride concentration** in the produced water, and (iii) the **hydraulic properties** of the different geological layers in the vadose zone. Without these parameters it is not possible to even approximately validate models for the evaluation of remediation strategies. Fortunately, at many sites test holes have been drilled and monitoring wells have been installed that provide at least some qualitative information on the composition of the vadose zone and the quality of the ground water. Especially, when chloride and BTEX concentrations have been measured in the vadose zone as well as in the ground water, it is often possible to validate release scenarios and the impact of the vadose zone on the fate and transport of chloride and BTEX.

Unfortunately, at the B.C. Dickenson site no simultaneous measurements have been made of chloride and BTEX concentrations in the vadose zone and in the ground water. For example, in May 2002 BTEX concentrations have been measured in the soil profiles SB1, SB2, SB3, SB4, SB5, and SB6 but no chloride concentrations have been measured in the samples that were taken. In soil profiles SB7, SB8, and SB9 chloride concentrations have been measured at one depth in each profile but no BTEX concentrations were measured at these depths. If chloride concentrations had been measured in soil profile SB6, a model validation would have been possible using a pseudo-inverse method but with the current data set it is not. The only approach feasible is to take the chloride measurements in SB7 and SB9 as indications of the chloride content deeper in the profile. As a worst-case scenario we assume that the soil chloride content below the clay cap is 874 ppm, i.e. the highest chloride content measured at the site in SB7 at a depth of 40 feet in May 2002.

Figure 1 shows the distribution of soils layers after remediation. The pit has a diameter of 140 feet. On the bottom of the pit a two-feet-thick clay cap (light blue color) is installed to prevent seepage water to enter the sandstone (purple color) and sand layers (green color) below it that contain chlorides. In the upper right hand corner of the cross section the original profile can be seen consisting of a 3 feet thick silty clay loam top soil over a 4 feet thick caliche layer. The caliche layer rests on a 18 feet sand layer underlain by a 6 feet sandstone layer. Between the sandstone and the ground water level is a 31 feet sand layer with properties identical to the sand layer above it. The soil hydraulic properties are derived from our field observations in the pit on March 30, 2005, the logs of soil borings at the site, and literature information. Pedotransfer functions of the HYDRUS code are used for the derivation of the Van Genuchten parameters on the basis of soil texture and bulk density (Table 1). These Van Genuchten parameters determine the soil hydraulic properties[18]. The hydraulic properties of the clay cap are based on those for a clay soil with a saturated hydraulic conductivity of 0.001 cm/day or 0.012 foot/year.

Table 1. Van Genuchten parameters that describe the hydraulic properties of the soil materials in, around, and below the restored pit.

Material	Material #	Van Genuchten Hydraulic Parameters¶				
		Θ_r	Θ_S	α	n	K_{sat}
		cm^3/cm^3	cm^3/cm^3	cm^{-1}	-	cm/day
Silty clay loam	1	0.078	0.43	0.036	1.56	24.96
Caliche	2	0.0195	0.12	0.075	1.89	31.8
Sand	3	0.0346	0.3946	0.048	2.1506	198.4
Sandstone	4	0.02	0.24	0.124	2.28	10
Clay cap	5	0.01	0.10	0.005	1.09	0.001

¶ θ_r residual water content, θ_s saturated water content, α and n are shape parameters, K_s saturated hydraulic conductivity.

Question One: It there evidence of lateral brine movement?

Lateral water movement may occur at sudden decreases of hydraulic conductivity in soil profiles[19-21]. Such a sudden decrease of saturated hydraulic conductivity at the Dickenson site is found at the interface between the sand layer and the sandstone. However, our field observations and literature data indicate that sandstone layers are not impermeable boundaries that will cause the brine to move laterally. As has been described in section "*Site Description*" the pink-tan colored sandstone layer shows gray patches. Many of these patches contain hydrocarbons indicating that these patches are hydrocarbon flow paths through the sandstone. There are also reports[5, 6] that organic acids –such as may be present in the leachate under the Dickenson site– can dissolve quartz and, thus, create flow paths through sandstone layers. Another report[7] presents measurements of the saturated hydraulic conductivity of sandstone taken along trenches with a total length of approximately 3 km. Saturated hydraulic conductivity values of weathered and non-weathered sandstone are similar and range from 1 to 42 cm/day, with geometric means of 17 and 10 cm/day. Since a saturated hydraulic conductivity of 1 cm/day would be sufficient to move more than 365 cm or 10 feet of hydrocarbon brines per year downward through the sandstone at the Dickenson site, we conclude that the principal direction of movement through the sandstone has been vertical. Therefore, we conclude that all contaminants remaining from the Dickenson Battery after restoration are located immediately underneath the restored pit.

Question Two: Will water seep around the clay cap and enter the impaired volume underneath?

The clay cap has a saturated hydraulic conductivity of 0.001 cm/day or 0.365 cm/year which is much less than the ground water recharge at the site. Therefore, deep percolation water will start flowing laterally over the clay cap towards its edge. After reaching the edge of the clay cap water will start moving vertically again and might be wicked into the impaired volume underneath the clay cap. How far the water will be wicked into the impaired volume depends on its hydraulic properties. The soil bore logs presented in a report by Environmental Technology Group, Inc.[2] and geological reports on the Ogallala Aquifer in Eastern New Mexico[3, 4] clearly indicate that the impaired volume underneath the sandstone consists of a sand layer very similar to the one above the sandstone. In other words the impaired volume has hydraulic properties typical for sand (see Table 1, material 3).

The flow of water from the edge of the clay cap into the underlying sand can be evaluated by considering what is know about infiltration from a line source. Theoretical and experimental evidence[22, 23] predict that the wetting front of the water infiltrating from a line source into a sand will become elongated with time since gravitational forces in the sand dominate the capillary forces (Figure 2). The same will happen over time with the water flowing over the edge of the clay cap into the sand layer. As a matter of fact during excavation of the pit we have observed a distinct vertical "wetting front" in the sand layer above the sandstone (Figure 3). This "wetting front" resulted from the infiltration of BTEX contaminated brine from the tank battery into the soil. Its vertical elongated shape is exactly what is predicted by the theory in this sand layer. Since the sand layer underneath the clay cap is similar to the one above, the same infiltration pattern will occur.

The model HYDRUS2D was used to simulate how far water would be wicked into the impaired volume. After ten years of simulation an approximately steady water content distribution developed (Figure 4) with a wetting front similar to the one predicted by the theory (Figure 2) and observed in the field (Figure 3). The wetting front wicks some water towards the impaired volume over a distance of about 7 feet. The diameter of the impaired volume is 120 feet; the clay cap has a diameter of 140 feet and, thus, extends 10 feet away from the contaminated sand. Since the wicking action of the sand is less than 10 feet, the chloride in the impaired volume will not be affected. This can be seen clearly in Figure 5 where the water flow velocity vectors are plotted for the area just below and surrounding the edge of the clay pan.

On the basis of our field observations, soil physics theory and experiments, and our HYDRUS2D modeling results we conclude that no or very little water will seep around the clay cap and enter the impaired soil volume.

Question Three: Will chloride seep out of the impaired volume underneath the clay cap after its installation?

One important question remains: what will happen to the chloride in the impaired volume after installation of the clay cap? The installation of the clay cap shuts off the driving force for vertical water movement inside the impaired volume, i.e. deep percolation water that is on its way

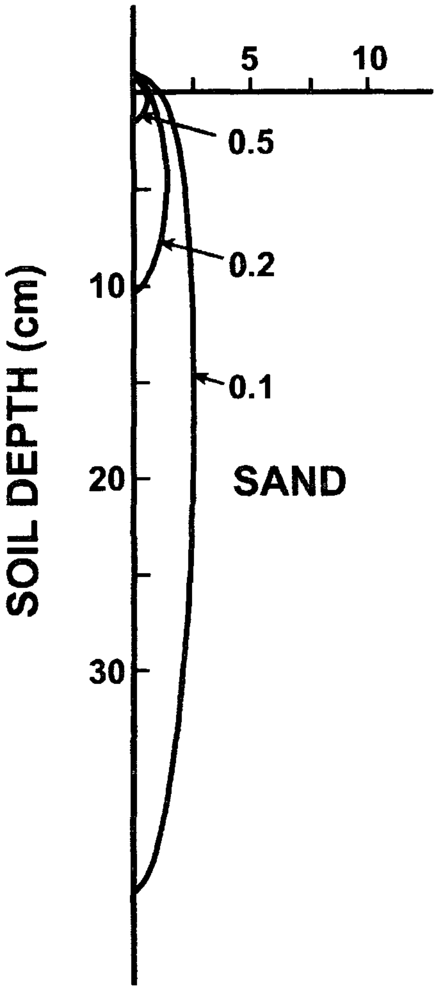


Figure 2. Limiting soil water content profiles as time goes to infinity during infiltration from a line source. Numbers on the curves represent values of degree of saturation. (After Jury & Horton, 2004).

Figure 3. Soil profile inside the excavated pit. The dark area to the right has been darkened due to infiltration of BTEX and brines; the light area at the left has not been affected. The sharp vertical boundary between the dark and light areas is evidence of the limiting soil water content profiles typical for sand soils during three-dimensional infiltration from the tank battery.

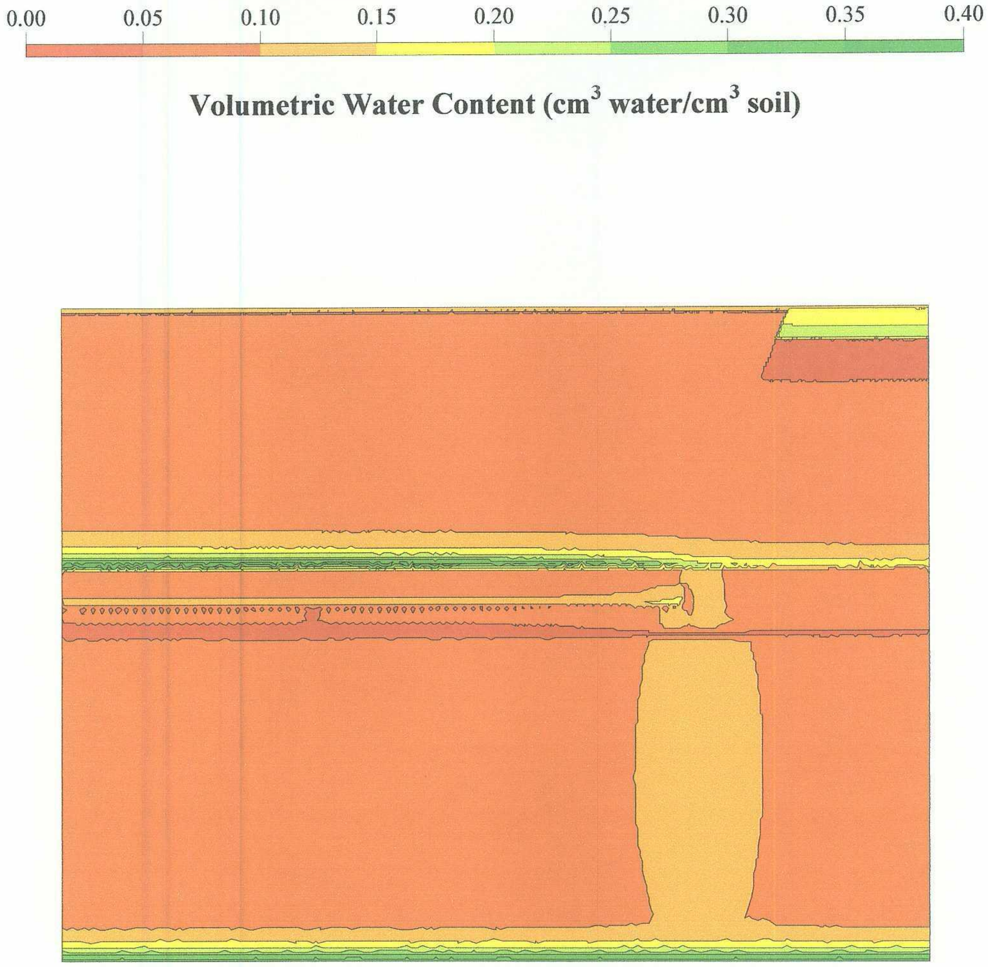


Figure 4. Soil water content distribution at the remediated site ten years after installation of the clay cap. The elongated shape with higher water contents is a result of infiltration from the edge of the clay cap. The impaired soil volume to the left of the infiltrating water is not affected by the higher water contents. See also detail in Figure 5.

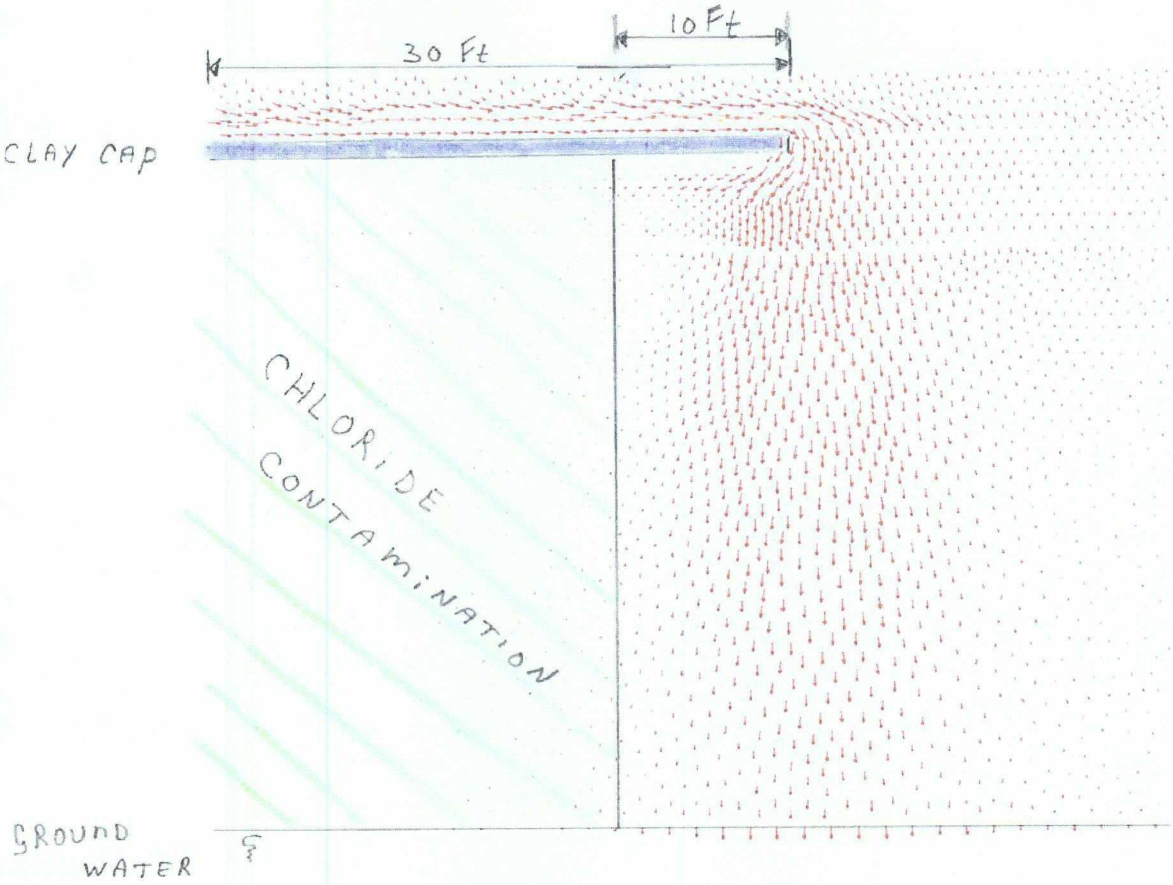


Figure 5. Water flow velocity vectors near the edge of the clay pan simulated with HYDRUS2D ten years after installation of the clay pan. The larger the vector, the more water flow. Note (i) the lateral flow on top of the clay cap and (ii) the absence of vectors inside the impaired soil volume with chloride contamination.

from the bottom of the root zone towards the ground water table. Therefore, the chloride seepage flux into the aquifer will gradually decrease to a very small negligible flux after installation of the clay cap.

In order to evaluate the decrease of chloride flux with time we have simulated chloride and water dynamics underneath the clay cap using HYDRUS1D. Initial conditions are taken from the HYDRUS2D simulation of the performance of the clay cap. The top boundary condition is set at a very small flux of 0.001 cm/day equal to the saturated hydraulic conductivity of the clay cap. The chloride content in the impaired volume is conservatively taken as 874 ppm, i.e. 974 mg of chloride per 1 kg of moist soil, as explained in section "*Remediation Approach*". The chloride content in the aquifer at the time of the installation of the clay cap is conservatively taken as 496 ppm which is the highest concentration measured in monitoring well MW1. Figure 6 presents the chloride concentrations simulated in a 10 feet deep monitoring well placed at the edge of the impaired soil volume after installation of the clay cap. In about one year the chloride concentration in the monitoring well drops below 250 ppm. Since the simulated chloride concentrations in Figure 6 are based on uncertain estimates of chloride concentrations in the impaired soil volume and in the impaired ground water, actual chloride measurements in the future may be somewhat different. However, Figure 6 clearly demonstrates how effective the clay cap will be for the reduction of future chloride concentrations in the monitoring well.

We conclude that the clay cap effectively eliminates the driving force for chloride seepage from the impaired soil volume. As a result the chloride concentrations in the monitoring well are expected to decrease below 250 ppm within a few years.

Question Four: What is the effect of "wicking" or a sudden rise in ground water level? Water will enter the impaired volume by capillary rise also known as "wicking". However, in a sand layer the effect of wicking is probably not going to be significant. Of more concern is a sudden rise of the ground water table. Therefore, we have simulated the chloride concentrations in the monitoring well if the ground water table would rise by four feet immediately after

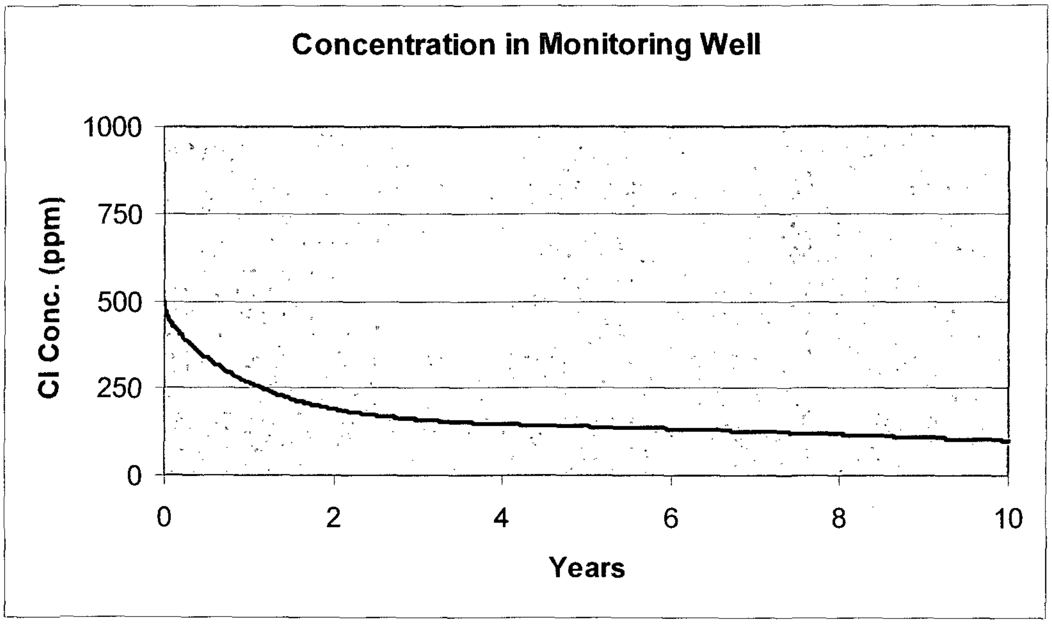


Figure 6. The chloride concentration in a down-gradient monitoring well as a function of time after clay cap installation.

installation of the clay cap. Figure 7 shows that the simulated chloride concentrations are higher than the ones presented in Figure 6. Nevertheless, in about four years the chloride concentration will be less than 250 ppm, even after the most catastrophic event that could happen at the site after installation of the clay cap. Therefore, we conclude that a sudden rise of ground water level will affect the concentrations in the monitoring well but its effect will be mitigated within only a few years.

Conclusion

The evaluation of the four critical questions clearly has shown that installation of the clay cap is a cost-effective restoration technique at Dickenson tank battery. The clay cap will all but eliminate seepage of chloride from the impaired soil volume into the ground water. The chloride concentrations in the monitoring well are expected to decrease within a few years to less than 250 ppm.

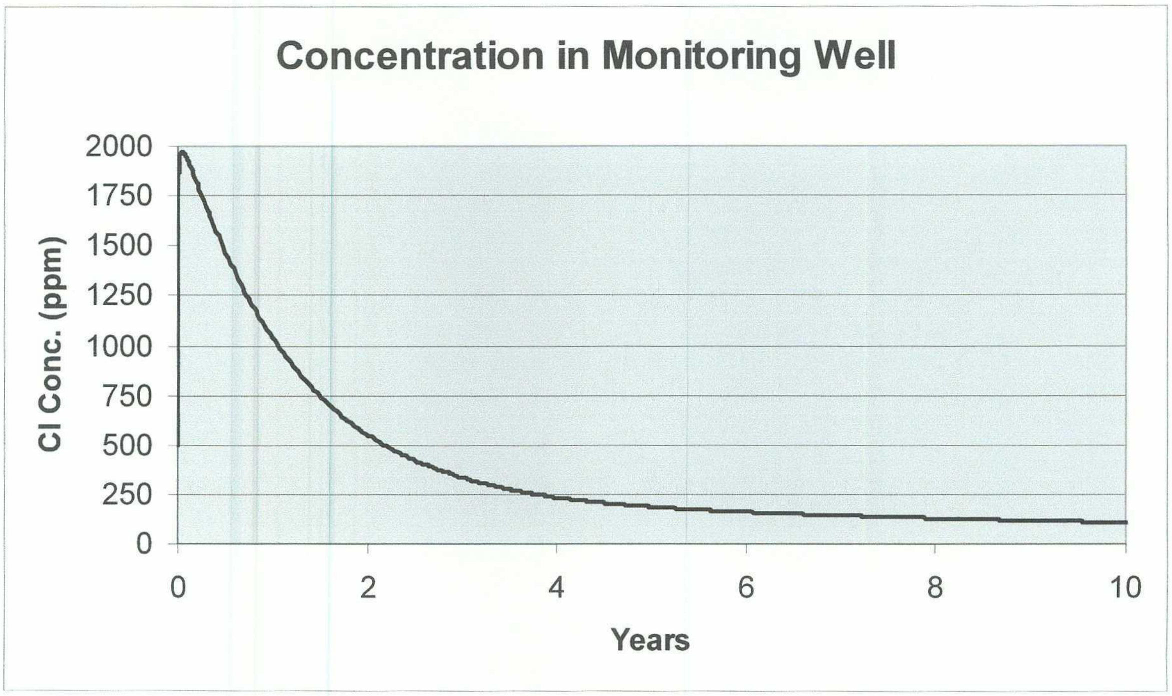
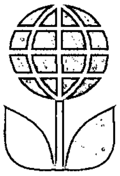


Figure 7. The chloride concentration in a down-gradient monitoring well as a function of time after a sudden 4 feet rise of ground water level immediately after installation of the clay cap.

References

1. Hendrickx, J.M.H., *Simulation of remediation strategies for the B.C. Dickenson site, Devon Energy Corporation.* Whole Earth Environmental, Inc.: Houston. p. 18. 2005.
2. Environmental Technology Group Inc., *Preliminary site investigation report and remediation work plan. B.C. Dickenson Site A-1 Site.*: Hobbs, New Mexico. 2002.
3. Frye, J.C., A.B. Leonard, and H.D. Glass, *Western extent of Ogallala Formation in New Mexico*, in *Circular 175*. New Mexico Bureau of Mines & Mineral Resources: Socorro, New Mexico. p. 41. 1982.
4. Frye, J.C. and A.B. Leonard, *Structure of Ogallala Formation in East-central New Mexico*, in *Target Exploration Report E-6*. New Mexico State Bureau of Mines and Mineral Resources: Socorro, New Mexico. p. 8. 1972.
5. Bennett, P. and D.I. Siegel, *Increased solubility of quartz in water due to complexing by organic compounds.* Nature. **326**: p. 684-686. 1987.
6. Bennett, P.C., M.E. Melcer, D.I. Siegel, and J.P. Hassett, *The dissolution of quartz in dilute aqueous solutions of organic acids at 25°C.* Geochimica et Cosmochimica Acta. **52**: p. 1521-1530. 1988.
7. Heilweil, V.M. and D.K. Solomon, *Millimeter- to kilometer scale variations in vadose-zone bedrock solutes: implications for estimating recharge in arid settings*, in *Groundwater recharge in a desert environment. The Southwestern United States*, J.F. Hogan, F.M. Phillips, and B.R. Scanlon, Editors., American Geophysical Union: Washington, DC. p. 49-68. 2004.
8. Cronin, J.C., *Ground water in the Ogallala formation in the southern high plains of Texas and New Mexico*, in *Hydrologic Investigations Atlas HA-330.* United States Geological Survey: Washington, D.C. p. 9. 1969.
9. McAda, D.P., *Projected water-level declines in the Ogallala aquifer in Lea County, New Mexico*, in *Water-resources investigations report 84-4062*. U.S. Geological Survey. p. 84. 1984.
10. Ash, S.R., *Ground water conditions in northern Lea County, New Mexico*, in *U.S. Geological Survey Hydrol. Inv. Atlas 62*. 1963.
11. Cronin, J.C. and L.C. Wells, *Geology and ground water resources of Hale County, Texas*, in *U.S. Geological Survey Water-Supply Paper 1539-U*. p. 38. 1963.
12. Nativ, R. and D.A. Smith, *Hydrogeology and geochemistry of the Ogallala aquifer, Southern High Plains.* J. Hydrol. **91**: p. 217-253. 1987.
13. Šimünek, J., M. Šejna, and M.T.V. Genuchten, *The HYDRUS-1D software package for simulating the one-dimensional movement of water, heat, and multiple solutes in variably saturated media. Version 2.0*. Vol. IGWMC-TPS-70. Golden, Colorado: International Ground Water Modelling Center, Colorado School of Mines. 202. 1998.
14. Simunek, J., M. Sejna, and M.T. Van Genuchten, *HYDRUS2D Simulating water flow and solute transport in two-dimensional variably saturated media*, in *Ground water modeling software*. International Ground Water Modeling Center: Golden, Colorado. p. 167. 1996.
15. Hendrickx, J.M.H., G. Rodríguez-Marín, R.T. Hicks, and J. Simunek, *Modeling study of produced water release scenarios.* API Publication, ed. A.P. Institute. Vol. 4734: American Petroleum Institute Publishing Services. 124. 2005.
16. Samani, Z.A. and M. Pessarakli, *Estimating potential crop evapotranspiration with minimum data in Arizona.* Transactions of the ASAE. **29**(2): p. 522-524. 1986.
17. Nicholson Jr., A. and A. Clebsch Jr., *Geology and Ground Water Conditions in Southern Lea County, New Mexico*, in *U.S. Geological Survey Ground-Water Report 6*. New Mexico Bureau of Mines and Mineral Resources: Socorro, New Mexico. p. 123. 1961.
18. Van Genuchten, M.T., *A closed form equation for predicting the hydraulic conductivity of unsaturated soils.* Soil Sci. Soc. Am. J. **44**: p. 892-898. 1980.
19. Hendrickx, J.M.H. and M. Flury, *Uniform and preferential flow mechanisms in the vadose zone*, in *Conceptual models of flow and transport in the fractured vadose zone*. National Academy Press: Washington D.C. p. 149-187. 2001.
20. Hendrickx, J.M.H., F.M. Phillips, and J.B.J. Harrison, *Chapter 5. Water flow processes in arid and semi-arid vadose zones*, in *Understanding water in a dry environment. Hydrological processes in arid and semi-arid zones*, I. Simmers, Editor., A.A. Balkema Publishers: Lisse, The Netherlands. p. 151-210. 2003.

21. Hendrickx, J.M.H., D. Vega, J.B.J. Harrison, P. Rojas, L.E.C. Gobbeti, and T.W. Miller, *Hydrology of hillslope soils in the Upper Rio Chagres watershed, Panama*, in *The Rio Chagres: A multidisciplinary profile of a tropical watershed*, R.S. Harmon, Editor., Springer: Dordrecht, The Netherlands. p. 113-138. 2005.
22. Jury, W.A. and R.E. Horton, *Soil physics. Sixth Edition*: John Wiley & Sons, Inc. 370. 2004.
23. Warrick, A.W., *Soil water dynamics*. New York: Oxford University Press. 391. 2003.



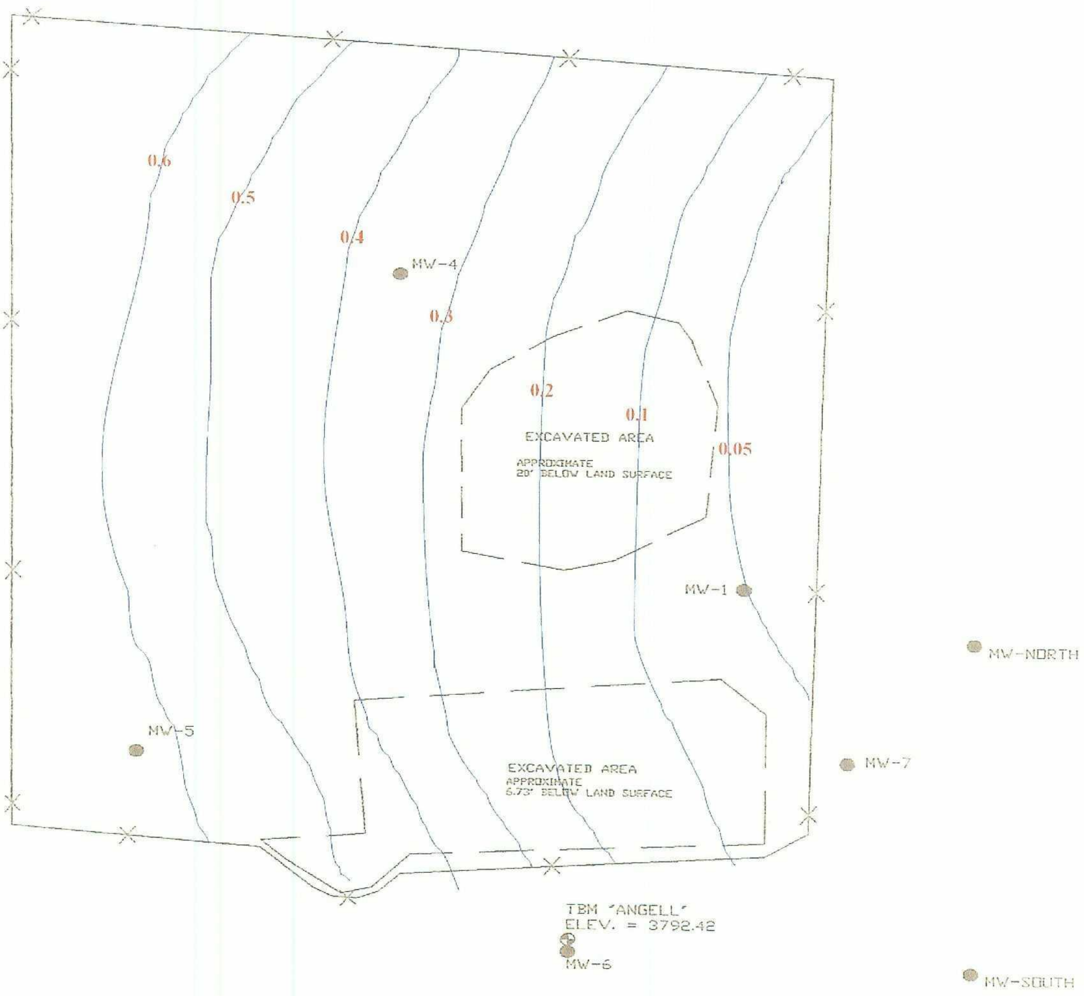
Laboratory Analytical Results

This section contains a copy the chain of custody, laboratory analytical results and quality control information for soil samples processed during this project.

Groundwater Section

This section contains a plat map of the site showing the locations of the monitor wells and related gradient, a colormetric histograph of the relative chloride concentrations and the individual laboratory analyses, chain of custody and quality control data.

Devon Energy Corporation
B.C. Dickinson Remediation Project
Hydrostatic Gradient



Whole Earth Environmental,Inc.
Devon/Darr Angell Site

Well #	State Plane Northing	State Plane Easting	Land Surface Northing	Land Surface Easting	M.S.L. Elevation
MW-1	745232.03	901340.68	745232.06	901340.69	3792.79
MW-4	745432.03	901147.63	745432.08	901147.61	3793.41
MW-5	745124.35	901004.03	745124.37	901004.00	3792.86
MW-6	744996.87	901245.15	744996.87	901245.15	3792.52
MW-7	745120.57	901399.10	745120.58	901399.12	3792.80
MW-South	744985.34	901468.30	744985.34	901468.33	3792.48
MW-North	745198.28	901468.49	745198.30	901468.52	3793.45
TBM	745000.81	901244.20	745000.81	901244.20	3792.42

Notes:

1.Horizontal coordinates are State Plane NAVD 83 datum referenced to USCGS Triangulation Station named "CREAK".

2.Elevations are NAVD 88 datum referenced to USCGS Bench Mark named "G-35".

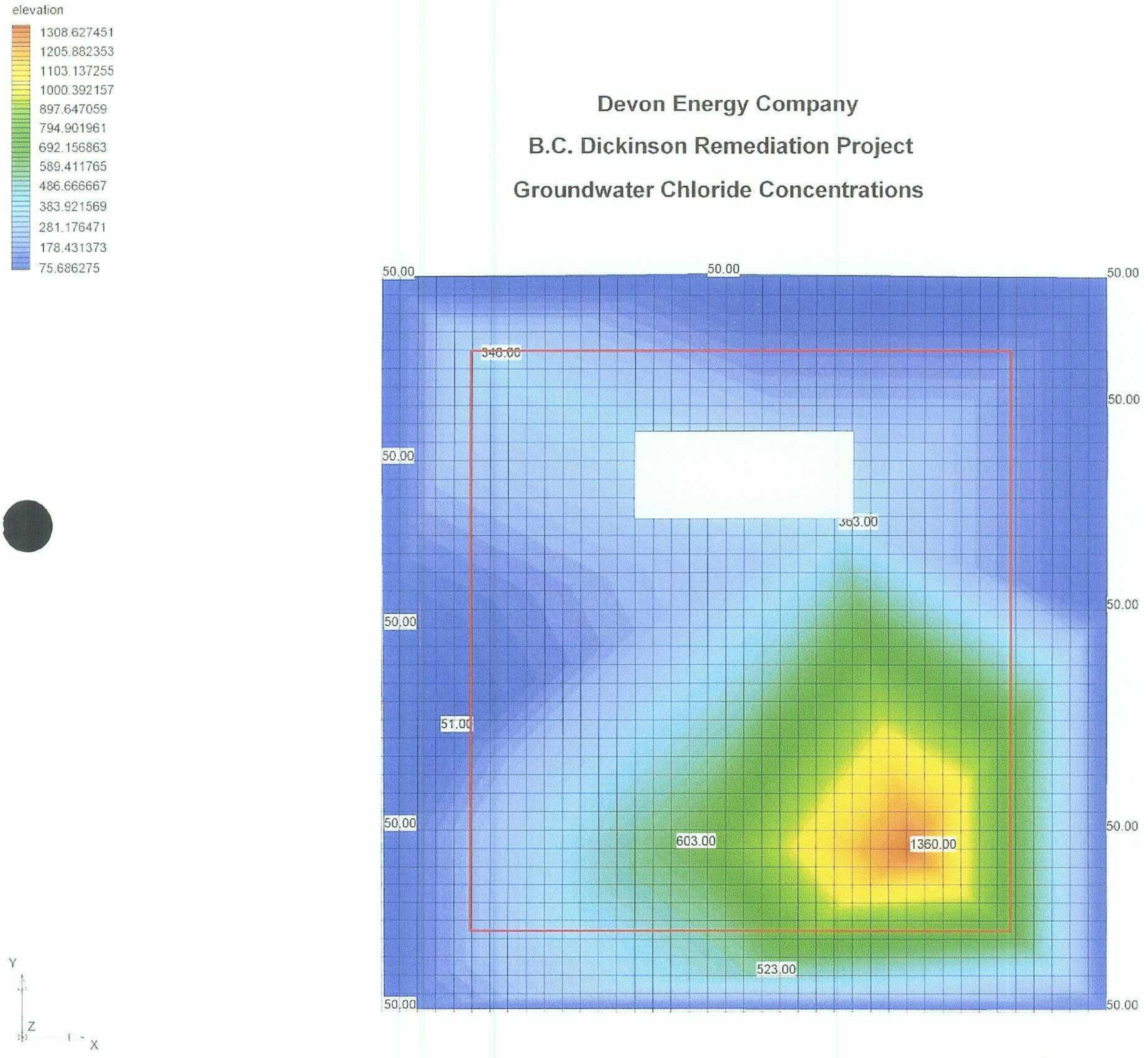
3. Elevations on monitor wells are taken on top of 2'x2' cement pad as requested by Mike Griffin in field 4-12-05.

4. TBM is ½" reinforcing bar with aluminum cap marked "ANGELL" located on the north side of the cement 2'x2' pad of monitor well 6.

Devon Energy Company

B.C. Dickinson Remediation Project

Groundwater Chloride Concentrations



ENVIRONMENTAL
LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Mike Griffin
WHOLE EARTH ENVIRONMENTAL
2103 Arbor Cove
Katy, TX 77494

Project: Devon
Project Number: Dickinson Battery
Location: None Given

Lab Order Number: 5E10010

Report Date: 05/11/05

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Battery Bottom	5E10010-01	Soil	05/10/05 00:00	05/10/05 13:30
MW-1	5E10010-02	Water	05/09/05 00:00	05/10/05 13:30
MW-4	5E10010-03	Water	05/09/05 00:00	05/10/05 13:30
MW-5	5E10010-04	Water	05/09/05 00:00	05/10/05 13:30
MW-6	5E10010-05	Water	05/09/05 00:00	05/10/05 13:30
MW-7	5E10010-06	Water	05/09/05 00:00	05/10/05 13:30

General Chemistry Parameters by EPA / Standard Methods
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Battery Bottom (5E10010-01) Soil									
Chloride	**216**	5.00	mg/kg	10	EE51108	05/10/05	05/10/05	EPA 300.0	
MW-1 (5E10010-02) Water									
Chloride	**368**	2.50	mg/L	5	EE51107	05/10/05	05/10/05	EPA 300.0	
MW-4 (5E10010-03) Water									
Chloride	**58.8**	2.50	mg/L	5	EE51107	05/10/05	05/10/05	EPA 300.0	
MW-5 (5E10010-04) Water									
Chloride	**53.1**	2.50	mg/L	5	EE51107	05/10/05	05/10/05	EPA 300.0	
MW-6 (5E10010-05) Water									
Chloride	**565**	5.00	mg/L	10	EE51107	05/10/05	05/10/05	EPA 300.0	
MW-7 (5E10010-06) Water									
[illegible]oride	**95.4**	2.50	mg/L	5	EE51107	05/10/05	05/10/05	EPA 300.0	

General Chemistry Parameters by EPA / Standard Methods - Quality Control
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE51107 - General Preparation (WetChem)										
Blank (EE51107-BLK1)				Prepared & Analyzed: 05/10/05						
Chloride	ND	0.500	mg/L							
LCS (EE51107-BS1)				Prepared & Analyzed: 05/10/05						
Chloride	10.1		mg/L	10.0		101	80-120			
Calibration Check (EE51107-CCV1)				Prepared & Analyzed: 05/10/05						
Chloride	10.3		mg/L	10.0		103	80-120			
Duplicate (EE51107-DUP1)	**Source: 5E10010-02**			Prepared & Analyzed: 05/10/05						
Chloride	367	2.50	mg/L		368			0.272	20	
Batch EE51108 - Water Extraction										
Blank (EE51108-BLK1)				Prepared & Analyzed: 05/10/05						
Chloride	ND	0.500	mg/kg							
LCS (EE51108-BS1)				Prepared & Analyzed: 05/10/05						
Chloride	10.3		mg/L	10.0		103	80-120			
Calibration Check (EE51108-CCV1)				Prepared & Analyzed: 05/10/05						
[illegible]ride	10.6		mg/L	10.0		106	80-120			
Duplicate (EE51108-DUP1)	**Source: 5E09009-01**			Prepared & Analyzed: 05/10/05						
Chloride	871	25.0	mg/kg		841			3.50	20	

The results in this report apply to the samples analyzed in accordance with the samples received in the laboratory. This analytical report must be reproduced in its entirety, with written approval of Environmental Lab of Texas.

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
LCS	Laboratory Control Spike
MS	Matrix Spike
Dup	Duplicate

Report Approved By: Raland K Date: 5-12-05

Raland K. Tuttle, Lab Manager
Celey D. Keene, Lab Director, Org. Tech Director
Peggy Allen, QA Officer

Jeanne Mc Murrey, Inorg. Tech Director
James L. Hawkins, Chemist/Geologist
Sandra Sanchez, Lab Tech.

This material is intended only for the use of the individual (s) or entity to whom it is addressed, and may contain information that is privileged and confidential.

If you have received this material in error, please notify us immediately at 432-563-1800.

Environmental Lab of Texas, Inc.

12600 West I-20 East
Odessa, Texas 79763

Phone: 915-563-1800
Fax: 915-563-1713

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: M. Griffin

Company Name Whole Earth Environmental, Inc.

Company Address: 2103 Arbor Cove

City/State/Zip: Katy, TX 77494

Telephone No: 281.394.2050 **Fax No:** 281.394.2051

Sampler Signature:

Project Name: Devon

Project #: Dickinson Battery

Project Loc:

PO #:

5E10010

					Preservative							Matrix				Analyze For: TCLP: / TOTAL:															
LAB # (lab use only)	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Ice	HNO_3	HCl	NaOH	H_2SO_4	None	Other (Specify)	Water	Sludge	Soil	Other (specify):	TDS / CL / SAR / EC	TPH 418.1	TPH TX 1005/1006	TPH 8015M GRO/DRO	Metals: As Ag Ba Cd Cr Pb Hg Se	Volatiles	Semivolatiles	BTEX 8021B/5030	Chlorides	S.A.R.	E.C.				RUSH TAT (Pre-Schedule	Standard TAT
-01	Battery Bottom	05/10/05		1						X				X										X							
-02	MW-1	05/09/05		1						X		X												X							
-03	MW-4	05/09/05		1						X		X												X							
-04	MW-5	05/09/05		1						X		X												X							
-05	MW-6	05/09/05		1						X		X												X							
-06	MW-7	05/09/05		1						X		X												X							

Special Instructions: By Wed 5/11

Sample Containers Intact? [✓ Y] N
Temperature Upon Receipt: 24.5°C
Laboratory Comments: 4oz glass unpreserved w/ label/seal

Relinquished by:	Date 1:30	Time 05-10-05	Received by:	Date	Time
Relinquished by:	Date	Time	Received by ELOT: Jane McMurrey	Date 05-10-05	Time 1330

ENVIRONMENTAL
LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:
Mike Griffin
WHOLE EARTH ENVIRONMENTAL
2103 Arbor Cove
Katy, TX 77494

Project: Devon
Project Number: Dickinson Lease
Location: Lea County, NM

Lab Order Number: 5F30001

Report Date: 07/08/05

WHOLE EARTH ENVIRONMENTAL	Project: Devon	Fax: (281) 394-2051
2103 Arbor Cove	Project Number: Dickinson Lease	**Reported:**
Katy TX, 77494	Project Manager: Mike Griffin	07/08/05 15:34

ANALYTICAL REPORT FOR SAMPLES

Sample ID	**Laboratory ID**	**Matrix**	**Date Sampled**	**Date Received**
Trip	5F30001-01	Water	06/29/05 09:45	06/30/05 07:55
North Well	5F30001-02	Water	06/29/05 09:00	06/30/05 07:55
South Well	5F30001-03	Water	06/29/05 09:00	06/30/05 07:55

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Trip (5F30001-01) Water									
Benzene	ND	0.00100	mg/L	1	EG50111	07/01/05	07/05/05	EPA 8021B	
Toluene	ND	0.00100	"	"	"	"	"	"	
Ethylbenzene	ND	0.00100	"	"	"	"	"	"	
Xylene (p/m)	ND	0.00100	"	"	"	"	"	"	
Xylene (o)	ND	0.00100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*87.0 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*94.3 %*	*80-120*		"	"	"	"	
North Well (5F30001-02) Water									
Benzene	ND	0.00100	mg/L	1	EG50111	07/01/05	07/02/05	EPA 8021B	
Toluene	ND	0.00100	"	"	"	"	"	"	
Ethylbenzene	ND	0.00100	"	"	"	"	"	"	
Xylene (p/m)	ND	0.00100	"	"	"	"	"	"	
Xylene (o)	ND	0.00100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*82.7 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*91.8 %*	*80-120*		"	"	"	"	
South Well (5F30001-03) Water									
Benzene	ND	0.00100	mg/L	1	EG50111	07/01/05	07/02/05	EPA 8021B	
Toluene	ND	0.00100	"	"	"	"	"	"	
Ethylbenzene	ND	0.00100	"	"	"	"	"	"	
Xylene (p/m)	ND	0.00100	"	"	"	"	"	"	
Xylene (o)	ND	0.00100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*82.1 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*90.7 %*	*80-120*		"	"	"	"	

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
North Well (5F30001-02) Water									
Chloride	**99.3**	5.00	mg/L	10	EG50711	07/06/05	07/06/05	EPA 300.0	
Specific Conductance (EC)	**872**	5.00	umhos/cm	1	EG50502	06/30/05	06/30/05	EPA 120.1	
Total Dissolved Solids	**583**	5.00	mg/L	"	EF53006	06/30/05	07/01/05	EPA 160.1	
South Well (5F30001-03) Water									
Chloride	**73.4**	5.00	mg/L	10	EG50711	07/06/05	07/06/05	EPA 300.0	
Specific Conductance (EC)	**1000**	5.00	umhos/cm	1	EG50502	06/30/05	06/30/05	EPA 120.1	
Total Dissolved Solids	**573**	5.00	mg/L	"	EF53006	06/30/05	07/01/05	EPA 160.1	

Total Metals by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
North Well (5F30001-02) Water									
Mercury	ND	0.00100	mg/L	2	EG50807	07/08/05	07/08/05	EPA 7470A	
Arsenic	ND	0.00800	"	1	EG50102	06/30/05	07/01/05	EPA 6010B	
Barium	**0.0718**	0.00100	"	"	"	"	"	"	
Cadmium	**0.00190**	0.00100	"	"	"	"	"	"	
Chromium	ND	0.00500	"	"	"	"	"	"	
Lead	ND	0.0110	"	"	"	"	"	"	
Selenium	**0.00840**	0.00400	"	"	"	"	"	"	
Silver	**ND**	0.00500	"	"	"	"	"	"	
South Well (5F30001-03) Water									
Mercury	ND	0.00100	mg/L	2	EG50807	07/08/05	07/08/05	EPA 7470A	
Arsenic	ND	0.00800	"	1	EG50102	06/30/05	07/01/05	EPA 6010B	
Barium	**0.203**	0.00100	"	"	"	"	"	"	
Cadmium	**0.00800**	0.00100	"	"	"	"	"	"	
Chromium	**0.0174**	0.00500	"	"	"	"	"	"	
Lead	**0.0164**	0.0110	"	"	"	"	"	"	
Selenium	ND	0.00400	"	"	"	"	"	"	
Silver	ND	0.00500	"	"	"	"	"	"	

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EG50111 - EPA 5030C (GC)										
Blank (EG50111-BLK1)				Prepared & Analyzed: 07/01/05						
Benzene	ND	0.00100	mg/L							
Toluene	ND	0.00100	"							
Ethylbenzene	ND	0.00100	"							
Xylene (p/m)	ND	0.00100	"							
Xylene (o)	ND	0.00100	"							
Surrogate: a,a,a-Trifluorotoluene	*92.1*		*ug/l*	*100*		*92.1*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*92.3*		*"*	*100*		*92.3*	*80-120*			
LCS (EG50111-BS1)				Prepared & Analyzed: 07/01/05						
Benzene	103		ug/l	100		103	80-120			
Toluene	93.6		"	100		93.6	80-120			
Ethylbenzene	97.1		"	100		97.1	80-120			
Xylene (p/m)	175		"	200		87.5	80-120			
Xylene (o)	89.6		"	100		89.6	80-120			
Surrogate: a,a,a-Trifluorotoluene	*116*		*"*	*100*		*116*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*115*		*"*	*100*		*115*	*80-120*			
Calibration Check (EG50111-CCV1)				Prepared: 07/01/05 Analyzed: 07/05/05						
Benzene	106		ug/l	100		106	80-120			
Toluene	93.4		"	100		93.4	80-120			
Ethylbenzene	95.5		"	100		95.5	80-120			
Xylene (p/m)	173		"	200		86.5	80-120			
Xylene (o)	91.6		"	100		91.6	80-120			
Surrogate: a,a,a-Trifluorotoluene	*107*		*"*	*100*		*107*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*119*		*"*	*100*		*119*	*80-120*			
Matrix Spike (EG50111-MS1)		**Source: 5F30001-01**		Prepared: 07/01/05 Analyzed: 07/02/05						
Benzene	91.6		ug/l	100	ND	91.6	80-120			
Toluene	81.3		"	100	ND	81.3	80-120			
Ethylbenzene	89.5		"	100	ND	89.5	80-120			
Xylene (p/m)	160		"	200	ND	80.0	80-120			
Xylene (o)	89.4		"	100	ND	89.4	80-120			
Surrogate: a,a,a-Trifluorotoluene	*95.5*		*"*	*100*		*95.5*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*120*		*"*	*100*		*120*	*80-120*			

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EG50111 - EPA 5030C (GC)										
Matrix Spike Dup (EG50111-MSD1)	**Source: 5F30001-01**			Prepared: 07/01/05 Analyzed: 07/05/05						
Benzene	85.2		ug/l	100	ND	85.2	80-120	7.24	20	
Toluene	83.8		"	100	ND	83.8	80-120	3.03	20	
Ethylbenzene	90.8		"	100	ND	90.8	80-120	1.44	20	
Xylene (p/m)	166		"	200	ND	83.0	80-120	3.68	20	
Xylene (o)	87.2		"	100	ND	87.2	80-120	2.49	20	
Surrogate: a,a,a-Trifluorotoluene	*88.0*		"	*100*		*88.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*113*		"	*100*		*113*	*80-120*			

General Chemistry Parameters by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EF53006 - Filtration Preparation										
Blank (EF53006-BLK1)				Prepared: 06/30/05 Analyzed: 07/01/05						
Total Dissolved Solids	ND	5.00	mg/L							
Duplicate (EF53006-DUP1)		**Source: 5F29010-01**		Prepared: 06/30/05 Analyzed: 07/01/05						
Total Dissolved Solids	7110	10.0	mg/L		7230			1.67	20	
Batch EG50502 - General Preparation (WetChem)										
Calibration Check (EG50502-CCV1)				Prepared & Analyzed: 06/30/05						
Specific Conductance (EC)	1420		umhos/cm	1410		101	80-120			
Duplicate (EG50502-DUP1)		**Source: 5F30001-02**		Prepared & Analyzed: 06/30/05						
Specific Conductance (EC)	870	5.00	umhos/cm		872			0.230	20	
Batch EG50711 - General Preparation (WetChem)										
Blank (EG50711-BLK1)				Prepared & Analyzed: 07/06/05						
Chloride	ND	0.500	mg/L							
LCS (EG50711-BS1)				Prepared & Analyzed: 07/06/05						
Chloride	10.5		mg/L	10.0		105	80-120			
Calibration Check (EG50711-CCV1)				Prepared & Analyzed: 07/06/05						
Chloride	10.7		mg/L	10.0		107	80-120			
Duplicate (EG50711-DUP1)		**Source: 5F30001-02**		Prepared & Analyzed: 07/06/05						
Chloride	99.4	5.00	mg/L		99.3			0.101	20	

Total Metals by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Batch EG50102 - EPA 3005A

Blank (EG50102-BLK1) Prepared: 06/30/05 Analyzed: 07/01/05

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Arsenic	ND	0.00800	mg/L							
Barium	ND	0.00100	"							
Cadmium	ND	0.00100	"							
Chromium	ND	0.00500	"							
Lead	ND	0.0110	"							
Selenium	ND	0.00400	"							
Silver	ND	0.00500	"							

LCS (EG50102-BS1) Prepared: 06/30/05 Analyzed: 07/01/05

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Arsenic	0.811	0.00800	mg/L	0.800		101	85-115			
Barium	0.197	0.00100	"	0.200		98.5	85-115			
Cadmium	0.187	0.00100	"	0.200		93.5	85-115			
Chromium	0.194	0.00500	"	0.200		97.0	85-115			
Lead	0.936	0.0110	"	1.10		85.1	85-115			
Selenium	0.364	0.00400	"	0.400		91.0	85-115			
Silver	0.110	0.00500	"	0.100		110	85-115			

LCS Dup (EG50102-BSD1) Prepared: 06/30/05 Analyzed: 07/01/05

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Arsenic	0.778	0.00800	mg/L	0.800		97.2	85-115	4.15	20	
Barium	0.191	0.00100	"	0.200		95.5	85-115	3.09	20	
Cadmium	0.186	0.00100	"	0.200		93.0	85-115	0.536	20	
Chromium	0.180	0.00500	"	0.200		90.0	85-115	7.49	20	
Lead	1.18	0.0110	"	1.10		107	85-115	23.1	20	
Selenium	0.365	0.00400	"	0.400		91.2	85-115	0.274	20	
Silver	0.0998	0.00500	"	0.100		99.8	85-115	9.72	20	

Calibration Check (EG50102-CCV1) Prepared: 06/30/05 Analyzed: 07/01/05

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Arsenic	1.10		mg/L	1.00		110	90-110			
Barium	1.09		"	1.00		109	90-110			
Cadmium	1.08		"	1.00		108	90-110			
Chromium	1.06		"	1.00		106	90-110			
Lead	0.915		"	1.00		91.5	90-110			
Selenium	0.929		"	1.00		92.9	90-110			
Silver	0.524		"	0.500		105	90-110			

Total Metals by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EG50102 - EPA 3005A										
Matrix Spike (EG50102-MS1)		**Source: 5F16004-03**		Prepared: 06/30/05 Analyzed: 07/01/05						
Arsenic	1.61	0.00800	mg/L	0.800	0.657	119	75-125			
Barium	1.85	0.00100	"	0.200	1.67	90.0	75-125			
Cadmium	0.892	0.00100	"	0.200	0.667	112	75-125			
Chromium	0.476	0.00500	"	0.200	0.277	99.5	75-125			
Lead	2.11	0.0110	"	1.10	1.07	94.5	75-125			
Selenium	1.94	0.00400	"	0.400	1.52	105	75-125			
Silver	0.359	0.00500	"	0.100	0.282	77.0	75-125			
Batch EG50807 - EPA 7470A										
Blank (EG50807-BLK1)				Prepared & Analyzed: 07/08/05						
Mercury	ND	0.00100	mg/L							
LCS (EG50807-BS1)				Prepared & Analyzed: 07/08/05						
Mercury	0.00170	0.000500	mg/L	0.00200		85.0	85-115			
Calibration Check (EG50807-CCV1)				Prepared & Analyzed: 07/08/05						
Mercury	0.00103		mg/L	0.00100		103	90-110			
Matrix Spike (EG50807-MS1)		**Source: 5G01015-02**		Prepared & Analyzed: 07/08/05						
Mercury	0.00212	0.000500	mg/L		ND		75-125			
Matrix Spike Dup (EG50807-MSD1)		**Source: 5G01015-02**		Prepared & Analyzed: 07/08/05						
Mercury	0.00206	0.000500	mg/L		ND		75-125	2.87	20	

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
LCS	Laboratory Control Spike
MS	Matrix Spike
Dup	Duplicate

Report Approved By: Raland K Date: 7/8/2005

Raland K. Tuttle, Lab Manager
Celey D. Keene, Lab Director, Org. Tech Director
Peggy Allen, QA Officer
Jeanne Mc Murrey, Inorg. Tech Director
LaTasha Cornish, Chemist
Sandra Sanchez, Lab Tech.

This material is intended only for the use of the individual (s) or entity to whom it is addressed, and may contain information that is privileged and confidential.

If you have received this material in error, please notify us immediately at 432-563-1800.

Environmental Lab of Texas, Inc.

12600 West I-20 East
Odessa, Texas 79763

Phone: 915-563-1800
Fax: 915-563-1713

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: M. Griffin

Company Name Whole Earth Environmental, Inc.

Company Address: 2103 Arbor Cove

City/State/Zip: Katy, Texas 77494

Telephone No: (713) 775-6350

Fax No: (281) 394-2051

Sampler Signature:

Project Name: Devon

Project #: Dickinson Lease

Project Loc: Lea County, New Mexico

PO #:

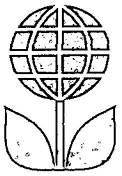
					Preservative							Matrix				Analyze For:															
																			TCLP:												
																			TOTAL:	X			X								
LAB # (lab use only)	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Ice	HNO_3	HCl	NaOH	H_2SO_4	None	Other (Specify)	Water	Sludge	Soil	Other (specify):	[✓ TDS] [✓ CL] SAR-EC	TPH 418.1	TPH TX 1005/1006	TPH 8015M GRO/DRO	Metals: As Ag Ba Cd Cr Pb Hg Se	Volatiles	Semivolatiles	BTEX 8021B/5030	Chlorides	S.A.R.	E.C.				RUSH TAT (Pre-Schedule)	Standard TAT
01	Trip	20050629	9:45	2	X		X					X											X								
02	North Well (BTEX)	20050629	9:00	2	X		X					X											X								
03	South Well (BTEX)	20050629	9:00	2	X		X					X											X								
04	North Well	20050629	9:00	1	X							X				X				X											
05	South Well	20050629	9:00	1	X							X				X				X											

Special Instructions:

Please e-mail results to Darrell Glueck at KK5LG@aol.com

Sample Containers Intact? [✓ Y] N
Temperature Upon Receipt: 0.5 °C
Laboratory Comments:
2 Liter HDPE unpreserved w/labels
6 - 40ml glass w/HCl w/label/seal
(Lab will preserve metals w/HNO3 for [illegible])

Relinquished by: D. A. Glueck	Date 20050630	Time 0755	Received by:	Date	Time
Relinquished by:	Date	Time	Received by ELOT:	Date 06-30-05	Time 0755



Soils Section

This section contains copies of six individual laboratory analytical reports along with their associated chains of custody and quality control information. A summary sheet is also provided to guide the reader through the various test sections.

Devon Energy Company
B.C. Dickinson Remediation Project
Laboratory Analytical Summary

Pit Area			
Sample Point	Report Date	Lab. I.D.	Chloride (ppm)
North Wall	3/31/2005	5C28001-01	76
East Wall	5/5/2005	5E02020-02	315
South Wall	5/5/2005	5E02020-03	107
West Wall	5/5/2005	5E02020-04	351
Bottom	3/31/2005	5C28001-03	286

Pit Lifts			
Sample Point	Report Date	Lab. I.D.	Chloride (ppm)
Lift 1	5/17/2005	5E13026-01	546
Lift 2	5/17/2005	5E13026-02	169
Lift 3	5/17/2005	5E13026-03	142
Lift 4	5/17/2005	5E13026-04	153
Lift 5	5/17/2005	5E13026-05	155
Lift 6	5/17/2005	5E13026-06	188

Borrow Pit Plifts			
Sample Point	Report Date	Lab. I.D.	Chloride (ppm)
Lift 1	6/16/2005	5F13009-01	621
Lift 2	6/16/2005	5F13009-02	122
Lift 3	6/16/2005	5F13009-03	521
Lift 4	6/16/2005	5F13009-04	103
Lift 5	6/16/2005	5F13009-05	170

ENVIRONMENTAL
LAB OF
12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:
Mike Griffin
WHOLE EARTH ENVIRONMENTAL
2103 Arbor Cove
Katy, TX 77494

Project: Devon
Project Number: Dickinson Battery
Location: None Given

Lab Order Number: 5C28001

Report Date: 03/31/05

WHOLE EARTH ENVIRONMENTAL	Project: Devon	Fax: (281) 394-2051
2103 Arbor Cove	Project Number: Dickinson Battery	**Reported:**
Katy TX, 77494	Project Manager: Mike Griffin	03/31/05 11:15

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Pit N. Wall	5C28001-01	Soil	03/28/05 00:00	03/28/05 10:55
Pit E. Wall	5C28001-02	Soil	03/28/05 00:00	03/28/05 10:55
Bottom	5C28001-03	Soil	03/28/05 00:00	03/28/05 10:55
Spread Composite	5C28001-04	Soil	03/28/05 00:00	03/28/05 10:55

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Pit N. Wall (5C28001-01) Soil									
Benzene	**0.554**	0.100	mg/kg dry	100	EC53009	03/28/05	03/28/05	EPA 8021B	
Toluene	**3.80**	0.100	"	"	"	"	"	"	
Ethylbenzene	**4.86**	0.100	"	"	"	"	"	"	
Xylene (p/m)	**18.8**	0.100	"	"	"	"	"	"	
Xylene (o)	**6.15**	0.100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*169 %*	*80-120*		"	"	"	"	*S-04*
Surrogate: 4-Bromofluorobenzene		*95.1 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	**965**	10.0	mg/kg dry	1	EC52901	03/29/05	03/29/05	EPA 8015M	
Diesel Range Organics >C12-C35	**4640**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**5600**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*129 %*	*67.6-140*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*129 %*	*70-130*		"	"	"	"	
Pit E. Wall (5C28001-02) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EC53009	03/28/05	03/28/05	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	**J [0.0246]**	0.0250	"	"	"	"	"	"	J
Xylene (p/m)	**0.105**	0.0250	"	"	"	"	"	"	
Xylene (o)	**J [0.0176]**	0.0250	"	"	"	"	"	"	J
Surrogate: a,a,a-Trifluorotoluene		*113 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*87.7 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	**36.5**	10.0	mg/kg dry	1	EC52901	03/29/05	03/29/05	EPA 8015M	
Diesel Range Organics >C12-C35	**128**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**164**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*128 %*	*67.6-140*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*123 %*	*70-130*		"	"	"	"	
Bottom (5C28001-03) Soil									
Benzene	**1.24**	0.100	mg/kg dry	100	EC53009	03/28/05	03/28/05	EPA 8021B	
Toluene	**5.31**	0.100	"	"	"	"	"	"	
Ethylbenzene	**5.69**	0.100	"	"	"	"	"	"	
Xylene (p/m)	**17.7**	0.100	"	"	"	"	"	"	
Xylene (o)	**6.31**	0.100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*189 %*	*80-120*		"	"	"	"	*S-04*
Surrogate: 4-Bromofluorobenzene		*105 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	**1330**	10.0	mg/kg dry	1	EC52901	03/29/05	03/29/05	EPA 8015M	
Diesel Range Organics >C12-C35	**5280**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**6610**	10.0	"	"	"	"	"	"	

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Bottom (5C28001-03) Soil									
Surrogate: 1-Chlorooctane		*126 %*	*67.6-140*		*EC52901*	*03/29/05*	*03/29/05*	*EPA 8015M*	
Surrogate: 1-Chlorooctadecane		*122 %*	*70-130*		"	"	"	"	
Spread Composite (5C28001-04) Soil									
Benzene	ND	0.0500	mg/kg dry	50	EC53009	03/28/05	03/28/05	EPA 8021B	
Toluene	**J [0.0403]**	0.0500	"	"	"	"	"	"	J
Ethylbenzene	**0.169**	0.0500	"	"	"	"	"	"	
Xylene (p/m)	**0.904**	0.0500	"	"	"	"	"	"	
Xylene (o)	**0.363**	0.0500	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*120 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*84.1 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	**416**	10.0	mg/kg dry	1	EC52901	03/29/05	03/29/05	EPA 8015M	
Diesel Range Organics >C12-C35	**3280**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**3700**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*162 %*	*67.6-140*		"	"	"	"	*S-04*
Surrogate: 1-Chlorooctadecane		*208 %*	*70-130*		"	"	"	"	*S-04*

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Pit N. Wall (5C28001-01) Soil									
Chloride	**76.6**	5.00	mg/kg	10	EC53014	03/30/05	03/30/05	EPA 300.0	
% Moisture	**12.1**	0.1	%	1	EC52904	03/28/05	03/29/05	% calculation	
Pit E. Wall (5C28001-02) Soil									
Chloride	**668**	25.0	mg/kg	50	EC53014	03/30/05	03/30/05	EPA 300.0	
% Moisture	**9.2**	0.1	%	1	EC52904	03/28/05	03/29/05	% calculation	
Bottom (5C28001-03) Soil									
Chloride	**286**	10.0	mg/kg	20	EC53014	03/30/05	03/30/05	EPA 300.0	
% Moisture	**7.3**	0.1	%	1	EC52904	03/28/05	03/29/05	% calculation	
Spread Composite (5C28001-04) Soil									
Chloride	**344**	10.0	mg/kg	20	EC53014	03/30/05	03/30/05	EPA 300.0	
% Moisture	**7.8**	0.1	%	1	EC52904	03/28/05	03/29/05	% calculation	

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC52901 - Solvent Extraction (GC)										
Blank (EC52901-BLK1)				Prepared & Analyzed: 03/29/05						
Gasoline Range Organics C6-C12	ND	10.0	mg/kg wet							
Diesel Range Organics >C12-C35	ND	10.0	"							
Total Hydrocarbon C6-C35	ND	10.0	"							
Surrogate: 1-Chlorooctane	*35.0*		*mg/kg*	*50.0*		*70.0*	*67.6-140*			
Surrogate: 1-Chlorooctadecane	*36.5*		*"*	*50.0*		*73.0*	*70-130*			
LCS (EC52901-BS1)				Prepared & Analyzed: 03/29/05						
Gasoline Range Organics C6-C12	452	10.0	mg/kg wet	500		90.4	76.3-104			
Diesel Range Organics >C12-C35	560	10.0	"	500		112	76.1-118			
Total Hydrocarbon C6-C35	1010	10.0	"	1000		101	81.8-105			
Surrogate: 1-Chlorooctane	*39.9*		*mg/kg*	*50.0*		*79.8*	*67.6-140*			
Surrogate: 1-Chlorooctadecane	*37.6*		*"*	*50.0*		*75.2*	*70-130*			
Calibration Check (EC52901-CCV1)				Prepared & Analyzed: 03/29/05						
Gasoline Range Organics C6-C12	495		mg/kg	500		99.0	80-120			
Diesel Range Organics >C12-C35	494		"	500		98.8	80-120			
Total Hydrocarbon C6-C35	989		"	1000		98.9	80-120			
Surrogate: 1-Chlorooctane	*48.8*		*"*	*50.0*		*97.6*	*67.6-140*			
Surrogate: 1-Chlorooctadecane	*40.7*		*"*	*50.0*		*81.4*	*70-130*			
Matrix Spike (EC52901-MS1)	**Source: 5C28004-01**			Prepared & Analyzed: 03/29/05						
Gasoline Range Organics C6-C12	494	10.0	mg/kg dry	570	ND	86.7	75.9-114			
Diesel Range Organics >C12-C35	631	10.0	"	570	ND	111	85.3-122			
Total Hydrocarbon C6-C35	1130	10.0	"	1140	ND	99.1	84.4-115			
Surrogate: 1-Chlorooctane	*50.0*		*mg/kg*	*50.0*		*100*	*67.6-140*			
Surrogate: 1-Chlorooctadecane	*64.1*		*"*	*50.0*		*128*	*70-130*			
Matrix Spike Dup (EC52901-MSD1)	**Source: 5C28004-01**			Prepared & Analyzed: 03/29/05						
Gasoline Range Organics C6-C12	495	10.0	mg/kg dry	570	ND	86.8	75.9-114	0.202	10.4	
Diesel Range Organics >C12-C35	627	10.0	"	570	ND	110	85.3-122	0.636	10.4	
Total Hydrocarbon C6-C35	1120	10.0	"	1140	ND	98.2	84.4-115	0.889	7.6	
Surrogate: 1-Chlorooctane	*50.8*		*mg/kg*	*50.0*		*102*	*67.6-140*			
Surrogate: 1-Chlorooctadecane	*62.9*		*"*	*50.0*		*126*	*70-130*			

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC53009 - EPA 5030C (GC)										
Blank (EC53009-BLK1)				Prepared: 03/28/05 Analyzed: 03/29/05						
Benzene	ND	0.0250	mg/kg wet							
Toluene	ND	0.0250	"							
Ethylbenzene	ND	0.0250	"							
Xylene (p/m)	ND	0.0250	"							
Xylene (o)	ND	0.0250	"							
Surrogate: a,a,a-Trifluorotoluene	*98.5*		*ug/kg*	*100*		*98.5*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*84.5*		*"*	*100*		*84.5*	*80-120*			
LCS (EC53009-BS1)				Prepared & Analyzed: 03/28/05						
Benzene	107		ug/kg	100		107	80-120			
Toluene	110		"	100		110	80-120			
Ethylbenzene	113		"	100		113	80-120			
Xylene (p/m)	237		"	200		118	80-120			
Xylene (o)	116		"	100		116	80-120			
Surrogate: a,a,a-Trifluorotoluene	*118*		*"*	*100*		*118*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*119*		*"*	*100*		*119*	*80-120*			
Calibration Check (EC53009-CCV1)				Prepared: 03/28/05 Analyzed: 03/29/05						
Benzene	93.3		ug/kg	100		93.3	80-120			
Toluene	93.2		"	100		93.2	80-120			
Ethylbenzene	87.2		"	100		87.2	80-120			
Xylene (p/m)	189		"	200		94.5	80-120			
Xylene (o)	95.1		"	100		95.1	80-120			
Surrogate: a,a,a-Trifluorotoluene	*117*		*"*	*100*		*117*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*84.6*		*"*	*100*		*84.6*	*80-120*			
Matrix Spike (EC53009-MS1)	**Source: 5C28005-05**			Prepared: 03/28/05 Analyzed: 03/29/05						
Benzene	95.1		ug/kg	100	ND	95.1	80-120			
Toluene	98.9		"	100	ND	98.9	80-120			
Ethylbenzene	98.0		"	100	ND	98.0	80-120			
Xylene (p/m)	217		"	200	ND	108	80-120			
Xylene (o)	107		"	100	ND	107	80-120			
Surrogate: a,a,a-Trifluorotoluene	*117*		*"*	*100*		*117*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*92.7*		*"*	*100*		*92.7*	*80-120*			

Organics by GC - Quality Control

Environmental Lab of Texas

Batch EC53009 - EPA 5030C (GC)

Matrix Spike Dup (EC53009-MSD1) **Source: 5C28005-05** Prepared: 03/28/05 Analyzed: 03/29/05

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Benzene	95.3		ug/kg	100	ND	95.3	80-120	0.210	20	
Toluene	98.9		"	100	ND	98.9	80-120	0.00	20	
Ethylbenzene	102		"	100	ND	102	80-120	4.00	20	
Xylene (p/m)	232		"	200	ND	116	80-120	7.14	20	
Xylene (o)	117		"	100	ND	117	80-120	8.93	20	
Surrogate: a,a,a-Trifluorotoluene	*113*		"	*100*		*113*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*107*		"	*100*		*107*	*80-120*			

General Chemistry Parameters by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC52904 - General Preparation (Prep)										
Blank (EC52904-BLK1)				Prepared: 03/28/05 Analyzed: 03/29/05						
% Moisture	ND	0.1	%							
Duplicate (EC52904-DUP1)	**Source: 5C28001-01**			Prepared: 03/28/05 Analyzed: 03/29/05						
% Moisture	11.1	0.1	%		12.1			8.62	20	
Batch EC53014 - Water Extraction										
Blank (EC53014-BLK1)				Prepared & Analyzed: 03/30/05						
Chloride	ND	0.500	mg/kg							
LCS (EC53014-BS1)				Prepared & Analyzed: 03/30/05						
Chloride	10.5		mg/L	10.0		105	80-120			
Calibration Check (EC53014-CCV1)				Prepared & Analyzed: 03/30/05						
Chloride	10.6		mg/L	10.0		106	80-120			
Duplicate (EC53014-DUP1)	**Source: 5C25006-51**			Prepared & Analyzed: 03/30/05						
Chloride	449	25.0	mg/kg		444			1.12	20	

Notes and Definitions

S-04	The surrogate recovery for this sample is outside of established control limits due to a sample matrix effect.
J	Detected but below the Reporting Limit; therefore, result is an estimated concentration (CLP J-Flag).
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
LCS	Laboratory Control Spike
MS	Matrix Spike
Dup	Duplicate

Report Approved By: Raland K Date: 3/31/2005

Raland K. Tuttle, Lab Manager
Celey D. Keene, Lab Director, Org. Tech Director
Peggy Allen, QA Officer

Jeanne Mc Murrey, Inorg. Tech Director
James L. Hawkins, Chemist/Geologist
Sandra Sanchez, Lab Tech.

Environmental Lab of Texas, Inc.

12600 West I-20 East
Odessa, Texas 79763

Phone: 915-563-1800
Fax: 915-563-1713

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: M. Griffin

Company Name: Whole Earth Environmental, Inc.

Company Address: 2103 Arbor Cove

City/State/Zip: Katy, TX 77494

Telephone No: 281.394.2050

Fax No: 281.394.2051

Sampler Signature:

Project Name: Devon

Project #: Dickinson Battery

Project Loc:

PO #:

Analyze For: TCLP: TOTAL: X

LAB # (lab use only) 5C28001	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Preservative: Ice	HNO$_3$	HCl	NaOH	H$_2$SO$_4$	None	Other (Specify)	Matrix: Water	Sludge	Soil	Other (specify):	TDS / CL / SAR / EC	TPH 418.1	TPH TX 1005/1006	TPH 8015M GRO/DRO	Metals: As Ag Ba Cd Cr Pb Hg Se	Volatiles	Semivolatiles	BTEX 8021B/5030	Chlorides	S.A.R.	E.C.	RUSH TAT (Pre-Schedule)	Standard TAT
-01	Pit N. Wall	03/28/05		1	X									X					X				X	X				
-02	Pit E. Wall	03/28/05		1	X									X					X				X	X				
-03	Bottom	03/28/05		1	X									X					X				X	X				
-04	Spread Composite	03/28/05		1	X									X					X				X	X				

Special Instructions: ASAP

Relinquished by:	Date	Time	Received by:	Date	Time
M.G.	3-28-05	10:55			
Relinquished by:	**Date**	**Time**	**Received by ELOT:**	**Date**	**Time**
			Jeanne McMurrey	03.28.05	1055

Sample Containers Intact? [✓ Y] N

Temperature Upon Receipt: 1.5°C

Laboratory Comments:

4oz glass on ice
[illegible]

ENVIRONMENTAL
LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:
Mike Griffin
WHOLE EARTH ENVIRONMENTAL
2103 Arbor Cove
Katy, TX 77494

Project: Devon
Project Number: Dickinson Battery
Location: None Given

Lab Order Number: 5E02020

Report Date: 05/05/05

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Pit N. Wall	5E02020-01	Soil	05/02/05 09:00	05/02/05 14:45
Pit E. Wall	5E02020-02	Soil	05/02/05 09:10	05/02/05 14:45
Pit S. Wall	5E02020-03	Soil	05/02/05 09:15	05/02/05 14:45
Pit W. Wall	5E02020-04	Soil	05/02/05 09:20	05/02/05 14:45
Battery Bottom Composite	5E02020-05	Soil	05/02/05 10:00	05/02/05 14:45

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Pit N. Wall (5E02020-01) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EE50306	05/03/05	05/03/05	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*82.8 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*96.1 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EE50205	05/02/05	05/02/05	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*77.6 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*72.8 %*	*70-130*		"	"	"	"	
Pit E. Wall (5E02020-02) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EE50306	05/03/05	05/03/05	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*83.6 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*91.7 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EE50205	05/02/05	05/02/05	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*84.2 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*77.0 %*	*70-130*		"	"	"	"	
Pit S. Wall (5E02020-03) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EE50306	05/03/05	05/03/05	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*81.1 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*104 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EE50205	05/02/05	05/02/05	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	

Organics by GC
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Pit S. Wall (5E02020-03) Soil									
Surrogate: 1-Chlorooctane		*86.6 %*	*70-130*		*EE50205*	*05/02/05*	*05/02/05*	*EPA 8015M*	
Surrogate: 1-Chlorooctadecane		*81.2 %*	*70-130*		"	"	"	"	
Pit W. Wall (5E02020-04) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EE50306	05/03/05	05/03/05	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*80.8 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*88.4 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EE50205	05/02/05	05/02/05	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*81.8 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*75.0 %*	*70-130*		"	"	"	"	
Battery Bottom Composite (5E02020-05) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EE50306	05/03/05	05/03/05	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*80.5 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*91.0 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EE50205	05/02/05	05/02/05	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*81.2 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*76.2 %*	*70-130*		"	"	"	"	

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Pit N. Wall (5E02020-01) Soil									
Chloride	**385**	20.0	mg/kg	40	EE50410	05/04/05	05/04/05	EPA 300.0	
% Moisture	**6.7**	0.1	%	1	EE50301	05/02/05	05/03/05	% calculation	
Pit E. Wall (5E02020-02) Soil									
Chloride	**315**	20.0	mg/kg	40	EE50410	05/04/05	05/04/05	EPA 300.0	
% Moisture	**6.6**	0.1	%	1	EE50301	05/02/05	05/03/05	% calculation	
Pit S. Wall (5E02020-03) Soil									
Chloride	**107**	5.00	mg/kg	10	EE50410	05/04/05	05/04/05	EPA 300.0	
% Moisture	**7.0**	0.1	%	1	EE50301	05/02/05	05/03/05	% calculation	
Pit W. Wall (5E02020-04) Soil									
Chloride	**351**	20.0	mg/kg	40	EE50410	05/04/05	05/04/05	EPA 300.0	
% Moisture	**6.1**	0.1	%	1	EE50301	05/02/05	05/03/05	% calculation	
Battery Bottom Composite (5E02020-05) Soil									
Chloride	**464**	25.0	mg/kg	50	EE50410	05/04/05	05/04/05	EPA 300.0	
% Moisture	**2.6**	0.1	%	1	EE50301	05/02/05	05/03/05	% calculation	

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE50205 - Solvent Extraction (GC)										
Blank (EE50205-BLK1)				Prepared & Analyzed: 05/02/05						
Gasoline Range Organics C6-C12	ND	10.0	mg/kg wet							
Diesel Range Organics >C12-C35	ND	10.0	"							
Total Hydrocarbon C6-C35	ND	10.0	"							
Surrogate: 1-Chlorooctane	*38.5*		*mg/kg*	*50.0*		*77.0*	*70-130*			
Surrogate: 1-Chlorooctadecane	*37.4*		*"*	*50.0*		*74.8*	*70-130*			
LCS (EE50205-BS1)				Prepared & Analyzed: 05/02/05						
Gasoline Range Organics C6-C12	411	10.0	mg/kg wet	500		82.2	75-125			
Diesel Range Organics >C12-C35	444	10.0	"	500		88.8	75-125			
Total Hydrocarbon C6-C35	855	10.0	"	1000		85.5	75-125			
Surrogate: 1-Chlorooctane	*35.7*		*mg/kg*	*50.0*		*71.4*	*70-130*			
Surrogate: 1-Chlorooctadecane	*39.8*		*"*	*50.0*		*79.6*	*70-130*			
Calibration Check (EE50205-CCV1)				Prepared & Analyzed: 05/02/05						
Gasoline Range Organics C6-C12	428		mg/kg	500		85.6	80-120			
Diesel Range Organics >C12-C35	520		"	500		104	80-120			
Total Hydrocarbon C6-C35	948		"	1000		94.8	80-120			
Surrogate: 1-Chlorooctane	*46.4*		*"*	*50.0*		*92.8*	*70-130*			
Surrogate: 1-Chlorooctadecane	*38.2*		*"*	*50.0*		*76.4*	*70-130*			
Matrix Spike (EE50205-MS1)	**Source: 5E02002-01**			Prepared & Analyzed: 05/02/05						
Gasoline Range Organics C6-C12	411	10.0	mg/kg dry	503	ND	81.7	75-125			
Diesel Range Organics >C12-C35	545	10.0	"	503	ND	108	75-125			
Total Hydrocarbon C6-C35	956	10.0	"	1010	ND	94.7	75-125			
Surrogate: 1-Chlorooctane	*40.7*		*mg/kg*	*50.0*		*81.4*	*70-130*			
Surrogate: 1-Chlorooctadecane	*36.1*		*"*	*50.0*		*72.2*	*70-130*			
Matrix Spike Dup (EE50205-MSD1)	**Source: 5E02002-01**			Prepared & Analyzed: 05/02/05						
Gasoline Range Organics C6-C12	495	10.0	mg/kg dry	503	ND	98.4	75-125	18.5	20	
Diesel Range Organics >C12-C35	523	10.0	"	503	ND	104	75-125	4.12	20	
Total Hydrocarbon C6-C35	1020	10.0	"	1010	ND	101	75-125	6.48	20	
Surrogate: 1-Chlorooctane	*42.0*		*mg/kg*	*50.0*		*84.0*	*70-130*			
Surrogate: 1-Chlorooctadecane	*35.8*		*"*	*50.0*		*71.6*	*70-130*			

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE50306 - EPA 5030C (GC)										
Blank (EE50306-BLK1)				Prepared & Analyzed: 05/03/05						
Benzene	ND	0.0250	mg/kg wet							
Toluene	ND	0.0250	"							
Ethylbenzene	ND	0.0250	"							
Xylene (p/m)	ND	0.0250	"							
Xylene (o)	ND	0.0250	"							
Surrogate: a,a,a-Trifluorotoluene	*87.8*		*ug/kg*	*100*		*87.8*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*94.7*		*"*	*100*		*94.7*	*80-120*			
LCS (EE50306-BS1)				Prepared & Analyzed: 05/03/05						
Benzene	86.9		ug/kg	100		86.9	80-120			
Toluene	90.9		"	100		90.9	80-120			
Ethylbenzene	91.8		"	100		91.8	80-120			
Xylene (p/m)	208		"	200		104	80-120			
Xylene (o)	99.3		"	100		99.3	80-120			
Surrogate: a,a,a-Trifluorotoluene	*104*		*"*	*100*		*104*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*117*		*"*	*100*		*117*	*80-120*			
Calibration Check (EE50306-CCV1)				Prepared: 05/03/05 Analyzed: 05/04/05						
Benzene	86.1		ug/kg	100		86.1	80-120			
Toluene	87.3		"	100		87.3	80-120			
Ethylbenzene	82.6		"	100		82.6	80-120			
Xylene (p/m)	178		"	200		89.0	80-120			
Xylene (o)	85.5		"	100		85.5	80-120			
Surrogate: a,a,a-Trifluorotoluene	*99.5*		*"*	*100*		*99.5*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*88.0*		*"*	*100*		*88.0*	*80-120*			
Matrix Spike (EE50306-MS1)	**Source: 5D29014-02**			Prepared: 05/03/05 Analyzed: 05/04/05						
Benzene	90.6		ug/kg	100	ND	90.6	80-120			
Toluene	93.5		"	100	ND	93.5	80-120			
Ethylbenzene	93.6		"	100	ND	93.6	80-120			
Xylene (p/m)	211		"	200	ND	106	80-120			
Xylene (o)	101		"	100	ND	101	80-120			
Surrogate: a,a,a-Trifluorotoluene	*101*		*"*	*100*		*101*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*106*		*"*	*100*		*106*	*80-120*			

Organics by GC - Quality Control

Environmental Lab of Texas

Batch EE50306 - EPA 5030C (GC)

Matrix Spike Dup (EE50306-MSD1) **Source: 5D29014-02** Prepared & Analyzed: 05/03/05

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Benzene	83.2		ug/kg	100	ND	83.2	80-120	8.52	20	
Toluene	85.0		"	100	ND	85.0	80-120	9.52	20	
Ethylbenzene	82.2		"	100	ND	82.2	80-120	13.0	20	
Xylene (p/m)	182		"	200	ND	91.0	80-120	15.2	20	
Xylene (o)	88.5		"	100	ND	88.5	80-120	13.2	20	
Surrogate: a,a,a-Trifluorotoluene	*96.0*		"	*100*		*96.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*113*		"	*100*		*113*	*80-120*			

General Chemistry Parameters by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE50301 - General Preparation (Prep)										
Blank (EE50301-BLK1)				Prepared: 05/02/05 Analyzed: 05/03/05						
% Moisture	ND	0.1	%							
Duplicate (EE50301-DUP1)		**Source: 5E02002-01**		Prepared: 05/02/05 Analyzed: 05/03/05						
% Moisture	0.5	0.1	%		0.5			0.00	20	
Batch EE50410 - Water Extraction										
Blank (EE50410-BLK1)				Prepared & Analyzed: 05/04/05						
Chloride	ND	0.500	mg/kg							
LCS (EE50410-BS1)				Prepared & Analyzed: 05/04/05						
Chloride	10.5		mg/L	10.0		105	80-120			
Calibration Check (EE50410-CCV1)				Prepared & Analyzed: 05/04/05						
Chloride	10.6		mg/L	10.0		106	80-120			
Duplicate (EE50410-DUP1)		**Source: 5E02020-01**		Prepared & Analyzed: 05/04/05						
Chloride	383	20.0	mg/kg		385			0.521	20	

ENVIRONMENTAL
LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:
Mike Griffin
WHOLE EARTH ENVIRONMENTAL
2103 Arbor Cove
Katy, TX 77494

Project: Devon Dickinson Lease
Project Number: None Given
Location: Lea County, New Mexico

Lab Order Number: 5E13026

Report Date: 05/17/05

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
BL-1	5E13026-01	Soil	05/12/05 16:00	05/13/05 11:40
BL-2	5E13026-02	Soil	05/12/05 16:00	05/13/05 11:40
BL-3	5E13026-03	Soil	05/12/05 16:00	05/13/05 11:40
BL-4	5E13026-04	Soil	05/12/05 16:00	05/13/05 11:40
BL-4A	5E13026-05	Soil	05/12/05 16:00	05/13/05 11:40
Clay- QC	5E13026-06	Soil	05/12/05 16:00	05/13/05 11:40

General Chemistry Parameters by EPA / Standard Methods
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
BL-1 (5E13026-01) Soil									
Chloride	**428**	10.0	mg/kg	20	EE51607	05/14/05	05/16/05	EPA 300.0	
BL-2 (5E13026-02) Soil									
Chloride	**434**	10.0	mg/kg	20	EE51607	05/14/05	05/16/05	EPA 300.0	
BL-3 (5E13026-03) Soil									
Chloride	**357**	10.0	mg/kg	20	EE51607	05/14/05	05/16/05	EPA 300.0	
BL-4 (5E13026-04) Soil									
Chloride	**544**	10.0	mg/kg	20	EE51607	05/14/05	05/16/05	EPA 300.0	
BL-4A (5E13026-05) Soil									
Chloride	**367**	10.0	mg/kg	20	EE51607	05/14/05	05/16/05	EPA 300.0	
Clay- QC (5E13026-06) Soil									
[illegible]ide	**189**	10.0	mg/kg	20	EE51607	05/14/05	05/16/05	EPA 300.0	

General Chemistry Parameters by EPA / Standard Methods - Quality Control
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE51607 - Water Extraction										
Blank (EE51607-BLK1)				Prepared: 05/14/05	Analyzed: 05/16/05					
Chloride	ND	0.500	mg/kg							
LCS (EE51607-BS1)				Prepared: 05/14/05	Analyzed: 05/16/05					
Chloride	10.4		mg/L	10.0		104	80-120			
Calibration Check (EE51607-CCV1)				Prepared: 05/14/05	Analyzed: 05/16/05					
Chloride	10.5		mg/L	10.0		105	80-120			
Duplicate (EE51607-DUP1)	**Source: 5E13025-25**			Prepared: 05/14/05	Analyzed: 05/16/05					
Chloride	7690	1000	mg/kg		7760			0.906	20	

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
LCS	Laboratory Control Spike
MS	Matrix Spike
Dup	Duplicate

Report Approved By: Raland K Tuttle Date: 5-17-05

Raland K. Tuttle, Lab Manager
Celey D. Keene, Lab Director, Org. Tech Director
Peggy Allen, QA Officer

Jeanne Mc Murrey, Inorg. Tech Director
James L. Hawkins, Chemist/Geologist
Sandra Sanchez, Lab Tech.

This material is intended only for the use of the individual (s) or entity to whom it is addressed, and may contain information that is privileged and confidential.

If you have received this material in error, please notify us immediately at 432-563-1800.

Environmental Lab of Texas

12600 West I-20 East
Odessa, Texas 79765

Phone: 432-563-1800
Fax: 432-563-1713

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: Mike Griffin

Company Name: WHOLE EARTH ENVIRONMENTAL

Company Address: 2103 ARBOR COVE

City/State/Zip: KATY TEXAS

Telephone No: (713) 775 6356

Fax No:

Sampler Signature:

Email:

Project Name: DEVON DICKINSON LEASE

Project #:

Project Loc: ~~LEA~~ LEA COUNTY, NEW MEXICO

PO #:

					Preservative							Matrix				Analyze For:															
																TCLP:															
																TOTAL:															
LAB # (lab use only) 5E13026	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Ice	HNO_3	HCl	NaOH	H_2SO_4	None	Other (Specify)	Water	Sludge	Soil	Other (specify):	TPH: 418.1 8015M 1005 1006	Cations (Ca, Mg, Na, K)	Anions ([✓ Cl], ~~SO_4, CO_3, HCO_3~~)	SAR / ESP / CEC	Metals: As Ag Ba Cd Cr Pb Hg Se	Volatiles	Semivolatiles	BTEX 8021B/5030 or BTEX 8260	RCI	N.O.R.M.					RUSH TAT (Pre-Schedule)	Standard TAT
~~BL-1~~ -01	BL-1	5/12/05	1600	1						X				✓				X													
-02	BL-2	✓	✓	1						✓				✓				✓													
-03	BL-3	✓	✓	1						✓				✓				✓													
-04	BL-4	✓	✓	1						✓				✓				✓													
-05	BL-4A	✓	✓	1						✓				✓				✓													
-06	CLAY-QC	✓	✓	1						✓				✓				✓													

Special Instructions:

Sample Containers Intact? [✓ Y] N
Labels on container? Y [✓ N] written o. bag
Custody Seals: Containers / Cooler None
Temperature Upon Receipt: 24.0°C

Laboratory Comments:

plastic bags unpreserved

Relinquished by: DARRELL GLLIECK	Date 5/13/05	Time 11 40	Received by:	Date	Time
Relinquished by:	Date	Time	Received by ELOT: Jeanne McMurry	Date 05-13-05	Time 1140

ENVIRONMENTAL
LAB OF
12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Darrell Glueck
WHOLE EARTH ENVIRONMENTAL
2103 Arbor Cove
Katy, TX 77494

Project: Devon Dickinson Lease
Project Number: None Given
Location: Lea County, NM

Lab Order Number: 5F13009

Report Date: 06/16/05

WHOLE EARTH ENVIRONMENTAL 2103 Arbor Cove Katy TX, 77494	Project: Devon Dickinson Lease Project Number: None Given Project Manager: Darrell Glueck	Fax: (281) 394-2051 **Reported:** 06/16/05 11:13

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Backfill +3	5F13009-01	Soil	06/10/05 09:50	06/10/05 16:42
Backfill 0 (Surface)	5F13009-02	Soil	06/10/05 09:45	06/10/05 16:42
Backfill -3	5F13009-03	Soil	06/10/05 09:50	06/10/05 16:42
Backfill -6	5F13009-04	Soil	06/10/05 09:35	06/10/05 16:42
Backfill -9	5F13009-05	Soil	06/10/05 09:40	06/10/05 16:42

Organics by GC
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Backfill +3 (5F13009-01) Soil									
Gasoline Range Organics C6-C12	**154**	10.0	mg/kg dry	1	EF51309	06/13/05	06/14/05	EPA 8015M	
Diesel Range Organics >C12-C35	**1260**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**1410**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*96.0 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*123 %*	*70-130*		"	"	"	"	
Backfill 0 (Surface) (5F13009-02) Soil									
Gasoline Range Organics C6-C12	**34.0**	10.0	mg/kg dry	1	EF51309	06/13/05	06/14/05	EPA 8015M	
Diesel Range Organics >C12-C35	**231**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**265**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*94.2 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*107 %*	*70-130*		"	"	"	"	
Backfill -3 (5F13009-03) Soil									
Gasoline Range Organics C6-C12	**125**	10.0	mg/kg dry	1	EF51309	06/13/05	06/14/05	EPA 8015M	
Diesel Range Organics >C12-C35	**979**	10.0	"	"	"	"	"	"	
[illegible]l Hydrocarbon C6-C35	**1100**	10.0	"	"	"	"	"	"	
[illegible]rrogate: 1-Chlorooctane		*89.2 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*114 %*	*70-130*		"	"	"	"	
Backfill -6 (5F13009-04) Soil									
Gasoline Range Organics C6-C12	**14.4**	10.0	mg/kg dry	1	EF51309	06/13/05	06/14/05	EPA 8015M	
Diesel Range Organics >C12-C35	**123**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**137**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*88.8 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*103 %*	*70-130*		"	"	"	"	
Backfill -9 (5F13009-05) Soil									
Gasoline Range Organics C6-C12	**34.0**	10.0	mg/kg dry	1	EF51309	06/13/05	06/14/05	EPA 8015M	
Diesel Range Organics >C12-C35	**259**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**293**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*90.8 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*104 %*	*70-130*		"	"	"	"	

General Chemistry Parameters by EPA / Standard Methods
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Backfill +3 (5F13009-01) Soil									
Chloride	**621**	10.0	mg/kg	20	EF51507	06/14/05	06/14/05	EPA 300.0	
% Moisture	**7.8**	0.1	%	1	EF51401	06/13/05	06/14/05	% calculation	
Backfill 0 (Surface) (5F13009-02) Soil									
Chloride	**122**	5.00	mg/kg	10	EF51507	06/14/05	06/14/05	EPA 300.0	
% Moisture	**15.7**	0.1	%	1	EF51401	06/13/05	06/14/05	% calculation	
Backfill -3 (5F13009-03) Soil									
Chloride	**521**	10.0	mg/kg	20	EF51507	06/14/05	06/14/05	EPA 300.0	
% Moisture	**6.8**	0.1	%	1	EF51401	06/13/05	06/14/05	% calculation	
Backfill -6 (5F13009-04) Soil									
Chloride	**163**	5.00	mg/kg	10	EF51507	06/14/05	06/14/05	EPA 300.0	
% Moisture	**7.5**	0.1	%	1	EF51401	06/13/05	06/14/05	% calculation	
TPH 418.1	**1450**	10.0	mg/kg dry	10	EF51409	06/14/05	06/14/05	EPA 418.1	
Backfill -9 (5F13009-05) Soil									
[illegible]oride	**170**	5.00	mg/kg	10	EF51507	06/14/05	06/14/05	EPA 300.0	
% Moisture	**10.7**	0.1	%	1	EF51401	06/13/05	06/14/05	% calculation	
TPH 418.1	**2780**	10.0	mg/kg dry	10	EF51409	06/14/05	06/14/05	EPA 418.1	

Organics by GC - Quality Control
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EF51309 - Solvent Extraction (GC)										
Blank (EF51309-BLK1)				Prepared: 06/13/05 Analyzed: 06/14/05						
Gasoline Range Organics C6-C12	ND	10.0	mg/kg wet							
Diesel Range Organics >C12-C35	ND	10.0	"							
Total Hydrocarbon C6-C35	ND	10.0	"							
Surrogate: 1-Chlorooctane	*35.3*		*mg/kg*	*50.0*		*70.6*	*70-130*			
Surrogate: 1-Chlorooctadecane	*36.8*		*"*	*50.0*		*73.6*	*70-130*			
LCS (EF51309-BS1)				Prepared & Analyzed: 06/13/05						
Gasoline Range Organics C6-C12	410	10.0	mg/kg wet	500		82.0	75-125			
Diesel Range Organics >C12-C35	408	10.0	"	500		81.6	75-125			
Total Hydrocarbon C6-C35	818	10.0	"	1000		81.8	75-125			
Surrogate: 1-Chlorooctane	*41.9*		*mg/kg*	*50.0*		*83.8*	*70-130*			
Surrogate: 1-Chlorooctadecane	*37.6*		*"*	*50.0*		*75.2*	*70-130*			
Calibration Check (EF51309-CCV1)				Prepared: 06/13/05 Analyzed: 06/14/05						
Gasoline Range Organics C6-C12	502		mg/kg	500		100	80-120			
Diesel Range Organics >C12-C35	571		"	500		114	80-120			
Total Hydrocarbon C6-C35	1070		"	1000		107	80-120			
Surrogate: 1-Chlorooctane	*55.6*		*"*	*50.0*		*111*	*70-130*			
ogate: 1-Chlorooctadecane	*56.1*		*"*	*50.0*		*112*	*70-130*			
trix Spike (EF51309-MS1)	**Source: 5F13010-01**			Prepared: 06/13/05 Analyzed: 06/14/05						
Gasoline Range Organics C6-C12	557	10.0	mg/kg dry	522	ND	107	75-125			
Diesel Range Organics >C12-C35	575	10.0	"	522	ND	110	75-125			
Total Hydrocarbon C6-C35	1130	10.0	"	1040	ND	109	75-125			
Surrogate: 1-Chlorooctane	*62.5*		*mg/kg*	*50.0*		*125*	*70-130*			
Surrogate: 1-Chlorooctadecane	*63.5*		*"*	*50.0*		*127*	*70-130*			
Matrix Spike Dup (EF51309-MSD1)	**Source: 5F13010-01**			Prepared: 06/13/05 Analyzed: 06/14/05						
Gasoline Range Organics C6-C12	587	10.0	mg/kg dry	522	ND	112	75-125	5.24	20	
Diesel Range Organics >C12-C35	571	10.0	"	522	ND	109	75-125	0.698	20	
Total Hydrocarbon C6-C35	1160	10.0	"	1040	ND	112	75-125	2.62	20	
Surrogate: 1-Chlorooctane	*62.6*		*mg/kg*	*50.0*		*125*	*70-130*			
Surrogate: 1-Chlorooctadecane	*64.4*		*"*	*50.0*		*129*	*70-130*			

General Chemistry Parameters by EPA / Standard Methods - Quality Control
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EF51401 - General Preparation (Prep)										
Blank (EF51401-BLK1)				Prepared: 06/13/05 Analyzed: 06/14/05						
% Moisture	ND	0.1	%							
Duplicate (EF51401-DUP1)	**Source: 5F13001-01**			Prepared: 06/13/05 Analyzed: 06/14/05						
% Moisture	7.1	0.1	%		6.9			2.86	20	
Batch EF51507 - Water Extraction										
Blank (EF51507-BLK1)				Prepared & Analyzed: 06/14/05						
Chloride	ND	0.500	mg/kg							
LCS (EF51507-BS1)				Prepared & Analyzed: 06/14/05						
Chloride	11.4		mg/L	10.0		114	80-120			
Calibration Check (EF51507-CCV1)				Prepared & Analyzed: 06/14/05						
Chloride	11.3		mg/L	10.0		113	80-120			
Duplicate (EF51507-DUP1)	**Source: 5F13006-04**			Prepared & Analyzed: 06/14/05						
Chloride	586	10.0	mg/kg		573			2.24	20	

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
LCS	Laboratory Control Spike
MS	Matrix Spike
Dup	Duplicate

Report Approved By: Raland K. Tuttle Date: 6-16-05

Raland K. Tuttle, Lab Manager
Celey D. Keene, Lab Director, Org. Tech Director
Peggy Allen, QA Officer

Jeanne Mc Murrey, Inorg. Tech Director
LaTasha Cornish, Chemist
Sandra Sanchez, Lab Tech.