1R - 427-163

WORKPLANS

Addendum

Date:

2-26-10

February 26, 2010

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Environmental Bureau
Oil Conservation Division

Corrective Action Plan Addendum
Calculation of Chloride Load

ROC EME JR Phillips
NMOCD #: 1R427-163

prepared for:

Rice Operating Company
122 West Taylor
Hobbs, NM 88240

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

February 26, 2010

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Environmental Bureau
Oil Conservation Division

Edward J. Hansen
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail and FedEx

RE: ROC EME JR Phillips Site NMOCD: 1R427-163
Corrective Action Plan Addendum: Calculation of Chloride Load
Unit D, Section 6, Township 20S, Range 37E

Mr. Hansen:

In August 2008 we submitted a Corrective Action Plan (CAP) for the above referenced site. This letter is a proposed addendum to that Corrective Action Plan and presents a calculated chloride load for the vadose zone at the site. We propose to complete the remedy proposed in the August CAP and to remove the calculated chloride mass ROC contributed to the vadose zone at the site from ground water at another site nearby.

Our August 2008 Corrective Action Plan concluded:

- Activities at the JR Phillips EOL have not caused constituents of concern (COCs) to enter ground water. Saturated conditions between the surface and ground water never developed at the ROC site.
- The COCs reside in the upper half of the vadose zone.
- Activities in the area near the former EOL have resulted in ambient chloride concentrations of about 1,000 mg/kg in soil.
- The EOL is the source of chloride where soil concentrations are greater than 2,000 mg/kg in soil. The geometry of the hypothesized 2,000 mg/kg isopleths at the site is presented in Plate 4 of our CAP, see Appendix A.
- The JR Phillips site presents no threat to fresh water, public health, or the environment.
- Re-vegetating a 50 foot by 50 foot area centered over the former excavation at the EOL site would reduce infiltration. This remedy is protective of ground water quality, human health, and the environment.

This letter describes our estimate of the mass of chloride the ROC EOL contributed to the vadose zone at this site. We propose to remove the calculated mass by pumping saline water from EME L-6 to maximize environmental benefit of the chloride mass removal effort. This site has a recovery well with a 4" casing (RW-1) that will allow for a high pumping rate. Ground water quality at L-6 allows a minimal removal of water and a high removal of chloride from ground water. This water will be used for line maintenance or put to some other beneficial use.

Chloride Calculation

The chloride mass calculation employed at this site uses collected soil data from borings within the known area of disturbance near the junction box: SB -1 and SB-2, drilled in December 2007. The depth to water at the site is approximately 35 feet below ground surface (bgs). These borings extend to 30 feet bgs and chloride data was collected for soil at 5 foot intervals. The observed chloride concentrations in these borings are presented in the lithologic logs provided in Appendix B and shown in table 1.

Table 1. Chloride Concentrations Observed in Soil at JR Phillips

Depth (ft bgs)	SB-1 - Center of source area	SB-2 - 5' South of source area
	Chloride (mg/kg)	
0-12	624	624
15	653	700
20	227	418
25	1010	480
30	1730	629

The former EOL was excavated in an area 30 feet wide and 30 feet long, a total of 900 ft^2. The chloride load calculation methodology along with tables showing inputs and results is given in Appendix C. As discussed in the CAP, ROC excavated the site to 12 feet below ground surface and blended soil. The backfill in the excavation had a chloride concentration of 624 mg/kg. A "chloride load" is calculated for each boring. The chloride loads from all borings are averaged to give a chloride load representative of the overall site area. In this case, the chloride load for SB-1 is 13.60 kg/m^2 and 9.92 kg/m^2 for SB-2. A background chloride concentration of 100 mg/kg is assumed and removed from the total estimated contributed chloride in the vadose zone (1.84 kg/m^2). We estimate that the chloride load in the vadose zone is 829 kg (or 1,829 lbs) of chloride.

Recommendation

We propose to remove this chloride mass from ground water at the EME L-6 location (located less than 2,000 feet to the southwest of JR Phillips, see Figure 1). In November 2009, chloride concentrations of 11,200 mg/L were observed in RW-1. We estimate 829 kg of chloride may be removed from this site over the course of about 33 days by pumping 1 gallon per minute approximately 10 hours a day.

Table 2. Chloride Removal at EME L-6 RW-1

Chloride mass at JR Phillips (kg)	Possible Site of Impacted Water Removal	chloride in water to be removed - mg/L	# of gallons to remove	Approximate days needed at 1 gpm for 10 hours/day
829	EME L-6 RW-1	11,200	19,530	33

Re-vegetation efforts will continue as necessary to restore the surface of the site to natural vegetation conditions.

If you have any questions or comments, please do not hesitate to contact us or Hack Conder at Rice Operating Company.

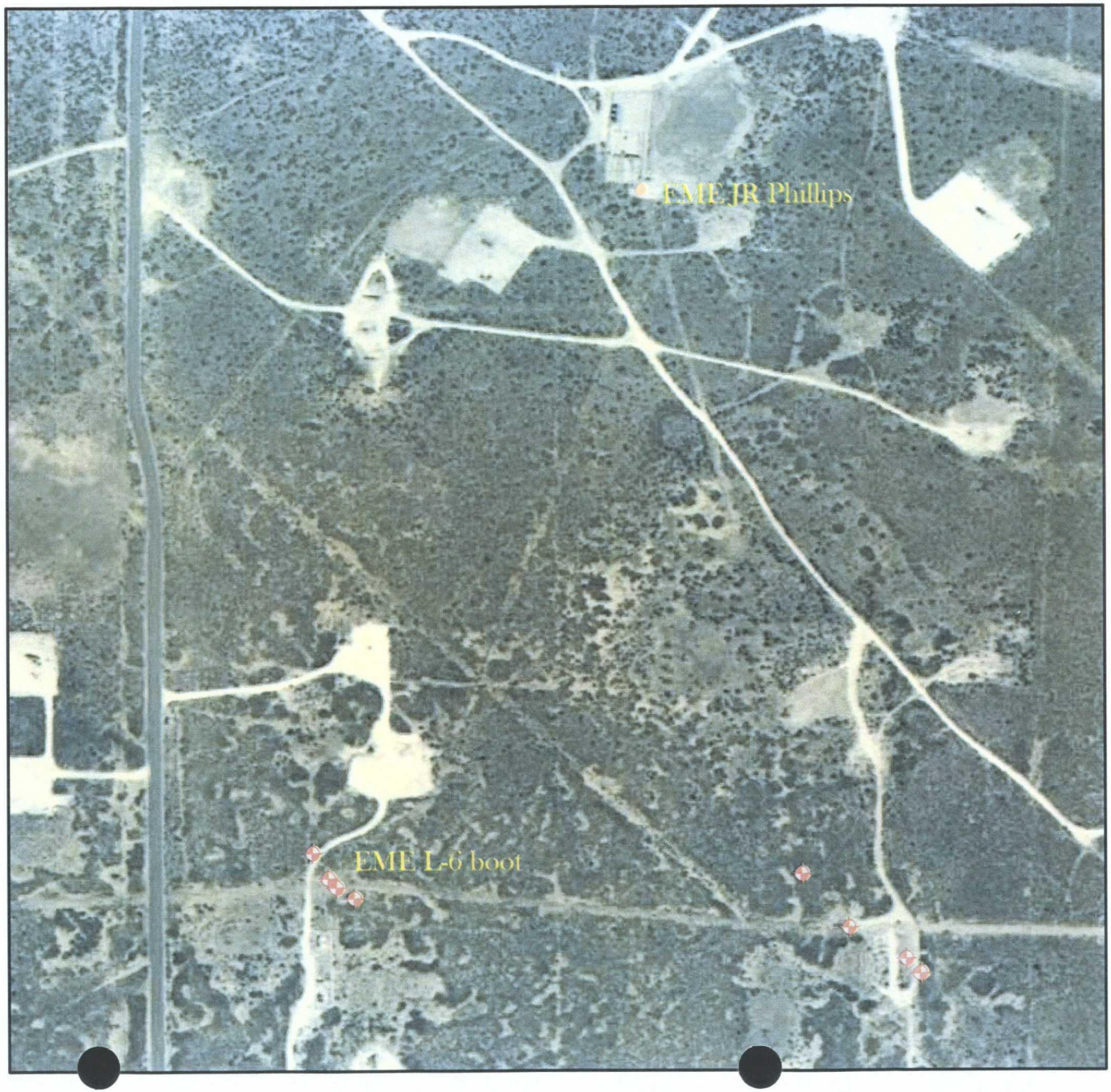
Sincerely,
R.T. Hicks Consultants, Ltd.

Katie Lee

Katie Lee
Project Scientist

Copy: Hack Conder, Rice Operating Company

Monitor well locations



Rice Operating Company
ROC
SINCE 1955

122 W. Taylor
Hobbs, NM 88240
Phone (575) 393-9174
Fax (575) 397-1471

EME JR Phillips

Legals: UL/D sec.6 T20S R37E
NMOCD Case #: 1R427-163
Consultant: R.T. Hicks

EME L-6 boot

Legals: UL/L sec.6 T20S R37E

0 250 500 1,000 Feet

Drawing date: 2-2-10
Revision date:
Drafted by: Lara Weinheimer

N
W E
S

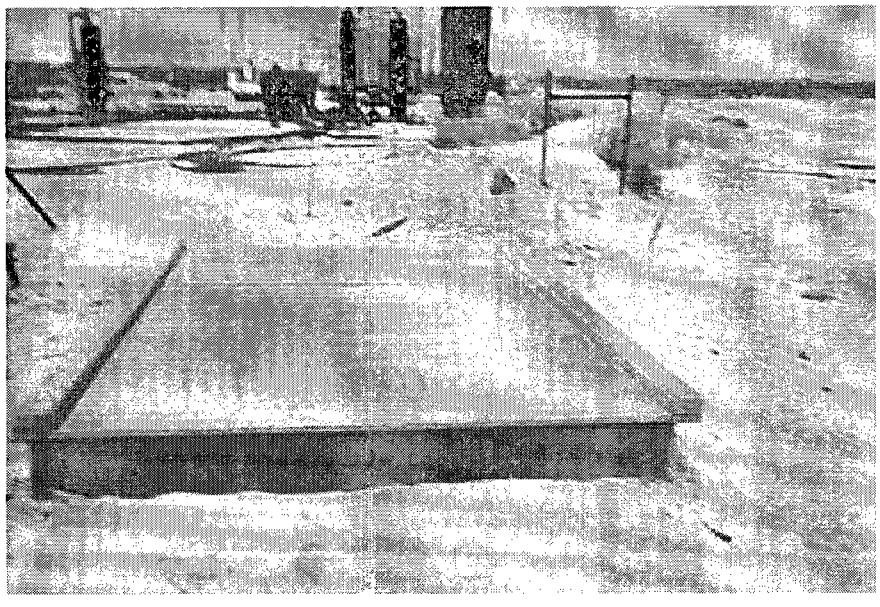
FIGURE 1

Appendix A

August 2008 Corrective Action Plan

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

August 28, 2008



JR Phillips
NMOCD Case #: 1R-427163

Corrective Action Plan

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

August 28, 2008

JR Phillips
NMOCD Case #: 1R-427163

Corrective Action Plan

prepared for:

Rice Operating Company
122 West Taylor
Hobbs, NM 88240

R.T. Hicks Consultants, Ltd.

901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

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901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

Introduction

The JR Phillips site is located southwest of Hobbs, New Mexico in Section 6 of T20S, R37E (see Plate 1). To reach the site from Hobbs, drive:

1) West 10.0 miles on US Highway 62 from the junction of US Highway 62 and State Highway 209,
2) South about 6.1 miles on County Road 41 (Maddox Road), and
3) Southeast about 0.35 miles on dirt roads.

The site was an End of Line (EOL) box with boot in the EME System which was refurbished in 2004 (See Figure 1). In 2004, Rice Operating Company (ROC) excavated and removed the JR Phillips box and a 30-foot by 30-foot area of surrounding soil to a depth of twelve-feet. Junction box characterization activities at the site followed ROC standard practices associated with junction box characterization and closure and the results of this program are presented in Appendix A.

Figure 1. Completed Junction Box, October 2004

At the time of the 2007 investigation, the 30x30x12 foot excavation was filled with a mixture of silt and caliche.

This Corrective Action Plan presents:

1) A description of the characterization activities performed by R.T. Hicks Consultants (Hicks Consultants) and ROC at the JR Phillips site in the EME system.
2) Evaluations and conclusions drawn from activities performed, and
3) A proposal for closure of the site after the selected remedy is implemented.

Characterization Program

Work Elements Performed

Detailed descriptions of the characterization activities performed by ROC and Hicks Consultants are provided in Appendix A.

Plate 2 is an aerial photo of the site when it was active, taken in 1966. Plate 3 shows the locations of the ROC borings, excavation and trenches at the same scale as Plate 2. Plate 3 also shows monitoring wells of Chevron/Texaco. Characterization activities performed included:

1) Initial ROC characterization, June 2004: ROC sampled the bottom and walls of the 30x30x12 foot excavation and nine locations within the excavation to a depth of 12 feet below ground surface. As shown on Plate 3, one location is at the center of the former box. One location is 5 feet north of the former box. Two locations each are to the west and to the east: and three locations are south of the former box. ROC conducted field chloride tests in all locations. In addition to field tests within the excavation, two soil samples were submitted for laboratory analyses: a composite from the walls of the excavation and a composite from the floor of the excavation.
2) After initial characterization the surface was restored and the site was re-seeded. Excavated soils were blended and backfilled, showing a chloride concentration of 624 mg/kg.
3) In December 2007, two soil borings were advanced to a total depth of 30 feet below ground surface. SB-1 was located at the center of the former junction box and SB-2 was placed 15 feet to the south of SB-1.

Results

Tables 1, 2, and 3 present chloride and PID measurements from the sampling locations and excavation in June, 2004 and the 2 soil borings in December, 2007. Appendix A presents laboratory and field data from the characterization activities.

Table 1. Field Results for Chloride and Volatile Organic Constituents in Trenches at Site

Trench Samples, June 2004									
Location relative to the 30' by 30' Excavation	At Former Junction Box (source)	5 feet North	5 feet East	15 feet East	5 feet South	15 feet South	25 feet South	5 feet West	15 feet West
Depth in feet	Chloride Concentration in mg/kg								
8	2,219	1,319	1,270	809	1,580	3,059	929	1,409	1,769
9	1,709	1,139	1,319	1,349	1,160	2,609	1,349	1,619	1,439
10	2,180	1,379	2,003	2,249	1,469	2,579	1,169	1,649	1,679
11	2,519	779	3,412	2,369	1,709	2,219	1,106	1,679	1,289
12	2,429	659	2,390	2,039	2,039	2,279	743	1,409	1,259
Depth in feet	PID Measurements in ppm								
6	6.5			0.0					
7	27.2			0.0					
8	1.6	0.0	0.0	0.0	0.0	0.0	0.0	42.4	2.7
9	29.5	0.0	0.0	0.0	0.0	0.0	1.4	4.3	1.5
10	2.3	0.0	0.0	59.5	0.0	0.0	0.0	9.1	0.0
11	6.3	0.0	0.0	2.4	0.0	0.0	0.0	5.4	0.0
12	0.0	0.0	0.0	2.3	0.0	0.0	0.0	9.5	0.0

Table 2. Field Results for Chloride and Volatile Organic Constituents in Excavation at Site

Soil Borings, December 2007			
SB-1		SB-2	
Center of Former Junction Box		5 Feet South of Former Junction Box	
Split Spoon Sample Depths in feet	Lab. Chloride (mg/kg)	Grab Sample Depths in feet	Field Chloride (mg/kg)
15 to 17	653	15	700
20 to 22	227	20	418
25 to 27	1,010	25	480
30 to 32	1,730	30	629

Table 3. Comparison of Chloride in Soil Borings 1 and 2

Excavation Samples, June 2004		
Samples from the 30' by 30' by 12' Excavation	**Chloride in mg/kg**	**PID Measurements in ppm**
4-Wall Composite Sample	1,109	2.3
Composite Sample of Excavation Floor	1,079	15.5
Remedial Backfill Material	624	0.0

3 Conclusions

3.1 Activities at the at JR Phillips Junction Box have not caused COC's to Enter Ground Water

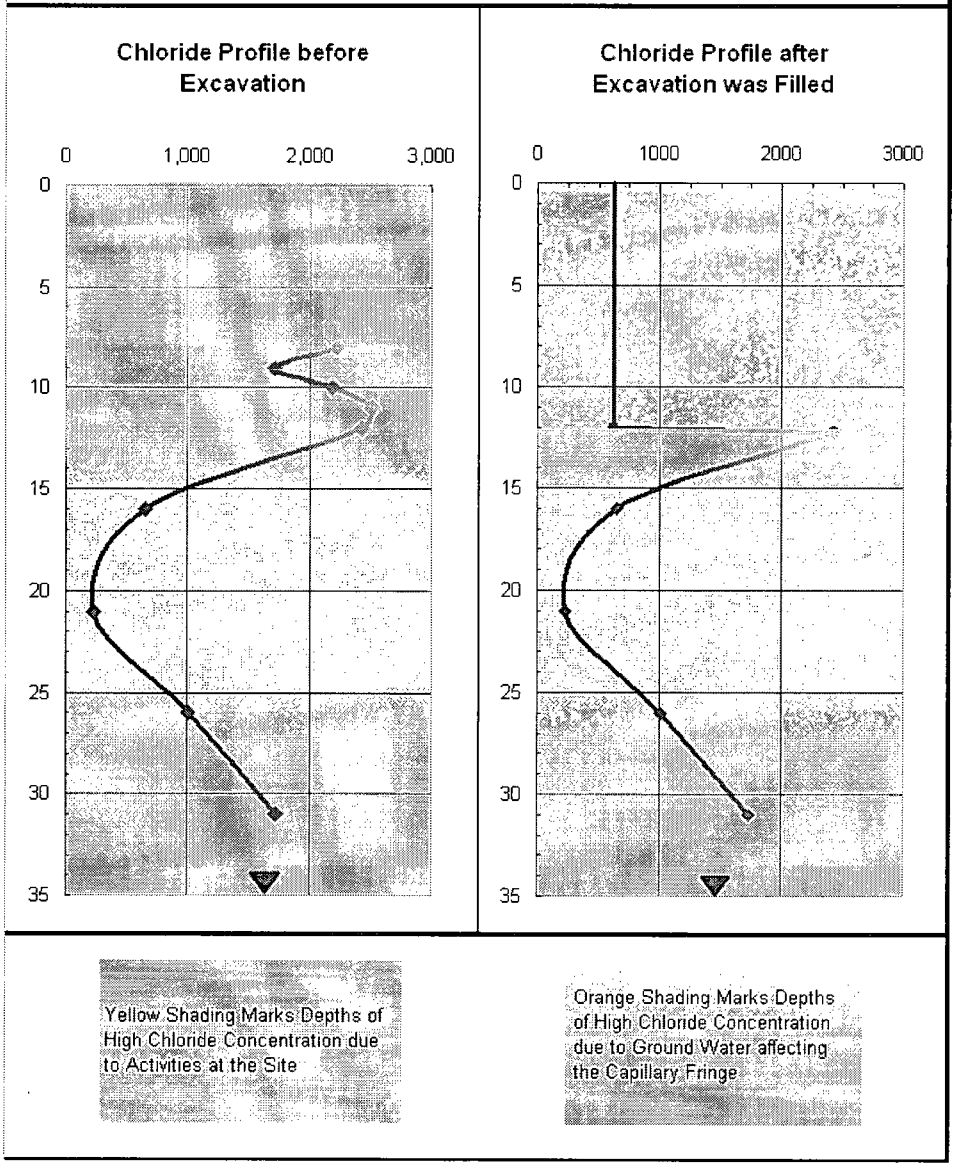
From chloride concentration and PID measurement profiles (confirmed by laboratory analysis), Hicks Consultants concludes that saturated conditions between the surface and ground water never developed at the ROC site. The constituents of concern (COC's) reside in the upper half of the vadose zone.

Figure 2 shows chloride concentrations versus depth at the center of the former junction box before the excavation to a depth of 12 feet. Also shown on Figure 2 is the chloride concentration profile that exists at present after filling the excavation with blended fill material (624 mg/kg). Chloride concentration data is from field and laboratory data.

Superimposed on the graphs are transparent shadings varying in intensity with chloride concentration. The yellow shading represents chloride from activities at the site in the upper vadose zone. The orange shading represents chloride in the capillary fringe connected with ground water.

Figure 2: Chloride Profiles at the Center of the Former JR Phillips Junction Box (SB-1)

Depth is in Feet. Chloride Concentration is in mg/kg



Between these two depth intervals, chloride concentrations decrease from 663 mg/kg (16-feet) to 227 mg/kg at the depth of 21 feet. These low chloride concentrations demonstrate that produced water (which exhibits chloride concentrations in excess of 30,000 mg/L, based upon ROC data) has not migrated through this depth interval and therefore has not entered ground water. Saturated flow of produced water through the vadose zone always leaves a "footprint" of chloride concentrations that typically exceed 1500 mg/kg (see Appendix B).

Below the depth of 21 feet, chloride concentration increases to 1,730 mg/kg at a depth of 31 feet. The water table has risen about 6 feet from 2004 to 2006 at nearby monitoring wells and is now about 35 feet below ground surface. With the accompanying rise of the capillary fringe (the saturated vadose zone connected to ground water), the chloride concentrations in the sample at 31 feet, which we believe is near the capillary fringe, is about twice the chloride concentration measured in ground water.

However, the ground water samples are from wells with a minimum of ten feet of screen below the water table; and are therefore, composite samples over this depth interval. About 900 feet to the southeast is a water well with the top of its 40-foot screen set ten feet below the water table. Groundwater samples from this well have chloride concentrations less than one-fifth that of the monitoring wells, and are representative of this screened interval. These facts suggest that chloride concentration in ground water is higher near the water table and lower near the bottom of the aquifer. Within the ground water-vadose zone interface, the well data and the soil samples suggest that chloride concentration may be about twice that of samples from the monitoring wells. Therefore, chloride concentrations in the capillary fringe are a result of connection with ground water (see Appendix B).

3.2 Activities in the Area have Resulted in Ambient Chloride Concentrations of about 1000 mg/kg

Plate 4 shows the excavated area centered over the EOL and the locations of the characterization trenches. Plotted with each trench is the averaged chloride concentration of the samples obtained at depths of 8, 9, 10, 11, and 12 feet. Isoplaths (contours of constant chloride concentration) are plotted using these data.

Plate 5 presents North-South and East-West cross-sections through the center of the site. Averaged chloride concentrations are shown plotted against lateral distance from the center of the site (placed at (0, 0)). The vertical dashed lines show the limits of the excavated area from the center of the site.

As can be seen from examining both Plates 4 and 5:

1) Chloride concentrations are greater than or equal to 1,000 mg/kg at the edges of the excavation.
2) Regardless of direction and local topography, none of the averaged chloride concentrations decline below 1,000 mg/kg at the edge of the excavated area.
3) The highest chloride concentration encountered is 15 feet south of the junction box (deep vadose chloride concentrations are higher in SB-2 than in SB-1)

Hicks Consultants concludes that:

1) Because the averaged chloride concentrations do not materially decline below 1,000 mg/kg with distance or direction from the EOL, the EOL is not the source of the

1000 mg/kg or greater average chloride concentration observed at the edges of the excavated area.

2) The EOL is the source of chloride where ispleths show concentrations greater than 2000 mg/kg. The geometry of the hypothesized 2000 mg/kg isopleths shown in Plate 4 is consistent with a small surface depression near the EOL.

3.3 The Site presents no threat to Fresh Water, Public Health or the Environment

Past activities in the area resulted in chloride concentrations above 1,000 mg/kg from the surface to a depth of less than 16 feet. ROC removed the soil associated with the former EOL site to a depth of 12 feet. Therefore, the chloride concentration at the former EOL site is less than 1000 mg/kg from 0-12 feet, greater than 1000 mg/kg from 12 feet to 14 feet, and less than 300 mg/kg from 14 feet to the capillary fringe. We conclude that the residual chloride mass is insufficient to pose a threat to fresh water, public health, safety, the environment or property.

Deep borings (SB-1 and SB-2, December, 2007) showed no evidence of hydrocarbon concentrations above 20 mg/kg DRO and ROC trench samples showed all hydrocarbon vapors were less than or equal to 60 ppm. In six of the eight trenches, all hydrocarbon vapors measured below 10 ppm. Because ROC has excavated and removed all soil to a depth of 12 feet, Hicks Consultants concludes that residual hydrocarbons are not present in sufficient concentrations or sufficient mass at the ROC site to represent a threat to fresh water, public health, safety, property or the environment.

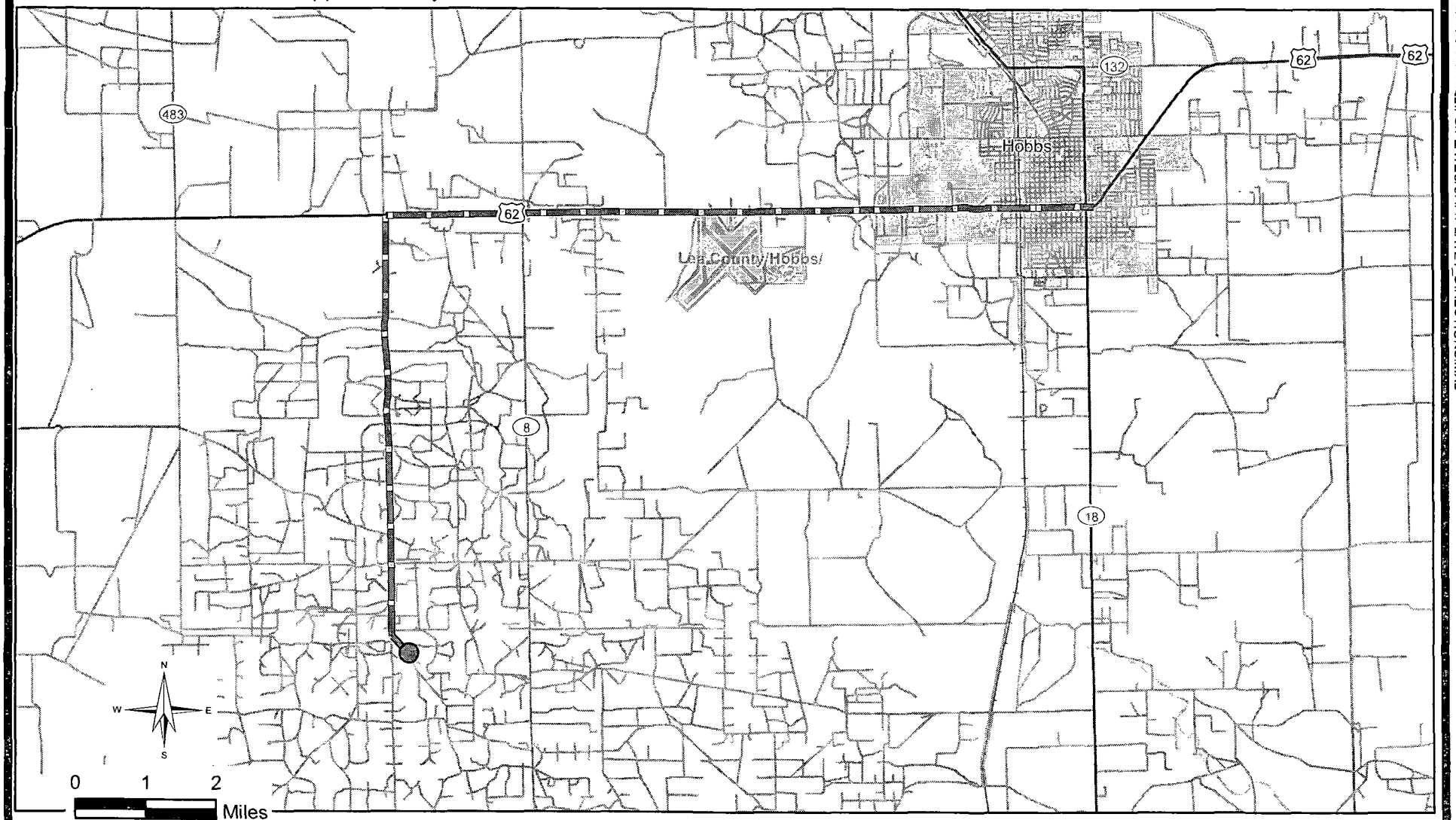
4 Recommendation

Hicks Consultants recommends that ROC re-vegetate a 50-foot by 50-foot area centered over the former excavation at the EOL site to reduce infiltration. This remedy is protective of ground water quality, human health, and the environment. Upon documentation of this action, a closure report/request will be submitted to NMOCD.

Plates

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

Driving Directions: From the intersection of US Highway 62 and State Highway 209 in Hobbs, NM, travel west 10 miles on US Highway 62. Then south approximately 6.1 miles on County Road 41 (Maddox Road). Turn east on a dirt road and head southeast for approximately 0.35 miles.



Map Source: ESRI, 2008

Explanation

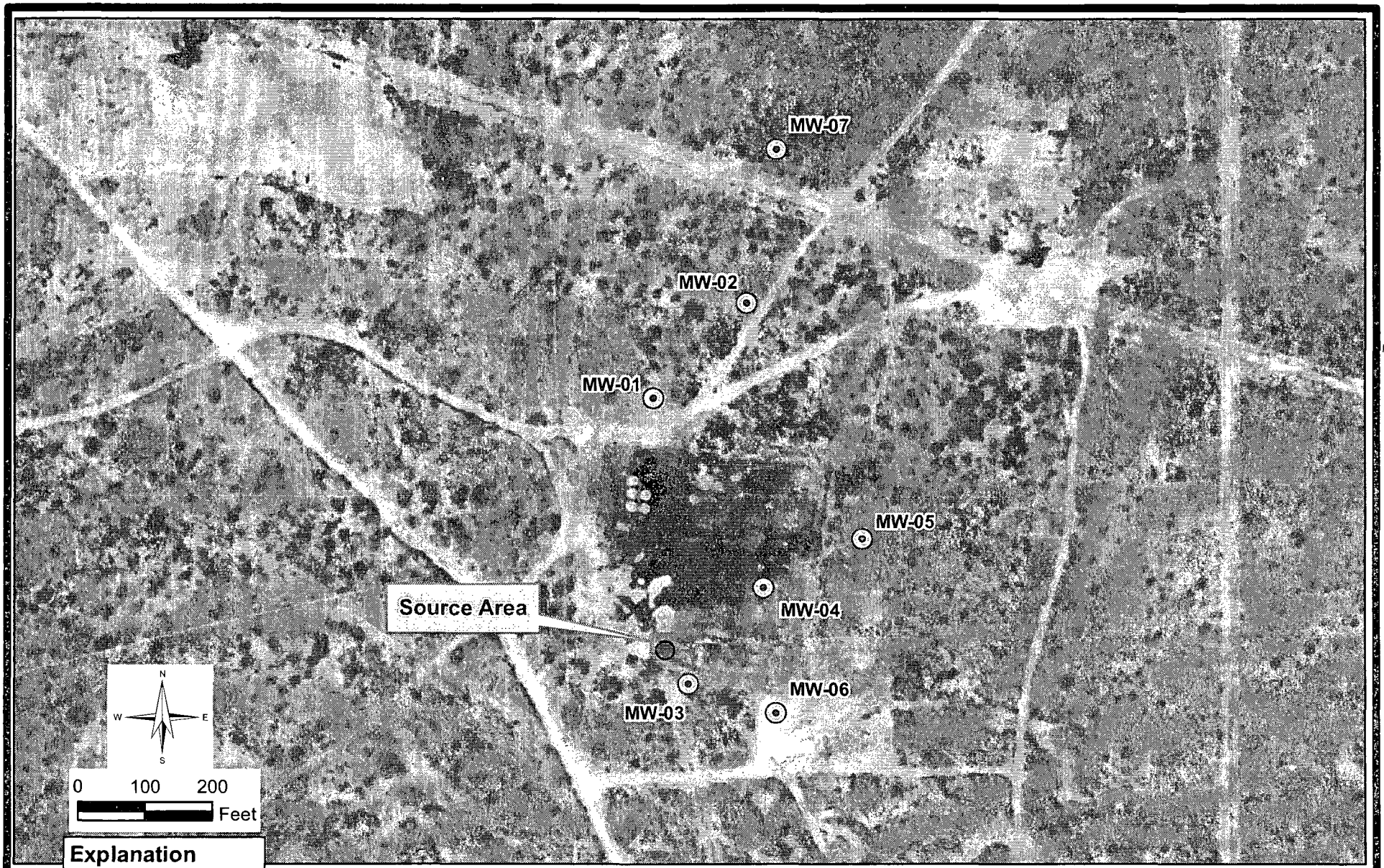
- JR Phillips EOL Boot
- Route to Site

R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

Driving Directions to the Site	Plate 1
Rice Operating Company: JR Phillips Boot EOL	February 2008

S:/PROJECTS/ROC/JRPHILLIPS/PLATES/CAP/PLATE1_DIRECTIONS.MXD

2/22/2008



1966 Aerial Photograph (EDAC, 2008)

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	Site Environs Relative to a 1966 Aerial Photo	Plate 2
	Rice Operating Company: JR Phillips Boot EOL	February 2008

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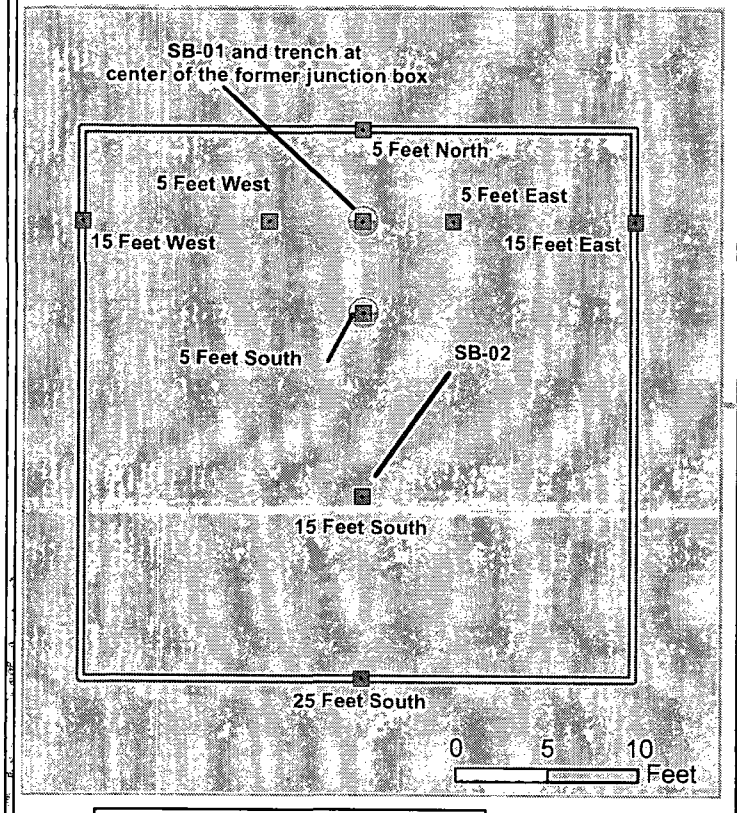
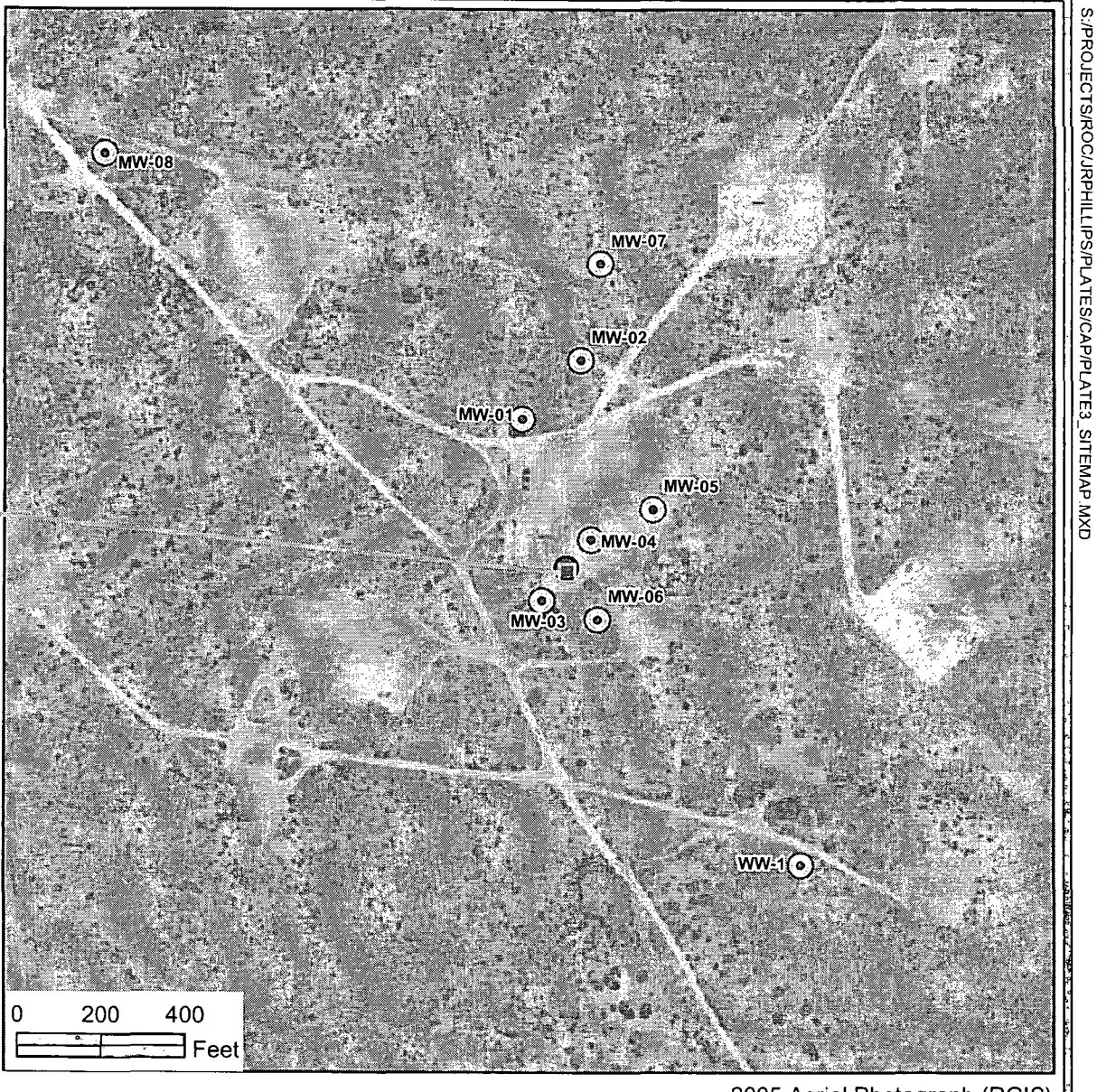
2/22/2008





Explanation

- Chevron Wells
- JR Phillips EOL Boot
- Trench
- Soil Boring
- Extent of 30x30 foot excavation

N
W E
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2005 Aerial Photograph (RGIS)

R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
Ph: 505.266.5004

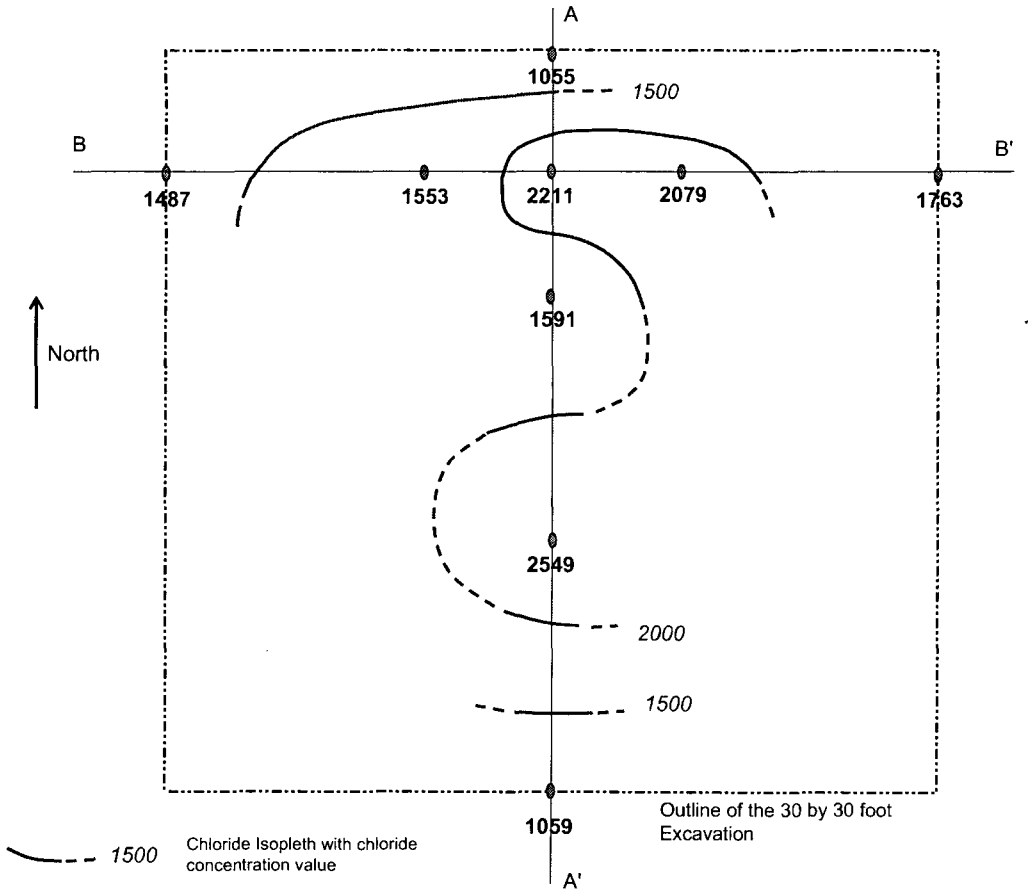
Site Map of JR Phillips Boot EOL and Chevron's JR Phillips #2 Tank Battery	Plate 3
Rice Operating Company: JR Phillips Boot EOL	April 2008

S:/PROJECTS/ROC/JRPHILLIPS/PLATES/CAP/PLATE3_SITEMAP.MXD

04/30/2008

Isoplath Map of Chloride Concentrations at JR Phillips Site. Chloride Concentrations from the 8, 9, 10, 11, and 12 foot depths are averaged and contoured.

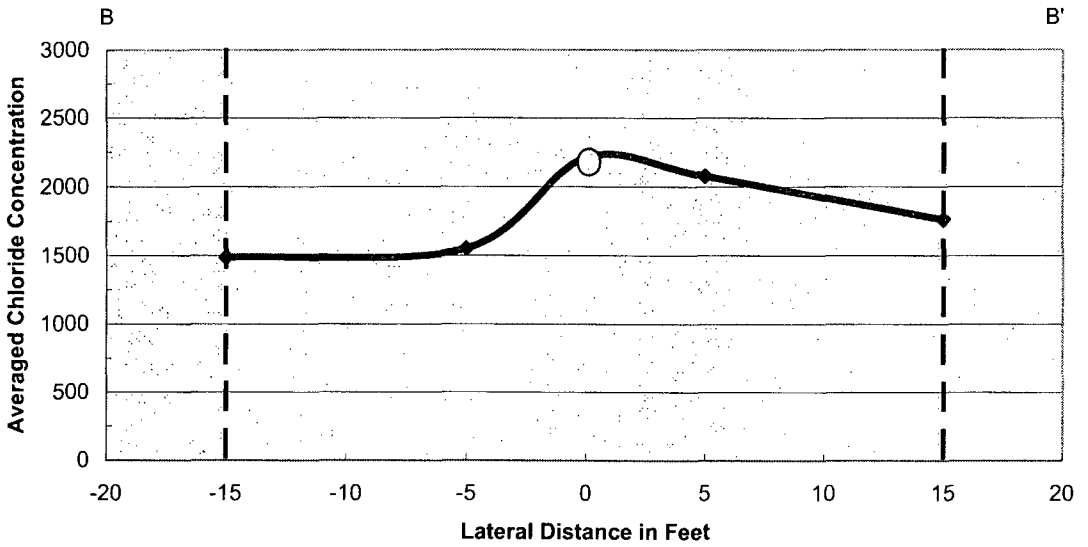
Client:	Location:
Rice Operating Company	Section 6, T20S, R37E
Project Name: JR Phillips Site	



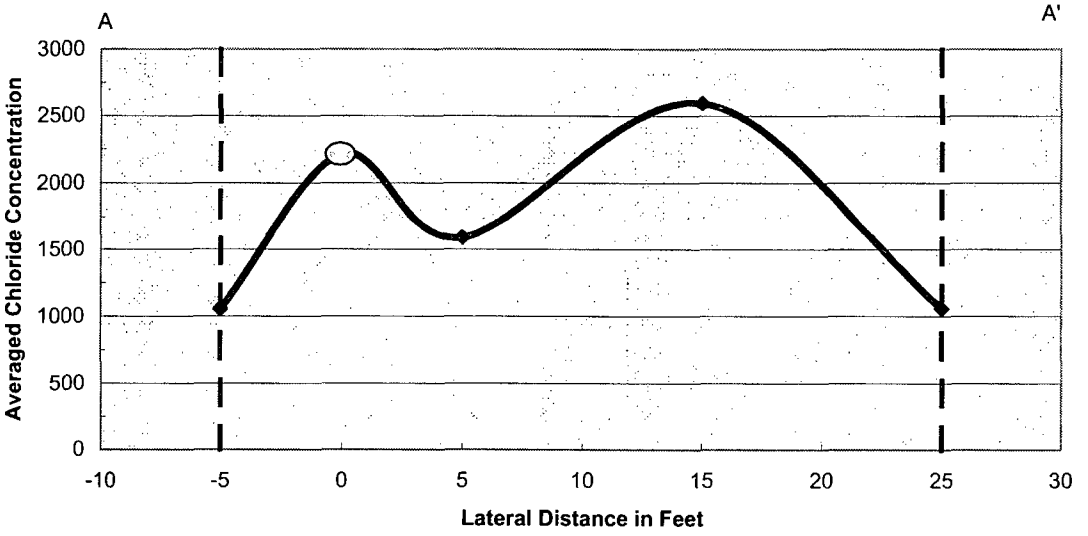
R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	**JR Phillips Site**	**Plate 4**
		May, 2008

Averaged chloride concentrations (from 8, 9, 10, 11, and 12 foot depths at each location) plotted by distance from the center of the site. Dashed lines mark the limits of the excavation.	**Client:** Rice Operating Company **Project:** JR Phillips Site	**Location:** Section 6, T20S, R37E

West to East Cross Section Through the Center of the Site



North to South Cross Section Through the Center of the Site



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	**JR Phillips Site**	**Plate 5** **May, 2008**

Appendix A

Characterization Program

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

RICE OPERATING COMPANY
JUNCTION BOX DISCLOSURE* REPORT

BOX LOCATION

SWD SYSTEM	JUNCTION	UNIT	SECTION	TOWNSHIP	RANGE	COUNTY	BOX DIMENSIONS - FEET		
							Length	Width	Depth
EME	JR Phillips boot EOL	D	6	20S	37E	Lea	7	5	5

LAND TYPE: BLM _____ STATE _____ FEE LANDOWNER Charlcie Byrd OTHER _____

Depth to Groundwater 35 feet NMOCD SITE ASSESSMENT RANKING SCORE: 20

Date Started 6/15/2004 Date Completed 7/1/2004 OCD Witness No

Soil Excavated 200 cubic yards Excavation Length 30 Width 30 Depth 12 feet

Soil Disposed 0 cubic yards Offsite Facility n/a Location n/a

FINAL ANALYTICAL RESULTS: Sample Date 6/18/2004 Sample Depth 12 ft

Procure 5-point composite sample of bottom and 4-point composite sample of sidewalls. TPH and Chloride laboratory test results completed by using an approved lab and testing procedures pursuant to NMOCD guidelines.

Sample Location	PID ppm	GRO mg/kg	DRO mg/kg	Chloride mg/kg
4-WALL COMP.	2.3	<10.0	<10.0	1180
BOTTOM COMP.	15.5	<10.0	105	1120
REMED. BACKFILL	0.0	<10.0	<10.0	624

CHLORIDE FIELD TESTS

LOCATION	DEPTH (ft)	ppm
Vertical	8	2219
at box	9	1709
	10	2189
	11	2519
	12	2429
25 ft South	8	929
	9	1349
	10	1169
	11	1109
	12	749
15 ft East	8	809
	9	1349
	10	2249
	11	2389
	12	2039
4-wall comp.	n/a	1109
bottom comp.	12	1079
backfill comp.	n/a	629

General Description of Remedial Action: This end-of-line (EOL) box contained a boot and was located directly southeast of an active production battery. The site was delineated with a backhoe while chloride field tests and PID field screenings were conducted at regular intervals. Although PID readings were generally low, TPH NMOCD guidelines were not met on the 12 ft bottom composite of the 30 x 30 x 12-ft deep excavation. Chloride concentrations did not decline with depth or breath throughout the excavation. The excavated soils were blended on-site and then backfilled into the excavation. An identification plate was placed on the surface where the box was to mark the site for future considerations. The disturbed surface will be seeded with a blend of native vegetation and monitored for growth. A new watertight junction box has been built at this location with the pipeline replacement.

ADDITIONAL EVALUATION IS *HIGH* PRIORITY

enclosures: chloride graph, photos, lab results, PID Screenings

I HEREBY CERTIFY THAT THE INFORMATION ABOVE IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

SITE SUPERVISOR Rob Elam SIGNATURE Rob Elam COMPANY Curtis Environmental--Odessa, TX

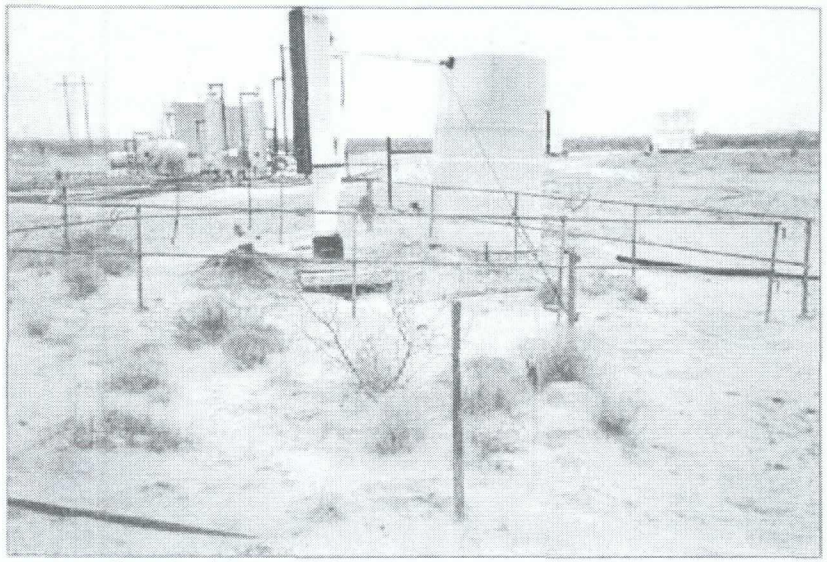
REPORT ASSEMBLED BY Kristin Farris Pope SIGNATURE Kristin Farris Pope

DATE 8/9/2004 TITLE Project Scientist

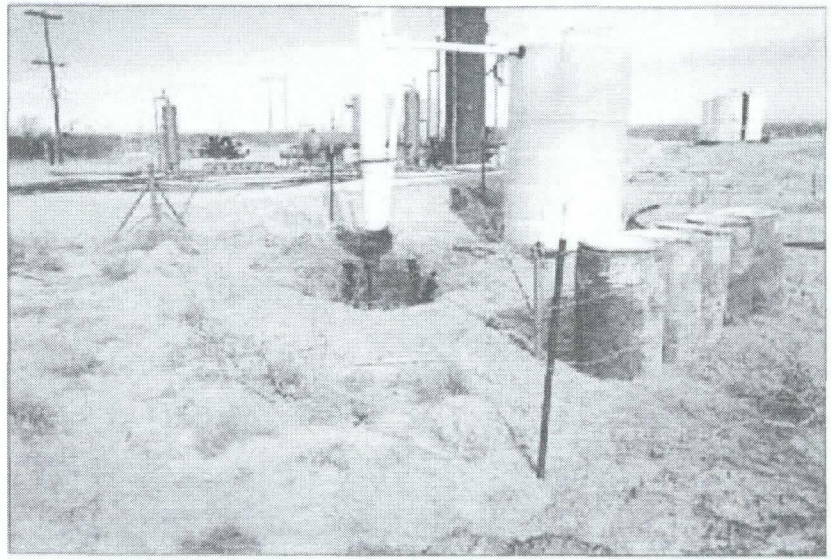
*** This site is a "DISCLOSURE." It will be placed on a prioritized list of similar sites for further consideration.***

EME J.R. Phillips boot EOL

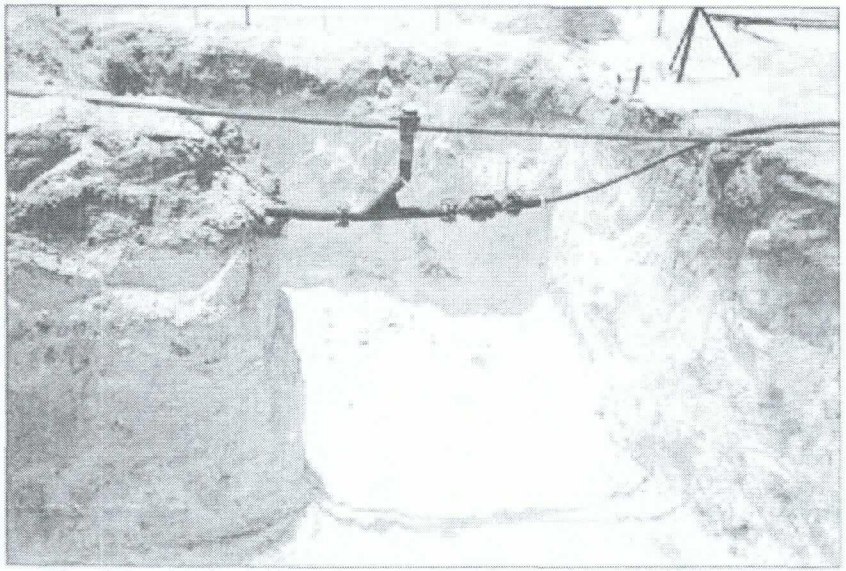
unit 'D', Sec. 6, T20S, R37E



undisturbed junction box and boot 12/05/2002



after NORM decontamination; box removed 12/9/2002

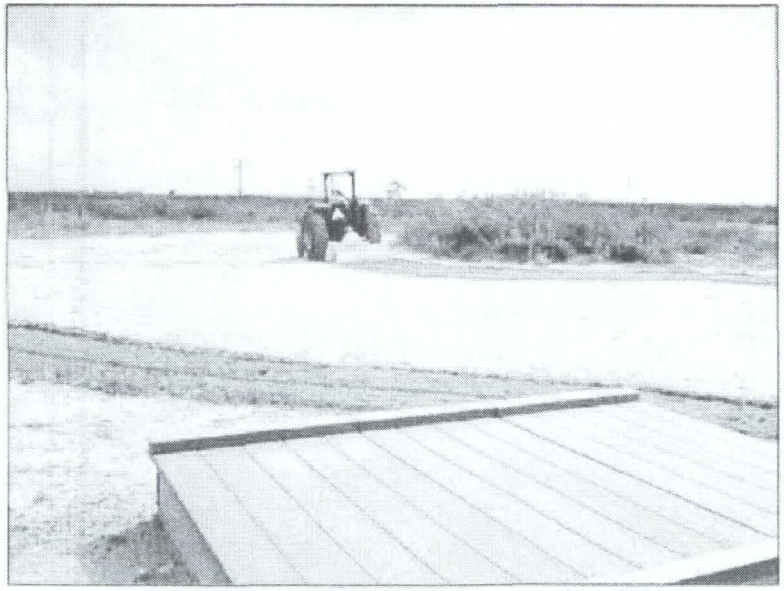


30 x 30 x 12 ft delineation excavation 6/21/2004

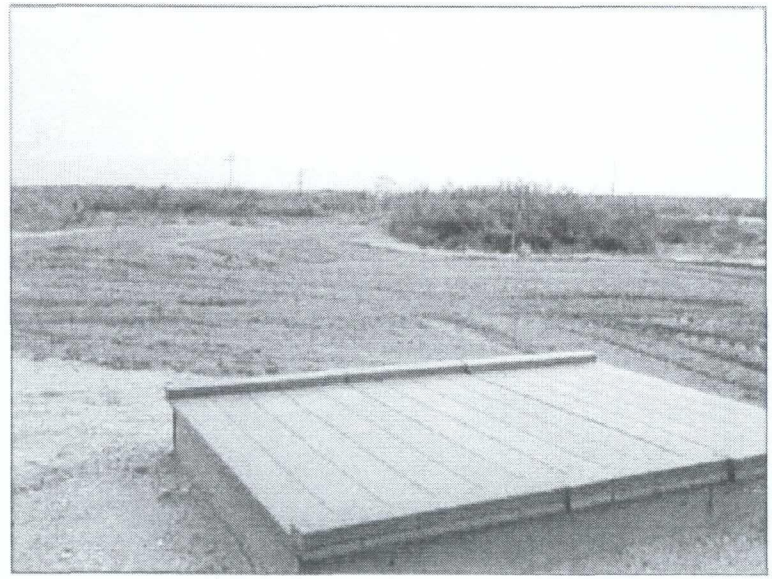
backfilled excavation; new plumbing ready for box 7/1/2004

Identification plate 10/4/2004

seeding 10/4/2004



tilling seed into soil 10/4/2004



completed site 10/4/2004

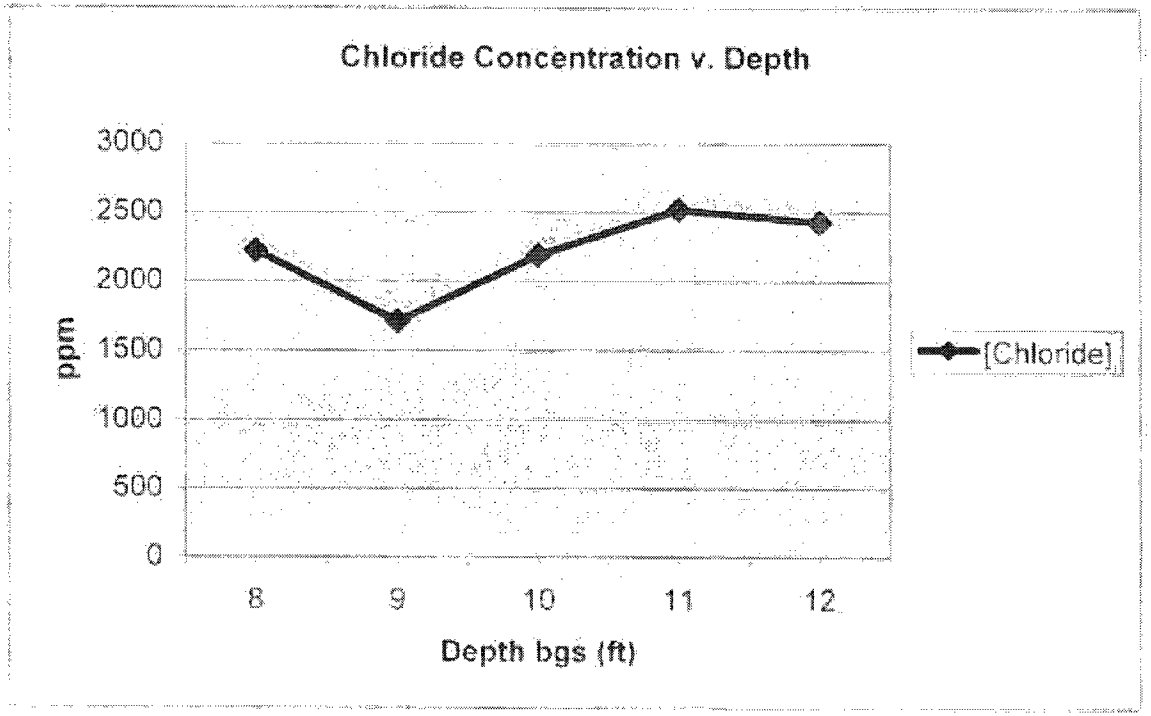
EME JR Phillips boot EOL

Unit 'D', Sec. 6, T20S, R37E

Vertical Delineation at Source

Depth bgs (ft)	[Cl] ppm
8	2219
9	1709
10	2189
11	2519
12	2429

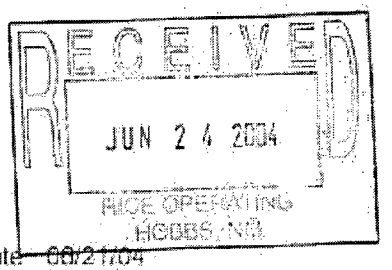
Groundwater = 35 ft



CARDINAL LABORATORIES

PHONE (325) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
RICE OPERATING CO.
ATTN: RICK ELAM
122 W. TAYLOR
HOBBS, NM 88240
FAX TO: (505) 397-1471



Receiving Date: 06/21/04
Reporting Date: 06/22/04
Project Number: NOT GIVEN
Project Name: EME JR PHILLIPS TEXACO
Project Location: NOT GIVEN

Sampling Date: 06/21/04
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: HM
Analyzed By: BC/HM

LAB NUMBER	SAMPLE ID	GRO (C_6-C_{10}) (mg/Kg)	DRO (>C_{10}-C_{28}) (mg/Kg)	Cl* (mg/Kg)
ANALYSIS DATE		06/21/04	06/21/04	06/22/04
H8838-1	12' BOTTOM COMPOSITE	<10.0	105	1120
H8838-2	WALL COMPOSITE	<10.0	<10.0	1180
Quality Control		803	808	1020
True Value QC		800	800	1000
% Recovery		100	101	102
Relative Percent Difference		3.9	1.8	1.0

METHODS: TPH GRO & DRO: EPA SW-846 8015 M; Cl: Std. Methods 4500-ClˉB
*Analyses performed on 1:4 w:v aqueous extracts.

Chemist

6/22/04
Date

H8838.XLS

CARDINAL LABORATORIES, INC.

2111 Beechwood, Abilene, TX 79603 101 East Marland, Hobbs, NM 88240
(915) 673-7001 Fax (915) 673-7020 (505) 393-2326 Fax (505) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Page ____ of ____

Company Name:	BILL TO
Project Manager: KB-ELAM	P.O. #:
Address: 122 W. Taylor	Company:
City: Hobbs State: Zip:	Attn:
Phone #: 393-9174 Fax #:	Address:
Project #: Project Owner:	City:
Project Name: EME JR Phillips	State: Zip:
Project Location:	Phone #:
Sampler Name: KB ELAM	Fax #:

FOR LAB USE ONLY				MATRIX						PRESERV.			SAMPLING		ANALYSIS REQUEST							
Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	ACID/BASE:	ICE / COOL	OTHER:	DATE	TIME	8015	Chloride						
H38384-1	12' Bottom Composite					X							6-2-04	10:16	X	X						
-2-	Wall Composite					X							6-2-04	10:20	X	X						

PLEASE NOTE: Liability and Damages. Cardinal's liability and client's exclusive remedy for any claim arising whether based in contract or tort, shall be limited to the amount paid by the client for the analyses. All claims, including those for negligence and any other cause whatsoever shall be deemed waived unless made in writing and received by Cardinal within 30 days after completion of the applicable service. In no event shall Cardinal be liable for incidental or consequential damages, including without limitation, business interruptions, loss of use, or loss of profits incurred by client, its subsidiaries, affiliates or successors arising out of or related to the performance of services hereunder by Cardinal, regardless of whether such claim is based upon any of the above stated reasons or otherwise.

Terms and Conditions: Interest will be charged on all accounts more than 30 days past due at the rate of 24% per annum from the original date of invoice, and all costs of collections, including attorney's fees.

Sampler Relinquished:	Date: 6-18-04	Received By:	Phone Result: ☐ Yes ☐ No
	Time: 1:20 P		Fax Result: ☐ Yes ☐ No
Relinquished By:	Date: 6-21-04	Received By: (Lab Staff)	REMARKS: Please fax
	Time: 9:42		

Delivered By: (Circle One)
Sampler - UPS - Bus - Other:

Sample Condition		Checked By: (Initials)
Temp. °C	Intact? ☑ Yes ☐ No	

† Cardinal cannot accept verbal changes. Please fax written changes to (915) 673-7020.

CARDINAL LABORATORIES

PHONE (325) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
RICE OPERATING CO.
ATTN: ROB ELAM
122 W.TAYLOR
HOBBS, NM 88240
FAX TO: (505) 397-1471

Receiving Date: 06/28/04
Reporting Date: 06/29/04
Project Number: NOT GIVEN
Project Name: EME B1-2 - JR PHILLIPS
Project Location: EME

Sampling Date: 06/25/04
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: HM
Analyzed By: BC/HM

LAB NO.	SAMPLE ID	GRO (C_6-C_{10}) (mg/Kg)	DRO (>C_{10}-C_{28}) (mg/Kg)	Cl* (mg/Kg)
ANALYSIS DATE		06/28/04	06/28/04	06/25/04
H8862-1	EME B1-2, REMED. BACKFILL	<10.0	<10.0	112
H8862-2	EME JR PHILLIPS REMEDIATE BACKFILL	<10.0	<10.0	624
Quality Control		770	818	1000
True Value QC		800	800	1000
% Recovery		96.2	102	100
Relative Percent Difference		0.9	3.4	2.0

METHODS: TPH GRO & DRO: EPA SW-846 8015 M; Cl: Std. Methods 4500-Cl B
*Analyses performed on 1:4 w:v aqueous extracts.

Chemist

6/29/04
Date

COPY

H8862.XLS

CARDINAL LABORATORIES, INC.

2111 Beechwood, Abilene, TX 79603 (915) 673-7001 Fax (915) 673-7020
101 East Marland, Hobbs, NM 88240 (505) 393-2326 Fax (505) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Page ____ of ____

Company Name:	R.U.E.	BILL TO	
Project Manager:	Rob Elam	P.O. #:	
Address:	122 W. Taylor	Company:	
City:	Hobbs	State:	Zip:
Phone #:	393-4954	Fax #:	
Project #:		Project Owner:	
Project Name:	EME B1-2 - JR Phillips	State:	Zip:
Project Location:	EME	Phone #:	
Sampler Name:	Rob Elam	Fax #:	

FOR LAB USE ONLY				MATRIX						PRESERV.			SAMPLING		ANALYSIS REQUEST							
Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	ACID/BASE:	ICE / COOL	OTHER:	DATE	TIME	BTEX	Chlorides						
	EME B1-2	Remediate Backfill				✓							6-25-09	10:30	✓	✓						
	EME SWMP	"	"			✓							"	"	✓	✓						

PLEASE NOTE: Liability and Damages. Cardinal's liability and client's exclusive remedy for any claim arising whether based in contract or tort, shall be limited to the amount paid by the client for the analyses. All claims, including those for negligence and any other cause whatsoever shall be deemed waived unless made in writing and received by Cardinal within 30 days after completion of the applicable service. In no event shall Cardinal be liable for incidental or consequential damages, including without limitation, business interruptions, loss of use, or loss of profits incurred by client, its subsidiaries, affiliates or successors arising out of or related to the performance of services hereunder by Cardinal, regardless of whether such claim is based upon any of the above stated reasons or otherwise.

Terms and Conditions: Interest will be charged on all accounts more than 30 days past due at the rate of 24% per annum from the original date of invoice, and all costs of collection, including attorney's fees.

Sampler Relinquished:	Date: 6-25-09	Received By:	
	Time: 4:21		
Relinquished By:	Date: 6-28-09	Received By: (Lab Staff)	
	Time: 9:21		

Delivered By: (Circle One)	Sample Condition		Checked By:
Sampler - UPS - Bus - Other:	Temp. °C	Intact? ☐ Yes ☐ No	(Initials)

Phone Result:	☐ Yes	☐ No
Fax Result:	☐ Yes	☐ No
REMARKS:		

COPY

† Cardinal cannot accept verbal changes. Please fax written changes to (915) 673-7020.

RICE OPERATING COMPANY

122 WEST TAYLOR
HOBBS, NEW MEXICO 88240
PHONE: (505) 393-9174 FAX: (505) 397-1471

VOC FIELD TEST REPORT FORM

MINI RAE PLUS CLASSIC PHOTOIONIZATION GAS DETECTOR

MODEL NO: PGM-76LS
CALIBRATION GAS
GAS COMPOSITION: ISOBUTYLENE
AIR
LOT NO: D3-2475
EXP. DATE: 10-19-05
METER READING
ACCURACY: 100

SERIAL NO: ~~[illegible]~~ 104550

100 PPM
BALANCE
FIELD DATE: 4-19-04
ACCURACY: ± 2%

SYSTEM	JUNCTION	UNIT	SECTION	TOWNSHIP	RANGE
EME	JR Phillips EOL	D	6	20-S	37-E

SAMPLE	PID RESULT	SAMPLE	PID RESULT
25' South 8'	0		
9'	1.4		
10'	0		
11'	0		
12'	0		
South Wall Comp	0		
North Wall Comp	0		
East Wall Comp	0		
West Wall Comp	0		
Wall Comp	2.3		
12' Bottom Comp	15.5		
Back Fill Comp	0		

I certify that I have calibrated the above instrument in accordance to the manufacturer operation manual.

Signature

6-18-04
Date

LITHOLOGIC LOG (SOIL BORING)

R T Hicks Consultants Ltd

P O Box 7624
Midland, TX 79708
(432) 528-3878

MONITOR WELL NO.:	SB-1	TOTAL DEPTH:	30 Feet
SITE ID:	ROC EME SWD JR Phillips	CLIENT:	Rice Operating Company
SURFACE ELEVATION:	3563 (MSL)	COUNTY:	Lea County
CONTRACTOR:	Harrison & Cooper, Inc.	STATE:	New Mexico
DRILLING METHOD:	Air-Rotary	LOCATION:	T-20-S, R-37-E, Sec. 60 (D)
INSTALLATION DATE:	12/21/07	FIELD REP.:	Dale Littlejohn
WELL PLACEMENT:	Adjacent to Jct Box	FILE NAME:	\JR Phillips\Lithlogs (12-07)
COMMENTS:	Lat. 32° 36' 19.2" North, Long. 103° 17' 41.1" West		

Depth	Samples Type	Cl (fld)	PID	LITHOLOGIC DESCRIPTION: LITHOLOGY, COLOR, GRAIN SIZE, SORTING, ROUNDING, CONSOL., DIST. DEATURES
				SILT AND CALICHE Brown to grayish brown (fill material).
5	excav	--	6.6	
	excav	--	27.2	
	excav	2,219	1.6	
	excav	1,709	29.5	
10	excav	2,189	2.3	
	excav	2,519	6.3	
	excav	2,429	0	
				SILT Light brown with some caliche and sand grains.
15	spoon	137	--	Split spoon 15 -17 feet (653 mg/kg Cl, 20 mg/kg DRO)
				SILTY SAND Brown to reddish brown, medium grain, poorly sorted, sub angula
20				30% silt, decreasing with depth.
	spoon	154	--	Split spoon 20 -22 feet (227 mg/kg Cl, <16.0 mg/kg DRO)
25	spoon	692	--	Split spoon 25 -27 feet (1,010 mg/kg Cl, <16.2 mg/kg DRO)
30	spoon	1,190	--	Split spoon 30 -32 feet (1,730 mg/kg Cl, <16.9 mg/kg DRO)

Cuttings

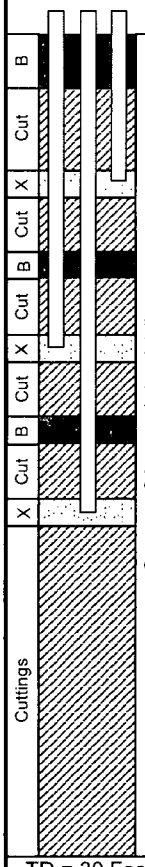
TD = 30 Feet

LITHOLOGIC LOG (SOIL BORING)

R T Hicks Consultants Ltd

P O Box 7624
Midland, TX 79708
(432) 528-3878

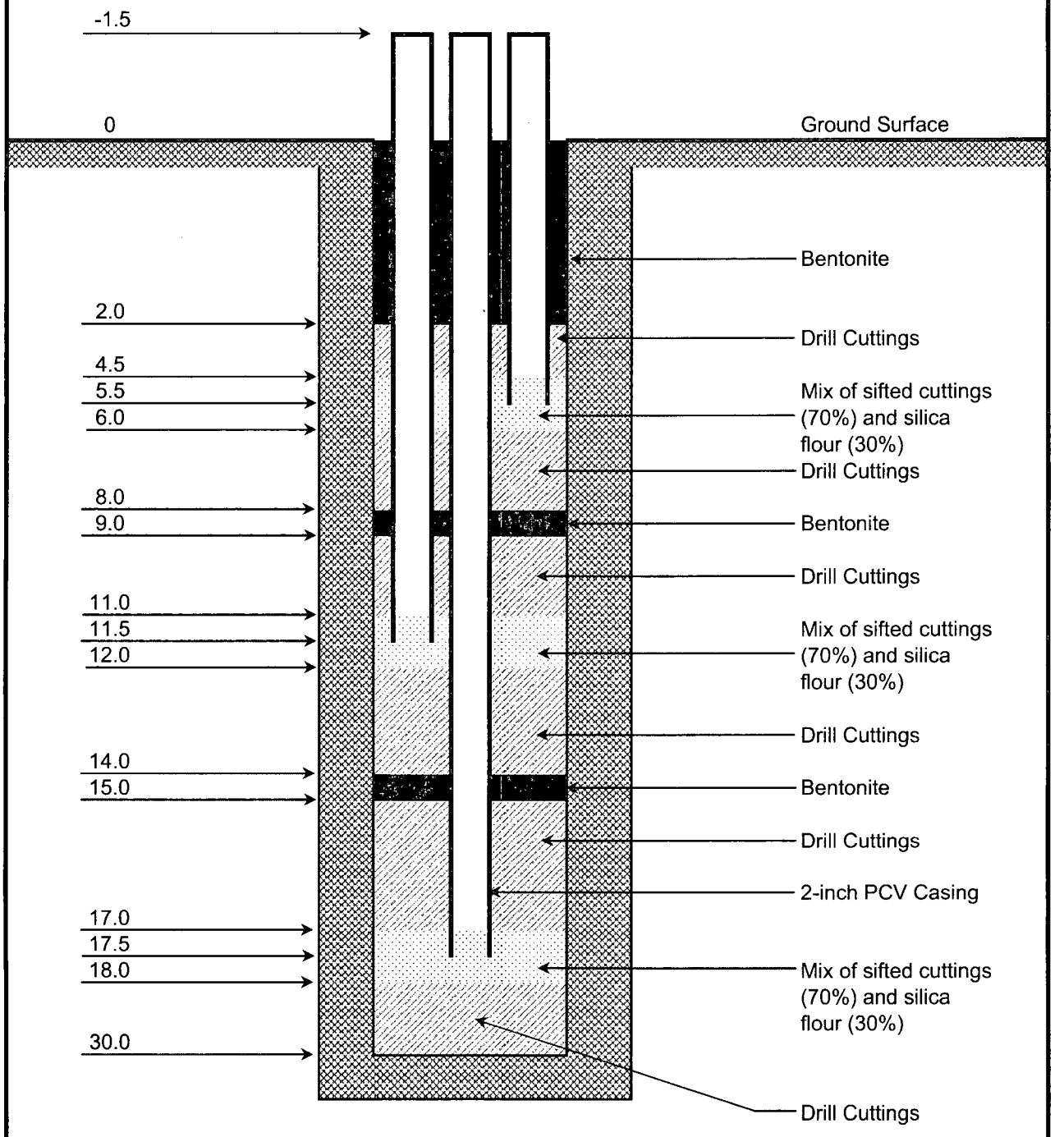
MONITOR WELL NO.:	SB-2	TOTAL DEPTH:	30.0 Ft
SITE ID:	ROC EME SWD JR Phillips	CLIENT:	Rice Operating Company
SURFACE ELEVATION:	3563 (MSL)	COUNTY:	Lea County
CONTRACTOR:	Harrison & Cooper, Inc.	STATE:	New Mexico
DRILLING METHOD:	Air-Rotary	LOCATION:	T-20-S, R-37-E, Sec. 60 (D)
INSTALLATION DATE:	12/21/07	FIELD REP.:	Dale Littlejohn
WELL PLACEMENT:	15 Feet south of Excavation	FILE NAME:	\JR Phillips\Lithlogs (12-07)
COMMENTS:	Lat. 32° 36' 19.1" North, Long. 103° 17' 41.3" West		



Depth	Type	Cl (fld)	PID	LITHOLOGIC DESCRIPTION: LITHOLOGY, COLOR, GRAIN SIZE, SORTING, ROUNDING, CONSOL., DIST. DEATURES
				SAND Brown, fine grain, well sorted, angular.
5	excav	3,059	0	SILT AND CALICHE Brown to grayish brown (fill material).
	excav	2,609	0	
10	excav	2,579	0	
	excav	2,219	0	
	excav	2,279	0	
15	cut	700	--	SILT Light brown with some caliche and sand grains.
			--	
20	cut	418	--	SILTY SAND Brown to reddish brown, medium grain, poorly sorted, sub angular, 30% silt, decreasing with depth.
			--	
25	cut	480	--	
			--	
30	cut	629	--	

TD = 30 Feet

TENSIOMETER ACCESS CONSTRUCTION DIAGRAM



R T Hicks Consultants Ltd	SITE: ROC EME SWD JR Phillips		**Soil Boring SB-2**
	DATE: 12/21/07	REV. NO.: 1	
	AUTHOR: DTL	TECH: DTL	
	DRILLER: H & C	FILE: \Lithlog 12-07	

Appendix B

Vadose Zone Discussion

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

APPENDIX B

Chloride concentrations observed in the two soil borings at JR Phillips at different depths from surface to 32 feet below ground surface, together with a working understanding of chloride fate and transport, vadose zone physics, and regional ground water quality all may be used to come to conclusions about possible impacts of activities at the JR Phillips junction box site. This appendix presents findings on these topics and our interpretation of available data.

Chloride concentrations from a soil sample are commonly expressed as chloride (in mg.) per mass of soil (in kilograms). Soil in the vadose zone is not saturated with water and it is assumed that all of the chloride is dissolved within the water contained in a soil sample. As a result, comparison of a chloride concentration for soil (expressed as mg/kg) with a chloride concentration of pore water from a soil sample (expressed as mg/L) can be confusing since the latter will be much larger.

Produced water within the EME system commonly has chloride concentrations of 20,000 mg/L to 50,000 mg/L. If produced water is released on the surface, it enters the vadose zone and mixes with pore water already present in the soil. The chloride concentration within the released produced water and the vadose zone water it encounters may be increased or decreased through the following mechanisms:

i. A release of produced water that has entered the vadose zone and is near the ground surface can cause chloride concentrations in pore water to increase due to evaporation during long dry periods as water evaporates and leaves behind chlorides in the soil.

ii. Precipitation events occurring at relatively the same time as the release will dilute the chloride concentration in accordance with the relative proportions of the volumes of water.

iii. Chloride in produced water will disperse into contacted soil water, lowering the chloride concentration of the produced water by dilution. The lower the pre-existing moisture content of the soil, the less soil water is available to dilute produced water and thus, the less effect this mechanism has.

Produced water within the vadose zone will almost certainly undergo some change of chloride concentration depending on site characteristics.

Table B-1 presents examples of chloride concentrations from soil samples (mg/kg) and their resultant chloride concentrations in soil water (mg/L) given a measured percent soil moisture and an assumed dry bulk soil density (taken as 1,500 kg/m^3). Soil moisture has a significant impact on how chloride concentrations in soils relate to chloride concentrations in pore water. Examples include:

1) Soil concentrations from background locations (often with 25 mg/kg to 150 mg/kg chloride concentrations);

2) A concentration typical of material excavated at the JR Phillips site (Samples ranged from 1,300 mg/kg to 3,100 mg/kg);

3) An example of saturated material from the vadose zone - ground water interface at the JR Phillips site;

4) And examples from SB-1 below the floor of the excavation (at the center of the JR Phillips site).

Table B-1. Comparison of Chloride Concentrations in Soil and Inferred Chloride Concentrations in Pore Water

Example Type	Sample Location (if applicable)	Soil Chloride Concentration [mg/kg] ***Lab. Values are in Italics***	Percent Moisture [%] ***Lab. Values are in italics***	Assumed Dry Bulk Density [kg/m^3]	Volumetric Moisture Content using Assumed Dry Bulk Density [-]	Resulting Chloride Concentration in Pore Water [mg/L]
Background Concentration Examples	Abo 1-G Background Location, 4 to 6 feet	***30***	***6.10***	1500	0.09	530
		125	5.00		0.08	2625
		125	8.00		0.12	1688
Example of Material from Excavation (depth of 8 to 12 feet)	JR Phillip Site	2100	5.00		0.08	44100
		2100	8.00		0.12	28350
		2100	12.00		0.18	19600
Materials from Below Excavation at JR Phillips Site	SB-1, 15 to 17 feet	***653***	***8.80***		0.13	8073
	SB-1, 20 to 22 feet	***227***	***6.50***		0.10	3719
	SB-1, 25 to 27 feet	***1010***	***7.17***		0.11	15096
	SB-1, 30 to 32 feet	***1730***	***11.40***		0.17	16905
Example of Saturated Material at Vadose Zone-Ground Water Interface		1700	25.00		0.38	8500

Examples of background materials include a background sample from the Abo 1-G site (about 20 miles to the north) and a higher concentration (125 mg/kg) at different percentages of moisture content (5% to 8% moisture). The corresponding chloride concentrations in vadose zone pore water range from about 500 mg/L to 2,600 mg/L.

An example concentration (2,100 mg/kg) of material from the excavation at the JR Phillips site is shown at several percent moisture contents (5% to 12% moisture). Corresponding chloride concentrations are from 44,000 mg/L to 19,600 mg/L.

Also shown is an example of a saturated material (25%) with a chloride concentration similar to that found in the capillary fringe of SB-1 (30-32 feet bgs - 1,700 mg/kg). The resultant chloride concentration in pore water is 8,500 mg/L.

Finally, there are four examples from SB-1 at depths from 15 feet to 32 feet. The uppermost two samples have soil concentrations of 653 mg/kg and 227 mg/kg and percent moistures of 8.8% and 6.5%. Resulting vadose zone pore water concentrations are 8,073 mg/L and 3,719 mg/L respectively. The lowermost two samples have soil concentrations of 1,010 mg/kg and 1,730 mg/kg and percent moistures of 7.17% and

11.4%. Resulting chloride concentrations in vadose zone pore water are 15,096 mg/L and 16,905 mg/L.

OBSERVATIONS

1) Vadose zone pore water from background locations has chloride concentrations ranging from about 500 mg/L to 2,500 mg/L, one to two orders of magnitude less than chloride concentrations of produced water.

2) An example of a soil chloride concentration from the excavation at the JR Phillips site (considering a range of percent moisture contents) features chloride concentrations within the range of chloride concentration of produced water within the EME system.

3) The SB-1 samples from the depths of 15 feet and 20 feet with pore water concentrations of 8,073 mg/L and 3,719 mg/L are higher than background concentrations and lower than pore water significantly impacted by produced water.

4) The SB-1 samples from the depths of 25 feet and 30 feet with pore water concentrations of 15,096 mg/L and 16,905 mg/L are also higher in concentration than those from the depths of 15 and 20 feet but are still lower than produced water concentrations. The lowermost sample also has a relatively high percent moisture (11.4%).

5) If soil from 30 feet bgs in SB-1 was saturated, its pore water concentration would match the chloride levels observed in nearby monitoring wells. A saturated soil with a chloride concentration of 1,700 mg/kg has a pore water concentration of about 8,500 mg/L. At nearby monitoring wells, recent samples (May, 2006) have been collected with chloride concentrations of 8,600 mg/L to 8,700 mg/L.

INTERPRETATIONS

- The samples from the excavation have chloride concentrations consistent with produced water altered by the processes discussed above.

- The two samples from depths of 15 feet and 20 feet are not consistent with produced water (compare with samples from the excavation), but rather is indicative of water that was at background concentration and is now being affected by chloride dispersing from produced water above. The decreasing chloride concentration and decreasing moisture content with depth is consistent with this interpretation.

- In contrast, the two samples from depths of 25 feet and 30 feet have increasing chloride concentration and increasing percent moisture with depth. From 2004 to 2006, ground water has risen about six feet in this area with a resultant rise in the

capillary fringe. We consider this evidence of the lower vadose zone pore water being affected by high chloride concentration in regional ground water.

- If the soil concentration of the lowermost sample (30 feet) is considered to be from the saturated capillary fringe, the pore water has a concentration of about 8,500 mg/L, about the same as that seen in ground water samples from nearby monitoring wells. However, the sample from this depth is not saturated and has a chloride concentration in pore water of about 16,900 mg/L, about twice what is observed in ground water. Nearby monitoring wells (both up and down gradient) have twenty-foot screen lengths with at least ten feet of screen in ground water, and therefore produce a composite sample of ground water from this upper portion of the aquifer. As mentioned, recent ground water samples from these wells have chloride concentrations of about 8,500 mg/L. This data is consistent with ground water closer to the vadose zone interface (in the upper portion of the aquifer) having highest chloride concentrations.

- About 900 feet to the southeast of the site there is a water well with the top of its 40-foot screen set ten feet below the water table. Ground water samples from this well are about 1,300 mg/L and are representative of concentrations lower in the aquifer (from 10-50 feet below the water table surface).

- We conclude that chloride concentration in ground water is higher near the vadose zone-water table interface and much lower near the bottom of the aquifer. The well data and the soil samples show that chloride concentration in the upper aquifer and within the capillary fringe is about 17,000 mg/L.

The weight of evidence suggests that chloride concentrations beneath the JR Phillips junction box site from 0-22 feet below ground surface have been influenced by what may have been small, intermittent releases of produced water at the surface due to ROC activities at the site. The elevated levels of chloride encountered in SB-1 and SB-2 from 25-32 feet below ground surface appear to be indicative of regional ground water impacts and a recent rise in ground water levels with a corresponding rise in the capillary fringe.

Appendix B

Lithologic Logs

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

LITHOLOGIC LOG (SOIL BORING)

R T Hicks Consultants Ltd

P O Box 7624
Midland, TX 79708
(432) 528-3878

MONITOR WELL NO.:	SB-1	TOTAL DEPTH:	30 Feet
SITE ID:	ROC EME SWD JR Phillips	CLIENT:	Rice Operating Company
SURFACE ELEVATION:	3563 (MSL)	COUNTY:	Lea County
CONTRACTOR:	Harrison & Cooper, Inc.	STATE:	New Mexico
DRILLING METHOD:	Air-Rotary	LOCATION:	T-20-S, R-37-E, Sec. 60 (D)
INSTALLATION DATE:	12/21/07	FIELD REP.:	Dale Littlejohn
WELL PLACEMENT:	Adjacent to Jct Box	FILE NAME:	\JR Phillips\Lithlogs (12-07)
COMMENTS:	Lat. 32° 36' 19.2" North, Long. 103° 17' 41.1" West		

Depth	Samples Type	Cl (fld)	PID	LITHOLOGIC DESCRIPTION: LITHOLOGY, COLOR, GRAIN SIZE, SORTING, ROUNDING, CONSOL., DIST. DEATURES
				SILT AND CALICHE Brown to grayish brown (fill material).
5	excav	--	6.6	
	excav	--	27.2	
	excav	2,219	1.6	
	excav	1,709	29.5	
10	excav	2,189	2.3	
	excav	2,519	6.3	
	excav	2,429	0	
				SILT Light brown with some caliche and sand grains.
15	spoon	137	--	Split spoon 15 -17 feet (653 mg/kg Cl, 20 mg/kg DRO)
				SILTY SAND Brown to reddish brown, medium grain, poorly sorted, sub angula
20				30% silt, decreasing with depth.
	spoon	154	--	Split spoon 20 -22 feet (227 mg/kg Cl, <16.0 mg/kg DRO)
25	spoon	692	--	Split spoon 25 -27 feet (1,010 mg/kg Cl, <16.2 mg/kg DRO)
30	spoon	1,190	--	Split spoon 30 -32 feet (1,730 mg/kg Cl, <16.9 mg/kg DRO)

Cuttings

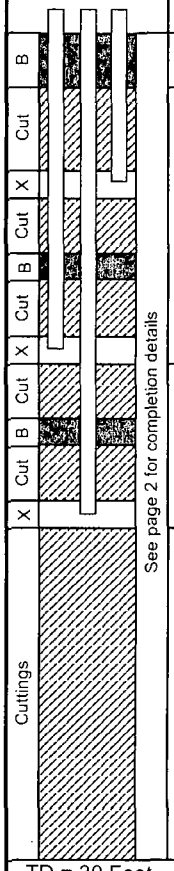
TD = 30 Feet

LITHOLOGIC LOG (SOIL BORING)

R T Hicks Consultants Ltd

P O Box 7624
Midland, TX 79708
(432) 528-3878

MONITOR WELL NO.:	SB-2	TOTAL DEPTH:	30.0 Ft
SITE ID:	ROC EME SWD JR Phillips	CLIENT:	Rice Operating Company
SURFACE ELEVATION:	3563 (MSL)	COUNTY:	Lea County
CONTRACTOR:	Harrison & Cooper, Inc.	STATE:	New Mexico
DRILLING METHOD:	Air-Rotary	LOCATION:	T-20-S, R-37-E, Sec. 60 (D)
INSTALLATION DATE:	12/21/07	FIELD REP.:	Dale Littlejohn
WELL PLACEMENT:	15 Feet south of Excavation	FILE NAME:	\JR Phillips\Lithlogs (12-07)
COMMENTS:	Lat. 32° 36' 19.1" North, Long. 103° 17' 41.3" West		



Depth	Type	Cl (fld)	PID	LITHOLOGIC DESCRIPTION: LITHOLOGY, COLOR, GRAIN SIZE, SORTING, ROUNDING, CONSOL., DIST. DEATURES
				SAND Brown, fine grain, well sorted, angular.
5	excav	3,059	0	SILT AND CALICHE Brown to grayish brown (fill material).
	excav	2,609	0	
10	excav	2,579	0	
	excav	2,219	0	
	excav	2,279	0	
15	cut	700	--	SILT Light brown with some caliche and sand grains.
			--	
20	cut	418	--	SILTY SAND Brown to reddish brown, medium grain, poorly sorted, sub angular, 30% silt, decreasing with depth.
			--	
25	cut	480	--	
			--	
30	cut	629	--	

TD = 30 Feet

Appendix C

Chloride Load Methodology & Calculations

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

CALCULATION OF CHLORIDE IN THE VADOSE ZONE

Chloride Load Calculation in the vadose zone requires chloride concentrations from sample points taken from a boring or a trench. Through use of these concentrations and the variables described below; an average "chloride loading" for a site is calculated. The site chloride loading is an averaged mass of chloride between the ground surface and ground water per unit of site area. Total mass of chloride in the vadose zone beneath the site is obtained by multiplying the chloride loading by the site area.

Variables:

In this calculation, the points are numbered from 1 to N with Point 1 being the uppermost sample point and Point N being the sample point closest to ground water.

A(Point i) (mg/kg(moist soil)) - chloride concentration in soil at Point i where i = 1,2,…,N . All chloride is assumed to be in the soil moisture.

Rho_moist (kg/m^3) - moist soil bulk density. This is calculated using the inputs of porosity (n) and gravimetric moisture content (phi) with a particle density of 2.65 gm/cm^3 (Smettem, K.R.J., 2006). Use of porosity and particle density gives:

Rho_dry = (1 – n) * Rho_particle

Use of dry bulk density (Rho_dry), the density of water, and the gravimetric moisture content (phi) allows the calculation of volumetric moisture content (theta)

theta = phi * (Rho_water/Rho_dry)

Moist bulk density is then given by:

Rho_moist = Rho_dry + (theta * Rho_water)

Following these steps using a porosity (n) of 0.4 and a gravimetric moisture content (phi) of 0.085 results in a moist bulk density of 1725 kg/m^3

Unless one has some special knowledge of the site, USE THIS VALUE.

del_x (feet) - the depth interval between two sample points
del_x_a – the depth interval above a sample point
del_x_b – the depth interval below a sample point

Calculation of Chloride Loading for each Depth Interval

The calculation for each depth interval "centered" around the sample point is given below. In effect, the chloride concentration of the sample point is considered constant over the depth interval around the sample point. This depth interval extends halfway to the sample points above and below the current sample point (Point i).

ChlLoad(Point i) = A (mg/kg) * Rho_moist (kg/m^3) * (del_x_a + del_x_b)/2 (feet) * (0.3048 meter/foot) * (1 kg/10^6 mg)

= A * Rho_moist * (del_x_a + del_x_b)/2 * (0.3048/10^6) kg/m^2

The depth intervals at each "end" of the profile are special cases. For the topmost interval:

ChlLoad(Point 1) = A * Rho_moist * (del_x_a + del_x_b/2) * (0.3048/10^6) kg/m^2

For the bottom interval:

ChlLoad(Point N) = A * Rho_moist * (del_x_a/2 + del_x_b) * (0.3048/10^6) kg/m^2

Calculation of Chloride Loading for the Site

Total chloride loading is obtained by adding together the chloride loading of all of the intervals for Sample Points 1,2,…,N.

TChlLoad = ChlLoad(Point1) + ChlLoad(Point2)+… +ChlLoad(PointN)

This number represents total chloride from the ground surface to ground water per unit of area at the site.

Calculation of Total Chloride in the Vadose Zone for the Site

To obtain total chloride in the vadose zone at the site, multiply the "Total Chloride Loading" by the area of the site:

TotalChl(kg) = TChlLoad kg/m^2 * Area (feet^2) * 0.0929 (m^2/feet^2)
= TChlLoad * Area * 0.0929 (kg)

Inputs are in Blue
Outputs are in yellow

	Boring ID	Chloride Mass Loading [kg/m^2]	[lbs/yard^2]
Linked From ChlLoadBorings Worksheet			
	SB #1	13.60	25.08
	SB #2	9.92	18.28
	Average for Site using Equal Areas	**11.76**	**21.68**
	Background Chloride Loading	**1.84**	**3.39**

Input Values Used Elsewhwere in the Calculation			
Porosity	0.4	[-]	Soil Density Sheet
Gravimetric Moisture Content	0.085	[mass of water/mass of dry soil]	Soil Density Sheet

Resultant Values Used Elsewhwere in the Calculation			
Resultant Dry Bulk Density	1590	[kg/meter^3]	Soil Density Sheet
Volumetric Moisture Content	0.1352	[-]	Soil Density Sheet
Resultant Moist Bulk Density	1725.2	[kg/meter^3]	Soil Density Sheet

Input	Length of Site	30.00	[feet]
Input	Width of Site	30.00	[feet]
	Area of Site	900.00	[feet^2]

Output	Total Chloride in Vadose zone at Site	**983**	**[kg]**	9.14	[meters]
		2168	**[lbs]**	9.14	[meters]
		1.08	**[tons]**	83.61	[meters^2]
	Total Chloride in Vadose Zone Minus Background Chloride	**829**	**[kg]**		
		1829	**[lbs]**		
		0.91	**[tons]**		

Inputs are in Blue
Outputs are in yellow

Dry Bulk Density from Porosity		
	2.65	Particle Density [g/cm^3] See Almost Any Textbook
Input	**0.4**	Porosity [-]
Output	1.59	Dry Bulk Density [g/cm^3]
Output	1590	Dry Bulk Density [kg/m^3]

Moist Bulk Density from Porosity and Gravimetric Moisture Content		
	1.0	Density of Water [gm/cm^3]
	1000.0	Density of Water [kg/meter^3]
Input	**0.085**	Gravimetric moisture content moisture [mass of water/mass of dry soil]
Output	0.1352	Volumetric moisture content [-] (theta_v)
Output	1.7252	Moist Bulk Density [g/cm^3]
Output	**1725.2**	Moist Bulk Density [kg/m^3]

Inputs are in Blue
Outputs are in yellow

EME JR Phillips

Assumed moist bulk density **(From Soil Density Worksheet)**	1725	[kg/m^3]		**Background Concentration**	[mg/kg]	**100**	**Input**
conversuion factor	0.000001	[kg/mg]		**Depth to Water minus Depth of Excavation**	[feet]	**35**	**Input**
conversuion factor	0.3048	[meter/foot]		Background Chloride Loading	[mg/kg]	**1.84**	

Depth of Excavation	**0.0**	[feet]

	SB #1	Depth	Depth below excavated floor	del_x	Chl conc.		Chloride Load per depth interval	
		{feet}	{feet}	[feet]	[mg/kg]		[kg/m^2]	
	Assumed		0.0		624			
Input		12	12.0	12.0	624		4.43	
Input		15	15.0	3.0	653		1.37	
Input		20	20.0	5.0	227		0.60	
Input		25	25.0	5.0	1010		2.66	
Input		30	30.0	5.0	1730		4.55	
Input	Assumed		35.0		1730			
						Total Chloride load	**13.60**	[kg/m^2]

	SB #2	Depth	Depth below excavated floor	del_x	Chl conc.		Chloride Load per depth interval	
		{feet}	{feet}	[feet]	[mg/kg]		[kg/m^2]	
	Assumed		0.0		624			
Input		12	12.0	12.0	624		4.43	
Input		15	15.0	3.0	700		1.47	
Input		20	20.0	5.0	418		1.10	
Input		25	25.0	5.0	480		1.26	
Input		30	30.0	5.0	629		1.65	
	Assumed		35.0		629			
						Total Chloride load	**9.92**	[kg/m^2]