1R - 428-52

REPORTS

DATE:

5-6-09 & 4-22-09

From:	Katie Lee
To:	Brad A. Jones; Edward J. EMNRD Hansen;
cc:	Hack Conder; Katie Jones; "Dale Littlejohn";
Subject:	ROC Hobbs O-29-1, NMOCD #: 1R428-52
Date:	Wednesday, May 06, 2009 10:36:54 AM
Attachments:	O-29-1_Seed_5-6-09.pdf

Mr. Jones and Mr. Hansen,

Attached please find documentation of seeding Rice Operating Company's Hobbs Jct. O-29-1 Vent site, NMOCD Case #1R428-52. A hard copy follows via FedEx.

If you have questions or concerns, please do not hesitate to contact me at our office or Hack Conder at 575-393-3174.

Best regards,

Katie Lee
Project Scientist
R.T. Hicks Consultants, Ltd.
ph. 505-266-5004
fax 505-266-0745
mobile 505-400-7925

R. T. HICKS CONSULTANTS, LTD.

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

May 6, 2009

Mr. Brad A. Jones
Mr. Edward J. Hansen
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Termination Request Follow-up
Hobbs Salt Water Disposal System: Jct. O-29-1 Vent
NMOCD Case #: 1R428-52
T18S, R38E, Sections 29, Unit O

Dear Mr. Jones and Mr. Hansen:

On behalf of Rice Operating Company (ROC), R.T. Hicks Consultants, Ltd. submitted a Termination Request for the above referenced site, dated April 22, 2009. To further support our request for termination of this regulatory file, ROC personnel completed the following work at the site on April 28th, 2009: tilled the soil, removed large rocks, seeded and re-tilled the area. Documentation of this work is presented in Appendix A.

Rice Operating Company (ROC) is the service provider (agent) for the Hobbs Saltwater Disposal System and has no ownership of any portion of pipeline, well, or facility. A consortium of oil producers who own the Hobbs System (System Partners) provide all operating capital on a percentage ownership/usage basis. Major projects require System Partner authorization for expenditures (AFE) approval and work begins as funds are received. We will implement the work outlined herein after NMOCD approval and subsequent authorization from the System Partners. The Hobbs SWD system is in abandonment.

If you have any questions or comments regarding this letter, please contact me or Hack Conder of Rice Operating Company, 575-393-9174.

Sincerely,
R.T. Hicks Consultants, Ltd.

Katie Lee

Katie Lee
Project Scientist

Copy: Rice Operating Company

HOBBS O-29-1 VENT

4/28/09: TILLING SOIL PRIOR TO PLANTING SEED

4/28/09: REMOVING ROCKS PRIOR TO PLANTING

HOBBS O-29-1 VENT

4/28/09: SEEDING SITE
Seed mix: 2.5 lbs Lea County mix, 2 lbs Blue Grama, 10 lbs Heavey Recleaned Race Horse Oats

4/28/09: TILLING IN SEED

From:	Katie Lee
To:	Brad A. Jones; Edward J. EMNRD Hansen;
cc:	Hack Conder; "Dale Littlejohn"; Katie Jones;
Subject:	Hobbs O-29-1 Vent, NMOCD Case #1R428-52, Termination Request
Date:	Thursday, April 23, 2009 11:09:12 AM
Attachments:	O-29-1 Term Request 4-22-09.pdf

Mr. Jones,

R.T. Hicks Consultants is pleased to submit the attached termination request for the Hobbs O-29-1 Vent regulatory file on behalf of Rice Operating Company. A hard copy follows via FedEx.

If you have any questions or concerns regarding this submission, please contact us at our office or Hack Conder of Rice Operating Company at 575-393-9174.

Sincerely,
R. T. Hicks Consultants, Ltd.

Katie Lee
Project Scientist
ph. 505-266-5004
fax 505-266-0745
mobile 505-400-7925

// R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266.0745

April 22, 2009

Mr. Brad Jones
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: **Hobbs SWD System O-29-1 Vent Site (NMOCD CASE #: 1R428-52) Termination Request**

Dear Mr. Jones:

On behalf of Rice Operating Company (ROC), R.T. Hicks Consultants, Ltd. is submitting this termination request for the Hobbs O-29-1 Vent regulatory file. The investigation demonstrated that neither salt nor hydrocarbons are present in the vadose zone in quantities that represent a threat to ground water quality.

Background

The Hobbs SWD O-29-1 Vent Site is located west of the city of Hobbs at T-18-S, R-38-E, Section 29, in Unit O, and a release was verified during excavations that were conducted in November of 2002. The NMOCD-approved Investigation Characterization Plan (ICP), dated April 4, 2008, is provided as Attachment A to this letter. The ICP includes background information and a site vicinity map for this and six other nearby ROC sites.

Field Program

As a part of the approved ICP, ROC installed and sampled nine backhoe trenches from June 18 to 19, 2008 to delineate the horizontal extent of chloride in the soil. Attachment B presents a summary map prepared by ROC that includes results of the field chloride analyses and hydrocarbon screening data as well as a laboratory report for the soil samples used to verify the ROC field data. The results of this initial assessment indicate that the highest chloride concentrations (600 to 800 mg/kg) are present at four to eight feet below the surface in an area that surrounds the original excavation up to ten feet in all directions.

Field screening of hydrocarbons in the soil were generally low (<10 ppm), however, one sample located at seven feet below the surface in the "10-foot South" trench indicated a PID reading of 1,241 ppm. Laboratory analysis of this sample identified <0.01 mg/kg Benzene and 0.8 mg/kg total BTEX. This suggests that regulated hydrocarbons are not present in soil at concentrations that represent a threat to fresh water, human health, or the environment.

Hicks Consultants supervised a deep soil sampling program to delineate the vertical extent of the chloride-impacted soil. On October 22, 2008, soil boring

No. 1 (SB-1) was installed adjacent to the northeast edge of the original excavation to evaluate the vertical extent of remaining chloride in the soil. Plate 1 shows the location of the soil boring relative to the initial excavation and sampling trenches. Soil samples were collected and field screened by ROC for chloride and hydrocarbons.

Attachment C provides a soil lithology log, including the field chloride and hydrocarbon screening data. Attachment D provides the laboratory report and chain of custody for verification of field data.

Results
Data from the deep soil boring program indicates that the chloride concentrations from 15 to 40 feet below the surface are less than those identified during the trenching operation. The horizontal extent of the chloride-impacted soil is approximately 1,200 ft^2 with the highest levels located near the original excavation. All soil sample hydrocarbon (PID) readings from the borings were below 0.1 ppm.

Simulation Modeling
We used the AMIGO tool (HYDRUS-1D model) to simulate the potential impact to ground water due to chloride transport through the vadose zone. The input to the model employed field data from the site, nearby locations, and conservative input data for parameters that were not measured at or near the site. Attachment E provides a summary description of the HYDRUS-1D model used in this simulation and a general discussion of the input parameters. The specific parameters used in the simulation at the O-29-1 site are presented in the table below.

Table 1. Parameters Employed in AMIGO tool for O-29-1

Model Parameter	Value	Source of Value
Climate (non-smoothed)	1946 - 1992	Pearl, NM Station
Input for distant or hypothetical well (ft)	NA	Not Required
Background Chloride in Aquifer (mg/L)	80	NM WAIDS, PTTC
Aquifer Porosity (unitless)	0.25	Sample Description
Groundwater Table Depth (ft)	60	Site Borings, F-29 Site
Aquifer Thickness (ft)	30	Prof. Judgment – Conservative Assumption
Slope of Water Table	0.0035	2007 ROC Water Table Data Section 29
Hydraulic Conductivity (ft/d)	80	Musharrafieh 1999
Average Chloride Load (kg/m^2)	4.51	Calculated From Site Data using Massload
Max length of spill in dir. of GW flow (ft)	50	Site Data
Plant Uptake Trigger (%)	1.0	Prof. Judgment – Conservative Assumption
Surface Layer	Caliche	Site Data
Soil Profile (sandy clay:caliche:sand ratio)	1:1:1	Boring Log

Musharrafieh and Chudnoff (1999) predict that the saturated thickness of the aquifer beneath the site will remain at least 50 feet from now until the year 2040. Data from similar sites show that, unlike hydrocarbons, chloride that enters the upper portion of an aquifer will become distributed throughout the entire saturated thickness within a relatively short travel distance from the source. The arbitrary selection of a 10-foot thick mixing zone (used as a default value for hydrocarbon sites) is unrealistic where the constituent of concern is chloride. In our opinion, a simulation using the 30-foot thickness of the aquifer is conservative for this site.

As described in Appendix E, the AMIGO tool assumes a single surface spill is the initial source of chloride that is subsequently observed in the subsurface. In order to ensure an accurate calibration of the model to the historic spill which occurred at the Hobbs O-29-1 site, we compared each year of the simulated profile with the field data until a conservative match was achieved. A favorable but conservative match to the field data was achieved using the year 10 simulation as demonstrated in Figure 1.

Figure 1
Field vs. AMIGO Chloride Profiles
Hobbs O-29-1 Vent Site (Yr 10)

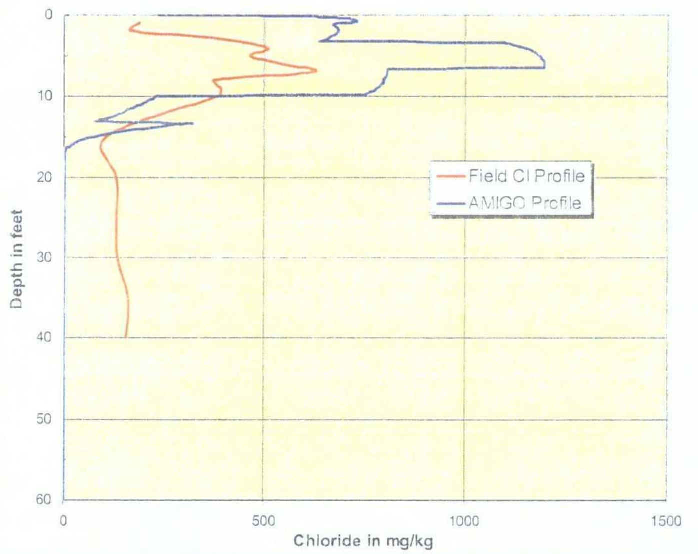
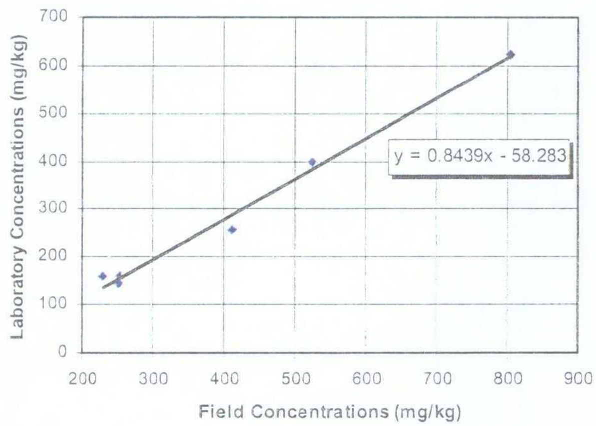


Figure 2
Field vs Lab Chloride



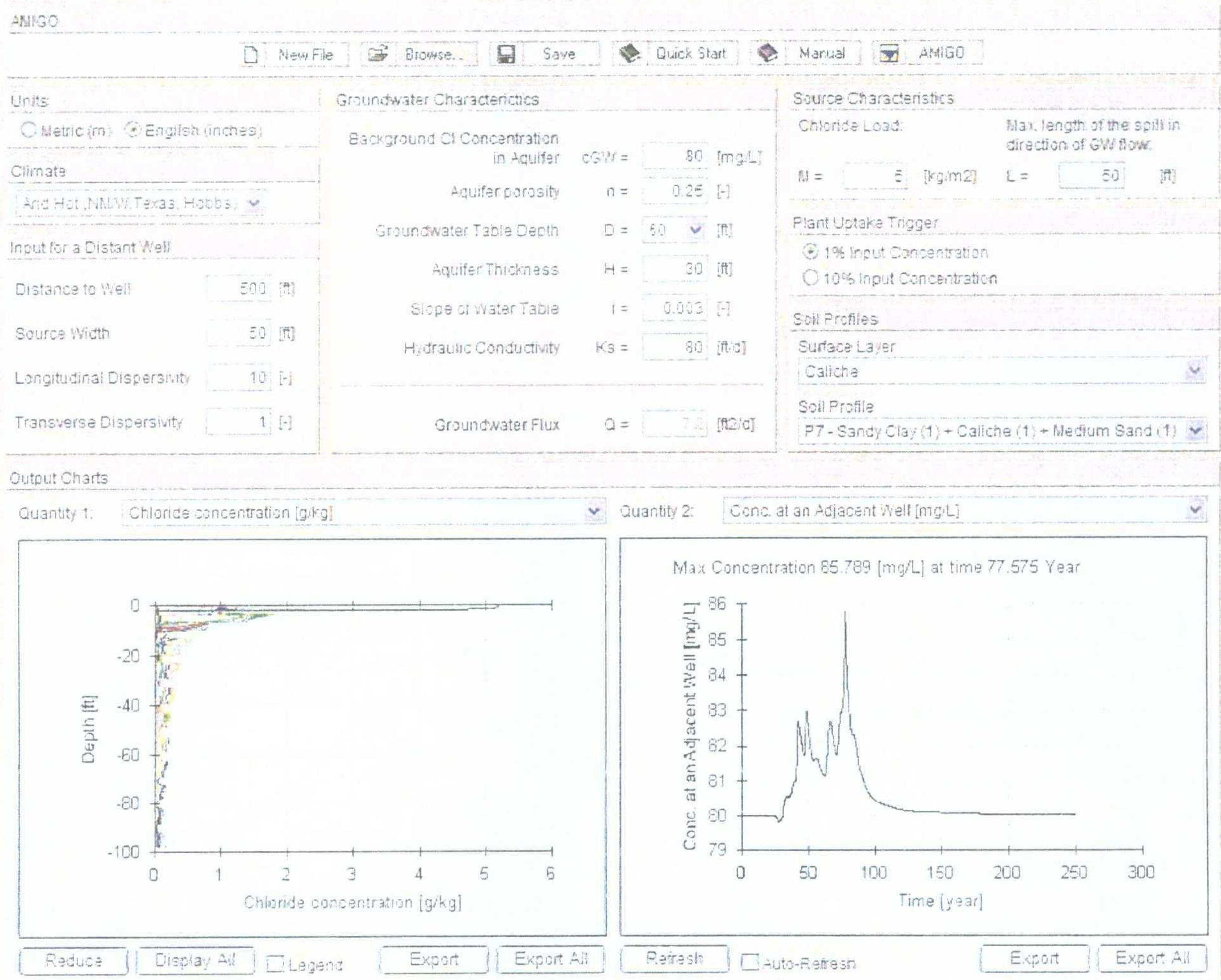
The red curve on Figure 1 is the profile using the maximum field chloride analysis for each depth sampled from the trenches (1 to 10 feet) and SB-1 (below 15 feet). The field (titration) concentrations were then adjusted based on a correction determined by comparing the field chloride concentrations with the duplicate laboratory sample concentrations as shown in Figure 2.

The blue curve in Figure 1 is the predicted chloride profile at year 10 of the simulation using a chloride load of 5.0 kg/m^2 (calculated from site data).

Because the AMIGO simulation predicts higher chloride concentrations than documented by field data, this use of 5.0 kg/m^2 is a conservative input parameter.

The results of the simulation are shown below on the AMIGO ground water output chart which has been copied directly from the model results screen. It indicates that the ground water below the site will not exceed 86 mg/L (below WQCC standards) if no further corrective actions are taken.

Figure 3 - AMIGO ground water output chart for O-29-1 Vent Site



We believe the simulated concentration in ground water is a "worst-case" prediction because of the conservative input parameters used in the model.

Recommendations

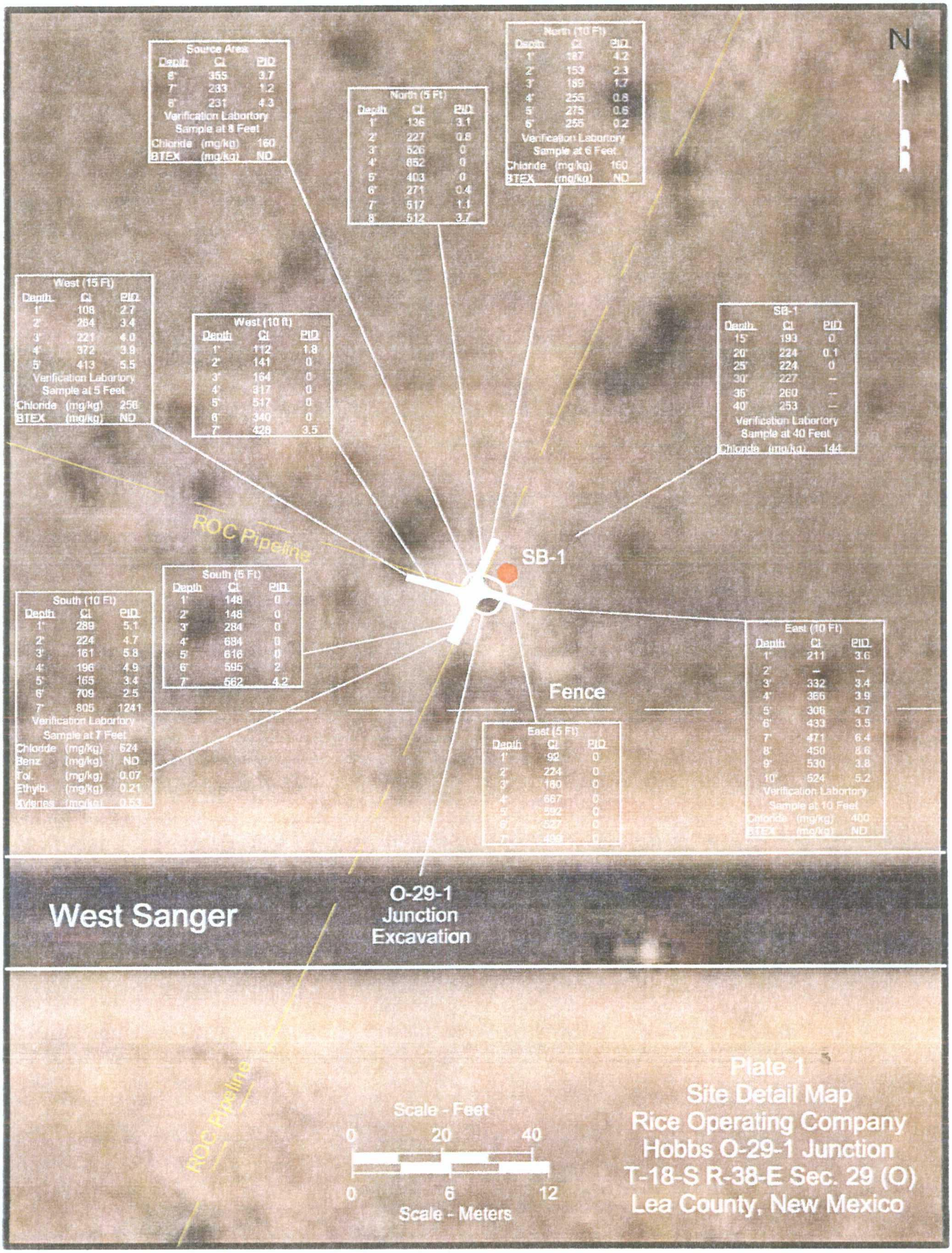
Based on these results, we conclude that this site is in compliance with the mandates of Part 29 such that the remaining chloride-impacted soil does not and will not endanger public health or the environment. We recommend termination of the regulatory file.

Please contact Hack Conder of ROC at 575-393-9174 if you have any questions concerning this submission. Thank you for your time and consideration.

Sincerely,
R.T Hicks Consultants, Ltd.

Dale T Littlejohn
Geologist

Copy: Hack Conder, ROC
NMOCD Hobbs


N
Source Area
Depth Cl PID
6' 355 3.7
7' 233 1.2
8' 231 4.3
Verification Labortory
Sample at 8 Feet
Chloride (mg/kg) 160
BTEX (mg/kg) ND
North (5 Ft)
Depth Cl PID
1' 136 3.1
2' 227 0.8
3' 526 0
4' 852 0
5' 403 0
6' 271 0.4
7' 517 1.1
8' 512 3.7
North (10 Ft)
Depth Cl PID
1' 187 4.2
2' 153 2.3
3' 189 1.7
4' 255 0.8
5' 275 0.6
6' 255 0.2
Verification Labortory
Sample at 6 Feet
Chloride (mg/kg) 160
BTEX (mg/kg) ND
West (15 Ft)
Depth Cl PID
1' 108 2.7
2' 264 3.4
3' 221 4.0
4' 372 3.9
5' 413 5.5
Verification Labortory
Sample at 5 Feet
Chloride (mg/kg) 256
BTEX (mg/kg) ND
West (10 ft)
Depth Cl PID
1' 112 1.8
2' 141 0
3' 164 0
4' 317 0
5' 517 0
6' 340 0
7' 428 3.5
SB-1
Depth Cl PID
15' 193 0
20' 224 0.1
25' 224 0
30' 227 --
35' 260 --
40' 253 --
Verification Labortory
Sample at 40 Feet
Chloride (mg/kg) 144
ROC Pipeline
SB-1
South (5 Ft)
Depth Cl PID
1' 148 0
2' 148 0
3' 284 0
4' 684 0
5' 616 0
6' 595 2
7' 562 4.2
South (10 Ft)
Depth Cl PID
1' 289 5.1
2' 224 4.7
3' 161 5.8
4' 196 4.9
5' 165 3.4
6' 709 2.5
7' 805 1241
Verification Labortory
Sample at 7 Feet
Chloride (mg/kg) 624
Benz. (mg/kg) ND
Tol. (mg/kg) 0.07
Ethylb. (mg/kg) 0.21
Xylenes (mg/kg) 0.53
Fence
East (10 Ft)
Depth Cl PID
1' 211 3.6
2' -- --
3' 332 3.4
4' 366 3.9
5' 306 4.7
6' 433 3.5
7' 471 6.4
8' 450 8.6
9' 530 3.8
10' 524 5.2
Verification Labortory
Sample at 10 Feet
Chloride (mg/kg) 400
BTEX (mg/kg) ND
East (5 Ft)
Depth Cl PID
1' 92 0
2' 224 0
3' 160 0
4' 667 0
5' 592 0
6' 527 0
7' 499 0
West Sanger
O-29-1
Junction
Excavation
ROC Pipeline
Scale - Feet
0 20 40
0 6 12
Scale - Meters
Plate 1
Site Detail Map
Rice Operating Company
Hobbs O-29-1 Junction
T-18-S R-38-E Sec. 29 (O)
Lea County, New Mexico

ATTACHMENT A
Investigation Characterization Plan

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

April 4, 2008

COPY

Mr. Edward Hansen
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Investigation & Characterization Plan
Hobbs Salt Water Disposal System: A-6 Vent, E-29 Vent, Jct. E-33-2, Jct L-30, K-29 EOL, Jct. O-29-1 Vent, P-29 Vent
T18S, R38E, Sections 29, 30, 33 and T19S, R38E Section 6

Dear Mr. Hansen:

On behalf of Rice Operating Company (ROC), R.T. Hicks Consultants, Ltd. is pleased to submit this Investigation & Characterization Plan (ICP) for the seven junction box and vent sites within the Hobbs Salt Water Disposal System referenced above. Plate 1 is a map showing the sites relative to major roads in the area. Plate 2 shows the sites, nearby USGS monitoring wells and a regional potentiometric surface map.

The work elements proposed to characterize these sites sufficiently to develop and appropriate corrective action plan are presented below.

1. ROC will identify and document the location of all current and historic equipment and pipelines associated with each site.
2. ROC will use a backhoe with a 12-foot vertical reach to install a series of sampling trenches in order to recover soil samples and delineate the lateral extent (and potentially the vertical extent) of impacted soil.
3. If characterization by the backhoe is insufficient to define the extent and magnitude of past releases, ROC and Hicks Consultants will use a drilling rig to install one soil boring at the center of the source area to delineate the vertical extent of chloride in the soil.
4. Soil samples employed for delineation will be obtained from regular intervals below ground surface.
5. Representative soil samples will be sent to a laboratory to allow for verification of the field results.
6. General soil texture descriptions will be provided for each sample trench or boring.
7. The criteria to delineate the extent of impact during trenching as well as in a soil boring is 5 point chloride decline vs. depth, or:
   a. After three consecutive samples demonstrate <250 ppm chloride using field analyses and <100ppm total hydrocarbon vapors using the

headspace method (see attached ROC Quality Procedure in Appendix A), or

b. After five consecutive samples show a decreasing trend of chloride and hydrocarbons and the last sample shows chloride < 250 ppm and total hydrocarbon vapors <100 ppm (Appendix A).
c. Soil boring to capillary fringe should neither (a) or (b) apply

8. If the boring penetrates the capillary fringe, a monitoring well will be completed with a 2 or 4" diameter 25 feet down gradient from the source for use during possible corrective actions. Plate 2 presents a potentiometric surface map for the site area.
9. If field analysis of hydrocarbon vapors and observations of staining show that hydrocarbon impact is unlikely at the site or below 20-feet, collection of samples from cuttings may be substituted for split spoon sampling (chloride only).

The ROC trench characterization will be employed to identify the lateral extent of chloride at each site, if possible. If trenching does not fully characterize the lateral extent of chloride at each site, boreholes will be advanced 20 feet beyond the furthest trenches where the soil data has an average chloride concentration greater than 1,000 mg/kg. The total depth of borings installed to characterize lateral extent shall be 20 feet below ground surface with soil samples for delineation taken at 5 foot intervals.

Rice Operating Company (ROC) is the service provider (agent) for the Hobbs Saltwater Disposal System and has no ownership of any portion of pipeline, well, or facility. A consortium of oil producers who own the Hobbs System (System Partners) provide all operating capital on a percentage ownership/usage basis. Major projects require System Partner authorization for expenditures (AFE) approval and work begins as funds are received. We will implement the work outlined herein after NMOCD approval and subsequent authorization from the System Partners. The Hobbs SWD system is in abandonment.

For all environmental projects, ROC will choose a path forward that:

1. Protects public health.
2. Provides the greatest net environmental benefit.
3. Complies with NMOCD Rules.
4. Is supported by good science.

The last criteria employed when evaluating any proposed remedy or investigative work is confirming that there is a reasonable relationship between the benefits created by the proposed remedy or assessment and the economic and social costs.

Each site shall have three submissions or a combination of:

1. This Investigation and Characterization Plan (ICP), which is a proposal for data gathering, and site characterization and assessment (this submission).
2. Upon evaluation of the data and results from the ICP, a recommended remedy will be submitted in a Corrective Action Plan (CAP).
3. Finally, after implementing the remedy, a closure report with final documentation will be submitted.

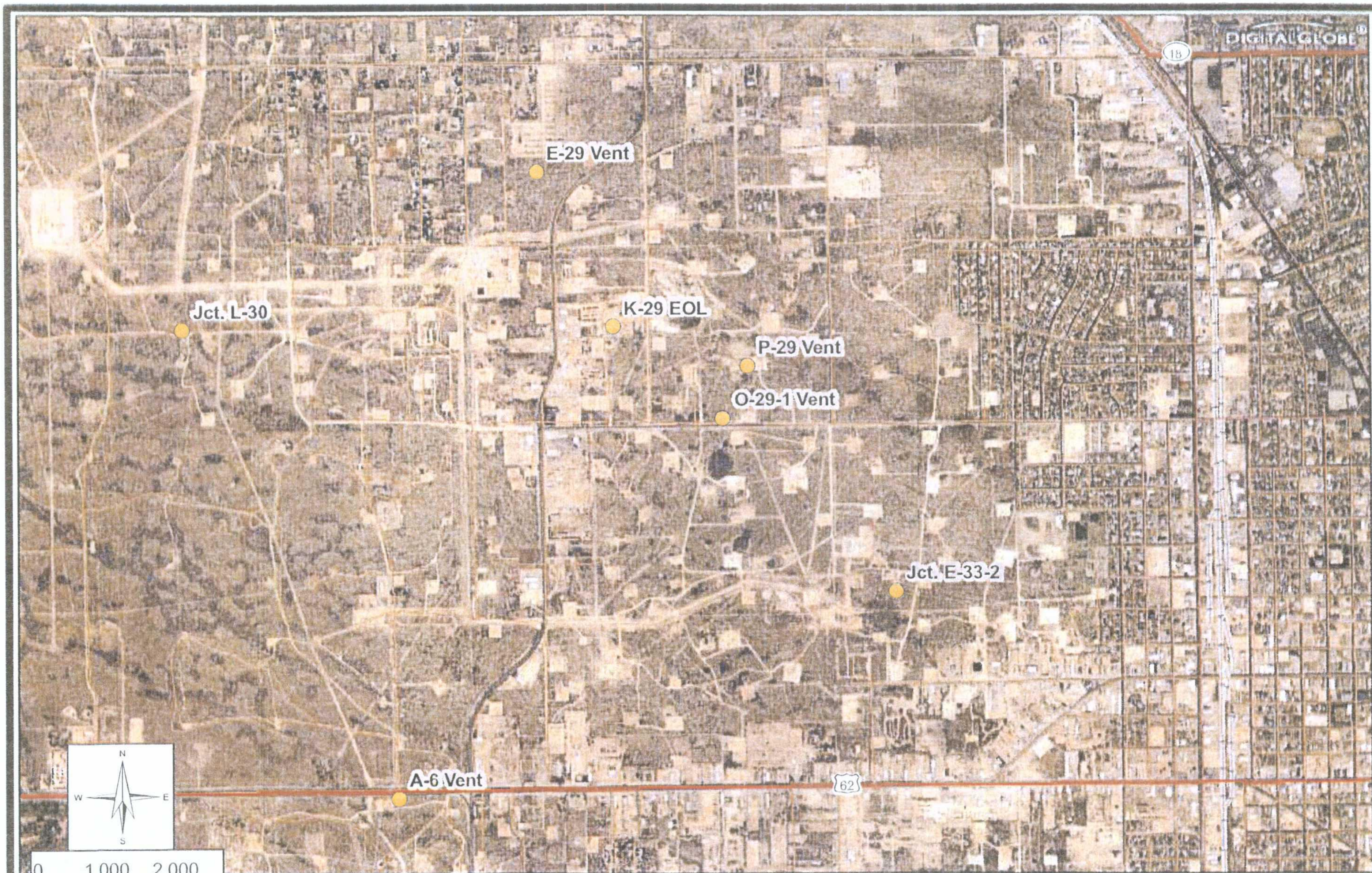
Following the site characterization described above, a Corrective Action Plan with the data and analysis supportive of a procedure for site closure will be submitted. Quality Procedures for characterization work are provided in Appendix A.

If you have any questions or comments regarding this ICP, please contact Kristin Pope of Rice Operating Company as she has reviewed and approved this submission.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks
Principal

Copy: Rice Operating Company



Explanation

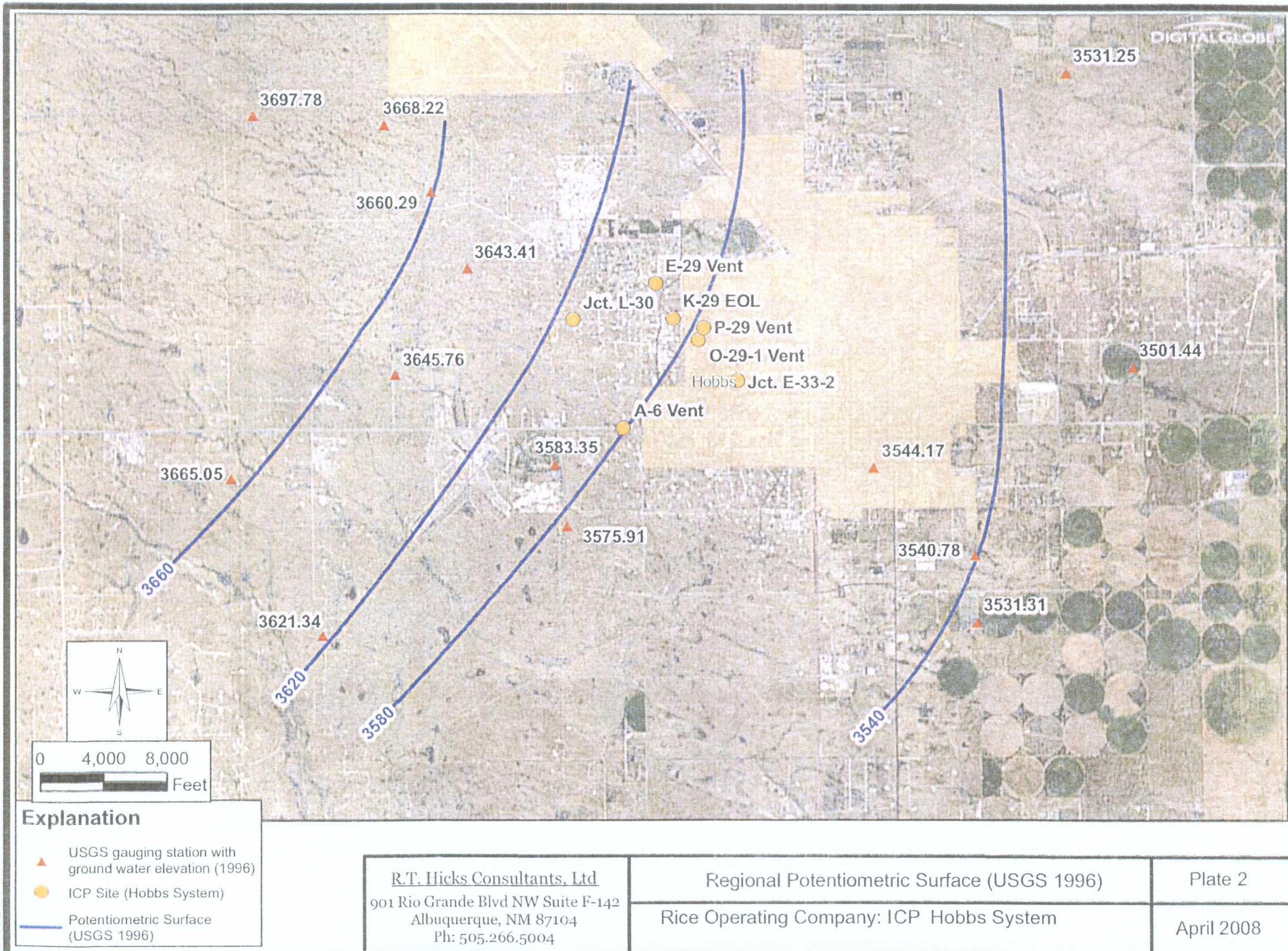
ICP Site (Hobbs System)

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

Site Environs Relative to Hobbs, NM	Plate 1
Rice Operating Company: Hobbs System Investigation & Characterization Plan	April 2008

S:/PROJECTS/ROC/ICPS_03_2008/PLATE1_ROADMAP_HOBBS.MXD 802//3

3/7/2008



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	Regional Potentiometric Surface (USGS 1996)	Plate 2
	Rice Operating Company: ICP Hobbs System	April 2008

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

Appendix A

Rice Operating Company

QUALITY PROCEDURE - 03
Sampling and Testing Protocol - Chloride Titration Using .282 Normal Silver Nitrate Solution

1.0 Purpose
This procedure is to be used to determine the concentration of chloride in soil.

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 grams 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 san1ple for 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 large polyethylene freezer bag. Care should be taken to insure that no cross-contamination occurs 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 clean glass vial having a minimum 40 ml capacity. Add at least 10 grams of the soil sample and record the weight.

4.2 Add at least 10 grams of reverse osmosis water to the soil sample and shake for 20 seconds.

4.3 Allow the sample to set for a period of 5 minutes or until the separation of soil and water.

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

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.

5.4 Using a 10 ml pipette, carefully add 0.282 normal silver nitrate (one drop at a time) to the sample while constantly agitating it. Stop adding silver nitrate when the solution begins to change from yellow to red. Be consistent with endpoint recognition.

5.5 Record the ml of silver nitrate used.

6.0 Calculation

To obtain the chloride concentration, insert measured data into the following formula:

$$\frac{0.282 \times 35{,}450 \times \text{ml } AgNO_3}{\text{ml water extract}} \quad \times \quad \frac{\text{grams of water in mixture}}{\text{grams of soil in mixture}}$$

Using Step 5.0, determine the chloride concentration of the RO water used to mix with the soil sample. Record this concentration and subtract it from the formula results to find the net chloride in the soil sample.

Record all results on the delineation form.

Appendix A
ICP- A-6 Vent, E-29 Vent, Jct. E-33-2, Jct L-30, K-29 EOL, Jct. O-29-1 Vent, P-29 Vent

Rice Operating Company

QUALITY PROCEDURE -07
Sampling and Testing Protocol for VOC in Soil

1.0 Purpose
This procedure is to be used to determine the concentrations of Volatile Organic Compounds in soils.

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

3.0 Procedure

3.1 Sample Collection and Preparation

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

3.1.2 The soil sample(s) shall be immediately inserted into a one-quart or larger polyethylene freezer bag and sealed. When sealed, the bag should contain a nearly equal space between the soil sample and trapped air. Record the sample name and the time that the sample was collected on the Field Analytical Report Form.

3.1.3 The sealed samples shall be allowed to set for a minimum of five minutes at a temperature of between 10-15 Celsius, (59-77° F). The sample temperatures may be adjusted by cooling the sample in ice, or by heating the sample within a generally controlled environment such as the inside of a vehicle. The samples should not be placed directly on heated surfaces or placed in direct heat sources such as lamps or heater vents.

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

3.2 Sampling Procedure

3.2.1 The instrument to be used in conducting VOC concentration testing shall be an Environmental Instruments 13471 OVM / Datalogger or a similar pro-type instrument. (Device will be identified on VOC Field Test Report Form.) Prior to use, the instrument shall be zeroed-out in accordance with the appropriate maintenance and calibration procedure outlined in the instrument operation manual. The PID device will be calibrated each day it's used.

3.2.2 Carefully open one end of the collection bag and insert the probe tip into the bag taking care that the probe tip not touch the soil sample or the sidewalls of the bag.

3.2.3 Set the instrument to retain the highest result reading value. Record the reading onto the Field Test Report Form.

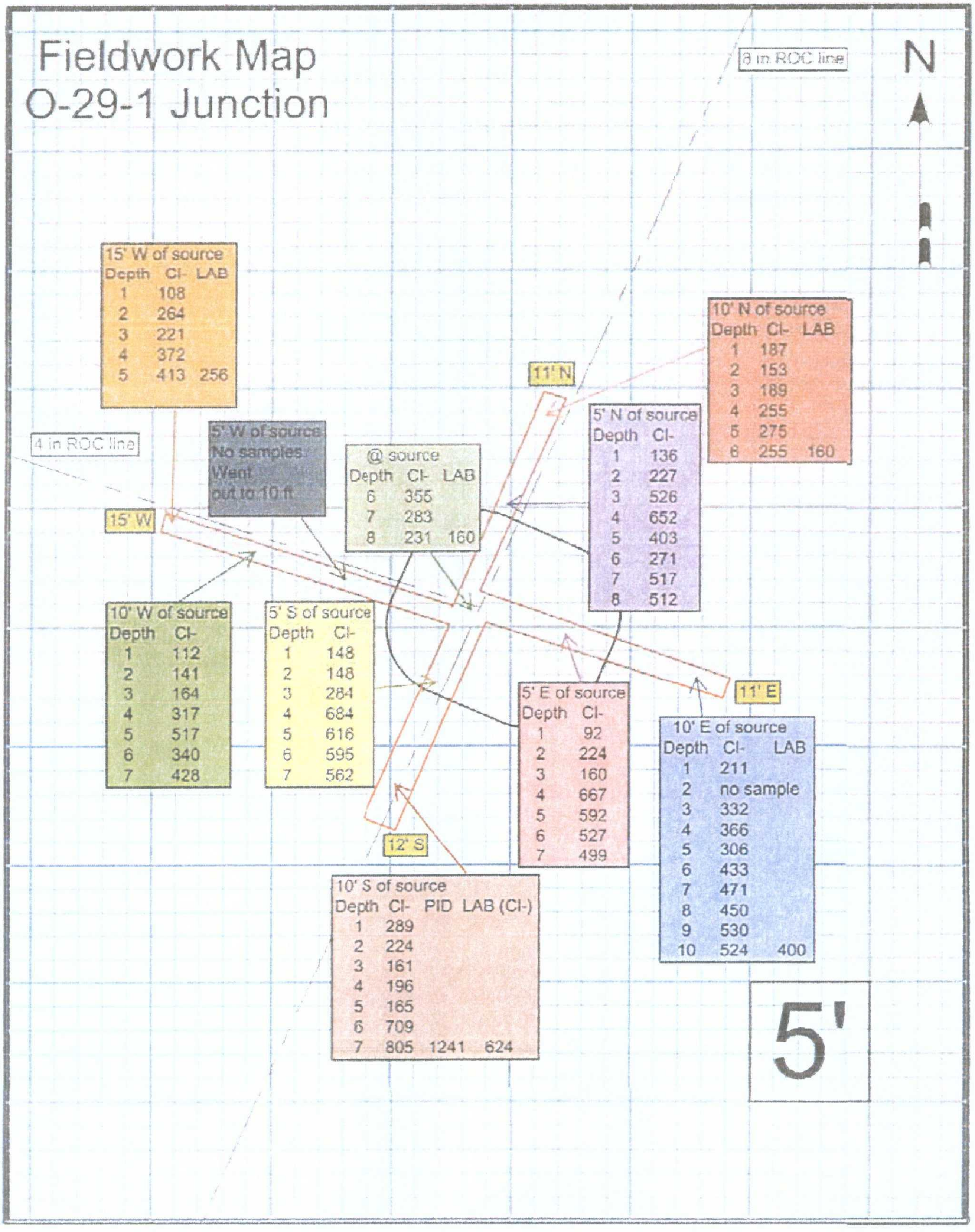
3.2.4 If the instrument provides a reading exceeding 100 ppm, proceed to conduct BTEX Speciation in accordance with QP-O2 and QP-O6. If the reading is 100 ppm or less, NMOCD BTEX guideline has been met and no further testing fur BTEX is necessary. File the Field Test Report Form in the project file.

4.0 Clean-up

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

ATTACHMENT B

Summary of Trench Assessment (Horizontal Delineation)
Conducted by ROC in June 2008



Fieldwork Map
O-29-1 Junction
8 in ROC line
N
4 in ROC line
15' W of source
Depth Cl- LAB
1 108
2 264
3 221
4 372
5 413 256
5' W of source
No samples.
Went
out to 10 ft
@ source
Depth Cl- LAB
6 355
7 283
8 231 160
11' N
5' N of source
Depth Cl-
1 136
2 227
3 526
4 652
5 403
6 271
7 517
8 512
10' N of source
Depth Cl- LAB
1 187
2 153
3 189
4 255
5 275
6 255 160
15' W
10' W of source
Depth Cl-
1 112
2 141
3 164
4 317
5 517
6 340
7 428
5' S of source
Depth Cl-
1 148
2 148
3 284
4 684
5 616
6 595
7 562
11' E
5' E of source
Depth Cl-
1 92
2 224
3 160
4 667
5 592
6 527
7 499
10' E of source
Depth Cl- LAB
1 211
2 no sample
3 332
4 366
5 306
6 433
7 471
8 450
9 530
10 524 400
12' S
10' S of source
Depth Cl- PID LAB (Cl-)
1 289
2 224
3 161
4 196
5 165
6 709
7 805 1241 624
5'

CARDINAL LABORATORIES

PHONE (575) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
RICE OPERATING COMPANY
ATTN: HACK CONDER
122 WEST TAYLOR
HOBBS, NM 88240
FAX TO: (575) 397-1471

Receiving Date: 06/24/08
Reporting Date: 06/24/08
Project Number: NOT GIVEN
Project Name: HOBBS O-29-1 VENT
Project Location: HOBBS O-29-1 VENT

Analysis Date: 06/24/08
Sampling Date: 06/18/08 & 06/19/08
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: KS

LAB NO.	SAMPLE ID	Cl^- (mg/kg)
H15046-1	10' N TRENCH @ 6'	160
H15046-2	10' S TRENCH @ 7'	624
H15046-3	15' W TRENCH @ 5'	256
H15046-4	SOURCE TRENCH @ 8'	160
H15046-5	10' E TRENCH @ 10'	400
Quality Control		500
True Value QC		500
% Recovery		100
Relative Percent Difference		< 0.1

METHOD: Standard Methods	4500-Cl^-B

Note: Analyses performed on 1:4 w:v aqueous extracts.

Chemist

06/24/08
Date

H15046 RICE

CARDINAL LABORATORIES

PHONE (575) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
RICE OPERATING COMPANY
ATTN: HACK CONDER
122 WEST TAYLOR
HOBBS, NM 88240
FAX TO: (575) 397-1471

Receiving Date: 06/24/08
Reporting Date: 06/26/08
Project Number: NOT GIVEN
Project Name: HOBBS O-29-1 VENT
Project Location: HOBBS 0-29-1 VENT
Lab Number: H15046-1
Sample ID: 10' N TRENCH @ 6'

Analysis Date: 06/25/08
Sampling Date: 06/19/08
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

VOLATILES (mg/kg)	Sample Result	Method Blank	QC	%Recov	True Value QC
Benzene	<0.010	<0.002	0.051	102	0.050
Toluene	<0.010	<0.002	0.049	98.0	0.050
Ethylbenzene	<0.010	<0.002	0.049	98.0	0.050
m,p-Xylene	<0.020	<0.004	0.106	106	0.100
o-Xylene	<0.010	<0.002	0.056	112	0.050
Naphthalene	<0.025	<0.005	0.039	78.0	0.050

	% RECOVERY
Dibromofluoromethane	116
Toluene-d8	99.1
Bromofluorobenzene	100

METHODS: EPA SW-846 8260

Chemist

06/27/08
Date

CARDINAL LABORATORIES

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ANALYTICAL RESULTS FOR
RICE OPERATING COMPANY
ATTN: HACK CONDER
122 WEST TAYLOR
HOBBS, NM 88240
FAX TO: (575) 397-1471

Receiving Date: 06/24/08
Reporting Date: 06/26/08
Project Number: NOT GIVEN
Project Name: HOBBS O-29-1 VENT
Project Location: HOBBS 0-29-1 VENT
Lab Number: H15046-2
Sample ID: 10' S TRENCH @ 7'

Analysis Date: 06/25/08
Sampling Date: 06/19/08
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

VOLATILES (mg/kg)	Sample Result	Method Blank	QC	%Recov.	True Value QC
Benzene	<0.010	<0.002	0.051	102	0.050
Toluene	0.067	<0.002	0.049	98.0	0.050
Ethylbenzene	0.212	<0.002	0.049	98.0	0.050
m,p-Xylene	0.338	<0.004	0.106	106	0.100
o-Xylene	0.186	<0.002	0.056	112	0.050
Naphthalene	0.130	<0.005	0.039	78.0	0.050

	% RECOVERY
Dibromofluoromethane	102
Toluene-d8	131
Bromofluorobenzene	102

METHODS: EPA SW-846 8260

Chemist

06/27/08
Date

CARDINAL LABORATORIES

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ANALYTICAL RESULTS FOR
RICE OPERATING COMPANY
ATTN: HACK CONDER
122 WEST TAYLOR
HOBBS, NM 88240
FAX TO: (575) 397-1471

Receiving Date: 06/24/08
Reporting Date: 06/26/08
Project Number: NOT GIVEN
Project Name: HOBBS O-29-1 VENT
Project Location: HOBBS 0-29-1 VENT
Lab Number: H15046-3
Sample ID: 15' W TRENCH @ 5'

Analysis Date: 06/25/08
Sampling Date: 06/19/08
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

VOLATILES (mg/kg)	Sample Result	Method Blank	QC	%Recov.	True Value QC
Benzene	<0.010	<0.002	0.051	102	0.050
Toluene	<0.010	<0.002	0.049	98.0	0.050
Ethylbenzene	<0.010	<0.002	0.049	98.0	0.050
m,p-Xylene	<0.020	<0.004	0.106	106	0.100
o-Xylene	<0.010	<0.002	0.056	112	0.050
Naphthalene	<0.025	<0.005	0.039	78.0	0.050

	% RECOVERY
Dibromofluoromethane	124
Toluene-d8	97.5
Bromofluorobenzene	95.6

METHODS: EPA SW-846 8260

Chemist

06/27/08
Date

CARDINAL LABORATORIES

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ANALYTICAL RESULTS FOR
RICE OPERATING COMPANY
ATTN: HACK CONDER
122 WEST TAYLOR
HOBBS, NM 88240
FAX TO: (575) 397-1471

Receiving Date: 06/24/08
Reporting Date: 06/26/08
Project Number: NOT GIVEN
Project Name: HOBBS 0-29-1 VENT
Project Location: HOBBS 0-29-1 VENT
Lab Number: H15046-4
Sample ID: SOURCE TRENCH @ 8'

Analysis Date: 06/25/08
Sampling Date: 06/18/08
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

VOLATILES (mg/kg)	Sample Result	Method Blank	QC	%Recov.	True Value QC
Benzene	<0.010	<0.002	0.051	102	0.050
Toluene	<0.010	<0.002	0.049	98.0	0.050
Ethylbenzene	<0.010	<0.002	0.049	98.0	0.050
m,p-Xylene	<0.020	<0.004	0.106	106	0.100
o-Xylene	<0.010	<0.002	0.056	112	0.050
Naphthalene	<0.025	<0.005	0.039	78.0	0.050

	% RECOVERY
Dibromofluoromethane	124
Toluene-d8	115
Bromofluorobenzene	97.9

METHODS: EPA SW-846 8260

Chemist

06/27/08
Date

CARDINAL LABORATORIES

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ANALYTICAL RESULTS FOR
RICE OPERATING COMPANY
ATTN: HACK CONDER
122 WEST TAYLOR
HOBBS, NM 88240
FAX TO: (575) 397-1471

Receiving Date: 06/24/08
Reporting Date: 06/26/08
Project Number: NOT GIVEN
Project Name: HOBBS O-29-1 VENT
Project Location: HOBBS 0-29-1 VENT
Lab Number: H15046-5
Sample ID: 10' E TRENCH @ 10'

Analysis Date: 06/25/08
Sampling Date: 06/19/08
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

VOLATILES (mg/kg)	Sample Result	Method Blank	QC	%Recov	True Value QC
Benzene	<0.010	<0.002	0.051	102	0.050
Toluene	<0.010	<0.002	0.049	98.0	0.050
Ethylbenzene	<0.010	<0.002	0.049	98.0	0.050
m,p-Xylene	<0.020	<0.004	0.106	106	0.100
o-Xylene	<0.010	<0.002	0.056	112	0.050
Naphthalene	<0.025	<0.005	0.039	78.0	0.050

	% RECOVERY
Dibromofluoromethane	114
Toluene-d8	107
Bromofluorobenzene	102

METHODS: EPA SW-846 8260

Chemist

06/27/08
Date

CARDINAL LABORATORIES

101 East Marland, Hobbs, NM 88240 2111 Beechwood, Abilene, TX 79603
(505) 393-2326 FAX (505) 393-2476 (325) 673-7001 FAX (325)673-7020

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Company Name: Rice Operating Company
Project Manager: Hack Condor
Address: 122 West Taylor
City: Hobbs State: NM Zip: 88240
Phone #: 393-9174 Fax #: 397-1471
Project #: Project Owner:
Project Name: Hobbs O-29-1 vent
Project Location: Hobbs O-29-1 vent RCR
Sampler Name: Roy Rascon

BILL TO
P.O. #:
Company:
Attn:
Address:
City:
State: Zip:
Phone #:
Fax #:

Lab I.D. (FOR LAB USE ONLY)	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	PRESERV: ACID/BASE:	ICE / COOL	OTHER:	SAMPLING DATE	TIME	Chlorides	BTEX	Napthalene
H15046-1	10'N trench @ 6'		1			✓					✓		6/19/08	12:49	✓	✓	✓
-2	10'S trench @ 7'		1			✓					✓		6/19/08	13:12	✓	✓	✓
-3	15' W trench @ 5'		1			✓					✓		6/19/08	14:45	✓	✓	✓
-4	source trench @ 8'		1			✓					✓		6/18/08	09:15	✓	✓	✓
-5	10'E trench @ 10'		1			✓					✓		6/19/08	15:20	✓	✓	✓

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.

Relinquished By: Roy R. Rascon Date: 6-24-08 Time: 0811
Received By: [signature]
Relinquished By: Date: Time:
Received By:

Phone Result: ☐ Yes ☑ No Add'l Phone #:
Fax Result: ☐ Yes ☑ No Add'l Fax #:
REMARKS:
email results
Hconder@riceswd.com; jpurvis@riceswd.com;
Lweinheimer@rice.swd.com

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

Sample Condition: Cool ☑ Yes ☐ No; Intact ☑ Yes ☐ No

CHECKED BY: (Initials) [initials]

† Cardinal cannot accept verbal changes. Please fax written changes to 505-393-2476

ATTACHMENT C

Lithology Log from Soil Boring (Vertical Delineation)
Conducted by ROC and RTH in October 2008

RT Hicks Consultants Ltd
P O Box 7624
Midland, Texas 79708
(432) 528-3878
(432) 689-4578 (fax)

LITHOLOGIC LOG (Soil Boring)

SOIL BORING NO.: SB-1 | TOTAL DEPTH: 40 Feet
SITE ID: Hobbs SWD O-29-1 | CLIENT: Rice Operating Co.
SURFACE ELEVATION: 3,643 (USGS) | COUNTY: Lea County
CONTRACTOR: Harrison Cooper | STATE: New Mexico
DRILLING METHOD: Air-Rotary | LOCATION: T18-S R38-E 29 (O)
INSTALLATION DATE: 10/22/08 | FIELD REP: D. Littlejohn
WELL PLACEMENT: 5' NE of Marker | FILE NAME: \Hobbs SWD\O-29-1
BORING LAT /LONG: Lat. 32° 42' 40.7" North, Long. 103° 10' 02.1"

No Surface Completion: Bentonite Hole Plug; No Casing Installed

Sample Type	% Rec	Cl (mg/kg)	PID (ppm)	Depth (feet)	Lithologic Description: LITHOLOGY, Color, grain size, sorting, rounding, special features
				0–4	SILT Brown possibly backfill material.
Excav.	--	355	3.7		CALICHE Grayish white, with some interbedded light brown silt
Excav.	--	283	1.2		
Excav.	--	231	4.3		
Cutting	--	193	0	15	
Cutting	--	224	0.1	20	QUARTZITE Dark brown, fine crystilline, very hard.
					SAND Light brown, fine grain, well sorted, angular.
Spoon	100%	224	0	25	
Cutting	--	227	--	30	
					SAND Light brown, fine to medium grain, well sorted, sub rounded.
Cutting	--	260	--	35	
Cutting	--	253	--	40	

Laboratory Results (6-18-08 & 10-22-08)

Depth (feet)	Chloride (mg/kg)	Benzene (mg/kg)	BTEX (mg/kg)
8	160	<0.01	<0.06
40	144	--	--

TD = 40 Feet

ATTACHMENT D
Laboratory Reports and Chain-of-Custody Documentation

CARDINAL LABORATORIES

PHONE (575) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
RICE OPERATING COMPANY
ATTN: HACK CONDER
122 WEST TAYLOR
HOBBS, NM 88240
FAX TO: (575) 397-1471

Receiving Date: 10/22/08
Reporting Date: 10/23/08
Project Number: NOT GIVEN
Project Name: HOBBS O-29-1 VENT
Project Location: HOBBS O-29-1 VENT

Analysis Date: 10/23/08
Sampling Date: 10/22/08
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: HM

LAB NO.	SAMPLE ID	Cl^- (mg/kg)
H16170-1	SB #1 @ 40'	144
Quality Control		500
True Value QC		500
% Recovery		100
Relative Percent Difference		< 0.1

METHOD: Standard Methods	4500-ClB

Note: Analysis performed on a 1:4 w:v aqueous extract.

[signature]
Chemist

10-24-08
Date

H16170 RICE

CARDINAL LABORATORIES
101 East Marland, Hobbs, NM 88240 2111 Beechwood, Abilene, TX 79603
(505) 393-2326 FAX (505) 393-2476 (325) 673-7001 FAX (325)673-7020

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Company Name: Roc
Project Manager:
Address: 122 W. Taylor
City: Hobbs State: NM Zip: 88240
Phone #: Fax #:
Project #: Project Owner:
Project Name: Holly 0-29-1 vent
Project Location: Holly 0-29-1 vent
Sampler Name: Lara Weinheimer

BILL TO
P.O. #:
Company:
Attn:
Address:
City:
State: Zip:
Phone #:
Fax #:

Lab I.D. (FOR LAB USE ONLY)	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	PRESERV: ACID/BASE:	ICE / COOL	OTHER :	SAMPLING: DATE	TIME	ANALYSIS REQUEST: Chlorides
H16170-1	SB #1 @ 40'	G	1			✓					✓		10-22-08	1:00	✓

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.

Relinquished By: [signature] Date: 10-22-08 Time: 3:45
Received By: Misty LeBut

Relinquished By: Date: Time:
Received By:

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

Sample Condition: Cool ☑ Yes ☐ No; Intact ☑ Yes ☐ No
CHECKED BY: (Initials) MCAB

Phone Result: ☐ Yes ☒ No Add'l Phone #:
Fax Result: ☐ Yes ☒ No Add'l Fax #:
REMARKS: email results
Hcounder @ riceswd.com
Jpurvis @ riceswd.com
Lweinheimer @ riceswd.com

† Cardinal cannot accept verbal changes. Please fax written changes to 505-393-2476

ATTACHMENT E

Summary Description of the
AMIGO Vadose Zone Screening Model

R. T. HICKS CONSULTANTS, LTD. ATTACHMENT E

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266.0745

Description of the AMIGO Decision Tool

The AMIGO screening tool predicts the impact to ground water from a surface release of brine. The tool uses the HYDRUS-1D model to simulate gravity-driven vertical water flow through the vadose zone. The calculated chloride flux to ground water is the input to a simple ground water mixing model. The output of the mixing model is a predicted chloride concentration in ground water immediately down gradient of the affected area as would be observed in a monitoring or supply well at or near the location.

HYDRUS-1D numerically solves the Richard's equation for water flow and the Fickian-based advection-dispersion equation for heat and solute transportation. The HYDRUS-1D flow equation includes a sink term (a term used to specify water leaving the system) to account for transpiration by plants. The solute transport equation considers advective, dispersive transport in the liquid phase, diffusion in the gaseous phase, nonlinear and non-equilibrium sorption, linear equilibrium reactions between the liquid and gaseous phases, zero-order production, and first-order degradation.

The ground water mixing model uses the chloride flux from the vadose zone to ground water provided by HYDRUS-1D and instantaneously mixes this chloride and water with the ground water flux of chloride plus water that enters the mixing cell beneath the subject site. We refer the reader to API Publication 4734, Modeling Study of Produced Water Release Scenarios (Hendrickx and others, 2005) which describes the techniques employed in the screening model.

HYDRUS 1-D INPUTS

Climate – Weather data used in calculation of the initial condition and the predictive modeling was from the Pearl, New Mexico weather station located approximately 15 miles west of the city of Hobbs, New Mexico. This station has an excellent database of daily weather conditions that are used in the HYDRUS-1D model (e.g. precipitation, temperature). Although the weather on a given day in Roswell, New Mexico may be different from Midland, Texas, the climate in the Permian Basin of New Mexico and Texas is similar. The weather data spans the 46.5 year period from July, 1946 to December, 1992.

HYDRUS-1D can also employ a uniform yearly infiltration rate that will obviously smooth the temporal variations that may be caused by a strong El Niño event during a week in July or August. Because the daily atmospheric data are of high quality for Pearl, we have elected to allow the screening tool to predict the deep percolation rate and the resultant variable flux to ground water using actual (non-smoothed data). This choice results in higher predicted peak chloride concentrations in ground water due to temporally variable high fluxes from the vadose zone than would be predicted by an averaged infiltration rate. Where depth to ground water is greater than 30 feet in this climate, using the uniform annual infiltration rate may provide more realistic results. However, using daily weather data is conservative of ground water quality as it overestimates any impact.

Initial Soil Moisture - Because soils are relatively dry in this climate and vadose zone hydraulic conductivity varies with moisture content, it is important that simulations start with representative soil moisture content. In the absence of site-specific data, the calculation of soil moisture content begins with using professional judgment as an initial input and then running sufficient years of weather data through the model to establish a "steady state" moisture content. For simulations of the Permian Basin, only minimal changes in the HYDRUS-1D soil moisture content profile occurred after year 25 of the initial condition calculations, therefore, 92 years (2 cycle of the weather data) was considered sufficient to establish an initial moisture condition for the screening tool.

Input for a Distant Well – In addition to predicting the chloride concentration for a monitoring well located adjacent to the spill area, the screening tool allows for a prediction of a second well located at a specified distance from the spill in the down gradient direction. This can be utilized to determine the potential threat to an actual water well or a compliance monitoring well located down gradient from the release site.

Background Chloride Concentration in Aquifer – If an actual measured chloride concentration from a near-by well is not available, a background concentration of no less than 50 mg/L generally reflects regional conditions.

Aquifer Porosity – If an actual measured value is not available, a conservative estimate of 0.25 to 0.30 is generally acceptable.

Groundwater Table Depth – Published information on depth to ground water is readily available in the Permian Basin if no site specific data is available.

Aquifer Thickness - The thickness of the mixing zone is an important variable in the model. In the Ogallala Aquifer, which is the water table aquifer throughout much of the Permian Basin of Texas and New Mexico, several case studies show that chloride is distributed throughout the upper 20-50 feet of the saturated zone down gradient of a release site. At some sites, the nature of the release could cause brine to behave as a dense non-aqueous phase liquid, which could concentrate chloride in the lowermost 10-feet of a thin aquifer. In the absence of site-specific hydrogeologic data, use of the screen length of nearby supply wells is a reasonable choice for the aquifer thickness (mixing zone) input to the model.

Slope of the Water Table – If actual hydraulic gradient data from a nearby site or published information is not available, the slope of the water table is assumed to be approximately parallel to the topography.

Hydraulic Conductivity – If a measured hydraulic conductivity of the saturated zone at the release site is not available, a published value from Freeze and Cherry (1979) or Musharrafieh and Chudnoff (1999) is an acceptable choice.

Groundwater Flux – This is a calculated value based on the aquifer thickness, slope of the water table, and the hydraulic conductivity.

Chloride Load – This input parameter is very important. An estimate of the chloride load (weight/area) can be calculated from the analyses of soil boring samples recovered at the source area of the site multiplied by the bulk moist soil density and the vertical thickness interval of each sample. The result is the chloride load for the vadose zone profile, from the surface to the ground water depth.

The AMIGO screening tool model initial condition assumes that the release was a single, instantaneous event that saturated the upper half meter of the vadose zone with produced water, like a pipeline rupture. The chloride concentration of the produced water is set such that the mass of chloride within the volume of produced water matches the chloride mass calculated from the soil samples. In order to apply the screening tool to a historic spill or other release event, the user must match the vadose zone chloride profile observed in the field to a vadose zone chloride profile generated by the model. In most cases, the user can identify a match between the field data and a model generated chloride profile that is several years after time zero of the model. If AMIGO cannot make an acceptable soil chloride profile match, a site-specific HYDRUS-1D model may be necessary.

Max. Length of the Spill in the Direction of GW Flow - If the exact direction of ground water flow is not known, this value is taken as the maximum dimension of the site.

Plant Uptake Trigger – The AMIGO screening tool allows for an adjustment to be made in the natural infiltration rate based on the likelihood of vegetation being re-established at the site. Brine spills will often kill vegetation and sites without vegetation allow a higher infiltration rate than sites with vegetation. Over time, the salinity of a relatively porous soil, such as medium-grained sand, will decrease and vegetation will return. The screening tool permits vegetation to return to a spill site when the chloride concentration decreases to 10% or 1% of the initial concentration within the root zone. Should a "dry" spell within the climate data result in chloride being wicked upwards into the root zone and raising concentrations above the 10% (or 1%) concentration; the vegetation is "turned off" until later precipitation lowers concentrations below 10% or 1%. At most sites, vegetation will return when chloride concentrations in soil are 500 mg/kg or less.

Surface Layer and Soil Profile - The screening tool allows for several conservative surface and sub-surface soil types to be utilized based on conditions observed during the installation of soil borings at the site. The texture of the surface layer (the upper meter of the unsaturated zone) is very important. Fine-grained surface soils will prevent infiltration – which is good for the protection of ground water after a surface spill but hinders the natural flushing of salt from the root zone. Coarse-grained soils, such as sand, allow infiltration therefore natural re-vegetation of such a site can occur after several years, rather than decades for a fine-grained soil.

The screening tool cannot simulate placement of imported fine-grained soil onto a site, which is a common engineered remedy to enhance re-vegetation and to protect ground water by lowering natural infiltration.

Screening Tool (HYDRUS 1-D) OUTPUT CHARTS

The screening tool generates two types of charts. One presents the predicted constituent property profiles in the vadose zone (Quantity 1) and the second predicts ground water quality (Quantity 2) in a down gradient well.

The vadose zone profile chart can display the following constituent properties:

- Water content,
- Chloride concentration in the soil-water, and
- Chloride concentrations of the soil (using differently colored lines to represent future years.

Chloride concentrations in the soil are useful for calibrating the chloride load of the model to actual conditions determined by characterization samples.

As described in API Publication 4734, the ground water mixing model takes the background chloride concentration in ground water multiplied by the ground water flux to calculate the total mass of ground water chloride entering the ground water mixing cell, which lies below or down gradient from the release site. The chloride and water flux from HYDRUS-1D is added to the ground water chloride mass and flux to create a final chloride concentration in ground water at a hypothetical monitoring well located at the down gradient edge of the mixing cell (the edge of the release site) or another down gradient location of the user's choosing. In addition to the predicted future ground water concentration, the predicted water and chloride flux can also be displayed.