# 1R - 428-68

# WORKPLANS

# DATE:
# 7-8-08

R. T. HICKS CONSULTANTS, LTD.
PO Box 7624 ▲ Midland, Texas 79708 ▲ 432.528.3878 ▲ Fax: 432.689.4578

July 8, 2008

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

RE: **Hobbs SWD System N-4 Vent Site (NMOCD CASE #: 1R428-68)**

RECEIVED
2008 JUL 10 PM 1 48

Dear Mr. Hansen:

On behalf of Rice Operating Company (ROC), R.T. Hicks Consultants, Ltd. is submitting this request to close the regulatory file for the above referenced site. 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 N-4 Vent Site is located southwest of the city of Hobbs at T-19-S, R-38-E, Section 4, in Unit N and a release was verified during a excavations that were conducted in May and November of 2002. The NMOCD-approved Investigation Characterization Plan (ICP), dated April 13, 2007, provided as Attachment A to this letter, includes background information and a site vicinity map for this and two other nearby ROC sites.

**Field Program**
As a part of the approved ICP, ROC installed and sampled seven backhoe trenches from August 31 to September 4, 2007 to delineate the horizontal extent of chlorides in the soil. A summary map prepared by ROC presents the results of the field chloride analyses and hydrocarbon screening data and is provided as Attachment B to this letter. A laboratory report for the soil samples used to verify the ROC field data is also provided. The results of this initial assessment indicate that the highest chloride concentration (1,354 ppm) is present at four feet below the surface in an area approximately five feet south of the original excavation. None of the 2007 trenches identified the vertical extent of the chloride-impacted soil.

Field screening of hydrocarbons in the soil identified the highest concentration (18 ppm PID) was also present at a location five feet south of the initial excavation at a depth of 9 feet below the surface. All other soil sample PID readings were below 5.0 ppm; therefore, hydrocarbon-impacted soil is not present at a concentration that represents 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 February 18, 2008 the first soil boring (SB-1) collected samples at a location approximately seven feet south of the original excavation to evaluate the area of highest remaining chloride and hydrocarbon concentrations. On February 21, after ROC filled the original excavation, a second soil boring (SB-2) was installed to collect samples at the source area location. Plate 1 shows the location of both soil borings relative to the initial excavation and sampling trenches. Soil samples were collected and field screened by ROC for chloride and hydrocarbons. Each boring was terminated when either of the following conditions occurred:

- Five consecutive samples that exhibit decreasing concentrations with depth (chloride and hydrocarbons) and the deepest sample containing less than 250 ppm chloride and 100 ppm PID or

- Three consecutive samples that exhibit concentrations of less than 250 ppm chloride and 100 ppm PID

Attachment C provides soil lithology logs, which include the field chloride and hydrocarbon screening data, and Attachment D provides the laboratory report for field data verification samples.

**Results**
Data from the deep soil boring program indicates that highest chloride concentrations (>500 ppm) are present from just below the surface to a depth of 15 to 20 feet. The horizontal extent of the chloride-impacted soil is approximately 2,000 $ft^2$ with the highest levels located just south of the original excavation.

All soil sample hydrocarbon (PID) readings from the borings were below 5.2 ppm and do not extend beyond the limits identified during the 2007 investigation.

**Simulation Modeling**
We used the HYDRUS-1D model to simulate the impact to ground water due to chloride transport through the vadose zone. The input to the model employed field data from the site or 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 N-4 site include the following:

| 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, E-4 Site |
| Aquifer Porosity (unitless) | 0.30 | Sample Description |

| | | |
|---|---|---|
| Groundwater Table Depth (ft) | 30 | Site Soil Borings |
| Aquifer Thickness (ft) | 30 | Professional Judgment |
| Slope of Water Table | 0.003 | Nicholson 1961 |
| Hydraulic Conductivity (ft/d) | 50 | Musharrafieh 1999 |
| Average Chloride Load (kg/m$^2$) | 7.0 | Calc. from Site Data |
| Max length of spill in dir. of GW flow (ft) | 70 | Site Data |
| Plant Uptake Trigger (%) | 1.0 | Professional Judgment |
| Surface Layer | caliche | Boring Logs |
| Soil Profile (sandy clay:caliche:sand ratio) | 1:1:1 | Boring Logs |

Well depth information from NM WAIDS in the same section as the N-4 site indicates an aquifer thickness of at least 50 feet and Musharrafieh and Chudnoff (1999) predict that the saturated thickness of the aquifer beneath the site will remain at least 50 feet from now to 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. Therefore the arbitrary selection of a 10-foot thick mixing zone (used as a default value for hydrocarbon sites) is unrealistic where the chemical 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 HYDRUS-1D model assumes a single surface spill is the initial source of chloride that is subsequently observed in the subsurface. In order to apply this version of the HYDRUS-1D model to the Hobbs N-4 site, we calibrated the model by adjusting the chloride load parameter such that an emulated chloride concentration profile fifteen years after the surface release compared favorably with a chloride concentration profile from soil samples measured at the source area. A favorable but conservative comparison was achieved as demonstrated below:

**Figure 1A**
**South 10' Trench + SB-1**
**(Mass Load 7.14)**

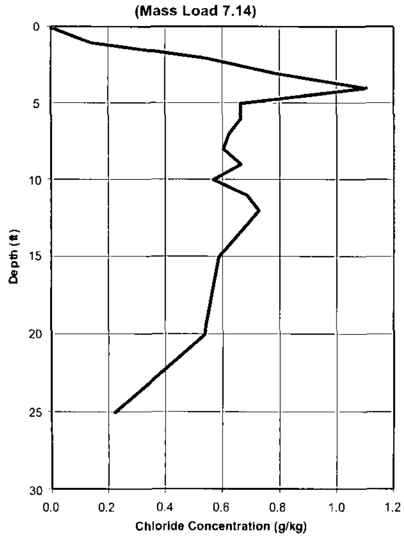



**Figure 1B**
**Predicted Chloride Profile (yr 15)**
**(Mass Load = 7.0)**

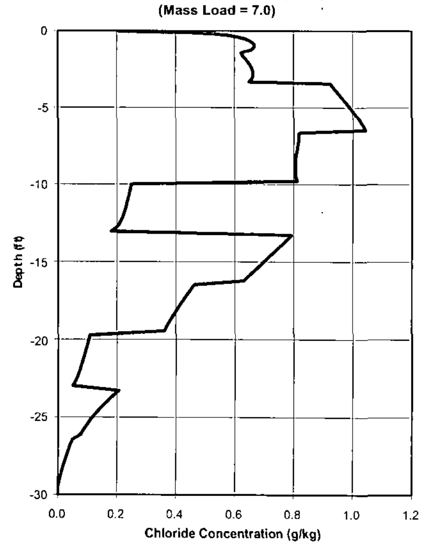
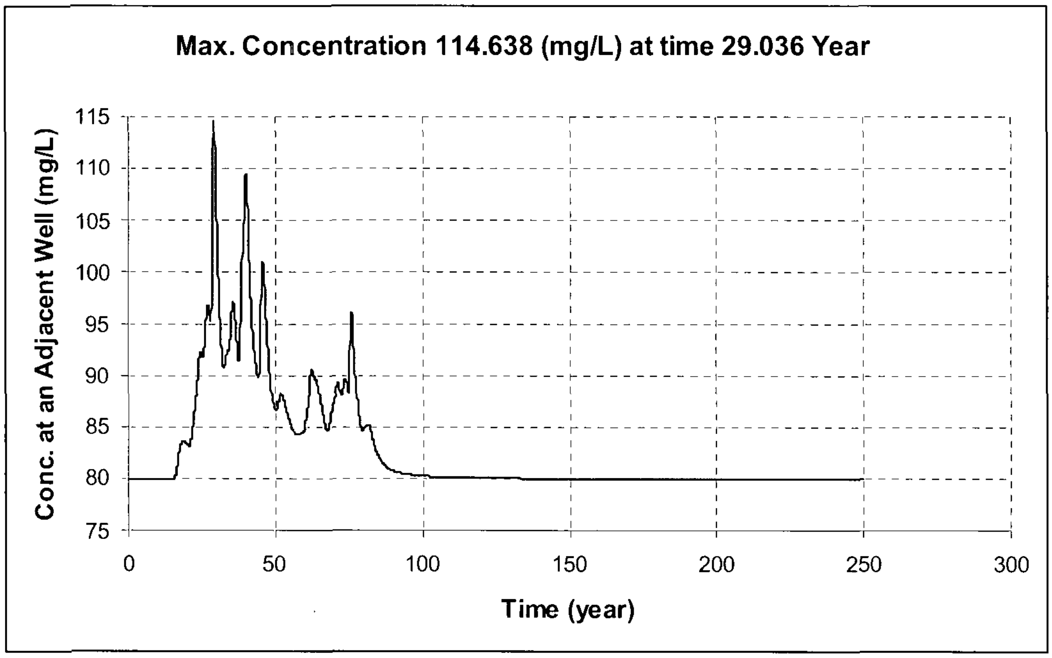


Figure 1A is the profile using field chloride analysis from the 10-Foot South Trench (to 12 feet bgs) and SB-1 (below 12 feet). The calculated chloride load for this profile is 7.14 $kg/m^2$. Figure 1B is the predicted chloride profile at year 15 of the simulation using a chloride load of 7.0 $kg/m^2$. It does not take into account the clean soil used for backfill of the original excavation.

The results of the simulation are shown below on the HYDRUS-1D model ground water output chart which has been constructed using the data files generated by the simulation. It indicates that the ground water below the site will not exceed 115 mg/L (below WQCC standards) if no further corrective actions are taken.




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

**Recommendations**

We conclude, based on these results that this site is in compliance with the mandates of Rule 116 such that the remaining chloride-impacted soil does not and will not endanger public health or the environment.

Please contact Marvin Burrows of ROC if you have any questions concerning this submission.

Sincerely,
R.T Hicks Consultants, Ltd.

Dale T Littlejohn

Dale T Littlejohn
Geologist

Copy: Marvin Burrows, ROC
NMOCD Hobbs

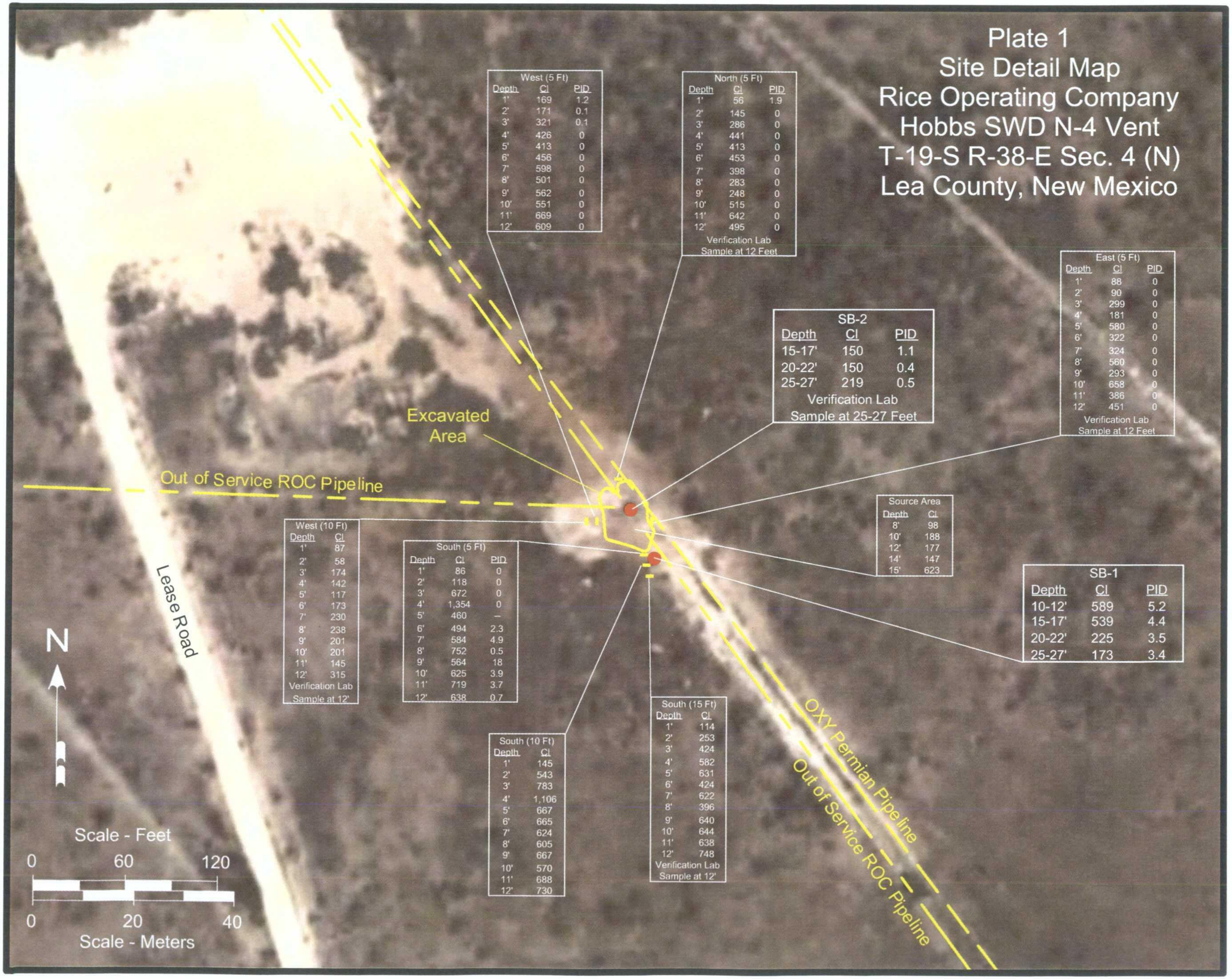


Plate 1
Site Detail Map
Rice Operating Company
Hobbs SWD N-4 Vent
T-19-S R-38-E Sec. 4 (N)
Lea County, New Mexico
West (5 Ft)
Depth Cl PID
1' 169 1.2
2' 171 0.1
3' 321 0.1
4' 426 0
5' 413 0
6' 456 0
7' 598 0
8' 501 0
9' 562 0
10' 551 0
11' 669 0
12' 609 0
North (5 Ft)
Depth Cl PID
1' 56 1.9
2' 145 0
3' 286 0
4' 441 0
5' 413 0
6' 453 0
7' 398 0
8' 283 0
9' 248 0
10' 515 0
11' 642 0
12' 495 0
Verification Lab
Sample at 12 Feet
East (5 Ft)
Depth Cl PID
1' 88 0
2' 90 0
3' 299 0
4' 181 0
5' 580 0
6' 322 0
7' 324 0
8' 560 0
9' 293 0
10' 658 0
11' 386 0
12' 451 0
Verification Lab
Sample at 12 Feet
SB-2
Depth Cl PID
15-17' 150 1.1
20-22' 150 0.4
25-27' 219 0.5
Verification Lab
Sample at 25-27 Feet
Excavated
Area
Out of Service ROC Pipeline
Source Area
Depth Cl
8' 98
10' 188
12' 177
14' 147
15' 623
SB-1
Depth Cl PID
10-12' 589 5.2
15-17' 539 4.4
20-22' 225 3.5
25-27' 173 3.4
West (10 Ft)
Depth Cl
1' 87
2' 58
3' 174
4' 142
5' 117
6' 173
7' 230
8' 238
9' 201
10' 201
11' 145
12' 315
Verification Lab
Sample at 12'
South (5 Ft)
Depth Cl PID
1' 86 0
2' 118 0
3' 672 0
4' 1,354 0
5' 460 --
6' 494 2.3
7' 584 4.9
8' 752 0.5
9' 564 18
10' 625 3.9
11' 719 3.7
12' 638 0.7
Lease Road
N
South (10 Ft)
Depth Cl
1' 145
2' 543
3' 783
4' 1,106
5' 667
6' 665
7' 624
8' 605
9' 667
10' 570
11' 688
12' 730
South (15 Ft)
Depth Cl
1' 114
2' 253
3' 424
4' 582
5' 631
6' 424
7' 622
8' 396
9' 640
10' 644
11' 638
12' 748
Verification Lab
Sample at 12'
OXY Permian Pipeline
Out of Service ROC Pipeline
Scale - Feet
0 60 120
0 20 40
Scale - Meters

# 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 13, 2007

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

RE: Investigation Characterization Plan: T18S R38E
Jct. E-4
Jct. N-4 Vent
Jct. M-4 Vent
Hobbs Salt Water Disposal System

Dear Mr. Price:

On behalf of Rice Operating Company (ROC), R.T. Hicks Consultants, Ltd. is pleased to submit this Investigation Characterization Plan (ICP) for the three (3) junction box sites referenced above within the Hobbs Salt Water Disposal System. Plate 1 is a map showing the location of these three sites relative to major roads in the area and other relevant sites.

The work elements proposed to characterize these sites sufficiently to develop an appropriate corrective action 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 and Hicks Consultants 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. Soil samples employed for delineation will be obtained from regular intervals below ground surface in each trench.
4. Representative soil samples will be sent to a laboratory to allow for verification of the field results.
5. General soil texture descriptions will be provided for each sample trench.
6. The criteria to delineate the extent of impact is 5 point chloride decline vs. depth, or:
   a. 250 ppm chloride using field analyses (see attached ROC Quality Procedure in Appendix A) whichever occurs first,
   b. 100 ppm total hydrocarbon vapors using the headspace method analysis (Appendix A).
   c. Soil boring to ground water depth should neither (a) nor (b) apply,
   d. Monitoring well installation if warranted to assess ground water at the site.

Following the site characterization described above, we will submit the data and analysis with a Corrective Action Plan that outlines the procedures for closure of the site.

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. The Hobbs SWD System has been abandoned.

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:

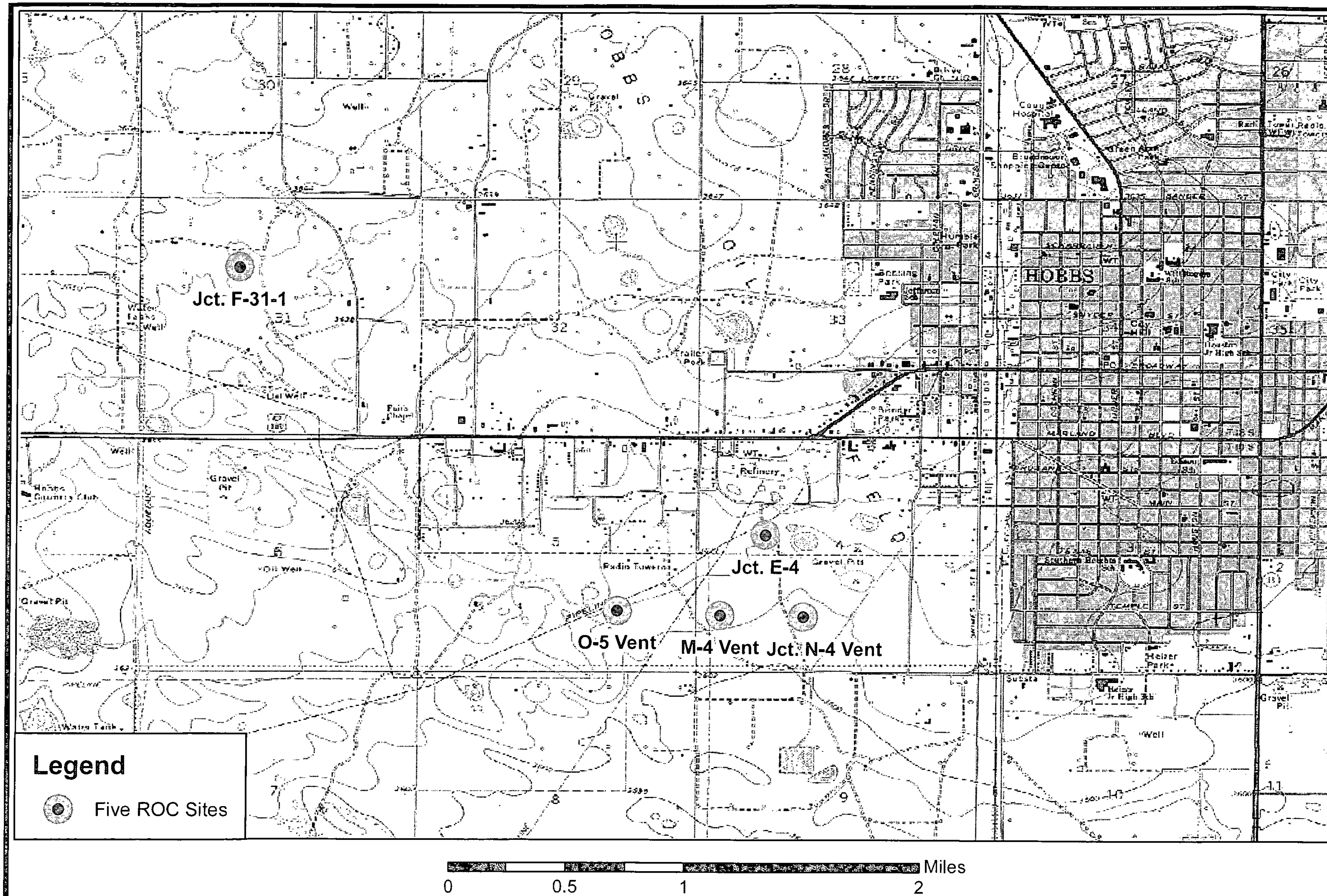
1. This Investigation and Characterization Plan (ICP), which is a proposal for data gathering, and site characterization and assessment (this submission).
2. Upon evaluation of the data and results from the ICP, a recommended remedy will be submitted in a Corrective Action Plan (CAP).
3. Finally, after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

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




| R.T. Hicks Consultants, Ltd<br>901 Rio Grande Blvd NW Suite F-142<br>Albuquerque, NM 87104<br>Ph: 505.266.5004 | Five New Sites Relative to Hobbs, New Mexico | Plate 1 |
|---|---|---|
| | Rice Operating Company | April 2007 |

## *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 of5 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 m1 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.

**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.

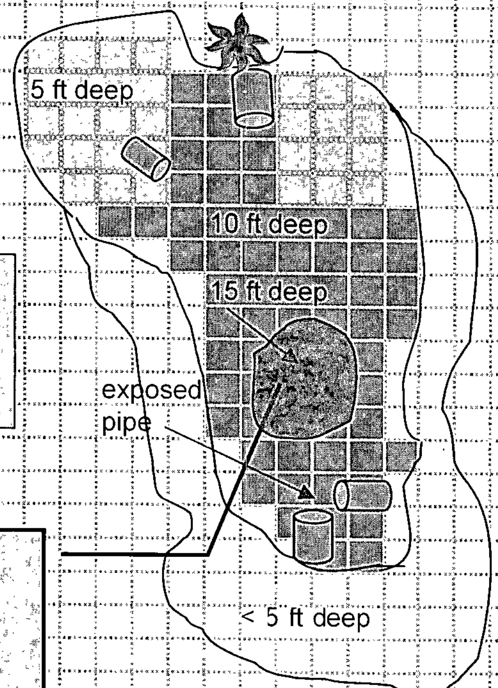
**4.0 Clean-up**
After testing, the soil samples shall be returned to the sampling location, and the bags collected for off-site disposal, IN NO CASE SHALL THE SAME BAG BE USED TWICE. EACH SAMPLE CONTAINER MUST BE DISCARDED AFTER EACH USE.

# ATTACHMENT B

**Summary of Trench Assessment (Horizontal Delineation)**
**Conducted by ROC in August and September 2007**

# Hobbs N-4 Vent

collected 8-31-07 & 9-4-07




**5' North**

| | Cl- | PID |
|---|---|---|
| 1' | 56 | 1.9 |
| 2' | 145 | 0 |
| 3' | 286 | 0 |
| 4' | 441 | 0 |
| 5' | 413 | 0 |
| 6' | 453 | 0 |
| 7' | 398 | 0 |
| 8' | 283 | 0 |
| 9' | 248 | 0 |
| 10' | 515 | 0 |
| 11' | 642 | 0 |
| 12' | 495 | 0 |

**5' West**

| | Cl- | PID |
|---|---|---|
| 1' | 169 | 1.2 |
| 2' | 171 | 0.1 |
| 3' | 321 | 0.1 |
| 4' | 426 | 0 |
| 5' | 413 | 0 |
| 6' | 456 | 0 |
| 7' | 598 | 0 |
| 8' | 501 | 0 |
| 9' | 562 | 0 |
| 10' | 551 | 0 |
| 11' | 669 | 0 |
| 12' | 609 | 0 |

**10' West**

| | Cl- |
|---|---|
| 1' | 87 |
| 2' | 58 |
| 3' | 174 |
| 4' | 142 |
| 5' | 117 |
| 6' | 173 |
| 7' | 230 |
| 8' | 238 |
| 9' | 201 |
| 10' | 201 |
| 11' | 145 |
| 12' | 315 |

| | Cl- |
|---|---|
| 8' | 98 |
| 10' | 188 |
| 12' | 177 |
| 14' | 147 |
| 15' | 623 |

Data Collected for Source on 11-15-02

**5' East**

| | Cl- | PID |
|---|---|---|
| 1' | 88 | 0 |
| 2' | 90 | 0 |
| 3' | 299 | 0 |
| 4' | 181 | 0 |
| 5' | 580 | 0 |
| 6' | 322 | 0 |
| 7' | 324 | 0 |
| 8' | 560 | 0 |
| 9' | 293 | 0 |
| 10' | 658 | 0 |
| 11' | 386 | 0 |
| 12' | 451 | 0 |

**5' South**

| | Cl- | PID |
|---|---|---|
| 1' | 86 | 0 |
| 2' | 118 | 0 |
| 3' | 672 | 0 |
| 4' | 1354 | 0 |
| 5' | 460 | *** |
| 6' | 494 | 2.3 |
| 7' | 584 | 4.9 |
| 8' | 752 | 0.5 |
| 9' | 564 | 18 |
| 10' | 625 | 3.9 |
| 11' | 719 | 3.7 |
| 12' | 638 | 0.7 |

At 5' we retrieved an inactive pipe with sludge.

**10' South**

| | Cl- |
|---|---|
| 1' | 145 |
| 2' | 543 |
| 3' | 783 |
| 4' | 1106 |
| 5' | 667 |
| 6' | 665 |
| 7' | 624 |
| 8' | 605 |
| 9' | 667 |
| 10' | 570 |
| 11' | 688 |
| 12' | 730 |

**15' South**

| | Cl- |
|---|---|
| 1' | 114 |
| 2' | 253 |
| 3' | 424 |
| 4' | 582 |
| 5' | 631 |
| 6' | 424 |
| 7' | 622 |
| 8' | 396 |
| 9' | 640 |
| 10' | 644 |
| 11' | 638 |
| 12' | 590/748 |

N

1 square equals 2 feet

Vegetation was surrounding and in site at the time of backhoe delineation.

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: KRISTIN FARRIS-POPE
122 W. TAYLOR ST.
HOBBS, NM 88240
FAX TO: (505) 397-1471

Receiving Date: 09/04/07
Reporting Date: 09/06/07
Project Owner: NOT GIVEN
Project Name: HOBBS N-4 VENT
Project Location: HOBBS N-4 VENT

Analysis Date: 09/06/07
Sampling Date: 08/31/07 & 09/04/07
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: NF
Analyzed By: KS

| LAB NUMBER | SAMPLE ID | $Cl^-$ (mg/Kg) |
|---|---|---|
| H13234-1 | 5' TRENCH NORTH @ 12 BGS | 512 |
| H13234-2 | 15' TRENCH SOUTH @ 12 BGS | 960 |
| H13234-3 | 5' TRENCH EAST @ 12 BGS | 576 |
| H13234-4 | 10' TRENCH WEST @ 12 BGS | 320 |
| 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.

Kristen Sepulveda
Chemist

09/06/07
Date

H13234 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

| | | BILL TO | |
|---|---|---|---|
| Company Name: Rice Operating Company | | | |
| Project Manager: Kristin Pope | | P.O. #: | |
| Address: 122 W. Taylor | | Company: | |
| City: Hobbs | State: NM Zip: 88240 | Attn: | |
| Phone #: 393-9174 | Fax #: 397-1471 | Address: | |
| Project #: | Project Owner: | City: | |
| Project Name: Hobbs N-4 vent | | State: | Zip: |
| Project Location: Hobbs N-4 vent | | Phone #: | |
| Sampler Name: Weinheimer | | Fax #: | |

ANALYSIS REQUEST

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H13334-1 | 5' trench north @ 12 bgs | G | 1 | | | X | | | | | X | | 8-31-07 | 9:12 a.m. | X |
| -2 | 15' trench south @ 12 bgs | G | 1 | | | X | | | | | X | | 9-4-07 | 1:37 p.m. | X |
| -3 | 5' trench east @ 12 bgs | G | 1 | | | X | | | | | X | | 8-31-07 | 11:00 a.m. | X |
| -4 | 10' trench west @ 12 bgs | G | 1 | | | X | | | | | X | | 9-4-07 | 2:14 a.m. | 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.

| | | | |
|---|---|---|---|
| Relinquished By: Lara Weinheimer | Date: 9-4-07 Time: 4:50 p.m. | Received By: [signature] | Phone Result: ☐ Yes ☐ No Add'l Phone #: |
| | | | Fax Result: ☒ Yes ☐ No Add'l Fax #: |
| Relinquished By: | Date: Time: | Received By: | REMARKS: email results Kpope@riceswd.com Lweinheimer@riceswd.com |
| Delivered By: (Circle One) Sampler - UPS - Bus - Other: | | Sample Condition Cool ☒ Yes ☐ No Intact ☒ Yes ☐ No | CHECKED BY: (Initials) MT |

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

# ATTACHMENT C

**Lithology Logs from Soil Borings (Vertical Delineation)**
**Conducted by ROC and RTH in February 2008**

# 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 Ft |
| SITE ID: | Hobbs SWD N-4 Vent | CLIENT: | Rice Operating Company |
| SURFACE ELEVATION: | 3,604 (USGS Map) | COUNTY: | Lea County |
| CONTRACTOR: | Harrison & Cooper, Inc. | STATE: | New Mexico |
| DRILLING METHOD: | Air-Rotary | LOCATION: | T-19-S, R-38-E, Sec. 4 (N) |
| INSTALLATION DATE: | 2/18/08 | FIELD REP.: | Dale Littlejohn |
| WELL PLACEMENT: | Between south 5' - 10' trench | FILE NAME: | \Hobbs SWD\N-4 Lithlogs |

COMMENTS: Lat. 32° 41' 7.1" North, Long. 103° 9' 19.3" West (Hand-Held GPS)

| | Lithology | SAMPLE DATA (PPM) | | | | | DEPTH | LITHOLOGIC DESCRIPTION: LITHOLOGY, COLOR, GRAIN SIZE SORTING, ROUNDING, CONSOL., DIST. DEATURES |
|---|---|---|---|---|---|---|---|---|
| | | TYPE | DEPTH | % REC | PID | Cl (Fld) | | |
| BENTONITE | | excav | 1 | -- | 0 | 86 | | CALICHE, Light brown, with some silt, soft. |
| | | excav | 2 | -- | 0 | 118 | | |
| | | excav | 3 | -- | 0 | 672 | | |
| | | excav | 4 | -- | 0 | 1,354 | | |
| | | excav | 5 | -- | -- | 460 | 5 | Inactive pipe (filled with sludge) recovered |
| | | excav | 6 | -- | 2.3 | 494 | | |
| | | excav | 7 | -- | 4.9 | 584 | | |
| | | excav | 8 | -- | 0.5 | 752 | | |
| | | excav | 9 | -- | 18 | 564 | | |
| | | excav | 10 | -- | 3.9 | 625 | 10 | |
| | | spoon | 10-12 | 10% | 5.2 | 589 | | |
| | | excav | 11 | -- | 3.7 | 719 | | SILTY SAND, Light brown, fine to very fine grain, poorly -sorted, angular. |
| | | excav | 12 | -- | 0.7 | 638 | | |
| | | | | | | | 15 | |
| | | spoon | 15-17 | 60% | 4.4 | 539 | | |
| | | | | | | | | CALICHE, Light gray, hard. |
| | | | | | | | 20 | |
| | | spoon | 20-22 | 70% | 3.5 | 225 | | SAND, Light brown, fine grain, well sorted, angular, with few thin-bedded sandstone layers |
| | | | | | | | 25 | |
| | | spoon | 25-27 | 70% | 3.4 | 173 | | |
| | | | | | | | | Saturated formation at 27 to 28 feet |
| | | | | | | | 30 | |

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: | 27 Ft |
| SITE ID: | Hobbs SWD N-4 Vent | CLIENT: | Rice Operating Company |
| SURFACE ELEVATION: | 3,604 (USGS Map) | COUNTY: | Lea County |
| CONTRACTOR: | Harrison & Cooper, Inc. | STATE: | New Mexico |
| DRILLING METHOD: | Air-Rotary | LOCATION: | T-19-S, R-38-E, Sec. 4 (N) |
| INSTALLATION DATE: | 2/21/08 | FIELD REP.: | Dale Littlejohn |
| WELL PLACEMENT: | Center of source area | FILE NAME: | \Hobbs SWD\N-4 Lithlogs |

COMMENTS: Lat. 32° 41' 7.2" North, Long. 103° 9' 19.5" West (Hand-Held GPS)

| Well | Lithology | TYPE | DEPTH | % REC | PID | Cl (Fld) | DEPTH | LITHOLOGIC DESCRIPTION: LITHOLOGY, COLOR, GRAIN SIZE SORTING, ROUNDING, CONSOL., DIST. DEATURES |
|---|---|---|---|---|---|---|---|---|
| 6-inch PCV; BENTONITE | PVC casing from surface to 6 feet | | | | | | 5 | No Cuttings; pit contained broken to massive caliche with light brown silt. |
| | | excav | 8 | -- | -- | 98 | | CALICHE AND SILT, gray to brown (fill). |
| | | excav | 10 | -- | -- | 188 | 10 | |
| | | excav | 12 | -- | -- | 177 | | CALICHE, Gray to white (hard) with interbedded silt. |
| | | excav | 14 | -- | -- | 147 | | |
| | | excav | 15 | -- | -- | 623 | 15 | |
| | | spoon | 15-17 | 100% | 1.1 | 150 | | SAND, Light grayish brown, very fine grain. Poorly-sorted, with some caliche. |
| | | spoon | 20-22 | 100% | 0.4 | 150 | 20 | SAND, Brown, fine grain, well-sorted, sub angular. |
| | | spoon | 25-27 | 100% | 0.5 | 219 | 25 | |

| Lab Data: | Chloride | BTEX | Benz | Naphthalene |
|---|---|---|---|---|
| (mg/kg) | 9 | <0.006 | ND | ND |

TD = 27 Feet

Moist formation at 27 feet.

# ATTACHMENT D
## Laboratory Reports and Chain-of-Custody Documentation

# Analytical Report 298150

## for

## Rice Operating Co.

**Project Manager: Kristin Pope**

**Hobbs SWD N-4 Vent**

**Hobbs SWD System**

**28-FEB-08**

ENVIRONMENTAL LAB OF

**12600 West I-20 East Odessa, Texas 79765**

Texas certification numbers:
Houston, TX T104704215

Florida certification numbers:
Houston, TX E871002 - Miami, FL E86678 - Tampa, FL E86675
Norcross(Atlanta), GA E87429

South Carolina certification numbers:
Norcross(Atlanta), GA 98015

North Carolina certification numbers:
Norcross(Atlanta), GA 483

Houston - Dallas - San Antonio - Austin - Tampa - Miami - Latin America
Midland - Corpus Christi - Atlanta

**XENCO Laboratories**

28-FEB-08

Project Manager: **Kristin Pope**
**Rice Operating Co.**
122 West Taylor
Hobbs, NM 88240

Reference: XENCO Report No: **298150**
**Hobbs SWD N-4 Vent**
Project Address: T19S, R38E, Sec 4, Unit Letter N

**Kristin Pope**:

We are reporting to you the results of the analyses performed on the samples received under the project name referenced above and identified with the XENCO Report Number 298150. All results being reported under this Report Number apply to the samples analyzed and properly identified with a Laboratory ID number. Subcontracted analyses are identified in this report with either the NELAC certification number of the subcontract lab in the analyst ID field, or the complete subcontracted report attached to this report.

Unless otherwise noted in a Case Narrative, all data reported in this Analytical Report are in compliance with NELAC standards. Estimation of data uncertainty for this report is found in the quality control section of this report unless otherwise noted. Should insufficient sample be provided to the laboratory to meet the method and NELAC Matrix Duplicate and Matrix Spike requirements, then the data will be analyzed, evaluated and reported using all other available quality control measures.

The validity and integrity of this report will remain intact as long as it is accompanied by this letter and reproduced in full, unless written approval is granted by XENCO Laboratories. This report will be filed for at least 5 years in our archives after which time it will be destroyed without further notice, unless otherwise arranged with you. The samples received, and described as recorded in Report No. 298150 will be filed for 60 days, and after that time they will be properly disposed without further notice, unless otherwise arranged with you. We reserve the right to return to you any unused samples, extracts or solutions related to them if we consider so necessary (e.g., samples identified as hazardous waste, sample sizes exceeding analytical standard practices, controlled substances under regulated protocols, etc).

We thank you for selecting XENCO Laboratories to serve your analytical needs. If you have any questions concerning this report, please feel free to contact us at any time.

Respectfully,

**Brent Barron, II**
Odessa Laboratory Manager

# Sample Cross Reference 298150

**Rice Operating Co., Hobbs, NM**

Hobbs SWD N-4 Vent

| Sample Id | Matrix | Date Collected | Sample Depth | Lab Sample Id |
|---|---|---|---|---|
| SB-2 | S | Feb-21-08 11:05 | 25 - 27 ft | 298150-001 |

# Certificate of Analysis Summary 298150
## Rice Operating Co., Hobbs, NM

**Project Name: Hobbs SWD N-4 Vent**

**Project Id:** Hobbs SWD System
**Contact:** Kristin Pope
**Project Location:** T19S, R38E, Sec 4, Unit Letter N

**Date Received in Lab:** Feb-22-08 10:20 am
**Report Date:** 28-FEB-08
**Project Manager:** Brent Barron, II

| *Analysis Requested* | | | | | |
|---|---|---|---|---|---|
| | *Lab Id:* | 298150-001 | | | |
| | *Field Id:* | SB-2 | | | |
| | *Depth:* | 25-27 ft | | | |
| | *Matrix:* | SOIL | | | |
| | *Sampled:* | Feb-21-08 11:05 | | | |
| **Anions by EPA 300/300.1** | *Extracted:* | | | | |
| | *Analyzed:* | Feb-23-08 10:52 | | | |
| | *Units/RL:* | mg/kg RL | | | |
| Chloride | | 9.03 5.26 | | | |
| **BTEX by SW 8260B** | *Extracted:* | Feb-26-08 10:15 | | | |
| | *Analyzed:* | Feb-26-08 11:28 | | | |
| | *Units/RL:* | mg/kg RL | | | |
| Benzene | | ND 0.0053 | | | |
| Toluene | | 0.0058 0.0053 | | | |
| Ethylbenzene | | ND 0.0053 | | | |
| m,p-Xylenes | | ND 0.0105 | | | |
| o-Xylene | | ND 0.0053 | | | |
| Naphthalene | | ND 0.053 | | | |
| Total BTEX | | 0.0058 | | | |
| Total Xylenes | | ND | | | |
| **Percent Moisture** | *Extracted:* | | | | |
| | *Analyzed:* | Feb-23-08 17:00 | | | |
| | *Units/RL:* | % RL | | | |
| Percent Moisture | | 4.9 | | | |





Brent Barron
Odessa Laboratory Director

# Flagging Criteria

**X** In our quality control review of the data a QC deficiency was observed and flagged as noted. MS/MSD recoveries were found to be outside of the laboratory control limits due to possible matrix /chemical interference, or a concentration of target analyte high enough to effect the recovery of the spike concentration. This condition could also effect the relative percent difference in the MS/MSD.

**B** A target analyte or common laboratory contaminant was identified in the method blank. Its presence indicates possible field or laboratory contamination.

**D** The sample(s) were diluted due to targets detected over the highest point of the calibration curve, or due to matrix interference. Dilution factors are included in the final results. The result is from a diluted sample.

**E** The data exceeds the upper calibration limit; therefore, the concentration is reported as estimated.

**F** RPD exceeded lab control limits.

**J** The target analyte was positively identified below the MQL(PQL) and above the SQL(MDL).

**U** Analyte was not detected.

**L** The LCS data for this analytical batch was reported below the laboratory control limits for this analyte. The department supervisor and QA Director reviewed data. The samples were either reanalyzed or flagged as estimated concentrations.

**H** The LCS data for this analytical batch was reported above the laboratory control limits. Supporting QC Data were reviewed by the Department Supervisor and QA Director. Data were determined to be valid for reporting.

**K** Sample analyzed outside of recommended hold time.

* Outside XENCO'S scope of NELAC Accreditation




| | Phone | Fax |
|---|---|---|
| 11381 Meadowglen Lane Suite L Houston, Tx 77082-2647 | (281) 589-0692 | (281) 589-0695 |
| 9701 Harry Hines Blvd , Dallas, TX 75220 | (214) 902 0300 | (214) 351-9139 |
| 5332 Blackberry Drive, Suite 104, San Antonio, TX 78238 | (210) 509-3334 | (210) 509-3335 |
| 2505 N. Falkenburg Rd., Tampa, FL 33619 | (813) 620-2000 | (813) 620-2033 |
| 5757 NW 158th St, Miami Lakes, FL 33014 | (305) 823-8500 | (305) 823-8555 |
| 6017 Financial Dr., Norcross, GA 30071 | (770) 449-8800 | (770) 449-5477 |

XENCO Laboratories

# Form 2 - Surrogate Recoveries

## Project Name: Hobbs SWD N-4 Vent

**Work Order #:** 298150 **Project ID:** Hobbs SWD System

**Lab Batch #:** 715658 **Sample:** 298150-001 / SMP **Batch:** 1 **Matrix:** Soil

**Units:** mg/kg

| BTEX by SW 8260B<br>Analytes | SURROGATE RECOVERY STUDY | | | | |
|---|---|---|---|---|---|
| | Amount Found [A] | True Amount [B] | Recovery %R [D] | Control Limits %R | Flags |
| 4-Bromofluorobenzene | 0.0550 | 0.0500 | 110 | 74-121 | |
| Dibromofluoromethane | 0.0464 | 0.0500 | 93 | 80-120 | |
| 1,2-Dichloroethane-D4 | 0.0469 | 0.0500 | 94 | 80-120 | |
| Toluene-D8 | 0.0530 | 0.0500 | 106 | 81-117 | |

**Lab Batch #:** 715658 **Sample:** 298150-001 S / MS **Batch:** 1 **Matrix:** Soil

**Units:** mg/kg

| BTEX by SW 8260B<br>Analytes | SURROGATE RECOVERY STUDY | | | | |
|---|---|---|---|---|---|
| | Amount Found [A] | True Amount [B] | Recovery %R [D] | Control Limits %R | Flags |
| 4-Bromofluorobenzene | 0.0502 | 0.0500 | 100 | 74-121 | |
| Dibromofluoromethane | 0.0527 | 0.0500 | 105 | 80-120 | |
| 1,2-Dichloroethane-D4 | 0.0493 | 0.0500 | 99 | 80-120 | |
| Toluene-D8 | 0.0511 | 0.0500 | 102 | 81-117 | |

**Lab Batch #:** 715658 **Sample:** 298150-001 SD / MSD **Batch:** 1 **Matrix:** Soil

**Units:** mg/kg

| BTEX by SW 8260B<br>Analytes | SURROGATE RECOVERY STUDY | | | | |
|---|---|---|---|---|---|
| | Amount Found [A] | True Amount [B] | Recovery %R [D] | Control Limits %R | Flags |
| 4-Bromofluorobenzene | 0.0535 | 0.0500 | 107 | 74-121 | |
| Dibromofluoromethane | 0.0500 | 0.0500 | 100 | 80-120 | |
| 1,2-Dichloroethane-D4 | 0.0467 | 0.0500 | 93 | 80-120 | |
| Toluene-D8 | 0.0521 | 0.0500 | 104 | 81-117 | |

**Lab Batch #:** 715658 **Sample:** 505131-1-BKS / BKS **Batch:** 1 **Matrix:** Solid

**Units:** mg/kg

| BTEX by SW 8260B<br>Analytes | SURROGATE RECOVERY STUDY | | | | |
|---|---|---|---|---|---|
| | Amount Found [A] | True Amount [B] | Recovery %R [D] | Control Limits %R | Flags |
| 4-Bromofluorobenzene | 0.0497 | 0.0500 | 99 | 74-121 | |
| Dibromofluoromethane | 0.0521 | 0.0500 | 104 | 80-120 | |
| 1,2-Dichloroethane-D4 | 0.0527 | 0.0500 | 105 | 80-120 | |
| Toluene-D8 | 0.0512 | 0.0500 | 102 | 81-117 | |

** Surrogates outside limits; data and surrogates confirmed by reanalysis

*** Poor recoveries due to dilution

Surrogate Recovery [D] = 100 * A / B

All results are based on MDL and validated for QC purposes.

# Form 2 - Surrogate Recoveries

**Project Name: Hobbs SWD N-4 Vent**

**Work Order #:** 298150 **Project ID:** Hobbs SWD System

**Lab Batch #:** 715658 **Sample:** 505131-1-BLK / BLK **Batch:** 1 **Matrix:** Solid

**Units:** mg/kg

| BTEX by SW 8260B<br>Analytes | SURROGATE RECOVERY STUDY<br>Amount Found [A] | True Amount [B] | Recovery %R [D] | Control Limits %R | Flags |
|---|---|---|---|---|---|
| 4-Bromofluorobenzene | 0.0538 | 0.0500 | 108 | 74-121 | |
| Dibromofluoromethane | 0.0519 | 0.0500 | 104 | 80-120 | |
| 1,2-Dichloroethane-D4 | 0.0496 | 0.0500 | 99 | 80-120 | |
| Toluene-D8 | 0.0507 | 0.0500 | 101 | 81-117 | |

** Surrogates outside limits; data and surrogates confirmed by reanalysis

*** Poor recoveries due to dilution

Surrogate Recovery [D] = 100 * A / B

All results are based on MDL and validated for QC purposes.

XENCO Laboratories

# Blank Spike Recovery

## Project Name: Hobbs SWD N-4 Vent

**Work Order #:** 298150 **Project ID:** Hobbs SWD System

**Lab Batch #:** 715658 **Sample:** 505131-1-BKS **Matrix:** Solid
**Date Analyzed:** 02/26/2008 **Date Prepared:** 02/26/2008 **Analyst:** WEW
**Reporting Units:** mg/kg **Batch #:** 1

| BTEX by SW 8260B<br>Analytes | BLANK /BLANK SPIKE RECOVERY STUDY<br>Blank Result [A] | Spike Added [B] | Blank Spike Result [C] | Blank Spike %R [D] | Control Limits %R | Flags |
|---|---|---|---|---|---|---|
| Benzene | ND | 0.0500 | 0.0496 | 99 | 66-142 | |
| Toluene | ND | 0.0500 | 0.0517 | 103 | 59-139 | |
| Ethylbenzene | ND | 0.0500 | 0.0507 | 101 | 75-125 | |
| m,p-Xylenes | ND | 0.1000 | 0.1003 | 100 | 75-125 | |
| o-Xylene | ND | 0.0500 | 0.0497 | 99 | 75-125 | |

**Lab Batch #:** 715578 **Sample:** 715578-1-BKS **Matrix:** Solid
**Date Analyzed:** 02/23/2008 **Date Prepared:** 02/23/2008 **Analyst:** IRO
**Reporting Units:** mg/kg **Batch #:** 1

| Anions by EPA 300/300.1<br>Analytes | BLANK /BLANK SPIKE RECOVERY STUDY<br>Blank Result [A] | Spike Added [B] | Blank Spike Result [C] | Blank Spike %R [D] | Control Limits %R | Flags |
|---|---|---|---|---|---|---|
| Chloride | ND | 10.0 | 9.95 | 100 | 75-125 | |

Blank Spike Recovery [D] = 100*[C]/[B]
All results are based on MDL and validated for QC purposes.

# Form 3 - MS Recoveries

## Project Name: Hobbs SWD N-4 Vent

**Work Order #:** 298150
**Lab Batch #:** 715578
**Date Analyzed:** 02/23/2008
**QC- Sample ID:** 298134-001 S
**Reporting Units:** mg/kg

**Date Prepared:** 02/23/2008
**Batch #:** 1

**Project ID:** Hobbs SWD System
**Analyst:** IRO
**Matrix:** Soil

| Inorganic Anions by EPA 300 | MATRIX / MATRIX SPIKE RECOVERY STUDY | | | | | |
|---|---|---|---|---|---|---|
| Analytes | Parent Sample Result [A] | Spike Added [B] | Spiked Sample Result [C] | %R [D] | Control Limits %R | Flag |
| Chloride | 987 | 210 | 1120 | 63 | 75-125 | X |

Matrix Spike Percent Recovery [D] = 100*(C-A)/B
Relative Percent Difference [E] = 200*(C-A)/(C+B)
All Results are based on MDL and Validated for QC Purposes

Environmental Lab of

# Form 3 - MS / MSD Recoveries

## Project Name: Hobbs SWD N-4 Vent

**Work Order # :** 298150

**Project ID:** Hobbs SWD System

**Lab Batch ID:** 715658 **QC- Sample ID:** 298150-001 S **Batch #:** 1 **Matrix:** Soil

**Date Analyzed:** 02/26/2008 **Date Prepared:** 02/26/2008 **Analyst:** WEW

**Reporting Units:** mg/kg

| BTEX by SW 8260B | MATRIX SPIKE / MATRIX SPIKE DUPLICATE RECOVERY STUDY | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Analytes | Parent Sample Result [A] | Spike Added [B] | Spiked Sample Result [C] | Spiked Sample %R [D] | Spike Added [E] | Duplicate Spiked Sample Result [F] | Spiked Dup. %R [G] | RPD % | Control Limits %R | Control Limits %RPD | Flag |
| Benzene | ND | 0.2629 | 0.2682 | 102 | 0.2655 | 0.2555 | 96 | 6 | 66-142 | 25 | |
| Toluene | 0.0058 | 0.2629 | 0.2761 | 103 | 0.2655 | 0.2761 | 102 | 1 | 59-139 | 25 | |
| Ethylbenzene | ND | 0.2629 | 0.2732 | 104 | 0.2655 | 0.2680 | 101 | 3 | 75-125 | 25 | |
| m,p-Xylenes | ND | 0.5258 | 0.5345 | 102 | 0.5311 | 0.5300 | 100 | 2 | 75-125 | 25 | |
| o-Xylene | ND | 0.2629 | 0.2619 | 100 | 0.2655 | 0.2564 | 97 | 3 | 75-125 | 25 | |

Matrix Spike Percent Recovery [D] = 100*(C-A)/B
Relative Percent Difference RPD = 200*(D-G)/(D+G)

Matrix Spike Duplicate Percent Recovery [G] = 100*(F-A)/E

ND = Not Detected, J = Present Below Reporting Limit, B = Present in Blank, NR = Not Requested, I = Interference, NA = Not ApplicableN = See Narrative, EQL = Estimated Quantitation Limit

# Sample Duplicate Recovery

## Project Name: Hobbs SWD N-4 Vent

**Work Order #:** 298150

**Lab Batch #:** 715578 **Project ID:** Hobbs SWD System
**Date Analyzed:** 02/23/2008 **Date Prepared:** 02/23/2008 **Analyst:** IRO
**QC- Sample ID:** 298134-001 D **Batch #:** 1 **Matrix:** Soil
**Reporting Units:** mg/kg

| Anions by EPA 300/300.1 Analyte | SAMPLE / SAMPLE DUPLICATE RECOVERY | | | | |
|---|---|---|---|---|---|
| | Parent Sample Result [A] | Sample Duplicate Result [B] | RPD | Control Limits %RPD | Flag |
| Chloride | 987 | 991 | 0 | 20 | |

**Lab Batch #:** 715411
**Date Analyzed:** 02/23/2008 **Date Prepared:** 02/23/2008 **Analyst:** WRU
**QC- Sample ID:** 298133-001 D **Batch #:** 1 **Matrix:** Sludge
**Reporting Units:** %

| Percent Moisture Analyte | SAMPLE / SAMPLE DUPLICATE RECOVERY | | | | |
|---|---|---|---|---|---|
| | Parent Sample Result [A] | Sample Duplicate Result [B] | RPD | Control Limits %RPD | Flag |
| Percent Moisture | 45.6 | 45.7 | 0 | 20 | |

Spike Relative Difference RPD 200 * | (B-A)/(B+A) |
All Results are based on MDL and validated for QC purposes.

# Environmental Lab of Texas

12600 West I-20 East
Odessa, Texas 79765

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

CHAIN OF CUSTOD

Project Manager: Kristin Farris

Company Name: Rice Operating Company

Company Address: 122 West Taylor

City/State/Zip: Hobbs, New Mexico 88240

Telephone No: 505-393-9174

Fax No: 505-397-1471

Email results to: dale@rthicksconsult.com, Lweinheimer@riceswd.com,and kpope@riceswd.com

Sampler Signature: Dale Littlejohn

Project Name

Project #

Project Locatior

ROC Billing Cod

| LAB # (lab use only) | GIS CODE | FIELD CODE | Sample Depth (soils only) Begin (ft) | End (ft) | Date Sampled | Time Sampled | No. of Containers | Preservative: Ice | $HNO_3$ | HCl | NaOH | $H_2SO_4$ | None | Other ( Specify) | Matrix: Water | Sludge | Soil | Other (specify): | GRO/DRO (EPA 8015M) | Cations (Ca, Mg, Na, K) | Anions (Cl, SO4, CO3, HCO3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 298150 | | | | | | | | | | | | | | | | | | | | | |
| -01 | | SB-2 | 25.0 | 27.0 | 2/21/08 | 1105 | 1 | X | | | | | | | | | X | | | | |
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| | | | | | | | | | | | | | | | | | | | | | |

Special Instructior

| Relinquished by: | Date | Time | Received by: | Date | Time |
|---|---|---|---|---|---|
| Dale Littlejohn | 2/22/08 | 10:20 | | | |
| Relinquished by: | Date | Time | Received by ELOT: Andrea Lam | 2.22.08 | 10:20 |

| | | | | | |
|---|---|---|---|---|---|
| #1 | Temperature of container/ cooler? | | | | |
| #2 | Shipping container in good condition? | Yes | No | | |
| #3 | Custody Seals intact on shipping container/ cooler? | Yes | No | Not Present | |
| #4 | Custody Seals intact on sample bottles/ container? | Yes | No | Not Present | |
| #5 | Chain of Custody present? | Yes | No | | |
| #6 | Sample instructions complete of Chain of Custody? | Yes | No | | |
| #7 | Chain of Custody signed when relinquished/ received? | Yes | No | | |
| #8 | Chain of Custody agrees with sample label(s)? | Yes | No | ID written on Cont./Lid | |
| #9 | Container label(s) legible and intact? | Yes | No | Not Applicable | |
| #10 | Sample matrix/ properties agree with Chain of Custody? | Yes | No | | |
| #11 | Containers supplied by ELOT? | Yes | No | | |
| #12 | Samples in proper container/ bottle? | Yes | No | See Below | |
| #13 | Samples properly preserved? | Yes | No | See Below | |
| #14 | Sample bottles intact? | Yes | No | | |
| #15 | Preservations documented on Chain of Custody? | Yes | No | | |
| #16 | Containers documented on Chain of Custody? | Yes | No | | |
| #17 | Sufficient sample amount for indicated test(s)? | Yes | No | See Below | |
| #18 | All samples received within sufficient hold time? | Yes | No | See Below | |
| #19 | Subcontract of sample(s)? | Yes | No | Not Applicable | |
| #20 | VOC samples have zero headspace? | Yes | No | Not Applicable | |

## Variance Documentation

Contact: ____________ Contacted by: ____________ Date/ Time: ____________

Regarding: ______________________________________________

______________________________________________

Corrective Action Taken:

______________________________________________

______________________________________________

______________________________________________

Check all that Apply:

- ☐ See attached e-mail/ fax
- ☐ Client understands and would like to proceed with analysis
- ☐ Cooling process had begun shortly after sampling event

# ATTACHMENT E

## Summary Description of the Vadose Zone Screening Tool Model

R. T. HICKS CONSULTANTS, LTD. ATTACHMENT E

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# Summary Description of the Vadose Zone Screening Tool Model

The 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 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, wind speed, etc.). 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 Nino 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 in the Permian Basin, only minimal changes in the HYDRUS-1D soil moisture content profile occurred after year 15 of the initial condition calculation, therefore, 46.5 years (1 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 then 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 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 then 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 then 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 moisture 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 Hydrus 1-D 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 profile generated by the model. In most cases, the user can identify a match between the field data and a generated profile that is several years after time zero of the model. If the screening tool cannot generate an acceptable profile match, a site-specific HYDRUS-1D model with input data that provides a better match than the drop-down menu choices allowed for the screening tool.

**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 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 by to 10% or 1% of the initial concentration. For 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 but 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 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 users choosing. In addition to the predicted future ground water concentration, the predicted water and chloride flux can also be displayed.

Note: Presently, R T Hicks Consultants Ltd. has not been given the authority to display the actual output charts from this version of the HYDRUS-1D tool as it is still in development for internet use. Therefore the graph which depicts future ground water chloride concentrations has been reproduced in the body of the report using the simulation data to demonstrate the modeling results.