From: Michael Taylor [mailto:MTaylor@texasbrine.com]
Sent: Friday, June 28, 2013 9:24 AM
To: Donald Haydel
Cc: Bruce Martin <BMartin@texasbrine.com> (BMartin@texasbrine.com); conservationorder; 'mcartwright@unitedbrine.com' (mcartwright@unitedbrine.com); Pastor, Dan
Subject: Re: RRD-8A Issues

Don,

Here are our replies to the BRC Gas Group's concerns. Please let me know if I can answer any questions.

Thanks,

mt

1. **When sub slab monitoring was performed on 6.14/2013, TBC's contractor did not use a permanent sealant as recommended for installing the floor probe. They used modeling type clay.**

Because the probe is smaller than the hole we are installing it in, out team places modeling clay around the probe before it is installed in the hole. This clay is placed near the bottom of the probe and it holds the probe in place allowing us to reposition as necessary so that we can get the top of the probe flus with the floor slab. Cement is then placed around the probe above the clay to seal the annulus between the probe and the hole side wall. The clay is a positioning aid and is not used to seal the hole.

2. **The contractor did not use a micromanometer as recommended to be able to detect micro-pressure readings down to 4/10,000 of an inch of water. They utilized a device that measured from zero to 10 inches of water.**

The purpose of the probe installation was to screen the under structure vapors for methane and H2S and collect laboratory confirmation samples, if warranted. We also do initial pressure screening using readily available equipment at that time as well. It's our understanding that the more rigorous (in this case, extremely rigorous) pressure monitoring is to be performed at locations where methane or H2S has been confirmed to be present under the structure.

Our preferred option of the two micromanometers that the BRC recommended is being delivered to the site this week (first available). It will be deployed for under structure pressure monitoring at 1465 Sauce Piquante and 116

SEVENTH AMEND. EMERGENCY DEC.
EXHIBIT "D"

Crawfish Stew, as these are the two locations with confirmed elevated concentrations of methane present. Because the BRC recommended requirements did not specify a monitoring period (per 2.0 Objective and Scope - "pressure recording period should be at least one week") we will initially install the pressure monitor for one to two weeks at 1465 Sauce Piquante and then move it to 116 Crawfish Stew. We are working to have temporary power installed at 116 Crawfish Stew so that detectors can be installed at this location. Power is also needed to operate the micromanometer and data recording equipment.

While the pressure monitoring equipment will provide very detailed information regarding potential gas pressure fluctuations under the structure, it is important to recognize that the detectors are/will continuously monitor the living space of the structures for the presence of methane and H2S. In addition, ventilation systems are currently being designed for both of these structures and will be installed as soon as possible (weeks).

3. **It was also reported that shut in valve was not utilized as was recommended.**

A valved quick connect fitting was not used during gas sampling since it was not a pressure monitoring event. We can install a valved fitting (or ball valve and quick connect) when we install the pressure monitoring equipment. However, it is our understanding that the pressure monitor will be connected to the probe for an at least a week, so we don't see an advantage to using a valved quick connect (or ball valve and quick connect) instead of a normal quick connect. There could be some leakage when the quick connect fittings are connected, but the goal is to observe the longer term pressure fluctuation, not an instantaneous pressure reading.

Michael Taylor, P.G.; P.E.A.
Grand Bayou Response Manager
901-482-2500

From: Donald Haydel <Donald.Haydel@LA.GOV>
To: "Bruce Martin <BMartin@texasbrine.com> (BMartin@texasbrine.com)" <BMartin@texasbrine.com>, "'mcartwright@unitedbrine.com' (mcartwright@unitedbrine.com)" <mcartwright@unitedbrine.com>, "MTAYLOR@TEXASBRINE.COM" <MTAYLOR@TEXASBRINE.COM>,
Cc: conservationorder <conservationorder@LA.GOV>
Date 06/27/2013 10:34 AM
Subject: RRD-8A Issues

Bruce, Mark, and Mike -

The Gas Group of the BRC met yesterday morning (6/26/2013) and expressed concern about a report that TBC did not follow the RRD-8A that was provided to TBC on June 5, 2013. The BRC considers the measurement of gas pressure present under Bayou Corne / Grand Bayou homes a **key** metric.

These are the issues that were expressed by the BRC:

When sub slab monitoring was performed on 6.14/2013, TBC's contractor did not use a permanent sealant as recommended for installing the floor probe. They used modeling

type clay.

4.1 Step 1—Install floor probe

Install the floor sample port in the selected location in the floor slab. Care must be taken to permanently seal the port into the concrete of the slab. Epoxy or similar sealant is recommended. If an instrument shut-in quick connect is to be used, then, depending on the quick connect being used, the female or male side of the quick connect is screwed into the port fitting using Teflon tape to seal the pipe threads. If a valve port is to be used, the ball or similar shut in valve should be installed on the port using a similar connection.

Also, the contractor did not use a micromanometer as recommended to be able to detect micro-pressure readings down to 4/10,000 of an inch of water. They utilized a device that measured from zero to 10 inches of water. It was also reported that shut in valve was not utilized as was recommended.

2.2 Micromanometer and recorder

The Micromanometer needs to be able to meet the pressure and data logging requirements outlined in the definitions. Attachment 1 contains the specification sheets of two example micromanometers that meet the pressure requirements. One instrument has an internal data logging capabilities and the other requires connection to a computer to record data. The manometer should be calibrated and checked before each use using a standardized pressure gauge capable of reading low pressures. The range of the instrument should be ±1,000 Pascal (±4 inches of water column) or less with a resolution of 0.1 Pascal (0.0004 inches of water). The instrument should be capable of recording differential pressures for up to seven days at 15-minute intervals (~700 data points). The micromanometer should be capable measuring and recording both positive and negative pressures.

Another major recurring concern of the BRC:

The BRC, in their three day working session Key Outcomes Memorandum, stated that in order to lift the evacuation order, one milestone that must be met is that gas pressure in the MRAA and overlying aquitard has to be maintained at less than hydrostatic.

TBC continues to report various well pressure readings without accompanying water level measurements. Without water level measurements taken at the same time the gas pressure is measured, actual formation pressure cannot be determined. Subsequently, the reported pressure data are not useful to determine actual gas pressure in the MRAA, a fundamental metric.

I have been asked to report back to the BRC by July 8, 2013 about whether the under-slab monitoring defficiencies have been resolved, and what TBC's path forward is to provide water level readings with pressure readings. Please provide me with that information by 2:00 PM, 7/5/13.

If you have any questions, please contact me and I will convey those to the BRC.

Don Haydel
225.342.8953

Blue Ribbon Commission on Bayou Corne and Grand Bayou Public Safety

RRD No.	RRD-GAS-05
BRC Task ID	GAS-07
Version	Final
Date of Revision	6/12/2013

RRD-GAS-005

MULTIPHASE FLOW GAS AND SOIL DATA

SEVENTH AMEND. EMERGENCY DEC.
EXHIBIT "E"

RECOMMENDED REQUIREMENTS DOCUMENT

Subject: **Multiphase Flow Gas and Soil Data**

1.0 Background

The Blue Ribbon Commission Gas Group has agreed to recommend that reducing and maintaining methane gas formation pressures in the Mississippi River Alluvial Aquifer (MRAA) to equal to hydrostatic pressure across the Bayou Corne gas area is necessary in order to lift the mandatory evacuation order (**Figure 1**). This Recommended Requirements Document (RRD) defines the technical requirements for obtaining ORW operational data to address this overall objective. The intent of this RRD is to provide recommended requirements for use by the appropriate state agencies when directing the development of a comprehensive work plan for addressing the RRD objective.

This RRD for collecting multiphase gas and soil parameter data has been prepared with consideration of the following site conditions and factors:

1. The gas formation pressures at the top of the MRAA are at least 10 pounds per square inch (psi) greater than hydrostatic. While it would be preferable for the borings to be in the gas area, it has proven to be difficult and hazardous to collect continuous soil cores because of the gas pressures encountered. Therefore, these borings have been located outside where the gas is believed to be present at pressures greater than hydrostatic. Because the area of gas is not currently well defined, appropriate health and safety protocols must be in place in the event that gas is encountered.

2. The gas has been encountered at pressures greater than hydrostatic in several geologic zones at the top of the MRAA and the overlying clay aquitard.

3. Multiphase flow gas and soil characteristics of these zones are necessary for analysis and modeling of the gas migration and mitigation.

4. Technically, the gas pressure in the MRAA only has to be reduced to a pressure that is less than the pressure required for the gas to flow through the aquitard to the surface. However, determining a value for this pressure requires substantial characterization of subsurface geologic conditions and multiphase gas flow parameters. Such characterization is not presently available so hydrostatic pressure was defined by the BRC as the appropriate benchmark pressure. As the mitigation and characterization efforts progress and a multiphase gas flow numerical model is developed based on site conditions, it may be possible to define a MRAA gas pressure greater than hydrostatic pressure that is an appropriate benchmark to protect human health and the environment.

This RRD has been prepared as part of the overall GAS-07 BRC task. This BRC task addresses the need for multiphase flow soil characteristics from the MRAA and overlying aquitard for use in quantitative evaluations of gas migration and mitigation. This RRD establishes the procedures and equipment required to collect these data.

2.0 Objective

The objective of this RRD is to define the multiphase flow characteristics of the subsurface soils and gas in the MRAA gas area. These properties are critical for migration and mitigation analysis and modeling of the Bayou Corne gas. The specific laboratory and testing programs shall be specified in the work plan.

3.0 Requirements

The requirements of this RRD for multiphase flow soil data are:

1. Collect several representative gas and groundwater samples from selected Observation Relief Wells (ORWs) and submit to a qualified laboratory for measurement of interfacial tension (surface tension) between the gas and MRAA groundwater.
2. Drill and sample five or six soil borings outside the perimeter of the gas impacted area. **Figure 1** presents the preliminary locations of the boreholes. Alternative locations can be specified in the work plan.
    a. Install a CPT boring at each location to define lithology and pore pressures prior to drilling.
    b. Collect undisturbed intact soil cores from selected aquitard and MRAA intervals to a depth of 150 feet.
    c. Install groundwater monitoring wells in the boreholes.
3. The soil samples should be tested at a qualified geotechnical laboratory experienced in in the following testing:
    a. The core in the acetate liner shall be cryogenically cut using a diamond segmented bandsaw (API RP40) and photographed using ASTM D5079 digital core photography requirements including full-scale white light core photographs. The core photos will be sent to the project geologist for determination of the intervals from each core that will be analyzed for laboratory testing.
    b. A professional geologist selects the test intervals based on the data needs for this RRD.
    c. Each selected core interval shall be analyzed for the following laboratory parameters:
        i. Grain size analysis by the laser method (ASTM D4464) or sieve analysis (ASTM D442) procedures. Laser method is used on finer-grained materials up to medium-grained sand. Sieve analysis is used on coarser-grained material of medium sand and larger.
        ii. Capillary parameters by ASTM D6836 and API RP40 procedures

1. Air/water drainage (air displacing water) including fluid production vs. capillary pressure and air/water drainage capillary pressure curve
2. Air permeability
3. Hydraulic conductivity to water
4. Total porosity
5. Dry bulk density

iii. Calculation of van Genuchten parameters and relative permeability curves from the air-water drainage curve data.

4. Based on site geology currently defined from geophysical and CPT logs, the following are the minimum core intervals for multiphase flow laboratory parameter testing (**Figure 2**):
   a. The clay above the upper fine-grained sand in the aquitard.
   b. The upper fine-grained sand in the aquitard. This fine-grained sand is observed at depths between 20 and 50 feet across the gas area.
   c. The base of the aquitard, the top of the principal gas accumulation interval, is nominally at a depth of between 95 and 100 feet in the gas area but has been encountered at 110 feet at some locations. Based on the CPT log results, continuous core samples will be collected starting five feet above the bottom of the aquitard continuing down to a depth of 150 feet. The test intervals for this core will be selected by a professional geologist after the core photographs are received from the laboratory.
   d. The sand/gravel in the upper part of the MRAA.

5. Laboratory testing to measure the interfacial energy (surface tension) using formation groundwater and gas.

6. The following reporting is recommended for this RRD. The work plan shall specify the reporting dates.
   a. The CPT logs with recommended sample interval shall be provided to the BRC and Louisiana Department of Natural Resources (LDNR) in Excel and PDF format for review and comment prior to start of the drilling program.
   b. Field boring, well construction, sampling, and daily activity logs are to be provided to LDNR as soon as the borings and wells are completed.
   c. The core photographs with the selected test intervals should be provided to the BRC and LDNR for review and comment prior to start of the laboratory geotechnical testing program.
   d. All laboratory test results shall be reported to the BRC and LNDR in both PDF and electronic data format. It is requested that the data be reported in Excel but the work plan can specify an alternate generally accepted electronic data reporting format.
   e. A summary report summarizing all of the data with appendices containing the laboratory reports, CPT, boring and well construction logs shall be submitted to the BRC and LDNR.

Appendix 1 presents suggested procedures for data collection to meet the above objective and requirements. These procedures can be modified or replaced as appropriate to meet the objectives and requirements.

APPENDIX 1
SUGGESTED PROCEDURES

1.0 Introduction

This appendix is intended for use as a procedural reference for obtaining the data required in the RRD. The procedures in this section have been used by one or more Blue Ribbon Commissioners to obtain or generate the data specified in Section 3.0 of the RRD. In preparing the work plan to address this RRD, other procedures can be used provided the objectives and data requirements in Sections 2 and 3 are met.

The following technical references are applicable to this appendix.

- Crain's Petrophysical Handbook (Crain, 2013), http://www.spec2000.net/09-cappres.htm
- Dense Chlorinated Solvents and other DNAPLS in Groundwater (Pankow and J.A. Cherry, 1996)
- LNAPL Distribution and Recovery Model Volumes 1 and 2 (LDRM) (Charbeneau, 2007)
- Louisiana Department of Environmental Quality (LDEQ)/Louisiana Department of Transportation and Development's (LDOTD) *Handbook for Construction of Geotechnical Boreholes and Groundwater Monitoring Systems, December 2000*
- Models for Design of Free-Product Recovery Systems for Petroleum Hydrocarbon Liquids (Charbeneau, 2003)
- PTS Core Handling Recommendations (Attachment 1)
- PTS Core Shipping Recommendations (Attachment 2)
- Standard Practice for Field Pneumatic Slug (Instantaneous Change in Head) Tests to Determine Hydraulic Properties of Aquifers with Direct Push Groundwater Samplers (ASTM, 2006)

2.0 Contract Services

2.1 CPT Contractor and Louisiana Licensed Drilling Contractor (Hollow-Stem Auger Drill Rig)

A CPT rig and hollow-stem auger drill rig will be required to obtain the subsurface data and collect the soil cores recommended in this RRD. All boring and wells shall comply with the applicable regulations. All wells shall be registered by the drilling contractor.

2.2 Multiphase Gas and Core Analysis Services Laboratory

Laboratory analysis of gas samples and soil cores for multiphase flow physical properties will be required. PTS Laboratories in California is a commercial laboratory that is equipped to conduct the required testing on the gas and soil cores. Certain academic and government laboratories are equipped to conduct the testing but they do not do commercial work. There may be other commercial geotechnical laboratories equipped and experienced in the required testing procedures but no other United States commercial laboratory has been identified to conduct the testing required by the RRD.

3.0 Definitions

The following definitions are applicable to this appendix:

- *Capillary pressure*—Capillary pressure is the pressure across the interface between two immiscible fluids such as water and air or oil and water. Capillary pressure is defined as the pressure across the interface between the non-wetting phase and the wetting phase. In the Bayou Corne gas area, the wetting phase is the groundwater in the MRAA and aquitard and the non-wetting phase is the gas.

- *Capillary pressure curve*—A capillary pressure curve defines the relationship between the water saturation in a porous media such as sand and the associated capillary pressure. For example, a sand 100% saturated with water and no gas will have a gas-water capillary pressure of zero. As the gas pressure is increased, there is a corresponding increase in capillary pressure. When the capillary pressure reaches a critical pressure termed the **entry or displacement pressure**, gas will enter the pore space displacing water. The capillary pressure is increased until no further reduction in water saturation is measured. The resulting end-point water saturation is termed the **residual saturation**. The capillary pressure curve is a function the grain-size and other physical characteristics of porous media, and fluid properties such as interfacial energy (surface tension).

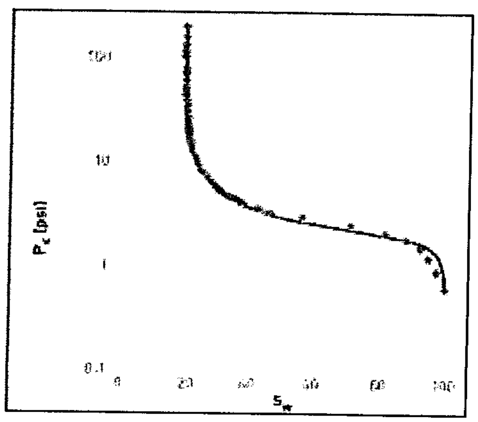


Figure 1. Example capillary curve
(from http://fesaus.org/temp/?task=view_event&event_id=1)

- *CPT*—Cone penetrometer testing (CPT). A direct-push method for obtaining detailed subsurface geologic and hydrogeologic data by pushing an instrumented cone into the soils using hydraulic rams and high-strength steel rods. At the Bayou Corne site, CPT has been successfully used to depths of 150 feet into the top of the MRAA. Once the coarser-grained sands of the MRAA are encountered, the CPT cone can no longer be advanced.

- *Interfacial tension (interfacial energy, surface tension)*—A property of the interface between two immiscible phases. When the phases are both liquid, it is termed interfacial tension; when one of the phases is air or a gas, it is termed surface tension. Interfacial tension is the Gibbs free energy per unit area of interface at fixed temperature and pressure. Interfacial tension occurs because a molecule near an interface has different molecular interactions than an equivalent molecule within the bulk fluid.
- *Multiphase flow*—Multiphase flow is subsurface flow of two or more fluids through geologic units. At the Bayou Corne site, the primary fluids of interest for multiphase flow evaluations are methane gas and groundwater in the gas area.

4.0 Procedure

The coring and sampling activities should be performed consistent with the following recommendations. These recommendations have been successfully used to collect gas and soil cores for multiphase flow laboratory analyses at many sites.

4.1 Gas Sampling and Interfacial Tension (Energy) Testing

Contemporaneous gas and groundwater samples should be collected from selected ORW wells and submitted a laboratory for interfacial tension testing according to ASTM Method D971. It is recommended that gas-water pairs be tested from 10 ORWs.

4.2 CPT Boring to Define Lithology and Sample Intervals

A CPT boring is recommended to define the geologic units and potential presence of gas at each location before coring is initiated. Once the lithology is defined using the CPT log, the core intervals for laboratory testing are selected to focus the coring efforts. The CPT hole must be grouted using appropriate methods after completion.

Based on site geology currently defined from geophysical and CPT logs, the following are the minimum core intervals for multiphase flow laboratory parameter testing (**Figure 2**):

1. The clay above the upper fine-grained sand in the aquitard.
2. The upper fine-grained sand in the aquitard. This fine-grained sand is observed at depths between 20 and 50 feet across the gas area.
3. The base of the aquitard, the top of the principal gas accumulation interval, is nominally at a depth of between 95 and 100 feet in the gas area but has been encountered at 110 feet at some locations. Based on the CPT log results, continuous core samples will be collected starting five feet above the bottom of the aquitard continuing down to a depth of 150 feet. The test intervals for this core will be selected after the core photographs are received from the laboratory.

4. The sand/gravel units near the upper part of the MRAA.

Once the core intervals have been selected, soil core samples will be collected in acetate liners for subsequent laboratory testing.

4.3 Soil Core Sampling

4.3.1 Core Handling and Documentation

A professional geologist shall oversee the coring and log the soil types. All soil descriptions and field test results will be recorded on a field boring log and a separate record of all field activities shall be documented in a Field Log notebook or Daily Activity form.

The core samples will be collected using a 2-inch continuous core or similar soil core sampler equipped with an acetate liner. When the acetate liners are removed from the core barrel, they will be capped and tape sealed. As necessary, the liner will be saw-cut and capped and tape sealed to fit in the sample coolers. Each acetate liner containing the soil samples will be clearly labeled with the boring ID, depth interval and top and bottom of the soil core, and the sequence in the core run (**Attachment 1**). The liners will be capped and tape sealed. Each core interval will be photographed in the field with the labels clearly visible. After labeling and photography, the samples will be placed on dry ice in the coolers (**Attachment 2**).

4.3.2 Aquitard Sampling

In the aquitard, only two definite samples per borehole in the shallow sand and overlying clay are planned as described in Section 5.1. These samples can potentially be collected from one 5-foot core interval using the appropriate coring device.

One or more shallow water-bearing zones may be encountered in the aquitard. In this case, a surface casing (set to a minimum depth of 30 feet-bgs) may be required.

Between core intervals, the hollow-stem augers are advanced without coring or sampling. For well construction and sampling purposes, 6-inch or larger augers are recommended.

4.3.3 Base of Aquitard and MRAA Sampling

The well locations on **Figure 1** have been selected to be outside the area of known gas but prudent caution is recommended when drilling these boreholes. It is recommended that the drilling stop for a short time just above the base of the aquitard to check for gas using the air quality instruments and signs of gas pressure. To check for gas pressure, the contractor may elect to fill the inside of the augers with water and watch for visible bubbles inside the augers. In the event that adverse gas pressures are indicated or encountered, the borehole will be grouted from the bottom using Portland cement grout and bentonite as required by applicable regulations. If gas is indicated or encountered, no attempt needs to be made to drill deeper.

Beginning at 5 feet above the uppermost sandy interval to the total borehole depth of 150 feet, soil cores will be collected by advancing a continuous core sampling device using acetate liners. These samples will be processed and logged as described in Section 5.2.1. Because the MRAA contains unconsolidated sands, the appropriate coring equipment capable of sampling loose sand should be used.

4.4 Multiphase Soil Core Laboratory Analysis

Soil cores from each boring in the acetate liners shall be shipped to the laboratory for analysis. Following receipt at the lab, each core shall be tested according to the following procedure:

- The core in the liner shall be cryogenically cut using a diamond segmented bandsaw (API RP40 Proprietary) and photographed using digital core photography according to ASTM D5079 requirements including full-scale white light core photographs. The core photos will be sent to the respective party for determination of the intervals from each core that will be analyzed for multiphase flow soil testing.
- The responsible professional geologist will select the test intervals based on the data needs for evaluation and modeling of gas migration and mitigation consistent with the objective of this RRD.
- To cores will be stored frozen at the laboratory for at least 6 months after collection to allow for any subsequent testing required.

Each selected core intervals shall be analyzed for the following multiphase flow parameters:

- Grain size analysis by the laser method (ASTM D4464) or sieve analysis (ASTM D442) procedures. Laser method is used on finer-grained materials up to medium-grained sand. Sieve analysis is used on coarser-grained material of medium sand and larger.
- PTS Capillarity test package. This package includes air/water drainage (air displacing water) according to ASTM D6836 and API RP40 procedures, air/water drainage capillary pressure curve, air permeability and hydraulic conductivity; includes fluid production vs. capillary pressure, total porosity, and dry bulk density.
- Calculation of van Genuchten parameters and relative permeability curves.

4.5 Monitoring Well Installation

Upon completion of soil sample collection to the required depth of 150 feet, a groundwater monitoring well shall be installed in each boring. The wells shall be installed and developed in accordance with the LDEQ/LDOTD *Handbook for Construction of Geotechnical Boreholes and Groundwater Monitoring Systems, (December 2000).* Each well will consist of 2-inch diameter PVC casing and 10 feet of 0.010-inch slotted PVC screen. Each well shall be completed with a graded-silica sand filter pack, bentonite seal, and cement-bentonite grout installed via tremie method. The surface will be completed with a flush-mounted bolt-down cover and concrete pad. The well will be developed until free of soil particles and has stable field parameters.

4.6 Slug Testing

Pneumatic slug tests are recommended according to ASTM procedures (ASTM, 2006) with necessary modifications for monitoring wells (Butler, 1997). The slug test data should be analyzed by the most applicable method (Dufield, 2013).

4.7 Monitoring Well Survey

The vertical (ground surface and top of casing) and horizontal position of each completed monitoring well shall be surveyed by a Louisiana licensed Professional Land Surveyor.

4.8 Monitoring

At this point in time, it is not anticipated that the monitoring wells will be sampled for water quality. If the wells are sampled, then normal groundwater purge and sample procedures shall be followed.

Because the groundwater flow gradients and fluctuations are poorly defined at the site, it is recommended that water levels in the wells be measured monthly and two of the wells be instrumented with recording, vented pressure transducers. The transducer wells should have manual water levels measured at least monthly and the transducer data adjusted accordingly.

4.9 Submittal of Data

All CPT, coring, slug testing, surveying, and monitoring data shall be documented and reported to LDNR in an electronic format once per week or as specified by LDNR directives. All CPT logs shall be submitted in PDF and Excel or similar electronic data transfer format.

5.0 Attachments

- ***Attachment 1***— PTS Core Handling Recommendations
- ***Attachment 2***—PTS Core Shipping Recommendations

6.0 FORMS

Soil Boring Log

Field Activity Daily Log

Well Construction Log

7.0 References

ASTM, 2006, Standard Practice for Field Pneumatic Slug (Instantaneous Change in Head) Tests to Determine Hydraulic Properties of Aquifers with Direct Push Groundwater Samplers, ASTM D7242-06, ASTM International, West Conshohocken, Pennsylvania.

Butler, J. J., 1997, The Design, Performance, and Analysis of Slug Tests, CRC Press, 262 p.;

Charbeneau, R., 2003, Models for Design of Free-Product Recovery Systems for Petroleum Hydrocarbon Liquids, API, 86 p.;

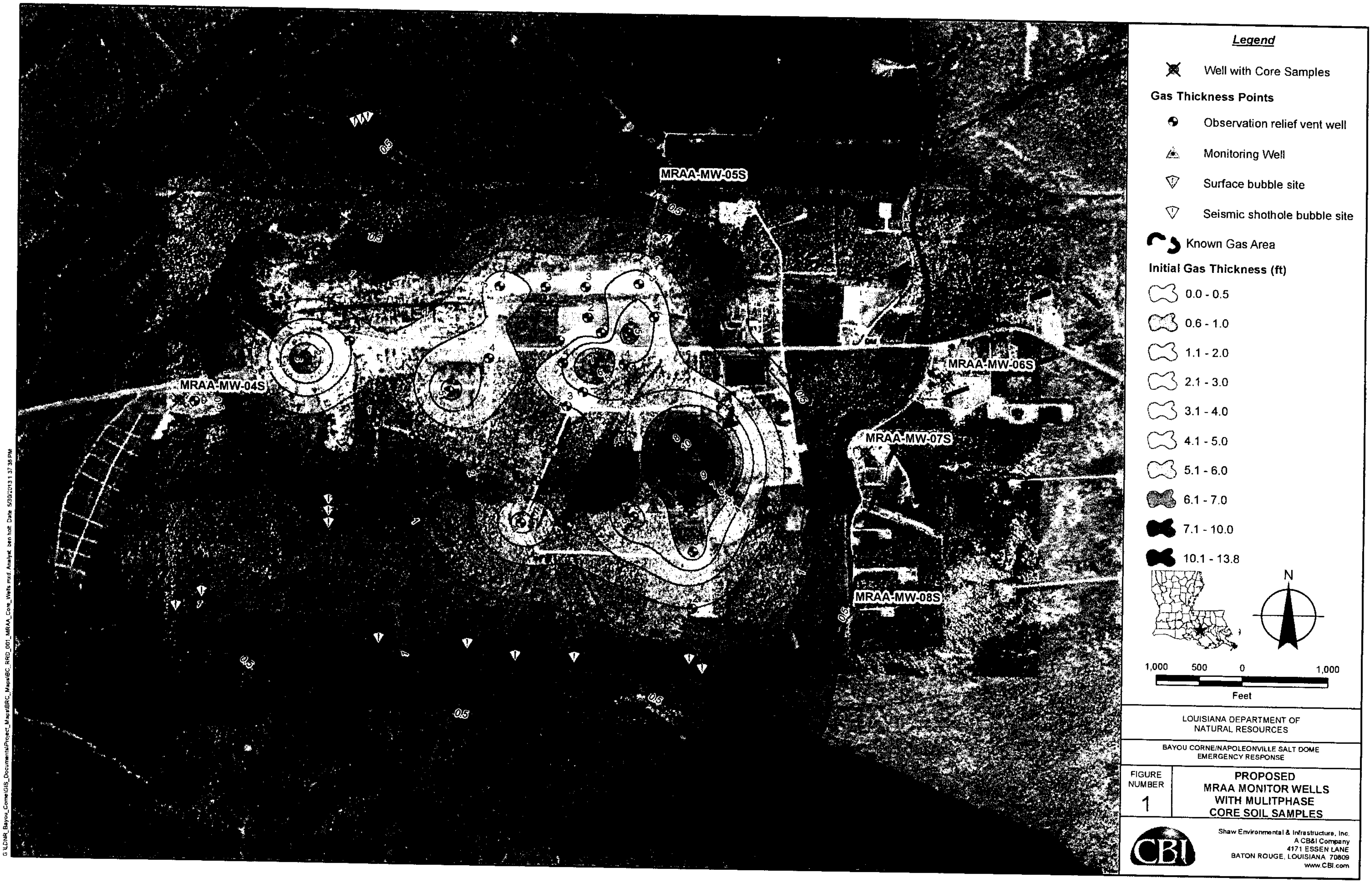
-, 2007, LNAPL Distribution and Recovery Model (LDRM), Volume 1: Distribution and Recovery of Petroleum Hydrocarbon Liquids in Porous Media, API.

Crain, E. R., 2013, Crain's Petrophysical Handbook (http://www.spec2000.net/01-index.htm).

Dufield, G. M., 2013, AQTESOLV for Windows, HydroSOLVE, Inc.

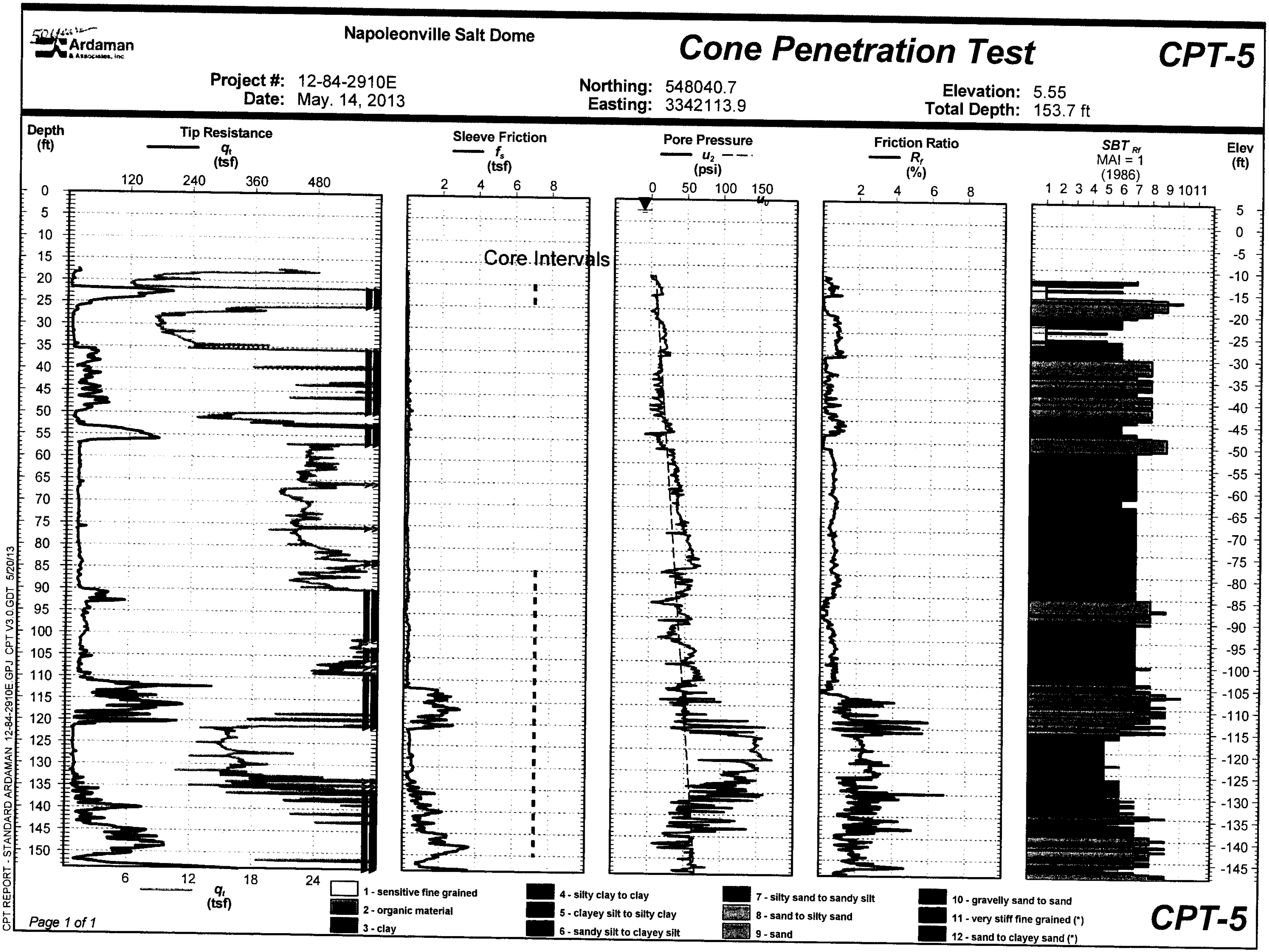
Pankow, J. F., and J.A. Cherry, e., 1996, Dense Chlorinated Solvents and other DNAPLS in Groundwater, Portland, OR, Waterloo Press, 522 p.:

FIGURES



G:\LDNR_Bayou_Corne\GIS_Documents\Project_Maps\BRC_Maps\BC_RRD_001_MRAA_Core_Wells.mxd Analyst: ben holt Date: 5/30/2013 1:37:38 PM

FIGURE 2


Ardaman & Associates, Inc
Napoleonville Salt Dome
Cone Penetration Test
CPT-5
Project #: 12-84-2910E
Date: May. 14, 2013
Northing: 548040.7
Easting: 3342113.9
Elevation: 5.55
Total Depth: 153.7 ft
Depth (ft)
Tip Resistance q_t (tsf)
Sleeve Friction f_s (tsf)
Core Intervals
Pore Pressure u_2 (psi) u_0
Friction Ratio R_f (%)
SBT Rf MAI = 1 (1986)
Elev (ft)
1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)
CPT-5
Page 1 of 1
CPT REPORT - STANDARD ARDAMAN 12-84-2910E.GPJ CPT V3.0.GDT 5/20/13

ATTACHMENT 1

PTS CORE HANDLING RECOMMENDATIONS

PTS Laboratories
Geotechnical Services
8100 Secura Way • Santa Fe Springs, CA 90670
Phone (562) 907-3607 • FAX (562) 907-3610

Client: Environmental
Client Project ID: Core Recovery Project

PTS Quote No: 00-200
January 2002

Recommended Core Handling/Preservation Field Procedures

Introduction

Following are recommended field procedures for handling, preserving and shipping unconsolidated cores obtained from shallow borings. Coring methods are beyond the scope of these procedures, as every site will have it's own unique problems and those are best addressed by the consultant and coring companies involved.

The goal of any coring operation is to obtain representative, *undisturbed* samples. If the core is being submitted to a laboratory for petrophysical analysis, it is recommended that the laboratory be contacted in advance to discuss the test program and required core size. Often, a compromise must be met between what the laboratory requires and what is practical in the field. Generally a 2" diameter by 6" long sleeve is suitable for most basic tests; horizontal and vertical permeability, TOC, density, grain size, porosity and pore fluid saturations. If larger diameter/continuous coring equipment is available, then a more detailed lithological and petrophysical data profile can be generated.

Procedure

1. Remove sample from core sampler as soon as possible.
   a. If core is in sleeves, fill any void space with saran wrap to minimize core movement, then seal with Teflon film and tape on plastic end caps.
   b. If core is not in sleeves, slide gently from sampler on to split PVC core supports - contact PTS for details. Wrap with Saran and secure with clear box tape.
2. Label each core section with top and bottom depths. Fractions of a foot should be recorded in tenths. Additionally, label multiple sleeves sequentially with A, B, C... etc starting with A on the top (shallowest) sleeve.
3. Immediately place cores in a cooler containing dry ice and freeze to minimize migration of core fluids (alternative: pack core into an ice chest with frozen "Blue Ice" and foam packing/cushioning material).
4. Ship cores at the end of each day by overnight courier (FedEx or AirBorne Express, etc.) to PTS Laboratories. Contact PTS for labeling requirements.

Applicable ASTM Standards

D3550-84:	Ring Lined Barrel Sampling of Soils; split spoon or one-piece sampling barrel.
D1587-83:	Thin-Walled Tube Sampling of Soils; Pitcher/Shelby tubes.
D4220-89:	Preserving and Transporting Soil Samples; basic, does not address contaminated samples.

•ATTACHMENT 2

PTS CORE SHIPPING RECOMMENDATIONS

Core Handling & Preservation

Freezing Core with Dry Ice

- Second fastest way to freeze core and preserve fluid saturations
- "Best" for most applications
- Longer freeze time results in little alteration of core physical properties
- Used when fluid saturations and physical properties are of equal importance
  - Preserves volatile and semivolatile hydrocarbons
  - Keeps fluids from migrating in high-permeance materials

PTS Laboratories

Core Handling & Preservation

Freezing Core with Dry Ice

1. Dry Ice is available at most industrial gas supply companies (some supermarkets).
2. Large marine ice chests are used to freeze and transport core.
   a. Up to 72 quart coolers used for smaller core.
   b. Large marine coolers (94 quarts and greater) used for core over two feet long.
3. Place approximately 50 to 75 pounds of dry ice in the bottom of the ice chest.
4. Label core, attach end caps, and place core in ice chest.
   a. Close lid and core will freeze solid in 30 minutes.
   b. Each ice chest freezes up to 22.5 feet of core using 50-75 pounds of dry ice.
5. Caution - Do not put dry ice in an unventilated or enclosed space due to risk of death by asphyxiation!

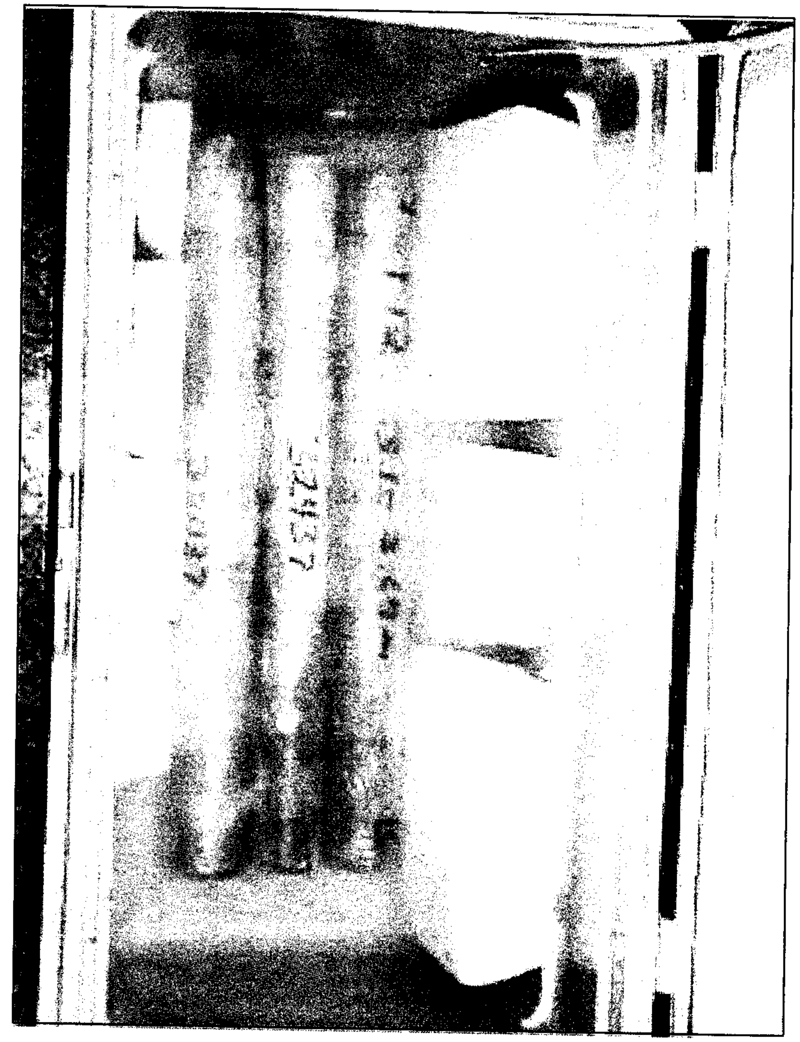
PTS

Core Handling & Preservation

Place 50 to 75 pounds of dry ice in the bottom of the ice chest.

Put core in ice chest and close lid. Core will freeze solid within 30 minutes.

Continue adding core and dry ice as necessary.



PTS Laboratories

Core Handling & Preservation

Transporting Frozen Core

1. Caution - Do not transport dry ice in passenger compartments due to risk of death by asphyxiation!
2. Large ice chests are used for transporting frozen core.
3. Place a layer of foam, bubble wrap, or "Styrofoam peanuts" in the bottom of ice chest to absorb shock during transport.
4. Place one layer of core on top of packing material.
5. Place a layer of dry ice over the core.
    a. Dry ice pellets can be used as a "packing material" to secure the core and fill any voids between cores.
    b. Block dry ice can also be used by breaking into smaller pieces and packing around core.
    c. Bubble wrap or styrofoam peanuts can be added to the core layers to cushion the core during transport.

PTS Laboratories

Core Handling & Preservation

Transporting Frozen Core

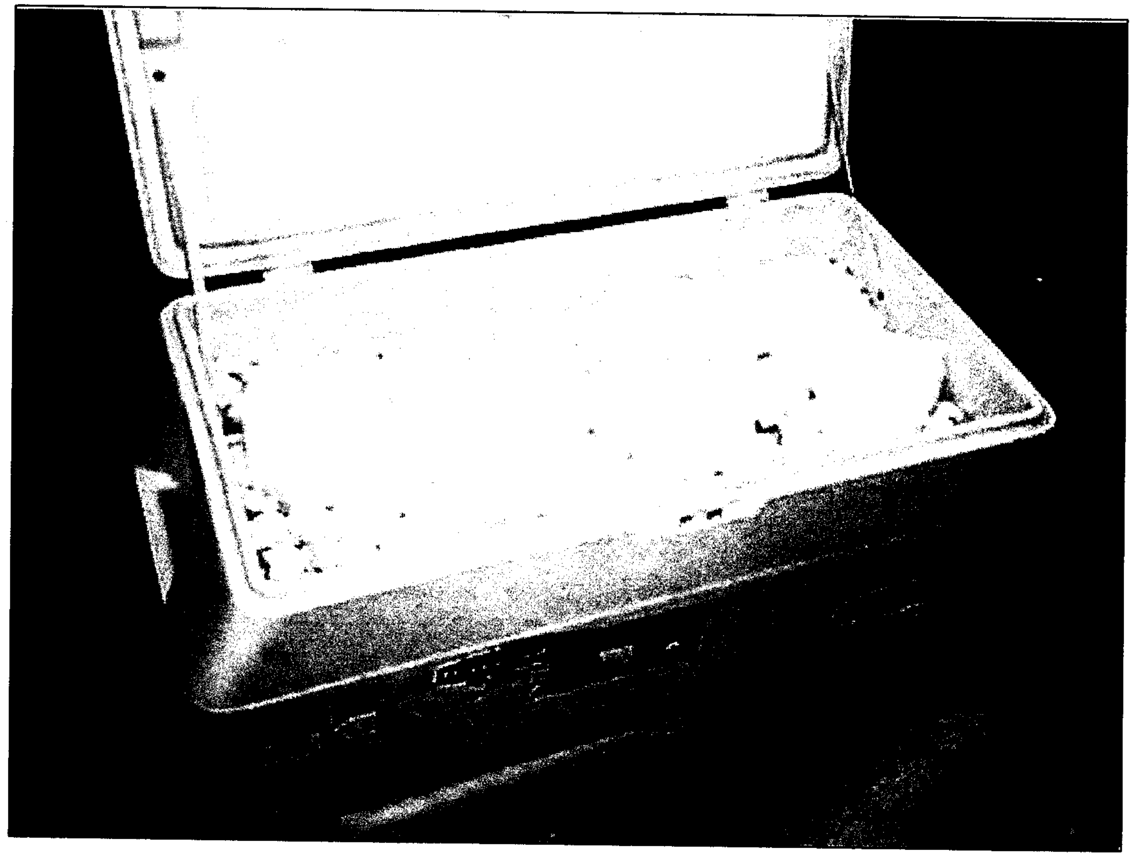
6. Continue alternating layers of core, packing materials and dry ice. Do not exceed three layers of core.
7. Fill remaining space with dry ice.
8. Put Chain of Custody in a zip lock bag and tape inside lid.
9. Close lid and seal with tape to keep cold.
10. Attach Dry Ice Placards to ice chest.
11. Contact Overnight Courier for shipment to laboratory for next day delivery. Notify laboratory of shipment arrival time (tracking numbers).
12. Arrange shipment so core does not sit in hot warehouse or truck for days.

PTS Laboratories

Core Handling & Preservation

Transporting Frozen Core

Ice chest filled with cores, dry ice, and packing material for cushioning.

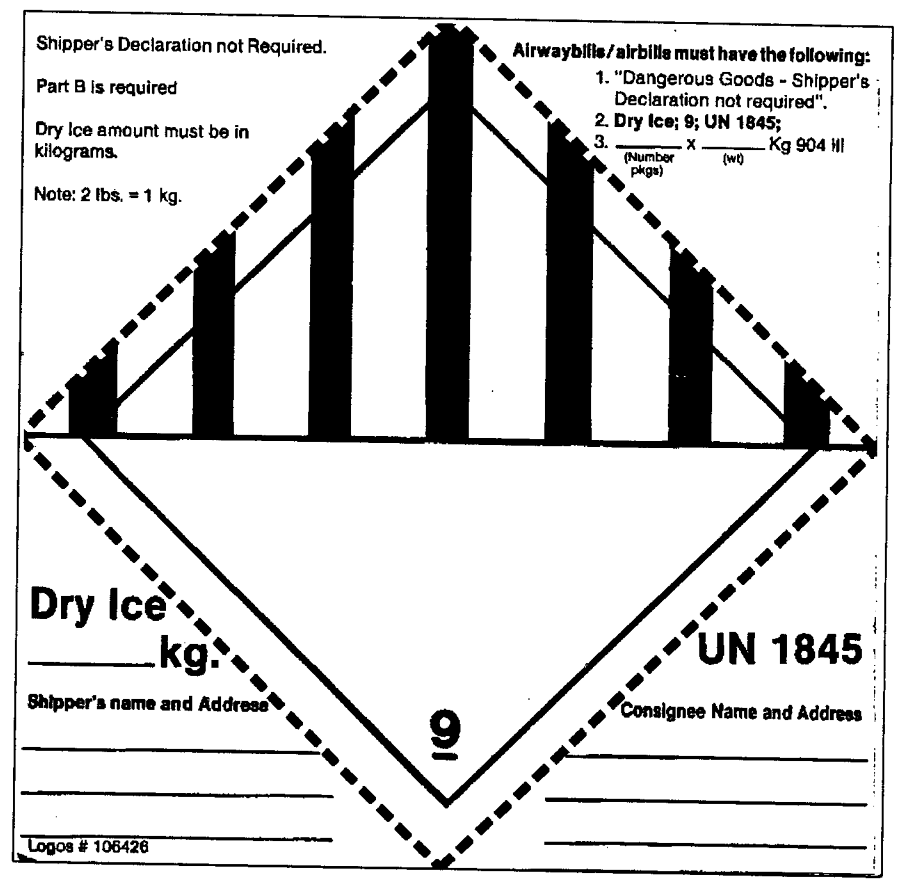


PTS Laboratories

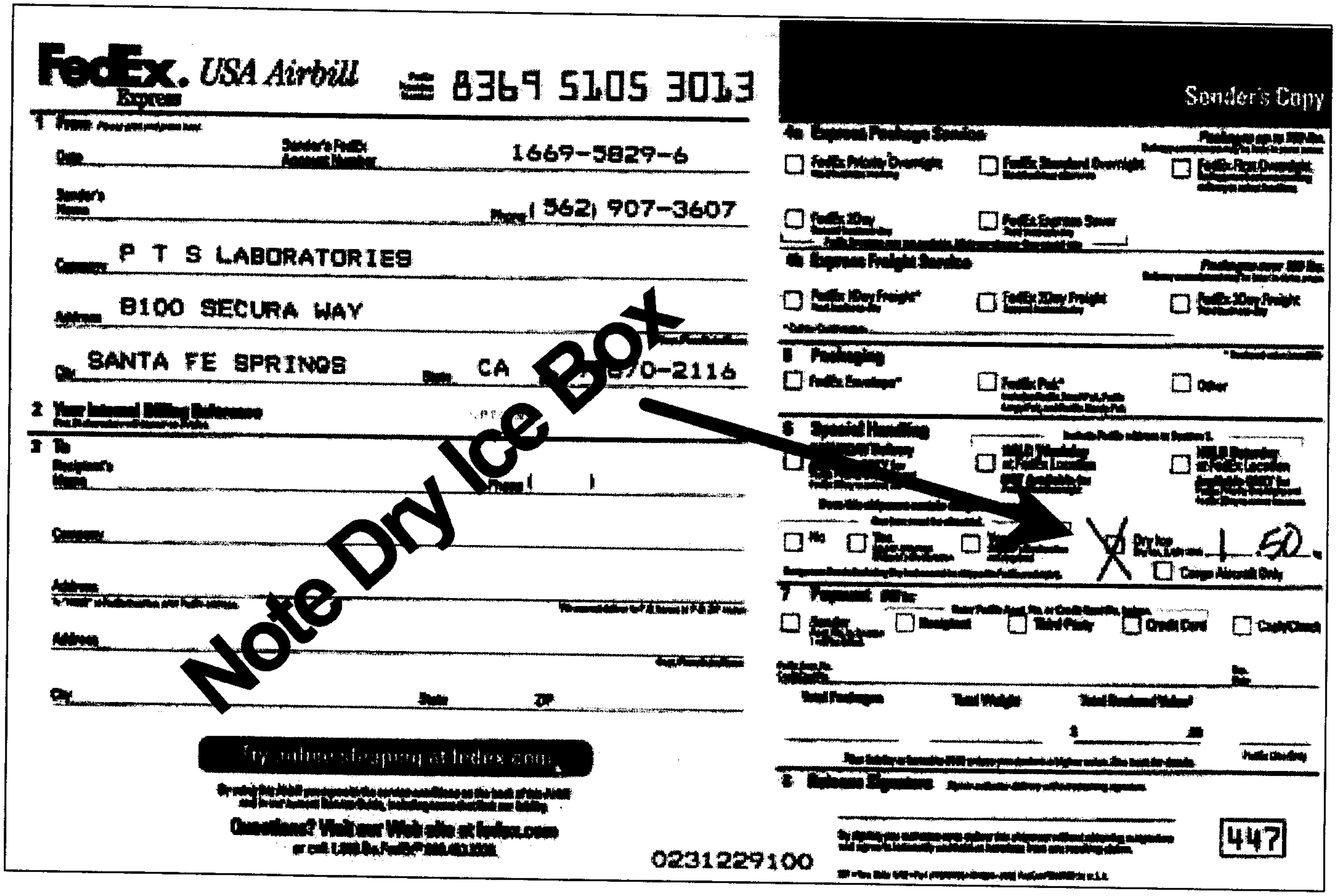
Core Handling & Preservation

Transporting Frozen Core

Dry Ice Placard: Overnight couriers can supply the placard stickers.

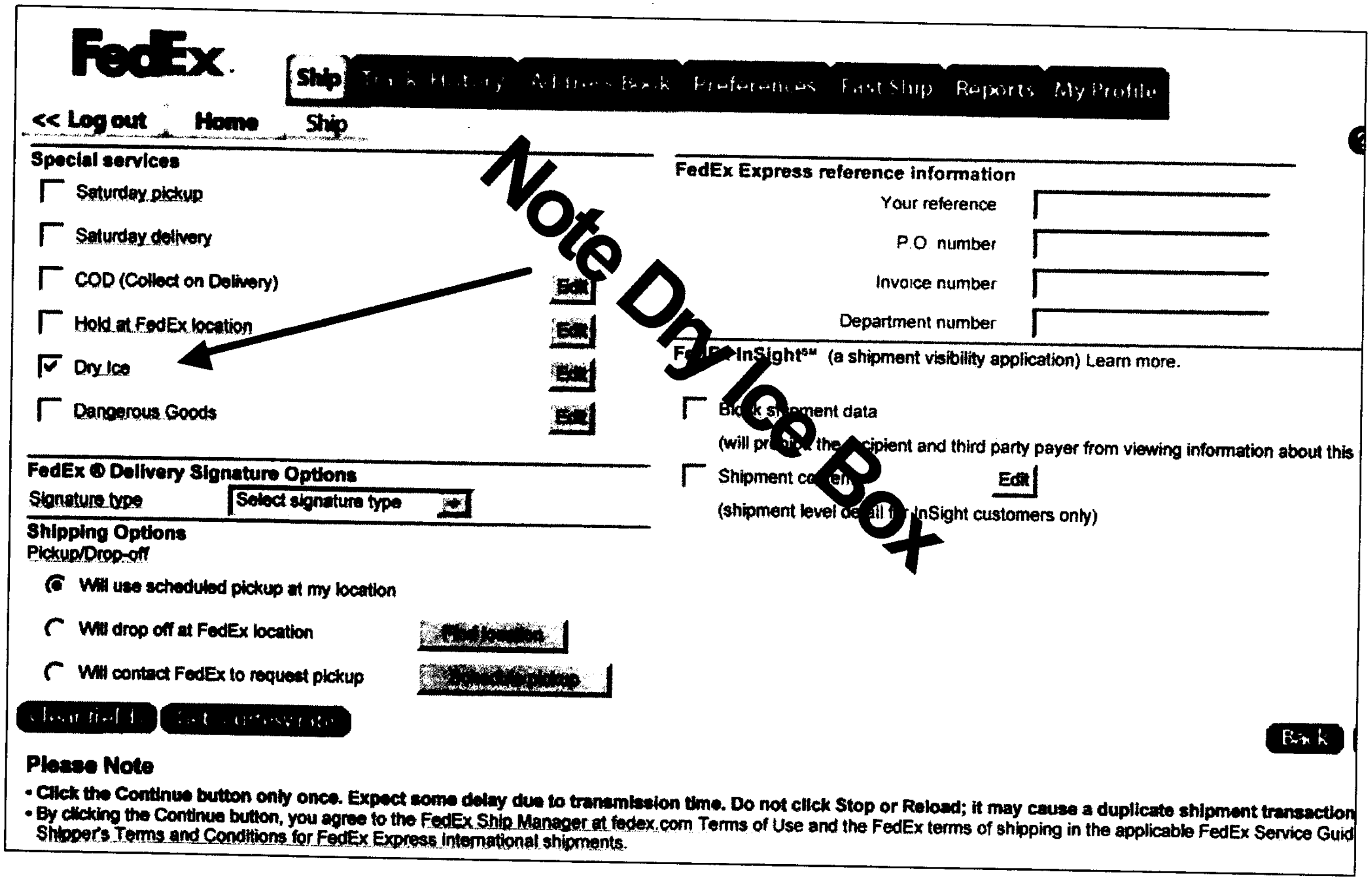


Core Handling & Preservation



Paper Shipping Label: FedEx is the easiest to ship with, they routinely handle dry ice shipments.

Core Handling & Preservation



Electronic Shipping: FedEx is the easiest to ship with, they routinely handle dry ice shipments.

PTS Laboratories

Alternative Technical Approach to Achieve Requirements of RRD-GAS-005 MULTIPHASE FLOW GAS AND SOIL DATA

Background

The Blue Ribbon Commission Gas Group (BRCGG) has prepared a Recommended Requirements Document (RRD) for collecting multiphase gas and soil parameter data (RRD-GAS-005). The purpose and scope of this RRD is described by the BRCGG as:

> "This RRD has been prepared as part of the overall GAS-07 BRC task. This BRC task addresses the need for multiphase flow soil characteristics from the MRAA and overlying aquitard for use in quantitative evaluations of gas migration and mitigation. This RRD establishes the procedures and equipment required to collect these data".

This alternative approach is intended to achieve the data collection requirements of RRD-GAS-005. This approach is based on experiences gained in the installation of various well types, on analysis of available operational data, and from the evaluation of Cone Penetrometer Testing (CPT) data. Also, it addresses some of the concerns raised by the BRCGG. TBC requests that LDNR provide this document for review and comment by the BRCGG so that TBC can develop an effective work plan to collect the multiphase gas and soil parameter data necessary for use in quantitative evaluations of gas migration and mitigation.

TBC's MRAA Science Team has reviewed RRD-GAS-005 and agrees that the types of samples to be collected and the analyses to be performed are appropriate and will be useful in ongoing evaluations of MRAA gas removal. In fact, TBC already has collected samples and contracted for analyses similar to those recommended. The alternative approach proposed here differs from RRD-GAS-005 mainly in the location and number of borings to be used for soil sample collection. Other differences in the TBC approach are minor and are noted in response to specific requirements outlined in the RRD.

The RRD recommends that five or six borings be located outside of gas impacted areas. Data from within the gas impacted areas would be preferable for quantitative gas cap analysis, so TBC proposes collecting soil samples within gas impacted areas during the construction of ORW wells or pressure monitoring wells. Experience gained over the last several months in well installation and soil sampling at Bayou Corne is the basis for revised drilling and sampling protocols (Appendix 1). These protocols address safety concerns related to collecting soil samples from borings that have elevated gas pressures above and at the top of the MRAA. Because soil samples (described in Appendix 2) have already been collected from two locations and sent to PTS for the same types of multiphase analyses recommended by the BRCGG, fewer than five or six locations will be necessary to collect a representative number of samples to characterize the MRAA gas area.

As part of the background discussion in RRD-GAS-005, the BRCGG expressed safety concerns related to elevated gas pressures:

"The gas formation pressures at the top of the MRAA are at least 10 pounds per square inch (psi) greater than hydrostatic. While it would be preferable for the borings to be in the gas area, it has proven to be difficult and hazardous to collect continuous soil cores because of the gas pressures encountered. Therefore, these borings have been located outside where the gas is believed to be present at pressures greater than hydrostatic. Because the area of gas is not currently well defined, appropriate health and safety protocols must be in place in the event that gas is encountered."

In addition to improving drilling protocols as described above and in Appendix 1, review of drilling records and CPT pressure results demonstrate that excess pressures can be safely addressed. Both the drilling records and the CPT data show that elevated pressures (greater than a few psi) occur in sand lenses above the MRAA and not in the MRAA. A summary of CPT gas pressure data is provided in Appendix 3. The CPT gas data show pressures very close to expected hydrostatic pressures in the MRAA and less than 10 psi greater in the sand lenses above the MRAA. To the extent that gas pressures within the MRAA may have been greater than 10 psi above hydrostatic in the past, that is an indication of significant gas depletion due to MRAA relief well operations.

Alternative Requirements

Alternatives to the requirements of this RRD-GAS-005 for multiphase flow soil data are noted in *italics*:

1. Collect several representative gas and groundwater samples from selected Observation Relief Wells (ORWs) and submit to a qualified laboratory for measurement of interfacial tension (surface tension) between the gas and MRAA groundwater.

2. Drill and sample five or six soil borings outside the perimeter of the gas impacted area. **Figure 1** presents the preliminary locations of the boreholes. Alternative locations can be specified in the work plan.

   Samples will be collected from four locations within gas impacted areas during the drilling of ORW and pressure monitoring wells (TBC-pmw-08 and 12, see RRD-GAS-09), in accordance with protocols outlined in Appendix 1. The relief well locations to be used for sampling will be selected based on CPT soundings and approval of LDNR.

   a. Install a CPT boring at each location to define lithology and pore pressures prior to drilling.
   b. Collect undisturbed intact soil cores from selected aquitard and MRAA intervals to a depth of 150 feet.

      RRD-GAS-005 suggests the use of a hollow stem auger (HAS) to drill through the aquitard. TBC proposes to continue to use rotosonic drilling methods which will allow for a better method to seal intermediate gas zones. The use of the rotosonic drilling method is a proven method at the Site with nearly 50 borings installed with this method. For the purpose of providing an open-cased borehole to begin the collection of soil cores from selected aquitard and MRAA intervals, the rotosonic and HAS methods are comparable.

      Five-foot acetate sleeved samples will be collected at intervals based on adjacent CPT log *and consultation with LDNR technical representation prior to well installation.*

c. Install groundwater monitoring wells in the boreholes.

Install wells for purpose as appropriate.

3. The soil samples should be tested at a qualified geotechnical laboratory experienced in in the following testing:

a. The core in the acetate liner shall be cryogenically cut using a diamond segmented bandsaw (API RP40) and photographed using ASTM D5079 digital core photography requirements including full-scale white light core photographs. The core photos will be sent to the project geologist for determination of the intervals from each core that will be analyzed for laboratory testing.

This procedure can be done but according to discussions with PTS, freezing of the soil samples is not necessary unless hydrocarbon and gas content analyses are to be conducted.

b. A professional geologist selects the test intervals based on the data needs for this RRD.

c. Each selected core interval shall be analyzed for the following laboratory parameters:

i. Grain size analysis by the laser method (ASTM D4464) or sieve analysis (ASTM D442) procedures. Laser method is used on finer-grained materials up to medium-grained sand. Sieve analysis is used on coarser-grained material of medium sand and larger.

ii. Capillary parameters by ASTM D6836 and API RP40 procedures

1. Air/water drainage (air displacing water) including fluid production vs. capillary pressure and air/water drainage capillary pressure curve
2. Air permeability
3. Hydraulic conductivity to water
4. Total porosity
5. Dry bulk density

iii. Calculation of van Genuchten parameters and relative permeability curves from the air-water drainage curve data.

4. Based on site geology currently defined from geophysical and CPT logs, the following are the minimum core intervals for multiphase flow laboratory parameter testing (Figure 2):

a. The clay above the upper fine-grained sand in the aquitard.

b. The upper fine-grained sand in the aquitard. This fine-grained sand is observed at depths between 20 and 50 feet across the gas area.

c. The base of the aquitard, the top of the principal gas accumulation interval, is nominally at a depth of between 95 and 100 feet in the gas area but has been encountered at 110 feet at some locations. Based on the CPT log results, continuous core samples will be collected starting five feet above the bottom of the aquitard continuing down to a depth of 150 feet.

The test intervals for this core will be selected by a professional geologist after the core photographs are received from the laboratory.

Five-foot acetate sleeved samples will be collected at intervals based on adjacent CPT log and consultation with LDNR technical representation prior to well installation. The base of the aquitard is typically at 125 feet in depth within gas impacted areas.

d. The sand/gravel in the upper part of the MRAA.

5. Laboratory testing to measure the interfacial energy (surface tension) using formation groundwater and gas.

6. The following reporting is recommended for this RRD. The work plan shall specify the reporting dates.

   a. The CPT logs with recommended sample interval shall be provided to the BRC and Louisiana Department of Natural Resources (LDNR) in Excel and PDF format for review and comment prior to start of the drilling program.

   b. Field boring, well construction, sampling, and daily activity logs are to be provided to LDNR as soon as the borings and wells are completed.

   c. The core photographs with the selected test intervals should be provided to the BRC and LDNR for review and comment prior to start of the laboratory geotechnical testing program.

   d. All laboratory test results shall be reported to the BRC and LNDR in both PDF and electronic data format. It is requested that the data be reported in Excel but the work plan can specify an alternate generally accepted electronic data reporting format.

   e. A summary report summarizing all of the data with appendices containing the laboratory reports, CPT, boring and well construction logs shall be submitted to the BRC and LDNR.

Appendix 1.

Drilling and Sampling Protocols for MRAA Wells.

The following Observation/Relief Well (ORW) upgrades, developed from lessons learned from installing and operating existing Site vent wells ORW-1 through ORW-38, will be implemented for future ORWs for a more cost-effective and reliable system for venting known gaseous hydrocarbon accumulation areas within the Mississippi River Alluvial Aquifer (MRAA). Ongoing Site investigation results will be used to guide the installation of these additional ORWs using conventional rotasonic technology and materials. The results of the CPT gas cap investigation program will be the primary driver for choosing the new ORW locations and screened interval depths.

This work will be conducted in general accordance with work plans specific to Directive No. 3 of the Fourth Amendment to the Declaration of Emergency to abate and remove the natural gas currently in the MRAA. All wells will be installed by a Louisiana-licensed well driller in accordance with Louisiana Department of Natural Resources (LDNR) well construction requirements and LDNR guidance. As with all drilling operations, Tetra Tech and Contractor Health and Safety Plans will be followed, including specific Job Hazard Analyses developed for drilling and coring into potential gas-bearing zones. This includes protocols for air monitoring, ventilation, and water management. Tetra Tech anticipates that field activities will be conducted using Level D personal protective equipment.

Well Drilling Methods and Procedures

Under Tetra Tech direction, WHE a Louisiana-licensed well driller will install the proposed methane vent wells using its rotasonic drilling rig. Nominal 8" diameter drill casing will be advanced using potable water from ground surface to total depth. Soil core will be collected from select intervals to:

- Mitigate sonic drilling impacts through adjacent gas-bearing MRAA sand units;
- Classify soil; and,
- Collect minimally disturbed soil core for off-site geotechnical testing.

Typical nominal 8" drill casing will be advanced to an elevation several feet above the top of the MRAA using potable water as the drilling fluid. Borehole material will be pushed out of the bottom of the casing by water pressure during drilling. No drilling returns are expected through the very soft clay aquitard. In an effort to limit the impacts of sonic drilling on MRAA sands adjacent to the borehole, WHE will remove most of the MRAA borehole soils prior to continuing override casing advancement into the MRAA. At a drill casing elevation of several feet above the top of the MRAA, a nominal 7" diameter x 10 LF core barrel will be sonically driven through the bottom of the aquitard and into MRAA sands. Thereafter, the nominal 8" casing will override the core barrel and be advanced to the same interim depth using potable water to flush the nominal ¼" gap of soil between the outside of the core barrel and the inside of the override casing.

Thereafter, the 10 LF core barrel will be removed from the borehole. Soil core from the aquitard clays/silts and the MRAA sands will be extruded into plastic core sleeve bags and logged for soil classification. The empty core barrel will then be tripped down inside the casing to the elevation of the override casing drive shoe and the coring/override procedure resumed in a stepwise fashion until total depth is achieved. This soil removal process will limit the amount of soil available to be flushed laterally into gas-bearing formations during casing advancement.

All down-hole drilling equipment will be pressure washed with hot potable before and after drilling. Decontamination will occur in a designated decontamination area away from the wells.

Override penetration rates will be observed during core override casing advancement to determine the depth of the top of the MRAA to confirm CPT results and screened intervals. The final construction depth of each well will be determined by the field geologist overseeing well installation based on lithological information, but in no cases will be less than 20 feet below the top of the MRAA contact. An experienced Tetra Tech field geologist will log the soil samples, monitor the drilling operations, record the well installation procedures, and prepare boring logs and well construction diagrams.

Soil Core Sampling for Geotechnical Analyses

Soil core for certain geotechnical parameters will require undisturbed soil core samples with as much preserved original depositional layering as possible. Soil core samples will be collected using standard sonic drilling methods and a nominal 5 LF x 3-1/8" diameter solid core barrel housing with a clear plastic sleeve. A drill casing sleeve will be advanced to the top of the target interval using potable water drilling fluid. Upon reaching target depth, the drill casing will be detached from the pressurized drilling head. If gas kicks are noted in the water-filled casing, the drive head will be re-attached to suppress the kick and prevent a blow-out. If kicks persist after subsequent detachments, drilling fluid inside the casing will be replaced with drilling mud to increase bottom-hole pressure and suppress gas kicks when the drive cap is removed.

Soil cores will be collected using a 5 LF core barrel with 3.125" clear acetate sleeve. A sand catcher basket will be installed in the core barrel drive shoe to retain unconsolidated sands on the trip out of the borehole. The core barrel will be advanced from the bottom of the borehole for 5 LF using optimal down feed pressure with minimal rotation and minimal sonic vibration designed to maximize undisturbed core recovery. The core barrel will then be withdrawn slowly to avoid swabbing effect that might generate gas kicks through the water column. If at any time gas kicks are noted, the core rods will be disconnected and the well head sealed with the drive cap to prevent kicks from developing into blow-outs. In this case, the override casing will be advanced incrementally to below the gas cap in an iterative fashion until noted kicks are suppressed, allowing the core barrel to be safely retrieved.

The complete 5-ft core sleeve will be extruded from the solid core barrel using a special pushrod tool. The geologist will examine core recovery and determine if sufficient quantity is present for representative laboratory samples. The outside of the sleeve will be marked with cut lines in 6" to 12" sections where 100% core recovery is present. Core sections will be identified with permanent marker. As soon as practicable, the sample core will be cut with a reciprocating saw with the core sleeve placed in a surface jig to minimize saw vibration that could disaggregate the core. Tube end caps will be placed flush over the open ends of the core tubes and secured with tape. The core sections will then be labeled, packaged, and shipped under Chain of custody procedures according to the directive referenced above.

A discrete core interval can only be sampled once per borehole. If insufficient recovery volume is attained, that interval cannot be re-pushed at that borehole.

ORW Construction

The proposed ORWs will be constructed in a manner that is consistent with previously installed wells at this site. All well construction will be accomplished inside the nominal 8" diameter temporary drill casing. Wells will be constructed of nominal 4-inch diameter flush thread, Sch 40 carbon steel casing, or similar, to approximately 2.5 ft above grade. The screened interval will consist of 4-inch diameter 0.008- or 0.006-slot casing-based type 304 stainless steel screen. A sump will be installed under the screen for both ease of well constructability (it anchors the well to overcome friction lock lifting forces that could potentially lift the well when the drill casing is retracted) and for PDK logging access across the gas cap zones. A schematic design of the ORW well is provided in Figure 1. Voltage potential differences between the stainless steel screen and carbon steel riser will not require a dielectric couple, as the well is expected to be abandoned prior to any significant corrosion.

The wells will be packed to 2 feet above the screened interval with washed 20-40 grade silica sand. The seal will be set using a 2- to 3- foot thick layer of bentonite pellets, allowed to hydrate for at least 8 hours. A 2-ft thick layer of very fine seal sand will be installed above the hydrated bentonite. The well will then be sealed to ground surface with a minimum 13.4 lbs/gal bentonite grout (PureGold® Grout by Cetco or equivalent) pumped from the bottom up via a side-discharge tremie pipe.

The wells will be completed with a fabricated 45° wye lateral under the WOG 4" master valve. The wye will have a 4" NPT male top thread, 4" casing bottom thread and a welded flange. The flange will connect through a flange gasket to another flange machined to house three pass-through high-pressure fittings for the air lift pump and transducer cable. The airlift pump will feature vales on the intake and discharge tubing and a copper "U-tube" bubbler that will discharge compressed air approximately 3 ft up into the open bottom of the 1" HDPE installed near the bottom of the well.

At the completion of the monitoring well installations, the horizontal and vertical coordinates of the monitoring wells will be surveyed by a Louisiana-licensed surveyor.

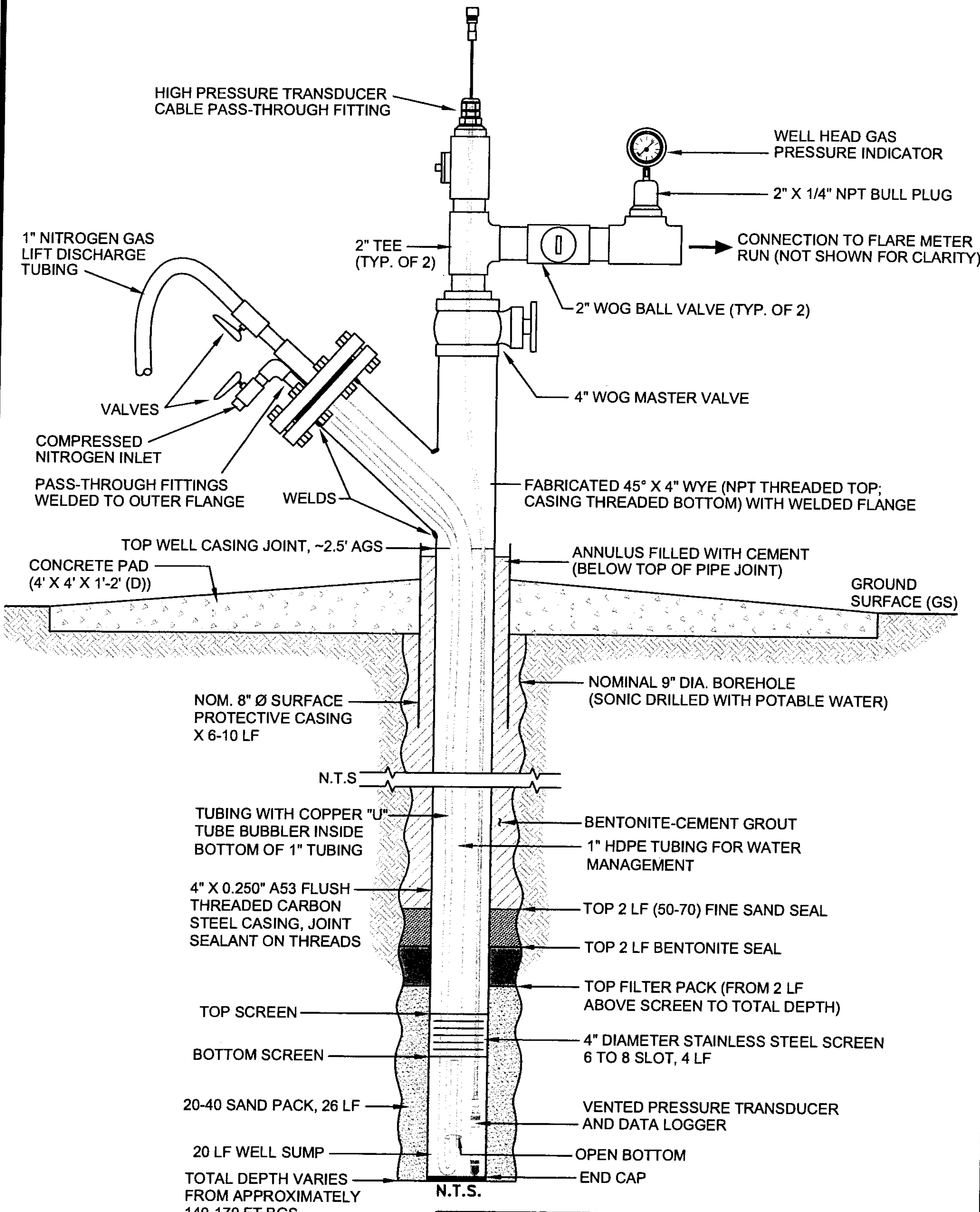
Well Development

Following well completion, the wells will be developed using the following guidelines:

- Development will not be initiated for a minimum of 24 hours after well construction to allow sufficient time for the well seal to cure.
- Development will consist of gentle surging of the screened interval using a surge block or a close fitting bailer, and a submersible pump.
- Temperature, specific conductance, pH, redox potential, and turbidity readings will be collected and recorded after the removal of each well volume.
- Surging and pumping will continue until the turbidity has decreased to 10 Nephelometric Turbidity Units (NTUs) or less, and field parameters have stabilized (less than 10 percent variance in specific conductance and pH, and less than 1 degree Celsius in temperature), or until a minimum of 10 casing volumes have been removed.

Well Operations

Each ORW will be connected to a flare using the same means and methods as established for the ORW program. The only operational difference will be the method of water management. Instead of using a submersible pneumatic pump inside tubing, watered-in wells will be purged using a simple nitrogen pump. This pump is composed of two HDPE pipes extending from the Wye under the master valve to near the bottom of the well where the smaller ½" tubing bends 180 degrees and is terminated approximately 3 feet inside the open bottom of the larger tubing. Compressed nitrogen is injected through the ½" tubing where this bubbling effect transports groundwater out of the casing entrained in the ascendant nitrogen gas flow. The design intent is to purge only enough water to lower the downhole pressure enough to promote gas movement into the well. Discharge water volumes will be measured to ensure the well in not fully dewatered. Discharged gas will be monitored for the presence of methane. All water purging will be temporarily stopped and the well shut-in in the unlikely event methane is detected in the gas stream.



TITLE: **ORW DESIGN, TYPE C**

LOCATION: **Napoleonville Salt Dome Project**
Bayou Corne, Louisiana

TETRA TECH

APPROVED	JT	FIGURE
DRAFTED	CP	1
PROJECT#	117-0504116	
DATE	7-2-13	

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Appendix 2.

Summary of Soil Samples Collected by TBC for Multiphase Analyses.

Table 1: Summary of Geotechnical Analyses from Select Soil Cores for Air/Water Capillary Pressure, van Genuchten Parameters and Gran Size Analyses, from Project Inception to Date.

Sample ID	Location	Date	Depth	Formation	Lab
GOW-5-2(129--130)	ORW-5 Cluster	4/16/13	129-130	MRAA	AAI
GOW-5-2(130--131)	ORW-5 Cluster	4/16/13	130-131	MRAA	PTS
GOW-5-2(131--132)	ORW-5 Cluster	4/16/13	131-132	MRAA	AAI
GOW-5-2(132--133)	ORW-5 Cluster	4/16/13	132-133	MRAA	PTS
GOW-5-2(136--137)	ORW-5 Cluster	4/16/13	136-137	MRAA	PTS
GOW-5-2(137--138)	ORW-5 Cluster	4/16/13	137-138	MRAA	AAI
ORW-5A(162-163)	ORW-5 Cluster	4/10/13	162-163	MRAA	AAI
GWOW-9-1(118-119)	ORW-9 Cluster	4/23/13	118-119	MRAA	PTS
GWOW-9-1(119-120)	ORW-9 Cluster	4/23/13	119-120	MRAA	PTS
GWOW-9-1(120-121)	ORW-9 Cluster	4/23/13	120-121	MRAA	AAI
GWOW-9-1(121-122)	ORW-9 Cluster	4/23/13	121-122	MRAA	AAI
GWOW-9-1(122-123)	ORW-9 Cluster	4/23/13	122-123	MRAA	AAI
GWOW-9-1(123-124)	ORW-9 Cluster	4/23/13	123-124	MRAA	AAI
GWOW-9-1(124-125)	ORW-9 Cluster	4/23/13	124-125	MRAA	AAI
GWOW-9-1(125-126)	ORW-9 Cluster	4/23/13	125-126	MRAA	AAI
GWOW-9-1(126-127)	ORW-9 Cluster	4/23/13	126-127	MRAA	AAI
GWOW-9-1(127-128)	ORW-9 Cluster	4/23/13	127-128	MRAA	PTS
GOW-9-5(113-114)	ORW-9 Cluster	5/09/13	113-114	Aquitard	PTS
GOW-9-5(115-116)	ORW-9 Cluster	5/09/13	115-116	Aquitard	AAI
GOW-9-5(117-118)	ORW-9 Cluster	5/09/13	117-118	Aquitard	PTS

Appendix 3.

Summary of Gas Pressure Data from CPT logs.

Appendix 3.
Summary of Gas Pressure Data from CPT Logs.

CPT Sounding	Depth to MRAA (ft, BGS)	Top of Gas Bearing Zone (ft, BGS)	Bottom of Gas Bearing Zone (ft, BGS)	Depth to Dissipation Point (ft, BGS)	Pressure at Dissipation Point (psi)	Hydrostatic Pressure 0 psi @ 5' BGS (psi)	Hydrostatic Pressure 0 psi @2' BGS (psi)	Comment	Stratigraphic Position
CPT-1	140			155.9	67.0	65.340	66.639	no gas	MRAA
CPT-2	130	101.0	101.8	101.2	47.8	41.655	42.954		above MRAA
CPT-2	130	130.6	131.1	130.0	55.2	54.125	55.424		MRAA
CPT-3	134	89.2	92.7	89.3	44.6	36.502	37.801		above MRAA
CPT-3	134	110.7	114.7	111.0	49.8	45.898	47.197		above MRAA
CPT-3	134	134.8	140.0	134.8	56.3	56.203	57.502		MRAA
CPT-4	142	143.3	144.2	143.3	62.0	59.884	61.183		MRAA
CPT-5	145	135.8	135.9	135.9	57.9	56.680	57.979		MRAA
CPT-6	127	78.1	79.5	78.7	36.8	31.912	33.211		above MRAA
CPT-6	127	124.9	125.2	125.0	54.5	51.960	53.259		above MRAA
CPT-7	129	20.3	23.2	23.0	9.7	7.794	9.093		above MRAA
CPT-7	129	100.5	102.2	101.1	44.6	41.611	42.910		above MRAA
CPT-7	129	130.2	131.0	130.5	54.2	54.342	55.641		MRAA
CPT-8		19.0	19.7	19.6	7.1	6.322	7.621		above MRAA
CPT-8		110.3	113.3	111.4	49.9	46.071	47.370		MRAA
CPT-9		34.1	35.4	34.2	15.0	12.644	13.943		cable broke- did not reach MRAA
CPT-10	124	17.4	18.5	18.2	7.6	5.716	7.015		above MRAA
CPT-10	124	107.7	110.3	107.7	50.2	44.469	45.768		above MRAA
CPT-10	124	124.0	125.7	124.1	52.8	51.570	52.869		MRAA
CPT-11	129	98.9	99.9	99.8	45.0	41.048	42.347		above MRAA
CPT-11	129	126.1	126.8	126.2	53.0	52.480	53.779		MRAA
CPT-12	127	118.9	119.1	119.0	53.0	49.362	50.661		above MRAA
CPT-12	127	127.8	127.9	127.8	55.0	53.172	54.471		MRAA
CPT-13	129			134.4	56.1	56.030	57.329	no gas	MRAA
CPT-14	132			132.3	57.0	55.121	56.420	no gas	MRAA
CPT-15				117.0	53.8	48.496	49.795	no gas	above MRAA ??
CPT-16	136	138.0	138.1	138.1	59.2	57.632	58.931		MRAA
CPT-17	124.5	121.1	122.0	121.1	53.2	50.271	51.570		MRAA
CPT-18	141	141.5	141.6	141.6	62.2	59.148	60.447		MRAA
CPT-19	127			128.3	55.4	53.389	54.688	no gas	MRAA
CPT-20	124.5			125.7	54.4	52.263	53.562	no gas	MRAA
CPT-21	131.5			133.5	57.7	55.641	56.940	no gas	MRAA
CPT-22	133.5	105.0	106.5	106.0	47.4	43.733	45.032		above MRAA
CPT-22	133.5	123.0	125.0	124.9	53.2	51.917	53.216		above MRAA
CPT-23				114.6	50.3	47.457	48.756	no gas	MRAA
CPT-26	132	37.0	38.9	38.8	15.7	14.635	15.934		above MRAA
CPT-26	132	118.4	120.0	118.5	53.3	49.146	50.445		above MRAA
CPT-26	132	130.6	131.4	131.5	55.4	54.775	56.074		above MRAA
CPT-27	131	132.5	132.7	132.5	54.2	55.208	56.507		MRAA
CPT-28	130	20.0	21.0	20.0	6.9	6.495	7.794		above MRAA
CPT-28	130	94.1	94.6	94.2	39.9	38.624	39.923		above MRAA
CPT-28	130	131.0	131.0	131.0	53.1	54.558	55.857		MRAA
CPT-29	131	62.0	62.6	62.3	28.5	24.811	26.110		above MRAA

Appendix 3.
Summary of Gas Pressure Data from CPT Logs.

CPT Sounding	Depth to MRAA (ft, BGS)	Top of Gas Bearing Zone (ft, BGS)	Bottom of Gas Bearing Zone (ft, BGS)	Depth to Dissipation Point (ft, BGS)	Pressure at Dissipation Point (psi)	Hydrostatic Pressure 0 psi @ 5' BGS (psi)	Hydrostatic Pressure 0 psi @2' BGS (psi)	Comment	Stratigraphic Position
CPT-29	131	131.6	132.1	132.1	54.2	55.034	56.333		MRAA
CPT-30				115.1	50.6	47.673	48.972	no gas	MRAA
CPT-32	122	98.9	99.3	99.0	44.4	40.702	42.001		above MRAA