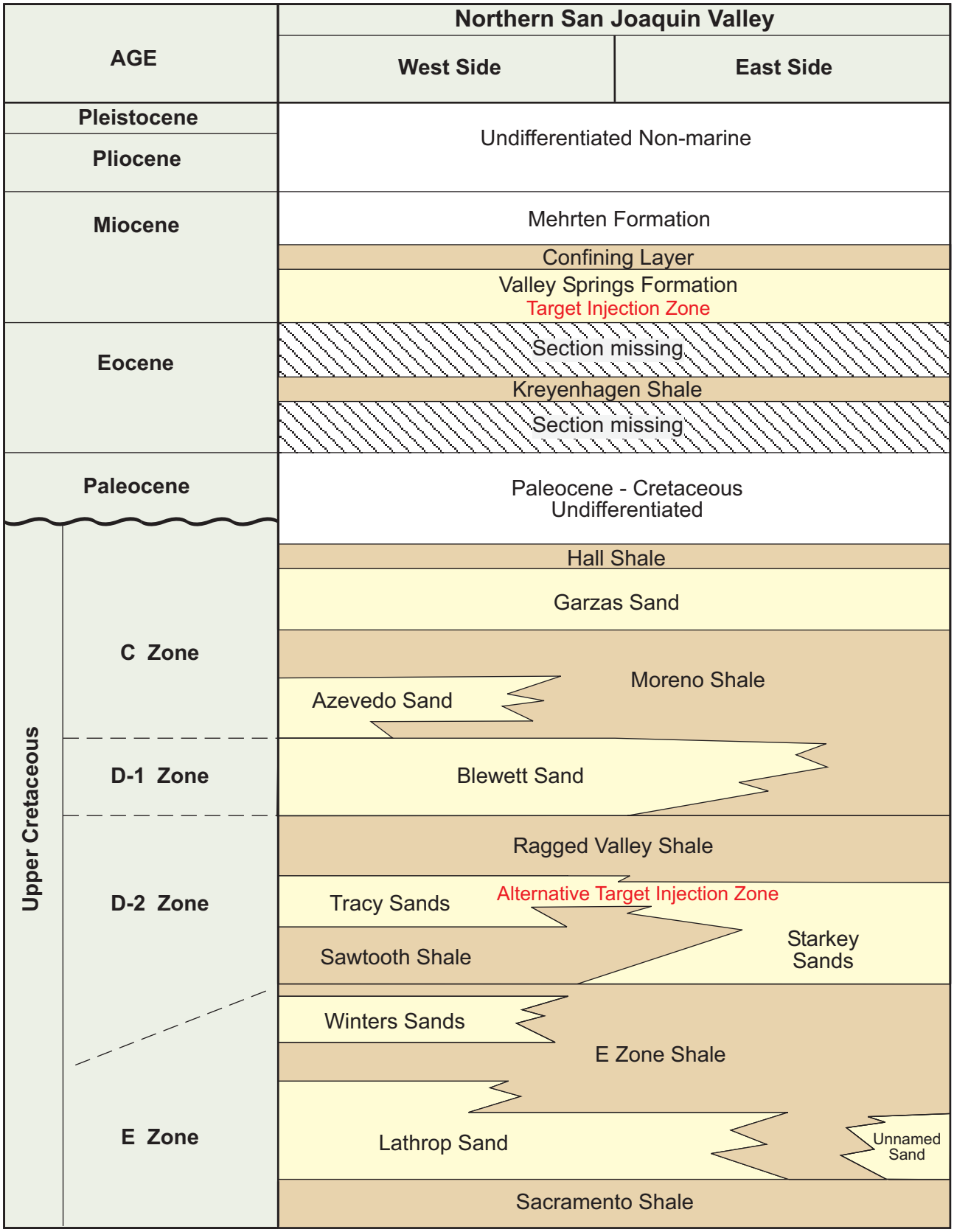


Source: Modified from W.F. Edmondson, et. al., 1964.

October 2005

TODD ENGINEERS
Emeryville, California

Figure 12
Stratigraphic Units of Northern San Joaquin Valley

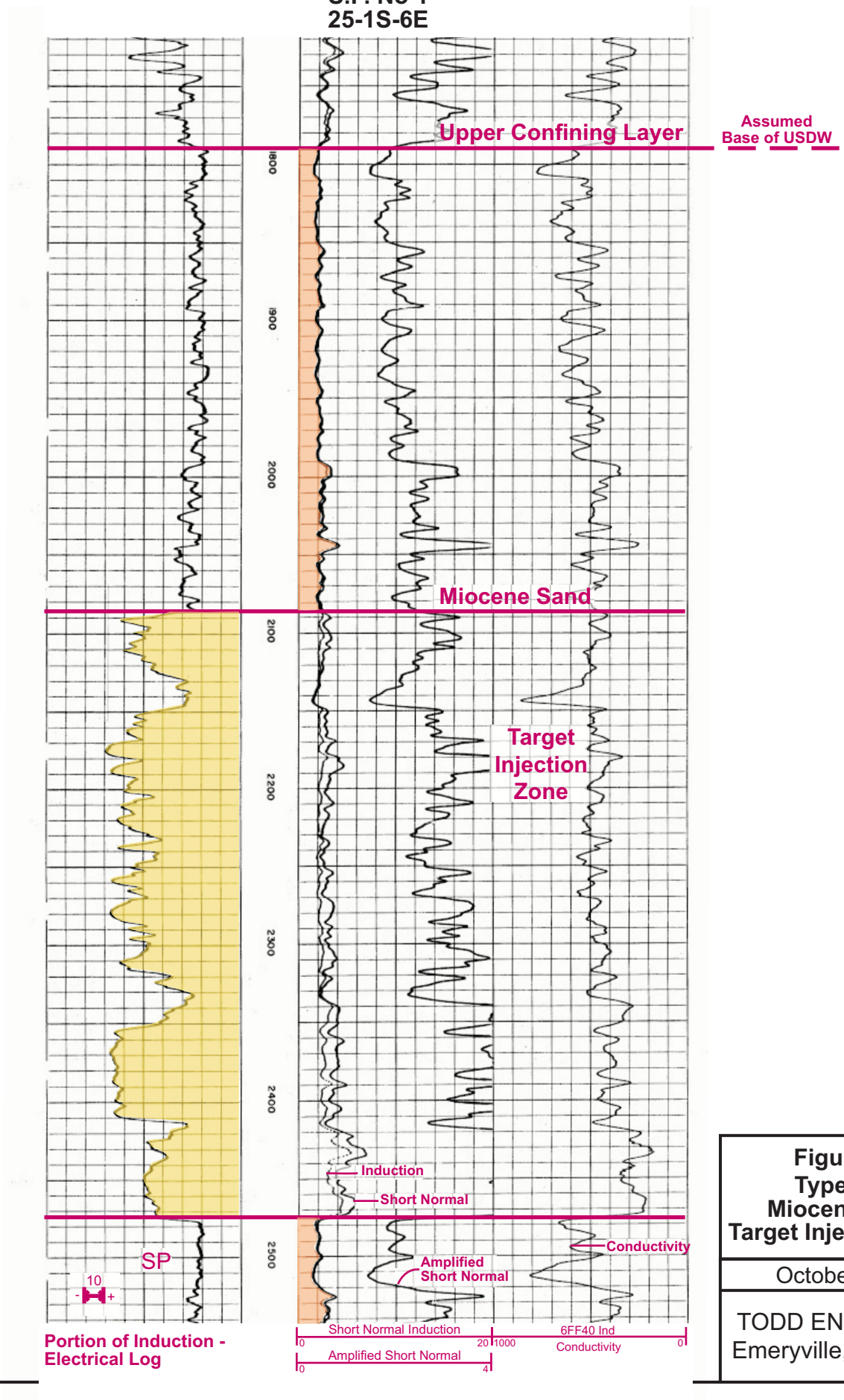


Figure 13
Type Log
Miocene Sand
Target Injection Zone

October 2005

TODD ENGINEERS
Emeryville, California

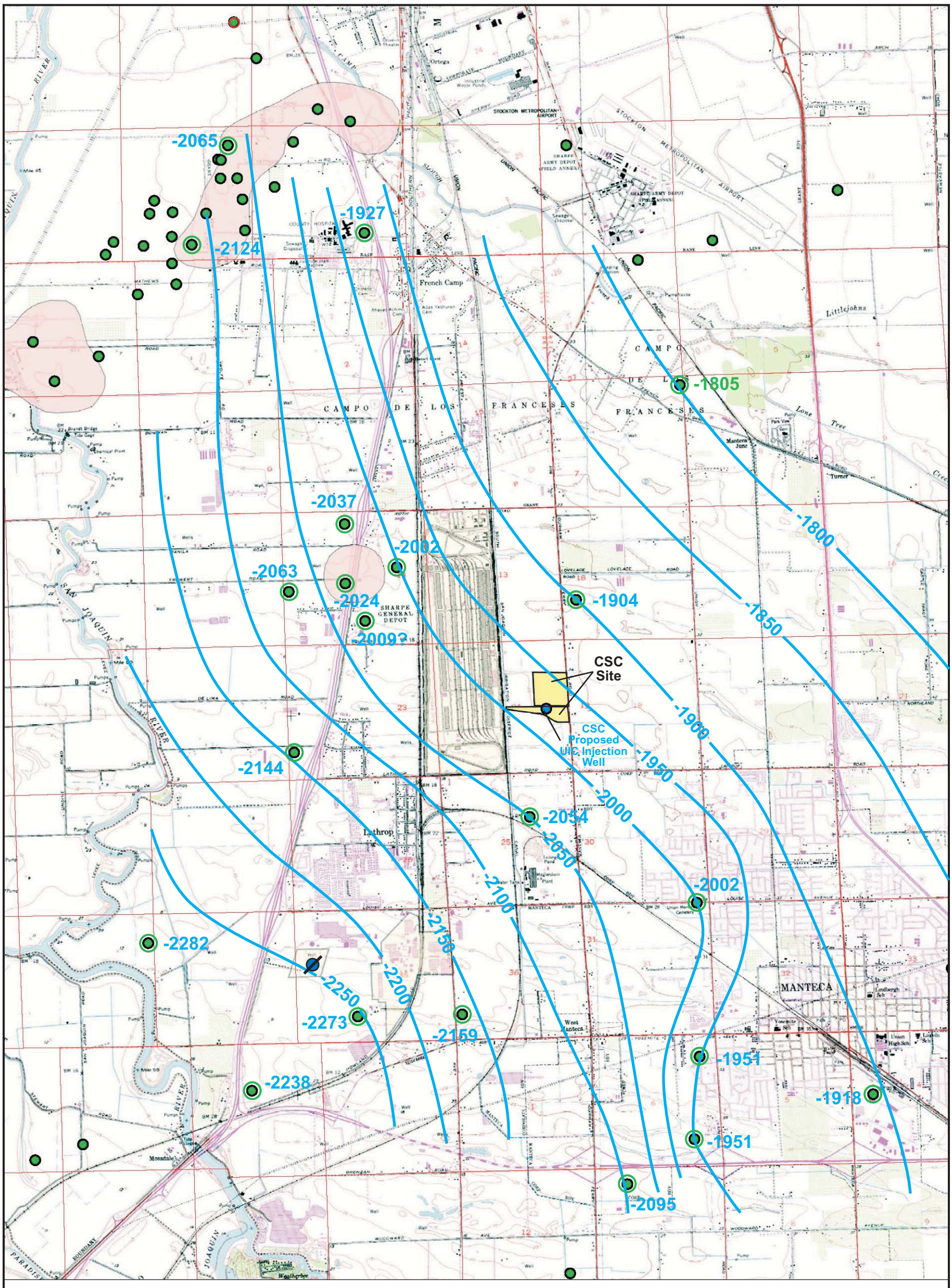
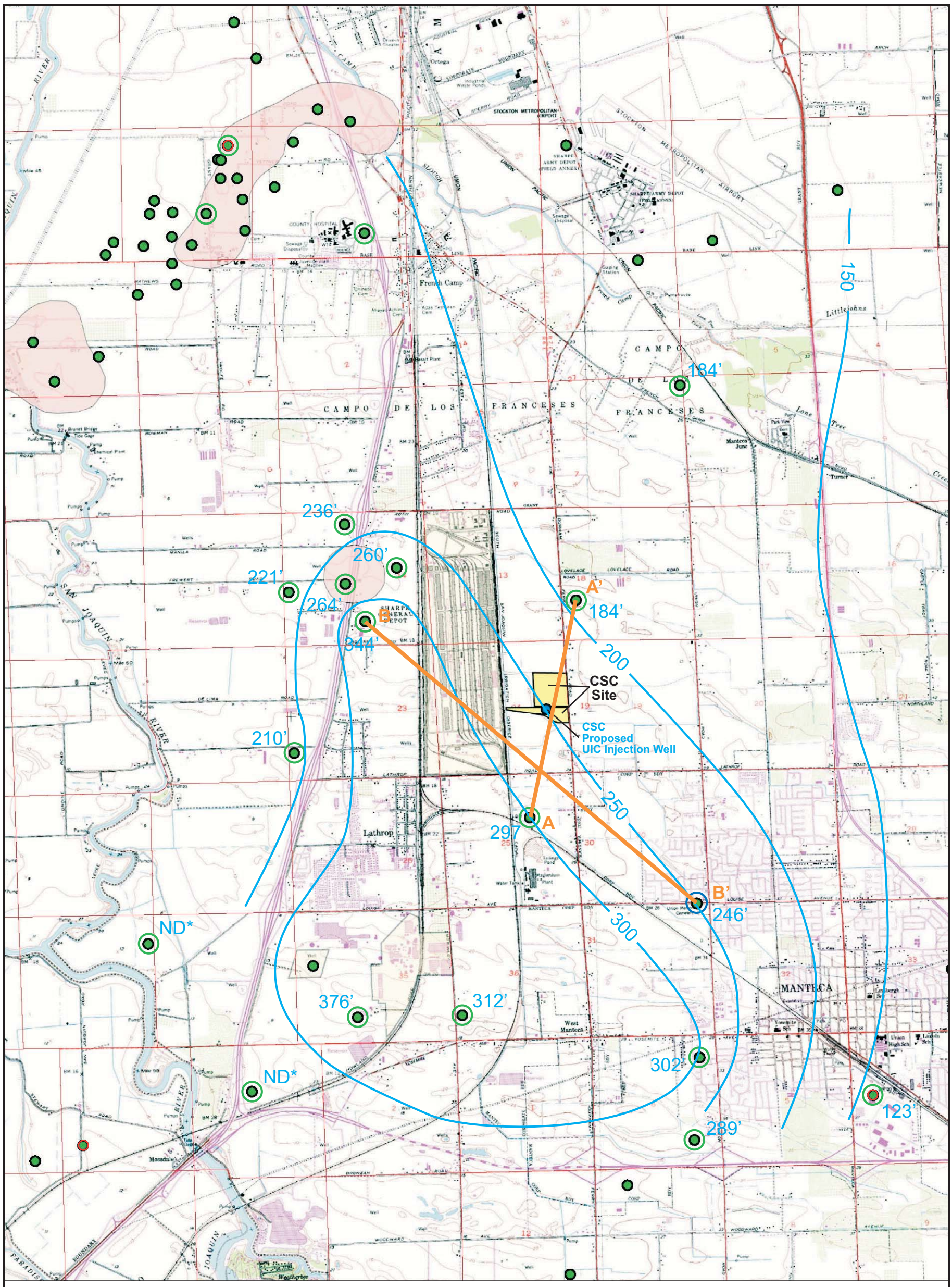


Figure 14
Structural Contour Map
Top of the Target Miocene Sand

October 2005

TODD ENGINEERS
Emeryville, California



LEGEND

- Deep Gas Exploratory Well
- Well used in regional mapping
- Proposed UIC Injection Well at CSC site
- Abandoned UIC Injection Well
- 376’ — Thickness of confining layer in exploratory gas well, feet
- 250 — Equal thickness of confining layer, feet
- ND* — Target sand package not developed Correlations are suspect
- A — A’ Cross Section

N

0 4,000

Scale in Feet

Figure 15
Isopach Map
Miocene Confining Layer

October 2005

TODD ENGINEERS
Emeryville, California

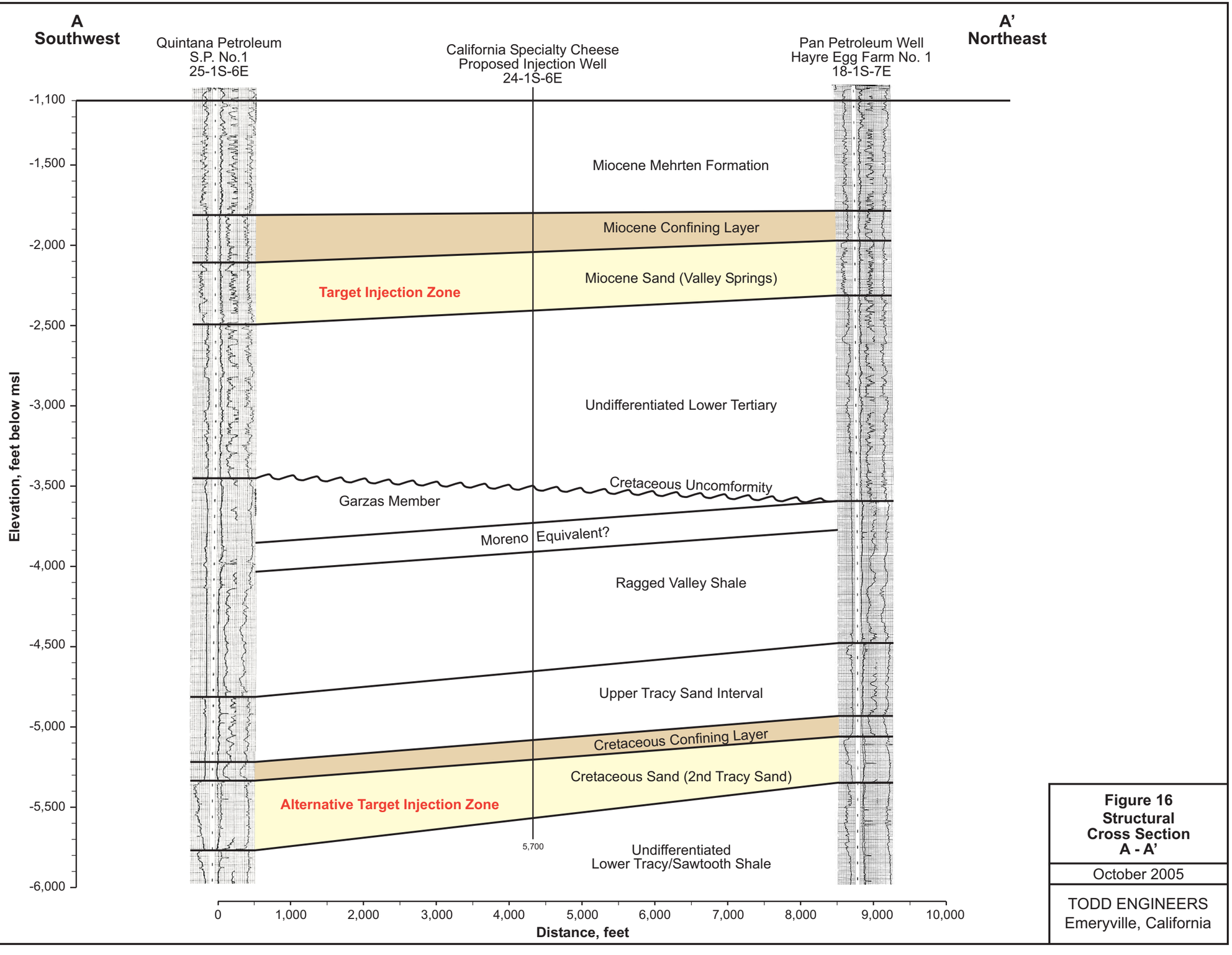


Figure 16
Structural Cross Section A - A'

October 2005

TODD ENGINEERS
Emeryville, California

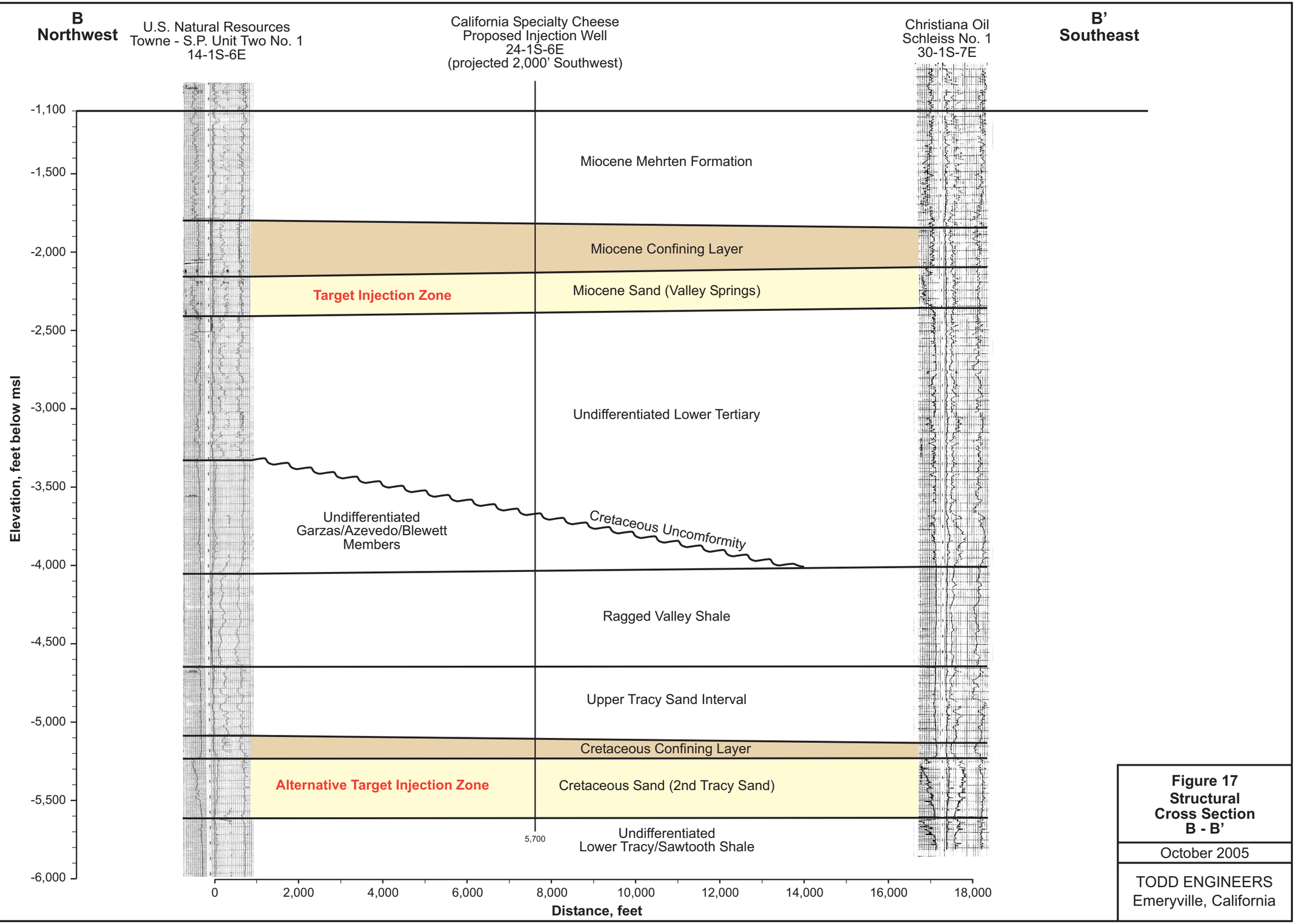
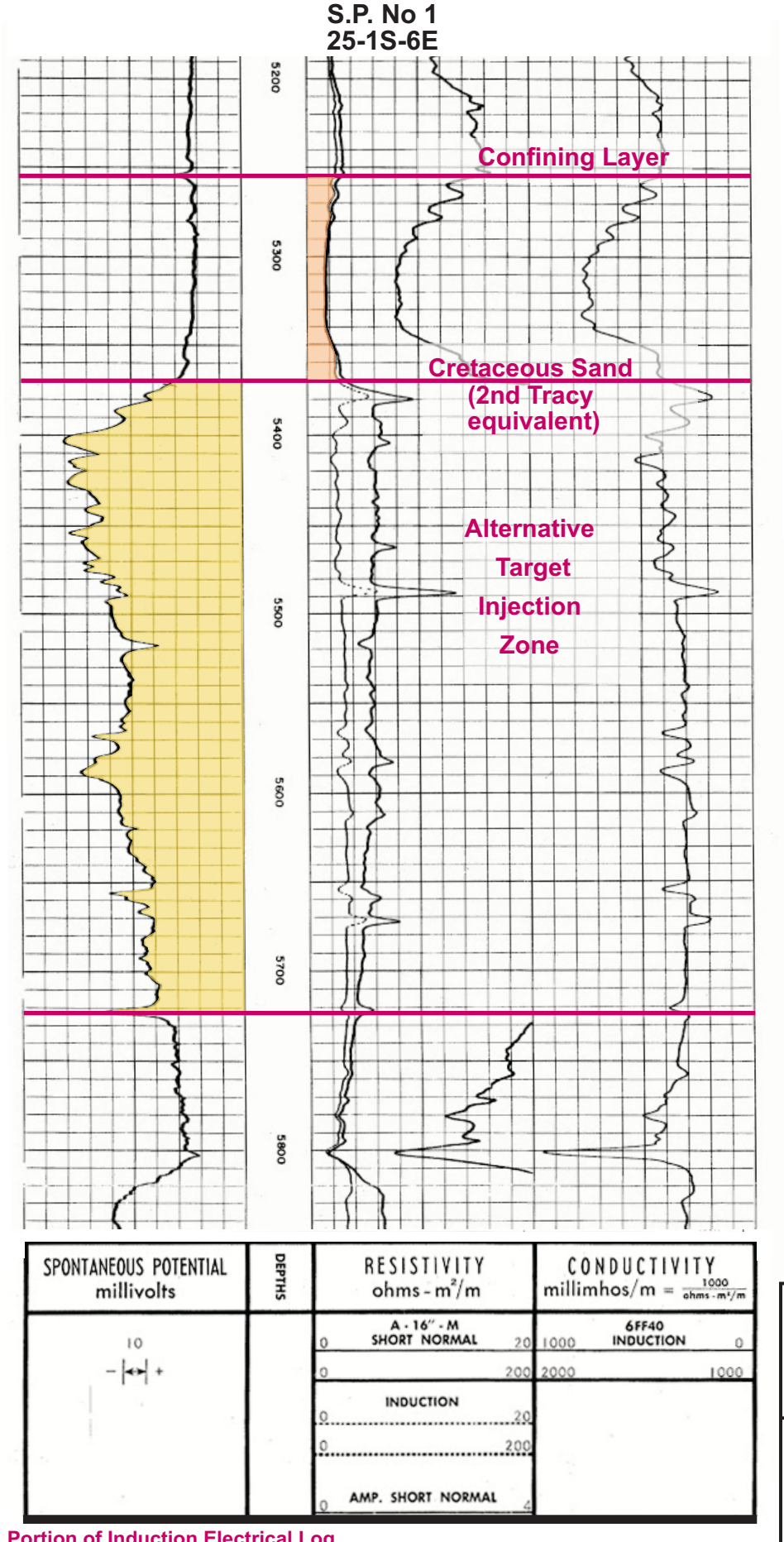


Figure 17
Structural Cross Section B - B'

October 2005

TODD ENGINEERS
Emeryville, California

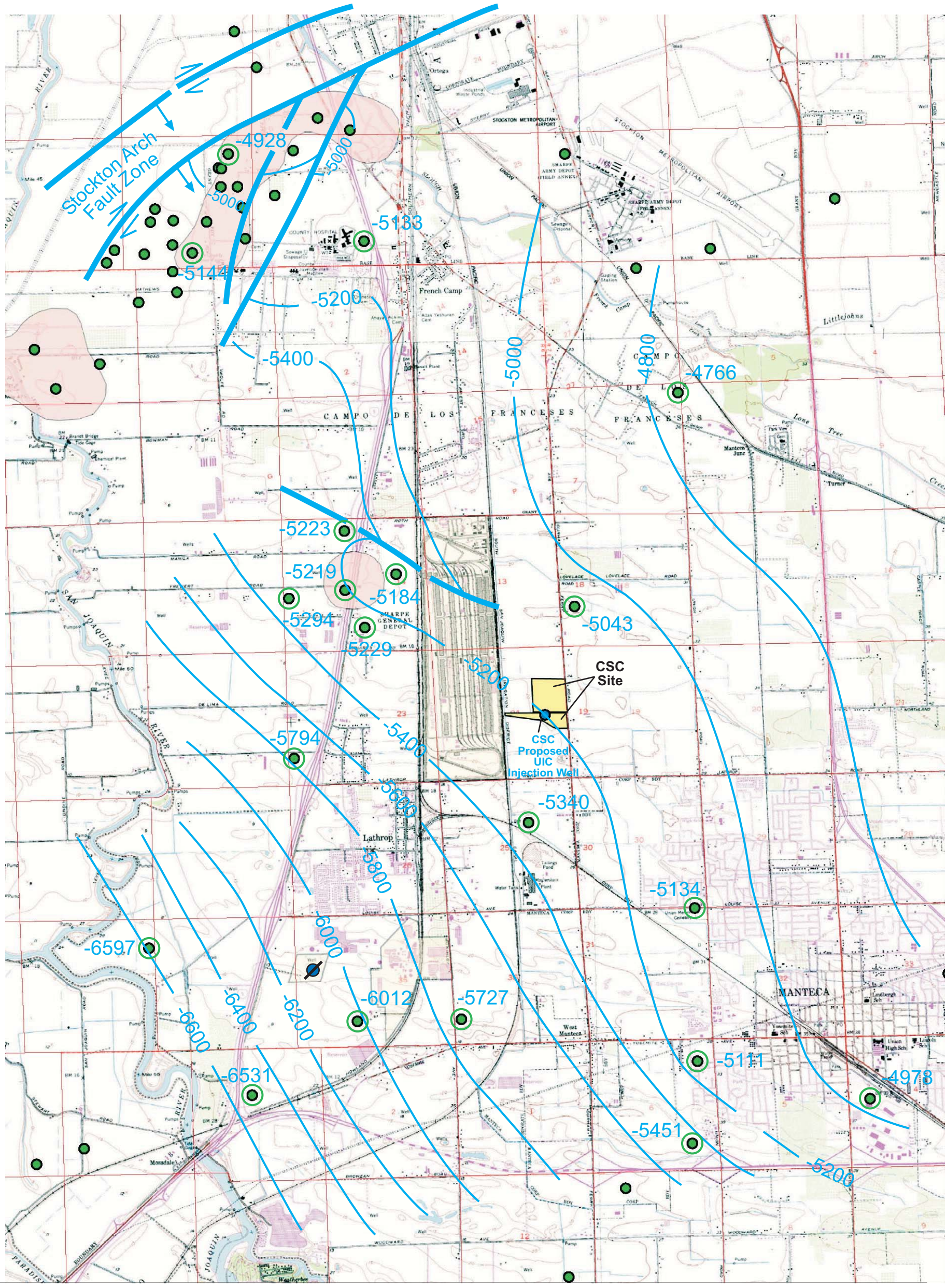


Portion of Induction Electrical Log

Figure 18
Type Log
Cretaceous Sand
Target Injection Zone

October 2005

TODD ENGINEERS
Emeryville, California



LEGEND

- Deep Gas Exploratory Well
- Well used in regional mapping
- Proposed UIC Injection Well at CSC site
- Abandoned UIC Injection Well
- -5219 — Top of 2nd Tracy Sand in gas exploratory well, feet below msl
- -5200 — Structural contour, top of 2nd Tracy Sand, feet below msl
- Fault (fault locations taken from CDOG, 1982)

Figure 19
Structural Contour Map
Top of Target Cretaceous Sand
(2nd Tracy Sand)

October 2005

TODD ENGINEERS
Emeryville, California

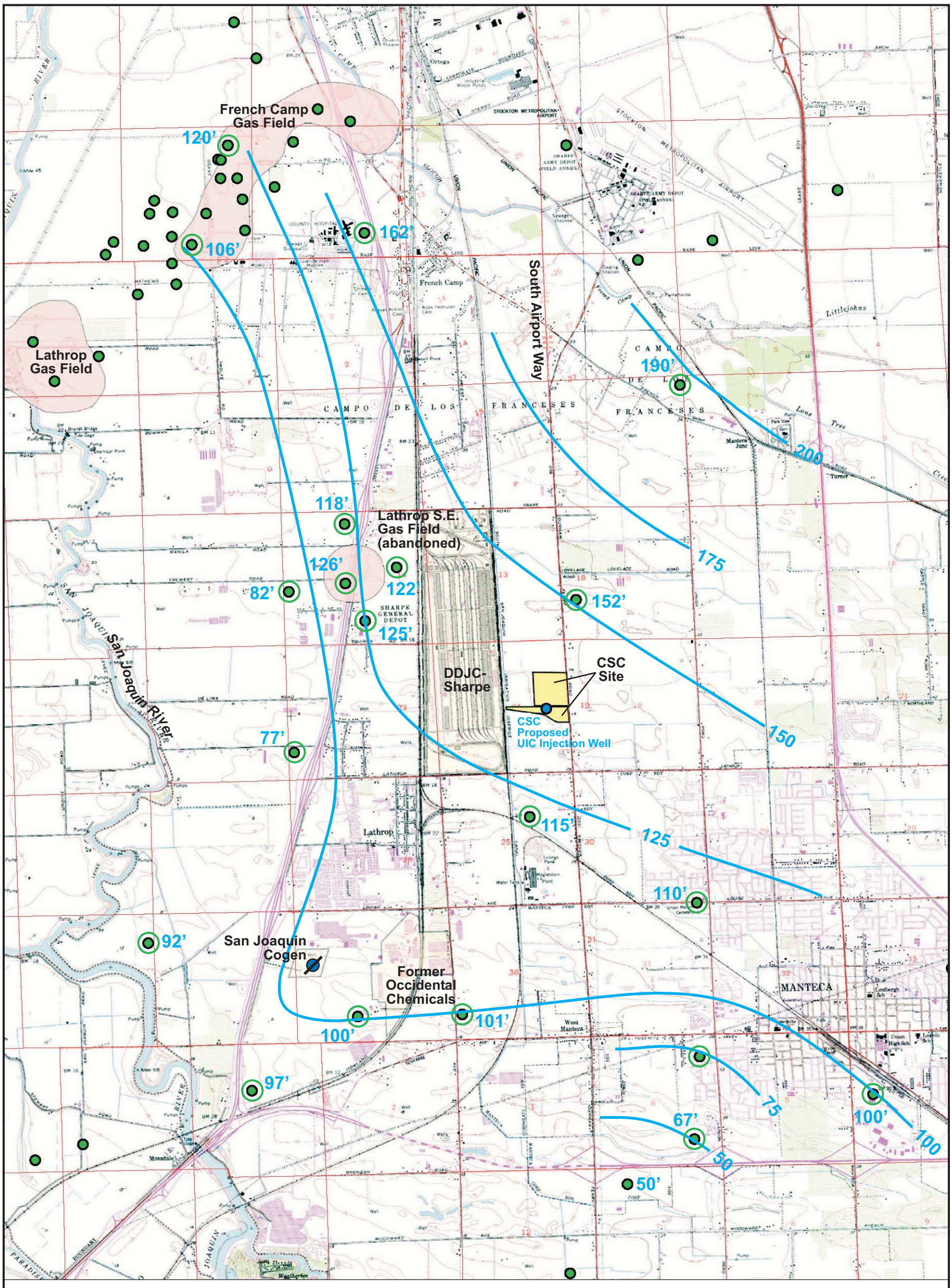
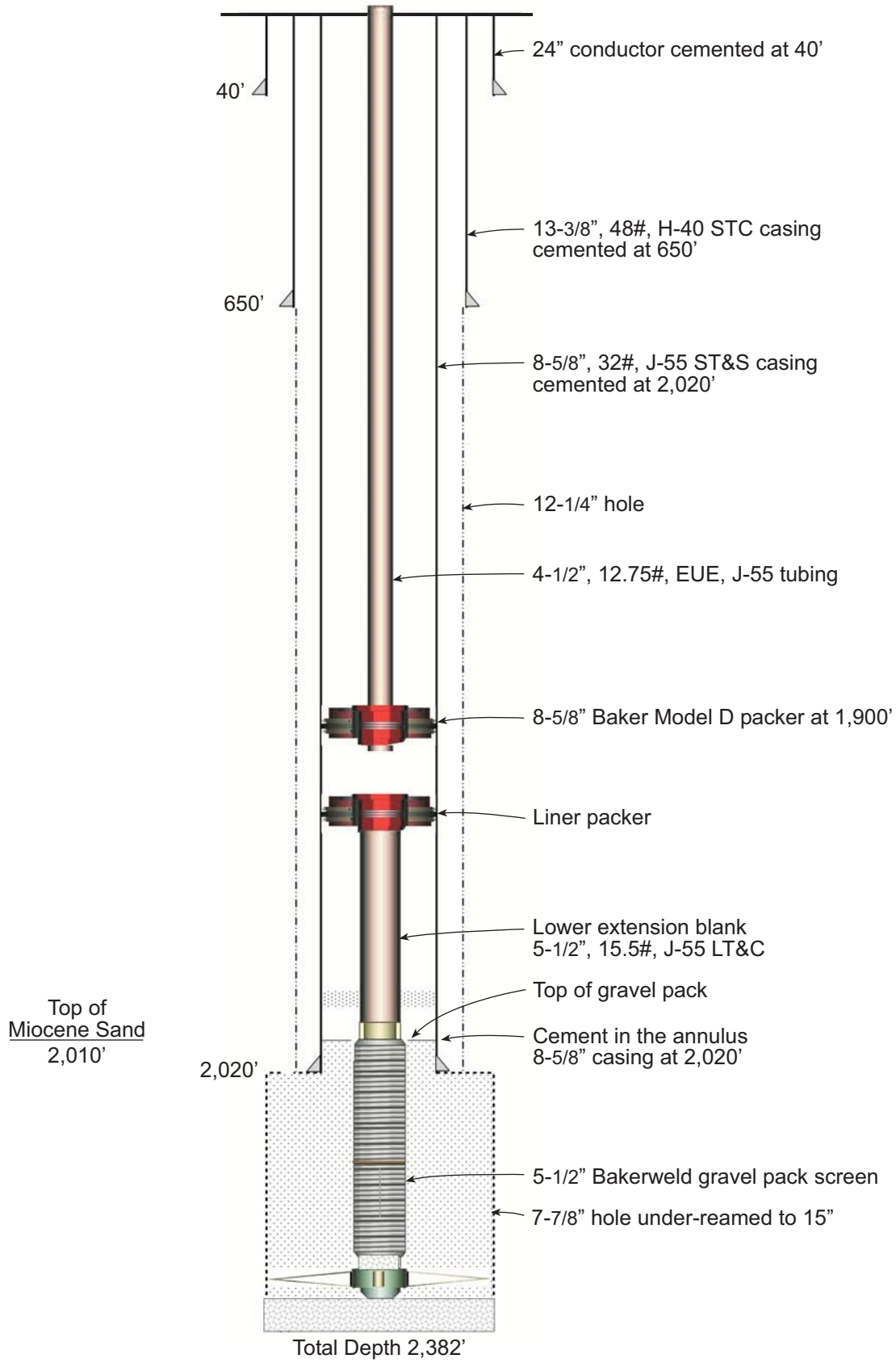


Figure 20
Isopach Map
Cretaceous Confining Layer

October 2005

TODD ENGINEERS
Emeryville, California

Proposed Miocene Injection Well



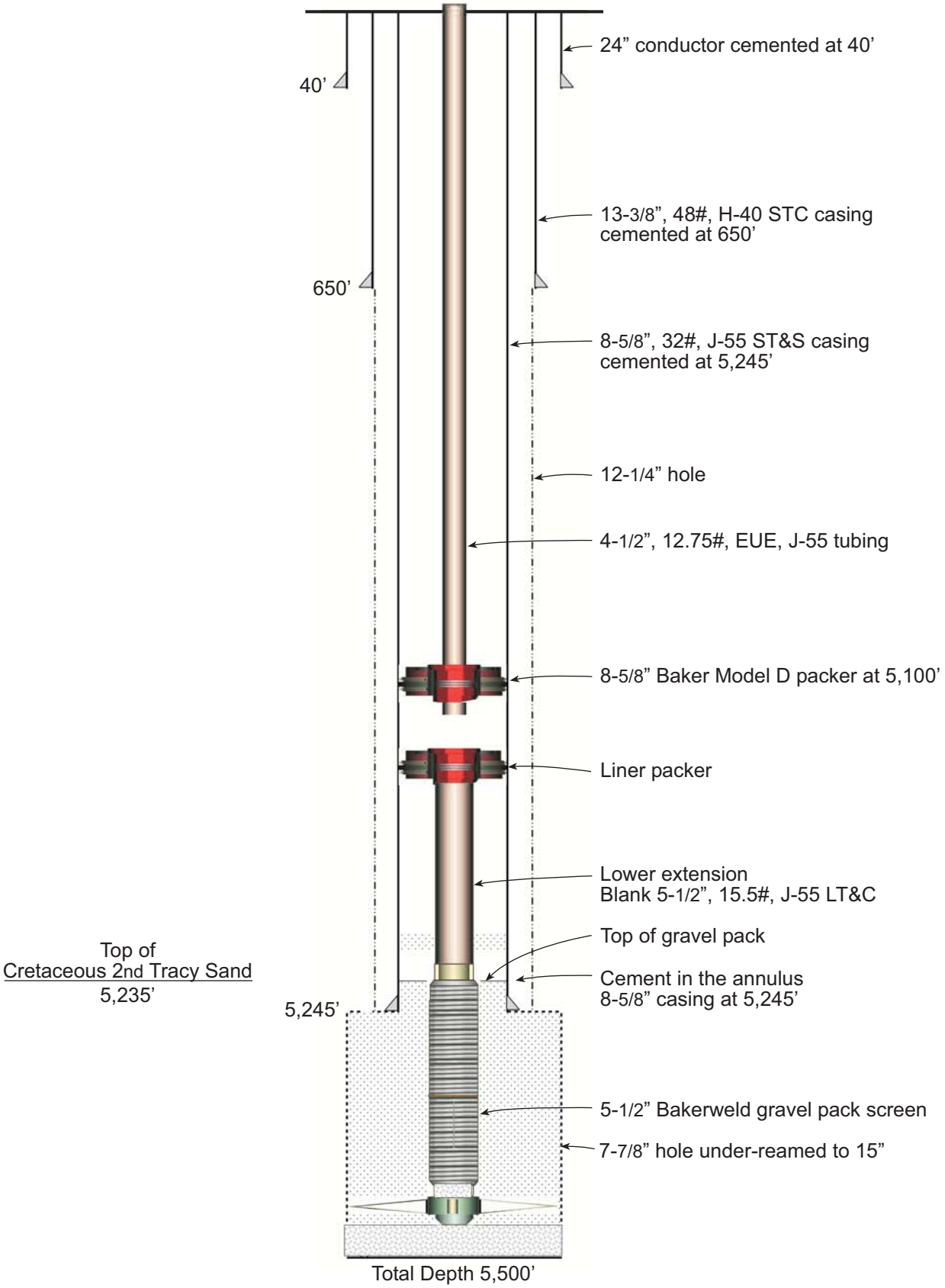
Note: All depths and equipment descriptions are approximate.

October 2005

TODD ENGINEERS
Emeryville, California

Figure 21
Proposed Miocene Injection Well Design

Proposed Cretaceous 2nd Tracv Iniection Well



Note: All depths and equipment descriptions are approximate.

October 2005	**Figure 22**
TODD ENGINEERS Emeryville, California	**Proposed Cretaceous Injection Well Design**

Chemours DeLisle Plant 2017
Section 4
Area of Review

CHEMOURS DELISLE PLANT

2017 HWDIR EXEMPTION PETITION REISSUANCE APPLICATION

SECTION 4.0 AREA OF REVIEW

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

Appendix 4-1 Artificial Penetration Protocol

Appendix 4-2 Records for Wells within the 2.0-Mile Radius Area of Review and the Extended Area of Review, Chemours DeLisle Plant

4.0 AREA OF REVIEW

4.1 SUMMARY

To demonstrate non-endangerment to underground sources of drinking water (USDW), the owner or operator of a Class I Hazardous waste well must locate, identify, and ascertain the condition of all wells (artificial penetrations) that penetrate the Injection Zone or Confining Zone within the injection well's Area of Review. The Area of Review is defined as not less than a fixed 2.0-mile radius around the injection wellbore, unless the Director specifies a larger Area of Review. This extended Area of Review may be based on the calculated Cone of Influence [EPA, 1988, 40 CFR 146.63]. The Cone of Influence is that area around the well within which increased Injection Zone pressures caused by injection into the injection well could be sufficient to drive fluids into an underground source of drinking water (USDW) [EPA, 1988, 40 CFR 146.61]. In this 2017 Hazardous Waste Disposal Injection Restrictions (HWDIR) Exemption Petition Reissuance, the minimum Area of Review is a 2.0-mile radius from the injection wells at the Chemours DeLisle Plant.

The predicted Cone of Influence was calculated (modeled) by using maximum facility injection rates through year-end 2050. Actual injection volumes and injection rates are used through year-end 2015, and maximum facility injection rates are used from the beginning of 2016 through year-end 2050 to provide an overly conservative estimate of pressure buildup and plume development within the injection interval. This conservatively calculated Cone of Influence (incremental 254 psi pressure isopleth) at the end of the projected injection period extends approximately 23,100 feet from the injection wells. This places the calculated Cone of Influence beyond the minimum 2.0-mile Area of Review boundary, thus resulting in an "Extended Area of Review" for this reissuance.

Five artificial penetrations are present within the 2.0-mile radius Area of Review for the DeLisle Plant. These wells are Monitor Well No. 1 and the 4 injection wells (Injection Well Nos. 2, 3, 4, and 5). Additionally, when drilled, Injection Wells No. 6 and No. 7 will also be located within the 2.0-mile radius Area of Review. Construction details for each of the wells are presented in Section 5.0. These artificial penetrations are evaluated according to the criteria outlined in

Artificial Penetration Protocol (Appendix 4-1). Each of the wells are found to meet the non-endangerment standard as they are properly constructed (see Section 5). These wells are constantly monitored and annually tested for integrity.

Based on the conservatively calculated Cone of Influence at year end 2050, there are three additional wells located within the 23,100 foot-radius Extended Area of Review. Of the three wells, only one qualifies as an artificial penetration (D-75) as it penetrates through the confining zone and the injection zone. The other wells (D-72 and D-74) do not penetrate either the top of the confining zone or the top of the injection zone. Therefore, these two wells (D-72 and D-74) are not artificial penetrations and do not need to be evaluated further. A review of the records for Artificial Penetration D-75 shows that it is properly plugged and abandoned to prevent the movement of fluid into the borehole and is protective of the overlying USDWs. Therefore, neither corrective action nor a corrective action plan as required in 40 §CFR 144.55 is needed for the site.

4.2 INTRODUCTION

The potential for vertical movement through breaches in geologic units is addressed in this 2017 HWDIR Exemption Petition Reissuance request. Natural breaches, such as faults and fractures near the injection site, are addressed in Section 2.0 – Site Geology. Man-made breaches in the form of abandoned boreholes and active wells are addressed in this section. The Area of Review evaluation assures that there will be no-migration of effluent and/or formation brine into an Underground Source of Drinking Water (USDW) (non-endangerment standard) or migration of effluent out of the injection zone (no-migration standard) through an artificial penetration.

Whenever effluent is injected into a subsurface geologic formation, the pressure within the formation will increase. This pressure increase will be greatest at the injection well(s), and will decrease with radial distance. Because of the driving force supplied by the increase in formation pressure within the injection sand, artificial penetrations within the radius of the effluent plume have the potential to convey effluent out of the injection zone, and artificial penetrations within the Area of Review have the potential to convey formation brines into a USDW. In an unplugged borehole, this driving force is opposed by the flow resistance of the material (drilling mud) residing in the borehole. Fluid movement cannot begin until the pressure in the injection zone has increased beyond the critical threshold value necessary to overcome the flow resistance of the borehole material. As long as the pressure buildup in the injection sand is less than the threshold value, the artificial penetration cannot serve as a conduit for effluent or formation brines. Therefore, the artificial penetration is safe, and corrective action to plug the well is not necessary.

After injection operations are completed, either temporarily or permanently, the pressure buildup within the injection sand will decrease to a value approaching the original formation pressure. This occurs rapidly, within a few years of cessation of injection. Upon pressure stabilization in the injection sand, the effluent plume will be in hydrostatic equilibrium with surrounding formation brines. Consequently, no driving force capable of conveying effluent or formation brines out of the injection zone will be present. Therefore, even if the resulting effluent plume, pushed by natural hydrogeologic or geochemical processes (acting over 10,000 years), encounters a mud-filled artificial penetration, the only process available to transport constituents

out of the injection zone is molecular diffusion (see Section 4.6).

An Artificial Penetration Protocol (Appendix 4-1) is used to identify, locate, and evaluate artificial penetrations within the Area of Review. A methodology for evaluating the construction or plugging of wells within the Area of Review is based on stringent rules for oil, gas, and geothermal operations. Wells that are known to have been plugged across the injection interval, obviously cannot provide pathways for migration from the injection zone or injection-induced movement of fluids into a USDW, and do not require detailed evaluation. Wells that are plugged across the lowermost USDW, or at some point between the injection interval and the lowermost USDW, cannot serve as pathways for injection-induced movement of fluids into a USDW, but are evaluated as potential pathways for migration from the injection zone. Wells not known to have been plugged in either manner are further evaluated to determine whether they can serve as potential pathways for migration from the injection zone or for injection-induced movement of fluids into a USDW.

4.3 DETERMINING OF THE AREA OF REVIEW

Under federal regulations, the Area of Review (pursuant to the non-endangerment standard) for a Class I injection well "shall be a 2.0-mile radius around the wellbore" [EPA 40 CFR 146.63, 53 Fed. Reg. 28149 (July 26, 1988)]. However, "the Director may specify a larger Area of Review based on the calculated *cone of influence* of the well" (emphasis added) [EPA 40 CFR 146.63, 53 Fed. Reg. 28149 (July 26, 1988)]. In addition, in the preamble to the HWDIR final rule, the EPA states:

> "the Agency is now specifying in today's rule, a fixed 2.0-mile minimum Area of Review. But in recognition that in some circumstances an Area of Review may be greater than two miles, the Director has the discretion to require a larger Area of Review. One such reason may be the cone of influence. [EPA 40 CFR 146.63 (preamble), 53 Fed. Reg. 28135 (July 26, 1988)]"

The "cone of influence" is defined in the HWDIR final rule as:

> "that area around the well within which increased injection zone pressures caused by injection into the hazardous effluent injection well would be sufficient to drive fluids into an underground source of drinking water. [EPA 40 CFR 146.61 (b), 53 Fed. Reg. 28148 (July 26, 1988)]"

It is apparent from the preamble language (see 53 Fed. Reg. at 28134 Col. 2) that the pressure increase of concern in the Area of Review determination is the pressure increment, over the preexisting static background conditions, resulting from the regulated (Class I injection) activity. The EPA indicated that for the vast majority of Class I well sites, the calculated "cone of influence" were expected to be substantially less than the fixed 2.0-mile radius for the Area of Review. The "cone of influence" concept was, therefore, developed specifically to preclude consideration of extraneous factors not resulting from the injection activity itself.

In the HWDIR final rule, the EPA states that they:

> "do not believe that a single calculation, or a set of calculations, describes the universe of acceptable methods for determining Area of Review. [EPA 40 CFR 146.63 (preamble), 53 Fed. Reg. 28135 (July 26, 1988)]"

In the preamble language, the EPA explicitly recognizes that several different methodologies for calculating the "cone of influence" may be developed and, therefore, they do not want to limit the "cone of influence" calculation to a single approach for all sites.

The methodology used for calculating the Cone of Influence at the Chemours DeLisle Plant was developed by DuPont. The basic underlying assumption in this approach is that, in the absence of naturally occurring, vertically transmissive conduits (faults and fractures) between the Injection Interval and any USDW, as is the case at the DeLisle Plant (Section 2.0), the only potential pathway between the Injection Zone and any USDW is through an artificial penetration (active or inactive). In order to pose a potential threat to a USDW (i.e., pressure buildup from injection sufficient to drive fluids into a USDW), the pressure increase in the Injection Zone would have to be greater than the pressure necessary to displace the material residing within the borehole. This pressure is defined as the “allowable pressure buildup”. Therefore, the Cone of Influence is the area within which Injection Zone pressures are greater than this allowable pressure buildup. The following discussion describes the steps used in conservatively calculating the allowable pressure buildup at Chemours DeLisle Plant.

4.3.1 Allowable Pressure Buildup for the Cone of Influence

4.3.1.1 Mud Weight

Barker (1981) was the first to document the development of the basic theoretical equation for calculating maximum allowable formation pressure at an abandoned borehole in terms of wellbore mud properties. The equation includes the effects of both weight and gel strength of the mud. Resistance to upward migration based on mud weight alone can be determined by examining the records of inactive artificial penetrations for their respective abandonment mud weights.

At the Chemours DeLisle Plant, site-specific drilling records from wells drilled throughout the local area support the application of a minimum 9.3 lb/gal mud weight in a wellbore. This mud weight (9.3 lb/gal) is recorded as the minimum mud weight used within the 2.0-mile Area of Review and in the offset oil and gas fields west of the Area of Review. Barker (1981) advocates

a similar method of determining the minimum mud weight in the Area of Review based upon well data in a particular area. Consequently, 9.3 lb/gal is used as one of the factors in determining allowable pressure buildup at Chemours DeLisle Plant.

4.3.1.2 Gel Strength

Drilling mud is largely composed of clays and water. Commonly, bentonite (sodium montmorillonite) is added to the drilling mud to obtain viscosity in the slurry, in addition to promoting the formation of wall cake (the low-permeability layer of clay lining the borehole). Bentonite is hydrophyllic (it readily absorbs water), and its flat platy shape is the primary reason it is desired for use in drilling fluids. Clay platelets aggregate (flocculate) in three ways: 1) face-to-face, 2) edge-to-edge, or 3) edge-to-face, because the platelets are electrically charged. This thixotropic or gelling property of a bentonite slurry is what gives drilling mud its gel strength.

The gel strength and wall cake of bentonite clay mud systems provide an effective barrier against both vertical fluid migration within the wellbore, and migration of fluids into overlying formations. The following subsections examine various aspects of mud plugs and their ability to effectively prevent migration of fluids.

The permeability of drilling mud in abandoned wells depends on the amount and size of the clay particles and other colloidals available in the slurry, as well as the time the mud has been left in the hole. Although the permeability of mud in deep boreholes has not been measured directly, the permeability of other similar clay mixtures, such as those used in slurry wall construction and bentonite grout slurry mixtures used to plug shallow borings, has been measured and quantified. Alther (1982), while investigating the use of bentonite for clay caps and slurry wall containment, found that a mixture of bentonite and high-permeability soils reduced the coefficient of permeability to 10^{-9} cm/sec. In his laboratory testing, Alther (1982) used a falling head permeameter to measure the permeability of a mixture of 8 percent bentonite and 92 percent Lake Michigan sand.

Polk and Gray (1984) investigated the adequacy of mud as a sealing agent in abandoned boreholes related to mineral exploration. Their focus was on the ability of a bentonite mud to

form a filter cake with a low enough permeability to ensure that there would not be fluid flow between aquifers penetrated during drilling. Polk and Gray (1984) directly measured filter cake permeabilities using the cake formed in a standard American Petroleum Institute (API) filter press filtration test run for 30 minutes at a differential pressure of 100 psi. The cake that formed on the filter paper was then tested with water to determine the cake's permeability. The cake had measured permeabilities ranging from 2×10^{-8} to 8×10^{-9} cm/sec, which are regarded as low enough permeability values to prevent fluid flow from one aquifer to another through an open borehole.

Because the EPA defines "low permeability" for soil as 1×10^{-7} cm/sec, the minimum required permeability of the 3 feet of compacted clay beneath a landfill or surface impoundment, then it is reasonable to believe that the permeability of a column or mud plug (1×10^{-7} cm/sec or less) is more than sufficient to prevent movement of fluids within an "open" unplugged well bore.

Many models assume that the top of the mud column is at, or very near, ground level for boreholes in the Gulf Coast area. This assumption is justified by documentation offered from several field examples cited below.

- In the Nora Schulze wellbore, reentered by K. E. Davis Associates during 1988, the top of the mud plug was encountered just below the 12 ft of cement at the top of the wellbore. Additionally, the well was plugged with 10.6 to 11.0 lb/gal mud when abandoned in 1959 (Pierce, 1989). Mud samples were taken upon reentry to approximately 754 ft. The average mud weight of the recovered samples was 11.1 lb/gal, and gel strengths of the samples ranged between 217 lb/100 ft^2 to greater than 320 lb/100 ft^2. These values are over an order of magnitude greater than the conservative 20 lb/100 ft^2 commonly used for modeling purposes (Pierce, 1989). In addition, shear strength of the mud samples ranged from 170 lb/100 ft^2 to 7,000 lb/100 ft^2, increasing with depth (Pierce, 1989).

- Subsurface, Inc. (1976) reentered and replugged the Brewster Bartle Drilling Company (British American Oil Production Company), University of Texas No. 1B (Galveston County, Texas) during 1976, at the request of Amoco and Monsanto. The

11,720-ft dry hole was abandoned with casing left in place to 11,200 ft. Cement plugs were placed from 11,000 to 11,200 ft, and from 130 to 180 ft, and also near the surface. Mud-laden fluid filled the remainder, conforming to Texas Railroad Commission plugging and abandonment requirements of 1961. During the reentry operation, drilling mud was found immediately below the surface cement plug with its properties relatively intact. A drill bit was run on tubing to 960 ft, after the upper cement plug was broken through. The well fluid was then circulated out using 12-lb/gal mud. This confirms that mud properties maintain their plugging capabilities and offer major resistance as fluid barriers.AIC (1988), in a study of well reentries originally plugged 20 to 30 years ago, found that in the Gulf Coast (Texas) and West Texas, most operators reported finding the top of the mud just below the surface plug. In the Gulf Coast, mud was generally hard, whereas in West Texas, the mud was soft.

The following comments reflect the condition of the drilling mud and/or borehole fluids encountered in the Gulf Coast:

- mud sets up like cement;
- mud sets up firm after about five years;
- mud encountered is hard and firm; and
- the top of the mud is usually just below the top cement plug

Even if cement plugs are present in the borehole, it is considered a more conservative approach to model a full column of mud because the resistance of the cement plug would be expected to be greater than the pressure exerted by the mud column. In addition, the system is closed because it is not possible to force significant quantities of mud into a permeable formation because of the effect of nearly impermeable residual mud cake that has formed on the formation wall. This mud cake acts as a skin or barrier to effectively seal off formations and prevent fluid loss from the mud to the formation or loss of fluid from the formation when the well was drilled.

Most drilling fluids are thixotropic, as they nearly always utilize clay as their colloidal base. Thixotropy is the characteristic whereby certain gels evolve to a solid state when allowed to

stand undisturbed, but liquefy upon shock disturbance (such as at start-up of the rig's mud pumps). In drilling fluids, thixotropy is caused by using clay minerals in the size range of colloidal particles (<0.00024 mm) as additives. They enhance the formation of the gel phase of the mud. This gel phase is desirable because it assists in suspending cuttings released by the drilling procedure, producing the required viscosity and mud cake properties. Gel structures build with time as the positive edge of one particle or plate moves toward the negatively-charged surface of another; that is, when the platelets are layered (Gray et al., 1980). This orientation significantly reduces the vertical permeability of the mud column because tortuosity is increased. Gel strength is a function of: 1) the amount and type of clays in suspension, 2) time, 3) temperature, and 4) mud additives (chemistry). The significance of mud gel strength is that it increases the pressure that is required prior to the onset of fluid migration in a borehole (Figure 4-2).

The long-term properties of mud can be determined from a theoretical standpoint. Mud weight should not vary significantly from that at abandonment because virtually all of the barite particles will remain in suspension due to mud gel strength. Pierce (1989) found that gravitational settling of barite or other mud additives has been overestimated. Even though settling of the largest cutting particles may occur, overall, this effect does not diminish mud density, or more importantly, affect the plugging and sealing characteristics of a column of mud in an abandoned borehole. The higher the gel strength of a mud column, the larger the particle that can remain in suspension. This essentially can be shown by analogy to a solid mechanics problem where a sphere is suspended in an elastic solid. Only when the maximum shear stress on the surface of the particle exceeds the gel strength of the mud will the particle settle out of the mud column. For barite particles, with a density of 4.2 grams per cubic centimeter (gm/cm^3), the critical diameter (in centimeters) for settling is approximately equal to the gel strength of the mud (in pounds per 100 square-feet ($lb/100\ feet^2$)) divided by 100. For a reasonable worst case gel strength of 20 $lb/100\ feet^2$, all barite particles smaller than 0.2 cm will remain in suspension. In a typical drilling mud, barite particles are generally an order of magnitude less than 0.2 cm in diameter (NL Baroid, 1988).

The relationship between gel strength and time varies with the mud type, depending on such variables as composition, pH, temperature, pressure, solids, and degree of flocculation. There are considered to be two types of gel: progressive and fragile. Progressive gels have a fairly low initial gel strength just after circulation is discontinued, but the strength consistently increases with time. This type of gel is present in "native" type drilling muds with a high solids content and is typical of wells drilled in the early part of this century. Fragile gels generally have a high initial gel strength that only increases slightly with time. This type of gel is only found in "treated" muds; *i.e.*, muds with an organic surfactant additive (typically lignites or lignosulfonates), which is added to peptize or deflocculate the clay particles. This type of inhibited mud is a fairly recent development, with the first thinning agents introduced in the 1930s (Gray et al., 1980).

Gel strength generally increases with time because of the electrical attraction of the clay platelets in the mud. Though it is difficult to quantify the gel strength of old muds, the gel strength is known to significantly increase with time in all cases (Davis, 1986). The time dependence of gel strength has been investigated by several authors. Garrison (1939) found that the gel strength of a montmorillonite-clay water system (California bentonite) could be empirically correlated with time. Although the exact relationship between gel strength and time varies, depending on mud composition, the gel strength always increases with time. Weintritt and Hughes (1965) measured the gel strength of field muds containing calcium sulfate and ferrochrome lignosulfonate for static periods, up to a day. They found that the data generally follow Garrison's empirical model for time periods of up to two hours; however, for longer time periods, Weintritt and Hughes (1965) found that the gel strength continues to increase at a rate in excess of what Garrison's empirical relationship would have predicted.

The pressure required to displace borehole mud can be large, and gel strength can be the main factor in preventing fluid migration within an abandoned wellbore (Collins, 1986; Collins 1989; Johnston and Knape, 1986; and Pearce, 1989b). Collins further states that in order to properly model abandoned boreholes, it is important to use ". . . realistic values for mud and hole properties," and that ". . . in most cases the contribution of the gel property (gel strength) to the

critical pressure increase required for fluid entry into the well may be more significant than previously thought."

For the purpose of calculating the pressure due to gel at Chemours DeLisle Plant, a conservative gel strength value of 20 lb/100 feet^2 is used. Grey and Darley (in Collins, 1986) determined that 20 lb/100 feet^2 is the lowest possible gel strength that could occur. Studies indicate that with time the gel strength of drilling mud may be more than an order of magnitude higher (Pierce, 1989).

Pressure due to gel strength for an open borehole is more conservative than for a cased borehole, and is calculated by the following formula (Davis, 1986):

$$Pg = \frac{0.00333 \times G \times h}{d}$$

Where:

Pg = pressure due to gel strength (psi)

G = gel strength (lb/100 feet^2)

d = borehole diameter (inches)

h = the shallowest depth within the 2.0-mile radius Area of Review of the top of the Washita-Fredericksburg injection interval, for the DeLisle Plant this is 9,520 feet)

And 0.00333 is the conversion factor such that Pg is in psi:

$$Pg = \frac{0.00333 \times 20 \times 9{,}520}{14.325} = 44 \text{psi}$$

The identical formula is used to calculate the pressure due to gel strength in the Tuscaloosa Massive Sand:

$$Pg = \frac{0.00333 \times G \times h}{d}$$

Where:

Pg = pressure due to gel strength (psi)

G = gel strength (lb/100 feet^2)

d = borehole diameter (inches)

h = the shallowest depth within the 2.0-mile radius Area of Review of the top of the injection interval, for the DeLisle Plant this is 9,150 feet)

And 0.00333 is the conversion factor such that Pg is in psi:

$$\text{Pg} = \frac{0.00333 \text{ x } 20 \text{ x } 9{,}150}{14.325} = 43 \text{ psi}$$

Collins and Kortum (1989) found that nonuniformities in hole diameter (borehole rugosity) may increase the pressure necessary to break the strength of the gel in a borehole by a factor of three to five over gel strength alone. This would add a significant margin of safety (132 to 220 psi) to the Cone of Influence and abandoned well modeling calculations.

4.3.1.3 Calculating the Allowable Pressure Buildup

The initial step in calculating the allowable pressure buildup (Cone of Influence) for the injection sands at the DeLisle Plant is to determine the original formation pressure gradient. The original formation pressure gradient of an injection sand is calculated by dividing the initial formation pressure by the depth at which the pressure was recorded. At the Chemours DeLisle Plant, the original formation pressure gradient for the Washita-Fredericksburg injection interval is

determined to be 0.462 psi/foot and the Tuscaloosa Massive Sand is determined to be 0.459 psi/foot (see Section 3.0).

Within the calculation, it is conservative to select the minimum below ground depth to the top of the Washita-Fredericksburg Injection Interval in the specified 2-mile radius Area of Review. The shallowest depth to the top of the Washita-Fredericksburg Injection Interval occurs along the north-northwest perimeter of the Area of Review (see Appendix 2-11 - Top of Washita-Fredericksburg Sand (Injection Interval) Structure Map). The depth to the top of the Washita-Fredericksburg Injection Interval is approximately 9,520 feet below ground level. The maximum pressure buildup is then calculated by subtracting the original formation pressure from a conservative 9.3 lb/gal mud column pressure, as demonstrated by the following:

0.052 x 9.3 lb/gal = 0.484 psi/foot	(mud column gradient, modified from Barker, 1981; 0.052 is a conversion factor)
0.484 psi/foot x 9,520 feet = 4,608 psi	(9,520 feet to the shallowest injection interval within the AOR x 0.484 psi/foot exerted by the mud column)
0.462 psi/foot x 9,520 feet = 4,398 psi	(original formation pressure gradient x depth to the shallowest top of the injection interval within the AOR)
4,608 psi – 4,398 psi + 44 psi = 254 psi	(mud column pressure minus original formation pressure, + pressure due to gel strength = allowable pressure buildup)

Therefore, an incremental pressure of 254 psi over the original pressure is the calculated allowable formation pressure buildup in the Washita-Fredericksburg injection interval sand prior to the onset of possible fluid movement in an artificial penetration.

The shallowest depth to the top of the Tuscaloosa Massive Sand occurs along the north-northwest perimeter of the Area of Review (see Appendix 2-10 - Top of Tuscaloosa Massive Sand Structure Map). The depth to the top of the Tuscaloosa Massive Sand is approximately 9,150 feet below ground level. The maximum pressure buildup is then calculated by subtracting

the original formation pressure from a conservative 9.3 lb/gal mud column pressure, as demonstrated by the following:

0.052 x 9.3 lb/gal = 0.484 psi/foot	(mud column gradient, modified from Barker, 1981; 0.052 is a conversion factor)
0.484 psi/foot x 9,150 feet = 4,429 psi	(9,150 feet is the shallowest Tuscaloosa Massive Sand depth within the AOR x 0.484 psi/foot exerted by the mud column)
0.459 psi/foot x 9,150 feet = 4,200 psi	(original formation pressure gradient x depth to the shallowest top of the Tuscaloosa Massive Sand within the AOR)
4,433 psi – 4,204 psi + 43 psi = 272 psi	(mud column pressure minus original formation pressure, + pressure due to gel strength = allowable pressure buildup)

Therefore, an incremental pressure of approximately 272 psi over the original pressure is the calculated allowable formation pressure buildup in the Tuscaloosa Massive Sand prior to the onset of possible fluid movement in an artificial penetration.

4.3.2 Determination of Cone of Influence

The conservative Cone of Influence calculation for this petition application is based on the worst-case scenario of 2,200 gallons per minute (gpm) maximum facility injection rate from the beginning of 2016 through year-end 2050. The Cone of Influence during the injection period extends approximately 23,100 feet from the injection wells (see Section 3.0). The Extended Search area is shown on the map included in Figure 4-1.

4.4 ARTIFICIAL PENETRATIONS IN THE EXTENDED AREA OF REVIEW

4.4.1 Record Search

A record search was initially conducted by Geosource, Incorporated in 1995 for wells drilled within a six-mile radius of the DeLisle injection wells (Appendix 4-2). A records check and update search was conducted by Geostock Sandia, LLC in preparation of this 2017 HWDIR Exemption Petition renewal application for the DeLisle Plant. This updated search was performed using the Mississippi Oil and Gas Board GIS (http://gis.ogb.state.ms.us/MSOGBOnline/) site and a search though records maintained by IHS Energy. An annual search is conducted by the DeLisle Plant through the Mississippi Oil and Gas Board, to satisfy requirements of the MDEQ UIC Permit MSI1001 Part 1 Section D Paragraph 4. All known artificial penetrations located in the 23,100 foot-radius Extended Area of Review have been identified through these searches. Information for all wells is presented in Table 4-1 and records for the wells are contained in Appendix 4-2. These searches focused on well records maintained on file with federal, state, and county agencies, and private log libraries.

Within the fixed 2.0-mile radius Area of Review, the only wells that penetrate the Injection Zone and/or the Confining Zone are the DeLisle Injection Well Nos. 2, 3, 4, and 5, and Monitor Well No. 1. Information on the DeLisle Plant wells and well schematics are contained in Section 5.0. Wells located outside of the 2.0-mile radius Area of Review but within the year-end 2050 Cone of Influence (Extended Area of Review) are also included on Table 4-1. Well data and schematics for these wells are included in Appendix 4-2.

4.4.2 Rock Type

The geologic strata above the Confining Zone consists of Tertiary deltaic sandstones and marine shales. Tertiary Gulf Coast shales are known to exhibit viscoelastic deformational behavior that causes natural fractures to close rapidly under the action of in situ compressive stresses (Aumman, 1966; Neuzil, 1986; Bowden and Curran, 1984; Collins, 1986). Evidence of this includes rapid borehole closure often encountered while drilling and running casing in oil and gas wells (Johnston and Knape, 1986; Clark et al., 1987). Furthermore, old abandoned boreholes have been observed to heal across shale sections to the extent that reentering them requires

drilling a new hole (Clark et al., 1987). Borehole closure by caving sands and swelling shales common in the Gulf Coast region is prevalent in the area, because of the unconsolidated nature of the shallow sedimentary section (Johnston and Greene, 1979; Davis, 1986; Johnston and Knape, 1986; Warner, 1988; Agency Information Consultants, 1987c). Therefore, discounting borehole closure results in a very conservative approach and adds a significant degree of safety in the criteria used to evaluate artificial penetrations.

Davis (1986) summarized the ability of shales to absorb water, a process that commonly results in desiccation and ultimate borehole blockage. Water wetting of shales causes instability, resulting primarily from overburden pressure, pore pressure, or tectonic stress. The hydration of the shales causes the platy nature of shale to become unstable and tend to flow in a plastic manner. Natural borehole closure mechanisms and shale "sloughing" can be directly attributable to adsorption of water by shale formations. As shales are buried with depth, more water is squeezed out of the platy sheets by overburden pressures, and the force present is equal to the matrix stress. As the formation is drilled, compacting force is relieved on the borehole face by the drill bit. Consequently, hydration force equal to the degree of relief develops. For example, in a normally pressured Gulf Coast shale at 10,000 feet deep, the shale hydration force in normal pore pressure is expected to be in excess of 5,000 psi.

4.4.3 Confining Zone and Injection Zone Penetration

All identified artificial penetrations (Monitor Well No. 1 and Injection Well Nos. 2, 3, 4, and 5) within the 2.0-mile radius Area of Review were drilled to a depth sufficient to penetrate the permitted Confining Zone and Injection Zone (8,000 feet).

Based on the conservatively calculated Cone of Influence at year-end 2050, there are an additional six wells located within this Extended Area of Review (see Figure 4-1). Well Nos. D-72, D-74, and D-100 do not penetrate the Confining Zone and are, therefore, not artificial penetrations. The remaining three wells (D-4, D-9, and D-75) are artificial penetrations as they penetrate the Injection Zone.

4.4.4 Evaluation of Wells

Wells are evaluated against the non-endangerment standard in accordance with the Artificial Penetration Protocol (Appendix 4-1). A well is properly plugged for non-endangerment if it was fully plugged across its diameter somewhere between the Injection Interval and lowermost USDW. In other cases, the theoretical possibility exists that fluid (formation brine or effluent) might move out of the injection zone and into a USDW, because of pressure increases resulting from injection operations. Once injection operations are completed, this risk is eliminated as formation pressures decrease back towards background.

Within the fixed 2.0-mile radius Area of Review, the only wells that penetrate the Injection Zone and/or the Confining Zone are the DeLisle Injection Well Nos. 2, 3, 4, and 5, and Monitor Well No. 1. Once drilled, DeLisle Injection Well No. 6 will also penetrate the Injection Zone and/or the Confining Zone. Information on the DeLisle Plant wells and well schematics are contained in Section 5.0. The injection wells and the monitor well casings were all cemented to surface upon installation. These injection wells are continuously monitored and are tested annually. These tests show that the injecate is contained within the Injection Zone. Therefore, these wells do not need further evaluation. The plugging program shows that the injection well(s) will be safe upon abandonment.

In the Extended Area of Review, Well Nos. D-72 and D-74 do not penetrate either the Confining Zone or the Injection Zone. Therefore, these two wells are not artificial penetrations and do not require further evaluation. The remaining well (D-75) is an artificial penetration as it penetrates both the Confining Zone and the Injection Zone. As an Artificial Penetration, this well is evaluated against the non-endangerment standard in accordance with the Artificial Penetration Protocol (Appendix 4-2).

Artificial Penetration D-75 is properly plugged with cement plug(s) between the Injection Zone top and the base of the lowermost USDW. Upon abandonment, a cement plug was placed in and out of the surface casing in the well, with surface casing set below the base of the lowermost USDW. Therefore, USDWs are protected and this well is safe as currently abandoned.

The well evaluation determined that no inter-formational fluid flow will occur in any of the artificial penetrations in the Extended Area of Review.

4.5 MODELING ARTIFICIAL PENETATIONS FOR NON-ENDANGERMENT

Improperly constructed/abandoned wells may require a model evaluation pursuant to the non-endangerment criteria outlined in the Artificial Penetration Protocol (Appendix 4-1) because either:

1. there are no cement plugs placed in the borehole above the uppermost injection interval;
2. the wells penetrate the Injection Interval and are potentially in pressure communication with the effluent wells;
3. the annular space of the outermost casing string across the injection interval is not cemented across the interval; or
4. the outermost casing string across the injection interval has not been perforated and squeeze-cemented, effectively sealing the annular space to potential vertical fluid movement.

A review of the records for the artificial penetrations shows that all wells within the 23,100-foot radius of the Extended Area of Review are safe as currently abandoned, with the exception of Map ID No. D-4. In Map ID No. D-4, the surface casing was set to a depth of 1,993 feet. A review of the open hole well log (Appendix 4-2) shows the presence of resistive water-bearing sands just below the base of the surface casing string. The base of the lowermost USDW is placed at a depth of 2,865 feet on the open hole well log. During abandonment, the lowermost cement plug was placed from 2,510 to 2,570 feet in the open hole and a shallower plug was set from 1,935 to 1,985 feet, in and out of the surface casing. Although the majority of USDWs are protected, the interval between the base of the deepest cement plug (2,570 feet) and the base of the lowermost USDW (2,865 feet) is potentially exposed in the open borehole. Therefore, this well is a potential problem well when evaluated against the Artificial Penetration Protocol (Appendix 4-1).

A two-step screening process, has been performed on Map ID No. D-4. In the event that a new well was drilled in the Extended Area of Review, the evaluation methodology would follow a similar process:

1. Total depth of penetration; and

2. Comparison of allowable pressure buildup at the well versus modeled pressure buildup.

A well requiring further review would be evaluated to see if it penetrates either the confining zone or the injection zone. Wells that do not penetrate the confining zone do not need further evaluation and they cannot be potential conduits for fluid movement. Additionally, the well would be screened to determine if it penetrates either the proposed Tuscaloosa Injection Interval or the Washita-Fredericksburg Injection Interval. If the well penetrates the confining zone, it would be an "Artificial Penetration". The second component of the depth of the penetration evaluates whether the well penetrates the injection interval(s) or any sand that could be in communication with the injection interval(s). Wells that do not penetrate the injection interval(s) or any sand in communication with the injection interval(s) are safe as currently abandoned as it cannot be a conduit for interformational fluid flow.

Map ID No. D-4 penetrates the Lower Cretaceous Unconformity that separates the Tuscaloosa Formation from the deeper Washita-Fredericksburg Group. However, the well only penetrates the first 40 feet of the upper Washita-Fredericksburg shale and is, therefore, about 70 feet short of penetrating the uppermost sand lobe in the Washita-Fredericksburg Injection Interval. Therefore, the well is not in communication with any of the active injection interval sands. This well is safe as currently abandoned as it cannot be a conduit for interformational fluid flow.

As an increased level of assurance, however, Map ID No. D-4 is also screened as if it were in communication with the Washita-Fredericksburg Injection Interval sandstones. The well is modeled by first comparing the predicted pressure increase from the DuPont Multilayer Pressure Model (Section 3.0) with the conservatively calculated allowable pressure buildup (static column pressure plus minimum gel strength) at the well, using well-specific information (mud weight, borehole diameter, sand depth, etc.). The relevant wellbore parameters are shown on Table 4-2. In cases where information is not available, conservative assumptions are made in the model calculations based on nearby drilling practices. The assumptions are summarized below:

- For purposes of calculating the pressure from the gel, in cases where the borehole diameter (bit size) across the Wastita-Fredericksburg Injection Interval is unknown, the bit size plus one inch is used.

- The contribution of flow resistance due to cement plugs being present in the wellbore and in the surface casing is completely discounted.
- The contribution of flow resistance due to borehole rugosity of the open wellbore is completely discounted.
- For purposes of calculating the pressure from the gel, a very conservative ultimate gel strength of 20 lb/100 feet^2 is used. This is conservative as studies and well reentries indicate that with time, the long-term gel strength of mud is at least an order of magnitude higher (Pierce, 1989).

The calculations used in the model screening analysis are presented below.

Static fluid column pressure is calculated using the equation:

$$P_s = 0.052 \times M \times h$$

where:

P_s = pressure of static mud column (psi)

h = depth to the injection reservoir (feet)

M = fluid weight (lb/gal)

The constant 0.052 converts mud weight in pounds per gallon to a pressure gradient value in psi per foot of depth. To be overly conservative, a fallback of 50 feet in the height of the mud column was assumed for the calculation of the static fluid column pressure.

In an artificial penetration filled with a column of drilling mud, the gel strength of the mud must also be considered. In this case, for upward fluid movement to begin, original formation pressure (P_f) plus the pressure due to injection (P_i) must be greater than the static fluid column pressure (P_s) plus the gel strength of the mud (P_g). As previously described, this relationship is based on a simple balance of forces (Davis, 1986):

$$P_f + P_i > P_s + P_g$$

where:

P_f = original formation pressure (psi)

P_i = formation pressure increase due to injection (psi)

P_s = static fluid column pressure (psi)

P_g = gel strength pressure (psi)

Therefore, pressure increase due to injection must be greater than static fluid column pressure minus original formation pressure:

$$P_i > P_s + P_g - P_f$$

The pressure due to gel strength (G) in an open borehole can be calculated from the following equation

$$P_g = \frac{0.00333 \text{ x } G \text{ x } h}{d}$$

where:

P_g = pressure due to gel strength (psi)

G = gel strength (lb/100 feet^2)

d = borehole diameter (in.)

h = depth to the injection reservoir (feet)

The conversion factor is 0.00333, such that P_g is in psi.

For a hypothetical open borehole, the added resistance due to gel strength for a mud with a very conservative ultimate gel strength of 20 lb/100 feet^2 in a 10-in. borehole is approximately 6.7 psi for every 1,000 feet of depth.

As the above calculations show, gel strength provides a significant additional resistance to fluid movement caused by injection. Additional conservatism is added by discounting borehole rugosity, which can increase the contribution in pressure from gel strength by a factor of three to five (Collins and Kortum, 1989).

Screening Calculation for the Washita-Fredericksburg Injection Interval:

If Map ID No. D-4 had been drilled deeper in depth, the top of the Washita-Fredericksburg Injection Interval is estimated to occur at a below ground depth of approximately 10,062 feet. The abandonment records show that this well was plugged and abandoned with 10.8 lb/gal drilling mud set between the cement plugs in the well. In order to be conservative in the screening computation, a fallback of 50 feet in the height of the static mud column is considered in performing the screening calculation of the static mud column pressure. Additionally, any additional resistance provided by the cement plugs set in the well are completely discounted. Therefore, the well is modeled as if it were a mud filled borehole with the mud column extending within 50 feet of the surface. The computation of the resistance due to the static mud column becomes:

$$P_s = 0.052 \text{ x } (h\text{-}50 \text{ feet}) \text{ x } M$$

or:

$$P_s = 0.052 \text{psi/feet x } (10{,}062 \text{ feet} - 50 \text{ feet}) \text{ x } 10.8 \text{ lbs/gal}$$

$$P_s = 5{,}623 \text{ psi}$$

The incremental allowable static column pressure buildup is equal to the static fluid column pressure of 5,623 psi minus the original formation pressure at the top of the Washita-Fredericksburg Injection Interval. The original formation pressure at the top of the Washita-Fredericksburg Injection Interval is calculated from the original formation pressure gradient. The reference original pressure at the reference depth for the Washita-Fredericksburg Sand is 4,555 psi at 9,850 feet, for a gradient of 0.464 psi/foot of depth. The original formation pressure is:

$$P_f = 0.4624 \text{ psi/feet x } 10{,}062 \text{ feet}$$

$$P_f = 4{,}653 \text{ psi}$$

Therefore, the incremental pressure increase is equal to:

$$P_A = P_s - P_f$$

where:

P_A = incremental allowable pressure of static mud column (psi)

P_s = static column pressure (psi)

P_f = original formation (psi)

or:

$$P_A = 5{,}623 \text{ psi} - 4{,}653 \text{ psi}$$

$$P_A = 970 \text{ psi}$$

Additionally, in an artificial penetration that is filled with a column of standard drilling mud, the gel strength of the mud must also be considered.

At the estimated depth of 10,062 feet for Map ID No. D-4, assuming an effective borehole diameter of 9-1/2-inches (actual bit diameter of 8-1/2 inches and using a 1-inch washout in the borehole), and a 50 foot fallback of the mud column from the surface, the added incremental resistance due to gel strength for a mud with a very conservative ultimate gel strength of 20 lb/100 feet[2] is:

$$P_g = \frac{0.00333x20x(10{,}062 - 50)}{9.50}$$

$$P_g = 70 \text{ psi}$$

The allowable incremental pressure buildup at Map ID No. D-4 is equal to the incremental static column pressure buildup (P_S) plus the added incremental resistance due to gel strength (P_g), or:

$$P_{Allow} = Ps + Pg$$

$$P_{Allow} = 970 \text{ psi} + 70 \text{ psi}$$

$$P_{Allow} = 1{,}040 \text{ psi}$$

Therefore, the minimum incremental allowable pressure buildup required, prior to potential initiation of fluid movement in Map ID No. D-4 is calculated to be 1,040 psi for the Washita-Fredericksburg Injection Interval.

Screening Calculation for the Tuscaloosa Massive Sand:

Map ID No. D-4 was drilled deep enough to completely penetrate the Tuscaloosa Massive Sand Injection Interval. The top of the injection interval occurs at a below ground depth of 9,672 feet. The abandonment records show that the well was abandoned with 10.8 lb/gal mud. In order to be conservative in the computation, a fallback of 50 feet in the height of the static mud column is assumed for the calculation of the static mud column pressure. Additionally, any additional resistance provided by the cement plugs in the well are completely discounted. Therefore, the well is modeled as if it were a mud filled borehole with the mud column extending within 50 feet of the surface. The computation of the resistance due to the static mud column becomes:

$$P_s = 0.052 \text{ x (h-50 feet) x M}$$

or:

$$P_s = 0.052 \text{ psi/feet x (9,672 feet - 50 feet) x 10.8 lbs/gal}$$

$$P_s = 5{,}404 \text{ psi}$$

The incremental allowable static column pressure buildup is equal to the static fluid column pressure of 5,404 psi minus the original formation pressure at the top of the Tuscaloosa Massive Sand Injection Interval, which is calculated from the original formation pressure gradient. The estimated original formation pressure used in the model is approximately 4,340 psig at a depth of 9,455 feet below ground level, or a formation pressure gradient of 0.459 psig/ft. The original formation pressure is:

$$P_f = 0.459 \text{ psi/ft x } 9{,}672 \text{ feet}$$

$$P_f = 4{,}439 \text{ psi}$$

Therefore, the incremental pressure increase is equal to:

$$P_A = P_s - P_f$$

where:

P_A = incremental allowable pressure of static mud column (psi)

P_s = static column pressure (psi)

P_f = original formation (psi)

or:

$$P_A = 5{,}404 \text{ psi} - 4{,}439 \text{ psi}$$

$$P_A = 965 \text{ psi}$$

Additionally, in an artificial penetration filled with a column of drilling mud, the gel strength of the mud must also be considered.

At the estimated depth for Map ID No. D-4 (9,672 feet), assuming an effective borehole diameter of 9-1/2-inches (actual bit diameter of 8-1/2 inches and a 1-inch washout), and a 50 foot fallback of the mud column from the surface, the added incremental resistance due to gel strength for a mud with a very conservative ultimate gel strength of 20 lb/100 feet[2] is:

$$P_g = \frac{0.00333x20x(9{,}672 - 50)}{9.50}$$

$$P_g = 67 \text{ psi}$$

Therefore, the allowable incremental pressure buildup at Map ID No. D-4 is equal to the incremental static column pressure buildup (P_S) plus the added incremental resistance due to gel strength (P_g), or:

$$P_{Allow} = Ps + Pg$$

$$P_{Allow} = 965 \text{ psi} + 67 \text{ psi}$$

$$P_{Allow} = 1{,}032 \text{ psi}$$

The minimum incremental allowable pressure buildup required, prior to potential initiation of fluid movement in Map ID No. D-4 is calculated to be 1,032 psi for the Tuscaloosa Massive Sand Injection Interval.

The calculated allowable pressures due to the static mud column in Map ID No. D-4 exceed the modeled pressure increases by a factor of four (Section 3.0). Therefore, even if the well was in direct pressure communication with the Washita-Fredericksburg Injection Interval and the Tuscaloosa Massive Sand Injection Interval, it is safe as currently abandoned.

4.6 NO-MIGRATION DEMONSTRATION--MOLECULAR DIFFUSION

If, over the 10,000-year time frame, a contaminant plume in the injection reservoir encounters preexisting boreholes, then any of these, which are open to the injection reservoir (or in communication with the injection reservoir), could provide a path for upward fluid movement. For the situation where the effluent stream is less dense than the borehole fluid, vertical movement of effluent could potentially occur by buoyancy or molecular diffusion.

Long-term plume simulations show that the modeled low-density and high density plumes may emerge from the 2.0-mile radius Area of Review and the Extended Area of Review (Figure 4-1). Low density plumes in the Washita-Fredericksburg Injection Interval and in the Tuscaloosa Injection Interval emerge from the Extended Area of Review to the northwest of the facility (Figure 4-1), extending out approximately 35,000 feet to the northwest of the injection wells. In addition to the injection wells and the monitor well, the low-density plumes may impact three artificial penetrations to the north-northwest of the facility (D-72, D-74, and D-75). Of these wells, only D-75 penetrates the Washita-Fredericksburg Injection Interval and in the Tuscaloosa Injection Interval. The other two wells do not penetrate the confining zone and cannot come into contact with the plume materials. High density plumes in the Washita-Fredericksburg Injection Interval and in the Tuscaloosa Injection Interval emerge from the Extended Area of Review to the southeast of the facility (Figure 4-1), extending out approximately 96,000 feet to the southeast of the injection wells. Two down-structure wells (D-4 and D-101) may come into contact with the dense plumes over the long term. Wells that are deep enough to penetrate the Washita-Fredericksburg Injection Interval and the Tuscaloosa Injection Interval, but are not properly plugged, with regards to no-migration, are screened as outlined in the Artificial Penetration Protocol (Appendix 4-1).

Since all of the wells within the long-term plume tracks have been evaluated and have been determined to be mud-laden at the time they were plugged, the potential for effluent to buoyantly rise through a mud-filled artificial penetration is minimal in the vicinity of the Chemours DeLisle Plant. The only process by which this could potentially occur is for the effluent to enter the borehole and displace the drilling mud, creating a situation where a lower-density fluid column (effluent) is present within the wellbore. However, this cannot occur in a mud-filled borehole

because the hydrostatic head of the mud column is *always* greater than the injection interval pressure. In this situation, effluent and/or formation fluid cannot even begin to enter a borehole; therefore, buoyancy-driven vertical flow of the effluent cannot occur. Factors that help prevent effluent from entering a mud-filled borehole are:

- Low-permeability, drilling-derived filter cake will be present along a mud-filled open borehole, providing a physical barrier and seal to fluids entering or exiting the borehole.
- Drilling muds are specifically designed so that the clay platelets and other components in the mud will not exit an open borehole into a formation, thus there is no process by which the mud would leave the borehole and be replaced by effluent fluid.
- Even if some mud that was in the proximity to the effluent plume were to leave the borehole by some process, the overbalanced mud column would immediately force new mud downward to replace it.
- Most of the wells in the long-term plume track are either cased or have cement and/or mud plugs in them, creating a closed system, and fluid entry into the wellbore would be prevented by the mechanical barrier of the well casing/cement, or by the inability of effluent fluid to "elevate" a cement plug in order to create space for the effluent fluid to enter the borehole.
- Natural wellbore, or borehole closure and sloughing processes will seal off any open boreholes to fluid flow.
- The gel strength and static fluid column pressure of the mud in an open mud-filled borehole will resist any influx of fluids from outside the borehole.
- In an open borehole, in cases where the pressure is highest due to elevated injection pressures, effluent will not enter the borehole. The downward force of the mud column will, in all cases, exceed the upward driving forces caused by injection.
- Buoyancy is a vertical force, with a minimal horizontal component due to the gently dipping beds in the vicinity of the Chemours DeLisle Plant. Unless the lighter density effluent could be emplaced into the borehole, there will be no significant driving vertical force exerted on the borehole mud column.

The net effect of the above factors is that a significant effluent-fluid-induced density contrast cannot occur in a mud-filled borehole, and thus, the creation of a buoyant fluid column pressure in a wellbore will not occur.

The above discussion describes a series of factors that would prevent effluent or formation fluid from entering a wellbore and creating a buoyancy situation. The only other process whereby the effluent or formation fluid could enter a borehole would be on a molecular level with molecules of formation fluid or effluent constituents being substituted for molecules of borehole fluid. However, this would not result in a significant change in the resultant borehole fluid density.

A static mud-filled borehole (using conventional mud systems) contains a colloidal suspension of microscopic-sized clay, barite, and other particles in water, which has been set up to form a gel. Clay particles in this structure are immobilized mechanically by electrostatic forces. Specifically, the positively charged edges of the clay platelets align with the negatively charged flat surfaces of the adjacent platelets. It is the electrostatic attraction of the clay particles that gives the mud its gel strength and also prevents the clay and other particles from settling out in the mud. Clay particles cannot diffuse out of the borehole because their dimensions are much greater than those of molecules. The ability of drilling mud to carry particles in suspension, even when static, is a key property of mud. Without sufficient gel strength, mud would not be able to effectively remove excess solids, and the solids would drop to the bottom of the borehole. Since the density of mud is primarily a function of the suspended particles, immobilization of these particles by electrostatic forces prevents any potential loss in mud column density resulting from interaction between the effluent and the mud.

Water is a component of both drilling mud and the injected effluent fluid. Since water is a polar molecule, it will interact electrostatically with clay particles in the mud by hydrogen bonding. This will tend to immobilize water molecules with the gel structure of the mud and keep them from leaving. However, even if the water molecules could diffuse out of the mud, each departing molecule would be replaced by a readily available counter-diffusing molecule from the effluent fluid. Because the vast majority of the injected effluent is composed of water, the overall result would be no net gain or loss of water molecules into or out of the mud in the wellbore.

Therefore, the diffusional interaction of water molecules between the effluent fluid and the drilling mud would, at worst, result in no net density change for the mud. Therefore, density contrasts sufficient to create a driving force in the borehole will not occur.

In addition, since effluent constituent molecules are typically heavier than water molecules, if contaminant molecules in the effluent were to diffuse into the drilling mud, this would produce an increase in mud density, not a decrease. However, the amount of potential density increase would typically be insignificant, because of the low concentration of the contaminant species in the effluent.

In conclusion, the binding gel structure of drilling mud prevents clay and weighting agents from migrating out of the mud. Since these particles cannot leave the mud because of the electrostatic bonding forces, the portion of the mud column in contact with the effluent plume cannot become more buoyant than the native mud. Water within the mud can interchange with water in the effluent fluid; however, this will only occur on a one-for-one basis, resulting in no net density change. Although contaminant species within the effluent could minutely diffuse into the mud column, no net density change can occur (diffusion of the contaminant species in the effluent stream in considered below). Therefore, buoyancy-driven flow of the effluent stream into a wellbore cannot occur. Since it can be demonstrated that all of the wells within the 10,000-year effluent plume track are mud-filled, the wells are safe with regard to buoyancy.

The physical characteristics that make drilling muds useful during drilling also make them moderately effective barriers against molecular diffusion (though not as effective as geologically deposited clays). This is particularly true of a commonly used base for mud, bentonite, which is predominantly sodium montmorillonite clay. The platy, electrically charged clay particles comprising bentonite attract water, a polar molecule. This causes the clay to swell, thereby increasing the borehole fluid viscosity. Of the clays, montmorillonite has the greatest hydration potential and effects the greatest viscosity enhancement for a given amount of solids. This accounts for its long-standing popularity as an additive.

A second important property, the gel strength of clay-based drilling muds, comes from the tendency of the plate-like clay particles to align so that positively charged edges are adjacent to

negatively charged flat surfaces. If the mud is agitated, then the gel breaks down. If, on the other hand, the mud sits at rest, then gel strength increases with time, as the additional clay particles come into alignment. If the drilling fluid is at rest for some time, high pump pressures are sometimes necessary to restore circulation in the borehole, to the extent that the fluid may be forced into weak or fractured formations.

Thus, in the case of a borehole abandoned for some time, it is likely that the mud originally used during drilling has set to form a gel with a substantial gel strength. The gel is "a disheveled yet interconnected network of parallel clay particles separated by an average distance" (Jahnke, 1987). Since gel strength results from a preferential alignment of clay particles, the borehole fluid will possess a low Geometric Correction Factor (G) for molecular diffusion. This is because G is equal to the reciprocal of the tortuosity factor, which is a measure of the extra path length that diffusing molecules must follow in the pores of the mud, and the tortuosity in materials with platy structures is generally high.

Numerical values of quantities related to the G have been measured for specific samples of clays by several researchers, and these results are adopted as indicative. Nye (1979) referred to the measurements of Cremers (1968) on four clays (a Wyoming bentonite, a montmorillonite, and two kaolinites). This work shows that the electrical formation factor, which is related to the G, is strongly dependent upon porosity; for Wyoming bentonite, G varies as porosity raised to the 12.6 power. This means that a 9.0-lb/gal mud, which has a porosity of 95 percent, has a G of $(0.95)^{12.6} = 0.52$.

In another study, Jahnke (1987) diffused tritium in montmorillonite clay gels. Neutral tritium was used since it is not subject to sorption and thus gives a true measure of the geometric effect of tortuosity (Jahnke and Radke, 1987). By fitting the effective diffusion coefficient to the experimental data, he determined tortuosity factors from 2.7 to 3.2. The former value was associated with a mud of 13.6 weight percent of solids, which corresponds to 9.0-lb/gal mud. Since G is the reciprocal of the tortuosity factor, this mud had a G of 0.37.

In the DeLisle area, mud weights employed are generally equal to or exceed 9.3 lb/gal. Heavier muds have lower porosities and higher Geometric Correction Factors (G). Therefore, using 9.0 lb/gal mud (G = 0.5) is overly conservative.

In 10,000 years, molecular diffusion of the contaminant constituents injected at the Chemours DeLisle Plant will not exceed the values shown in Table 4-3 within a mud-filled borehole. These distances are the vertical thicknesses of a conservative mud weight (9.0 lb/gal) required to reduce the concentrations of the constituents to less than health-based standard levels. These distances are overestimates, because the constituents cannot begin diffusing into the borehole until the plume reaches the borehole. Additionally, the actual borehole fluid in the wells, within the 10,000-year waste plume track, is always heavier than the modeled 9.0 lb/gal mud (in a 10.2 lb/gal mud, the diffusion distances would be approximately one-half that shown in Table 4-3).

Since the distance from the injection interval to the top of the injection zone is greater than the very conservative estimate of the maximum 10,000-year diffusion distance for the most mobile constituent, there will be no migration of effluent out of the injection zone by the process of molecular diffusion. Therefore, no corrective action is necessary for the wells in the long-term plume track.

REFERENCES

Agency Information Consultants, (AIC), 1987c, Survey of proper plugging hearings for fluid migration from unplugged or improperly plugged wells in the Texas Railroad Commission Districts 02, 03, 04, 07B, 07C, and 09: Prepared for DuPont: Austin, Texas.

Agency Information Consultants, Inc., 1988, Mud conditions of re-entered wells: Prepared for E. I. du Pont de Nemours.

Alther, G. R., 1982, The role of bentonite in soil sealing applications: Association of Engineering Geologists Bulletin, v. 19, no. 4, p. 401-409.

Aumman, H. H., 1966, Experimental study of the effect of stress on the creep in shales: Exxon Production Research Report, (private communication to R. E. Collins, DuPont consultant).

Barker, S. E., 1981, Determining the Area of Review for Industrial Waste Disposal Wells, master's thesis, The University of Texas at Austin, Austin, Texas [0110853].

Bowden, R. K. and Curran, J. H., 1984, Time dependent behavior of joints in shale: Proc. 25th Symposium of Rock Mechanics, Northwestern University, Evanston, Illinois, published by American Institute of Mechanical Engineers, New York, New York, pp. 320 328.

Clark, J. E., Howard, M. R., and Sparks, D. K., 1987, Factors that can cause abandoned wells to leak as verified by case histories from Class II injection, Texas Railroad Commission Files: International Symposium on Subsurface Injection of Oil Field Brines, Underground Injection Practices Council, New Orleans, Louisiana, pp. 166 223.

Collins, R. E., 1986, Technical Basis for Area of Review, an engineering study prepared for Chemical Manufacturers Association: CMA Reference Number 80-160-000-4 [0110859].

Collins, R. E., 1989, Drilling mud as a hydraulic seal in abandoned wellbores. Presented at the Underground Injection Practice Council's semi-annual meeting, February 29, 1989, San Antonio, Texas.

Collins, R. E., and D. Kortum, 1989, Drilling mud as a hydraulic seal in abandoned wellbores: Underground Injection Practices Council, 1989 Winter Meeting, San Antonio, Texas.

Cremers, A., 1968 D. Sc. Thesis, University of Louvain, Belgium.

Davis, K. E., 1986, Factors affecting the area of review for hazardous waste disposal wells in Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes: Dublin, Ohio, National Water Well Association, 148-194.

Garrison, A. D., 1939, Surface chemistry of clays and shales: Petroleum Transactions of AIME, V. 132, 191-203.

Gray, G. R., H. C. H. Darley, and W. F. Rogers, 1980, Composition and Properties of Oil Well Drilling Fluids: Houston, Gulf Publishing Company.

Gray, G. R., and H. C. H. Darley, cited in R. F. Collins, 1986, Technical basis for area of review: prepared for Chemical Manufacturers Association, reference 80-160-000-4 [0110859].

Jahnke, F. M., 1987, Diffusion of ion-exchanging electrolytes in montmorillonite gels: Ph.D. Dissertation, University of California, Berkeley.

Jahnke, F. M. and Radke, C. J., 1987, Electrolyte diffusion in compacted montmorillonite engineered barriers: *in* Coupled Processes Associated with Nuclear Effluent Repositories, ed. by C. F. Tsang, Academic Press, Orlando.

Johnston, O. C. and Greene, C. J., 1979, Investigation of artificial penetrations in the vicinity of subsurface disposal wells, Technical Report: Texas Department of Water Resources.

Johnston, O. C., and B. K. Knape, 1986, Pressure Effects of the Static Mud Column in Abandoned Wells, Texas Water Commission LP 86-06 [0110880].

NL Baroid, 1988, Particle size distribution curve for standard API calibration barite sample (letter from Mark F. Warnack).

Neuzil, C. E., 1986, Groundwater flow in low permeability environments: Water Resources, v. 22, n. 8, pp. 1163-1195

Nye, P. H., 1979, Diffusion of ions and uncharged solutes in soils and soil clays: Advances in Agronomy, v. 31, pp. 225-272.

Pierce, M. S., 1989, Long-term properties of clay, water-based drilling fluids: Proceedings of the International Symposium on Class I & II Injection Well Technology, Dallas, Texas, Underground Injection Practices Council Research Foundation, pp. 115-132.

Pearce, M. S., 1989b, Test results for the Nora Schulze Well No. 2. Memo to DuPont.

Polk, G. and Gray, G. R., 1984, Plugging mineral exploration holes with a drilling fluid conditioner, *in* Proceedings of the First National Conference on Abandoned Wells: Problems and Solutions, May 20-21, 1984, p. 295-300.

Subsurface, Inc., 1976, Plugging and abandonment of British-American, University of Texas B-1, Prepared for Amoco/Monsanto.

Warner, D. L., 1988, Abandoned oil and gas industry wells and their environmental implications: Prepared for the American Petroleum Institute.

Weintritt, D. J., and Hughes, R. G., 1965, Factors involved in high temperature drilling fluids: Journal of Petroleum Technology, Transaction American Institute of Mechanical Engineers, v. 234, pp. 707-716.

TABLES

TABLE 4-1
DATA TABULATION FOR WELLS WITHIN THE EXTENDED 4.4 MILE RADIUS AREA OF REVIEW

Well Map ID #	Artificial Penetration Y/N	Operator	Lease and Well #	Ground Elevation (feet)	Kelly Bushing Elevation (feet)	Well Spud Date	Status	Date Plugged	Well Depth (feet)	P&A Mud Wt. (ppg)	Log Mud Wt (ppg)	Depth top of Injection Zone	Depth Top of Massive Tuscaloosa Sand Injection Interval (feet)	Depth Top of Washita Fredericksburg Injection Interval (feet)	Depth Base of USDW (feet)	Depth of CMT Plugs (feet)	Surface Casing Size (inch)	Surface Casing Depth (feet)	Protection Casing Size (inch)	Protection Casing Depth (feet)	Protection Casing Cutoff (feet)	Hole Size (inch)	Properly Plugged for Non-Endangerment	Properly Plugged for No-Migration
D-1	Y	Chemours	Monitor Well No. 1	3.6	19.6	1/9/1974	Active	--	10,030	--	11	7,971	9,385	9,745	2,764	--	11 3/4	3,459		10,015	--	10 5/8	Yes	Yes
D-66	Y	Chemours	Injection Well No. 2		46 est	5/19/1978	Active	--	10,060	--	9.7	7,988	9,382	9,800	<3658	--	13 3/8	3,658	9 5/8 7"-liner	9855 9743	--	8 3/8	Yes	Yes
D-67	Y	Chemours	Injection Well No. 3	16.58	37.58	12/9/1978	Active	--	10,103	--	9.4	8,002	9,320	9,769	<3613	--	13 3/8	3,613	9 5/8 7" -liner	9610 9,735	--	8 5/8	Yes	Yes
D-68	Y	Chemours	Injection Well No. 4	12.3	33.3	6/21/1982	Active	--	10,040	--	9.3	7,989	9,347	9,753	<3745	--	16	3,745	9 5/8 7" -liner	9320 9738	--	14 3/4	Yes	Yes
D-69	Y	Chemours	Injection Well No. 5	33	64	12/11/1992	Active	--	10,050	--	9.7	7,996	9,270	9,745	2,750	--	13 3/8	3,440	9 5/8	9,765	--	12 1/4	Yes	Yes
Wells in Extended 4.4 mile Radius Area of Review																								
D-4	Y	Willis J Hughes	State of Mississippi No. 3		19 est	8/9/1956	P&A	11/20/56	9,996	Mud	10.8	8,281	9,719	NDE	2,865	20' on Top 1,935 - 1,985' 2,510 - 2,570'	9 5/8	1,963	--	--	--	8 1/2	No	No
D-9	Y	First Mississippi Corp	Diamondhead No. 1	11	38	12/29/1977	P&A	04/14/78	14,000	9.6	9.6	7,771	9,158	9,530	2,825	3,730 - 3,967'	9 5/8	3,818	5	13,976	3,970	8 3/4	Yes	Yes
D-72	N	Bay Gas LLC	Board of Education Nv No. 1	91	102	8/7/2004	P&A	08/10/04	4,000	9.9	9.9	NDE	NDE	NDE	3,046	0 - 50' 358 - 458' 2,946 - 3,046'	8 5/8	410	--	--	--	7 7/8	NDE	NDE
D-74	N	Mobile Minerals Corp.	Unit 35-3 No. 1	52	62	10/28/2003	P&A	11/02/03	5,020	9.4	9.4	NDE	NDE	NDE	3,100	5 - 35' 326 - 426' 3,425 - 3,566'	8 5/8	376	--	--	--	7 7/8	NDE	NDE
D-75	Y	Land & Nat Resources Dev.	Jane Byrne 501 Trust 27-7 No. 1	74.9	106.9	9/27/2001	P&A	1/4/2002	15,258	10	10	7,971	9,368	9,750	<4,000'	0 - 50' 1,500 - 1,600' 3,950 - 4,050'	9 7/8	4,000	--	--	--	8 3/4	Yes	No
D-100	N	Bay Gas LLC	Jones et al. No. 1	11	22	7/27/2004	P&A	07/30/04	4,250	9.8	9.8	NDE	NDE	NDE	3,025	0 - 50' 370 - 470' 2,970 - 3,070'	8 5/8	422	--	--	--	0	NDE	NDE
D-101	Y	Chevron USA	MS87-01-OS # 1 Block 57	MWL -14	147	12/21/1988	P&A	10/28/1989	23,550		9.7	9,221	10,400	11,250	2,800'	210'-360' 360'-1,260' 1,260'-2,160' 7,910'-8,410' 8,410' - Bridge 16,195'-16,695' 16,695 - Bridge 22,156'-22,562'	20	8,665	13 5/8 10 3/4 -9 5/8	16506 21,400		12 1/4	Yes	No

TABLE 4-2
ARTIFICIAL PENETRATIONS REQUIRING FURTHER EVALUATION
CALCULATION DATA TABLE

Map ID #	Operator	Lease & Well #	Status	Depth Below Mean Sea Level Massive Tuscaloosa Injection Interval	Depth Below Mean Sea Level Washita-Fredericksburg Injection Interval	Kelly Bushing Elevation (feet)	Ground Elevation (feet)	Well Depth (feet)	P&A Mud Wt. (ppg)	Log Mud Wt. (ppg)	Mud Wt. Used in Static Calculation (ppg)	Surface Casing Size (inch)	Surface Casing Depth (feet)	Protection Casing Size (inches)	Protection Casing Cutoff (feet)	Hole Size (inches)	Diameter Used in Well Gel Calculation (inches)	Massive Tuscaloosa		Washita Fredericksburg	
																		Calculated Strength do to Gel (psi)	Allowable Buildup Pressure (psi)	Calculated Strength do to Gel (psi)	Allowable Buildup Pressure (psi)
D-4	Willis J Hughes	State of Mississippi No. 3	P&A	-9,672	-10,062	18	0	10,006	10.8	10.8	10.8	9 5/8	1,963	--	--	8 1/2	9 1/2	67	964	70	970

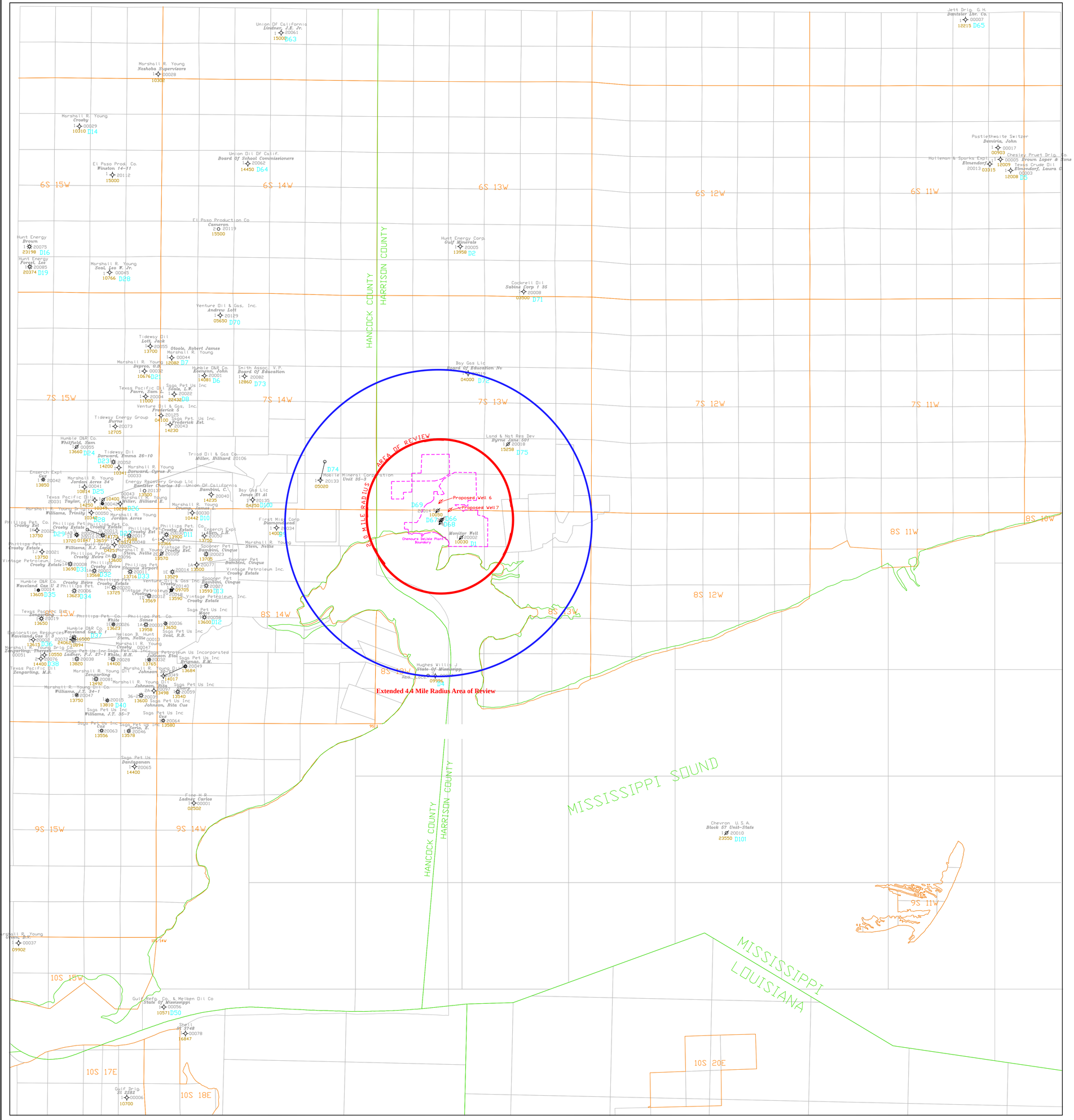
* Well does not penetrate the top of the uppermost Washita-Fredericksburg Sand

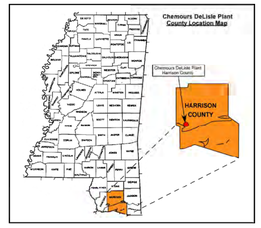
TABLE 4-3
MOLECULAR DIFFUSION TRANSPORT DISTANCES

Constituent	Waste Code	Effective Diffusion Coefficient in Mud-filled Borehole (ft^2/day)	Vertical Diffusion Distance Through Mud-filled Borehole (ft)
Arsenic	D004	6.43E-03	1,088
Barium	D005	1.84E-03	493
Cadmium	D006	2.16E-03	702
Chromium	D007	6.72E-03	1,081
Lead	D008	3.15E-03	851
Mercury	D009	2.59E-03	771
Selenium	D010	7.04E-03	1,139
Silver	D011	3.15E-03	847

- See Section 3.0

FIGURES





Legend

- Deviated Well Spot
- P&A Oil and Gas Well
- Injection Well
- Proposed Injection Well
- Gas Well
- Oil Well
- Dry & Abandoned Well
- -4650 Post Numbers
- D40 Map ID Wells
- 11600 Total Depth
- 31290 API Number
- NDE Log Not Deep Enough
- NL No Log

SCALE

0 6000 12000 18000 24000 30000

FEET

The Chemours Company FC, LLC
Titanium Technologies
Harrison County, MS

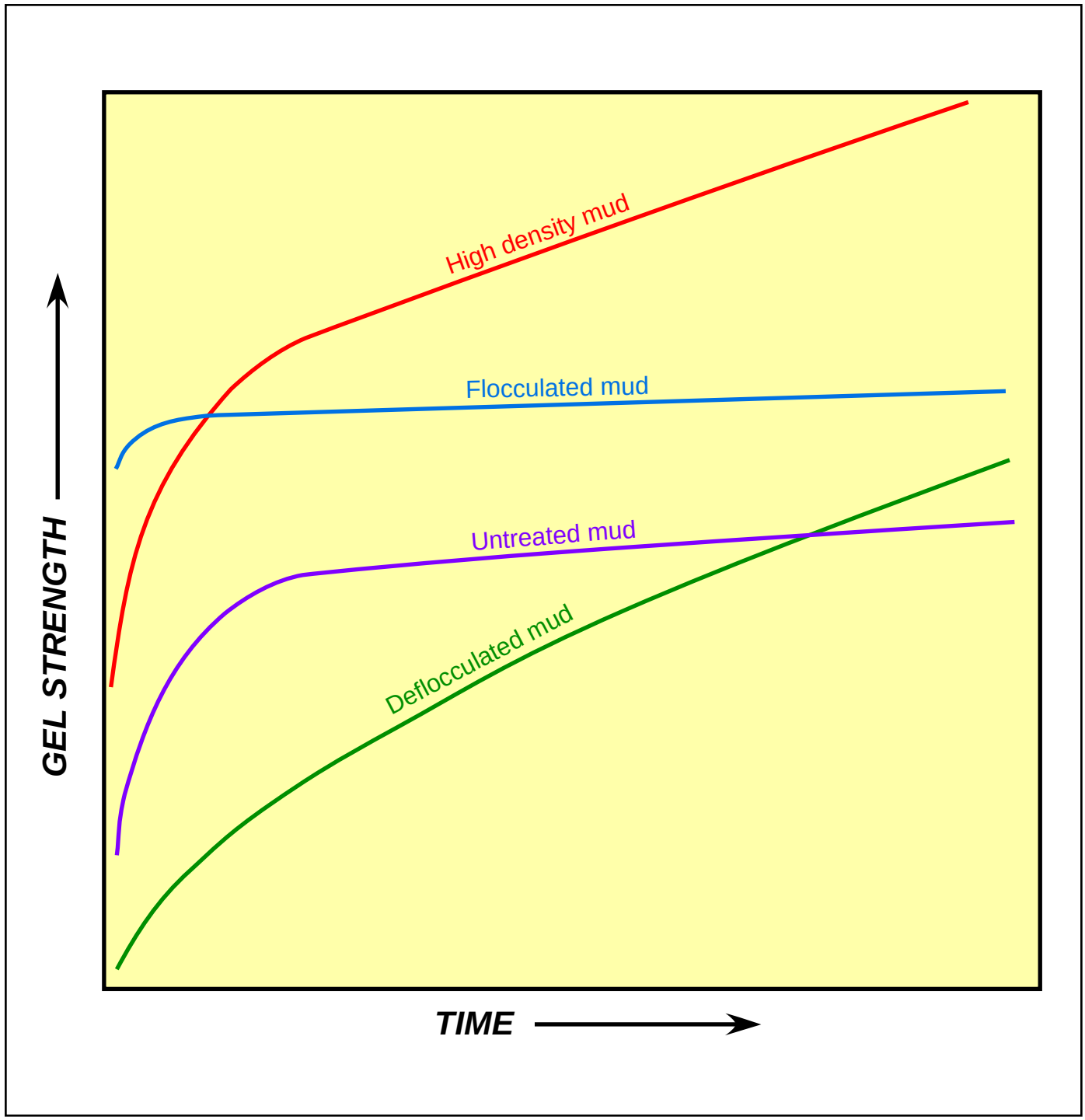
Figure 4-1

Location Map of Wells within the 2.0 Mile Radius Area of Review and the Extended Area of Review Chemours DeLisle Plant

Base Map Prepared & compiled from Tobin International, Ltd. digital Map Data

Compiled & Drafted by: (ESSJ, WGK) Sandia	Scale: 1" = 6000'	Date Revised: July 2017

GEOSTOCK SANDIA ENTREPOSE
8860 Fallbrook Drive Houston, TX 77064 USA Tel: (346) 314 - 4347 Fax: (832) 478 - 5172



recreated by: (ESSJ) Sandia; 9/13/06
adapted from Gray et al., 1980

Figure 4-2 Gel Strengths of Muds with Time

APPENDICES

APPENDIX 4-1

ARTIFICIAL PENETRATION PROTOCOL

As used in current regulations, the Area of Review (AOR) pertains to the area within which the owner or operator of Class I injection wells must identify all artificial penetrations that penetration the permitted confining and injection zones. The following is an outline of the steps and methodology used to identify and evaluate artificial penetrations in an AOR.

WELL IDENTIFICATION

Data Sources

A specific and consistent methodology was used to identify all artificial penetrations within the AOR surrounding each Solutia injection well. Several data sources were utilized to locate pertinent information regarding each artificial penetration. Revised or updated base maps, such as Cambe Geological Services, Zingery Map Co., Tobin Surveys, United States Geological Survey, state regulatory maps, and state highway county maps were utilized to initially identify and establish a general background on the wells identified in each AOR. State agency files along with state libraries were research by Agency Information Co. (AIC) for descriptive well documentation (see Appendix VIII-1 State Forms). Internal documents such as old abandoned well studies, well replugging documents, maps reservoir pressure studies, and well schematics were gathered from the records of previous permits and petitions. Commercial log service companies with regional libraries such as Cambe Geological Services, Inc., and A2D, and IHS (Petroleum Information-Dwight's) Energy Services, were researched for historical well logs and scout ticket information. Additional records and data were also obtained through oil company sources when warranted. Wells lacking data after utilizing the primary resources were researched by contacting original/current operators, lease owners and consulting geologists familiar with that area. Where discrepancies existed among data sources, state form data were considered to be the most accurate.

Well Type

Once identified, the artificial penetrations were then subdivided into wells that are abandoned and wells that are active. An abandoned well is a well where use has been permanently discontinued or is in disrepair such that it cannot be used for its intended purpose. These types of wells include dry holes, abandoned production (oil and gas) wells and injection wells. An active well is a well that is currently operating that includes production and injection (saltwater disposal, enhanced recovery, or other) wells. An active well is a well that is currently operating that includes production and/or injection (saltwater disposal, enhanced recovery, or other) wells.

WELL DATA EVALUATION AND CRITERIA

Well Status

Each artificial penetration (active/abandoned) was evaluated as to the adequacy of well construction and plugging because of the potential for conveying fluid from an injection zone into the overlying USDW. Potential problems wells were identified by failure to meet the criteria outlined below and were subsequently modeled for potential upward migration of fluids in the well bore.

Confining Zone and Injection Zone Penetration

Wells that penetrate the permitted confining zone or injection zone constitute a possible threat to USDW because of their potential for conveying fluid from the injection zone to an overlying USDW. Available geophysical well logs from the artificial penetrations within the AOR were correlated to determine which of the wells penetrated the confining zone or injection zone. Wells that do not penetrate this interval were considered to be safe from vertical fluid flow and not potential avenue or open conduits for fluid migration.

Injection Interval Penetration

Also, any well that is not deep enough to penetrate the injection interval, and is not in direct pressure or fluid communication within the injection interval is considered not a risk and safe to injection operations.

Rock Types

Discussion has previously been given on the qualities of clays/shale in the Gulf Coast for confinement of waste by permeation, diffusion, and pressure increase due to injection; that discussion will not be repeated here except to mention that modeling calculations typically include large safety factors in unconsolidated rock regions.

Drilling Methods and the Mud Column

The artificial penetrations were classified by their drilling methods (rotary vs. cable). Because boreholes tend to close in unconsolidated rock formations such as the geologically young and immature sediments, the sands and hydrated shale of the Gulf Coastal Plain, rotary drilling has been the most preferred drilling method. Generally, the drilling mud (typically used with rotary methods) is carefully balanced to keep the caving sand and sloughing shale from entering the borehole and maintain wellbore stability. Rotary drilled dry holes (wells without economically recoverable hydrocarbons) without proper plugging records can be assumed to have been left mud-filled as a minimum condition because there is no economic reason to recover the drilling mud prior to abandonment (Johnston and Knape, 1986). An exception to this is wells drilled with polymer or oil-based muds which are economical to extract from the well and recycle; however, the hole after extraction is filled with a less expensive bentonite mud. In addition, from examination of mud characteristics taken from well logs for artificial penetrations in each AOR, none of the wells (with available well logs) lacking plugging records were drilled with these types of mud. Mud characteristics (density, viscosity, type and pH) were obtained from geophysical well logs, state and operator records. Rotary drilled dry holes with protection and/or production casing strings were surveyed for perforations because a well that has been production tested by perforating usually has the drilling mud replaced with a water cushion.

Mud plugs provide an effective barrier to vertical fluid flow in the abandoned well bore as documented previously.

Cable tool drilling is primarily used in consolidated rock formations where the target horizon is shallow. However, this drilling method has not been used in unconsolidated formation regions for the past 50 years. This type of drilling operation does not use drilling fluids for well control; therefore, these types of wells are limited to shallow, low pressure formations

in regions where the formations are consolidated or semiconsolidated. Fluid left in the hole is typically either water or brine. Cable tool holes are hard to locate because surface casing was usually not cemented and was removed after drilling.

Proper Plugging

An abandoned well is properly plugged if no upward fluid migration or interformational fluid flow occurs as a result of increased reservoir pressure due to injection operations. The Texas Railroad Commission, under Statewide Rule 14 (c. 1967), requires all formations bearing USDW, oil, gas, or geothermal resources be protected with type specific cement plugs and mud-laden fluid. Uncemented areas in the abandoned wellbore must be filled with at least 9.5 lb/gal mud. The State of Louisiana has adopted similar requirements. Setting depth for cement plugs are dependent upon the specific construction of the well and the geological environment. Production or injection wells abandoned with casing left in the hole should be plugged across the base of the lowermost USDW, in each casing string and across all 'productive horizons'. A productive horizon is defined as any stratum known to contain oil, gas, or geothermal resources.

Wells abandoned with only surface casing should be plugged across the base of the lowermost USDW regardless of casing depth. Where insufficient surface casing is set to protect all USDW and such strata is exposed to the open wellbore, a cement plug must be placed across the exposed strata with an additional cement plug set across the surface casing shoe (Texas Railroad Commission, 1986). When sufficient surface casing has been set to protect all USDW strata, a cement plug must be set across the surface casing shoe (Texas Railroad Commission, 1986). Wells abandoned with protection and/or production casing that have been cemented through all USDW strata, all productive horizons must have cement plugs inside the casing and centered opposite the base of the deepest USDW stratum (Texas Railroad Commission, 1986). For wells abandoned with protection and/or production casing set back to surface, the casing must be perforated at the depths required to protect all productive horizons and USDW strata with cement placed outside of the casing by squeeze cementing (Texas Railroad Commission, 1986). Wells evaluated to be improperly plugged by the above criteria were considered as "potential problem wells" and were modeled for potential upward migration of fluids.

Proper Well Construction

For the purpose of this study, a properly constructed active or abandoned well is defined as a well where the annulus between the borehole and a casing string has been effectively sealed by cement across the correlated injection interval(s), thereby preventing potential vertical fluid migration. Wells that were drilled into or through the injection interval and abandoned with protection and/or production casing left in the hole can pose potential problems. If cement was not circulated to a depth above the correlated injection zone, only drilling fluid would be present in the annulus. Although the drilling fluid in the annulus would provide the same resistance to vertical fluid migration as a mud plug in the wellbore, wells that were constructed improperly were also considered as potential problem wells and modeled for possible vertical fluid migration.

Cement volume calculations were made on each well that has full protection and/or production casing left intact in the well. Only conservative data values were used in the calculations. One inch was added to the drilled borehole diameter of the open hole and all slurry volumes were calculated using Class H cement with 0% Gel (1.06 ft^3/sack)-slurry volume.

Incomplete Records

By far, most of the data on the artificial penetrations in the AOR were obtained from state records. Where public records were missing or virtually non-existent, private record searches were conducted to locate pertinent data.

Many current operators or well owners have ceased operation or have changed names making it even more difficult to locate records on abandoned boreholes. Consulting geologists or engineers familiar with the area were contacted to help locate some of the current operators. Many of these operators did not keep records on older wells that were dry holes making it increasingly difficult to document the present status of the well(s).

A number of oil and gas wells were permitted but have never been drilled. These expired permit surface locations sometimes have been erroneously spotted as oil and gas wells on certain base maps by cartographer or drafter error. The proposed wells, of course, have no construction, plugging or operation records and were verified as being non-existent by the state agency responsible for records in that area. Wells that were identified as having been

drilled but missing the necessary records to document adequacy of plugging and/or construction were labeled potential problem wells and modeled for possible vertical fluid migration.

Corrective Action Plan

Potential problem well(s) that fail the pressure model are labeled "problem wells" as they constitute a potential threat to USDWs. If vertical fluid migration is calculated for any of the potential problem wells, then one of the following steps must be taken:

1. Locate and re-enter the problem well to plug properly;
2. Decrease the injection rate to reduce pressure (head) driving force;
3. Recomplete the injection well at a greater depth so that the problem well can tolerate a higher pressure without fluid migration;
4. Recomplete the injection well in an interval deeper than the problem well penetrates;
5. Increase the density of the injected waste to prevent possible vertical fluid migration;
6. Drill a monitor well adjacent to the problem well to monitor possible vertical fluid migration.

Other Disposal Operations

State or Federal agencies responsible for permitting UIC operations will rarely permit Class I injection wells in an area where injection (Class I and Class II), in the same zone, is already taking place. If injection wells (saltwater disposal, enhanced recovery, or other) were found in or near the AOR, a search for operations records and well completion data must be obtained for those wells. Injection intervals and volumes injected were researched and subsequently modeled to show if significant pressure increase were resulting from additional injection source(s).

Data Organization

After each data source was reviewed and pertinent data has been extracted and tabulated, each identified artificial penetration was given an identification number (map identification

number = artificial penetration number). A base location map was built from all available state records, and commercial data sources showing each artificial penetration well in its identified proper location (see Figure 4-1).

References

Johnston, O.C. and Knape, B.K., 1986, Pressure Effects of the Static Mud Column in Abandoned Wells: Texas Water Commission LP86-06, p.99.

Texas Railroad Commission, 1986, Statewide rules for oil, gas, and geothermal operations, Austin, Texas, p. 172.

APPENDIX 4-2

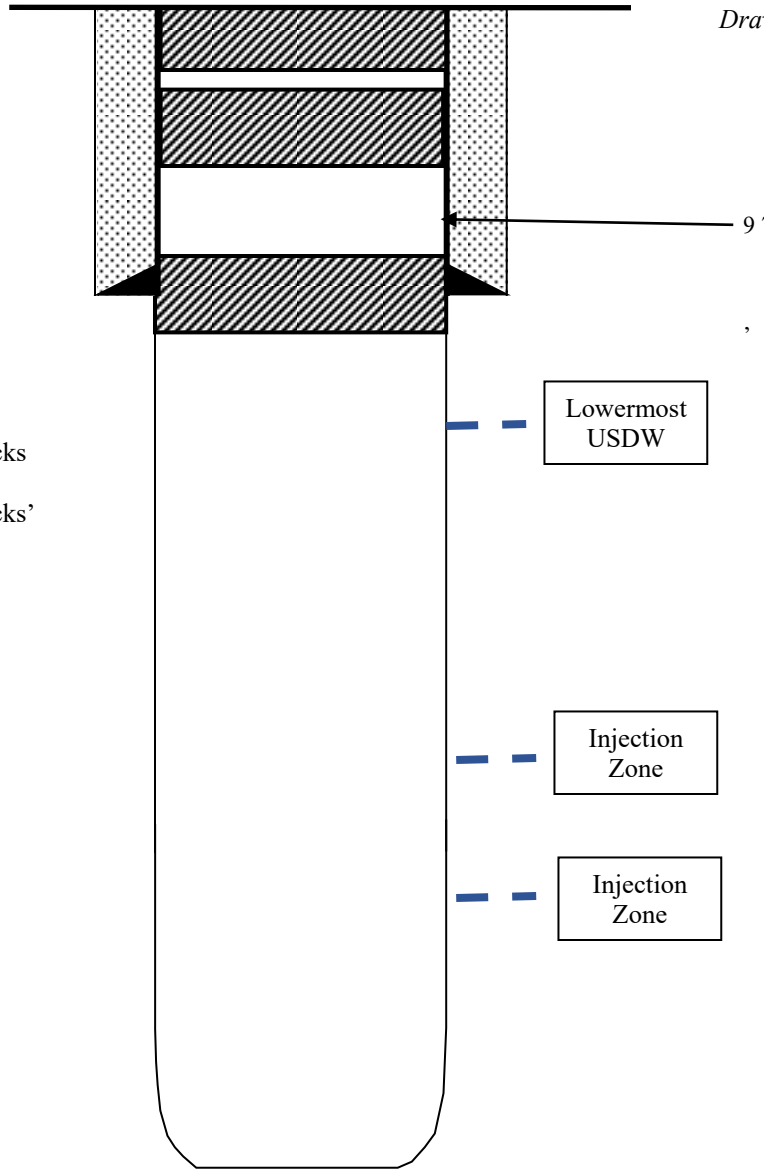
ARTIFICIAL PENETRATION #D-4

WILLIS J. HUGHES
STATE OF MISSISSIPPI NO. 3

ARTIFICIAL PENETRATION DATA SHEET AND WELL SCHEMATIC FOR CHEMOURS DELISLE PLANT

Plant: Chemours DeLisle	**API #:** 2304500007
Map ID No.: D-4	**Status:** P & A
Operator: J Willis Hughes	**Date Plugged:** 11/20/56
Well Name: State of Mississippi No. 3	**Distance from DeLisle Well #5:** 24,650’
Location: T8S, R13W, SEC -	**Well Type:** Exploration
TD: 10,006’	
Date Drilled: 08/09/56	

Drawing not to scale



Plugged : 11/20/56
20 feet on top

1,935’ to 1,985’ w/40 sacks

2,510’ to 2,570’ w/40 sacks’

Total Depth: 10,006’

Drawn by: GKS – July 2016
Checked by:
Revised by:

JAMES WILLIS HUGHES
P. O. BOX 1713
JACKSON, MISSISSIPPI

September 14, 1956

Mr. H. M. Morse
State Oil & Gas Board
P. O. Box 1332
Jackson, Mississippi

Hancock County, Miss.
State of Mississippi #3
Permit # 68

Dear Sir:

We hereby request our Form #2 as approved August 8, 1956 be amended to reflect proposed drilling depth as 10,000 feet. We have set 1,963 feet 9 5/8" 40# casing with 700 sacks of cement.

The Drilling Contractor on this well is Carter-Beveridge Drilling Co., Inc. New Orleans, Louisiana.

Yours very truly,

Ben R. Freeman

for J. Willis Hughes

JWH:F

H M Morse

J J Bartunek J

SEP 17 1956
STATE OIL & GAS BOARD

23-045-00007

September 20, 1956

J. Willis Hughes
Box 1713
Jackson, Mississippi

In Re: Hancock County
State of Miss. #3
Permit # 68

Dear Sir:

Attached is approved copy of your letter requesting permit # 68 be amended to reflect proposed drilling depth to 10,000 feet.

Very truly yours,

H. M. Morse, Secretary & Supervisor
STATE OIL AND GAS BOARD

GHHmp

23-045-00007

August 6, 1956

J. Willis Hughes
P. O. Box 1713
Jackson, Mississippi

Attention: Mr. Murray D. Stringer

Dear Sir:

Re: Notice of Intention to Drill
State of Mississippi #3
Hancock County

Attached is approved Mississippi Oil and Gas Board Form No. 2, together with Permit No. 68, to drill the J. Willis Hughes - State of Mississippi #3, located in Township 8 South, Range 13 West, Hancock County, Mississippi.

Yours very truly,

H. M. Morse, Secretary & Supervisor
STATE OIL AND GAS BOARD

HMM:mf

Attachments
1 - Approved Form No. 2
2 - Permit No. 68

23-045-00007

Form No. 2
(Rev. - 51)

MISSISSIPPI OIL AND GAS BOARD

NOTICE OF INTENTION TO DRILL

(Permit Fee - $25.00)

INSTRUCTIONS

Notice must be filed in duplicate on every well. Do not begin operations on any location until approval from the Board has been received. Approved duplicate copy of this notice will be returned to the applicant. It is mandatory that the proposed location covered by this notice conform to the spacing rules of the Board. Attach a certified plat or sketch drawn to the scale of one inch equalling 1000 feet, locating thereon all previously drilled and drilling wells and proposed location with reference to the two nearest lease and/or drilling unit lines, or sketch may be drawn on the reverse side of this form. On plat show distance between two points farthest removed apart on drilling unit.

GIVE LEGAL DESCRIPTION OF UNIT ON THE BACK OF THIS FORM OR ATTACH TO APPLICATION.
Refer to Statewide Rule No. 11 for surface Casing requirements.

IMPORTANT—SEE REVERSE SIDE

Name J. WILLIS HUGHES (Operator) Date August 6, 1956

Address P. O. Box 1713 City Jackson State Mississippi

DESCRIPTION OF FARM OR LEASE

Name (Fee Owner) State of Mississippi Well No. 3

Exact Location of Well Lat. 30° 18' 59.13" N.

Long. 89° 18' 52.8" W.

Off-shore 2484.44 ftEast; 730.23ft. South of U.S. Highway 90 Toll Bridge.

Sec. _____ Twp. 8S Range 13W County Hancock

Name of Field _____ Wildcat Yes.

Nearest distance from proposed location to drilling unit line 330 feet.

Distance from proposed location to nearest drilling, completed, permitted or applied for well 990 feet approx.

Proposed Drilling Depth 5,000 feet. Proposed Length of Surface Casing 400 feet.

Check the type of proposed well Oil X Gas _____ Other _____ (Name)

Does proposed well location conform to all laws, rules and regulations as to size and shape of drilling unit and footage from lease or drilling unit lines Yes

RECEIVED AUG 8 1956 STATE OIL & GAS BOARD

Name rule or regulation governing location of the well and size of the drilling unit Statewide Rule #7 Acres in Drilling Unit 40
(Statewide Rule 7 for oil or Rule 8 for gas, Field or Special Exception)

Name of Drilling Contractor _____

Address _____ City _____ State _____

AFFIDAVIT:

I Murray D. Stringer, being first duly sworn on oath, state that I have knowledge of the facts and matter herein set forth and that the same are true and correct.

Name Murray D. Stringer Title _____

Form No. 3
(Rev. - 51)

MISSISSIPPI OIL AND GAS BOARD

WELL COMPLETION REPORT

(File in Duplicate)

Permit No. 68

OPERATOR J. Willis Hughes FIELD Wildcat
STREET P. O. Box 1713 POOL Dry & Abandoned.
CITY Jackson, Mississippi STATE Mississippi COUNTY Hancock
LEASE NAME State of Mississippi WELL NO. 3 ACRES IN UNIT 40
LOCATION Lat: 30°18'59.13" North; Long: 89°18'52.80" West
SEC - TWP - RGE -
ELEVATION DF 18' GR - DATE SPUDDED 8-9- (Dlr.) 1956 COMP. DATE 11-20- 1956
TOTAL DEPTH WELL 10,006 FINAL ELECTRICAL LOG TO 9,996 DATE RUN 11-12 1956
NUMBER OF CRUDE OIL PRODUCING WELLS ON THIS LEASE, INCLUDING THIS WELL None

OFFICIAL COMPLETION GAUGE (D & A)

Date Test Commenced ____ M. ____ 19__ Completed ____ M. ____ 19__
Produced ____ barrels of oil in ____ hours ____ minutes
At the rate of ____ net bbls. oil per 24 hours plus ____ % BS&W
API Gravity @ 60° F ____ Gas/Oil Ratio ____ (Cu. Ft. Per Net Bbl. Oil)

For Flowing Well:
Flowing Pressure: Tbg. ____ psi Csg. ____ psi
Choke diam. ____ in Type ____ Length ____ in.
Shut-in tbg. Pr. ____ psi. If gas-lift, number gas valves used ____ Cu. Ft. Gas Per Net Bbl. Oil ____

For Pumping Well:
Length of Stroke ____ in
Strokes per min. ____
Diam. working bbl. ____ in.
Pumping depth ____

If tubing packer used, set at ____ ft.
If completed in open hole, net pay open to production from ____ to ____
Name of Pipe Line or other carrier ____
If gas well, Form 4 must be filed in addition to Form 3

CASING, LINER AND TUBING RECORD

STRING	SIZE	WT./FT.	GRADE	NO. JTS	NAME AND TYPE	AMT FT.	DEPTH SET
Conductor	16"						183'
Surface	9 5/8"	40#					1,963'

CEMENT AND TESTING RECORD

HOLE SIZE	STRING	WHERE CEMENT PLACED	NO. SKS.	TYPE CEMENT	PR. APPLIED IN TESTING
20"	Conductor	203'	200	Common	--
12 1/4"	Surface	1975'	700	Common	1000#

PERFORATING, CHEMICAL AND EXPLOSIVE RECORD

DATE	TYPE AND SIZE OF SHOT, CHEMICAL OR EXPLOSIVE	QUANTITY (No. shots, gals. or qts.)	FROM	TO

RECEIVED
DEC 27 1956
STATE OIL & GAS BOARD

AFFIDAVIT

I, Murray D. Stringer, being first duly sworn on oath state that I have knowledge of the facts and matter herein set forth and that the same are true and correct.

Form No. 6
(Rev. - 51)

MISSISSIPPI OIL AND GAS BOARD

APPLICATION TO PLUG, ABANDON, SIDETRACK, WORKOVER OR PULL CASING

INSTRUCTIONS: File in duplicate with Board. One copy will be returned with approval or denial. Follow Instructions on reverse side of form.

OPERATOR J. WILLIS HUGHES FIELD Wildcat
ADDRESS P. O. Box 1713 Jackson, Mississippi
(Street) (City) (State)
LEASE: State of Mississippi WELL NO.: 3 COUNTY Hancock
SURVEY: -- SECTION: -- DRILLING PERMIT NO.
LOCATION: Lat. 30°18' 59.13"North; Long. 89°18'52.8" West.
Located offshore in Bay of St. Louis

TYPE OF WELL: Dry Hole (Oil, Gas, Dry Hole or Other) TOTAL DEPTH 10,006(Driller) 9,996(El)

ALLOWABLE (If Assigned)
LAST PRODUCTION TEST: OIL (Bbls.) WATER (Bbls.)
GAS (M. C. F.) DATE OF TEST:

PRODUCING POOL: PRODUCING FROM: TO:

FULL DETAILS OF PROPOSED PLAN OF WORK:

Plug and Abandon:

1. 60' Cement plug, 2510-2570'

2. 50' Cement plug, 1935-1985'

3. 20' Cement plug in top of casing after cutting casing off at floor of bay.

Note: Verify telephone authority given Walter Troegel by Mr. J. F. Borthwick, Jr. on November 20, 1956.

If the well is to be reworked to another pool other than that covered by permit, this form shall be accompanied by a certified lease plat as is prescribed on Form No. 2.

DATE OF COMMENCING PROPOSED OPERATIONS: November 20, 1956
NAME OF PARTY DOING WORK: Carter-Beveridge Drlg. Co. ADDRESS: New Orleans, La.
CORRESPONDENCE SHOULD BE SENT TO J. Willis Hughes

Form No. 7
(Rev - 51)

MISSISSIPPI OIL AND GAS BOARD

PLUGGING RECORD

Within 30 days after the plugging of any well the owner, operator or producer responsible therefor shall file an affidavit on Form No. 7 with the Board setting forth in detail the method used in plugging the well and a record of any casing removed

Producer J. WILLIS HUGHES Field Wildcat

Pool -- County Hancock

Address all correspondence concerning this form to

Street P. O. Box 1713 City Jackson State Mississippi

Lease Name State of Mississippi Well No #3

Sec -- Township -- Range -- Date Plugged 11-20-56

Set out in detail the method used in plugging well, showing the interval of cement plugs, weight of mud left in hole, description of plug left at surface, and a record of any casing pulled with notation of any junk left in hole at time of plugging

Plugged Well: 2510-2570 w/25 sx Common Cement

1935-1985 w/20 sx Common Cement

After cutting casing off at floor of Bay, placed

20' cement plug in top of casing.

CASING RECORD

(This information to be furnished in full)

CASING SET IN WELL

Size	Depth Set	Sacks Cement
16"	183'	200
9 5/8"	1,963'	700

CASING PULLED FROM WELL

Size	Amount Pulled	Date Pulled

TOTAL DEPTH OF WELL 9,996'(EL); 10,006 (Dlr) (This data must be supplied)

BASE OF FRESH WATER STRATA 2530 Ft

(Affidavit)

STATE OF Mississippi

COUNTY OF Hinds

Murray D. Stringer
Representative of Operator

Title

Before me, the undersigned authority, on this day personally appeared Murray D. Stringer, known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states that he is authorized to make this report and has knowledge of the facts stated herein and that said report is true and correct.

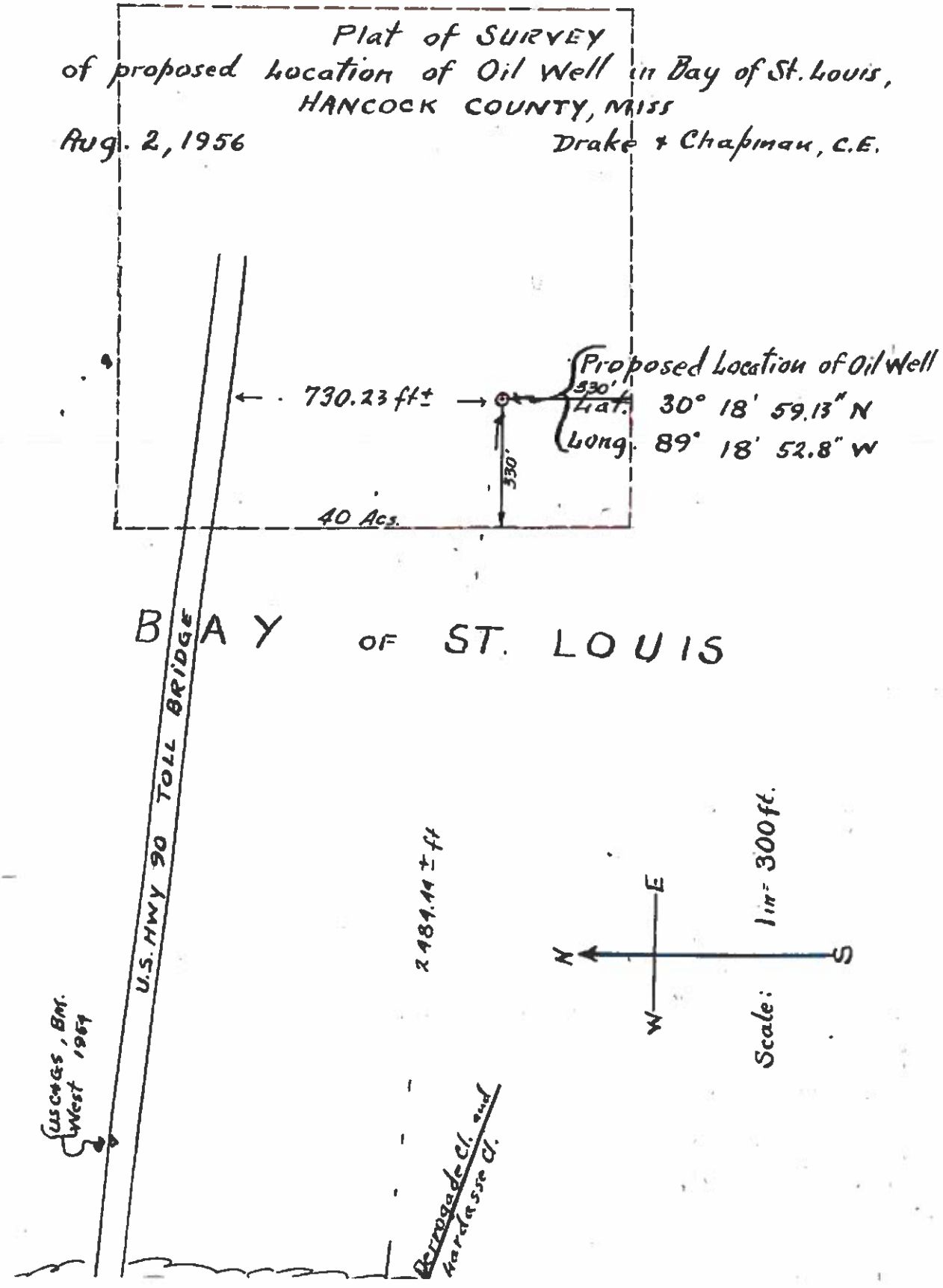
Displaying image 1 of 1

Previous Next

HENRY B. CHAPMAN, SURVEYOR

Plat of Survey
of proposed location of Oil Well in Bay of St. Louis,
HANCOCK COUNTY, MISS

Aug. 2, 1956 Drake & Chapman, C.E.



23045000070000 : Dan Morgan Scout Reports
Mississippi DEQ - Office of Geology

23045000070000

GEOLOGICAL FIELD SHEET

SECTION No Sec TWP. 8 S RG. 13 W ELEV.
OPERATOR J. Willis Hughes
FEE OWNER #3 State of Mississippi
LOCATION Lat 30° 18' 59.13" N; Long 89° 18' 52.8" W. Offshore 2484.44' E & 730.23' S of US Hwy.90 toll Bridge
PARISH Hancock STATE Mississippi
BEGIN DATE 8/12/56 COMPLETION DATE 11/20/56

CASING RECORD

SIZE	DEPTH
13-3/8" @ 12 w/ 100 sx.	

COMPLETION RECORD
TD 10,006 Drlr; 9996 Schl
Dry and abandoned.

TOPS

SCHLUMBERGER

FORMATION	DEPTH	SUB-SEA	FORMATION	DEPTH	SUB-SEA
Het	4598				
Wx	4870				
Ch	7690				
B Ch	8504				
L Tusc	9307				
TD (Drlr	10,006				
(Schl	9996				

MISCELLANEOUS INFORMATION

8/ 9/56 Location - 5000' Permit.

11/15/56 TD 9996 - Shut down.

11/29/56 TD 10,006 Drlr, 9996 Schl. Comp: 11/20/56. Dry and abandoned. Holding for Tops

12/19/57 Schlumberger Tops. No elevation given.

23045000070000 : OXY

Mississippi DEQ - Office of Geology

AFO 3089 SE

WELL RECORD

WC 23045000070000 FLD-WC

Hancock COUNTY Miss.

OPERATOR J. Willis Hughes FARM State of Mississippi NO. 2

SEC TWP. RGE. DHQ; 1520' E of surface location.

Bay 8S 13W LOC. Pr SE/c of Lot #218 go SE alg a continuationm of S/L of said lot

St. Louis 160', th NE & RA 10' to surf. loc. Scale: 7200'N-6100'E of SW/c of 8S-13W.

SPUD COMP. I.P. BOPD CK T.P. C.P. CG GOR

DATE	DATA
	11,000'
	Loc.
AUG 1 1956	✓
AUG 8 1956	✓
AUG 15 1956	✓
AUG 22 1956	✓
AUG 29 1956	✓
SEP 5 1956	✓
SEP 12 1956	✓
SEP 19 1956	✓
SEP 26 1956	✓
OCT 3 1956	✓
OCT 10 1956	✓
OCT 17 1956	✓
OCT 24 1956	✓
OCT 31 1956	✓
NOV 7 1956	Abandon Loc 11-4-56

N

FIRST REPORT

DATE JUL 25 1956

W E

COMPLETION:

DATE NOV 7 1956

S

ELEV. DF GR. (L-S)

TOPS BY SCHLUM.

ELEC. LOG IN FILE DRLR'S TD

CASING RECORD

Form N 01348 Printed in U. S. A.

Parish County 23045000070000

Company J. Willis Hughes Farm State of Mississippi Well No. 1

Parish County Hancock County Area Field Wildcat ☒ State Misc.

Located 'FNL 'FSL 'FEL 'FWL of Sec. 20 T 8S R 13W

Location Lat 30°18' 59.13" N. & long 89°18' 52.6" W. (Also scales from NW cor Sec 20, 8S-13W go SE along extended Sec line 2800'; thence SW @ R/A 950' to loc in Bay.

Offset Within Mile Lease Discovery Elev 25' (est) DF

	First Report	Commenced	Completed	Total Depth	PBTD	TD 1st S/T	TD 2nd S/T	Abandoned
	8-9-56	8-12-56	11-20-56	9956'				
Casing	13 3/8"					Prod. Zone or Zones (Perfs.-O.H.)		
Depth	42'							
Sacks	100 sx							

Initial Production 12/

Geology.DEQ.State.MS.US
Mississippi DEQ
Office of Geology

TD 11,454
USR

Rework IP.

	Plotted	
	Fm	Date
Land		2-16-57
Prod.		
Geol.		
SWE		
FACT		

MDEQ MDECD PTTC MDEQ MDECD PTTC MDEQ MDECD PTTC MDEQ MDECD PTTC MDEQ

23045000070000 : MOG Scout Cards
Mississippi DEQ - Office of Geology

Date	Remarks 23045000070000
8-9-56	Location.
8-16-56	Beg 8-12-56. Set 13 3/8" csg @ 42' w/100 sx cmt. TD 42. W. O. C.
8-23-56	TD 42. Waiting on barge.
9-13-56	Drlg 525.
9-20-56	Drlg 4010.
9-27-56	TD 6320. Prep to drill ahead.
10-4-56	Drlg 7200'.
10-11-56	Drlg 8361'.
10-18-56	Drlg 8940.
10-25-56	Drlg 9512'.
11-8-56	Drlg 9800'.
11-15-56	TD 9996. S. D. W. O. O.
11-29-56	TD 9996. Pan Schl @ 9996. Top Lower Tuscaloosa 9315 (Schl). Elev. 25' (est) DF.
	** TD 9996. Completed 11-20-56. D&A

MDEQ MDECD PTTC MDEQ MDECD PTTC MDEQ MDECD

FORM 85-1058

Ridgway's
L. L. RIDGWAY COMPANY, INC.

NO. C-IE-46318-M

23-045-00007

SCHLUMBERGER WELL SURVEYING CORPORATION
HOUSTON, TEXAS

Induction - Electrical Log

COUNTY HANCOCK MISSISSIPPI
FIELD or LOCATION WILDCAT (OFF SHORE) 89-13W
WELL STATE OF MISS. #3
COMPANY J. WILLIS HUGHES

COMPANY	J. WILLIS HUGHES	Other Surveys
WELL	STATE OF MISS. #3	
FIELD	WILDCAT	Location of Well: LAT 30° 18' 59.13" N LONG 89° 18' 52.8" W OFFSHORE 2484.44' E & 730.23' S OF US HWY 90 TOLL BRIDGE
LOCATION	(OFF SHORE) 89-13W	Elevation: D.F. 16.0' K.B. or G.L.
COUNTY	HANCOCK	
STATE	MISSISSIPPI	FILING No.

RUN No.	ONE
Date	11-12-56
First Reading	9991
Last Reading	1962
Feet Measured	8029
Csg. Schlum.	1962
Csg. Driller	1965
Depth Reached	9996
Bottom Driller	10006
Depth Datum	1' ABOVE ROTARY OR 16.15' ABOVE B.H.
Mud Nat.	GEL
Dens. | Visc.	10.8 | 45
Mud Resist.	2.0 @ 90 °F
" Res. BHT	.91 @ 198 °F
" Rmf	1.75 @ 80 °F
" Rmc	2.3 @ 80 °F
" pH	9.5 @ °F
" Wtr. Loss	9.0 CC30 min.
Bit Size	8 5/8"
Spcgs.—AM	16"
IND.	40"
MN	16' 6"
Opr. Rig Time	3 HRS.
Truck No.	1761-LAUREL
Recorded By	ELLIOTT
Witness	TROGEL-HUGHES

REMARKS: NO C.D. USED. S.O. - 0

Cartridge No. IBC 806
Panel No. IBP 824
Sonde No. IBS 741

CORES FURNISHED BY J. WILLIS HUGHES

SPONTANEOUS-POTENTIAL millivolts	DEPTHS	RESISTIVITY ohms. m²/m	CONDUCTIVITY millimhos/m = 1000/ohms m²/m
SP — 20 MV +		16" NORMAL 0 — 10; HIGH SCALE 0 — 100	INDUCTION 2000 — 0
		INDUCTION 0 — 10; 0 — 100	4000 HIGH SCALE 2000

SPONTANEOUS-POTENTIAL millivolts		RESISTIVITY -ohms. m²/m	CONDUCTIVITY MILLIMHOS/M
SP — 20 MV +		16" NORMAL 0 — 10; HIGH SCALE 0 — 100; INDUCTION 0 — 10; 0 — 100	INDUCTION 2000 — 0; 4000 HIGH SCALE 2000
J. WILLIS HUGHES STATE OF MISS. #3 WC/HANCOCK COUNTY, MISS.		SCHL. T.D. 9996' DRLR. T.D. 10006'	ELEV. D.F. 16.0' K.B. NA G.L. NA

J. WILLIS HUGHES — STATE OF MISS. #3

LEGEND

SW CORES →

SERIES OF SIDEWALL CORES:

(1)	4128	Limestone, gray, sandy, NS.
	4130	Limestone, gray, slightly sandy, NS.
(2)	4602	Limestone, white, chalky to fine crystalline, NS.
	4606	Limestone, white, chalky to slightly crystalline, NS.
	4610	Limestone, white, chalky to fine crystalline, NS.
	4612	Limestone, white, chalky to fine crystalline, contains calcite crystals, NS.
	4614	Limestone, white, chalky to slightly crystalline, NS.
	4617	Limestone, white, chalky to fine crystalline, NS.
	4618	No recovery.
	4620	Limestone, white, chalky to fine crystalline, NS.
	4622	Limestone, white, chalky to fine crystalline, NS.
	4624	Limestone, white, chalky, NS.
	4626	Limestone, white, chalky to fine crystalline, NS.
	4628	Limestone, white, soft, chalky to fine crystalline, containing shale inclusions, NS.
	4630	Limestone, white, chalky, NS.
(3)	4788	Limestone, white, chalky to fine crystalline, soft, NS.
(4)	4814	Limestone, white to light gray, chalky to fine crystalline, with some vugular porosity, NS.
(5)	5015	No recovery (2 bullets).
(6)	5969	No recovery.
(7)	6118	Limestone, gray, tight, fossiliferous, NS.
	6122	Limestone, white to light gray, crystalline with calcite crystals, tight, NS.
	6125	Limestone, tan, crystalline with shale inclusions, NS.
(8)	8809	Sand, fine to very fine grained, very silty, calcareous, NS.
	8812	No recovery.
(9)	9262	No recovery.
(10)	9294	Shale, dark gray, silty, NS.
(11)	9315	Limestone, gray to tan, dense to fine crystalline, hard with shale inclusions, NS.
(12)	9795	Sand, fine grained, silty, NS.

FILE #C-IE-46318-M

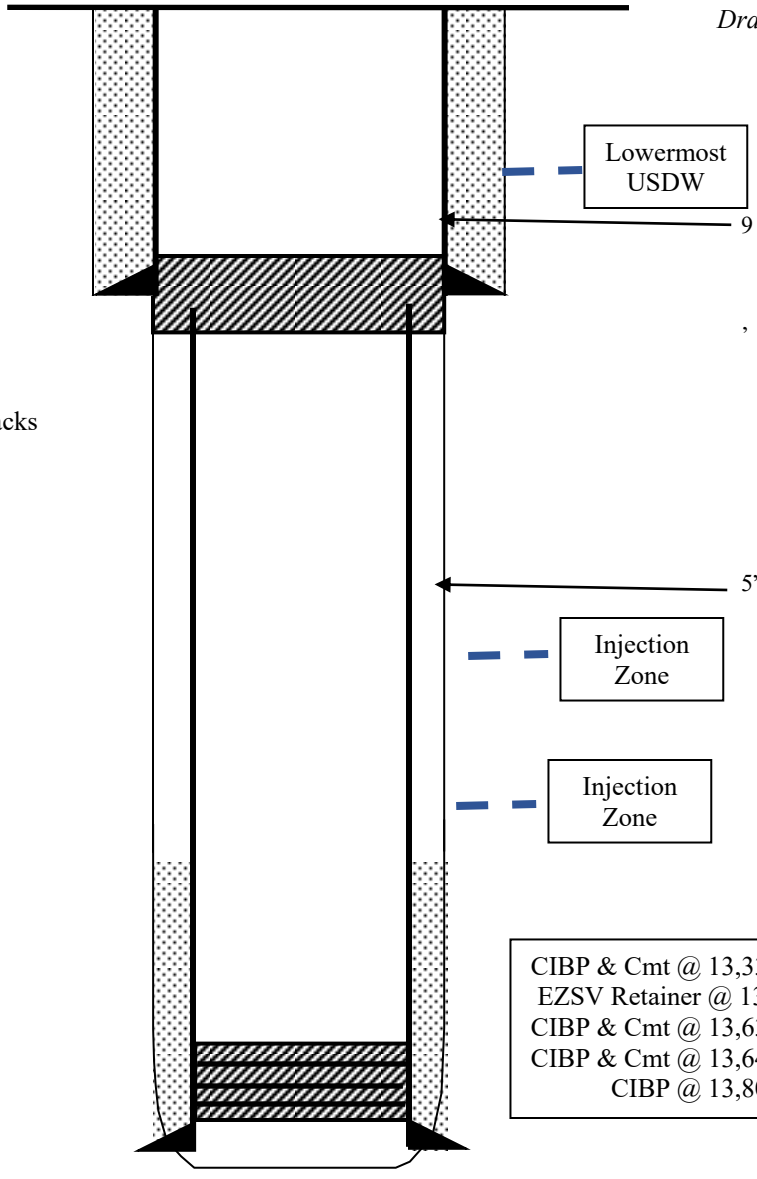
ARTIFICIAL PENETRATION #D-9

FIRST MISSISSIPPI CORPORATION
DIAMONDHEAD NO. 1

ARTIFICIAL PENETRATION DATA SHEET AND WELL SCHEMATIC FOR CHEMOURS DELISLE PLANT

Plant: Chemours DeLisle	**API #:** 2304520034
Map ID No.: D-9	**Status:** P & A
Operator: First Mississippi Corp.	**Date Plugged:** 04/14/78
Well Name: Diamondhead No. 1	**Distance from DeLisle Well #5:** 24,150’
Location: T8S, R14W, SEC 8	**Well Type:** Exploration
TD: 14,000’	
Date Drilled: 12/29/77	

Drawing not to scale



Plugged : 04/14/78

3,730’ to 3,967’ w/160 sacks

Total Depth: 14,000’

Drawn by: GKS – July 2016
Checked by:
Revised by:

FIRST MISSISSIPPI CORPORATION

P. O. BOX 1249 / 700 NORTH STREET JACKSON, MISSISSIPPI 39205
TELEPHONE (601) 948 7550 TWX 810-366-2738 CABLE ADDRESS FIRMCO

June 6, 1978

Mississippi State Oil & Gas Board
P. O. Box 1332
Jackson, Mississippi 39205

RE: #1 Diamondhead

Gentlemen:

Attached for your records are two copies of Plugging Form 7 and letters confirming Diamondhead's liability for completion of subject well as a fresh water producer and their liability for subsequent plugging.

Very truly yours,

C. Douglas Womack

C. Douglas Womack
Assistant Engineer

CDW:meg

Attachments

23-045-20034

DIAMONDHEAD CORPORATION
Diamondhead Project

March 22, 1978

Mr. J. C. Thompson
First Mississippi Corporation
P. O. Box 1249
Jackson, Mississippi 39205

Dear J.C.:

In accordance with our conversation of March 22, 1978, and to meet the requirement of Rule No. 30 of the Mississippi State Oil and Gas Board, state wide rules and regulations, we hereby request that in abandoning Diamondhead Gas Well No. One, you leave the casing in the best possible condition for use as a future artesian water well for our community.

We wish to examine the fresh water aquifer between the depths of 1,000 to 5,000 feet for potable water. Please cap the casing at or above ground level to afford future access.

Please let me know if you should have any questions or need additional information, and I look forward to seeing you on your next trip to this area.

Best regards.

Sincerely,

DIAMONDHEAD CORPORATION

Paul L. Vegas
Project Manager
Diamondhead Development

PLV:rw

RECEIVED
JUN 7 1978
STATE OIL & GAS BOARD

P. O. Box 22 / Bay St. Louis, Miss. 39520 / (601) 255 9464

23-045-20034

FIRST MISSISSIPPI CORPORATION

P. O. BOX 1249 / 700 NORTH STREET JACKSON, MISSISSIPPI 39205
TELEPHONE (601) 948-7550 TWX 810-966-2738 CABLE ADDRESS FIRMCO

March 28, 1978

Diamondhead Corporation
4450 General DeGaulle Drive
New Orleans, Louisiana 70114

Attention: Mr. William B. Bru

No. 1 Diamondhead
Waveland Field
Hancock County, Mississippi

Gentlemen:

By letter dated March 22, 1978, from Mr. Paul L. Vegas to Mr. J. C. Thompson, Mr. Vegas expressed Diamondhead's desire to make an artesian water well out of the Diamondhead No. 1 well and advised First Mississippi to conduct our operations upon plugging said well with regards to Diamondhead's desire.

Inasmuch as this request seems to be in compliance with Rule No. 30 of the Mississippi State Oil and Gas Board's state wide rules and regulations, First Mississippi is agreeable in meeting same, however, as you may well understand, First Mississippi wishes to be held harmless from any liability occurring subsequent to plugging and abandoning said Diamondhead No. 1 well. Therefore, submitted herewith are two copies of First Mississippi's Release form. Please return one fully executed copy to this office at your earliest convenience.

Mr. Thompson is presently on location conducting the necessary operations to meet your request and should you or your staff have any questions or need any additional information, I suggest you contact him.

Sincerely,

FIRST MISSISSIPPI CORPORATION

Vincent C. Vodicka

Vincent C. Vodicka
Senior Landman

VCV/bad

Enclosure

23-045-20034

AREA Diamondhead

DATE March 27, 1978

First Mississippi Corporation
P. O. Box 1249
Jackson, Mississippi 39205

Gentlemen:

For and in consideration of the sum of $10.00 in hand paid to us, receipt of which is hereby acknowledged, we do hereby release, acquit and forever discharge First Mississippi Corporation, and its employees, agents and contractors, of any and all actions, causes of action, claims, damages, demands, and liabilities in any way growing out of any injuries or damages resulting to

any lands owned by Diamondhead Corporation in Section 3, Township 6 South, Range 14 West, Hancock County, Mississippi

by reason of construction of location, drilling, completion and/or plugging and abandoning of the Diamondhead No. 1 Well located on the above described lands.

It is understood and agreed that the acceptance of the above sum is in full payment, settlement, compromise and satisfaction of a disputed claim or claims; and that the payment of this sum is not an admission of liability by First Mississippi Corporation.

WITNESSES:

1) Joanne Marullo

2) Karen Cancilleon

DIAMONDHEAD CORPORATION

By William B. Bru

William B. Bru, President

RECEIVED
JUN 7 1978
STATE OIL & GAS BOARD

23-045-20034

DIAMONDHEAD CORPORATION

4450 GENERAL DEGAULLE DRIVE NEW ORLEANS, LA 70114

WILLIAM B. BRU
PRESIDENT

April 12, 1978

Mr. Vincent C. Vodicka
Senior Landman
First Mississippi Corporation
P. O. Box 1249
Jackson, Mississippi 39205

Dear Mr. Vodicka:

As per your letter dated March 28, 1978, enclosed is one fully executed copy of First Mississippi's Release form in connection with Diamondhead #1 located in Waveland Field, Hancock County, Mississippi.

Sincerely yours,

William B. Bru
President

dm

cc: J. A. Furman

Enclosure

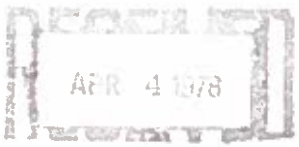
23-045-20034

PERFORATION RECORD

4SPF	.48"	13848'-853'
4SPF	.48"	13707'-722'
4SPF	.48"	13475'-13480' (5')
4SPF	.48"	13482'-13492' (10')
4SPF	.48"	13416'-13426'

ACID, FRACTURE, CEMENT SQZ. RECORD

250 Gals 15% HCL	13848'-853
Set cast iron bridge plug	13800'
Set cast iron bridge plug	13650'
Dumped 10'Cmt. on bridge plug	13640' top of cement
300 Gals 15% HCL	13475-13480
1250 Gals 15% HCL	13475'-13480', 13482'-13492'
Set EZSU Cmt. retainer	13463'
Sqz W 27 sx. class "H"	13475', 13480', 13482' -13492'
300 Gals 15% HCL	13416'-13426'
3000 Gals 15%HCL	13416'-13426'
20,000 Gals MOD 202 acid	13416'-13426'
Set cast iron bridge plug	13350'
Dumped 20'CMt. on Bridge plug	13350'-13330' top of CMT



23-045-20034

DIAMONDHEAD CORPORATION
Diamondhead Project

March 22, 1978

Mr. J. C. Thompson
First Mississippi Corporation
P. O. Box 1249
Jackson, Mississippi 39205

Dear J.C.:

In accordance with our conversation of March 22, 1978, and to meet the requirement of Rule No. 30 of the Mississippi State Oil and Gas Board, state wide rules and regulations, we hereby request that in abandoning Diamondhead Gas Well No. One, you leave the casing in the best possible condition for use as a future artesian water well for our community.

We wish to examine the fresh water aquifer between the depths of 1,000 to 3,000 feet for potable water. Please cap the casing at or above ground level to afford future access.

Please let me know if you should have any questions or need additional information, and I look forward to seeing you on your next trip to this area.

Best regards.

Sincerely,

DIAMONDHEAD CORPORATION

Paul L. Vegas
Project Manager
Diamondhead Development

PLV:rw

RECEIVED
APR 4 1978
STATE OIL & GAS BOARD

P. O. Box 22 / Bay St. Louis, Miss. 39520 / (601) 255 - 9464

23-045-20034

FIRST MISSISSIPPI CORPORATION

P. O. BOX 1249 / 700 NORTH STREET, JACKSON, MISSISSIPPI 39205
TELEPHONE (601) 948-7550/TWX 810-986-2736/CABLE ADDRESS FIRMCO

March 31, 1978

Mississippi State Oil and Gas Board
Post Office Box 1332
Jackson, Mississippi 39205

Re: Plugging Form 3 and Form 6
No, 1 Diamondhead
Hancock County, Ms.

Gentlemen;

Attached are the complete Form 3 and Form 6 for the subject well.

Also attached is a copy of the Dual Induction Laterlog for which we request the six month period of confidentiality.

If you have any questions regarding this matter, please advise.

Very truly yours,

Doug Womack

Doug Womack
Engineering Assistant

DW/doh
attachments

cc: All Co-owners
P.D. Cate
Well File

RECEIVED
APR 4 1978
STATE OIL & GAS BOARD

23-045-20034

Re: First Mississippi Corporation & Diamondhead Exploration
Diamondhead No. 1
Section 3, T 8 S, R 14 W
Hancock County, Mississippi

DESCRIPTION OF WELL LOCATION:

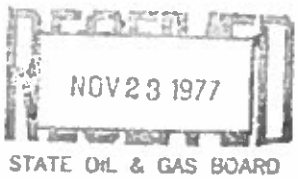
2565.0 feet from the South line and 1200.0 feet from the West line of Section 3, Township 8 South, Range 14 West, Hancock County, Mississippi.

SECTION 3, T 8 S, R 14 W, HANCOCK COUNTY, MISSISSIPPI

DESCRIPTION OF DRILLING UNIT:

Beginning at the Northwest Corner of Section 3, Township 8 South, Range 14 West, Hancock County, Mississippi, run thence Easterly along the North line of said Section 3 and its extension for 5280.0 feet, more or less; thence Southerly and parallel to the West line of said Section 3 for 5280.0 feet, more or less; thence Westerly along the South line of said Section 3 for 5280.0 feet, more or less; thence Northerly along the West line of said Section 3 for 5280.0 feet, more or less, to the point of beginning.

The above described unit is situated in Section 3 and Claim 13, Township 8 South, Range 14 West, Hancock County, Mississippi, and does contain 640.0 acres.



23-045-20031

State Oil and Gas Board

State of Mississippi

TELEPHONE 354 7104 P. O. BOX 1332
JACKSON 39205

November 29, 1977

(X) Permit to Drill and approved Form 2 enclosed.
Minimum surface casing requirement: 2180 feet.

( ) Workover Permit and approved Form 2 enclosed.

( ) Change of Operator Permit and approved Form _____ enclosed.

( ) Approved Form 8, Authority to Transport _____ enclosed.
Allowable: _____ barrels of oil per day, effective _____.

ORIGINAL SIGNED BY
C. R. DAVIS

Clyde R. Davis
STATE OIL AND GAS SUPERVISOR

23-045-20034

APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

AMMENDED

APPLICATION TO DRILL [X] WORKOVER [ ] CHANGE OPERATOR [ ]

NAME OF COMPANY OR OPERATOR: AMMENDED

DATE

FIRST MISSISSIPPI CORPORATION & DIAMONDHEAD EXPLORATION — December 22, 1977

Address: Post Office Box 1249 — City: Jackson — State: Mississippi 39205

DESCRIPTION OF WELL

Name of well: DIAMONDHEAD

Well number: 1

Elevation (ground): 110' GL

Well location (give footage from section lines): 2565' FSL & 1200' FWL

Section — township — range or block & survey: 3 - 8S - 14W

Field & reservoir (if wildcat, so state): WAVELAND - MOORINGSPORT TEST

County: HANCOCK

Check the type of proposed well: Oil ____ Gas X Other (Name) ____

Nearest distance from proposed location to drilling unit line: 1200 feet

Distance from proposed location to nearest drilling, completed or applied — for well: SPOONER BAMBINI #1 11,000 feet

Proposed depth: 14,000 feet

Proposed length of surface casing: 3,900 feet

Approx. date work will start: November 25, 1977

Number of acres in drilling unit: 640

Name of drilling contractor: TESORO DRILLING COMPANY

Address ____ City: LAUREL State: MS

STATE OIL AND GAS BOARD OFFICES	P. O. Box 1232 JACKSON, MISS. Tel. 354-7104	Bill Southern NATCHEZ, MISS. Tel. 445-5041	Bob Cameron WAYNESBORO, MISS. Tel. 735-9400	John Leger ARCOLA HAVEN, MISS. Tel. 833-5170	Perry Cain COLUMBIA, MISS. Tel. 736-4390	Travis West WAYNESBORO, MISS. Tel. 648-2550	George Yoder LAUREL, MISS. Tel. 428-0148

NOTE: Notify nearest field office or Jackson office on dates of spudding and reaching total depth.

Remarks (If this is an application to workover briefly describe work to be done, giving present producing zone and expected new producing zone)

See attached copy of unit description
Original permit #278
Ammended due to change in unit configuration

Refer to Docket No. 16-78-224
Order No 24-78

RECEIVED
DEC 29 1977
STATE [illegible]

[X] YES [ ] NO Are there separately owned tracts in the drilling unit for which this permit is sought?

[ ] YES [X] NO If so, has the person owning the drilling rights in said tracts and the rights to share in the production therefrom agreed to develop their lands as a drilling unit and to the drilling of the well?

Executed this 2nd day of December, 19 77

State of Mississippi

County of Hinds

Signature of Affiant: Doug Womack

Before me the undersigned authority, on this day personally appeared Doug Womack known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that said report is true and correct.

Subscribed and sworn to before me this 2nd day of December, 19 77

SEAL

My commission expires: My Commission Expires April 24, 1979

Notary Public in and for Mississippi County, Hinds

Permit Number: 278

Approval Date: 1-27-78

Approved By: Clyde H. Davis / By

Notice: Before sending in this form be sure that you have given all information requested.

See Instructions on Reverse Side of Form

MISSISSIPPI STATE OIL AND GAS BOARD

Form No. 2 (Rev. 8/1977)

A. P. I. Well Number

State	County	Well
23	045	20034

MISSISSIPPI STATE OIL & GAS BOARD
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

Form No. 3

DESIGNATE TYPE OF COMPLETION

New Well ☐ Work-Over ☐ Deepen ☐ Plug Back ☐ Same Reservoir ☐ Different Reservoir ☐ Oil ☐ Gas ☐ Dry ☒

DESCRIPTION OF WELL AND LEASE

Operator: FIRST MISSISSIPPI CORPORATION	Address: P.O. Box 1249 Jackson, Ms. 39205		
Lease Name: DIAMONDHEAD	Well Number:	Field & Reservoir: WAVELAND MOORINGSPORT	
Location: 2565' FSL & 1200' FWL		Sec.—TWP—Range or Block & Survey: 3-8S-14W	
County: HANCOCK	Permit number: 278	Date issued: 11/23/77	Previous permit number:	Date issued:
Date spudded: 12/29/77	Date total depth reached: 1/29/78	Date completed, ready to produce: DRY	Elevation (DF, RKB, RT or Gr.): GR 11' DF 37 feet	Elevation of casing hd. flange: feet
Total depth: 14,000'	P.B.T.D.: DRY	Single, dual or triple completion?: NA	If this is a dual or triple completion, furnish separate report for each completion.	
Producing interval (s) for this completion: DRY	Rotary or cable tools used (interval): ROTARY	Drilling Contractor: TESORO DRILLING		
Was this well directionally drilled?: NO	Was directional survey made?: NO	Was copy of directional survey filed?: NA	Date filed: NA	
Type of electrical or other logs run (check logs filed with the commission): FDC CNL GR DIL, FID, BHCS-GR			Date filed: 3-30-78	

CASING RECORD

Casing (report all strings set in well—conductor, surface, intermediate, producing, etc.)

Purpose	Size hole drilled	Size casing set	Weight (lb./ft.)	Depth set	Sacks cement	Amt. pulled
Conductor	26"	16"	42 lb.	93'	250	0
Surface	12¼"	9 5/8"	36 lb.	3,818'	1625	0
Production	8 3/4	5"	17#, 20#, 23	13,976'	525	(to be pulled)

TUBING RECORD

Size	Depth set	Packer set at	Size
NA in.	NA ft.	ft	in.

LINER RECORD

Top	Bottom	Sacks cement	Screen (ft.)
NA ft.	ft		

PERFORATION RECORD

Number per ft.	Size & type	Depth interval
SEE ATTACHED		

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD

Amt. & kind of material used	Depth interval
SEE ATTACHED	

INITIAL PRODUCTION

Date of first production: DRY

Producing method (indicate if flowing, gas lift or pumping—if pumping, show size & type of pump.):

Date of test	Hrs. tested	Choke size	Oil prod. during test bbls.	Gas prod. during test MCF	Water prod. during test bbls.	Oil gravity ° API (Corr.)

Tubing pressure	Casing pressure	Calculated rate of Production per 24 hrs.	Oil bbls.	Gas MCF	Water bbls.	Gas—oil ratio

Disposition of gas (state whether vented, used for fuel or sold):

For Sour Gas or Oil: Amount H_2S: Amount CO_2:

Subscribed and sworn to before me this 31 day of March 19 78

State of Mississippi

County of Hinds

C. Douglas Womack
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared C. Douglas Womack known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make this report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 31 day of March 19 78

SEAL

My commission expires April 24, 1979

Annette Upton (Baker)
Notary Public in and for Hinds County, Mississippi

Casing tests as required by Statewide Rules 11 and 12 must be made.

RECEIVED
APR 4 1978
STATE OIL & GAS BOARD

23-045-20034

MISSISSIPPI STATE OIL AND GAS BOARD

NOTICE OF INTENTION TO PLUG AND ABANDON

Operator FIRST MISSISSIPPI CORPORATION Address P.O. BOX 1249

Lease Name DIAMONDHEAD Well No. 1

Location of Well 2565' FSL & 1200' FWL

FIELD NAME WAVELAND

Sec. 3 Twp. 8S Rge. 14W Or Block & Survey County HANCOCK

Date Plugging to Commence 3-28-78

Firm Engaged to Plug Well HALLIBURTON Address LAUREL Permit No. 278

Operators of Offset Leases Notified

Operator	Lease	Direction from this Well

RECEIVED APR 4 1978 STATE OIL & GAS BOARD

C. Douglas Womack
Signature of Operator's Agent.

APPRCVED 4/21/78
CLYDE R. DAVIS / By JAW
State Supervisor

STATE OF MISSISSIPPI

COUNTY OF HINDS

Before me, the undersigned Notary Public on this day personally appeared C. Douglas Womack known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath, states that he is authorized to make the above instrument and that he has knowledge of the facts stated therein and that said instrument is true and correct.

Subscribed and sworn to before me this 31 day of March, 19 78

My Commission expires April 24, 1979

Notary Public

23-045-20634

PLUGGING RECORD

Operator: First Mississippi Corp. & Diamondhead Exp.	Address: P. O. Box 1249, Jackson, Mississippi 39205
Name of Lease: Diamondhead	Well No: 1
Field & Reservoir: Wayeland Mooringsport	
Location of Well: 2565' FSL & 1200' FWL	Sec-Twp-Rge or Block & Survey: 3 - 8S - 14W
County: Hancock	
Application to drill this well was filed in name of: First Miss. Corp. & Diamondhead Exploration	Has this well ever produced oil or gas: No
Character of well at completion (initial production) Oil (bbls/day): -	Gas (MCF/day): -
Dry: Yes	
Date plugged: 4/14/78	Total depth: 14,000'
Amount well producing when plugged Oil (bbls/day): 0	Gas (MCF/day): 0
Water (bbls/day): 0	

Name of each formation containing oil or gas. Indicate which formation open to well-bore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used. Indicate zones squeeze cemented, giving amount cement
	"SEE OTHER SIDE"		

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped etc)	Packers and shoes
16"	93'	0'	93'		
9-5/8"	3818'	0'	3818'		Disposal packer @ 3784'
5"	13976'	3970'	10006'	Cut	

Was well filled with mud-laden fluid, according to regulations? Yes

Indicate deepest formation containing fresh water: 2800'

NAMES AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well
Saga Petroleum		
Phillips Petroleum		
Texas Pacific		

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Well plugged from 3730' - 3967' with 160 sx Class H cement. Diamondhead will perforate and complete as fresh water well. Letters from surface owner attached.

Use reverse side for additional detail
File this form in duplicate with

Executed this the 6th day of June 19 78

State of Mississippi
County of Hinds

C. Douglas Womack
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared C. Douglas Womack, Asst. Engr. known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 6th day of June 19 78

SEAL

My Commission Expires April 24, 1979

My commission expires

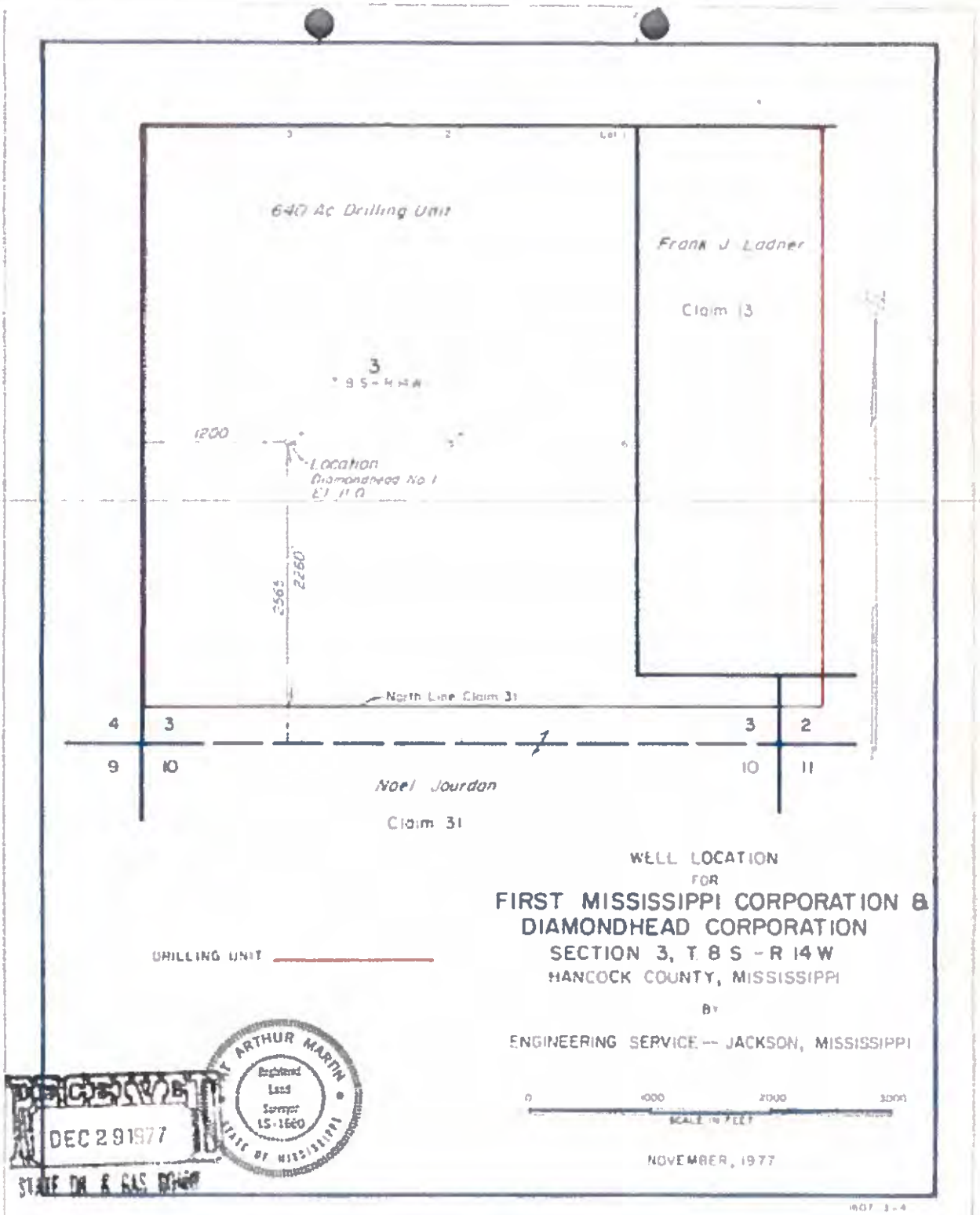
Notary Public in and for Hinds County Mississippi

JUN 7 MISSISSIPPI STATE OIL AND GAS BOARD

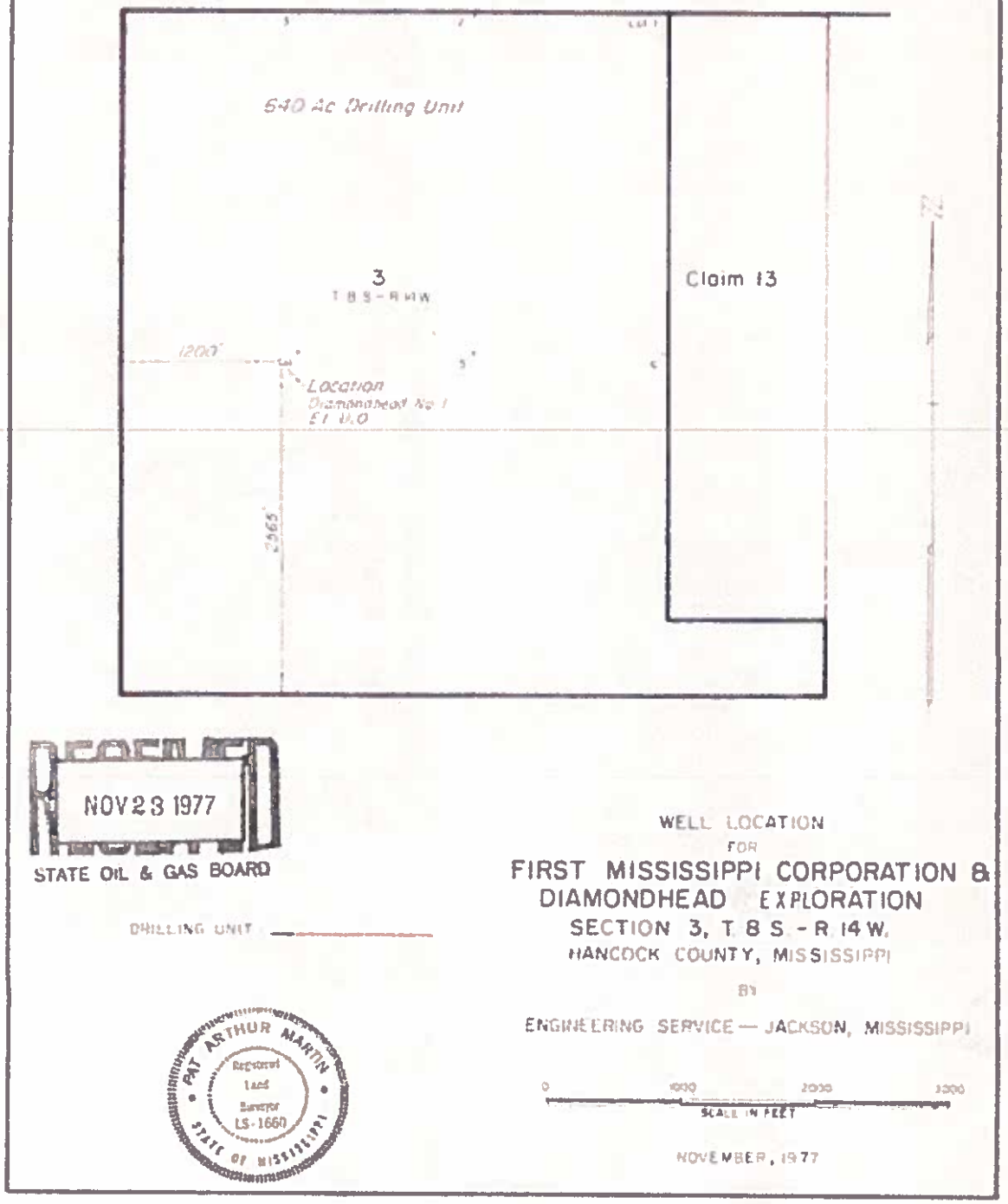
STATE OIL & GAS BOARD

Plugging Record
FORM 7 - IOCC P-15
Authorized by Order No. 118-58 Effective November 1, 1958

23-045-20034


640 Ac Drilling Unit
Frank J Ladner
Claim 13
3
1200
Location
Diamondhead No 1
2260'
2565'
North Line Claim 31
4
3
3
2
9
10
10
11
Noel Jourdon
Claim 31
WELL LOCATION
FOR
FIRST MISSISSIPPI CORPORATION &
DIAMONDHEAD CORPORATION
SECTION 3, T 8 S - R 14 W
HANCOCK COUNTY, MISSISSIPPI
BY
ENGINEERING SERVICE -- JACKSON, MISSISSIPPI
DRILLING UNIT
0
1000
2000
3000
SCALE IN FEET
NOVEMBER, 1977
ARTHUR MARTIN
Registered
Land
Surveyor
LS-1660
STATE OF MISSISSIPPI
RECEIVED
DEC 29 1977
STATE OIL & GAS BOARD

23-045-20034



RECEIVED
NOV 23 1977
STATE OIL & GAS BOARD

DRILLING UNIT

PAT ARTHUR MARTIN
Registered Land Surveyor
LS-1660
STATE OF MISSISSIPPI

WELL LOCATION
FOR
FIRST MISSISSIPPI CORPORATION &
DIAMONDHEAD EXPLORATION
SECTION 3, T 8 S - R 14 W,
HANCOCK COUNTY, MISSISSIPPI
BY
ENGINEERING SERVICE — JACKSON, MISSISSIPPI

0 1000 2000 3000
SCALE IN FEET

NOVEMBER, 1977

23-045-20034

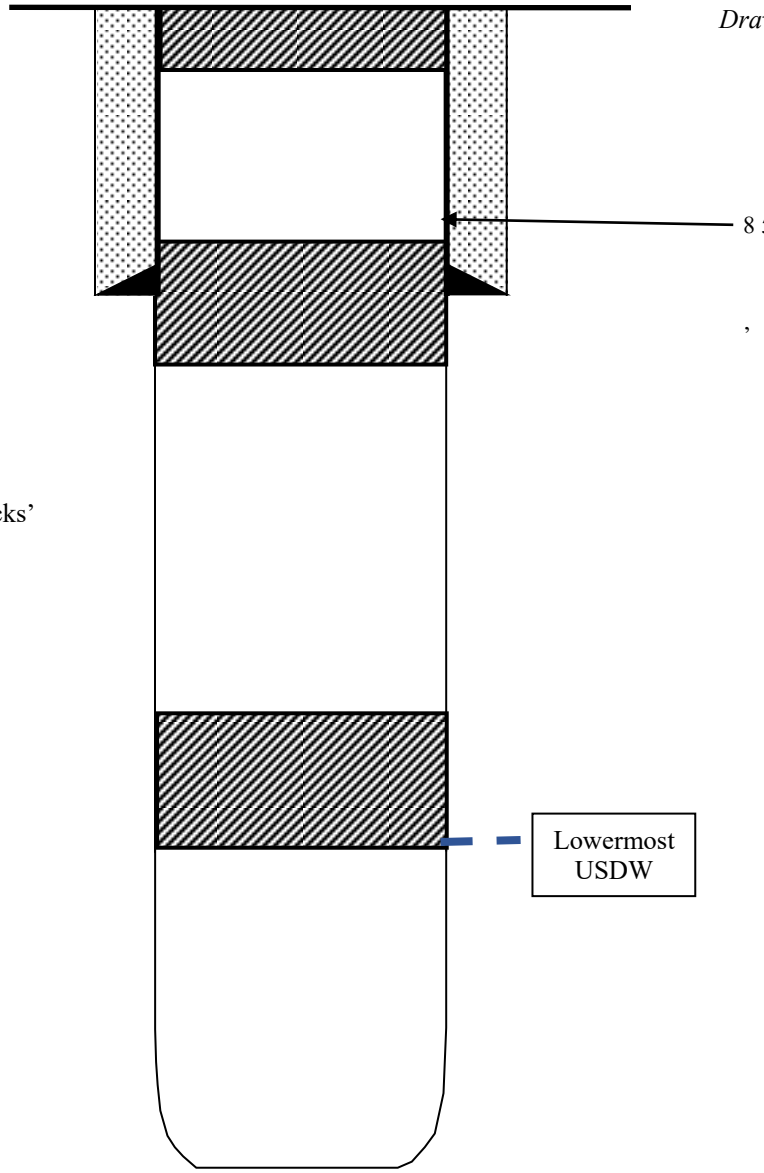
ARTIFICIAL PENETRATION #D-72

BAY GAS LLC
BOARD OF EDUCATION N-V NO. 1

ARTIFICIAL PENETRATION DATA SHEET AND WELL SCHEMATIC FOR CHEMOURS DELISLE PLANT

Plant: Chemours DeLisle	**API #:** 2304720019000
Map ID No.: D-72	**Status:** P & A
Operator: Bay Gas LLC	**Date Plugged:** 08/10/04
Well Name: Board of Education Nv No. 1	**Distance from DeLisle Well #5:** 21,000’
Location: T7S, R13W, SEC 16	**Well Type:** Exploration
TD: 4,000’	
Date Drilled: 08/07/04	

Drawing not to scale



Plugged : 08/10/04
0 to 50’ w/10 sacks

358’ to 458’ w/35 sacks

2,946’ to 3,046’ w/35 sacks’

Total Depth: 4,000’

Drawn by: GKS – July 2016
Checked by:
Revised by:

OPERATORS RESPONSIBILITY FOR LAND DISPOSAL OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERVE PIT.

Please complete the following. Each separate document shall reference the well name, operator, location. An employee of the MSOGB cannot sign as a witness when witness or notarization is required.

I. FIELD Wildcat Operator: J Bay Exp, L.L.C.

WellName&Number: Board of Education #16-1

A.P.I.Number: 23-047-20019

Location: Sec. 16 T7S R13E County: Harrison

II. Location of disposal site: Sec 16-T7S-R13E - on location

Landowner (Mr./Mrs.) Pass Christian School District

III. Interim Land-site approval by MSOGB Inspector, before land spreading begins.

A. Site acceptable (YES/NO) Yes
B. Land Owners approval granted** (YES/NO) Yes
C. Pit Analysis acceptable** (YES/NO) Yes
D. Were Hazardous materials in the waste** (YES/NO) No

** REQUIRED ATTACHMENTS

✓ LAND OWNERS WITNESSED OR NOTARIZED SIGNED AGREEMENT

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

✓ COPY OF THE PIT ANALYSIS

✓ NOTARIZED SIGN OFF BY THE DRILLING CONTRACTOR THAT NO HAZARDOUS MATERIALS WERE INTRODUCED TO THE WASTE.

E. Conditions for land spreading by MSOGB _____

F. FIELD INSPECTOR _____ DATE 8-15-04
(Signature)

IV. Final Inspection and approval by MSOGB after landfarming is completed.

FIELD INSPECTOR _____ DATE 9-8-04
(Signature)

[redacted]

BONNER ANALYTICAL TESTING COMPANY
2703 OAK GROVE ROAD
HATTIESBURG, MS 39402
PH (601) 264-2854
FAX (601) 268-7084

Client: THOMCO

Project #: 010870
Collected By: Client

Sample Date/Time: 08-09-04 @ 1030
Date/Time Rec'd: 08-09-04 @ 1300

RESERVE PIT

BAY GAS – BOARD OF EDUCATION N-V #1

Analyte/Method #	Result BT09241	Concentration Limit	MDL	Date/Time/Analyst
pH/150.1	9.96	6.0-9.0	±0.01	08-09-04/1315/MLF
Chlorides/325.3-	273	500	0.27	08-09-04/1320/MLF
TSS/160.2	169,333	100	1.0	08-09-04/1530/TNJ
COD/410.4	3,498	250	15.0	08-09-04/1430/MLF
Conductivity/120.1	1,402	100	±0.1	08-09-04/1315/MLF
Phenol/420.1	0.17	0.1	0.02	08-10-04/0900/KAW
Chromium/200.7	7.19	0.5	0.035	08-11-04/0959/JSG
Zinc/200.7	15.1	5	0.500	08-11-04/0959/JSG

Data reported in mg/Kg, unless otherwise noted. All analyses performed in accordance with 40 CFR 136 and amendments.

MDL = Method Detection Limit.

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

Certified by: _____
Michael S. Bonner, Ph.D.
BONNER ANALYTICAL TESTING COMPANY

kr

D&D DRILLING & EXPLORATION INC.

MISSISSIPPI STATE OIL & GAS BOARD
500 GREYMONT AVENUE, SUITE E
JACKSON, MS 39202

RE: API Well No. 23 045 20019
Operator Bay Gas, L. L. C.
Well Name Board of Education NV No. 1
Location Hancock County, MS.

Gentlemen:

I, Jess Horton, Vice-President of D & D Drilling & Exploration Inc., drilling contractor for the above referenced well, being duly sworn, do hereby state under oath, to the best of my knowledge no hazardous materials were introduced or contained in the drilling fluid, mud or waste which is to be spread over or buried on the location of the above referenced well.

Witness my signature this 11th day of August 2004.

D & D DRILLING & EXPLORATION INC.

By _____
Jess Horton

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

Sworn to and subscribed before me, this 11th day of August 2004.

_____
Notary Public

My commission expires:

June 3, 2005

SHIRLEY R. PRIEST ADAMS COUNTY MS NOTARY PUBLIC

P. O. BOX 1634 • FERRIDAY, LOUISIANA 71334-1634 • (318) 757-3274 • FAX (318) 757-8595

The undersigned, **Pass Christian Schools** is the landowners on which the Bay Gas, LLC School District #1 well will be drilled by D&D Drilling and Exploration, Inc. Also, the undersigned hereby authorizes Bay Gas, LLC to land spread, on said landowners land and on the respected location, the ***drilling mud*** from the reserve pit, in accordance with the provisions set out in the attached Mississippi State Oil & Gas Board Form designated: **OPERATORS RESPONSIBILITY FOR LAND DISPOSAL OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERV PIT.**

IN WITNESS WHEREOF, this instrument is executed on the date of acknowledgement.

Sue Mathison

Dr. Sue Mathison
Pass Christian Schools

ACKNOWLEDGMENTS

STATE OF MISSISSIPPI
COUNTY OF HARRISON

I hereby certify, that on this day, before me, the undersigned authority duly authorized in the state and parish aforesaid to take acknowledgments, personally appeared **Dr. Sue Mathison** to me known to be the persons described in and who executed the foregoing instrument and they acknowledged before me that, being informed of the contents of the same, they voluntarily signed and delivered the within and foregoing instrument on the day and year therein mentioned.

[illegible] hand and official seal, this 27th day of

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

MISSISSIPPI OIL AND GAS BOARD

INSPECTOR'S VERIFICATION OF WELL SPUDDING

FIELD: Wild Cat INSPECTOR: Lowery

OPERATOR: Bay Gas LLC INSPECTION DATE: 8-9-04

WELL NAME & NO.: BOF NV #1 API #: 23-047-20019

COUNTY: Harrison SEC: 16 TWN: 7S RANGE: 13W

LATITUDE N 30-44'12 LONGITUDE W 89-29838

WELL SPUDDED ON 8-5-04

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

(To be completed by field inspector upon first routine inspection after well is spudded - Will be placed in well file to verify well was drilled)

D&D DRILLING & EXPLORATION INC.

MISSISSIPPI STATE OIL & GAS BOARD
500 GREYMONT AVENUE, SUITE E
JACKSON, MS. 39202

RE: API Well No. 23 047 20019
Operator Bay Gas, L. L. C.
Well Name Board of Education NV No. 1
Location ~~Hancock~~ Harrison County, MS.

Gentlemen:

I, Jess Horton, Vice-President of D & D Drilling & Exploration Inc., drilling contractor for the above referenced well, being duly sworn, do hereby state under oath, to the best of my knowledge no hazardous materials were introduced or contained in the drilling fluid, mud or waste which is to be spread over or buried on the location of the above referenced well.

Witness my signature this 11th day of August 2004.

D & D DRILLING & EXPLORATION INC.

By _____
Jess Horton

Sworn to and subscribed before me, this 11th day of August 2004.

_____
Notary Public

My commission expires:

June 7, 2005

SHIRLEY R. PRIEST ADAMS COUNTY MS NOTARY PUBLIC

RECEIVED
AUG 13 2004
STATE OIL & GAS BOARD

P. O. BOX 1634 • FERRIDAY, LOUISIANA 71334-1634 • (318) 757-3274 • FAX (318) 757-8595

BAY GAS, LLC
2 JACK KELLY ROAD
NATCHEZ, MISSISSIPPI 39120

Ferriday, LA
Office: (318) 757-3274
Fax: (318) 757-8595

Natchez, MS
Office: (601) 445-5026
Fax: (601) 445-5026

June 2, 2004

Mississippi State Oil & Gas Board
500 Greymont Ave Ste E
Jackson, Mississippi 39202

Please find two enclosed Permit Applications for the Bay Gas, LLC Board of Education NV #1 and the Jones etal #1. Included with the applications are checks for both applications and for the Emergency Plugging Fund, and original plats of the locations. If you have any questions or concerns, please don't hesitate to call me at (601) 445-5026. I appreciate your attention on this matter.

Sincerely,

Clark Nerren
Exploration Manager

RECEIVED
JUN 0 3 2004
STATE OIL & GAS BOARD

State Oil and Gas Board

State of Mississippi
500 Greymont Avenue, Suite E
Jackson, MS 39202
Telephone (601) 354-7142

WALTER L. BOONE, JR.
STATE OIL & GAS SUPERVISOR

June 3, 2004

(X) Permit to drill and approved Form 2 enclosed.

(X) Minimum surface casing requirements 320 feet.

(X) Permit issued pursuant to Docket No _____.

Order No. _____

(X) Land disposal form attached.

(X) Form 21, NORM Survey attached.

Lisa A. Ischer

Walter L. Boone, Jr.
STATE OIL AND GAS SUPERVISOR

[redacted]

The undersigned, **Pass Christian Schools** is the landowners on which the Bay Gas, LLC School District #1 well will be drilled by D&D Drilling and Exploration, Inc. Also, the undersigned hereby authorizes Bay Gas, LLC to land spread, on said landowners land and on the respected location, the ***drilling mud*** from the reserve pit, in accordance with the provisions set out in the attached Mississippi State Oil & Gas Board Form designated: **OPERATORS RESPONSIBILITY FOR LAND DISPOSAL OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERV PIT.**

IN WITNESS WHEREOF, this instrument is executed on the date of acknowledgement.

Sue Mathison

Dr. Sue Mathison
Pass Christian Schools

ACKNOWLEDGMENTS

STATE OF MISSISSIPPI
COUNTY OF HARRISON

I hereby certify, that on this day, before me, the undersigned authority duly authorized in the state and parish aforesaid to take acknowledgments, personally appeared **Dr. Sue Mathison** to me known to be the persons described in and who executed the foregoing instrument and they acknowledged before me that, being informed of the contents of the same, they voluntarily signed and delivered the within and foregoing instrument on the day and year therein mentioned.

Given under my hand and official seal, this 27th day of July, 2004

(Affix Seal)

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

Notary
(Title of Officer)

My Commission expires: Notary Public State of Mississippi at Large My Commission Expires: SEP 25, 2005 County, Mississippii.

139997

MISSISSIPPI STATE OIL AND GAS BOARD
APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

FORM No. 2

☒ APPLICATION TO DRILL ☐ WORKOVER ☐ CHANGE OF OPERATOR

NAME OF COMPANY OR OPERATOR: Bay Gas, LLC				DATE: 5-11-04
ADDRESS: P. O. Box 1634	CITY: Ferriday	STATE: LA.	ZIP: 71334	TELEPHONE: 601-445-5026
NAME OF WELL: Board of Education NV	WELL NO: 1	ELEVATION (GROUND): 91.2 NGVD		CIRCLE TYPE OF PROPOSED WELL: Oil (GAS) OTHER (NAME)
WELL LOCATION (WHEN POSSIBLE GIVE FOOTAGE FROM SECTION LINES): See Remarks.	SECTION-TOWNSHIP-RANGE: Section 16, T7S-R13W			
	LATITUDE-LONGITUDE (NEW WELLS) (to nearest): Lat. 30° 26' 25" and Lat. 89° 17' 53"			
FIELD & RESERVOIR (IF WILDCAT SO STATE): Wildcat	API No. (EXISTING WELL): N/A			APPROX. DATE WORK BEGINS: Upon Approval
	COUNTY: Harrison			

PROPOSED DEPTH	PROPOSED LENGTH OF SURFACE CASING	NUMBER OF ACRES IN DRILLING UNIT	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING UNIT LINE	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING COMPLETED OR APPLIED FOR WELL
4000 FEET	320 FEET	320 ACRES	1000 FEET	N/A FEET

NAME OF DRILLING CONTRACTOR: D & D Drilling Company, Inc.

NOTICE PRIOR TO BEGINNING WORK

ADDRESS: P. O. Box 1634 STATE: LA. ZIP: 71334

INSPECTOR
RONNIE "PETE" LOWERY
RECORDER 601-787-4953
MOBIL 601-543-5175

FOR CHANGE OF OPERATOR REQUIRED FOR TRANSFER

AUTHORIZED REPRESENTATIVE SIGNATURE

FORMER OPERATOR

RECEIVED
JUN 03 2004
STATE OIL & GAS BOARD

NOTE: NOTIFY AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON OFFICE) OF DATES OF SPUDDING AND REACHING TOTAL DEPTH

State Oil and Gas Board 500 Greymont Avenue, Suite E Jackson, MS 39202 601-354-7142

REMARKS (IF THIS IS AN APPLICATION TO WORKOVER BRIEFLY DESCRIBE WORK TO BE DONE GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)

DESCRIPTION OF LOCATION: 1000 feet from the north line and 2390 feet from the east line of Section 16, T7S-R13W, Harrison County, Mississippi.
Position of location from GPS Axis: Lat. 30° 26' 25" and Long. 89° 17' 53".

DESCRIPTION OF DRILLING UNIT: North 1/2 of Section 16, T7S-R13W, Harrison County, Mississippi containing 320 Acres, more or less.

ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS. STATUTE 53-3-7)	YES	NO	IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS. STATUTE 53-3-7)	YES	NO
		X			

EXECUTED THIS THE 11th DAY OF May 20 04

STATE OF Mississippi

COUNTY OF Adams

SIGNATURE OF AFFIANT Malcolm G. Barlow

BEFORE ME, THE UNDERSIGNED AUTHORITY ON THIS DAY PERSONALLY APPEARED Malcolm G. Barlow KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT WHO BEING BY ME DULY SWORN ON OATH, STATES THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN AND THAT SAID REPORT IS TRUE AND CORRECT

SUBSCRIBED AND SWORN TO BEFORE ME THIS 11th DAY OF May 20 04

SEAL

NOTARY PUBLIC IN AND FOR Adams COUNTY Mississippi

MY COMMISSION EXPIRES 09-11-07

PERMIT NUMBER 2004-DRD-406

APPROVAL DATE 6-3-04

APPROVED BY D. J.

NOTICE: BEFORE SENDING THIS FORM, BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN. SEE INSTRUCTIONS ON REVERSE SIDE OF FORM.

MISSISSIPPI STATE OIL AND GAS BOARD
FORM 2 (Rev. 4/91)
A.P.I. WELL NUMBER

STATE	COUNTY	WELL
23	047	20019

MISSISSIPPI STATE OIL & GAS BOARD
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

Form No. 3

DESIGNATE TYPE OF COMPLETION:

New Well [X] Work-Over [ ] Deepen [ ] Plug Back [ ] Same Reservoir [ ] Different Reservoir [ ] Oil [ ] Gas [ ] Dry [X]

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

DESCRIPTION OF WELL AND LEASE

Operator: Bay Gas, LLC	Address: PO Box 1634 Ferriday, Louisiana 71334		
Lease Name: Board Education 'NV'	Well Number: 1	Field & Reservoir:	
Location: 1000 feet from the north line and 2390 feet from the east		Sec.—TWP-Range or Block & Survey: Sec 16, T7S-R13W	
County: Hancock	Permit number: 2004-OPD-406	Date issued: June 3, 2004	Previous permit number: / Date issued:
Date spudded: 08/07/04	Date total depth reached: 08/09/04	Date completed, ready to produce:	Elevation (DF, RKB, RT or Gr.) feet: / Elevation of casing hd. flange feet:
Total depth: 4000'	P.B.T.D.:	Single, dual or triple completion?	If this is a dual or triple completion, furnish separate report for each completion.
Producing interval (s) for this completion		Rotary or cable tools used (interval)	Drilling Contractor: D&D Drilling & Exploration
Was this well directionally drilled? No	Was directional survey made?	Was copy of directional survey filed?	Date filed:
Type of electrical or other logs run (check logs filed with the commission): Induction-Gamma Ray-Sonic			Date filed: Filed w/ this report 8/16/04

CASING RECORD

Casing (report all strings set in well—conductor, surface, intermediate, producing, etc.)

Purpose	Size hole drilled	Size casing set	Weight (lb./ft.)	Depth set	Sacks cement	Amt. pulled
Surface	11"	8 5/8"	23#	432'	175	None

TUBING RECORD			LINER RECORD				
Size: in.	Depth set: ft.	Packer set at: ft.	Size: in.	Top: ft.	Bottom: ft.	Sacks cement	Screen (ft.)

PERFORATION RECORD			ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD	
Number per ft.	Size & type	Depth interval	Am't. & kind of material used	Depth interval

INITIAL PRODUCTION

Date of first production	Producing method (indicate if flowing, gas lift or pumping—if pumping, show size & type of pump)					
Date of test	Hrs. tested	Choke size	Oil prod. during test: bbls.	Gas prod. during test: MCF	Water prod. during test: bbls.	Oil gravity: ° API (Corr.)
Tubing pressure	Casing pressure	Cal'ted rate of Production per 24 hrs.	Oil: bbls.	Gas: MCF	Water: bbls.	Gas—oil ratio

Disposition of gas (state whether vented, used for fuel or sold):

For Sour Gas or Oil
Amount H_2S: Amount CO_2:

Executed this the 13th day of August, 19 2004

State of Mississippi
County of Adams

J Clark Nerren
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared J Clark Nerren known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 13th day of August, 19 2004

Shirley R. Quett

SEAL

My commission expires June 5, 2005

Notary Public in and for Adams County, Mississippi

Casing tests as required by Statewide Rules 11 and 12 must be made.

MISSISSIPPI STATE OIL AND GAS BOARD

Form No 3

A. P. I. Well Number

State	County	Well
23	047	20019

DETAIL OF FORMATIONS PENETRATED

Formation	Top	Bottom	Description*
Miocene Formation			
Base LMUSDW	2998		
Amos Sand	3150		
Globoratalia Sand	3320		
Amphistegia Lime	3448		
Amphistegia Sand	3468		
Planulina Sand	3516		
Top of Het Carbonates	3596		

* Show all important zones of porosity, details of all cores, and all drill-stem tests, including depth interval tested, cushion used, time tool open, flowing and shut-in pressures, and recoveries.

INSTRUCTIONS:

Attach electrical log if run.

This well completion or recompletion report and well log shall be filed with the Mississippi State Oil and Gas Board not later than thirty days after project completion.

Form No. 6

MISSISSIPPI STATE OIL & GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON

ADDRESS	
Bay Gas, LLC	PO Box 1634 Ferriday, Louisiana 71334

LEASE NAME	WELL NO.
Board Education NV	1

LOCATION OF WELL

1000' from the north line and 2390' from the east line, Section 16,T7S-R13W

A.P.I. NO.	FIELD NAME
23 047 200190000	Wildcat

SECTION	TOWNSHIP	RANGE	COUNTY	DATE PLUGGING TO COMMENCE
16	7S	13W	Harrison	08/10/04

FIRM ENGAGED TO PLUG WELL	ADDRESS
Armadillo Services	Vidalia, Louisiana 71373

PROPOSED PLUGGING PROCEDURE

1) 2946-3046 with 35 sacks,
2) 358-458 with 35 sacks,
3) 0 - 50 with 10 sacks

Notice: Prior To Beginning Work Notify Oil & Gas Board Representative

RONNIE "PETE" LOWERY
RECORDER # 601-787-4953
MOBILE # 601-543-5175

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

Executed this the 13th day of August, 19 2004

State of Mississippi
County of Adams

J Clark Nerren
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared J Clark Nerren known to me to be the person whose name is subscribed to the above instrument, who being by me dully sworn on oath, states that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 13th day of August, 19 2004

SHIRLEY R. PRICE NOTARY PUBLIC ADAMS COUNTY, MS SEAL

Shirley R. Price
Notary Public in and for Adams County, Mississippi

My commission expires: June 3, 2005

FOR OFFICIAL OIL & GAS BOARD USE ONLY

Approval Date 8/19/04

Supervisor/By WJC

MISSISSIPPI STATE OIL AND GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON
FORM 6

PLUGGING RECORD

Operator: Bay Gas, LLC	Address: PO Box 1634 Fe[illegible]y, Louisiana 71334		
Name of Lease: Board Education NV	Well No.: 1	Field & Reservoir:	
Location of Well: 1000 feet from the north line and 2390 feet from the east line	Sec-Twp-Rge or Block & Survey: 16 7S-13W	County: Harrison	
Application to drill this well was filed in name of: Bay Gas, LLC	Has this well ever produced oil or gas: No	Character of well at completion (initial production): Oil (bbls/day)	Gas (MCF/day) / Dry: Yes
Date plugged: 8/10/04	Total depth: 4000'	Amount well producing when plugged: Oil (bbls/day)	Gas (MCF/day) / Water (bbls/day)

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used Indicate zones squeeze cemented, giving amount cement.
			2946 -3046 with 35 sacks
			358 - 458 with 35 sacks
			0 - 50 with 10 sacks

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped etc)	Packers and shoes
8 5/8"	410	None	410		

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

Was well filled with mud-laden fluid, according to regulations? Indicate deepest formation containing fresh water.

NAMES AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well:

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Use reverse side for additional detail
File this form in duplicate with

Executed this the 13th day of August, 19 2004

State of Mississippi
County of Adams

J Clark Nelson
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared J Clark Nelson known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 13th day of August, 19 2004

Notary Public in and for Adams County, Mississippi

My commission expires: March 2005

OK
8/18/04

MISSISSIPPI STATE OIL AND GAS BOARD

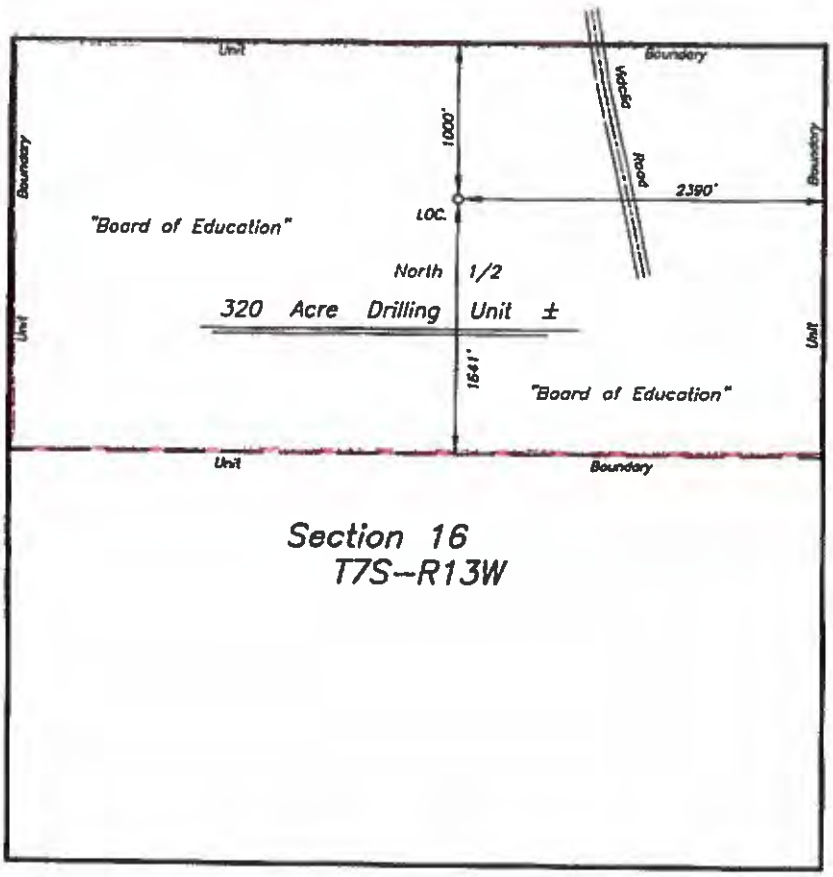
Plugging Record

FORM 7 - MOCC 7-15

Authorized by Order No. 118-58 Effective November 1, 1958

23-047-20019

NOTE: The drilling unit shown hereon lies totally within the confines of a rectangle 5380.0 by 3735.0 feet.



Ground Elevation at Staked Location = 91.2 N.G.V.D.

DESCRIPTION OF LOCATION: 1000 feet from the north line and 2390 feet from the east line of Section 16, T7S-R13W, Harrison County, Mississippi. Position of Location from G.P.S. Axis: Lat. 30°26'25" and Long. 89°17'53".

DESCRIPTION OF DRILLING UNIT: North 1/2 of Section 16, T7S-R13W, Harrison County, Mississippi containing 320 Acres more or less.

RECEIVED
JUN 03 2004
STATE OIL & GAS BOARD

Malcolm G. Barlow, Reg. P.L.S. #1499
April 10, 2003

MALCOLM G. BARLOW

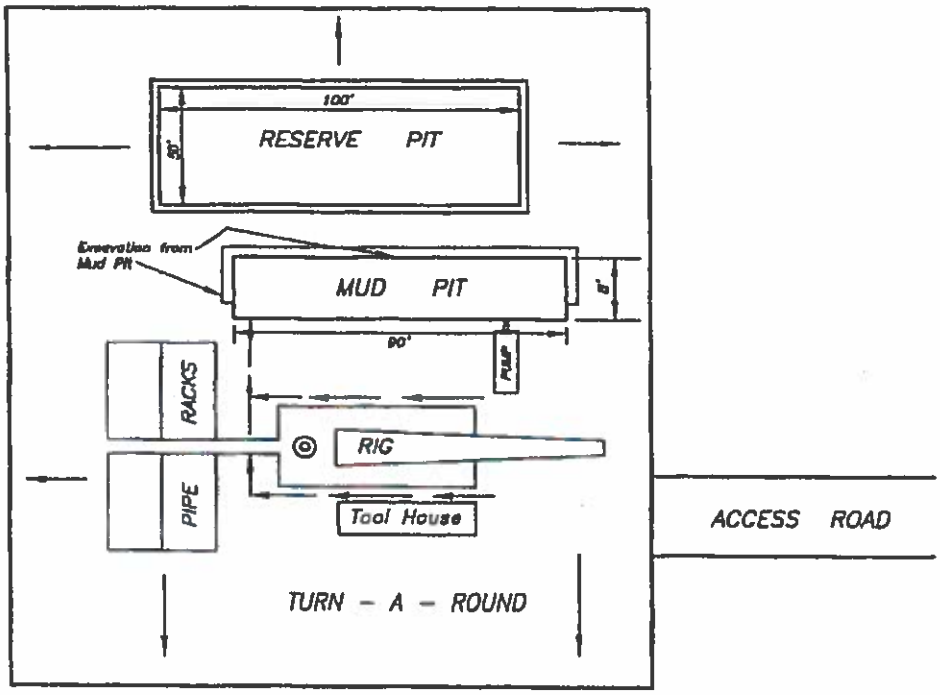
Well Location For

INFORMATION REQUESTED FOR DRILLING FLUID DISPOSAL AND RESERVE PIT

A. *The drilling fluids associated with drilling this well location will be spread over the surface of lands with prior permission obtained from the surface owner.*

B. *The approximate volume of drilling mud, cuttings, drainage water and other associated fluids to be contained within the reserve pit is 18,000 cubic feet or 3,250 barrels.*

C. *The typical size of the reserve pit will vary from 50 feet by 100 feet to 100 feet by 100 feet, depending on the topography of the drill site. The depth of the reserve pit will be sufficient to accommodate the volume of the drilling fluids.*



---NOTE---
Drawing Not To Scale

TYPICAL WILCOX ROTARY RIG FACILITY SITE
(Frio)

OPERATOR'S REP.: Clark Nerren *OPERATOR:* Bay Gas, LLC

COMPUTALOG
Wireline Services

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

SIMULTANEOUS TRIPLE INDUCTION / BOREHOLE COMPENSATED SONIC LOG

COMPANY BAT GAS, LLC.
WELL BOARD OF EDUCATION NV#1
FIELD WILDCAT
COUNTY HARRISON
STATE MISSISSIPPI

COMPANY BAY GAS, LLC.
WELL BOARD OF EDUCATION NV #1
FIELD WILDCAT
COUNTY HARRISON STATE MISSISSIPPI
Location 1000'FNL & 2390'FEL SEC 16 T7S-R11W
Other Services: SMC
API 23-047-20019000
SEC. TWP RGE
Perm. Datum Ground Level Elev 91 ft
Log Measured From K.B. 11 ft above Permanent Datum
ELEV. K.B. 102 ft
D.F. 101 ft
G.L. 91 ft

Date	AUGUST 9, 2004		
Run No.	ONE		
Depth Driller	4000 ft.	ft.	ft.
Depth Logger	4016 ft.	ft.	ft.
First Reading	4009 ft.	ft.	ft.
Last Reading	408 ft.	ft.	ft.
Log Interval	3601 ft.	ft.	ft.
Csg. Driller	8.625 in.@ 410 ft.	in.@ ft.	in.@ ft.
Csg. Logger	408 ft.	ft.	ft.
Bit Size	7.875 in.	in.	in.
Fluid Type	WATER BASED		
Dens. / Visc.	9.9 lbm/gal 39 s	lbm/gal s	lbm/gal s
pH / Fluid Loss	10.0 / 20.0 cc	cc	cc
Sample Source	Flowline		
Rm @Temp.-Meas	3.5 ohm-m @ 98 °F	ohm-m @ °F	ohm-m @ °F
Rmf @Temp.-Meas	1.8 ohm-m @ 90 °F	ohm-m @ °F	ohm-m @ °F
Rmc @Temp.-Meas	3.0 ohm-m @ 90 °F	ohm-m @ °F	ohm-m @ °F
Rm @BHT -Calc	2.6 ohm-m @ 135 °F	ohm-m @ °F	ohm-m @ °F
Rmf @BHT -Calc	1.3 ohm-m @ 135 °F	ohm-m @ °F	ohm-m @ °F
Rmc @BHT -Calc	3.0 ohm-m @ 135 °F	ohm-m @ °F	ohm-m @ °F
Last Circ.	08/09/04 - 1300 hrs	hrs	hrs
Max Rec. Temp	135 °F	°F	°F
Operating Time	hrs	hrs	hrs
Unit / Loc.	777 / ROSENBERG		
Recorded By	J. WRIGHT		
Witnessed By	NERREN, MCGEHEE		

All interpretations are opinions based on inferences from electrical or other measurements. We do not guarantee the accuracy or correctness of any interpretation or recommendation and we shall not be liable or responsible for any loss, cost, damages or expenses incurred or sustained by anyone resulting from any interpretation or recommendation made by any of our employees or agents.

REMARKS Rig: D & D DRILLING Service Order # 03480885
Drilling Stopped 11:00/08 Circulation Stopped 13:00/08 Tool on Bottom 17:00/09 BHT 135 °F
STI/UGR/HBC/CAL LOGGED IN COMBINATION Prints: 4

Rwa Parameters: a 0.62 m 2.15
Porosity SPSS Resistivity DVR2
Hole Volume Presented in Depth Track
Open Hole Volume on the Left
Annular Volume on the Right
Annular Volume for 4.5 " Casing
Large Ticks Represent 100 cu feet.
Small Ticks represent 10 cu feet.

EQUIPMENT DATA

Run No.	Tool Type	Tool No.	Other
ONE	STI	177/177	NO STANDOFF
	HBC	153	
	UGR	135	RA-20S-53
	CALF	1501	
	HCCB	177	

DEPTH SCALE: 1":100' VERSION: 2004.06.02.287 *STAG
MAIN PASS
03480485 st.imp
BHV CASING SIZE: 4.50 Inches CALIPERS: CAL2,None ,None
FINISH DEPTH: 0.0 FROM DIRECTION UP DATE: TIME: MODE: TRACE PLAYBACK

SP -160 Millivolts 40
Gamma Ray 0 API 150
20K Deep STI 0.0 OhmMeters 20.0
20K Deep STI Cond. 2000.0 Milli-Mho/Meter 0.0
SFL Resistivity 0.0 OhmMeters 20.0
AMP SFL Resistivity 0.0 OhmMeters 4.0

START DEPTH: 4043.81 DIRECTION: UP DATE: 08/09/2004 TIME: 18:20 MODE: TRACE PLAYBACK
BHV CASING SIZE: 4.50 Inches CALIPERS: CAL2,None ,None
03480845 st.imp
MAIN PASS
DEPTH SCALE: 1":100' VERSION: 2004.06.02.287 *STAG

23-047-20019 ep

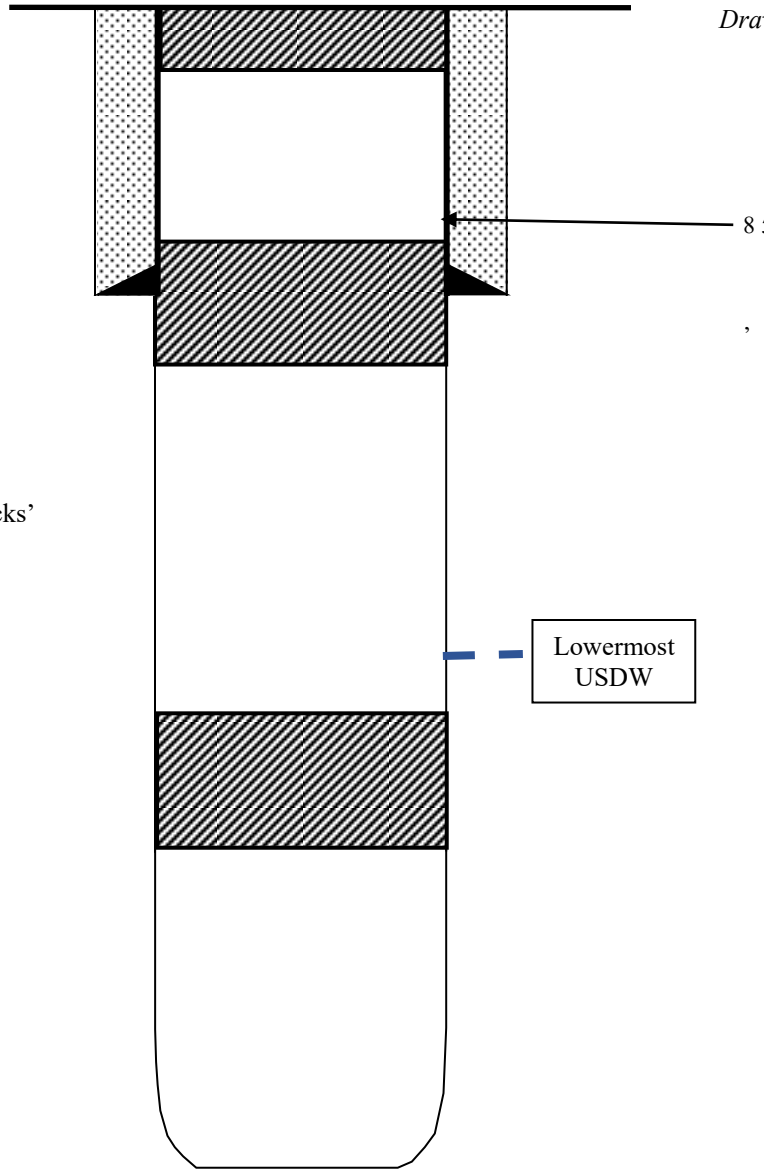
ARTIFICIAL PENETRATION #D-74

MOBILE MINERALS CORPORATION
UNIT 35-3 NO. 1

ARTIFICIAL PENETRATION DATA SHEET AND WELL SCHEMATIC FOR CHEMOURS DELISLE PLANT

Plant: Chemours DeLisle	**API #:** 230452013300
Map ID No.: D-74	**Status:** P & A
Operator: Mobile Minerals Corp.	**Date Plugged:** 11/02/03
Well Name: Unit 35-3 No. 1	**Distance from DeLisle Well #5:** 18,300’
Location: T7S, R14W, SEC 26	**Well Type:** Exploration
TD: 5,020’	
Date Drilled: 10/28/03	

Drawing not to scale



Plugged : 11/02/03
5 to 35’ w/10 sacks

326’ to 426’ w/35 sacks

3,425’ to 3,566’ w/55 sacks’

Total Depth: 5,020’

Drawn by: GKS – July 2016
Checked by:
Revised by:

OPERATORS RESPONSIBILITY FOR LAND DISPOSAL OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM RESERVE PIT.

Please complete the following. Each separate document shall reference the well name, operator, location. An employee of the MSOGB cannot sign as a witness when witness or notarization is required.

I. FIELD Wildcat Operator White Warrior (Cont'd)

WellName&Number Unit 20-3-H1

A.P.I.Number 23-065-20134-01

Location Sec. 20 T 7S R 11W County Humphreys

II. Location of disposal site

Landowner (Mr./Mrs.) Larry Evans

III. Interim Land-site approval by MSOGB Inspector, before land spreading begins.

A. Site acceptable (YES/NO) Yes
B. Land Owners approval granted** (YES/NO) Yes
C. Pit Analysis acceptable** (YES/NO) Yes
D. Were Hazardous materials in the waste** (YES/NO) No

** REQUIRED ATTACHMENTS

✓ LAND OWNERS WITNESSED OR NOTARIZED SIGNED APPROVAL

✓ COPY OF THE PIT ANALYSIS

✓ NOTARIZED SIGN OFF BY THE DRILLING CONTRACTOR THAT NO HAZARDOUS MATERIALS WERE INTRODUCED TO THE WASTE.

E. Conditions for land spreading by MSOGB

F. FIELD INSPECTOR (Signature) DATE 11-12-03

IV. Final Inspection and approval by MSOGB after landfarming is completed.

FIELD INSPECTOR (Signature) DATE 12-4-03

RECEIVED
DEC 0 8 2003
STATE OIL & GAS BOARD

DRILLING CONTRACTOR

WELL NAME: UNIT 35-3 NO. 1

API NO.: 23-045-20133000

FIELD: WILDCAT

SECTION: SEC. 26, T7S-R14W

COUNTY: HANCOCK

On this 3RD day of NOVEMBER, 2003, I hereby certify that to the best of my knowledge there were no hazardous waste materials in the drilling mud used for the above named well. The drilling fluids that were used in the drilling of the above named well are set forth as follows.

Type Waste: FRESH WATER-GEL-MUD

Volume: 3200+ - BBLS

CONTRACTOR: SHAMROCK DRILLING, INC.

BY: X Charles Wallace

CHARLES WALLACE, JR.

STATE OF MISSISSIPPI

COUNTY OF ADAMS

On this 3RD day of NOVEMBER, 2003, personally appeared the above named CHARLES WALLACE, JR, who being by me duly sworn on his oath stated that he is duly authorized to make the above statement on behalf of the named Contractor, and has knowledge of the facts stated therein, and said that the statement is true and correct.

Mary P. Brown

NOTARY PUBLIC IN AND FOR
ADAMS COUNTY, MISSISSIPPI

COMM. EXP.: MARCH 13, 2006

RECEIVED
DEC 08 2003
STATE OIL & GAS BOARD

s-muddis.ofm

Report of Analytical Results

From: EDL Labs, Inc.
39 King Road
Hattiesburg, MS 39402
(601)264-2222

To: Venture Oil & Gas, Inc.
1104 West 1st Street
Laurel, Ms 39440

The following analytical results have been obtained for the indicated sample which was submitted to this laboratory:

Sample ID: BB03628
Location Description: Unit 35-3 # 1
Lab Submittal Date: 11/03/03
Received By: JGS

Location Code: VENTURE
Sample Collection Date: 11/03/03
Sample Collection Time: 00:00
Validated By: JGS

Sample #			BB03628				
Collected on:			11/03/03				
Collection Time			00:00				
Analyte	Result	MDL	Units	Analysis Date	Analysis Time	Analyst	Method
PH	9.72	0.5	SU	11/05/03	08:55	CRR	EPA 150.1
Total Suspended Solids	1,842	1.0	mg/L	11/04/03	17:15	CRR	EPA 160.2
Chemical Oxygen Demand	565	10	mg/L	11/04/03	17:10	CRR	EPA 410.4
Chlorides	100	10	mg/kg	11/05/03	09:10	CRR	SM 4500-CL B
Conductivity	765	1	uMhos/cm	11/05/03	08:55	CRR	EPA 120.1
Chromium, total	0.331	0.005	mg/L	11/04/03	11:35	DEC	EPA 200.7
Zinc, total	0.553	0.002	mg/L	11/04/03	11:35	DEC	EPA 200.7
Phenol, total	Not detected	0.1	mg/L	11/04/03	15:20	CRR	EPA 420.1

Reference Lab Report No. R 2455

If there are questions regarding this data, please call.

RECEIVED
[illegible]
STATE OIL & GAS BOARD

Rodney W. Culpepper
Laboratory Manager

DATE: 11-6-03

I, LARRY EVANS give permission to Mobile Minerals Contractors to land farm reserve pit contents from Wildcat Unit 35-3 #1 in Hancock County to my land in Wayne County - S22, T10N, R5W.

X Larry Evans

X James Varner Witness

X Robert W Winstead Witness

RECEIVED

DEC 0 8 2003

STATE OIL & GAS BOARD

KFG PETROLEUM CORPORATION
118 LOWER WOODVILLE RD SUITE 2 NATCHEZ, MISSISSIPPI 39120
601-446 5219 601-442 5364 FAX 601-446 9437

November 10, 2003

Mississippi Oil and Gas Board
500 Greymont Avenue - Suite E
Jackson, MS 39202

Re: Unit 35-3 No. 1
Sec. 26, T7S-R14W
Hancock Co., MS

Dear Sir:

Enclosed are the following forms concerning the above referenced dry hole:

1) Form No. 3 - Well Completion or Recompletion report and Well Log;
2) Form No. 6 - Notice of Intention to Plug & Abandon;
3) Form No. 7 - Plugging Record;
4) Drilling Contractor's statement of nonhazardous wastes in the drilling mud

Yours very truly,

SHAMROCK DRILLING, INC.

Diane Kerrigan

Diane Kerrigan

/dk
Encl.

cc: Mr. Tom Krafft
1332 Enos Street
Diamond Head, MS 39525

Venture Oil & Gas, Inc.
1104 West 1st. Street - Suite 4
Laurel, MS 39440

MISSISSIPPI OIL AND GAS BOARD

INSPECTOR'S VERIFICATION OF WELL SPUDDING

FIELD: Wildcat INSPECTOR: JB

OPERATOR: Mobile Mineral Corp INSPECTION DATE: 10-30-03

WELL NAME & NO.: Unit 35-2 no-1 API #: 23045-20133-01

COUNTY: Hancock SEC: 26 TWN: 7S RANGE: 14W

LATITUDE N30-40441 LONGITUDE W8934579

WELL SPUDDED ON 10-27-03

RECEIVED
NOV 03 2003
STATE OIL & GAS BOARD

To be completed by field inspector upon first routine inspection after well is spudded - Will be placed in well file to verify well was drilled)

Mobile Mineral Corp.

DRILLING CONTRACTOR

WELL NAME: UNIT 35-3 NO. 1

API NO.: 23-045-20133000

FIELD: WILDCAT

SECTION: SEC. 26, T7S-R14W

COUNTY: HANCOCK

On this 3RD day of NOVEMBER, 2003, I hereby certify that to the best of my knowledge there were no hazardous waste materials in the drilling mud used for the above named well. The drilling fluids that were used in the drilling of the above named well are set forth as follows:

Type Waste: FRESH WATER-GEL-MUD

Volume: 3200+- BBLS

CONTRACTOR SHAMROCK DRILLING, INC.

BY: X Charles Wallace

CHARLES WALLACE, JR.

STATE OF MISSISSIPPI

COUNTY OF ADAMS

On this 3RD day of NOVEMBER, 2003, personally appeared the above named CHARLES WALLACE, JR., who being by me duly sworn on his oath stated that he is duly authorized to make the above statement on behalf of the named Contractor, and has knowledge of the facts stated therein, and said that the statement is true and correct.

Mary P. Brown

NOTARY PUBLIC IN AND FOR
ADAMS COUNTY, MISSISSIPPI

COMM. EXP.: MARCH 13, 2006

RECEIVED
NOV 13 2003
STATE OIL & GAS BOARD

s- muddis ofm

State Oil and Gas Board

State of Mississippi
500 Greymont Avenue Suite F
Jackson MS 39202
Telephone (601) 354-7142

WALTER L. BOONE, JR
STATE OIL & GAS SUPERVISOR

August 21 2003

(X) Permit to drill and approved Form 2 enclosed

(X) Minimum surface casing requirements 336 feet

(X) Permit issued pursuant to Docket No 273-2003

Order No 410-2003

(X) Land disposal form attached

(X) Form 21 NORM Survey attached

Lisa A. Dodson

Walter L. Boone, Jr.
STATE OIL AND GAS SUPERVISOR

DIRECTIONAL SURVEY REPORT

VENTURE OIL & GAS
DIAMONDHEAD/ HANCOCK COUNTY, MS.
RIG: SHAMROCK #1
API#: 23-045-20133
OCT 28 – NOV 2, 2003
LA-MM-2710363

SPERRY-SUN DRILLING SERVICES
MWD DIRECTIONAL SURVEY REPORT
DIAMONDHEAD FIELD / HANCOCK COUNTY, MISSISSIPPI
RIG: SHAMROCK #1/ SURVEYS ARE DF @ 52 FT. ABOVE GROUND LEVEL OF 11 FT.
API# 23-045-20133

VENTURE OIL & GAS COMPANY
DIAMONDHEAD #1

OCTOBER 28, 2003
2710363

MEASURED DEPTH	ANGLE DEG	DIRECTION DEG	VERTICAL DEPTH	LATITUDE FEET	DEPARTURE FEET	VERTICAL SECTION	DOG LEG
3555.00	45.40	190.45	3091.90	1402.44 S	322.79 W	1439.10	0.62
3650.00	43.87	189.17	3159.50	1468.20 S	334.17 W	1505.75	1.87
3744.00	44.58	188.55	3226.86	1532.98 S	344.27 W	1571.16	0.88
3838.00	44.85	188.55	3293.66	1598.39 S	354.10 W	1637.12	0.29
3932.00	45.46	188.72	3359.94	1664.28 S	364.11 W	1703.60	0.66
4025.00	43.52	188.72	3426.29	1728.69 S	373.99 W	1768.61	2.09
4116.00	42.82	191.37	3492.66	1789.99 S	384.83 W	1830.79	2.14
4211.00	43.00	191.72	3562.24	1853.36 S	397.78 W	1895.46	0.31
4307.00	43.26	192.07	3632.30	1917.58 S	411.31 W	1961.08	0.37
4398.00	43.61	191.37	3698.38	1978.84 S	424.01 W	2023.64	0.65
4492.00	44.14	191.01	3766.14	2042.75 S	436.66 W	2088.76	0.62
4587.00	44.58	190.13	3834.06	2108.05 S	448.84 W	2155.13	0.80
4681.00	44.67	191.54	3900.97	2172.90 S	461.25 W	2221.13	1.06
4775.00	44.93	191.19	3967.67	2237.83 S	474.30 W	2287.34	0.38
4869.00	45.64	190.48	4033.80	2303.44 S	486.86 W	2354.10	0.93
4932.00	46.52	189.96	4077.50	2348.10 S	494.91 W	2399.44	1.52
5020.00	46.52	189.96	4138.06	2410.99 S	505.95 W	2463.22	0.00

THE DOGLEG SEVERITY IS IN DEGREES PER 100.00 FEET
THE VERTICAL SECTION WAS COMPUTED ALONG 192.73° (GRID)

BASED UPON MINIMUM CURVATURE TYPE CALCULATIONS. THE BOTTOM HOLE DISPLACEMENT IS 2463.51 FEET, IN THE DIRECTION OF 191.85° (GRID)

SURVEYS CORRECTED +0.53°(E) FROM MAG.NORTH TO MS. EASTERN STATE PLANE GRID NORTH. SPERRY-SUN SINGLE COLLAR 375-4932. TOT.MAG.FLD - 49139nT, DIP - 60.565°. WELLBORE ASSUMED VERTICAL AT SURFACE. FINAL SURVEY PROJECTED TO TD AT 5020.
SPERRY-SUN CREW: Y.ADEJUWON, E.CONNER.

SPERRY-SUN DRILLING SERVICES
MWD DIRECTIONAL SURVEY REPORT
DIAMONDHEAD FIELD / HANCOCK COUNTY, MISSISSIPPI
RIG: SHAMROCK #1/ SURVEYS ARE DF @ 52 FT. ABOVE GROUND LEVEL OF 11 FT.
API# 23-045-20133

VENTURE OIL & GAS COMPANY
DIAMONDHEAD #1

OCTOBER 28, 2003
2710363

MEASURED DEPTH	ANGLE DEG	DIRECTION DEG	VERTICAL DEPTH	LATITUDE FEET	DEPARTURE FEET	VERTICAL SECTION	DOG LEG
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
375.00	0.00	0.00	375.00	0.00	0.00	0.00	0.00
474.00	0.67	337.59	474.00	0.54 N	0.22 W	-0.47	0.68
567.00	3.63	205.57	566.94	1.62 S	1.70 W	1.95	4.42
657.00	3.34	199.40	656.77	6.66 S	3.80 W	7.34	0.53
751.00	4.41	201.78	750.56	12.60 S	6.05 W	13.62	1.15
844.00	7.95	201.59	843.00	21.90 S	9.74 W	23.51	3.81
937.00	12.05	199.89	934.57	37.02 S	15.42 W	39.51	4.42
1032.00	15.54	198.57	1026.82	58.41 S	22.85 W	62.01	3.69
1125.00	17.89	193.83	1115.89	84.10 S	30.23 W	88.69	2.92
1219.00	19.89	190.72	1204.82	113.83 S	36.65 W	119.11	2.38
1312.00	19.93	190.50	1292.26	144.96 S	42.49 W	150.76	0.09
1406.00	20.33	190.77	1380.52	176.76 S	48.46 W	183.09	0.44
1497.00	20.72	191.26	1465.74	208.07 S	54.55 W	214.98	0.47
1591.00	20.45	190.51	1553.74	240.53 S	60.80 W	248.01	0.40
1685.00	22.53	194.71	1641.21	274.10 S	68.37 W	282.43	2.75
1779.00	25.28	194.61	1727.14	310.95 S	78.00 W	320.49	2.93
1873.00	27.56	196.46	1811.31	351.23 S	89.23 W	362.26	2.58
1965.00	28.59	192.85	1892.49	393.11 S	100.16 W	405.51	2.16
2059.00	30.04	192.61	1974.45	438.00 S	110.30 W	451.53	1.55
2150.00	32.12	194.36	2052.39	483.67 S	121.27 W	498.50	2.49
2244.00	33.92	192.07	2131.20	533.53 S	132.95 W	549.71	2.33
2338.00	36.74	191.72	2207.88	586.72 S	144.15 W	604.06	3.01
2432.00	38.77	191.89	2282.20	643.05 S	155.93 W	661.60	2.16
2526.00	40.88	191.89	2354.39	701.96 S	168.33 W	721.80	2.24
2618.00	42.82	192.78	2422.92	761.92 S	181.45 W	783.17	2.21
2711.00	43.76	193.65	2490.61	823.99 S	196.03 W	846.94	1.20
2805.00	43.81	193.52	2558.47	887.22 S	211.31 W	911.97	0.11
2899.00	44.55	192.63	2625.89	951.03 S	226.13 W	977.48	1.03
2993.00	44.43	192.58	2692.94	1015.31 S	240.50 W	1043.35	0.13
3086.00	44.77	193.11	2759.16	1078.98 S	255.02 W	1108.65	0.54
3180.00	45.06	192.10	2825.73	1143.75 S	269.50 W	1175.02	0.82
3273.00	44.32	193.03	2891.84	1207.58 S	283.73 W	1240.42	1.06
3367.00	44.64	191.33	2958.92	1271.96 S	297.62 W	1306.28	1.31
3461.00	44.94	190.95	3025.63	1336.94 S	310.41 W	1372.47	0.43

APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

☒ APPLICATION TO DRILL ☐ WORKOVER 136402 ☐ CHANGE OPERATOR

NAME OF COMPANY OR OPERATOR: Mobile Mineral Corporation				DATE
ADDRESS: 164 St. Francis Street, Suite 205	CITY: Mobile	STATE: AL	ZIP: 36602	TELEPHONE
NAME OF WELL: Unit 35-3	WELL NO: No. 1	ELEVATION (GROUND): 52		CIRCLE TYPE OF PROPOSED WELL: OIL GAS OTHER (NAME)
WELL LOCATION WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES: BHL 990 FNL 2329 FWL Section 35 SL 2,377 FEL and 1,759 FSL.	SECTION 26	TOWNSHIP 7S	RANGE 14W	
FIELD & RESERVOIR (IF WILDCAT, SO STATE): Wildcat	COUNTY: Hancock			APPROX. DATE WORK BEGINS: ASAP
PROPOSED DEPTH: 4,200 FEET	PROPOSED LENGTH OF SURFACE CASING: 3361 Minimum FEET	NUMBER OF ACRES IN DRILLING UNIT: 320 ACRES	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING UNIT LINE: BHL 990 FEET	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING COMPLETED OR APPLIED FOR WELL: N/A FEET
NAME OF DRILLING CONTRACTOR: Unknown				
ADDRESS	CITY	STATE	ZIP	

FOR CHANGE OF OPERATOR ONLY SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL

AUTHORIZED REPRESENTATIVE

NOTICE PRIOR TO BEGINNING WORK NOTIFY OIL & GAS BD REPRESENTATIVE

H2S OPERATIONS (F

INSPECTOR
JOHN W. "DOUG" BOYD
RECORDER 601-587-2777
MOBIL 601-543-5177

FORM 18 DATE REQUESTED DATE RECEIVED

CONTINGENCY PLAN: DATE RECEIVED

NOTE: NOTIFY AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON OFFICE) OF DATES OF SPUDDING AND REACHING TOTAL DEPTH
State Oil and Gas Board, 500 Greymont Avenue, Suite E, Jackson, MS 39202 601-354-7142

REMARKS: (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)
See Docket No. 223-2003
The Drilling Unit is Section 26: E/2 of SW/4 and W/2 of SE/4 and Section 35: E/2 of NW/4 and W/2 of NE/4

RECEIVED
JUL 21 2003
STATE OIL & GAS BOARD

ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS. STATUTE 53-3-7)	YES	NO	IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS. STATUTE 53-3-7)	YES	NO
	X				X

EXECUTED THIS THE 18th DAY OF July 2003

STATE OF Mississippi

COUNTY OF Rankin

SIGNATURE OF AFFIANT

BEFORE ME, THE UNDERSIGNED AUTHORITY, ON THIS DAY PERSONALLY APPEARED William F. Blair KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH STATES THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT

SUBSCRIBED AND SWORN TO BEFORE ME THIS 18th DAY OF July 2003

SEAL

NOTARY PUBLIC STATE OF MISSISSIPPI AT LARGE
MY COMMISSION EXPIRES: Jan 22, 2007
BONDED THRU NOTARY PUBLIC UNDERWRITERS

LINDA GRANGER NOTARY PUBLIC RANKIN COUNTY, MS

NOTARY PUBLIC IN AND FOR

MY COMMISSION EXPIRES

COUNTY

PERMIT NUMBER 2004-OPD-070

APPROVAL DATE 8-20-2003

APPROVED BY Board

NOTICE: BEFORE SENDING THIS FORM BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN. SEE INSTRUCTIONS ON REVERSE SIDE OF FORM

MISSISSIPPI STATE OIL AND GAS BOARD
FORM NO. 2 (Rev. 4-90)
A.P.I. WELL NUMBER

STATE	COUNTY	WELL
23	045	20133 -01

Form No. 3

MISSISSIPPI STATE OIL & GAS BOARD
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

INDICATE TYPE OF COMPLETION

NEW WELL	WORKOVER	DEEPEN	PLUG BACK	SAME RESERVOIR	DIFFERENT RESERVOIR	OIL	GAS	DRY
						X		X

DESCRIPTION OF WELL AND LEASE

OPERATOR: MOBILE MINERAL CORPORATION	ADDRESS: 161 ST. FRANCIS STREET, SUITE 205 MOBILE, AL. 36602
LEASE NAME: UNIT 35-3	WELL NUMBER: 1
FIELD & RESERVOIR: WILDCAT	

LOCATION: BHL 990 FEET FROM NORTH LINE & 2,329 FEET FROM WEST LINE OF SEC 35 SL 2377 FEET FROM EAST LINE AND 1,250 FEET FROM SOUTH LINE — SEC 26 TWN 17S RGE 14W OR BLOCK & SURVEY: SEC 26 17S-R14W

COUNTY	PERMIT NUMBER	DATE ISSUED	PREVIOUS PERMIT NUMBER	DATE ISSUED
HANCOCK	2004-OPD-070	8 20 03		

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT, or GR)	ELEVATION OF CASING HD. FLANGE
10/28/03	11/1/03	DRY HOLE	520 GR	

TOTAL DEPTH	P B T D	SINGLE, DUAL, OR TRIPLE COMPLETION	IF THIS IS A DUAL OR TRIPLE COMPLETION FURNISH SEPARATE REPORT FOR EACH COMPLETION
5,020' TVD			

PRODUCING INTERVAL(S) FOR THIS COMPLETION	ROTARY OR CABLE TOOLS USED (Interval)	DRILLING CONTRACTOR
DRY HOLE	ROTARY	SHAMROCK DRILLING, INC.

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
NO	NO		

TYPE OF ELECTRICAL OR OTHER LOGS RUN (Check Logs Filed with the Commission): Array Induction — DATE FILED: BY OPERATOR

CASING RECORD (Report All Strings Set in Well: Conductor, Surface, Intermediate, Producing, etc.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT LB./FT.	DEPTH SET	SACKS CEMENT	AMOUNT PULLED
SURFACE	11"	8 5/8"	24#	376	175	-0-

TUBING RECORD

SIZE	DEPTH SET	PACKER SET AT

LINER RECORD

SIZE	TOP	BOTTOM	SACKS CEMENT	SCREEN

PERFORATION RECORD

NUMBER PER FOOT	SIZE & TYPE	DEPTH INTERVAL

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD

AMOUNT & KIND OF MATERIAL USED	DEPTH INTERVAL

RECEIVED
NOV 13 2003
STATE OIL & GAS BOARD

INITIAL PRODUCTION

DATE OF FIRST PRODUCTION	PRODUCING METHOD (Flowing, Gas Lift or Pumping - If Pumping, Indicate Size & Type of Pump)

DATE OF TEST	HOURS TESTED	CHOKE SIZE	OIL PRODUCED DURING TEST (BBLS.)	GAS PRODUCED DURING TEST (MCF)	WATER PRODUCED DURING TEST (BBLS.)	OIL GRAVITY (API-Corr.)

TUBING PRESSURE	CASING PRESSURE	CALCULATED RATE OF PRODUCTION PER 24 HRS	OIL (BBLS.)	GAS (MCF)	WATER (BBLS.)	GAS - OIL RATIO

DISPOSITION OF GAS (State Whether Vented, Used for Fuel or Sold): — SOLD GAS OR OIL: AMOUNT IN $ — AMOUNT CO.

Executed this the 4TH day of NOVEMBER 19 2003

State of MISSISSIPPI

County of ADAMS

Diane Kerrigan
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared DIANE KERRIGAN known to me to be the person whose name is subscribed to the above instrument and being by me duly sworn on oath states that he is duly authorized to make the above report and that he has knowledge of the facts stated therein and that said report is true and correct.

Subscribed and sworn to before me this 4TH day of NOVEMBER 19 2003

SEAL

Mary B. Brown
Notary Public in and for ADAMS County

My commission expires 3-13-06

CASING TESTS REQUIRED BY STATEWIDE RULES 11 AND 12 MUST BE MADE

MISSISSIPPI STATE OIL AND GAS BOARD
FORM NO. 3
A.P.I. WELL NUMBER
STATE COUNTY WELL

DETAIL OF FORMATIONS PENETRATED			
FORMATION	TOP	BOTTOM	DESCRIPTION *
HET	-3,937 TVD		
PLANULINA	-3,738		
AMPHISTEGINA SAND	-3,602		
AMPHISTEGINA LIME	-3,578'		
GLOBOROTALIA	-3,456'		

* Show all important zones of porosity; detail of all cores; and all drill-stem tests, including depth interval tested, cushion used, time tool open, flowing and shut-in pressures, and recoveries.

INSTRUCTIONS

Attach electrical log if run.

This well completion or recompletion report and well log shall be filed with the Mississippi State Oil and Gas Board no later than thirty (30) days after project completion.

Form No. 6

MISSISSIPPI STATE OIL & GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON

OPERATOR	ADDRESS
MOBILE MINERAL CORPORATION	164 ST. FRANCIS STREET, SUITE 205, MOBILE, AL 36602

LEASE NAME	WELL NO.
UNIT 35-3	1

LOCATION OF WELL

BHL: 990 FEET FROM THE NORTH LINE AND 2,329 FEET FROM THE WEST LINE OF SEC. 35. SL: 2,377 FEET FROM THE EAST LINE AND 1,759 FEET FROM THE SOUTH LINE.

A.P.I. NO.	FIELD NAME
23-045-20133000	WILDCAT

SECTION	TOWNSHIP	RANGE	COUNTY	DATE PLUGGING TO COMMENCE
26	7S	14W	HANCOCK	11/02/03

FIRM ENGAGED TO PLUG WELL	ADDRESS
ARMADILLO SERVICES, INC.	P.O. BOX 2086, VIDALIA, LA 71373

PROPOSED PLUGGING PROCEDURE

SET PLUGS AS FOLLOWS:

3,425' - 3,566' w/55 sx.

326' - 426' w/35 sx.

5' - 35' w/10 sx

CUT CASING OFF 5' BELOW GROUND LEVEL AND WELD 1/2" STEEL PLATE ON TOP

RECEIVED
NOV 13 2003
STATE OIL & GAS BOARD

Notice: Prior To Beginning Work Notify Oil & Gas Board Representative

JOHN D. "DOUG" BOYD
RECORDER 601/587-2777
MOBILE 601/543-5177

Executed this the 2ND day of NOVEMBER, A.D. 2003

State of MISSISSIPPI

County of ADAMS

Diane Kerrigan
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared _____ known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath, states that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 2ND day of NOVEMBER, A.D. 2003

SEAL

Mary P. Brown
Notary Public in and for ADAMS County, MISSISSIPPI

My commission expires : 3-13-06

FOR OFFICIAL OIL & GAS BOARD USE ONLY

Approval Date 11/18/03

Supervisor/By W Tc D

MISSISSIPPI STATE OIL AND GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON
FORM 6

PLUGGING RECORD

Operator	Address
MOBILE MINERAL CORPORATION	164 ST. FRANCIS STREET, SUITE 205, MOBILE, AL 36602

Name of Lease	Well No	Field & Reservoir
UNIT 35-3	1	WILDCAT

Location of Well	Sec Twp -Rge or Block & Survey	County
660' FEET FROM THE NORTH LINE AND 2,329 FEET FROM THE WEST LINE OF SEC 35, 2,377 FEET FROM THE EAST LINE AND 1,369 FEET FROM THE SOUTH LINE	SEC. 26, T7S-R14W	HANCOCK

Application to drill this well was filed in name of	Has this well ever produced oil or gas	Character of well at completion (initial production) Oil (bbls/day)	Gas (MCF/day)	Dry
MOBILE MINERAL CORPORATION				X

Date Plugged	Total Depth	Amount well producing when plugged Oil (bbls/day)	Gas (MCF/day)	Water (bbls/day)
11.02.03	5,020'			

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used. Indicate zones squeeze cemented, giving amount cement
			Plug No. 1 3,425' - 3,566' w/55 sx.
			Plug No. 2 326' - 426' w/35 sx.
			Plug No. 3 5' - 35' w/10 sx.
			CUT CASING OFF 5' BELOW GR & WELDED 1/2" STEEL PLATE ON TOP

CASING RECORD

Size pipe	Put in well (feet)	Pulled out (feet)	Left in well (feet)	Give depth & method of parting casing (shot, rasped, etc.)	Packers and shoes
8 5/8"	376'	-0-	376'		

Was well filled with mud-laden fluid, according to regulations?	Indicate deepest formation containing fresh water
YES	3,516'

NAME AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well

RECEIVED
NOV 13 2003
MS OIL & GAS BOARD

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Use reverse side for additional details.
File this form in duplicate with

Executed this the 3RD day of NOVEMBER A.D. 2003

State of MISSISSIPPI

County of ADAMS

Diane Kerrigan
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared _____ known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath, states that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 3RD day of NOVEMBER A.D. 2003

Mary D. Brown

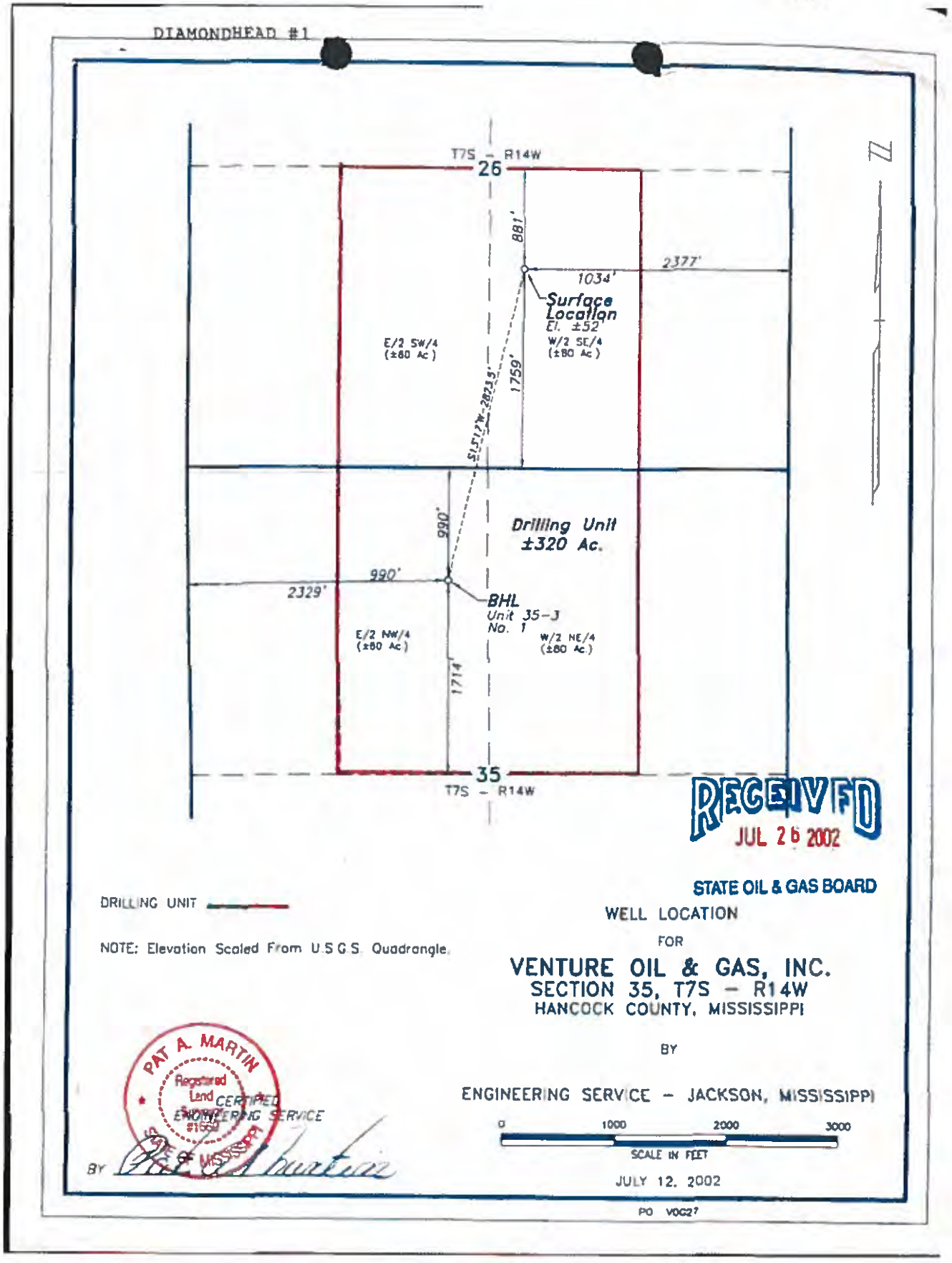
SEAL

Notary Public in and for ADAMS County

My commission expires 3-13-06 MISSISSIPPI County

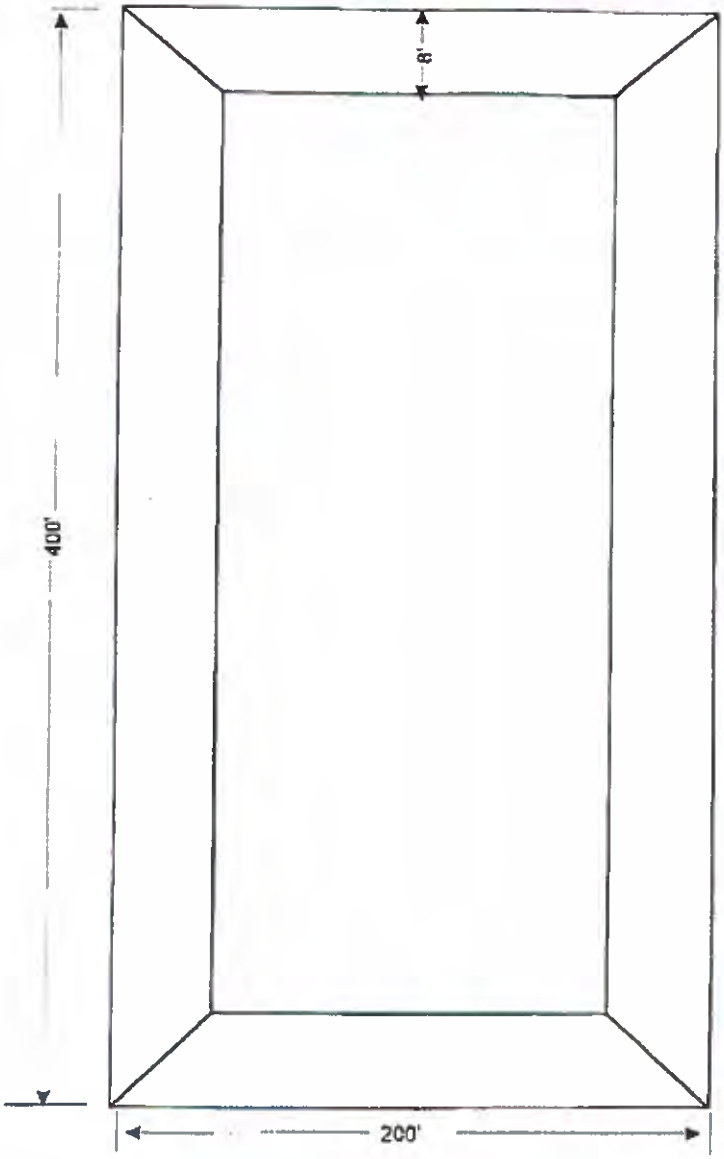
MISSISSIPPI STATE OIL AND GAS BOARD
Plugging Record
Form 7 - IOCC P-15
Authorized by Order No. 118.58 Effective November 1, 1958

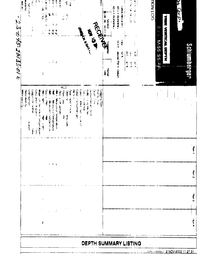
OK
LXJ
11/12/03

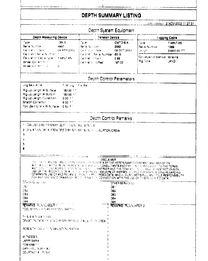

DIAMONDHEAD #1
T7S – R14W
26
881'
2377'
1034'
Surface Location
El. ±52
E/2 SW/4 (±80 Ac.)
W/2 SE/4 (±80 Ac.)
1759'
S15°17'W 2823.5'
990'
Drilling Unit ±320 Ac.
990'
2329'
BHL Unit 35-3 No. 1
E/2 NW/4 (±80 Ac.)
W/2 NE/4 (±80 Ac.)
1714'
35
T7S – R14W
N
RECEIVED
JUL 26 2002
STATE OIL & GAS BOARD
DRILLING UNIT
NOTE: Elevation Scaled From U.S.G.S. Quadrangle.
WELL LOCATION
FOR
VENTURE OIL & GAS, INC.
SECTION 35, T7S – R14W
HANCOCK COUNTY, MISSISSIPPI
BY
ENGINEERING SERVICE – JACKSON, MISSISSIPPI
PAT A. MARTIN
Registered Land
CERTIFIED ENGINEERING SERVICE
#1650
STATE OF MISSISSIPPI
BY
0 1000 2000 3000
SCALE IN FEET
JULY 12, 2002
PO V0G27

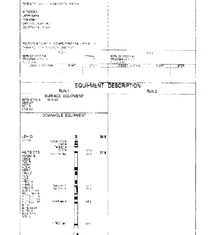
05 17 2002 10:50 FAX 1-601-355-3500 C DANNY FOSTER 002

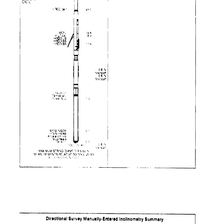
Mobile Minerals Corporation, 35-3 Well #1
Reserve Pit Diagram

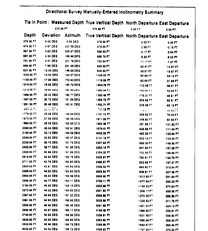


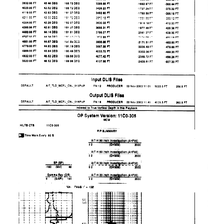


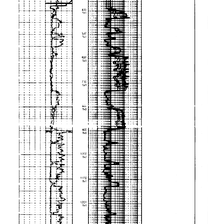


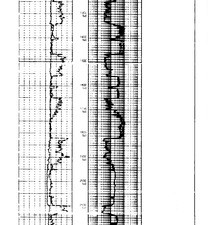


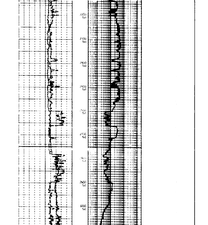


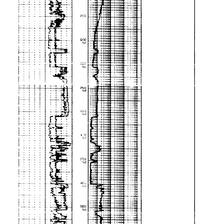


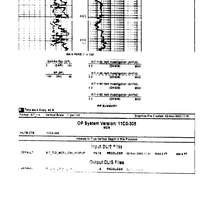












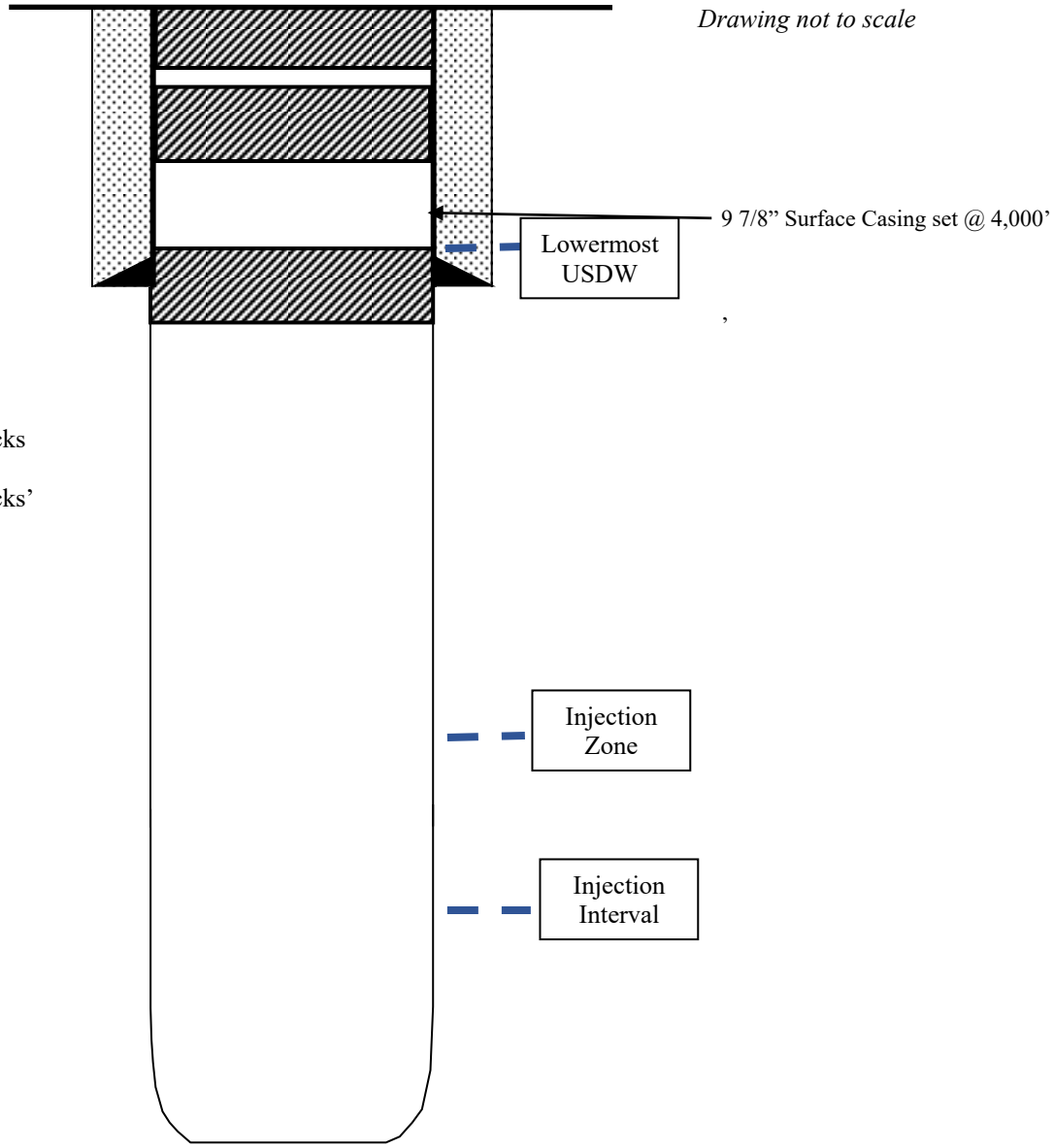
ARTIFICIAL PENETRATION #D-75

LAND AND NATURAL RESOURCES DEVELOPMENT
JAYNE BYRNE 501 TRUST 27-7 NO. 1

ARTIFICIAL PENETRATION DATA SHEET AND WELL SCHEMATIC FOR CHEMOURS DELISLE PLANT

Plant: Chemours DeLisle	**API #:** 230472001800
Map ID No.: D-75	**Status:** P & A
Operator: Land & Natural Resources Dev.	**Date Plugged:** 01/04/02
Well Name: J Byrne 501 Trust 27-7 No. 1	**Distance from DeLisle Well #5:** 14,400’
Location: T7S, R13W, SEC 27	**Well Type:** Exploration
TD: 15,258’	
Date Drilled: 09/27/01	

Drawing not to scale



Plugged : 01/04/02
0 to 50’ w/20 sacks

1,500’ to 1,600’ w/40 sacks

3,950’ to 4,050’ w/40 sacks’

Total Depth: 15,258’

Drawn by: GKS – July 2016
Checked by:
Revised by:

Scout Ticket

Wed May 09, 2012

23047200180000

General Information

1 BYRNE JANE TRUST 501

Data Source:	PI		
API:	23047200180000	**IC:**	
State:	MISSISSIPPI	**County:**	HARRISON
Field:	WILDCAT	**Operator:**	LAND & NATURAL RES
Initial Class:	NEW FIELD WILDCAT (WF)	**Final Well Class:**	NEW FIELD WILDCAT-DRY (INCLUDING TEMPORARILY ABANDONED WELL) (WF)
Status:	D&A	**Target Objective:**	O&G
Permit:	02OPD032 on Aug 21, 2001	**Hole Direction:**	VERTICAL
First Report Date:	Aug 24, 2001	**Abandonment Date:**	
Projected TD:	15,300 FT	**Projected Formation:**	
Geologic Province:	MID-GULF COAST BASIN	**Formation at TD:**	JAMES /LM/

Location

Section, Twp., Range:	27 7S 13W			**Data Source:**	PI
Spot Code:	SE NW NE				
Footage NS EW Origin:	825 FNL 1715 FEL CONGRESS SECTION				
Principal Meridian:	ST STEPHENS				
Lat/Long:	30.4114300 -89.2790300	**Lat/Long Source:**	TS	**Datum:**	NAD27

Location Narrative

Data Source	Type	Remark
PI	SCALED_FOOT	REGULATORY
PI	IRREG_SECT	N
PI	DST_FIELD	10 2/5 MI E WAVELAND FLD (MOORINGSPORT)

Dates and Depths

Data Source:	PI		
Spud:	Sep 27, 2001	**Spud Date Code:**	A
TD:	15,276 FT	**TD Date:**	Nov 12, 2001
TVD:		**PlugBack Depth:**	
Formation Code TD:	602JMESC	**Formation Name TD:**	JAMES /LM/
Ref. Elevation:		**KB. Elevation:**	
Ground Elevation:	65 FT GR	**LTD:**	
Contractor:	HELMERICH & PAYNE INCORPORATED		
Completed:	Jan 14, 2002	**Final Drilling:**	Nov 12, 2001
Rig Release Date:		**Rig #:**	72
Tool:			

Casing, Liner, Tubing

Casing	Data Source	Size	Base Depth	Cement
CASING	PI	9 5 8 IN	4,000 FT	

Drilling Journal

Narrative

Narrative	Data Source	Date	Remark
1	PI	Sep 20, 2001	MIRT
2	PI	Sep 26, 2001	PREP SPUD
3	PI	Oct 03, 2001	@ 4000 WOC

Narrative	Data Source	Date	Remark
4	PI	Oct 15, 2001	DRLG AHEAD
5	PI	Oct 22, 2001	DRLG AHEAD
6	PI	Oct 30, 2001	DRLG AHEAD
7	PI	Nov 05, 2001	DRLG AHEAD
8	PI	Nov 12, 2001	DRLG AHEAD
9	PI	Nov 19, 2001	RDRT

Logs

Log	Data Source	Type	Top Depth	Base Depth	Logging Co.	BHT	since circ.
1	PI	DI					
2	PI	DNL					
3	PI	MICL					
4	PI	SONL					

Dwights Energydata Narrative

Accumulated through 1997

Plugging Record

Number	Data Source	Interval	Cement	Remark
1	PI	3950 FT - 4050 FT	40 Sacks	
2	PI	1500 FT - 1600 FT	40 Sacks	
3	PI	0 FT - 50 FT	20 Sacks	

Old Information

Prior Well Number:

Prior Lease: 1 BYRNE JANE 501

Spud Date: Sep 27, 2001

Old TD:

Data Source:
Data Source: PI
Data Source: PI
Data Source: PI

Operator Address

Data Source: PI

Street or PO Box:

City:

State, Zip:

Country:

Phone:

Fax:

E-Mail:

Agent Name:

Agent Code:

Agent Remark: TOLBERT LAKE.....

Well Information

Name JAYNE BYRNE 501 # 1 **API Well #** 23047200180000 **Type** DH - Dry Hole **Status** PA - Plugged and Abandoned **Field** Wildcat

General Location Images Documents Construction Dates Injection Production Permit History MIT

Event	Date
Well Type Change	04/02/2010
Status Change Date	02/19/2002
Plugging Plan Date	01/31/2002
Plug and Abandon Date	01/04/2002
Total Depth Date	11/04/2001
Spud Date	09/27/2001

Development support provided by: the U.S. Department of Energy, the Ground Water Protection Council RBDMS, Coordinate Solutions, and Virtual Engineering Solutions.

Well Information

Name JAYNE BYRNE 501 # 1 **API Well #** 23047200180000 **Type** DH - Dry Hole **Status** PA - Plugged and Abandoned **Field** Wildcat

General Location Images Documents Construction Dates Injection Production Permit History MIT

SideTrack	Completion No	Completion Type	Diameter	Weight	Grade	Casing Top	Casing Bottom	New Pipe	Inside Ca
00	00	DH - Dry Hole	28			0	80	Yes	No
00	00	DH - Dry Hole	20	0	Grade J-55 Casing/Tubing	0	80	Yes	No
00	00	DH - Dry Hole	12.25			80	4000	Yes	No
00	00	DH - Dry Hole	9.625	40	Grade J-55 Casing/Tubing	0	4000	Yes	No

Development support provided by: the U.S. Department of Energy, the Ground Water Protection Council RBDMS, Coordinate Solutions, and Virtual Engineering Solutions.

LAND AND NATURAL RESOURCE DEVELOPMENT, INC.
2135 UNIVERSITY BLVD, SUITE B
TUSCALOOSA, AL 35480
PHONE (205) 248-6701
FAX (205) 248-6704

November 28, 2001

Mississippi State Oil & Gas Board
500 Graymont Ave
Suite E
Jackson, MS 39202

Re: Jayne Byrne 501 Trust 27-7 No. 1, API# 23-047-20018

To whom it may concern:

Enclosed are the following logs for the Jayne Byrne 501 Trust 27-7 No. 1 well:

Log Name	Run #	Depth
Correlation	Two	4003-14730
Borehole Compensated Sonic	Three	4003-15287
Compensated Neutron Lithology Density	Three	4003-15287
Microlog	Three	4003-15287
Array Induction	Three	4003-15287
Array Induction-Microlog Compensated Neutron Lithology Density	Three	4003-15287
Array Induction Imager	Two	4003-14730
Microlog	Two	4003-14730
Compensated Neutron Litho Density	Two	4003-14730
Array Induction Compensated Neutron Litho Density/Microlog	Two	4003-14730
Array Induction Imager Litho-Density Compensated Neutron	One	91-4002

Land, Inc. request that you keep these logs confidential for 6 months.

Sincerely,

Susan Marra

LAND AND NATURAL RESOURCE DEVELOPMENT, INC.
2135 UNIVERSITY BLVD, SUITE B
TUSCALOOSA, AL 35480
PHONE (205) 248-6701
FAX (205) 248-6704

November 28, 2001

Mississippi State Oil & Gas Board
500 Graymont Ave
Suite E
Jackson, MS 39202

1/3/02
Talked to Phyllis. She didn't know a F-3 was needed on a dry hole.
K F

Re: Jayne Byrne 501 Trust 27-7 No. 1, API# 23-0

To whom it may concern:

Enclosed are the following logs for the Jayne Byrn

Log Name	Run #	
Correlation	Two	
Borehole Compensated Sonic	Three	
Compensated Neutron Lithology Density	Three	
Microlog	Three	4003-15287
Array Induction	Three	4003-15287
Array Induction-Microlog Compensated Neutron Lithology Density	Three	4003-15287
Array Induction Imager	Two	4003-14730
Microlog	Two	4003-14730
Compensated Neutron Litho Density	Two	4003-14730
Array Induction Compensated Neutron Litho Density/Microlog	Two	4003-14730
Array Induction Imager Litho-Density Compensated Neutron	One	91-4002

Land, Inc. request that you keep these logs confidential for 6 months.

Sincerely,

Susan Marra

Susan Marra

RECEIVED
DEC 0 3 2001
STATE OIL & GAS BOARD

11/5/2001
PU Halliburton 9-5/8" OD RTTS packer, RIH to 3900'. Set pkr & test csg to 1400 psi for 30 min. Held OK. Breakdown formation @ 700 psi, pump into formation 8 BPM @ 650 psi, POOH w/RTTS pkr, LD RTTS, PU 9-5/8" OD csg mud EZ drill disposable pkr w/ mechanical setting tool. TIH to 3900', fill pipe and circ. Set pkr @ 3900'. Test csg 1000 psi, injection test.

12/26/2001 - 1/2/2002
Pumping mud in well and backfilling pits.

01/04/2002
Halliburton pump plugs 40 sks from 3950'-4050', 40 sks from 1500' - 1600', 20 sks from 0' - 50'. Weld steel plate on 9-5/8" csg 48" below ground level.

Stage	Sacks	Cement	Yield	lbs/gal
1	40	std/neat	1.18	15.6
2	40	std/neat	1.18	15.6
3	40	std/neat	1.18	15.6

LAND AND NATURAL RESOURCE DEVELOPMENT, INC.
2135 UNIVERSITY BOULEVARD, SUITE B
TUSCALOOSA, ALABAMA 35401
PHONE (205) 248-6701
FAX (205) 248-6704

Mississippi State Oil and Gas Board
Geology/Permits/Underground Injection
500 Greymont Avenue, Suite E
Jackson, MS 39202

Re: Land, Inc.
Jane Byrne 501 No. 1 Well
Harrison County, Mississippi
API # 23-047-20018

To Whom It May Concern:

Enclosed, please find OGB forms 6 and 7 on the above-referenced well. If you require additional information, please contact me.

Sincerely,

Phyllis Wood

Phyllis Wood

/phw

RECEIVED
JAN 30 2002
STATE OIL & GAS BOARD

MISSISSIPPI OIL AND GAS BOARD

INSPECTOR'S VERIFICATION OF WELL SPUDDING

FIELD: Wildcat INSPECTOR: JB

OPERATOR: Gulf Natural Resources Develop Inc INSPECTION DATE: 9-25-01

WELL NAME & NO.: Dave Byrne 501 #1 API #: 23-047-20018

COUNTY: Harrison SEC: 27 TWN: 7S RANGE: 13W

WELL SPUDDED ON 9-27-01

RECEIVED
OCT - 1 2001
STATE OIL & GAS BOARD

to be completed by field inspector upon first routine inspection after well is spudded - Will be placed in well file to verify well was drilled)

[redacted]tate Oil and Gas Boar[redacted]

State of Mississippi

500 Greymont Avenue, Suite F
Jackson, MS 39202
Telephone (601) 354-7142

WALTER L. BOONE, JR.
STATE OIL & GAS SUPERVISOR

July 23, 2001

(X) Permit to drill and approved Form 2 enclosed.

(X) Minimum surface casing requirements: 4,000 feet.

(X) Permit issued pursuant to Docket No. 206-2001-000.

Order No. 319-2001

(X) Land disposal form attached.

(X) Form 21, NORM Survey attached.

ORIGINAL SIGNED BY
WALTER BOONE

Walter L. Boone, Jr.
STATE OIL AND GAS SUPERVISOR

[redacted]

AMENDED

APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

☒ APPLICATION TO DRILL ☐ WORKOVER ☐ CHANGE OF OPERATOR

NAME OF COMPANY OR OPERATOR: Land and Natural Resource Development, Inc.			DATE: 11/05/2001
ADDRESS: 2135 University Blvd, Suite B.	CITY: Tuscaloosa	STATE: AL ZIP: 35401	TELEPHONE: 205-248-6701
NAME OF WELL: Jayne Byrne 501 Trust	WELL NO: 1	ELEVATION (GROUND): 65'	CIRCLE TYPE OF PROPOSED WELL: OIL GAS OTHER (NAME)
WELL LOCATION (WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES): 1715' WEL and 825' SNL, Section 27, T7S, R13W			
FIELD & RESERVOIR (IF WILDCAT, SO STATE): Wildcat	COUNTY: Harrison		APPROX. DATE WORK BEGINS: 9/1/2001
PROPOSED DEPTH: 15,300' FE	PROPOSED LENGTH OF SURFACE CASING: 400' FE	NUMBER OF ACRES IN DRILLING UNIT: 640 ACRE	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING: n/a FE
DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL: 7.5 miles NE of Waveland Field FEE			
NAME OF DRILLING CONTRACTOR: Helmerich & Payne International Drilling Company			
ADDRESS: Utica at 21st	CITY: Tulsa	STATE: OK	ZIP: 74114

FOR CHANGE OF OPERATOR ONLY - SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL

AUTHORIZED REPRESENTATIVE SIGNATURE: NOTICE PRIOR TO RECEIPT OF [illegible] NOTIFY [illegible]

NAME OF FORMER OPERATOR: [illegible] REPRESENTATIVE

H S OPE [illegible]

RECEIVED
NOV 0 6 2001
STATE OIL & GAS BOARD

FORM 1B: DATE REQUESTED

DATE APPROVED

CONTINGENCY PLAN: DATE RECEIVED

INSPECTOR
RONNIE "PETE" LOWERY
RECORDER 601-787-4953
MOBIL 601-543-5175

NOTE: NOTIFY AREA FIELD INSPECTOR OR FIELD DIRECT [illegible] TOTAL DEPTH.

State Oil and Gas Board, 500 Greymont Avenue, [illegible] 39202 601-354-7142

REMARKS: (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)

This application is to drill to a total depth of 15,300'. Previous application approved proposed depth of 15,000'. Verbal approval was given on location by field agent.

ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS. STATUTE 53-3-7)	YES	NO	IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS. STATUTE 53-3-7)	YES	NO
	X				X

EXECUTED THIS THE 6th DAY OF November 19 2001

STATE OF Alabama

COUNTY OF Tuscaloosa

SIGNATURE OF AFFIANT: William E. Tucker

BEFORE ME, THE UNDERSIGNED AUTHORITY, ON THIS DAY PERSONALLY APPEARED William E. Tucker KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH, STATES THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT.

SUBSCRIBED AND SWORN TO BEFORE ME THIS 6th DAY OF November 19 2001

SEAL

NOTARY PUBLIC IN AND FOR State of Alabama

MY COMMISSION EXPIRES January 7, 2003

COUNTY

PERMIT NUMBER 2002-ORD-032

APPROVAL DATE 11-8-2002

APPROVED BY [illegible]

NOTICE: BEFORE SENDING THIS FORM, BE SURE THAT ALL INFORMATION

MISSISSIPPI STATE OIL AND GAS BOARD
FORM 2 (Rev. 4/90)
A.P.I. WELL NUMBER

STATE	COUNTY	WELL
23	047	200180000

129428

APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

[X] APPLICATION TO DRILL [ ] WORKOVER [ ] CHANGE OPERATOR

NAME OF COMPANY OR OPERATOR: Land & Natural Resource Development, Inc.
DATE: 6/18/01

ADDRESS: 611 McFarland Blvd. | CITY: Northport | STATE: AL | ZIP: 36476 | TELEPHONE: 205) 339-4555

NAME OF WELL: Jayne Byrne 501 Trust 27-7 | WELL NO.: No. 1 | ELEVATION (GROUND): GL 65'

CIRCLE TYPE OF PROPOSED WELL: Oil (Gas) Other (Name)

WELL LOCATION (WHEN POSSIBLE GIVE FOOTAGE FROM SECTION LINES): 1715' WEL and 1238' SNL Section 27, T7S-R13W, Harrison County, MS
Drilling Unit S 1/2 of S 1/2 of Sec. 22 and N 3/4 of Sec. 27, T7S-R13W, Harrison Co., MS
SECTION ____ TOWNSHIP ____ RANGE ____

FIELD & RESERVOIR (IF WILDCAT, SO STATE): Wildcat | COUNTY: Harrison | APPROX. DATE WORK WILL BEGIN: 8/01/01

PROPOSED DEPTH	PROPOSED LENGTH OF SURFACE CASING	NUMBER OF ACRES IN DRILLING UNIT	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING UNIT LINE	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL
14,700 FEET	4000 FEET	640 ACRES	N/A FEET	7.5 miles NE of Waveland Field FEET

NAME OF DRILLING CONTRACTOR: Grey Wolf Drilling Company, L.P.

ADDRESS: 10370 Richmon Avenue, Suite 600 | CITY: Houston | STATE: TX | ZIP: 77042-4136

FOR CHANGE OF OPERATOR ONLY - SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL

NOTICE: PRIOR TO BEGINNING WORK NOTIFY OIL & GAS BD REPRESENTATIVE

AUTHORIZED REPRESENTATIVE SIGNATURE | FOR NEW OPERATOR

INSPECTOR
RONNIE "PETE" LOWERY
RECORDER 601-787-4953
MOBIL 601-543-5175

RECEIVED
JUN 18 2001
STATE OIL & GAS BOARD

FORM 18 | DATE REGISTERED | CONTINGENCY PLAN | DATE RECEIVED | E ONLY! | DATE APPROVED

NOTE: NOTIFY AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON OFFICE) OF DATES OF SPUDDING AND REACHING TOTAL DEPTH
State Oil and Gas Board, 500 Greymont Avenue, Suite E, Jackson, MS 39202 601-354-7142

REMARKS (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)

This is a renewal of the permit issued in January, 2001, in Docket No. 476-200.
(See new Docket No. 206-2001)

ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS STATUTE 53 3 7)	YES	NO	IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PROCEEDS THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS STATUTE 53 3 7)	YES	NO
	X				X

EXECUTED THIS THE 18th DAY OF June XX 2001

STATE OF Mississippi
COUNTY OF Hinds

Lake Tolbert
SIGNATURE OF AFFIANT

BEFORE ME, THE UNDERSIGNED AUTHORITY, ON THIS DAY PERSONALLY APPEARED Lake Tolbert KNOWN TO ME TO BE THE PERSON DESCRIBED IN THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH STATED THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT.

SUBSCRIBED AND SWORN TO BEFORE ME THIS 18th DAY OF June XX 2001

NOTARY PUBLIC
NANCY E. ROGERS HINDS COUNTY, MS
My Commission Expires November 14, 2001

Nancy E. Rogers
NOTARY PUBLIC SIGNATURE

11-14-2001
COMMISSION EXPIRES

Hinds
Mississippi
COUNTY

PERMIT NUMBER: 2002-OPD-032
APPROVAL DATE: 7-18-2001
APPROVED BY: Board 2.5.

NOTICE: BEFORE SENDING THIS FORM BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN. SEE INSTRUCTIONS ON REVERSE SIDE OF FORM

MISSISSIPPI STATE OIL AND GAS BOARD
FORM NO. 2 (Rev. 4-90)
A.P.I. WELL NUMBER

STATE	COUNTY	WELL
25	047	20018

MISSISSIPPI STATE OIL & GAS BOARD
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

INDICATE TYPE OF COMPLETION

NEW WELL	WORKOVER	DEEPEN	PLUG BACK	SAME RESERVOIR	DIFFERENT RESERVOIR	OIL	GAS	DRY
X								X

DESCRIPTION OF WELL AND LEASE

OPERATOR	ADDRESS
Land and Natural Resource Development, Inc.	2135 University Blvd.Ste B, Tuscaloosa, AL 35401

LEASE NAME	WELL NUMBER	FIELD & RESERVOIR
Jayne Byrne 501 Trust	1	Wildcat, James Lime

LOCATION: 1715' WEL amd 825' SNL — SEC - TWN - RGE OR BLOCK & SURVEY: 27, 7S, 13W

COUNTY	PERMIT NUMBER	DATE ISSUED	PREVIOUS PERMIT NUMBER	DATE ISSUED
Harrison	23-047-20018	8/21/2001		

DATE SPUDDED	DATE TOTAL DEPTH REACHED	DATE COMPLETED, READY TO PRODUCE	ELEVATION (DF, RKB, RT or GR)	ELEVATION OF CASING HD. FLANGE
9/27/01	11/4/01	N/A	RKB 106.9'	74.9'

TOTAL DEPTH	PBTD	SINGLE, DUAL OR TRIPLE COMPLETION?	IF THIS IS A DUAL OR TRIPLE COMPLETION, FURNISH SEPARATE REPORT FOR EACH COMPLETION.
15,258		Dry Hole	

PRODUCING INTERVAL(S) FOR THIS COMPLETION	ROTARY OR CABLE TOOLS USED (Interval)	DRILLING CONTRACTOR
Dry Hole		

WAS THIS WELL DIRECTIONALLY DRILLED?	WAS DIRECTIONAL SURVEY MADE?	WAS COPY OF DIRECTIONAL SURVEY FILED?	DATE FILED
No			

TYPE OF ELECTRICAL OR OTHER LOGS RUN (Check Logs Filed with the Commission)	DATE FILED
LDT, CNL, MI-C, AIT-B, BITC-Sonic, PEX-AITH See attached list	11/28/2001

CASING RECORD
CASING (Report All Strings Set in Well - Conductor, Surface, Intermediate, Producing etc.)

PURPOSE	SIZE HOLE DRILLED	SIZE CASING SET	WEIGHT (lb./Ft.)	DEPTH SET	SACKS CEMENT	AMOUNT PULLED
Surface	12 1/4"	9 5/8"	40#	4000'	925	-0-
Conductor	28"	20"		80'	150	

TUBING RECORD

SIZE IN	DEPTH SET FT.	PACKER SET AT

LINER RECORD

SIZE IN	TOP FT.	BOTTOM FT.	SACKS CEMENT	SCREEN FT.

PERFORATION RECORD

NUMBER PER FEET	SIZE & TYPE	DEPTH INTERVAL

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD

AMOUNT & KIND OF MATERIAL USED	DEPTH INTERVAL

INITIAL PRODUCTION

DATE OF FIRST PRODUCTION	PRODUCING METHOD (Indicate if Flowing, Gas Lift or Pumping - If Pumping, Indicate Size & Type of Pump)

DATE OF TEST	HOURS TESTED	CHOKE SIZE	OIL PRODUCED DURING TEST	GAS PRODUCED DURING TEST	WATER PRODUCED DURING TEST	OIL GRAVITY

TUBING PRESSURE	CASING PRESSURE	CALCULATED RATE OF PRODUCTION PER 24 HRS	OIL BBLS.	GAS MCF	WATER BBLS	GAS - OIL RATIO

DISPOSITION OF GAS (State Whether Vented, Used for Fuel or Sold)	SOUR GAS OR OIL: AMOUNT H_2S	AMOUNT CO_2

Executed this the 11th day of February 20 02

State of Alabama

County of Tuscaloosa

William E. Tucker
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared William E. Tucker known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath, states that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 11th day of February 20 02

SEAL

Notary Public in and for State at Large Alabama

My commission expires: January 7, 2003

RECEIVED
FEB 19 2002
STATE OIL & GAS BOARD

MISSISSIPPI STATE OIL AND GAS BOARD
FORM NO. 3
A.P.I. WELL NUMBER
STATE COUNTY WELL

CASING TESTS, REQUIRED BY STATEWIDE

11/5/2001
PU Halliburton 9-5/8" OD RTTS packer, RIH to 3900'. Set pkr & test csg to 1400 psi for 30 min. Held OK. Breakdown formation @ 700 psi, pump into formation 8 BPM @ 650 psi, POOH w/RTTS pkr, LD RTTS, PU 9-5/8" OD csg mud EZ drill disposable pkr w/ mechanical setting tool. TIH to 3900', fill pipe and circ. Set pkr @ 3900'. Test csg 1000 psi, injection test.

12/26/2001 - 1/2/2002
Pumping mud in well and backfilling pits.

01/04/2002
Halliburton pump plugs 40 sks from 3950'-4050', 40 sks from 1500' - 1600', 20 sks from 0' - 50'. Weld steel plate on 9-5/8" csg 48" below ground level.

Stage	Sacks	Cement	Yield	lbs/gal
1	40	std/neat	1.18	15.6
2	40	std/neat	1.18	15.6
3	40	std/neat	1.18	15.6

DETAIL OF FORMATIONS PENETRATED

FORMATION	TOP	BOTTOM	DESCRIPTION*
	Sub Sea		
Wx. Mkr	-5,379'	-7,085'	
T. Chalk	-7,085'	-8,015'	
B. Chalk	-8,015'	- 8,915'	
Tuscaloosa	-8,915'	-12,218'	
Paluxy	-12,218'	-13,125	
M'port	-13,125'	-13,533'	
M'port A	-13,533'	-14,623'	
James	-14,623'	-14,856	
Sligo	-14,856	-14,805	

* Show all important zones of porosity; detail of all cores; and all drill-stem tests, including depth interval tested, cushion used, time tool open, flowing and shut-in pressures, and recoveries.

INSTRUCTIONS

Attach electrical log if run.

This well completion or recompletion report and well log shall be filed with the Mississippi State Oil and Gas Board no later than thirty (30) days after project completion.

Form No 6

MISSISSIPPI STATE OIL & GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON

OPERATOR	ADDRESS
Land And Natural Resource Development, Inc.	2135 University Blvd., Suite B, Tuscaloosa, AL 35403

WELL NAME	WELL NO.
Jayne Byrne 501 Trust	1

LOCATION OF WELL
1715' WEL and 825' SNL

A.P.I. NO.	FIELD NAME
23-047-20018	Wildcat

SECTION	TOWNSHIP	RANGE	COUNTY	DATE PLUGGING TO
27	7S	13W	Harrison County	1/4/2002

FIRM ENGAGED TO PLUG WELL	ADDRESS
Halliburton Energy Services	1364 Sandersville-Sharon road Sandersville, MS 39477

PROPOSED PLUGGING PROCEDURE

Pump pit into wellbore.
Set 100' cement plug @ 4050' – 3950'
Set 100' cement plug @ 1600' – 1500'
Set 50' cement plug @ 50' – 0'
Cut casing and weld on steel plate.

RECEIVED
JAN 3 0 2002
STATE OIL & GAS BOARD

Notice: Prior To Beginning Work Notify Oil & Gas Board Representative

INSPECTOR
RONNIE "PETE" LOWERY
RECORDER 601-787-4953
MOBILE 601-543-5175

Executed this the 23rd day of January, 20 02

State of Alabama

County of Tuscaloosa

William E Tucker
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared William E. Tucker known to me to be the person whose name is subscribed to the above instrument, who being by me dully sworn on oath, states that he is duly authorizedto make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct

Subscribed and sworn to before me this 23rd day of January, 20 02

SEAL

Signature

Notary Public in and for State of Alabama

My commission expires: Jan. 7, 2003 County, State at Large

FOR OFFICIAL OIL & GAS BOARD USE ONLY
Approval Date 1/31/02
Supervisor/By WJC

MISSISSIPPI STATE OIL AND GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON
FORM 6

MISSISSIPPI STATE OIL & GAS BOARD

PLUGGING RECORD

FORM No 7

Operator: Land And Natural Resource Dev., Inc.		Address: 2135 University Blvd, Tusclaoosa, AL 35401	
Name of Well: Jayne Byrne E01 Trust	Well No.: 1	Field & Reservoir: Wildcat	
Location of Well: 1715' WEL and 825' SNL		Section: 27 Township: 7 S Range: 13 W	
API No.: 23-047-20018		County: Harrison	
Application to drill this well was filed in name of: Land and Natural Resource Development, Inc.	Has this well ever produced oil or gas: no	Character of well at completion (initial production): Oil (bbls/day)	Gas (MCF/day) / Dry: x
Date Plugged: 1/4/2002	Total Depth: 15,258	Amount well producing when plugged: Oil (bbls/day): 0	Gas (MCF/day): 0 / Water (bbls/day): 0

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used. Indicate zones squeeze cemented, giving amount cement
Oil and Gas - none	salt water	surface - 15,258'	40 sks std/neat 4050'-3950
Formations open			40 sks std/neat 1600'-1500
Wilcox to Sligo			20 sks std/neat 50' - 0'
			steel plate 48" below GL

CASING RECORD

Size pipe	Put in well (feet)	Pulled out (feet)	Left in well (feet)	Give depth & method of parting casing (shot, ripped, etc.)	Packers and shoes
9-5/8" 40#	4000'	0	4000'	n/a	9-5/8" Halliburton float shoe

Was well filled with mud-laden fluid, according to regulations? yes

Indicate deepest formation containing fresh water: 2275'-2490'

NAME AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well
Jayne Byrne c/o Eaton Lang	P.O.B 130, Gulfport, MS	Surface Owner
~~Byrne Trust c/o Eaton Lang~~	~~P.O.Box130, Gulfrpot, MS 39502~~	~~South~~
~~Annie Saucier~~	26104 Cunningham Rd, Pass Christian, MS	North
Weyerhaeuser Corp	33330 8th Av S,Ste 121,Federal Way, WA	East
Rodney & Teresa Roberts	26185 Cunningham R.,Pass Christian, MS	West

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Use reverse side for additional details
File this form in duplicate with see reverse side

Executed this the 24th day of January 20 02

State of Alabama

County of Tuscaloosa

William E. Tucker
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared William E. Tucker known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath, states that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 24th day of January 20 02

SEAL

Signature

My commission expires: January 7, 2003

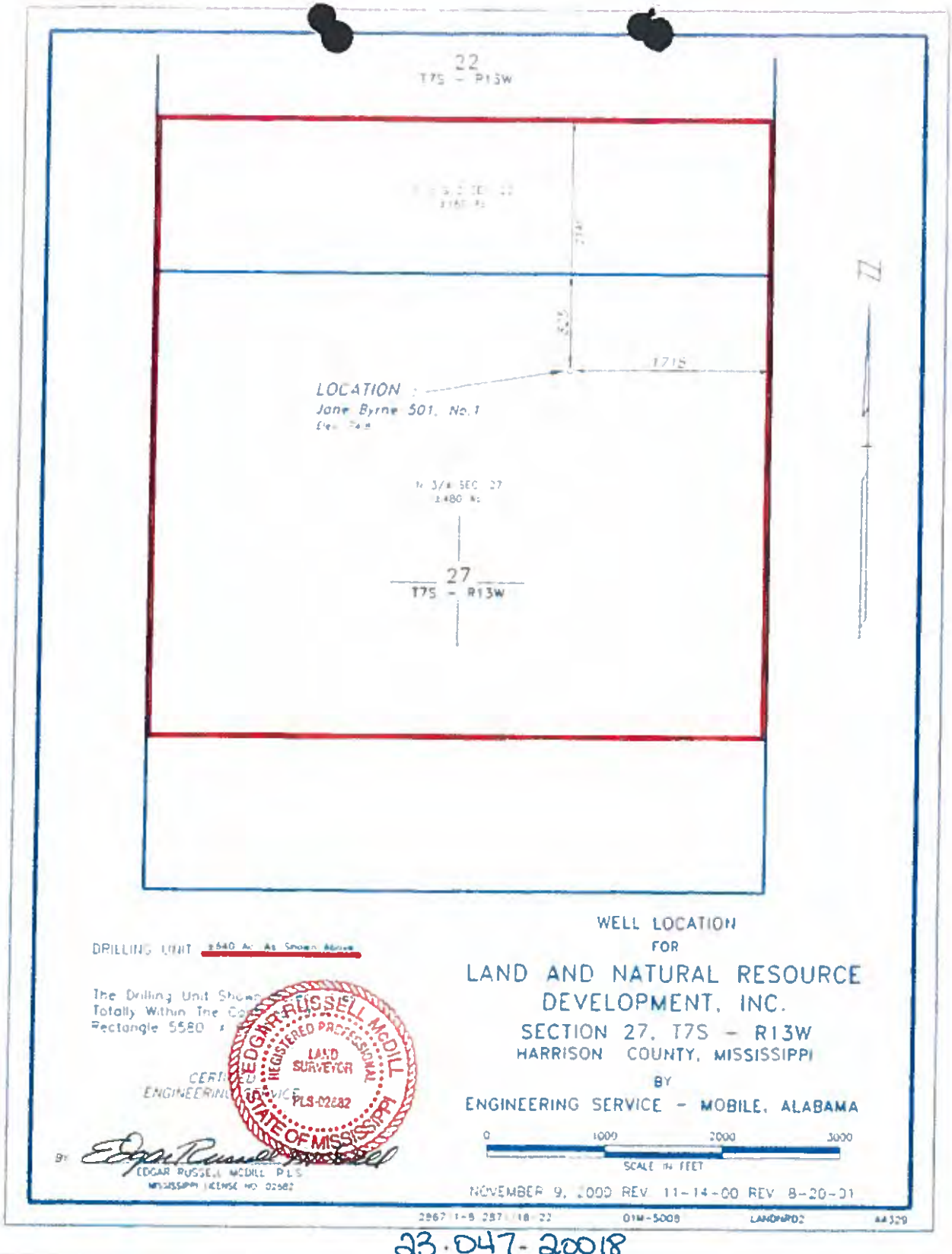
Notary Public in and for State at Large

County Alabama

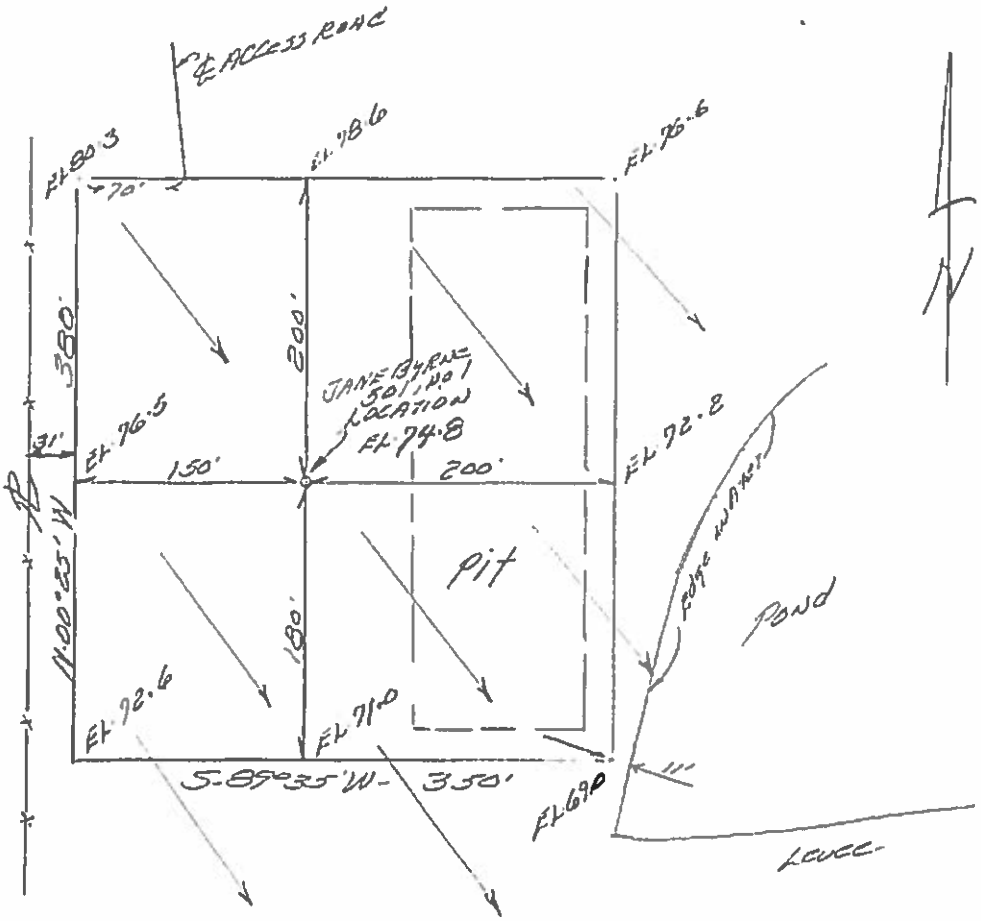
MISSISSIPPI STATE OIL AND GAS BOARD
Plugging Record
Form 7
Revised May, 2001

RECEIVED
JAN 30 2002
STATE OIL & GAS BOARD

OK
WFD
1/31/02


22
T7S - R13W
T7S
LOCATION
Jane Byrne 501, No. 1
N 3/4 SEC 27
2480 Ac.
27
T7S - R13W
N
DRILLING UNIT 640 Ac. As Shown Above
The Drilling Unit Shown
Totally Within The
Rectangle 5580
CERT
ENGINEERING SERVICE
EDGAR RUSSELL McDILL
REGISTERED PROFESSIONAL
LAND
SURVEYOR
PLS-02582
STATE OF MISSISSIPPI
By
EDGAR RUSSELL MCDILL PLS
MISSISSIPPI LICENSE NO 02582
WELL LOCATION
FOR
LAND AND NATURAL RESOURCE
DEVELOPMENT, INC.
SECTION 27, T7S - R13W
HARRISON COUNTY, MISSISSIPPI
BY
ENGINEERING SERVICE - MOBILE, ALABAMA
0
1000
2000
3000
SCALE IN FEET
NOVEMBER 9, 2000 REV 11-14-00 REV 8-20-01
2867 1-9 287 18-22
01M-5008
LANDNPD2
AA329

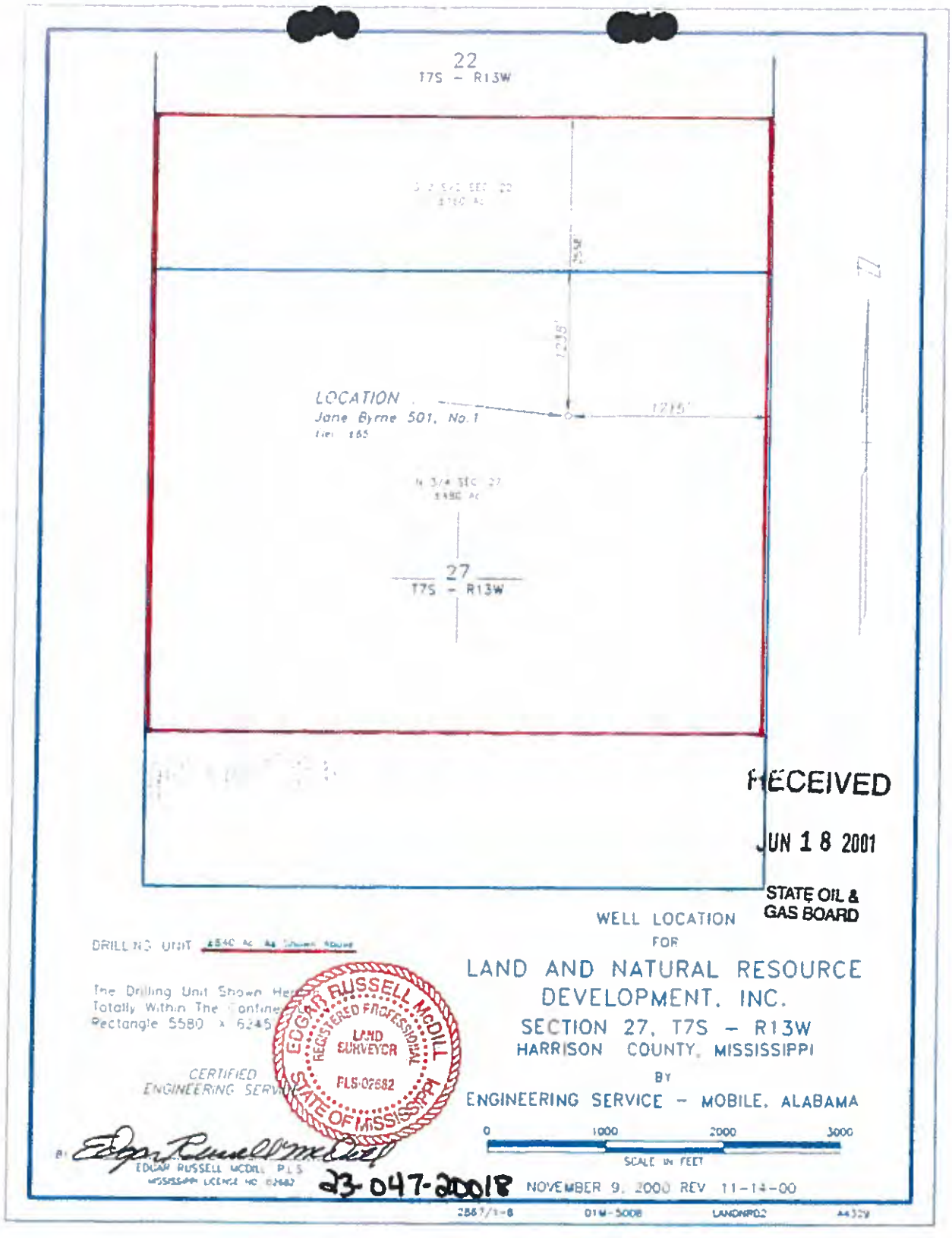
23-047-20018



Shows DRAINAGE →

SCALE
1" = 100'

WELL LOCATION
LAND AND NATURAL RESOURCES
DEVELOPMENT INC
SEC 27, T. 7S - R 13 W
HARRISON CO. MISS



RECEIVED

JUN 18 2001

STATE OIL & GAS BOARD

DRILLING UNIT 640 AC As Shown Above

The Drilling Unit Shown Hereon Is Totally Within The Continental Rectangle 5580 x 6245

CERTIFIED ENGINEERING SERVICE

EDGAR RUSSELL MCDILL REGISTERED PROFESSIONAL LAND SURVEYOR FLS-02682 STATE OF MISSISSIPPI

EDGAR RUSSELL MCDILL PLS
MISSISSIPPI LICENSE NO 02682

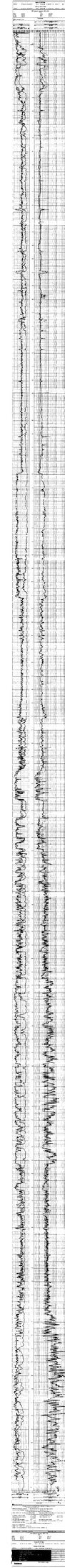
WELL LOCATION
FOR
LAND AND NATURAL RESOURCE DEVELOPMENT, INC.
SECTION 27, T7S - R13W
HARRISON COUNTY, MISSISSIPPI
BY
ENGINEERING SERVICE - MOBILE, ALABAMA

0 1000 2000 3000
SCALE IN FEET

23-047-20018

NOVEMBER 9, 2000 REV 11-14-00

2867/1-B 01M-5008 LANDNP02 A432W



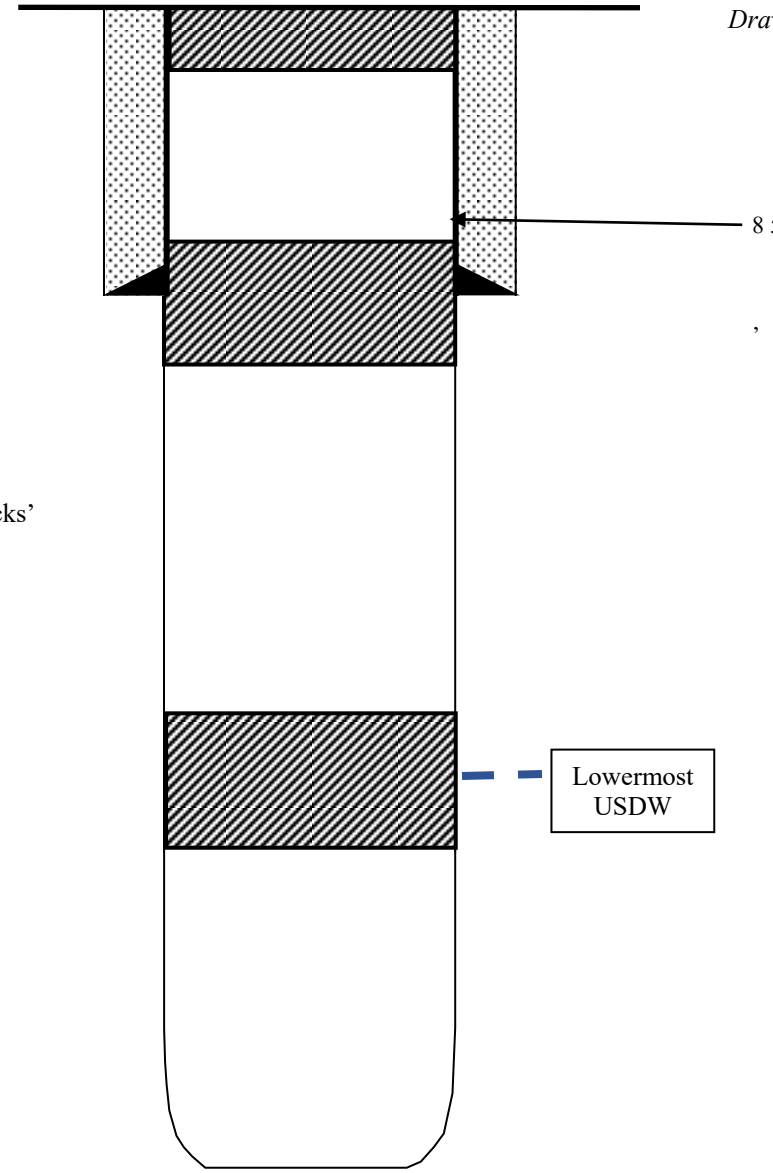
ARTIFICIAL PENETRATION #D-100

BAY GAS LLC
JONES ET AL. NO. 1

ARTIFICIAL PENETRATION DATA SHEET AND WELL SCHEMATIC FOR CHEMOURS DELISLE PLANT

Plant: Chemours DeLisle	**API #:** 2304520135000
Map ID No.: D-100	**Status:** P & A
Operator: Bay Gas LLC	**Date Plugged:** 07/30/04
Well Name: Jones et al. No. 1	**Distance from DeLisle Well #5:** 27,500’
Location: T7S, R14W, SEC 40	**Well Type:** Exploration
TD: 4,250’	
Date Drilled: 07/27/04	

Drawing not to scale



Plugged : 07/30/04
0 to 50’ w/10 sacks

370’ to 470’ w/35 sacks

2,970’ to 3,070 w/35 sacks’

Total Depth: 4,250’

Drawn by: GKS – July 2016
Checked by:
Revised by:

Permit Information

Permit No 2004-OPD-407 **Permit Type** Original Permit to Drill

General Location Dates Wells

Status Approved **Active** True

Lease Name Jones et al **Well Number** 1

Comment

Development support provided by: the U.S. Department of Energy, the Ground Water Protection Council RBDMS, Coordinate Solutions, and Virtual Engineering Solutions.

Well Information

Name Jones et al 1 **API Well #** 23045201350000 **Type** DH - Dry Hole **Status** PA - Plugged and Abandoned **Field** Wildcat

General Location Images Documents Construction Dates Injection Production Permit History MIT

Section	40	**TWP**	7S	**RNG**	14W	**Sectional Desc**	
Latitude	30.38832	**Longitude**	-89.39957	**Elev Gr**	11	**County**	HANCOCK
NS Feet		**From N/S**		**EW Feet**		**From E/W**	

Development support provided by: the U.S. Department of Energy, the Ground Water Protection Council RBDMS, Coordinate Solutions, and Virtual Engineering Solutions.

Well Information

Name Jones et al 1 **API Well #** 23045201350000 **Type** DH - Dry Hole **Status** PA - Plugged and Abandoned **Field** Wildcat

General Location Images Documents Construction Dates Injection Production Permit History MIT

SideTrack	Completion No	Completion Type	Diameter	Weight	Grade	Casing Top	Casing Bottom	New Pipe	Inside Ca
00	00	DH - Dry Hole	11			0	422	Yes	No
00	00	DH - Dry Hole	8.625	23	Grade J-55 Casing/Tubing	0	422	Yes	No

RESPONSIBILITY FOR LAND DISPOSAL OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERVE PIT.

Please complete the following. Each separate document shall reference the well name, operator, location. An employee of the MSOGB cannot sign as a witness when witness or notarization is required.

I. FIELD Gilbert Operator Indigo Exp. LLC

Well Name & Number Rowe Etal #C-1

A.P.I. Number 23-045-20135

Location: Sec 40 T7S-R14E County Hancock

II. Location of disposal site Sec 40 T7S-R14W Well Loc.

Landowner (Mr./Mrs.) Eugene Lewis Hagen, Successive Landlord William J Kearney, III and George Douglas, Jr.

III. Interim Land-site approval by MSOGB Inspector, before land spreading begins.

A. Site acceptable (YES/NO) Yes
B. Land Owners approval granted** (YES/NO) Yes
C. Pit Analysis acceptable** (YES/NO) Yes
D. Were Hazardous materials in the waste** (YES/NO) No

** REQUIRED ATTACHMENTS

1 LAND OWNERS WITNESSED OR NOTARIZED SIGNED APPROVAL

1 COPY OF THE PIT ANALYSIS

1 NOTARIZED SIGN OFF BY THE DRILLING CONTRACTOR THAT NO HAZARDOUS MATERIALS WERE INTRODUCED TO THE WASTE.

E. Conditions for land spreading by MSOGB

F. FIELD INSPECTOR (Signature) DATE 5-16-04

IV. Final Inspection and approval by MSOGB after landfarming is completed.

FIELD INSPECTOR (Signature) DATE 9-8-04

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

BONNER ANALYTICAL TESTING COMPANY
2703 OAK GROVE ROAD
HATTIESBURG, MS 39402
PH. (601) 264-2854
Fax (601) 268-7084

Client: THOMCO

Project #: 010792
Collected By: Client

Sample Date/Time: 08-01-04
Date/Time Rec'd: 08-02-04 @ 1130

RESERVE PIT

BAY GAS LLC – JONES ET AL #1

Analyte/Method #	Result BT09071	Concentration Limit	MDL	Date/Time/Analyst
pH/150.1	9.80	6.0-9.0	±0.01	08-02-04/1205/MLF
TSS/160.2	284,000	100	1.0	08-03-04/1300/TNJ
COD/410.4	6,627	250	15.0	08-03-04/1100/MLF
Chlorides/325.3	325	500	0.21	08-02-04/1430/MLF
Conductivity/120.1	1,876	100	±0.1	08-02-04/1205/MLF
Phenol/420.1	0.02	0.1	0.03	08-04-04/0820/KAW
Chromium/200.7	3.69	0.5	0.010	08-04-04/1200/BAW
Zinc/200.7	8.05	5	0.010	08-04-04/1200/BAW

Data reported in mg/Kg, unless otherwise noted. All analyses performed in accordance with 40 CFR 136 and amendments.

MDL = Method Detection Limit.

Certified by:
Michael S. Bonner, Ph.D.
BONNER ANALYTICAL TESTING COMPANY

kr

D&D DRILLING & EXPLORATION INC.

MISSISSIPPI STATE OIL & GAS BOARD
500 GREYMONT AVENUE, SUITE E
JACKSON, MS. 39202

RE: API Well No. 23 045 20135
Operator Bay Gas, L. L. C.
Well Name Jones et al No. 1
Location Hancock County, MS.

Gentlemen:

I, Jess Horton, Vice-President of D & D Drilling & Exploration Inc., drilling contractor for the above referenced well, being duly sworn, do hereby state under oath, to the best of my knowledge no hazardous materials were introduced or contained in the drilling fluid, mud or waste which is to be spread over or buried on the location of the above referenced well.

Witness my signature this 11th day of August 2004.

D & D DRILLING & EXPLORATION INC.

By _____
Jess Horton

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

Sworn to and subscribed before me, this 11th day of August 2004.

_____
Notary Public

My commission expires:

June 3, 2005

SHIRLEY R. PRIEST ADAMS COUNTY MS NOTARY PUBLIC

P. O. BOX 1634 • FERRIDAY, LOUISIANA 71334-1634 • (318) 757-3274 • FAX (318) 757-8595

The undersigned, **Eugenie Jones Huger, Susan Jones Gundlach and William J. Kearney, III and George Douglass, Jr., Co-Executors of the Succession of Joseph Merrick Jones, Jr.**, are the landowners on which the Bay Gas, LLC Jones et al #1 well will be drilled by D&D Drilling and Exploration, Inc. Also, the undersigned hereby authorizes Bay Gas, LLC to land spread, on said landowners land and on the respected location, the ***drilling mud*** from the reserve pit, in accordance with the provisions set out in the attached Mississippi State Oil & Gas Board Form designated: **OPERATORS RESPONSIBILITY FOR LAND DISPOSAL OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERV PIT.**

Sec 48 T7S R 14W

IN WITNESS WHEREOF, this instrument is executed on the date of acknowledgement.

Eugenie Jones Huger

EUGENIE JONES HUGER

SUCCESSION OF JOSEPH MERRICK JONES, JR.
BY:

Susan Jones Gundlach William J. Kearney III

SUSAN JONES GUNDLACH

WILLIAM J. KEARNEY, III, Co-Executor

GEORGE DOUGLASS, JR, Co-Executor

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

ACKNOWLEDGMENTS

STATE OF LOUISIANA
PARISH OF Orleans

I hereby certify, that on this day, before me, the undersigned authority duly authorized in the state and parish aforesaid to take acknowledgments, personally appeared **EUGENIE JONES HUGER and SUSAN JONES GUNDLACH** to me known to be the persons described in and who executed the foregoing instrument and they acknowledged before me that, being informed of the contents of the same, they voluntarily signed and delivered the within and foregoing instrument on the day and year therein mentioned.

Given under my hand and official seal, this 29th day of July, 2004

(Affix Seal)

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

The undersigned, **Eugenie Jones Huger, Susan Jones Gundlach and William J. Kearney, III and George Douglass, Jr., Co-Executors of the Succession of Joseph Merrick Jones, Jr.,** are the landowners on which the Bay Gas, LLC Jones et al #1 well will be drilled by D&D Drilling and Exploration, Inc. Also, the undersigned hereby authorizes Bay Gas, LLC to land spread, on said landowners land and on the respected location, the ***drilling mud*** from the reserve pit, in accordance with the provisions set out in the attached Mississippi State Oil & Gas Board Form designated: **OPERATORS RESPONSIBILITY FOR LAND DISPOSAL OF APPROVED EXPLORATION AND PRODUCTION WASTE FROM A RESERV PIT.**

Sec 4E T7S R14E 14W

IN WITNESS WHEREOF, this instrument is executed on the date of acknowledgement.

Eugenie Jones Huger

EUGENIE JONES HUGER

SUCCESSION OF JOSEPH MERRICK JONES, JR.
BY:

Susan Jones Gundlach William J. Kearney III

SUSAN JONES GUNDLACH

WILLIAM J. KEARNEY, III, Co-Executor

GEORGE DOUGLASS, JR, Co-Executor

RECEIVED
SEP 14 2004
STATE OIL & GAS BOARD

ACKNOWLEDGMENTS

STATE OF LOUISIANA
PARISH OF Orleans

I hereby certify, that on this day, before me, the undersigned authority duly authorized in the state and parish aforesaid to take acknowledgments, personally appeared **EUGENIE JONES HUGER and SUSAN JONES GUNDLACH** to me known to be the persons described in and who executed the foregoing instrument and they acknowledged before me that, being informed of the contents of the same, they voluntarily signed and delivered the within and foregoing instrument on the day and year therein mentioned.

Given under my hand and official seal, this 27th day of July, 2004

(Affix Seal)

Diann J. Sabich
Notary ID# 34693

(Title of Officer)

My Commission expires: at death. in and for St. Bernard Parish, Louisiana.

STATE OF LOUISIANA
PARISH OF Orleans

I hereby certify, that on this day, before me, the undersigned authority duly authorized in the state and parish aforesaid to take acknowledgments, personally appeared **WILLIAM J. KEARNEY, III and GEORGE DOUGLASS, JR.,** who acknowledged that they are the **Co-Executors of the Succession of JOSEPH MERRICK JONES, JR.** and that in said representative capacity they executed the above and foregoing instrument, after first having been duly authorized so to do.

Given under my hand and official seal, this 29th day of July, 2004

D&D DRILLING & EXPLORATION INC.

MISSISSIPPI STATE OIL & GAS BOARD
500 GREYMONT AVENUE, SUITE E
JACKSON, MS. 39202

WC

RE: API Well No. 23 045 20135
Operator Bay Gas, L. L. C.
Well Name Jones et al No. 1
Location Hancock County, MS.

Gentlemen:

I, Jess Horton, Vice-President of D & D Drilling & Exploration Inc., drilling contractor for the above referenced well, being duly sworn, do hereby state under oath, to the best of my knowledge no hazardous materials were introduced or contained in the drilling fluid, mud or waste which is to be spread over or buried on the location of the above referenced well.

Witness my signature this 11th day of August 2004.

D & D DRILLING & EXPLORATION INC.

By _____
Jess Horton

Sworn to and subscribed before me, this 11th day of August 2004.

_____
Notary Public

RECEIVED
AUG 13 2004
STATE OIL & GAS BOARD

My commission expires:

June 3, 2005

SHIRLEY R. PRIEST ADAMS COUNTY MS NOTARY PUBLIC

P. O. BOX 1634 • FERRIDAY, LOUISIANA 71334-1634 • (318) 757-3274 • FAX (318) 757-8595

MISSISSIPPI OIL AND GAS BOARD

INSPECTOR'S VERIFICATION OF WELL SPUDDING

FIELD: Wildcat INSPECTOR: JB

OPERATOR: Bay Gas LLC INSPECTION DATE: 7-26-04

WELL NAME & NO: Eleves Etal #1 API #: 23-045-30655

COUNTY: Hancock SEC: 40 TWN: 7S RANGE: 14W

LATITUDE N30-38832 LONGITUDE W089-39957

WELL SPUDDED ON 7-27-04

RECEIVED
AUG 09 2004
STATE OIL & GAS BOARD

(To be completed by field inspector upon first routine inspection after well is spudded - Will be placed in well file to verify well was drilled)

JORDAN, KAISER & SESSIONS, LLC
279 Lower Woodville Road • Natchez MS 39120
P. O. Box 1267 • Natchez MS 39121
601.442.3628 • 800.573.3303 • Fax 601.442.5511

Prepared For: Bay Gas, LLC

Date: April 16, 2003
Prepared By: MGB/jlm
File No.: B-23-02

LEGAL DESCRIPTION

BAY GAS, LLC
JONES ET AL NO. 1
SECTION 40, T7S-R14W
HANCOCK COUNTY, MISSISSIPPI

DESCRIPTION OF DRILLING UNIT:

From the southwest corner of Section 41, T7S-R14W, Hancock County, Mississippi, being a point on the South boundary of within described tract, also being on the boundary between T7S-R14W and T8S-R14W, go in a westerly direction along said Township Boundary for 1976 feet more or less to the westerly boundary of the marine mean high water line of the Jourdan River also being the southwest corner of within described tract; thence go in a general northerly direction along said westerly boundary of the marine mean high water line of the Jourdan River for 3640 feet more or less; thence leaving said boundary go East for 4023 feet to the East boundary of the Huger Tract.

Thence go South along the East boundary of the Huger Tract and the Gundlach Tract for 2572.00 feet to the southeast corner of the Gundlach; thence go West along the South boundary of said Gundlach Tract and extension thereof for 1075.00 feet; thence S 45° 34' W for 337 feet more or less to the southerly boundary of the marine mean high water of Rotten Bayou, also being a corner on the southerly boundary of the Gundlach Tract; thence continue along the boundary of said Gundlach Tract S 45° 34' E for 1000.00 feet to the South boundary of Section 41, also being the boundary between T7S-R14W and T8S-R14W; thence go West along said boundary for 895 feet more or less to the point of beginning. Within described tract contains 320 acres more or less, situated in Sections 33, 40 and 41, T7S-R14W, Hancock County, Mississippi.

W:\Description\MGB\Bay Gas-Rotten Bayou.wpd

[redacted]

State Oil and Gas Board

State of Mississippi
500 Greymont Avenue, Suite I
Jackson, MS 39202
Telephone (601) 354-7142

WALTER L. BOONE, JR.
STATE OIL & GAS SUPERVISOR

June 3, 2004

(X) Permit to drill and approved Form 2 enclosed

(X) Minimum surface casing requirements 340 feet

(X) Permit issued pursuant to Docket No _____

Order No _____

(X) Land disposal form attached

(X) Form 21, NORM Survey attached.

Lisa A. Dutcher

Walter L. Boone, Jr.
STATE OIL AND GAS SUPERVISOR

[redacted]

139995

MISSISSIPPI STATE OIL AND GAS BOARD
APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

FORM No. 2

☒ APPLICATION TO DRILL ☐ WORKOVER ☐ CHANGE OF OPERATOR

NAME OF COMPANY OR OPERATOR: Bay Gas, LLC				DATE: 5-11-04
ADDRESS: P. O. Box 1634	CITY: Ferriday	STATE: LA.	ZIP: 71334	TELEPHONE: 601-445-5026
NAME OF WELL: Jones et al	WELL NO: 1	ELEVATION (GROUND): 11.0 NGVD		CIRCLE TYPE OF PROPOSED WELL: OIL (GAS) OTHER (NAME)
WELL LOCATION (WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES): See Remarks.	SECTION-TOWNSHIP-RANGE: Section 40, T7S-R14W			
	LATITUDE-LONGITUDE (NEW WELLS) (to be added): Lat. 30° 23' 18" and Lat. 89° 23' 58"			
FIELD & RESERVOIR (IF WILDCAT, SO STATE): Wildcat	API No. (EXISTING WELL): N/A			APPROX. DATE WORK BEGINS: Upon Approval
	COUNTY: Hancock			

PROPOSED DEPTH	PROPOSED LENGTH OF SURFACE CASING	NUMBER OF ACRES IN DRILLING UNIT	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING UNIT LINE	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL
4250 FEET	340 FEET	320 ACRES	990 FEET	N/A FEET

NAME OF DRILLING CONTRACTOR: D & D Drilling Company, Inc.

NOTICE: PRIOR TO BEGINNING WORK NOTIFY OIL & GAS BD REPRESENTATIVE

ADDRESS: P. O. Box 1634 Fer STATE: ZIP: 71334

FOR CHANGE OF OPERATOR ONLY

AUTHORIZED REPRESENTATIVE SIGNATURE

INSPECTOR
JOHN W. "DOUG" BOYD
RECORDER 601-587-2777
MOBIL 601-543-5177

D FOR TRANSFER TO:

OR

TH:

RECEIVED
JUN 0 3 2004
STATE OIL & GAS BOARD

NOTE: NOTIFY AREA FIELD INSPECTOR OR FIELD DIRECTOR (JACKSON

State Oil and Gas Board 500 Greymont Avenue, Suite E, Jackson MS 39202 601-354-7142

REMARKS (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)

DESCRIPTION OF LOCATION: From the southeast corner of Section 28, T7S-R14W, Hancock County, Mississippi, go westerly along the south boundary of Section 28 for 2398 feet; thence southerly at right angles for 6629 feet to the location in Section 40, T7S-R14W, Hancock County, Mississippi. Position of location derived from GPS Axis NAD 83; Lat. = 30° 23' 18" and Long. = 89° 23' 58".

DESCRIPTION OF DRILLING UNIT: Attached.

ARE THERE SEPARATELY OWNED TRACTS OR INTERESTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT? (REF. MS. STATUTE 53-3-7)	YES	NO	IF YES, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS OR INTERESTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL? (REF. MS. STATUTE 53-3-7)	YES	NO
	X			X	

EXECUTED THIS THE 11th DAY OF May 20 04

STATE OF Mississippi

COUNTY OF Adams

SIGNATURE OF AFFIANT Malcolm G. Barlow

BEFORE ME, THE UNDERSIGNED AUTHORITY, ON THIS DAY PERSONALLY APPEARED Malcolm G. Barlow KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH, STATES THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT.

SUBSCRIBED AND SWORN TO BEFORE ME THIS 11th DAY OF May 20 04

SEAL

NOTARY PUBLIC IN AND FOR Adams COUNTY

MY COMMISSION EXPIRES 09-11-07

PERMIT NUMBER 2004-ORD-407

APPROVAL DATE 6-3-04

APPROVED BY

NOTICE: BEFORE SENDING THIS FORM, BE SURE THAT ALL INFORMATION REQUESTED IS GIVEN. SEE INSTRUCTIONS ON REVERSE SIDE OF FORM

MISSISSIPPI STATE OIL AND GAS BOARD
FORM 2 (Rev. 4/01)
A.P.I. WELL NUMBER
STATE 23 COUNTY 045 WELL 20135

MISSISSIPPI STATE OIL & GAS BOARD
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

Form No. 3

DESIGNATE TYPE OF COMPLETION

New Well [X] Work Over [ ] Deepen [ ] Plug Back [ ] Same Reservoir [ ] Different Reservoir [ ] Oil [ ] Gas [ ] Dry [X]

DESCRIPTION OF WELL AND LEASE

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

Operator: Bay Gas, LLC		Address: PO Box 1634 Ferriday, Louisiana 71334	
Lease Name: Jones et al		Well Number: 1	Field & Reservoir:
Location: From the southeast corner of Sec 28, go west along south boundary for 2388 feet; t south for 6829 feet to loc in Sec 40			Sec.—TWP-Range or Block & Survey: Sec 40, T7S-R14W
County: Hancock	Permit number: 2004-OPD-407	Date issued: June 3, 2004	Previous permit number:	Date issued:
Date spudded: 07/27/04	Date total depth reached: 07/30/04	Date completed, ready to produce:	Elevation (DF, RKB, RT or Gr.) feet:	Elevation of casing hd. flange feet:
Total depth: 4250'	P.B.T.D.	Single, dual or triple completion?	If this is a dual or triple completion, furnish separate report for each completion.	
Producing interval (s) for this completion		Rotary or cable tools used (interval)	Drilling Contractor: D&D Drilling & Exploration	
Was this well directionally drilled? No	Was directional survey made?	Was copy of directional survey filed?	Date filed	
Type of electrical or other logs run (check logs filed with the commission): Induction-Gamma Ray-Sonic-Neutron			Date filed: Filed w/ this report 8/16/04	

CASING RECORD

Casing (report all strings set in well—conductor, surface, intermediate, producing, etc.)

Purpose	Size hole drilled	Size casing set	Weight (lb./ft.)	Depth set	Sacks cement	Amt. pulled
Surface	11"	8 5/8"	23#	422'	175	None

TUBING RECORD

Size	Depth set	Packer set at
in.	ft.	ft.

LINER RECORD

Size	Top	Bottom	Sacks cement	Screen (ft.)
in.	ft.	ft.		

PERFORATION RECORD

Number per ft.	Size & type	Depth interval

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD

Amt. & kind of material used	Depth interval

INITIAL PRODUCTION

Date of first production	Producing method (indicate if flowing, gas lift or pumping—if pumping, show size & type of pump)

Date of test	Hrs tested	Choke size	Oil prod. during test bbls.	Gas prod. during test MCF	Water prod. during test bbls.	Oil gravity ° API (Corr)

Tubing pressure	Casing pressure	Calc'ed rate of Production per 24 hrs.	Oil bbls.	Gas MCF	Water bbls.	Gas—oil ratio

Disposition of gas (state whether vented, used for fuel or sold):

For Sour Gas or Oil
Amount H_2S:
Amount CO_2:

Executed this the 13th day of August, 19 2004

State of Mississippi
County of Adams

J Clark Norman
Signature of Affiant

Before me the undersigned authority, on this day personally appeared J Clark Norman known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report, and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 13th day of August, 19 2004.

Shirley R. Priest
Notary Public in and for Adams County Mississippi

SEAL

My commission expires June 3, 2005

Casing tests as required by Statewide Rules 11 and 12 must be made.

MISSISSIPPI STATE OIL AND GAS BOARD

Form No. 3

A. P. I. Well Number

State	County	Well
23	045	20135

Form No. 6

MISSISSIPPI STATE OIL & GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON

ADDRESS	
Bay Gas, LLC	PO Box 1634 Ferriday, Louisiana 71334

LEASE NAME	WELL NO.
Jones etal	1

LOCATION OF WELL

From the southeast corner of Sec 28, go west along south boundary for 2398'; thence south for 6629' to loc,in Section 40,T7S-R14W

A.P.I. NO.	FIELD NAME
23 045 20135000	Wildcat

SECTION	TOWNSHIP	RANGE	COUNTY	DATE PLUGGING TO COMMENCE
40	7S	14W	Hancock	07/30/04

FIRM ENGAGED TO PLUG WELL	ADDRESS
Armadillo Services	Vidalia, Louisiana 71373

PROPOSED PLUGGING PROCEDURE

1) 2970-3070 with 35 sacks,
2) 370-470 with 35 sacks,
3) 0 - 50 with 10 sacks

Notice: Prior To Beginning Work Notify Oil & Gas Board Representative

DOUG BOYD
RECORDER # 587-2777
MOBILE # 543-5177

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

Executed this the 13th day of August, 19 2004

State of Mississippi

County of Adams

J Clark Nerren
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared J Clark Nerren known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath, states that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 13th day of August, 19 2004

SEAL

Shirley A. Priest

Notary Public in and for Adams County, Mississippi

My commission expires June 3, 2005

FOR OFFICIAL OIL & GAS BOARD USE ONLY

Approval Date 8/18/04

Supervisor/By WK

MISSISSIPPI STATE OIL AND GAS BOARD
NOTICE OF INTENTION TO PLUG & ABANDON
FORM 6

PLUGGING RECORD

Operator: Bay Gas, LLC	Address: PO Box 1634 Ferriday, Louisiana 71334
Name of Lease: Jones etal No. 1	Well No.: 1
Field & Reservoir:	
Location of Well: From the southeast corner of Section 28, go west along south boundary for 2398 feet; thence south for 6629 feet to loc in Section 40	Sec-Twp-Rge or Block & Survey: 40 7S-14W
County: Hancock	
Application to drill this well was filed in name of: Bay Gas, LLC	Has this well ever produced oil or gas: No
Character of well at completion (initial production): Oil (bbls/day)	Gas (MCF/day)
Dry?: Yes	
Date plugged: 7/30/04	Total depth: 4250'
Amount well producing when plugged: Oil (bbls/day)	Gas (MCF/day)
Water (bbls/day)	

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used (indicate zones squeeze cemented, giving amount cement.
			2970 -3070 with 35 sacks
			370 - 470 with 35 sacks
			0 - 50 with 10 sacks

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped etc)	Packers and shoes
8 5/8"	422	None	422		

RECEIVED
AUG 16 2004
STATE OIL & GAS BOARD

Was well filled with mud-laden fluid, according to regulations?

Indicate deepest formation containing fresh water

NAMES AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well:

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Use reverse side for additional detail
File this form in duplicate with

Sworn to this the 13th day of August 19 2004

State of Mississippi
County of Adams

J Clark Nerren
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared J Clark Nerren known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 13th day of August 19 2004

Shirley A Quist

Notary Public in and for Adams County, Mississippi

My commission expires June 9 2005

OK
WX
8/18/04

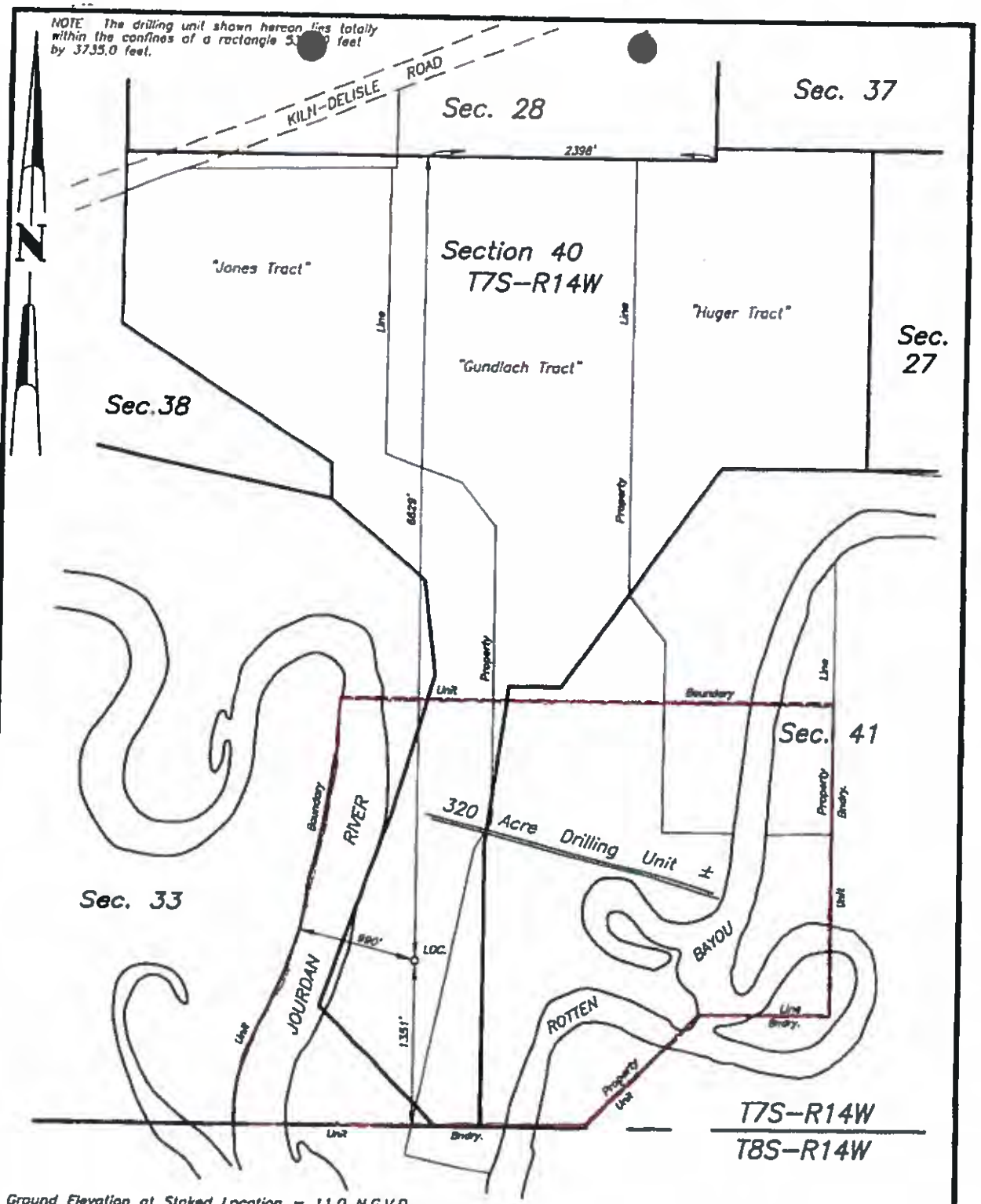
MISSISSIPPI STATE OIL AND GAS BOARD

Plugging Record

FORM 7 - MSCC P-15

Authorized by Order No. 118-58 Effective November 1, 1958

23-045-20135



Ground Elevation at Staked Location = 110 NGVD

DESCRIPTION OF LOCATION: From the southeast corner of Section 28, T7S-R14W, Hancock County, Mississippi, go westerly along the south boundary of Section 28 for 2398 feet; thence southerly at right angles for 6629 feet to the location in Section 40, T7S-R14W, Hancock County, Mississippi. Position of location derived from GPS Axis NAD 83; Lat. = 30°23'18" and Long. = 89°23'58".

RECEIVED 2004

Well Location For

Malcolm G. Barlow

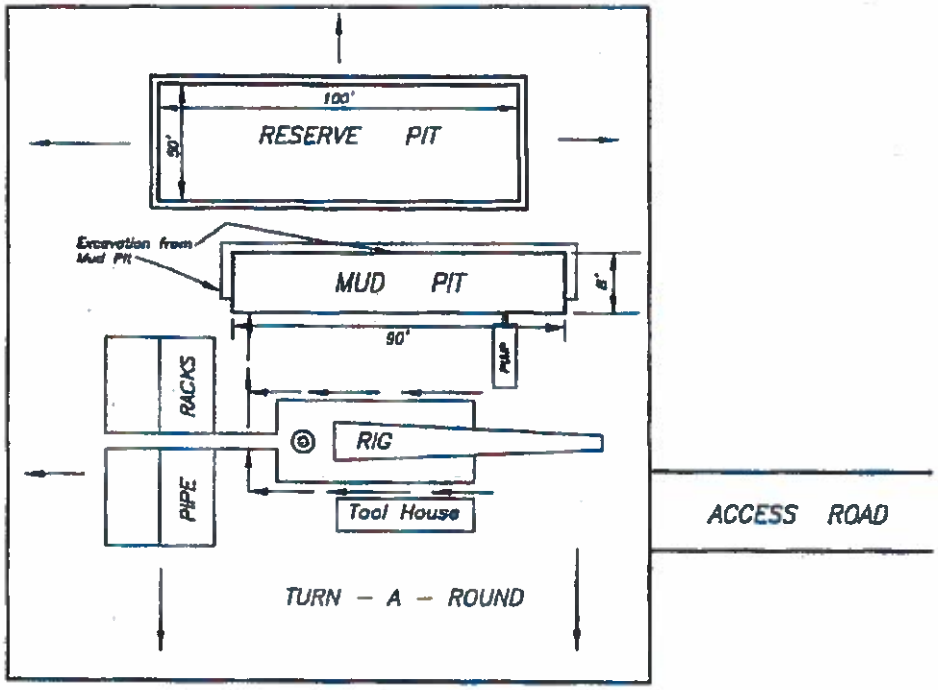
Malcolm G. Barlow, Reg. P.L.S. #1499
April 16, 2003

INFORMATION REQUESTED FOR DRILLING FLUID DISPOSAL AND RESERVE PIT

A. The drilling fluids associated with drilling this well location will be spread over the surface of lands with prior permission obtained from the surface owner.

B. The approximate volume of drilling mud, cuttings, drainage water and other associated fluids to be contained within the reserve pit is 18,000 cubic feet or 3,250 barrels.

C. The typical size of the reserve pit will vary from 50 feet by 100 feet to 100 feet by 100 feet, depending on the topography of the drill site. The depth of the reserve pit will be sufficient to accommodate the volume of the drilling fluids.



—NOTE—
Drawing Not To Scale

TYPICAL WILCOX ROTARY
RIG FACILITY SITE
(Frio)

RECEIVED
JUN 0 3 2004
STATE OIL & GAS BOARD

OPERATOR'S REP.: Clark Nerren OPERATOR: Bay Gas, LLC

ARTIFICIAL PENETRATION #D-101

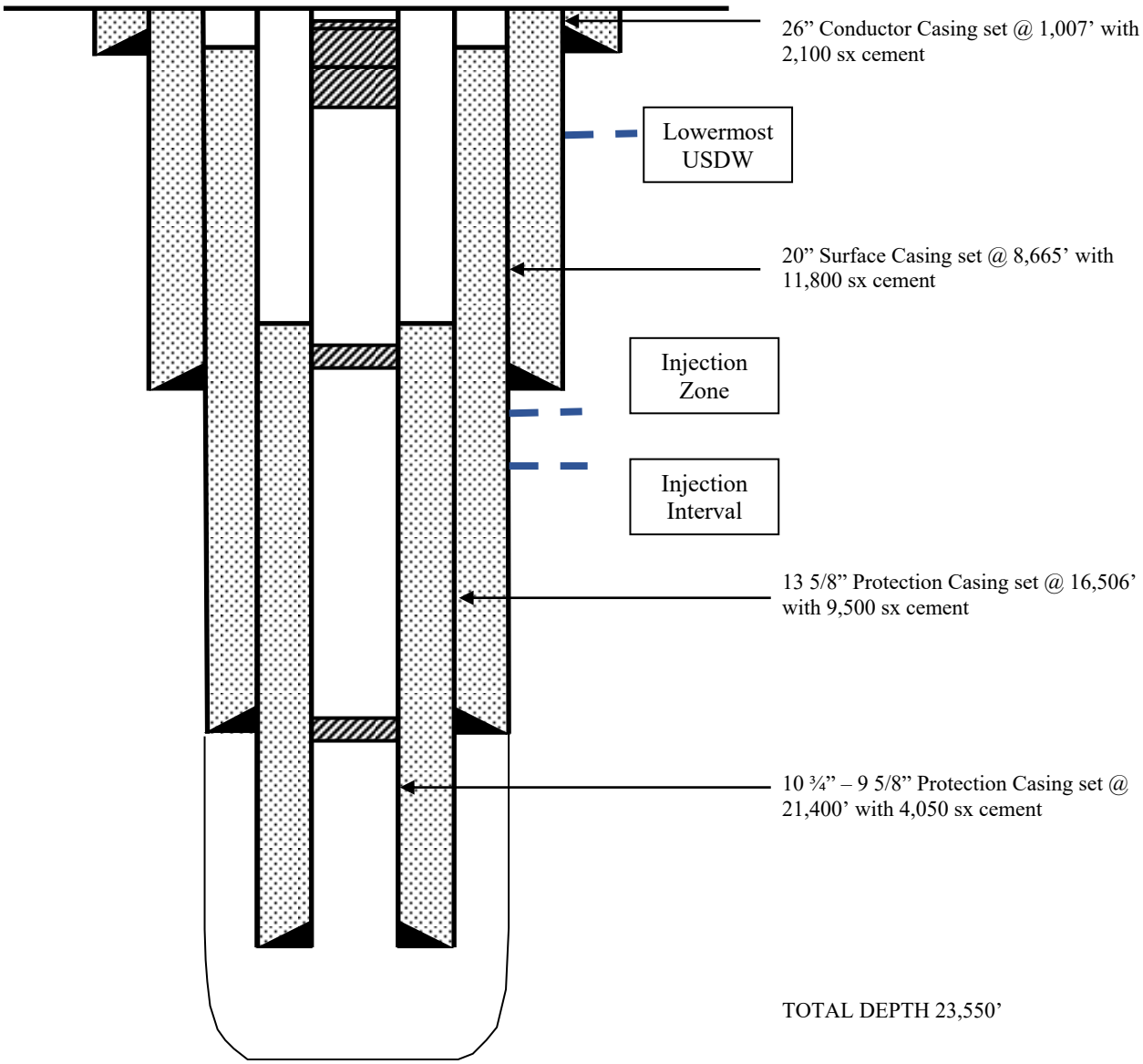
CHEVRON USA
MS87-0S #1 BLOCK 57

ARTIFICIAL PENETRATION DATA SHEET AND WELL SCHEMATIC FOR CHEMOURS DELISLE PLANT

Plant: Chemours DeLisle
Map ID No.: D-101
Operator: Chevron USA
Well Name: MS87-01-OS #1 Block 57
Location: 8450' FNL & 7650 FWL of MS Sound Block 57
TD: 23,550'
Date Drilled: 12/21/88

API #: 2304720010
Status: P & A
Date Plugged: 10/28/89
Distance from DeLisle Well #5: 63,000'
Well Type: Exploration

Drawing not to scale



Plugged: 10/28/89

210' to 360'
360' to 1,260'
1,260' to 2,160'
7,910 to 8,140'
Bridge @ 8,140'
16,195' to 16,695'
Bridge @ 16,695'

Drawn by: GKS – June 2017
Checked by:
Revised by:

State Oil and Gas Board

State of Mississippi

500 GREYMONT AVENUE SUITE E
JACKSON, MISSISSIPPI 39202

TELEPHONE 354-7142

DATE: February 11, 1992

VIOLATION - STATEWIDE RULE NO. 23

OPERATOR: Chevron USA, Inc.

WELL NAME & NO. MS-87-01-05

FIELD: _____

COUNTY: Harrison (wildcat)

VIOLATION:

The detail of formations penetrated information on the reverse side of Form No. 3 omitted.

A NEW FORM NO. 3 MUST BE FILED, CORRECTING THE VIOLATION

ATTACHED - COPY OF STATEWIDE RULE 23 - AMENDED June 16, 1988

State Oil and Gas Board

State of Mississippi

500 GREYMONT AVENUE SUITE E
JACKSON, MISSISSIPPI 39202

TELEPHONE 354-7142

October 28, 1991

Chevron USA, Inc.
P. O. Box 6056
New Orleans, LA 70174

Gentlemen:

Re: MS Sound Block 57 Unit;
State of MS No. 1
Harrison County, MS

In reviewing our records on the above referenced well, we find there is no Form 3, Completion Report, in the well file. Please file Form 3, Completion Report, as one is required even on a dry hole. If by some chance you did file a Form 3 and our copy has been misplaced, then please just send a copy. We do need one in the well file.

If you have any questions, please call.

We shall appreciate your cooperation.

Sincerely,

Martha Williams
Section Supervisor

Chevron U.S.A. Inc.
P.O. Box 6056, New Orleans, LA 70174

September 18, 1990

Eastern Profit Center
Gulf of Mexico Production Business Unit

Mr. A. Richard Henderson, Supervisor
State of Mississippi
State Oil and Gas Board
500 Greymont Avenue
Suite E
Jackson, MS 39202

Dear Dick:

I advised you on May 18, 1990 of a drilling mud discharge that may have occurred on August 9, 1989 during the drilling of the well in Mississippi Sound Block 57. On or about May 4, 1990, Transworld Drilling Company (Transworld) advised us of the incident prior to a deposition of a Transworld employee involved in an accident on August 9, 1989.

A thorough questioning of all Chevron personnel involved indicated that Transworld did not notify them of a mud spill incident and that they were unaware of such a spill. Several did recall seeing and requesting Transworld to clean mud from the rig boom to the cuttings barge. It was speculated that this mud originated from the wind carrying mud to the boom from the rig floor pollution pan.

The investigation of the incident by Transworld revealed that during morning hours of August 9, 1990, the trip-tank fill-up line running from the mud tanks to the trip-tank apparently became clogged when barite settled in the line. The line had to be disconnected in the attempt to get the mud flowing. During this activity the end of the trip-tank fill-up line fell over the side of the rig and allowed the contents of the line (maximum volume 48 gallons) to fall into the water. There was zero (0%) percent oil in the mud.

We regret the occurrence of the incident and the untimely reporting. The report of the discharge incident by the drilling contractor arose out of a contract employee's personal injury lawsuit against his contract employer. The incident was not reported or otherwise known by Chevron prior to being advised by Transworld.

If you require any additional information, please contact me.

Very truly yours,

Mark

M. S. Witten
Manager
Environment, Safety, Fire & Health

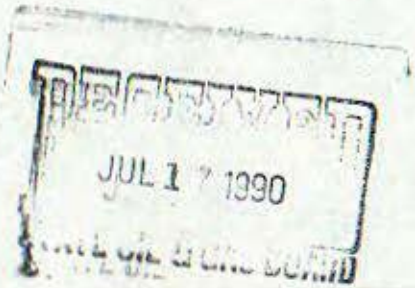
SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

GYROSCOPIC DIRECTIONAL SURVEY
FOR

****
CHEVRON, U.S.A., INCORPORATED
****

JOB NUMBER:	21FG989239
WELL NAME:	WELL # 1 MS-87-01-OS
LOCATION:	MISSISSIPPI SOUND BLOCK # 57
SURVEY DATE:	09/05/89
SURVEY ENGINEER:	CLARK/ROUGEOU/PICARD
METHOD OF CALCULATION:	THE MINIMUM CURVATURE
COMMENTS:	FINDER GMS SURVEY FROM SURFACE TO 8,500' M.D. FINDER GMS SURVEY FROM 8,600' M.D. TO 14,700' M.D. FINDER GMS SURVEY FROM 14,800' M.D. TO 18,686' M.D. FMS FROM 18,700' M.D. TO 21,250' M.D.

****
* THIS SURVEY IS CORRECT TO THE BEST OF MY *
KNOWLEDGE AND IS SUPPORTED BY ACTUAL FIELD DATA.
*
* Alvah J. Rheem Jr. *
* ********** *
* COMPANY REPRESENTATIVE *
****



Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

November 9, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 23,550'. 10-3/4"/9-5/8" @ 21,400'. Well P&A'd. Waiting on barges.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MLM

A1/ED1/08

Chevron
Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

November 16, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 23,550'. 10-3/4"/9-5/8" @ 21,400'. Well P&A'd. Moved rig off location on 11/13/89.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MLM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA 70174

November 2, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 23,550'. 10-3/4"/9-5/8". @ 21,400'. POOH to 22562'. Mix 100 sx cmt. Spotted plug f/22562'-22156'. POOH. M/U setting tool & EZSV cmt retainer. Set ret @ 21,288'. Test backside to 1000#. Mix & pump 250 sx cmt. Pump 200 sx below retainer. Spot 50 sx on top of retainer. Bottom of cement @ 22105'. Top of cement @ 21088'. POH & L/D DP. P/U bridge plug. TIH & set same @ 16695'. Wt test to 15000#. POOH. Mix & pump 123 sx cmt. Spot plug f/16695'-16195'. POOH. M/U 9-5/8" CIBP. TIH, set same @ 8410'. Mix & pump 136 sxs cmt. Spot cmt f/8410'-7910'. POOH. Test csg to 1800# for 30 min. Displace hole w/seawater f/2200' to surface. R/U Howco & pump 245 sxs cmt. Spot cmt f/2160'-1260'. POOH. TIH to 1260'. R/U HOWCO & pump 245 sxs cmt. Spot cmt f/1260'-360'. POOH .

A1/ED1/08

L/D DP. N/D BOP's. N/D wellhead. Cut 10-3/4" csg. P/U spear & TIH. Latch csg. Cut 14" csg @ 258'. TIH w/spear & sting into csg. Jar on; could not pull free. P/U 5" DP and lay cmt plug f/200' below mud line to 50' below mud line. Cut & ret 14" csg f/30' BML. Cut & ret 20" csg f/25' BML. Cut 26" csg @ 177'. TIH & cut 36" drive pipe @ 177'. Pull pipe free & L/D same. Clean mud pits.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MLM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

October 26, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 23,550'. 10-3/4"/9-5/8" @ 21,400'. M.W. 17.4.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MLM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

October 19, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 23,348'. 10-3/4"/9-5/8" @ 21400'. M.W. 17.3.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MLM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA. 70174

October 12, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 23,348'. 10-3/4"/9-5/8" @ 21400'. M.W. 17.2.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MLM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

October 5, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 23,146'. 10-3/4"/9-5/8" @ 21400'. M.W. 17.1.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MLM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

October 3, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Dear Sir:

As per your telephone conversation with Mr. Andrew T. Rawicki this morning, Chevron U.S.A. Inc. acknowledges your permission to deepen the "Mississippi Sound Block 57 Unit; State of Mississippi #1" to 24,500'. Enclosed find two copies of the Amended Form 2.

C. G. Canizaro

for M.S. Witten
Division Coordinator
Environmental and Regulatory Affairs

State Oil and Gas Boa

State of Mississippi
TELEPHONE 359-3730 P.O. BOX 1332
JACKSON 39215-1332

October 3, 1989

TO WELL FILE:

Andy Rawicki, P.E. with Chevron Offshore, called this A. M. and requested permission to extend the T. D. of the Mississippi Sound well another 1,000 feet. After considering the casing being set at 21,4000 feet and other items, permission was granted. Chevron will be forwarding an amended Form 2 for this verbal permission.

O. Richard Anderson

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

September 28, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 22,557'. 10-3/4"/9-5/8" @ 21400'. M.W. 17.0.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

September 21, 1989

State Oil and Gas Board
Attention Dr. Henderson
500 Greymont
Suite E
Jackson, MS 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 22,165'. 10-3/4"/9-5/8" @ 21400'. M.W. 17.0.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

September 14, 1989

State Oil and Gas Board
Attention Dr. Henderson
500 Greymont
Suite E
Jackson, MS 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M. D. 21,685'. 10-3/4"/9-5/8" @ 21400'. M.W. 16.4.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

September 7, 1989

State Oil and Gas Board
Attention Dr. Henderson
500 Greymont
Suite E
Jackson, MS 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M.D. 21,442. 10-3/4" - 9-5/8" @ 21442'. M.W. 16.4. Mix and pump 1350 sxs lead premium cmt w/additives @ 16.4 ppg followed by 2700 sxs tail premium cmt w/additives. Bumped plug @ 0600 hrs. w/3000 psi.
Install 13-5/8" 10M x 11" 15M csg spool & test same. R/U & test BOP's. TIH, drilled cmt collar & shoe to 21440'. Circ performed leakoff test = 18.5 EMW. Drilling new formation F/21440'- 21442'.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	BEARING
15500.00	15498.30	93.96	3.02	1-41 N	11-11 W	89.79 N	33.71 E	.19	95.91	AT N 20-35 E
15600.00	15598.26	96.62	2.81	1-32 N	8-29 W	92.55 N	33.23 E	.17	98.34	AT N 19-45 E
15700.00	15698.23	99.14	2.62	1-20 N	4-16 W	95.15 N	32.94 E	.13	100.69	AT N 19- 6 E
15800.00	15798.20	101.38	2.40	1-17 N	18-16 W	97.49 N	32.49 E	.38	102.76	AT N 18-26 E
15900.00	15898.17	103.56	2.50	1-35 N	22- 2 W	99.83 N	31.62 E	.31	104.72	AT N 17-34 E
16000.00	15998.13	106.16	2.85	1-41 N	5-50 W	102.58 N	30.95 E	.47	107.14	AT N 16-48 E
16100.00	16098.09	108.83	2.76	1-29 N	6-28 W	105.32 N	30.66 E	.20	109.69	AT N 16-14 E
16200.00	16198.06	111.18	2.41	1-17 N	1-35 E	107.73 N	30.54 E	.28	111.98	AT N 15-50 E
16300.00	16298.03	113.30	2.15	1-11 N	4-41 W	109.88 N	30.49 E	.17	114.03	AT N 15-31 E
16400.00	16398.02	115.14	1.92	1- 1 N	10-19 W	111.78 N	30.25 E	.20	115.80	AT N 15- 8 E
16500.00	16498.00	116.80	1.83	1- 5 N	19-49 W	113.54 N	29.77 E	.19	117.38	AT N 14-41 E
16600.00	16597.98	118.34	1.80	0-59 N	25- 6 W	115.21 N	29.08 E	.14	118.82	AT N 14-10 E
16700.00	16697.96	120.00	1.93	1-14 N	18-58 W	117.00 N	28.37 E	.28	120.39	AT N 13-38 E
16800.00	16797.94	122.07	2.23	1-19 N	4-55 W	119.17 N	27.92 E	.32	122.39	AT N 13-11 E
16900.00	16897.92	124.12	2.09	1- 5 N	1-48 E	121.25 N	27.85 E	.27	124.41	AT N 12-56 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
17000.00	16997.90	125.94	1.83	1- 1 N	3-21 E	123.09 N	27.93 E	.07	126.22	AT N 12-47 E
17100.00	17097.89	127.68	1.75	0-59 N	2-18 E	124.83 N	28.02 E	.04	127.93	AT N 12-39 E
17200.00	17197.88	129.25	1.60	0-51 N	5-50 W	126.42 N	27.98 E	.19	129.48	AT N 12-29 E
17300.00	17297.86	130.68	1.54	0-55 N	16-30 W	127.93 N	27.68 E	.18	130.89	AT N 12-12 E
17400.00	17397.84	132.56	1.96	1-20 N	2-17 E	129.86 N	27.50 E	.55	132.74	AT N 11-57 E
17500.00	17497.82	134.68	2.12	1- 6 N	5-40 E	131.98 N	27.64 E	.24	134.84	AT N 11-50 E
17600.00	17597.80	136.56	1.89	1- 4 N	7-55 E	133.85 N	27.86 E	.05	136.72	AT N 11-45 E
17700.00	17697.79	138.31	1.75	0-56 N	8-45 E	135.58 N	28.11 E	.13	138.46	AT N 11-43 E
17800.00	17797.77	140.03	1.72	1- 2 N	11-33 E	137.27 N	28.42 E	.11	140.18	AT N 11-42 E
17900.00	17897.75	141.91	1.93	1-11 N	8-13 W	139.17 N	28.45 E	.41	142.05	AT N 11-33 E
18000.00	17997.73	143.94	2.08	1-12 N	12-26 E	141.22 N	28.53 E	.43	144.07	AT N 11-25 E
18100.00	18097.71	145.86	1.93	1- 1 N	0-55 W	143.13 N	28.74 E	.32	145.98	AT N 11-21 E
18200.00	18197.69	147.81	1.96	1-14 N	9-19 E	145.08 N	28.90 E	.29	147.93	AT N 11-16 E
18300.00	18297.66	150.21	2.40	1-31 N	12-30 E	147.43 N	29.36 E	.29	150.33	AT N 11-16 E
18400.00	18397.63	152.65	2.44	1-17 N	10-22 E	149.82 N	29.85 E	.24	152.77	AT N 11-16 E

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

August 3, 1989

State Oil and Gas Board
Attention Dr. Henderson
500 Greymont
Suite E
Jackson, MS 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

Drilled F/20082'-20230'. POOH. Test BOPE. TIH. Drill F/20230'-20467'. POOH. Change out bit & shock sub. TIH.

Very truly yours,

A. S. Rawicki, for

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA 70174

July 27, 1989

State Oil and Gas Board
Attention Mr. Henderson
500 Greymont
Suite E
Jackson, MS 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

Drilled from 19746'-19833', POH looking for washout. Found mandrel on shock sub to be loose. Change out same. Tested BOP's. TIH. Drilled F/19833'-20050'. CIRC & raise MW F/15.4 PPG to 16.0 PPG. Drop survey. POOH. Change bit. TIH. Drilled 20050'-20082'.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

July 21, 1989

State Oil and Gas Board
Attention Mr. Henderson
500 Greymont
Suite E
Jackson, Mississippi 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-OS #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS-87-01-OS #1 BP #1
Transworld 70

Drilled from 19,480' - 19,615'. Drop survey, POOH. Ret. survey. Change bit. TIH. Drilled from 19,615' - 19,668'. Circ. & build MW from 12.0 to 16.4#. Short trip. Observe well. Circ. B/U. Drilled from 19,668' - 19,678'. Circ. Drilled from 19,678' - 19,746'.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A5/ED1/47

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

July 14, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Dear Mr. Henderson:

The following is a report of all significant activities on the MS 87-01-0S #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP#1
Transworld 70

M.D. 19,480'. 14" @ 16506'. M.W. 12.0. Drlg F/18920'-19332'. Drop survey, retrieve same on short trip to csg. Drld F/19332'-19413'. Circ B/U. POOH. Ran csg caliper log, test Bope. TIH. Drill 19413'-19480'

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA 70174

July 14, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, MS 39202

Attention Dr. Henderson

Dear Sir:

The Eastern Division Drilling Department has undergone some personnel changes recently. Please replace your current phone list in the MS87-01-OS #1 Hydrogen Sulfide Contingency Plan with the enclosed revision.

Andrew F. Rawicki, for
M. H. Hellrich
Eastern Division Drilling Manager

EMERGENCY TELEPHONE LISTING
OFFSHORE MISSISSIPPI DRILLING OPERATIONS
(Cont'd)

11. Chevron U.S.A. Inc.

	Office	Home
B. A. Jones (Drilling Superintendent)	(504)364-2325	(504)393-9940
G. E. Roebke (Drilling Superintendent)	364-2324	394-3310
M. H. Hellrich (Drilling Manager)	364-2312	367-7054
R. A. Hill (Staff Drilling Engineer)	364-2088	643-1056
L. R. Odom (Drilling Engineer)	364-2092	394-6388
J. S. Bartges (Drilling Engineer)	364-2090	362-2507
J. E. Vidal (Rig Safety Specialist)	592-6445	271-6487
W. J. Lowe (Manager of Drilling)	592-6844	626-5171
D. Brent Wood (Public Affairs)	592-6371	738-7174
J. D. Combes (Prin. Drlg. Consult.)	592-6373	737-8114
J. F. Lifa (Public Affairs)	592-6432	393-2751
C. R. Block (Division Manager)	364-2297	892-8833

12. Transworld Drilling Company
Lafayette, La. Office (J. W. Bullock) (318)234-2368 (318)837-3485

13. Air Ambulance Services

1. West Jefferson General Hospital — Marerro, La.
   Air Care — (504)347-5511
2. Un. of So. Al. Med. Center — Mobile, Al.
   South Flight Medi-Vac — (205)471-7100

14. Mississippi Emergency Management Agency
24 Hour Answering — 1-800-222-6362
(601)352-9100
Mr. J. E. Maher (Director) — (601)924-5436 (Home)
Mr. L. K. Shaifer (Operations Officer) — (601)373-2531 (Home)

15. Mississippi Highway Safety Patrol
24 Hour Answering — (601)987-1530

16. Harrison County Civil Defense
Gulfport, Ms. — (601)864-3843
(601)864-4002
Wade Guice - Director

17. Harrison County, Ms. Sheriff's Dept.
24 Hour Answering — (601)865-7070
Low Band Common Network Radio Frequency — 4514/4526/4522

18. Secorp Industries
Lafayette, La. — (318)237-3471

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

July 6, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, Mississippi 39202

Attention Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS 87-01-OS #1 BP #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-OS #1 BP #1
Transworld 70

M.D. 18,920'. 14" @ 16,506'. M.W. 12.0. Inspect BHA. TIH. Drill 18,085' - 18,859'. Drop survey. Retrieve on short trip into casing. Drilling from 18,859' - 18,920'.

Very truly yours,

Andrew S. Rawicki, for

M. H. Hellrich
Eastern Drilling Engineer
Eastern Production Division

MHM

A5/ED1/39

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

July 5, 1989

State Oil and Gas Board
500 Greymont, Suite E
Jackson, MS 39202

Attention: Dr. Henderson

Dear Sir:

As per Andrew Rawicki's telephone conversation with Mr. Lewis and yourself, the Transworld 70 Drilling Rig will be postponing their BOP test to allow for additional drilling with their current drill bit, with the understanding that crews will conduct a full BOP test immediately following the trip out of the hole.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

ATR/mnm

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA. 70174

June 29, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, Mississippi 39202

Dear Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS 87-01-0S #1 BP #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

Drill f/17030'-17059'. POOH. Test BOP. Run casing caliper f/16415' to surf. P/U bit. Drill 17059'-18085'. POOH for washout.

Very truly yours,

for M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A5/ED1/37

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

June 22, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, Mississippi 39202

Dear Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS 87-01-OS #1 BP #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-OS #1 BP #1
Transworld 70

M.D. 16,829'. 14" @ 16,506'. M.W. 10.0. N/U 13-5/8" BOPS. Test casing head and BOPS. TIH to 16,293', tag cement. Test casing to 6000 psi. Drill cement and float equipment. Wash/ream 16,506' - 16,546'. Perform lot 16.6 PPG EMW w/no leakoff. Drill 16,546' - 16,829'.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A5/ED1/37

THIS PAGE INTENTIONALLY LEFT BLANK.

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

May 10, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Mississippi 39215-1332

Attention Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS 87-01-05 #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-05 #1 BP #1
Transworld 70

M.D. 13,936'. 20" @ 8665'. M.W. 9.7. Drilling 13,646' - 13,659'. POOH. Test BOPS. P/U bit #26 and TIH. Inspect BHA. Drilling f/13,659' - 13,923'. POOH. C/O bit and TIH. Drill 13,923' - 14,079'.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A5/ED1/27

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA. 70174

May 4, 1989

Revised Oil Spill
Contingency Plan
Mississippi Sound Block 57

Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
2620 W. Beach Blvd.
Biloxi, MS 39531

Attention Mr. Joe Gill

Gentlemen:

Attached are revisions to our Oil Spill Contingency Plan for Mississippi Sound Block 57. They reflect minor changes to our equipment inventory and emergency contact lists.

If you have any questions, please call Ms. Laura Perica at (504) 364-2293.

Very truly yours,

M. S. Witten
Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

LEP

Attachments

cc: Dr. Richard Henderson
Mississippi State Oil and Gas Board
P. O. Box 1322
Jackson, MS 39215-1322

A2/EE1/62

Mr. Bob Rogers
Mississippi Department of Natural Resources
Bureau of Pollution Control
P. O. Box 10385
Jackson, MS 39209

Mr. David Schwartz
Department of the Army
Mobile District, Corps of Engineers
P. O. Box 2288
Mobile, AL 36628-0001

A2/EE1/62

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

May 3, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, MS 39215-1332

Dear Dr. Henderson:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-05 #1 BP#1
Transworld 70

M.D. 13,646'. 20" @ 8665'. M.W. 9.7. TIH w/ bit #24. Drlg f/12,540'-13,198'. POOH. C/O bit. TIH. Drill 13,197'-13,646'. Drilling.

Very truly yours,

for M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A3/ED1/21

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

April 27, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, MS 39215-1332

Dear Dr. Henderson:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-05 #1 BP#1
Transworld 70

M.D. 12,540'. 20" @ 8665'. M.W. 9.7. POOH, L/D fish, full recovery. M/U bit. TIH. Wash & ream 11,483'-12,314'. Drill 12,314'-12,335', torqued up. CBU. POOH. Run csg caliper. Test BOP's. TIH to 12,097', wash/ream to 12,335'. Drlg f/12,335'-12,540', POOH. P/U bit. TIH.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A3/ED1/20

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

April 21, 1989

State Oil and Gas Board
P. O. Box 1322
1404 Sillers Building
Jackson, MS 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP#1
Transworld 70

M.D. 12,314'. 20" @ 8665'. M.W. 9.7. Drlg F/11176' to 12035'. Bit started torquing. POOH. C/O BIT & TIH. Drill F/12035'-12314', one mud pump failed. P/U to 12273' to switch pumps, stuck pipe. Working pipe mixing pipe-lax pill, cut MW F/9.8 to 9.7 ppg. Spot 208 BBL pipe-lax pill. Run freept, made B/O @ 11895'. POOH. TIH. W/O/S & JARS latch fish. Jarred free. Circ pipelax pill into csg. POOH.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA. 70174

April 13, 1989

State Oil and Gas Board
P. O. Box 1322
1404 Sillers Building
Jackson, MS 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 57-01-05 #1 BP#1
Transworld 70

M.D. 11,176'. 20" @ 8665'. M.W. 9.3. Run csg caliper. Test BOPS. M/U bit #20 & new BHA & TIH. Drill f/10,262'-11,162'. POOH. Test BOP's. TIH w/bit #21. Drlg f/11,162'-11,176'.

Very truly yours,

for M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A3/ED1/17

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA. 70174

April 6, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, MS 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-05 #1 BP#1
Transworld 70

M.D. 10,262'. 20" @ 8665'. M.W. 9.5. Drill 9113' to 9490'. POOH. P/U bit & TIH. Drill 9490'-9839'. Made 5 std short trip. Drill 9839' T/10,138'. Pull into csg shoe T/repair scr. Drill 10,138'-10,180'. Survey. Drill 10,180'-10,262' & raise MW T/9.5 ppg. POOH T/csg shoe. CIRC.

Very truly yours,

for M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

RECEIVED
APR 10 1989
STATE OIL & GAS BOARD

A3/ED1/14

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

March 30, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, MS 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-05 #1 BP#1
Transworld 70

M. D. 9,113'. 20" @ 8665. M.W. 8.8. P/U 17-1/2" bit. TIH P/U 5-1/2" DP. Drill 8708'-9048'. POOH. P/U csg scraper & TIH. Circ B/U. POOH. Run gyro survey & csg caliper. Test BOPS. C/O BHA. TIH. Drill 9048'-9113'.

Very truly yours,

for M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A6/ED1/10

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA 70174

March 23, 1989

State Oil and Gas Board
P. O. Box 1322
1404 Sillers Building
Jackson, Mississippi 39215-1352

Attention Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

EXPLORATORY

Mississippi Sound 57

MS 87-01-05 #1 BP#1
Transworld 70

Mix & pump 10,200 sx lead cmt @ 12.4 ppg and 2000 sx tail cmt @ 16.2 ppg. POOH to 5000'. Estb inj on 26" x 20" annulus. Mix & pump 750 sx "H" cmt + 16% gel & 500 sx "H" cmt + 35% silica flour. Disp t/25' BML. N/D bell nipple & 30" diverter. Install 26-3/4" x 21-1/4" 5M wellhead. Test t/1000 psi. N/U BOPS. Run gyro & csg caliper. N/U bell nipple, pollution pan. Test void on casing head 3000 psi. Drill cmt 8476'-8708'. Perform lot = 13.3 EMW. L/D 5" drillpipe.

Very truly yours,

for M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A8/ED3/19

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA. 70174

March 16, 1989

State Oil and Gas Board
P. O. Box 1322
1404 Sillers Building
Jackson, Mississippi 39215-1352

Attention Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

EXPLORATORY

Mississippi sound 57

MS 87-01-05 #1 BP#1
Transworld 70

M.D. 8745'. 26" @ 1007'. M.W. 9.2. Open hole 17-1/2"-24" w/HO F/8006'-8495'. Open hole 17-1/2" w/24" bit F/8495'-8708'. POOH. TIH to shoe w/HO. R/U 14 lines. Wash & ream 7848'-8708'. Short trip. Run 20" csg. to 8655'.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A3/EDrlg.1/9

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

March 9, 1989

State Oil and Gas Board
P. O. Box 1322
1404 Sillers Building
Jackson, Mississippi 39215-1352

Attention Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS 87-01-05 #1 BP#1 Well in Mississippi Sound 57 during the past seven (7) days.

EXPLORATORY

Mississippi Sound 57

MS 87-01-05 #1 BP#1
Transworld 70

M.D. 8745'. 26" @ 1007'. M.W. 9.3. Open hole 12-1/4" to 17-1/2" 8196'-8700'. Ran multi-shot. TIH w/24" bit. Open hole from 17-1/2" to 24" 7520'-8006'.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A3/EDrlg.1/6

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA 70174

March 2, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Mississippi 39215-1332

Attention Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S. L. 3470 #1
Transworld 70

M.D. 8,745'. 26" @ 1007'. M.W. 9.1. POOH. MU 12-1/4" bit & TIH w/MM, drilling 8152 - 8337'. POOH. C/O bit, MM and bent sub. Drill w/MM 8337 - 8406'. POOH. P/U 12-1/4" HO & TIH. Wash & ream 8130 - 8406'. POOH. P/U steerable BHA. Drill 8406 - 8745'. POOH. TIH w/17-1/2". Open hole 12-1/4" to 17-1/2" 8075 - 8196'.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A5/ED1/15

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA. 70174

February 23, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, MS 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S/L 3470 #1
Transworld 70

M. D. 8071'. 26" @ 1007. M.W. 9.2. Sidetracking hole w/mud motor F/8038-8152', POOH, PU 12-1/4" HO and TIH, W & R 7986' to 8152'.

Very truly yours,

for M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A6/ED1/10

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

February 16, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Mississippi 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S. L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S.L. 3470 #1
Transworld 70

M.D. 8038'. 26" @ 1007. M.W. 9.3 Wash/ream 17-1/2" hole f/8133' - 8478'. TIH w/plug cutter to 8548'. Mix and pump 1450 sx. cement, set 1000' cement plug TIH. TOC @ 8348', 200' plug. Mix and pump 1950 sx. cement @ 8348'. TIH w/17-1/2" bit. Drill cement 7903-7954'. P/U 12-1/4" bit. Drill cement 7954-8008'. POOH - P/U 12-1/4" kickoff assm. and TIH. Control drill 1 ft./hr. f/8008-8038'. Present operations: sidetracking @ 8038'.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A5/ED1/9

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA. 70174

February 9, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, MS 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S/L 3470 #1
Transworld 70

M. D. 8548'. 26" @ 1007. M.W. 9.4. Opening hole w/24" bit to 7500'. P/U 17-1/2" drlg assm. TIH tag @ 7510'. Wash/ream f/7510-8478'. TIH w/plug cutter to 8548'. Setting cmt plug.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A6/ED1/10

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

February 3, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Miss 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S/L 3470 #1
Transworld 70

M. D. 8545'. 26" @ 1007. M.W. 9.2. TIH w/23-3/4" Open hole 5292-5317'. POOH-left HO in hole. TIH w/bit sub & wash T/HO @ 5312'. Att screw into HO-failed. TIH w/O/S & 20" guide. Tag up @ 5298'-UAT wash deeper. TIH w/20" bit & 23-3/4" HO. TAG @ 5298'. TIH w/O/S & 16" guide. Tag up @ 4868'-UAT get deeper. TIH w/20" bit & 23-3/4" HO. Tag. Wash & ream T/5300'. TIH w/O/S. Recv hole opener. TIH w/17-1/2" bit. Wash 8204-8548'. P/U 17-1/2" bit & 24" HO. Reamed 4776-5326'. P/U 24" bit & opening hole 17-1/2" to 24". F/5340-5543'.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

A6/ED1/10

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA 70174

January 19, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Miss 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S/L 3470 #1
Transworld 70

M. D. 8545'. 26" @ 1007. M.W. 9.5. Drill to 8545'. POOH. R/U WL and log. Open hole f/1022' to 4907'. Make trip-change out HO. Open hole to 5292'. POOH. Arm pins to HO missing. TIH w/electro-magnet. No recovery. TIH w/hydraulic junk catcher - no recv. TIH w/mill.

Very truly yours,

M. H. Hellrich for
Division Drilling Manager
Eastern Production Division

MNM

A6/ED1/10

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

January 11, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Miss 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S/L 3470 #1
Transworld 70

M.D. 8,302'. 26" @ 1,007'.
M.W. 9.0. Drill 5551-6875'.
Survey @ 6875'-2 deg. POOH. C/O BHA. Drill F/6875'-8304'.

Very truly yours,

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A6/ED1/10

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	BEARING
18500.00	18497.61	154.62	1.98	0-59 N	17-25 E	151.74 N	30.31 E	.33	154.74	AT N 11-18 E
18600.00	18597.60	156.35	1.76	1- 2 N	2-13 W	153.46 N	30.53 E	.35	156.47	AT N 11-15 E
18686.00	18683.59	157.78	1.46	0-55 N	5- 3 W	154.92 N	30.44 E	.15	157.89	AT N 11- 7 E
18700.00	18697.59	158.01	.23	0-57 N	7-56 E	155.15 N	30.44 E	1.53	158.11	AT N 11- 6 E
18800.00	18797.57	159.65	1.64	0-56 N	10-38 E	156.77 N	30.71 E	.05	159.75	AT N 11- 5 E
18900.00	18897.56	161.26	1.61	0-55 N	5-16 E	158.37 N	30.93 E	.09	161.36	AT N 11- 3 E
19000.00	18997.55	162.85	1.60	0-55 N	2- 0 E	159.97 N	31.03 E	.05	162.95	AT N 10-59 E
19100.00	19097.54	164.34	1.50	0-48 N	2- 0 E	161.46 N	31.09 E	.12	164.43	AT N 10-54 E
19200.00	19197.53	165.89	1.56	0-59 N	5- 1 E	163.02 N	31.18 E	.19	165.97	AT N 10-50 E
19300.00	19297.51	167.61	1.73	1- 0 N	0-53 E	164.74 N	31.27 E	.07	167.68	AT N 10-45 E
19400.00	19397.50	169.37	1.77	1- 2 N	3-47 E	166.51 N	31.35 E	.06	169.44	AT N 10-40 E
19500.00	19497.48	171.19	1.83	1- 4 N	0-17 W	168.35 N	31.40 E	.08	171.25	AT N 10-34 E
19600.00	19597.46	173.03	1.86	1- 4 N	0-50 E	170.21 N	31.41 E	.02	173.08	AT N 10-27 E
19700.00	19697.45	174.76	1.75	0-56 N	1-54 E	171.95 N	31.45 E	.13	174.80	AT N 10-22 E
19800.00	19797.44	176.36	1.63	0-56 N	4-24 W	173.58 N	31.42 E	.10	176.40	AT N 10-16 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	BEARING
18500.00	18497.61	154.62	1.98	0-59 N	17-25 E	151.74 N	30.31 E	.33	154.74	AT N 11-18 E
18600.00	18597.60	156.35	1.76	1- 2 N	2-13 W	153.46 N	30.53 E	.35	156.47	AT N 11-15 E
18686.00	18683.59	157.78	1.46	0-55 N	5- 3 W	154.92 N	30.44 E	.15	157.89	AT N 11- 7 E
18700.00	18697.59	158.01	.23	0-57 N	7-56 E	155.15 N	30.44 E	1.53	158.11	AT N 11- 6 E
18800.00	18797.57	159.65	1.64	0-56 N	10-38 E	156.77 N	30.71 E	.05	159.75	AT N 11- 5 E
18900.00	18897.56	161.26	1.61	0-55 N	5-16 E	158.37 N	30.93 E	.09	161.36	AT N 11- 3 E
19000.00	18997.55	162.85	1.60	0-55 N	2- 0 E	159.97 N	31.03 E	.05	162.95	AT N 10-59 E
19100.00	19097.54	164.34	1.50	0-48 N	2- 0 E	161.46 N	31.09 E	.12	164.43	AT N 10-54 E
19200.00	19197.53	165.89	1.56	0-59 N	5- 1 E	163.02 N	31.18 E	.19	165.97	AT N 10-50 E
19300.00	19297.51	167.61	1.73	1- 0 N	0-53 E	164.74 N	31.27 E	.07	167.68	AT N 10-45 E
19400.00	19397.50	169.37	1.77	1- 2 N	3-47 E	166.51 N	31.35 E	.06	169.44	AT N 10-40 E
19500.00	19497.48	171.19	1.83	1- 4 N	0-17 W	168.35 N	31.40 E	.08	171.25	AT N 10-34 E
19600.00	19597.46	173.03	1.86	1- 4 N	0-50 E	170.21 N	31.41 E	.02	173.08	AT N 10-27 E
19700.00	19697.45	174.76	1.75	0-56 N	1-54 E	171.95 N	31.45 E	.13	174.80	AT N 10-22 E
19800.00	19797.44	176.36	1.63	0-56 N	4-24 W	173.58 N	31.42 E	.10	176.40	AT N 10-16 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
21250.00	21247.27	198.20	.81	0-55 N	6-29 E	195.75 N	31.11 E	.00	198.20 AT	N 9- 2 E

****
THE HORIZONTAL DISPLACEMENT AT THE DEPTH OF
****
21250.00 FEET EQUALS 198.20 FEET AT N 9- 2 E.
****

TRANSMITTAL OF CONFIDENTIAL LOG DATA

TO: _____

ATTENTION: _____

FROM: _____

OPERATOR: Chevron USA Inc

FIELD/AREA: Mississippi Sound Blk 57

LEASE: MS 57-01-05

WELL: #1

PARISH/COUNTY AND STATE: Offshore ~~Hancock~~ Co., Miss Harrison

API#: 23 047 20010

SHIPPED VIA: _____ DATE: _____

QUANTITY	LOG DESCRIPTION
1	1" Phasor Induction-SFL
1	5" Phasor Induction-SFL-Sonic
1	Lithodensity
1	Lithodensity (SS)
1	Lithodensity (LS)
1	Sonic-VDL
1	Borehole Profile
1	Multifinger Caliper log
1	1" Physical Fm log (mud log)
1	5" Physical Fm log (mud log)
1	PEP log mud log
1	IDEL mud log

RECEIVED
JUL 02 1990
STATE OIL & GAS BOARD

INSTRUCTIONS: PLEASE ACKNOWLEDGE RECEIPT OF DATA BY SIGNING AND RETURNING ATTACHED YELLOW COPY

RECEIVED BY: _____ DATE: _____

(CC 591-1)

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
100.00	100.00	-.07	.41	0-28 S	70-38 E	.14 S	.38 E	.47	.41	AT S 70-37 E
200.00	199.99	-.16	1.31	1- 2 S	80-22 E	.42 S	1.66 E	.58	1.71	AT S 75-45 E
300.00	299.97	.02	1.93	1-11 N	88-41 E	.55 S	3.58 E	.26	3.62	AT S 81-17 E
400.00	399.95	.25	1.93	1- 2 S	83-56 E	.62 S	5.51 E	.21	5.54	AT S 83-35 E
500.00	499.93	.19	1.89	1- 8 S	74-46 E	.97 S	7.36 E	.20	7.42	AT S 82-27 E
600.00	599.92	-.07	1.85	0-59 S	70-44 E	1.52 S	9.12 E	.17	9.25	AT S 80-33 E
700.00	699.90	-.34	1.72	0-59 S	72-35 E	2.06 S	10.75 E	.03	10.93	AT S 79-10 E
800.00	799.89	-.60	1.75	1- 1 S	72-29 E	2.58 S	12.42 E	.03	12.68	AT S 78-15 E
900.00	899.87	-.87	1.60	0-49 S	69-58 E	3.09 S	13.93 E	.20	14.27	AT S 77-2[illegible]
1000.00	999.87	-1.13	1.31	0-41 S	68-45 E	3.55 S	15.16 E	.13	15.57	AT S 76-48 E
1100.00	1099.86	-1.33	1.19	0-41 S	74-18 E	3.93 S	16.29 E	.07	16.75	AT S 76-26 E
1200.00	1199.85	-1.48	.96	0-25 S	66-52 E	4.23 S	17.20 E	.28	17.71	AT S 76-10 E
1300.00	1299.85	-1.76	.83	0-32 S	57- 5 E	4.63 S	17.92 E	.14	18.51	AT S 75-31 E
1400.00	1399.85	-2.02	.92	0-31 S	72-27 E	5.02 S	18.74 E	.14	19.40	AT S 75- 0 E
1500.00	1499.84	-2.16	.84	0-27 S	69-13 E	5.29 S	19.54 E	.07	20.24	AT S 74-50 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
1600.00	1599.84	-2.27	.65	0-18	S 74-54 E	5.50 S	20.16 E	.15	20.90	AT S 74-44 E
1700.00	1699.84	-2.49	.61	0-24	S 47-19 E	5.81 S	20.67 E	.19	21.47	AT S 74-18 E
1800.00	1799.84	-2.73	.60	0-17	S 71- 0 E	6.12 S	21.16 E	.18	22.03	AT S 73-51 E
1900.00	1899.84	-2.86	.51	0-18	S 60-31 E	6.33 S	21.62 E	.06	22.53	AT S 73-40 E
2000.00	1999.83	-3.14	.54	0-19	S 39-32 E	6.68 S	22.02 E	.11	23.01	AT S 73- 8 E
2100.00	2099.83	-3.63	.64	0-25	S 23- 8 E	7.22 S	22.34 E	.14	23.48	AT S 72- 5 E
2200.00	2199.83	-4.24	.71	0-24	S 20-31 E	7.88 S	22.61 E	.03	23.94	AT S 70-46 E
2300.00	2299.83	-4.90	.80	0-31	S 29- 2 E	8.61 S	22.95 E	.13	24.51	AT S 69-27 E
2400.00	2399.82	-5.52	.76	0-21	S 21- 8 E	9.28 S	23.28 E	.18	25.06	AT S 68-19 E
2500.00	2499.82	-6.11	.67	0-25	S 17-43 E	9.92 S	23.50 E	.07	25.50	AT S 67- 7 E
2600.00	2599.82	-6.64	.68	0-22	S 40-26 E	10.51 S	23.82 E	.16	26.03	AT S 66-12 E
2700.00	2699.82	-7.18	.70	0-26	S 19-55 E	11.10 S	24.15 E	.16	26.58	AT S 65-18 E
2800.00	2799.81	-7.84	.76	0-26	S 21-16 E	11.81 S	24.42 E	.01	27.13	AT S 64-11 E
2900.00	2899.81	-8.52	.76	0-26	S 8-55 E	12.54 S	24.61 E	.09	27.62	AT S 63- 0 E
3000.00	2999.81	-9.16	.67	0-20	S 8-52 E	13.20 S	24.72 E	.10	28.02	AT S 61-54 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
3100.00	3099.81	-9.83	.71	0-29	S 13-13 E	13.90 S	24.86 E	.15	28.48	AT S 60-48 E
3200.00	3199.80	-10.50	.74	0-22	S 19-18 E	14.61 S	25.06 E	.12	29.01	AT S 59-45 E
3300.00	3299.80	-11.17	.74	0-29	S 13-13 E	15.32 S	25.26 E	.12	29.55	AT S 58-46 E
3400.00	3399.80	-11.89	.81	0-27	S 24-43 E	16.09 S	25.52 E	.10	30.17	AT S 57-46 E
3500.00	3499.79	-12.60	.93	0-37	S 35- 6 E	16.89 S	26.00 E	.19	31.00	AT S 57- 0 E
3600.00	3599.79	-13.45	1.13	0-41	S 30-37 E	17.84 S	26.61 E	.08	32.04	AT S 56-10 E
3700.00	3699.78	-14.32	1.09	0-34	S 24-53 E	18.80 S	27.12 E	.13	33.00	AT S 55-16 E
3800.00	3799.77	-15.09	.99	0-34	S 32-54 E	19.67 S	27.60 E	.08	33.89	AT S 54-32 E
3900.00	3899.77	-15.84	.90	0-28	S 13-13 E	20.48 S	27.96 E	.20	34.66	AT S 53-4[illegible]
4000.00	3999.77	-16.47	.71	0-21	S 23-48 E	21.15 S	28.18 E	.14	35.23	AT S 53- 6 E
4100.00	4099.77	-17.10	.68	0-26	S 16-37 W	21.80 S	28.19 E	.28	35.64	AT S 52-18 E
4200.00	4199.76	-17.72	.63	0-17	S 22-14 W	22.39 S	27.99 E	.15	35.84	AT S 51-21 E
4300.00	4299.76	-18.19	.49	0-17	S 29-54 W	22.83 S	27.77 E	.04	35.95	AT S 50-35 E
4400.00	4399.76	-18.68	.52	0-19	S 32-55 W	23.28 S	27.50 E	.04	36.03	AT S 49-45 E
4500.00	4499.76	-19.15	.52	0-17	S 37-23 W	23.71 S	27.20 E	.04	36.08	AT S 48-56 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
4600.00	4599.76	-19.49	.41	0-11 S	46-51 W	24.01 S	26.93 E	.11	36.08	AT S 48-17 E
4700.00	4699.76	-19.85	.39	0-16 S	0-56 W	24.35 S	26.81 E	.19	36.22	AT S 47-45 E
4800.00	4799.76	-20.31	.51	0-19 S	42-53 W	24.79 S	26.62 E	.21	36.37	AT S 47- 3 E
4900.00	4899.76	-20.62	.36	0- 6 S	9-41 W	25.08 S	26.42 E	.24	36.42	AT S 46-30 E
5000.00	4999.76	-20.84	.23	0-10 S	32-40 W	25.29 S	26.33 E	.08	36.50	AT S 46- 9 E
5100.00	5099.76	-21.11	.29	0-10 S	30-31 W	25.53 S	26.17 E	.01	36.56	AT S 45-43 E
5200.00	5199.76	-21.30	.29	0-10 S	59-34 E	25.73 S	26.22 E	.24	36.74	AT S 45-33 E
5300.00	5299.76	-21.47	.38	0-16 S	51-46 E	25.95 S	26.53 E	.10	37.11	AT S 45-38 E
5400.00	5399.75	-21.63	.57	0-23 S	73- 5 E	26.19 S	27.04 E	.17	37.64	AT S 45-55 E
5500.00	5499.75	-21.78	.67	0-23 S	63- 4 E	26.44 S	27.65 E	.07	38.26	AT S 46-17 E
5600.00	5599.75	-22.06	.61	0-19 S	39-14 E	26.81 S	28.13 E	.16	38.85	AT S 46-23 E
5700.00	5699.75	-22.36	.47	0-13 S	45-46 E	27.15 S	28.44 E	.10	39.32	AT S 46-19 E
5800.00	5799.75	-22.59	.35	0-11 S	32-25 E	27.42 S	28.66 E	.06	39.66	AT S 46-16 E
5900.00	5899.75	-22.80	.33	0-12 S	47-56 E	27.67 S	28.87 E	.05	39.99	AT S 46-13 E
6000.00	5999.75	-22.91	.28	0- 7 S	74-34 E	27.81 S	29.10 E	.11	40.26	AT S 46-18 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
6100.00	6099.75	-23.01	.20	0- 7 S	12-58 E	27.94 S	29.22 E	.12	40.43	AT S 46-17 E
6200.00	6199.75	-23.29	.29	0-13 S	0-54 W	28.23 S	29.24 E	.11	40.64	AT S 46- 1 E
6300.00	6299.75	-23.55	.35	0-11 S	57-31 E	28.50 S	29.37 E	.20	40.93	AT S 45-52 E
6400.00	6399.75	-23.48	.32	0-11 N	47-37 E	28.48 S	29.63 E	.22	41.10	AT S 46- 8 E
6500.00	6499.75	-23.32	.32	0-11 N	85- 0 E	28.36 S	29.90 E	.12	41.21	AT S 46-31 E
6600.00	6599.75	-23.21	.31	0-10 N	71-19 E	28.30 S	30.20 E	.04	41.39	AT S 46-52 E
6700.00	6699.74	-22.96	.49	0-24 N	48-11 W	28.02 S	30.08 E	.50	41.11	AT S 47- 2 E
6800.00	6799.74	-22.38	1.16	0-56 N	52-16 W	27.29 S	29.18 E	.54	39.95	AT S 46-55 E
6900.00	6899.72	-21.68	1.61	0-55 N	58-22 W	26.37 S	27.85 E	.10	38.35	AT S 46-34 E
7000.00	6999.71	-20.98	1.66	0-59 N	53-48 W	25.44 S	26.48 E	.10	36.72	AT S 46- 8 E
7100.00	7099.70	-20.31	1.70	0-58 N	61-53 W	24.54 S	25.04 E	.14	35.06	AT S 45-35 E
7200.00	7199.69	-19.87	1.45	0-42 N	65-37 W	23.89 S	23.74 E	.27	33.68	AT S 44-49 E
7300.00	7299.68	-19.55	1.32	0-49 N	67-55 W	23.37 S	22.52 E	.12	32.46	AT S 43-57 E
7400.00	7399.67	-19.17	1.27	0-38 N	57-31 W	22.81 S	21.40 E	.22	31.27	AT S 43-10 E
7500.00	7499.66	-18.81	.99	0-30 N	62-14 W	22.31 S	20.54 E	.14	30.33	AT S 42-39 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FC989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
7600.00	7599.66	-18.51	.99	0-38	N 64-13 W	21.86 S	19.66 E	.13	29.40	AT S 41-58 E
7700.00	7699.66	-18.31	.89	0-23	N 73-17 W	21.53 S	18.84 E	.26	28.61	AT S 41-12 E
7811.00	7810.65	-18.73	.86	0-30	S 24- 0 W	21.86 S	18.29 E	.53	28.50	AT S 39-55 E
7904.00	7903.65	-19.29	.81	0-30	S 74- 0 W	22.34 S	17.73 E	.45	28.53	AT S 38-26 E
7996.00	7995.65	-19.45	.80	0-30	N 79- 0 W	22.38 S	16.95 E	.25	28.08	AT S 37- 9 E
8027.00	8026.65	-19.47	.20	0-15	S 71- 0 W	22.37 S	16.76 E	1.00	27.95	AT S 36-50 E
8058.00	8057.65	-19.51	.20	0-30	N 82- 0 W	22.38 S	16.56 E	.97	27.84	AT S 36-30 E
8089.00	8088.64	-19.53	.20	0-15	S 86- 0 W	22.36 S	16.36 E	.84	27.71	AT S 36-11 E
8119.00	8118.64	-19.54	.07	0- 0	N / A	22.37 S	16.29 E	.83	27.67	AT S 36- 4
8150.00	8149.64	-19.61	.07	0-15	S 3- 0 W	22.44 S	16.29 E	.81	27.73	AT S 35-59 E
8181.00	8180.64	-19.81	.20	0-30	S 4- 0 E	22.64 S	16.30 E	.82	27.89	AT S 35-45 E
8212.00	8211.64	-20.05	.27	0-30	S 24- 0 E	22.90 S	16.36 E	.56	28.14	AT S 35-33 E
8243.00	8242.64	-20.30	.27	0-30	S 14- 0 W	23.15 S	16.38 E	1.05	28.36	AT S 35-17 E
8273.00	8272.64	-20.56	.26	0-30	S 15- 0 W	23.40 S	16.32 E	.03	28.53	AT S 34-53 E
8304.00	8303.64	-20.83	.27	0-30	S 18- 0 W	23.66 S	16.24 E	.08	28.70	AT S 34-28 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	BEARING
8335.00	8334.63	-21.10	.27	0-30 S	4- 0 E	23.93 S	16.21 E	.62	28.90	AT S 34- 7 E
8366.00	8365.63	-21.39	.34	0-45 S	28- 0 E	24.24 S	16.31 E	1.15	29.22	AT S 33-56 E
8397.00	8396.63	-21.69	.47	1- 0 S	49- 0 E	24.60 S	16.61 E	1.30	29.68	AT S 34- 2 E
8427.00	8426.62	-21.98	.65	1-30 S	59- 0 E	24.97 S	17.15 E	1.81	30.29	AT S 34-28 E
8458.00	8457.61	-22.32	.95	2- 0 S	61- 0 E	25.44 S	17.97 E	1.62	31.15	AT S 35-14 E
8489.00	8488.59	-22.75	1.15	2-15 S	57- 0 E	26.04 S	18.95 E	.94	32.20	AT S 36- 3 E
8600.00	8599.54	-23.47	3.34	1-12 S	88-55 E	27.25 S	21.94 E	1.25	34.98	AT S 38-51 E
8700.00	8699.51	-21.89	2.50	1-40 N	16-51 E	25.87 S	23.41 E	1.77	34.89	AT S 42- 8 E
8800.00	8799.47	-18.91	3.00	1-46 N	12- 4 E	22.97 S	24.15 E	.17	33.33	AT S 46-28 E
8900.00	8899.42	-15.90	3.01	1-41 N	13-20 E	20.04 S	24.81 E	.09	31.89	AT S 51- 5 E
9000.00	8999.38	-12.88	3.04	1-48 N	14-19 E	17.09 S	25.54 E	.12	30.73	AT S 56-13 E
9100.00	9099.33	-9.86	3.02	1-40 N	8- 8 E	14.13 S	26.13 E	.23	29.71	AT S 61-37 E
9200.00	9199.29	-7.15	2.70	1-26 N	6-50 E	11.44 S	26.49 E	.24	28.86	AT S 66-38 E
9300.00	9299.26	-4.65	2.52	1-27 N	2-37 E	8.94 S	26.70 E	.11	28.15	AT S 71-29 E
9400.00	9399.24	-2.37	2.30	1-11 N	1-23 W	6.64 S	26.73 E	.28	27.54	AT S 76- 3 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
9500.00	9499.21	-.29	2.11	1-14 N	0-53 E	4.53 S	26.72 E	.07	27.10	AT S 80-22 E
9600.00	9599.19	1.84	2.15	1-14 N	0-12 E	2.38 S	26.74 E	.01	26.85	AT S 84-55 E
9700.00	9699.17	3.96	2.14	1-13 N	5-17 E	.25 S	26.84 E	.11	26.84	AT S 89-28 E
9800.00	9799.15	6.00	2.05	1- 8 N	4-46 E	1.79 N	27.02 E	.08	27.08	AT N 86-12 E
9900.00	9899.13	8.11	2.11	1-17 N	4-51 E	3.90 N	27.20 E	.15	27.48	AT N 81-51 E
10000.00	9999.10	10.26	2.15	1-11 N	6-57 E	6.04 N	27.42 E	.11	28.08	AT N 77-35 E
10100.00	10099.08	12.35	2.09	1-13 N	4-40 E	8.12 N	27.63 E	.06	28.80	AT N 73-37 E
10200.00	10199.05	14.55	2.21	1-19 N	7-25 E	10.32 N	27.86 E	.12	29.71	AT N 69-41 E
10300.00	10299.03	16.90	2.36	1-23 N	2-13 E	12.66 N	28.06 E	.14	30.78	AT N 65-43 E
10400.00	10399.00	19.26	2.37	1-20 N	9-32 E	15.02 N	28.30 E	.18	32.04	AT N 62- 3 E
10500.00	10498.97	21.47	2.21	1-12 N	11-20 E	17.19 N	28.70 E	.14	33.45	AT N 59- 5 E
10600.00	10598.95	23.64	2.17	1-17 N	12- 6 E	19.31 N	29.14 E	.08	34.96	AT N 56-28 E
10700.00	10698.93	25.61	1.98	0-59 N	8-51 E	21.26 N	29.50 E	.31	36.36	AT N 54-14 E
10800.00	10798.92	27.30	1.69	0-57 N	8- 8 E	22.92 N	29.75 E	.04	37.56	AT N 52-23 E
10900.00	10898.91	28.81	1.51	0-47 N	10-17 E	24.42 N	29.99 E	.17	38.68	AT N 50-51 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
11000.00	10998.89	30.35	1.54	0-59 N	4-16 E	25.95 N	30.18 E	.22	39.80	AT N 49-19 E
11100.00	11098.88	31.89	1.54	0-47 N	15-14 E	27.46 N	30.42 E	.26	40.98	AT N 47-56 E
11200.00	11198.87	33.29	1.41	0-50 N	5-51 E	28.84 N	30.68 E	.14	42.11	AT N 46-46 E
11300.00	11298.86	34.73	1.44	0-49 N	6-33 E	30.27 N	30.83 E	.02	43.21	AT N 45-31 E
11400.00	11398.86	35.96	1.24	0-36 N	1-36 E	31.51 N	30.93 E	.22	44.15	AT N 44-28 E
11500.00	11498.85	37.03	1.08	0-38 N	0-35 E	32.58 N	30.95 E	.04	44.94	AT N 43-32 E
11600.00	11598.84	38.10	1.08	0-36 N	3-56 E	33.66 N	30.99 E	.05	45.75	AT N 42-38 E
11700.00	11698.84	39.13	1.03	0-35 N	6-19 E	34.69 N	31.08 E	.03	46.57	AT N 41-52 E
11800.00	11798.83	40.08	.97	0-32 N	8- 1 W	35.65 N	31.07 E	.15	47.29	AT N 41- [illegible]
11900.00	11898.83	40.93	.87	0-28 N	5-37 E	36.52 N	31.05 E	.14	47.93	AT N 40-22 E
12000.00	11998.83	41.88	.95	0-37 N	7-21 E	37.46 N	31.16 E	.15	48.72	AT N 39-45 E
12100.00	12098.82	42.72	.84	0-21 N	0- 7 E	38.30 N	31.23 E	.27	49.41	AT N 39-12 E
12200.00	12198.82	43.34	.63	0-22 N	7-11 E	38.92 N	31.27 E	.05	49.92	AT N 38-47 E
12300.00	12298.82	43.99	.65	0-23 N	4- 6 E	39.57 N	31.33 E	.03	50.47	AT N 38-22 E
12400.00	12398.82	44.60	.61	0-19 N	3-35 E	40.18 N	31.37 E	.07	50.98	AT N 37-59 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	BEARING
12500.00	12498.81	45.16	.57	0-20 N	2-53 E	40.75 N	31.40 E	.02	51.44	AT N 37-37 E
12600.00	12598.81	45.68	.52	0-16 N	2-50 E	41.27 N	31.43 E	.07	51.87	AT N 37-17 E
12700.00	12698.81	46.28	.60	0-25 N	5-35 E	41.86 N	31.48 E	.15	52.38	AT N 36-56 E
12800.00	12798.81	47.03	.76	0-27 N	10-26 E	42.61 N	31.58 E	.05	53.04	AT N 36-33 E
12900.00	12898.80	47.87	.84	0-31 N	2-39 E	43.45 N	31.67 E	.09	53.77	AT N 36- 6 E
13000.00	12998.80	48.69	.81	0-25 N	9- 7 E	44.26 N	31.75 E	.11	54.47	AT N 35-39 E
13100.00	13098.80	49.47	.79	0-29 N	6-31 E	45.04 N	31.86 E	.07	55.17	AT N 35-17 E
13200.00	13198.79	50.36	.89	0-32 N	8-24 E	45.92 N	31.97 E	.05	55.95	AT N 34-51 E
13300.00	13298.79	51.24	.89	0-29 N	0-32 E	46.80 N	32.05 E	.09	56.72	AT N 34-2
13400.00	13398.79	52.11	.89	0-32 N	2-24 W	47.68 N	32.03 E	.06	57.44	AT N 33-53 E
13500.00	13498.78	53.07	.97	0-35 N	4-14 W	48.66 N	31.97 E	.05	58.22	AT N 33-19 E
13600.00	13598.78	54.07	1.02	0-35 N	2-40 E	49.67 N	31.96 E	.07	59.07	AT N 32-45 E
13700.00	13698.77	55.21	1.15	0-44 N	8-47 E	50.81 N	32.08 E	.17	60.09	AT N 32-16 E
13800.00	13798.76	56.45	1.24	0-41 N	14-13 E	52.02 N	32.33 E	.08	61.25	AT N 31-51 E
13900.00	13898.75	57.76	1.32	0-50 N	1-32 W	53.33 N	32.45 E	.26	62.43	AT N 31-19 E

SCIENTIFIC DRILLING INTERNATIONAL
LAFAYETTE, LOUISIANA

JOB NUMBER: 21FG989239 DATE: 09/05/89

INRUN SURVEY

BY

THE MINIMUM CURVATURE

MEAS. DEPTH	VERT. DEPTH	VERT. SECT.	COURSE DEV.	INC D M	BEARING D M	COORDINATES LATITUDE	COORDINATES DEPARTURE	D-LEG PER 100	STATION DISPLACEMENT DISTANCE	STATION DISPLACEMENT BEARING
14000.00	13998.74	59.11	1.37	0-44 N	7-12 E	54.69 N	32.51 E	.16	63.63	AT N 30-44 E
14100.00	14098.73	60.52	1.41	0-53 N	8-16 E	56.09 N	32.70 E	.15	64.93	AT N 30-15 E
14200.00	14198.72	62.14	1.61	0-58 N	7-28 E	57.69 N	32.92 E	.08	66.42	AT N 29-43 E
14300.00	14298.71	63.92	1.79	1- 5 N	12- 4 E	59.45 N	33.23 E	.14	68.11	AT N 29-12 E
14400.00	14398.69	65.80	1.89	1- 5 N	16-41 E	61.28 N	33.70 E	.09	69.93	AT N 28-49 E
14500.00	14498.67	67.72	1.93	1- 8 N	16-31 E	63.13 N	34.25 E	.05	71.83	AT N 28-29 E
14600.00	14598.64	69.92	2.21	1-24 N	13-50 E	65.27 N	34.83 E	.27	73.98	AT N 28- 5 E
14700.00	14698.62	72.21	2.30	1-14 N	4-19 E	67.53 N	35.20 E	.27	76.15	AT N 27-32 E
14800.00	14798.59	74.52	2.33	1-26 N	0-52 E	69.85 N	35.30 E	.22	78.26	AT N 26-49 E
14900.00	14898.56	76.99	2.50	1-26 N	1-55 W	72.35 N	35.28 E	.07	80.49	AT N 26- 0 E
15000.00	14998.52	79.55	2.62	1-34 N	3-20 W	74.97 N	35.16 E	.14	82.80	AT N 25- 7 E
15100.00	15098.48	82.31	2.82	1-40 N	2-35 W	77.78 N	35.01 E	.10	85.30	AT N 24-14 E
15200.00	15198.44	85.14	2.92	1-41 N	7-16 W	80.69 N	34.76 E	.14	87.86	AT N 23-18 E
15300.00	15298.39	88.07	3.02	1-47 N	4-36 W	83.70 N	34.45 E	.13	90.51	AT N 22-22 E
15400.00	15398.35	91.08	3.11	1-47 N	6- 2 W	86.80 N	34.16 E	.04	93.28	AT N 21-29 E

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA 70174

August 30, 1989

Dr. Richard Henderson
Mississippi State Oil and Gas Board
P. O. Box 1322
Jackson, MS 39215-1322

Gentlemen:

This is written confirmation of our oral report of August 28, 1989, for an unauthorized discharge incident which occurred at Chevron's Transworld 70 Drilling Rig in Mississippi Sound Block 57.

At 12:30 P.M. on August 26, 1989 less than 1/8 gal. of a refined product was discharged to the waters. A one-gallon paint can was crushed on the deck of a tending vessel (M/V Chip Six) when a piece of equipment rolled on the can. The remainder of the paint was contained on the vessel with sorbent pads.

An oil boom was deployed and sorbent pads were used to recover the paint from the water.

Environmental impact to the area should have been minimal, since all visable paint was retrieved.

Questions on this matter can be directed to Mr. C. A. Canzoneri, at (504) 364-2293.

Very truly yours,

M. S. Witten

M. S. Witten
Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

CAC

cc: Mr. Joe Gill
Mississippi Department of
Wildlife Conservation
Bureau of Marine Resources
2620 W. Beach Blvd.
Biloxi, MS 39531

A2/EE2/262

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA. 70174

August 25, 1989

State Oil and Gas Board
Attention Dr. Henderson
500 Greymont
Suite E
Jackson, MS 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M.D. 21440'. 14" @ 16506'. M.W. 16.4. Drilled F/21077'-21161'. Circ B/U. POOH & changed bit. Drill F/21161'-21440'. Circ B/U. POOH. Tested BOP's. TIH with temp bombs.

Very truly yours,

A. J. Pawicki, for

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

well file

August 21, 1989

State Oil & Gas Board
500 Greymont, Suite E
Jackson, MS 39202

Dear Sir:

Per the telephone conversation this afternoon between John S. Bartges of Chevron U.S.A., Inc. and Mr. Richard Lewis of the State Oil & Gas Board, the Transworld 70 Drilling Rig will postpone their BOP test until the current drill bit becomes dull or for 48 hours maximum. At this time, the bit will be pulled out of hole and the crews will conduct a full BOP test.

Very Truly Yours,

Sal

M.H. Hellrich
Division Drilling Manager
Eastern Production Division

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

August 17, 1989

State Oil and Gas Board
500 Greymont
Suite E
Jackson, Mississippi 39202

Attention Mr. Henderson

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

M.D. 21,157', 14" @ 16,506'. M.W. 16.4. Drill f/20,802' - 20,841'. Circ. B/U. POOH for new bit. Run casing caliper. TIH. Drilled 20,841' - 20,928'. Increased MW from 16.2 ppg to 16.4 ppg while drilling. Circ. B/U. POOH. Test BOP's. TIH. Drilled from 20,928' - 21,077'.

Very truly yours,

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A5/ED1/58

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

August 10, 1989

State Oil and Gas Board
Attention Dr. Henderson
500 Greymont
Suite E
Jackson, MS 39202

Gentlemen:

The following is a report of all significant activities on the MS-87-01-0S #1 BP #1 Well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

MS 87-01-0S #1 BP #1
Transworld 70

Drilled F/20467'-20637'. Circ B/U POOH. Test BOP's. TIH. Drilled F/20637'-20802'.

Very truly yours,

A. F. Lawicki, for

M. H. Hellrich
Eastern Drilling Manager
Eastern Production Division

MNM

A1/ED1/08

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

January 5, 1989

Mr. Bob Rogers
Mississippi Department of Natural Resources
Bureau of Pollution Control
P. O. Box 10385
Jackson, MS 39209

Gentlemen:

This is written confirmation of our oral report of January 3, 1989, for an unauthorized discharge incident which occurred at Chevron's Transworld 70 drilling rig in Mississippi Sound Block 57.

At 7:00 p.m. on December 31, 1988, approximately ten (10) barrels of drill cuttings were discharged adjacent to the rig. A flexible section of hose had pulled loose from the cuttings chute, allowing the cuttings to enter the water instead of the standby barge. The cuttings had accumulated inside this section of hose, causing it to bulge and become weighted down.

Drilling operations were ceased immediately. A rigid section of pipe was installed on the cuttings chute. This corrective action will prevent a recurrence of the incident.

Environmental impact to the area should be minimal, since the cuttings consisted primarily of native sand and clay.

Questions on this matter can be directed to Ms. Laura Perica at (504) 364-2293.

Very truly yours,

C. R. Block
Division Manager
Eastern Production Division

LEP

cc: Mr. Joe Gill
Mississippi Department of
Wildlife Conservation
Bureau of Marine Resources
2620 W. Beach Blvd.
Biloxi, MS 39531

Mr. David Schwartz
Department of the Army
Mobile District, Corps
of Engineers
P. O. Box 2288
Mobile, AL 36628-0001

A4/[illegible]1/9

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA. 70174

January 5, 1989

Mr. Joe Gill
Mississippi Department of
Wildlife Conservation
Bureau of Marine Resources
2620 W. Beach Blvd.
Biloxi, MS 39531

Gentlemen:

This is written confirmation of our oral report of January 3, 1989, for an unauthorized discharge incident which occurred at Chevron's Transworld 70 drilling rig in Mississippi Sound Block 57.

At 7:00 p.m. on December 31, 1988, approximately ten (10) barrels of drill cuttings were discharged adjacent to the rig. A flexible section of hose had pulled loose from the cuttings chute, allowing the cuttings to enter the water instead of the standby barge. The cuttings had accumulated inside this section of hose, causing it to bulge and become weighted down.

Drilling operations were ceased immediately. A rigid section of pipe was installed on the cuttings chute. This corrective action will prevent a recurrence of the incident.

Environmental impact to the area should be minimal, since the cuttings consisted primarily of native sand and clay.

Questions on this matter can be directed to Ms. Laura Perica at (504) 364-2293.

Very truly yours,

C. R. Block
Division Manager
Eastern Production Division

LEP

cc: Mr. Bob Rogers
Mississippi Department of
Natural Resources
Bureau of Pollution Control
P. O. Box 10385
Jackson, MS 39209

Mr. David Schwartz
Department of the Army
Mobile District, Corps
of Engineers
P. O. Box 2288
Mobile, AL 36628-0001

A4/EE1/9

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

January 5, 1989

Mr. David Schwartz
Department of the Army
Mobile District, Corps
of Engineers
P. O. Box 2288
Mobile, AL 36628-0001

Gentlemen:

This is written confirmation of our oral report of January 3, 1989, for an unauthorized discharge incident which occurred at Chevron's Transworld 70 drilling rig in Mississippi Sound Block 57.

At 7:00 p.m. on December 31, 1988, approximately ten (10) barrels of drill cuttings were discharged adjacent to the rig. A flexible section of hose had pulled loose from the cuttings chute, allowing the cuttings to enter the water instead of the standby barge. The cuttings had accumulated inside this section of hose, causing it to bulge and become weighted down.

Drilling operations were ceased immediately. A rigid section of pipe was installed on the cuttings chute. This corrective action will prevent a recurrence of the incident.

Environmental impact to the area should be minimal, since the cuttings consisted primarily of native sand and clay.

Questions on this matter can be directed to Ms. Laura Perica at (504) 364-2293.

Very truly yours,

C. R. Block
Division Manager
Eastern Production Division

LEP

cc: Mr. Bob Rogers
Mississippi Department of
Natural Resources
Bureau of Pollution Control
P. O. Box 10385
Jackson, MS 39209

Mr. Joe Gill
Mississippi Department of
Wildlife Conservation
Bureau of Marine Resources
2620 W. Beach Blvd.
Biloxi, MS 39531

A4/EE1/9

Chevron U.S.A. Inc.
P. O. Box 6056 New Orleans, LA 70174

January 3, 1989

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Miss 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S/L 3470 #1
Transworld 70

M.D. 6,014'. 26" @ 1,007'. M.W. 9.2. Test 26" csg to 400 psi. Drill out shoe. Test to 9.5 ppg EMW. Drill 1,022-2,559'. CBU. Make wiper trip. Drlg 2,559'-4,317'. POOH to change out cuttings barge. Drill 4,317'-6,104'.

Very truly yours,

for

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A6/ED1/10

RECEIVED
JAN 9 1989
STATE OIL & GAS BOARD

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

December 27, 1988

State Oil and Gas Board
P. O. Box 1332
1404 Sillers Building
Jackson, Miss 39215-1332

Dear Mr. Henderson:

The following is a report of all significant activities on the S.L. 3470 #1 well in Mississippi Sound 57 during the past seven (7) days.

Mississippi Sound 57

S/L 3470 #1
Transworld 70

M.D. 1,007'. 26" @ 1,007'. M.W. 8.5. Rig up. Wash out DP. Drill 20" hole from 333 to 1,007' & underream to 32". Run 26" casing and cement same. Install starting head. N/U 30" diverter system.

Very truly yours,

J S Bartges
for

M. H. Hellrich
Division Drilling Manager
Eastern Production Division

MNM

A6/ED1/10

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

December 6, 1988

State Oil and Gas Board
P.O. Box 1332
Jackson, MS 39215-1332

Attn: Dr. A. Richard Henderson

RE: Drilling Program Revision for the Mississippi Sound Block 57 Unit; State of Mississippi #1 Well

Gentlemen,

The original Drilling Program for the subject well has evolved somewhat since it was provided as the reverse side of the Application for Permit to Drill. All changes were discussed by telephone between Andrew Rawicki of our Drilling Department and your Mr. Ken McCarley.

Please accept the enclosed as an amendment to the original reverse side of the Form No. 2, dated August 20, 1988.

Note particularly an alternate designation of the well, which reflects the lease number rather than just the unit:

MS87-01-OS #1

All formal correspondence with the State of Mississippi will continue to use the as-permitted name of Mississippi Sound Block 57 Unit; State of Mississippi #1, however, unless advised otherwise.

M. S. Witten

M. S. Witten
Division Coordinator
Environmental and Regulatory Affairs

DRILLING PROGRAM

TYPE WELL: 1. EXPLORATORY
2. STRAIGHT HOLE

WELL NAME: MS87-01-OS #1 BLOCK: MS Sound Blk 57
CONTRACTOR: TRANSWORLD RIG: TRANSWORLD 70
SURFACE LOCATION: 8450'FNL & 7650' FWL OF MS. SOUND BLK 57; X=391,970 Y=213,310
WATER DEPTH: 14 FT. ELEVATION-KB TO MWL: 148 FT. TOTAL MEASURED DEPTH 23500FT.

	OBJECTIVES			TOLERANCE				
TARGETS	SAND	DIST.OUT	DIR.(GRID)	TVD	IN	OUT	LEFT	RIGHT
#1	NORPHLET	STRAIGHT HOLE		23500	100	100	100	100

KOP: N/A FT.
BUILD RATE N/A
ANGLE UP N/A FT.
AVERAGE ANGLE N/A DEG.
DOUBLE DOGLEG- NO

CASING PROGRAM

DRIVE PIPE: 36 " WITH MINIMUM OF 125' PENETRATION

	HOLE SIZE	DEPTH MD/TVD	CSG SIZE	CMT: CLASS 'H' TO FILL THESE THEORETICAL VOLUMES:	SHOE TEST MWE
CONDUCTOR	20"/32"	1000'	26"	3524 cu ft (20% washout)	9.5 ppg
SURFACE	17-1/2"/ 24"	7500'	20"	16215 cu ft (20% washout)	LEAKOFF
PROTECTIVE	17-1/2"	16500'	14"/13-5/8"	TO BE DETERMINED (caliper)	LEAKOFF
PROTECTIVE	12-1/4"	21500'	10-3/4"/ 9-5/8"	TO BE DETERMINED (caliper)	LEAKOFF
PRODUCTION LINER	8-1/2"	23500'	7-5/8"	TO BE DETERMINED (caliper)	LEAKOFF

Note: All zones which contain oil, gas, or fresh water shall be fully protected by casing and cement.

BLOWOUT PREVENTERS

	NUMBER-TYPE	SIZE	RATING	TEST PRESSURE	DRILLING BHA D.PIPE	HWDP	DRILL COLLARS	STRING STAB	JARS
COND.HOLE	DIVERTER	30"	1M	100PSI	5"	9JTS	9-1/2"	AS REQ	
SURF.HOLE	DIVERTER	30"	1M	400PSI	5"	9JTS	9-1/2"	AS REQ	NO
BELOW:									
20" CSG	1-ANNULAR	21-1/4"	5M	250/3500	5-1/2"	18JTS	11"	AS REQ	NO
	3-RAMS	21-1/4"	10M	250/5000					
14"/13-5/8"	1-ANNULAR	13-5/8"	5M	250/3500	5"	9JTS	8"	AS REQ	NO
	4-RAMS	13-5/8"	10M	250/10000					
10-3/4"/ 9-5/8"	1-ANNULAR	11"	10M	250/7000	5"	9JTS	6-1/4"	AS REQ	NO
	4-RAMS	11"	15M	250/15000					

OTHER SERVICES START MUD LOGGING @ BSC ; GAS DETECTOR @ SPUD ; PVT & FLOW METER @ SPUD ;
ADJ.CHOKE @ SPUD ; CENTRIFUGE @ SPUD ; DEGASSER @ SPUD ; DRLG. RECORDER @ SPUD ;
DESILTER @ SPUD ; MUD CLEANERS @ SPUD ; TV MONITOR @ N/A ; TRIP TANK @ SPUD

MUD PROGRAM- BREAKOVER TO NON-DISPERSED MUD SYSTEM @ SPUD
BREAKOVER TO DISPERSED WATER-BASED MUD SYSTEM @ 16500'

DEPTH	WEIGHT	VIS.	WL	DEPTH	WEIGHT	VIS.	WL	DEPTH	WEIGHT	VIS.	WL
1000'	9.0	45	NC	16500'	11.0	35	12	23000	17.5	44	5
7500'	9.0	45	20	18000'	15.6	35	10				
10000'	9.5	40	15	21500'	16.0	42	8				

LOGGING PROGRAM COMPANY SCHLUMBERGER
ELEC. LINE LOGS PLANNED AT THE FOLLOWING DEPTHS:
SURFACE, PROTECTIVE, AND LINER SETTING DEPTH

RUN 1" SCALE ON ELECTRIC LOG SURVEY WHILE GIH.
REFER TO GEOLOGICAL LETTER FOR TYPE OF LOGS TO RUN.
GEOLOGIST ASSIGNED: J.A. Elterman
WELL CLASSIFICATION: STANDARD

Formation tops:(Estimated from seismic)

Het	5200'
Upper Cretaceous	8400'
Lower Cretaceous	10400'
Cotton Valley	18100'
Norphlet	23000'

SPECIAL REMARKS

1. CK.DRLG.BREAKS FOR FLOW BELOW 7500'
2. HAVE DRLR. INITIAL PVT EVERY 30 MINS. BELOW 7500 '. EXP.ANY LEVEL CHANGES.
3. FILL DP EACH 20 STANDS WHEN RUNNING FLOAT.
4. IMPLEMENT HYDROGEN SULFIDE CONTINGENCY PLAN AT 16500'.
5. USE TRANSWORLD 10M psi CHOKE MANIFOLD TO 21,500', RENTAL 15M psi MANIFOLD THEREAFTER.

PREPARED BY: W.M.WILLIAMS/A.T.RAWICKI DATE: 12-05-88 APPROVED BY:

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA. 70174

October 5, 1988

Rider to Bond U89 76 11-265
Mississippi Sound Block 57 Unit

Mississippi State Oil and Gas Board
P. O. Box 1332
Jackson, MS 39215-1332

Attention Dr. Richard Henderson

Gentlemen:

Enclosed is a rider to our Mississippi Bond, U89 76 11-265, changing the number from a Louisiana number to a Mississippi number, U80 61 69-48.

I regret any inconvenience that this may cause you. Please contact Ms. Laura Perica at (504) 364-2293 should you have any questions.

Very truly yours,

M. S. Witten

M. S. Witten
Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

LEP
Enclosure

3/ESFH8/165

Reliance Insurance Companies

RELIANCE INSURANCE COMPANY
PHILADELPHIA, PENNSYLVANIA

UNITED PACIFIC INSURANCE COMPANY
FEDERAL WAY, WASHINGTON

PLANET INSURANCE COMPANY
FEDERAL WAY, WASHINGTON

RECEIVED
OCT 07 1988
STATE OIL & GAS BOARD

RIDER

To be attached to and form a part of

Type of Bond: DRILLING PERMIT BOND

Bond No. U89 76 11-265

executed by CHEVRON U.S.A. INC., as Principal,

and by UNITED PACIFIC INSURANCE COMPANY, as Surety,

in favor of STATE OF MISSISSIPPI

and dated SEPTEMBER 9, 1988.

In consideration of the premium charged for the attached bond, it is hereby agreed to change:

TO CHANGE BOND NUMBER

From: U89 76 11-265

To: U80 61 69-48

The attached bond shall be subject to all its agreements, limitations and conditions except as herein expressly modified.

This rider is effective SEPTEMBER 9, 1988

Signed and Sealed 28th DAY OF SEPTEMBER 1988

Principal CHEVRON U.S.A. INC.

By: _____
Title

UNITED PACIFIC INSURANCE COMPANY

By: Sylvia Copeland
SYLVIA COPELAND
Attorney-in-Fact

Countersigned by:

D. M. Ferris
Countersigning Agent for the
State of Mississippi

RIDER ACCEPTED (Please sign duplicate of this Rider and return to Surety)

By: _____

Date _____

BD-1468 Ed. 9/86

UNITED PACIFIC INSURANCE COMPANY

HEAD OFFICE, FEDERAL WAY, WASHINGTON

POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS, That the UNITED PACIFIC INSURANCE COMPANY, a corporation duly organized under the laws of the State of Washington, does hereby make, constitute and appoint E. Theodore LaBorde, Donald L. Pesquie, Lloyd C. Reid, Jr., Harold R. Scott, Jr., David B. Tidmore and Sylvia Copeland, individually, of New Orleans, Louisiana

its true and lawful Attorney-in-Fact, to make, execute, seal and deliver for and on its behalf, and as its act and deed any and all bonds and undertakings of Suretyship,

and to bind the UNITED PACIFIC INSURANCE COMPANY thereby as fully and to the same extent as if such bonds and undertakings and other writings obligatory in the nature thereof were signed by an Executive Officer of the UNITED PACIFIC INSURANCE COMPANY and sealed and attested by one other of such officers, and hereby ratifies and confirms all that its said Attorney(s)-in-Fact may do in pursuance hereof.

The Power of Attorney is granted under and by authority of Article VII of the By-Laws of UNITED PACIFIC INSURANCE COMPANY which became effective September 7, 1978, which provisions are now in full force and effect, reading as follows:

ARTICLE VII — EXECUTION OF BONDS AND UNDERTAKINGS

1. The Board of Directors, the President, the Chairman of the Board, any Senior Vice President, any Vice President or Assistant Vice President or other officer designated by the Board of Directors shall have power and authority to (a) appoint Attorneys-in-Fact and to authorize them to execute on behalf of the Company, bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof, and (b) to remove any such Attorney-in-Fact at any time and revoke the power and authority given to him.

2. Attorneys-in-Fact shall have power and authority, subject to the terms and limitations of the power of attorney issued to them, to execute and deliver on behalf of the Company, bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof. The corporate seal is not necessary for the validity of any bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof.

3. Attorneys-in-Fact shall have power and authority to execute affidavits required to be attached to bonds, recognizances, contracts of indemnity or other conditional or obligatory undertakings and they shall also have power and authority to certify the financial statement of the Company and to copies of the By-Laws of the Company or any article or section thereof.

The power of attorney is signed and sealed by facsimile under and by authority of the following Resolution adopted by the Board of Directors of UNITED PACIFIC INSURANCE COMPANY at a meeting held on the 5th day of June, 1979, at which a quorum was present, and said Resolution has not been amended or repealed:

> "Resolved, that the signature of such directors and officers and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signatures or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by facsimile signatures and facsimile seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached."

IN WITNESS WHEREOF, the UNITED PACIFIC INSURANCE COMPANY has caused these presents to be signed by its Vice President, and its corporate seal to be hereto affixed, this 28th day of April 1988.

UNITED PACIFIC INSURANCE COMPANY

SEAL

Vice President

STATE OF Pennsylvania
COUNTY OF Philadelphia ss.

On this 28th day of April, 1988, personally appeared Raymond MacNeil

to me known to be the Vice-President of the UNITED PACIFIC INSURANCE COMPANY, and acknowledged that he executed and attested the foregoing instrument and affixed the seal of said corporation thereto, and that Article VII, Section 1, 2, and 3 of the By-Laws of said Company, and the Resolution, set forth therein, are still in full force.

My Commission Expires:

September 28, 1991

Notary Public in and for State of Pennsylvania

Residing at Philadelphia

I, P. D. Crossetta, Assistant Secretary of the UNITED PACIFIC INSURANCE COMPANY, do hereby certify that the above and foregoing is a true and correct copy of a Power of Attorney executed by said UNITED PACIFIC INSURANCE COMPANY, which is still in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Company this 9th day of September 1988

SEAL

Assistant Secretary

BDU-1431 Ed. 6/79

RECEIVED
OCT 07 1988
STATE OIL & GAS BOARD

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

E. W. McCants
Manager
Eastern Production Division

September 13, 1988

Application for Permit to Drill
Mississippi Sound Block 57 Unit

Mississippi State Oil and Gas Board
P. O. Box 1332
Jackson, MS 39215-1332

Attention Dr. Richard Henderson

Gentlemen:

Enclosed are two copies of Form No. 2, Application for Permit to Drill, and the $300.00 application fee for the subject well. Copies of our drilling program, location plats, and Form No. 19 are also enclosed at this time. The Hydrogen Sulfide Contingency Plan will be submitted shortly after the commencement of drilling.

In addition, a $100,000 bond (Bond #U897611-265) is hereby filed with the Board in compliance with Rule OS-11.

Please contact Ms. Laura Perica at (504) 364-2293 should you have any questions or need additional information.

Very truly yours,

M. J. Witter

LEP
Enclosures

State Oil and Gas Board

State of Mississippi

TELEPHONE 359-3725 P. O. Box 1332
JACKSON 39215-1332

September 14, 1988

(X) Permit to Drill and Approved Form 2 enclosed.

Minimum surface casing requirements: 7,500 feet.

( ) Surface casing by Special Field Rules.

( ) Permit issued pursuant to Docket No._____,

Order No._____, _____.

ORIGINAL SIGNED BY
A. RICHARD HENDERSON

A. Richard Henderson
STATE OIL AND GAS SUPERVISOR

UNITED PACIFIC INSURANCE COMPANY

HEAD OFFICE, FEDERAL WAY, WASHINGTON

POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS, That the UNITED PACIFIC INSURANCE COMPANY, a corporation duly organized under the laws of the State of Washington, does hereby make, constitute and appoint E. Theodore LaBorde, Donald L. Pesquie, Lloyd C. Reid, Jr., Harold R. Scott, Jr., David B. Tidmore and Sylvia Copeland, individually, of New Orleans, Louisiana

its true and lawful Attorney-in-Fact, to make, execute, seal and deliver for and on its behalf, and as its act and deed any and all bonds and undertakings of Suretyship,

SEP 1 4 1988

and to bind the UNITED PACIFIC INSURANCE COMPANY thereby as fully and to the same extent as if such bonds and undertakings and other writings obligatory in the nature thereof were signed by an Executive Officer of the UNITED PACIFIC INSURANCE COMPANY and sealed and attested by one other of such officers, and hereby ratifies and confirms all that its said Attorney(s)-in-Fact may do in pursuance hereof.

The Power of Attorney is granted under and by authority of Article VII of the By-Laws of UNITED PACIFIC INSURANCE COMPANY which became effective September 7, 1978, which provisions are now in full force and effect, reading as follows:

ARTICLE VII — EXECUTION OF BONDS AND UNDERTAKINGS

1. The Board of Directors, the President, the Chairman of the Board, any Senior Vice President, any Vice President or Assistant Vice President or other officer designated by the Board of Directors shall have power and authority to (a) appoint Attorneys-in-Fact and to authorize them to execute on behalf of the Company, bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof, and (b) to remove any such Attorney-in-Fact at any time and revoke the power and authority given to him.

2. Attorneys-in-Fact shall have power and authority, subject to the terms and limitations of the power of attorney issued to them, to execute and deliver on behalf of the Company, bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof. The corporate seal is not necessary for the validity of any bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof.

3. Attorneys-in-Fact shall have power and authority to execute affidavits required to be attached to bonds, recognizances, contracts of indemnity or other conditional or obligatory undertakings and they shall also have power and authority to certify the financial statement of the Company and to copies of the By-Laws of the Company or any article or section thereof.

The power of attorney is signed and sealed by facsimile under and by authority of the following Resolution adopted by the Board of Directors of UNITED PACIFIC INSURANCE COMPANY at a meeting held on the 5th day of June, 1979, at which a quorum was present, and said Resolution has not been amended or repealed:

> "Resolved, that the signature of such directors and officers and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signatures or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by facsimile signatures and facsimile seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached."

IN WITNESS WHEREOF, the UNITED PACIFIC INSURANCE COMPANY has caused these presents to be signed by its Vice President, and its corporate seal to be hereto affixed, this 28th day of April 1988.

UNITED PACIFIC INSURANCE COMPANY

SEAL

Vice President

STATE OF Pennsylvania
COUNTY OF Philadelphia ss.

On this 28th day of April, 1988, personally appeared Raymond MacNeil to me known to be the Vice-President of the UNITED PACIFIC INSURANCE COMPANY, and acknowledged that he executed and attested the foregoing instrument and affixed the seal of said corporation thereto, and that Article VII, Section 1, 2, and 3 of the By-Laws of said Company, and the Resolution, set forth therein, are still in full force.

My Commission Expires:

September 28, 1991

Notary Public in and for State of Pennsylvania

Residing at Philadelphia

I, P. D. Crossetta, Assistant Secretary of the UNITED PACIFIC INSURANCE COMPANY, do hereby certify that the above and foregoing is a true and correct copy of a Power of Attorney executed by said UNITED PACIFIC INSURANCE COMPANY, which is still in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Company this 9th day of September 19 88

SEAL

Assistant Secretary

BDU-1431 Ed. 6/79

MISSISSIPPI DEPARTMENT OF NATURAL RESOURCES
Bureau of Pollution Control
P. O. Box 10385
Jackson, Mississippi 39209
(601) 961-5171

July 18, 1988

Mr. M. S. Witten, Coordinator
Environmental, Safety, Fire, & Health
Eastern Production Division
Chevron, USA, Inc.
P. O. Box 6056
New Orleans, Louisiana 70174

Dear Mr. Witten:

Re: Mississippi Sound Block 57

We have reviewed Chevron's submittal regarding the proposed drilling activities in the Mississippi Sound. Based on the premise that a "Pollution Free" rig such as the Transworld 69 will be used which will result in the collection in barges, and shore disposal of all wastes, wastewaters, stormwaters and drilling fluids, no discharge permit will be required. It is understood and concurred with, that uncontaminated ballast waters including preload ballast and collection barge ballast will be discharged. However, all ballast discharges are subject to the following conditions:

1. Inspection of ballast tanks prior to loading to ensure no contaminants are present (i.e., oil and grease, solids, and muds).

2. Only seawater or sound water may be used for ballast.

3. Visual inspection of ballast discharge during the period of discharge is required. No visible sheen of oil and grease is permitted.

4. Records shall be maintained as to time of discharge and estimated quantity. The same shall be submitted to the Bureau on the 15th day of the month following the month in which discharge occurred.

In addition to the foregoing requirements, Chevron shall comply with the following:

1. All wastes or wastewater shall be disposed in approved disposal facilities.

2. Provide the Mississippi Bureau of Pollution Control with copies of;

   A. Notification to appropriate environmental agency of intent to dispose of wastes and/or wastewaters within said environmental agency's jurisdiction.

   B. Names, addresses and environmental permit numbers (if applicable) of disposal facilities.

3. Chevron shall maintain a manifest system which shall describe the following:

   A. Volume, date, and types of wastes generated.

   B. Volume, date, and types of wastes disposed and disposal method/facility.

4. Chevron shall submit copies of the aforementioned manifest to the Mississippi Bureau of Pollution Control on the 15th day of the month following the previous month.

5. Chevron shall receive all necessary permits and/or certifications from all other Mississippi regulatory agencies.

All of the preceding conditions have been discussed previously with Chevron. Please notify the Bureau, in writing, of your acceptance of these compliance conditions within 30 days of receipt of this correspondence.

We look forward to Chevron's drilling activities in the Mississippi Sound. We also anticipate Chevron's continued cooperation with the Bureau on environmental protection. If Chevron has any questions or comments on the foregoing, please contact me at 1-601-961-5073.

Respectfully,

Jerry W. Cain, P. E., Coordinator
Industrial Wastewater Control Section

JWC:hdp
cc: Dr. R. Leard, Bureau of Marine Resources
Mr. Robert Seyfarth, BPC

State Oil and Gas Board

State of Mississippi

TELEPHONE 359-3730 P.O. BOX 1332

JACKSON 39205

DATE: 5-18-89

FIELD: OFFSHORE

OPERATOR: CHEVRON

WELL NAME & NO.: Miss Blk 57

DESCRIPTION OF WORK PERFORMED:

Waiver Weekly BOP Test for Max of 5 Days in order to keep Experimental Bit in Bottom for Max. of 100 Hours.

REQUESTED BY: Andy Rousch

APPROVED BY: W.R. Lewis

from

RICHARD LEWIS 8.28, 19 89

To FILE - MISS SD BLK 57 WELL

LOADER VESSEL CHIP 6 BLK 57 TRANSWORLD 70

12:30 p.m 8.26.89 — 1 GALLON PAINT CAN

CRUSHED ON DECK - ABOUT ⅛ GALLON (1 PINT)

PAINT WENT INTO WATER. ALL VISIBLE PAINT

ABSORBED FROM SURFACE.

RPTD TO: BUREAU OF MARINE RESOURCES

NATIONAL RESPONSE CNTR.

RPTD BY SUE CASTLEBURY

9:30 AM. 8.28.89

RL

State Oil and Gas Boa

State of Mississippi
TELEPHONE 359-3730 P.O. BOX 1332
JACKSON 39215-1332

December 22, 1988

Chevron U.S.A., Inc.
Harrison County, Mississippi
Ms. Sound Block 57 Unit
State of Miss. No. 1

Received call from Paul Hansen, Drilling Representative for Chevron that this well was spud 12-21-88 at 1400 hours.

DRILLING PROGRAM

TYPE WELL: 1. EXPLORATORY
2. STRAIGHT HOLE

WELL NAME: MS Sound Blk 57 Unit; State of MS #1 BLOCK: MS Sound Blk 57
CONTRACTOR: TRANSWORLD RIG: TRANSWORLD 70
SURFACE LOCATION: 8450'FNL & 7650' FWL OF MS. SOUND BLK 57; X=391,970 Y=213,310
WATER DEPTH: 14 FT. ELEVATION-KB TO MWL: 148 FT. TOTAL MEASURED DEPTH 23500FT.

	OBJECTIVES			TOLERANCE				
TARGETS	SAND	DIST.OUT	DIR.(GRID)	TVD	IN	OUT	LEFT	RIGHT
#1	NORPHLET	STRAIGHT HOLE		23500	100	100	100	100

KOP: N/A FT.
BUILD RATE N/A
ANGLE UP N/A FT.
AVERAGE ANGLE N/A DEG.
DOUBLE DOGLEG- NO

CASING PROGRAM

DRIVE PIPE: 36 " WITH MINIMUM OF 125' PENETRATION

	HOLE SIZE	DEPTH MD/TVD	CSG SIZE	CMT: CLASS 'H' TO FILL THESE THEORETICAL VOLUMES:	SHOE TEST
CONDUCTOR	20"/32"	1000'	26"	2280 cu ft (20% washout)	MWE LEAKOFF
SURFACE	17-1/2"/ 24"	7500'	20"	8622 cu ft (20% washout)	LEAKOFF
PROTECTIVE	17-1/2"	16500'	14"/13-5/8"	TO BE DETERMINED (caliper)	LEAKOFF
PROTECTIVE	12-1/4"	21500'	10-3/4"/ 9-5/8"	TO BE DETERMINED (caliper)	LEAKOFF
PRODUCTION LINER	8-1/2"	23500'	7-5/8"	TO BE DETERMINED (caliper)	LEAKOFF

Note: All zones which contain oil, gas, or fresh water shall be fully protected by casing and cement.

BLOWOUT PREVENTERS

	NUMBER-TYPE	SIZE	RATING	TEST PRESSURE	DRILLING BHA D.PIPE	HWDP	DRILL COLLARS	STRING STAB	JARS
COND.HOLE	DIVERTER	30"	1M	200PSI	5"	18JTS	11"	AS REQ	
SURF.HOLE	DIVERTER	30"	1M	300PSI	5"	18JTS	11"	AS REQ	NO
BELOW:									
20" CSG	1-ANNULAR	21-1/4"	5M	250/3500	5-1/2"	18JTS	11"	AS REQ	NO
	3-RAMS	21-1/4"	5M	250/5000					
14"/13-5/8"	1-ANNULAR	13-5/8"	5M	250/3500	5"	18JTS	9"	AS REQ	NO
	3-RAMS	13-5/8"	10M	250/10000					
10-3/4"/ 9-5/8"	1-ANNULAR	11"	10M	250/7000	5"	18JTS	7"	AS REQ	NO
	4-RAMS	11"	15M	250/15000					

OTHER SERVICES START MUD LOGGING @ BSC ; GAS DETECTOR @ SPUD ; PVT & FLOW METER @ SPUD ;
ADJ.CHOKE @ SPUD ; CENTRIFUGE @ SPUD ; DEGASSER @ SPUD ; DRLG. RECORDER @ SPUD ;
DESILTER @ SPUD ; MUD CLEANERS@ SPUD ; TV MONITOR @ N/A ; TRIP TANK @ SPUD

MUD PROGRAM

BREAKOVER TO NON-DISPERSED MUD SYSTEM @ SPUD
BREAKOVER TO DISPERSED WATER-BASED MUD SYSTEM @ 16500'

DEPTH	WEIGHT	VIS.	WL		DEPTH	WEIGHT	VIS.	WL		DEPTH	WEIGHT	VIS.	WL
1000'	9.0				16500'	11.0				23000	17.5		8-10
7500'	9.0				18000'	15.6							
10000'	9.5				21500'	16.0							

LOGGING PROGRAM

COMPANY SCHLUMBERGER

ELEC. LINE LOGS PLANNED AT THE FOLLOWING DEPTHS:
SURFACE, PROTECTIVE, AND LINER SETTING DEPTH

RUN 1" SCALE ON ELECTRIC LOG SURVEY WHILE GIH.
REFER TO GEOLOGICAL LETTER FOR TYPE OF LOGS TO RUN.
GEOLOGIST ASSIGNED:
WELL CLASSIFICATION: RESTRICTED

Formation tops:(Estimated from seismic)

Het	5200'
Upper Cretaceous	8400'
Lower Cretaceous	10400'
Cotton Valley	16100'
Norphlet	23000'

SPECIAL REMARKS

1. CK.DRLG.BREAKS FOR FLOW BELOW 7500'
2. HAVE DRLR. INITIAL PVT EVERY 30 MINS. BELOW 7500 '. EXP.ANY LEVEL CHANGES.
3. FILL DP EACH 20 STANDS WHEN RUNNING FLOAT.
4. IMPLEMENT HYDROGEN SULFIDE CONTINGENCY PLAN AT 16500'.
5. USE TRANSWORLD 10M psi CHOKE MANIFOLD TO 15,500', RENTAL 15M psi MANIFOLD THEREAFTER.

PREPARED BY: W.M.WILLIAMS/A.T.RAWICKI DATE: 8-20-88

BOND #U89 76 11 - 265

BEFORE THE STATE OIL AND GAS BOARD

OF THE STATE OF MISSISSIPPI

RE: Application of Chevron U.S.A. Inc. for the Approval of the Plan of Unitization for Mississippi Sand Block 57 Unit, Harrison County, Mississippi

DOCKET NO. 275-88

STATE OF MISSISSIPPI

COUNTY OF HINDS

B O N D

KNOW ALL MEN BY THESE PRESENTS that Chevron U.S.A. Inc., as Principal, and United Pacific Insurance Company, a surety company authorized to do business in the State of Mississippi, Surety, are held and firmly bound unto the State of Mississippi for the use and benefit of the Mississippi State Oil and Gas Board, in the penal sum of $100,000.00, for which payment well and truly to be made, we bind ourselves, our successors, legal representatives and assigns, jointly and severally, firmly by these presents.

The condition of the foregoing obligation is such that:

WHEREAS, in the above styled and numbered docket the State Oil and Gas Board on the 17th day of August, 1988, approved oil and gas operations in submerged offshore lands of the State of Mississippi; and

WHEREAS, Chevron U.S.A. Inc. desires to satisfy the bond requirement set forth in Rule OS-11 of the Mississippi State Oil and Gas Board; now, if Chevron U.S.A. Inc. shall well and truly conduct its operations in the submerged offshore lands of the State of Mississippi in compliance with the conservation statutes of the State of Mississippi, Sections 53-1-1 et seq., and the rules and regulations of the State Oil and Gas Board, OS-1 et seq., then this obligation shall be void, otherwise, to remain in full force and effect.

CHEVRON U.S.A. INC.,
Principal

BY: A. Y. Yaquin
Assistant Secretary

UNITED PACIFIC INSURANCE COMPANY
Surety

BY Sylvia Copeland
Sylvia Copeland Attorney-in-fact

The foregoing bond and surety are hereby approved, and the bond is herewith filed this the 9th day of September, 1988.

By: D. M. Ferris
D. M. Ferris
Countersigning Agent for Mississippi

KEY ACTIONS AND MONITORING PROGRAM

TO BE IMPLEMENTED BY

* Chevron U.S.A., Inc. *

Exploratory Drilling
Mississippi Sound
Block 57

KEY ACTIONS TO BE IMPLEMENTED
BY CHEVRON U.S.A., INC.

1. There shall be no discharge of liquids or solids associated with the drilling operations except for discharges into vessels and subsequently at permitted upland sites and except for uncontaminated ballast waters used to stabilize the rig when it is moved onto and off location.

2. Chevron U.S.A., Inc. shall conduct an environmental monitoring program as part of the proposed drilling activities on Lease Block 57 within Mississippi Sound with said environmental monitoring to conform to the program outline in Attachment I.

3. A minimum of two thousand feet (2,000') of oil spill containment boom must be maintained at the permitted site at all times prior to spudding the well and will remain until the rig is moved from the site. The specified boom equipment may be maintained on the drilling rig, barges or standby vessels, or on a combination of these or within one mile of the rig, as long as a minimum of 2,000' of boom is maintained at the permitted site at all times. Necessary equipment/manpower must be available to rapidly place the boom equipment in the water in the event it is needed. The specified boom equipment will serve as the "first line of defense" to protect nearby environments and resources in the event oil is spilled or released under any conditions.

   (Note: Based on 2,000' of boom on-site, eliminate 500' of boom on service vessels and require 1,000' of boom at shore base. See Oil Spill Contingency Plan, page 16, 3.1.2 and 3.1.3).

4. According to historical oyster harvesting records, the Buoy Reef area has produced oysters only once (in 1984) since 1948, nevertheless the area does have the potential for oyster production. It is therefore stipulated that the "Buoy Reef Area" be resampled for the presence of live oysters three (3) months or less prior to the proposed drilling date. Within 35 days after receipt of the information pertaining to the reef survey work conducted no more than three months in advance of the initiation of drilling operations, the DWC/BMR will render a response. The response will specify any mitigative measures that will be required relative to change in oyster productivity on the reef.

5. Drilling will not be allowed until the Hydrogen Sulfide Contingency Plan, which was submitted with the EED, is approved by the Mississippi Oil and Gas Board. All personnel on the drilling rig and visiting the drilling rig shall be trained in accordance with procedures contained in the plan.

6. Chevron U.S.A., Inc. shall designate an individual(s) who will be located on the drilling rig and who will be responsible for insuring compliance with all specifications/regulations pertaining to environmental of the exploratory drilling operations, including on-rig operations, off-rig loading, on-rig loading and transportation support activities occurring in Mississippi waters and in support of exploratory drilling activities. With respect to all environmental aspects pertaining to drilling rig operations

and associated support activities, this individual shall be the liaison person with the designated DWC/BMR officer for this project. The Chief of the Scientific-Statistical Division (SSD) shall be informed in advance as to the individual's name. The Chief of the Scientific-Statistical Division is the designated DWC/BMR officer for this project. All specified data and reports pertaining to environmental aspects of this project are to be submitted to the designated DWC/BMR project officer.

7. These conditions are applicable until the lease for Mississippi Sound Block 57 terminates or when exploratory drilling oeprations as permitted for this one well terminate, whichever action occurs first.

8. Chevron U.S.A. Inc. shall rehabilitate fourteen (14) acres of oyster reefs within the Mississippi Sound by planting clam shells at the rate of one hundred (100) cubic yards of shells per acre with the location, configuration and time of shell planting to be determimed by the DWC/BMR.

9. Relative to archived samples maintained by Chevron, when Chevron's operations cease in the territorial marine waters of the State of Mississippi, then Chevron's responsiblity for maintaining archived samples terminates one year from the official date of termination of operations as shown by offical records of the Mississippi Oil and Gas Board. Chevron will provide written notification to the DWC/BMR that drilling activities at a specific well site have been terminated.

ATTACHMENT I

ENVIRONMENTAL MONITORING PROGRAM
TO BE IMPLEMENTED BY CHEVRON U.S.A., INC.

TABLE OF CONTENTS

DRILLING PHASE ENVIRONMENTAL MONITORING PROGRAM

Four environmental monitoring programs (Ladner and Franks, 1986) which apply to oil and gas drilling activities will be conducted by Chevron U.S.A., Inc. (Chevron) in coastal waters of the State of Mississippi, Block 57, Mississippi Sound. These programs are as follows:

1) Monitoring Program at Rig (MPAR);
2) Drilling Area Monitoring Program (DAMP);
3) Selected Environmental Sites Monitoring Program (SESMoP); and
4) Sheen Monitoring Program (SMP).

The DAMP and SMP are required for all exploratory/appraisal activities. Although discharges are not permitted, certain elements of MPAR, and SESMoP are required. SESMoP is required in the event of an unapproved discharge or a spill occurs in association with exploratory/appraisal activities conducted by Chevron.

1.0 THE MONITORING PROGRAM AT RIG (MPAR)

1.1 Introduction

The Monitoring Program at Rig (MPAR) will include monitoring the current speed and current direction of the surrounding waters. The MPAR will also include maintaining records of all materials which are sent down the drilling hole.

1.2 MPAR SPECIFICATIONS

1.2.1 Chemical Inventory

A precise chemical inventory will be maintained. This inventory will include all constituents and their respective volumes or masses added downhole for the well. One gallon samples from the active mud pit will be collected once each month. The samples will be thoroughly mixed and each sample will be split providing 50% of the split sample to the DWC/BMR. The remaining portion of the split sample will be kept by Chevron. The samples are to be frozen.

1.2.2 Monitoring Movement of Surrounding Waters

Current speed and direction will be measured in the surrounding waters. Two Endeco Model 105 current meters will be deployed on separate moorings in the vicinity of the drilling rig. Current speed and direction will be determined for 1-h intervals. Depth of the current meters will be 1/5 of the water depth at the location of deployment. The current meters will be located to avoid the influence that the drilling structure may have on current dynamics.

Current meters will be changed out (recovered and redeployed) at 45 day intervals. Data from only one primary meter will be analyzed. In the event that this current meter malfunctions or the data are determined to have been unreliable, then data from the secondary, redundant meter will be analyzed.

1.2.3 Information Submission Under MPAR

The following information will be provided to the Chief, Scientific-Statistical Division of the DWC/BMR, Long Beach, Mississippi:

1) Current speed and the corresponding dates and times as a continuous graph.

2) Current direction and the corresponding dates and times as a continuous graph.
3) All information specified in 1 and 2 above shall be presented on one graph for each 1,080 hours of continuous recording.

The x axis of the graph will be labeled "time" and the y axis will be labeled "current speed" and "current direction." For all stated parameters, the y axis will start at zero where the x and y axes intersect. For plotting current direction relative to the y axis, the following scale will be used: in a clockwise direction, 0° = true north; 90° = east; 180° = south; 270° = west; the top of the y axis will approach 360° (true north). The scales of the x and y axis will be sufficient to permit resolution for sensitivity to significant changes.

4) Precise chemical inventory of all constituents and their respective volumes or masses added downhole.

The information will be submitted within 35 days after the completion of each respective 45 days of continuous recording.

2.0 THE DRILLING AREA MONITORING PROGRAM (DAMP)

2.1 Introduction

Monitoring data obtained from the DAMP will be used to determine pre- and post-operational conditions at and in the vicinity of the drilling site. DAMP is a compliance monitoring program because no drilling fluid discharges are allowed.

2.2 DAMP SPECIFICATIONS

2.2.1 Sediment Sample Collection

Sediment sampling will be conducted in a 5-Radial Line Sampling System with the addition of five Inter-radial sampling sites (Figures 1a and 1b). The first sediment samples are to be taken within a 20-foot radius of the drill hole site. This site shall be designated Site Number 1. After collecting the samples from Site Number 1 and moving away from the drill hole site, sediment samples will be collected along five equally spaced radial lines extending 457.2 m (1,500 ft) from the drilling site as follows: 15.2 m (50 ft), 61.0 m (200 ft), 106.7 m (350 ft), 152.4 m (500 ft), 213.4 m (700 ft), 335.3 m (1,100 ft), and 457.2 m (1,500). In addition, samples will be collected at each of the five inter-radial sampling sites located 213.4 m (700 ft) from the drilling site and between the radial lines.

A total of 15 15.2-cm (6-in) diameter cores will be collected at each sampling site by divers. Three groups of five cores will be collected. The upper 2.0 cm of sediment will be removed from each core. Within each group of five cores, the upper fraction will be composited and split into two separate samples. One of the samples will be archived by Chevron. The other sample will be provided to the DWC/BMR per the instructions of the Chief, Scientific-Statistical Division of the DWC/BMR.

2.2.2 Stationary Organism Collection

2.2.2(a) Stationary Organism Collection--Chemical

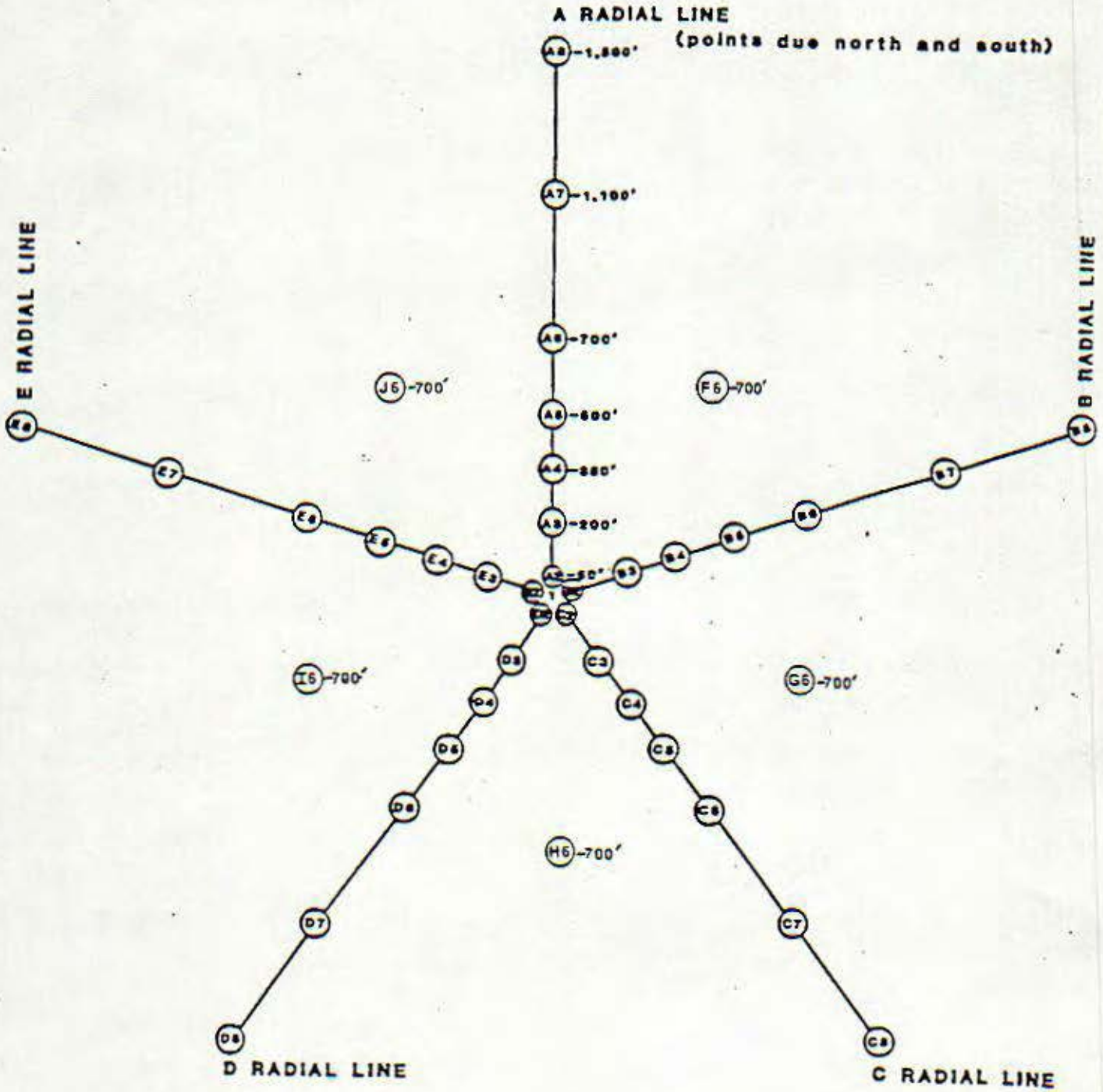
Stationary organisms for chemical analysis will be collected within a 106.7 m (350 ft) radius of the drilling site and at 1500 feet from the drilling site. Collections of stationary organisms will be ommitted, in part or in whole, if at the time of sampling, the stationary organisms are not readily available for collection from a reasonably small area or small volume of sediment. The decision of omission will be made and stated in writing by a biologist having recognized

FIGURE 1a.

SAMPLING SCHEME FOR THE DRILLING AREA MONITORING PROGRAM (DAMP)

APPLICABLE TO OIL AND GAS EXPLORATORY ACTIVITIES CONDUCTED IN MISSISSIPPI COASTAL WATERS

5-RADIAL LINE SYSTEM



LEGEND

○ = sample stations and station numbers. Distances shown are the distances from the center station designated No.1.

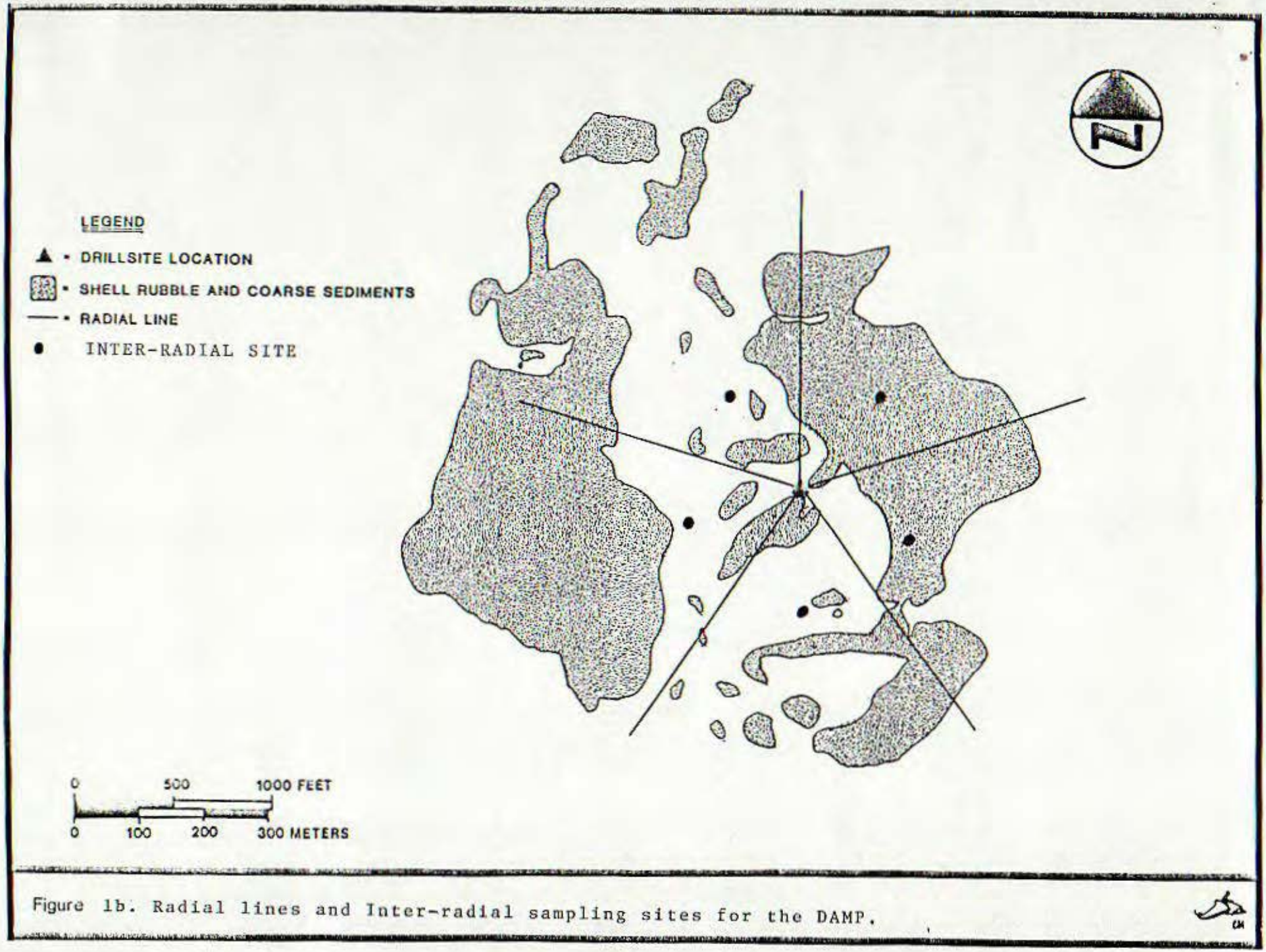


Figure 1b. Radial lines and Inter-radial sampling sites for the DAMP.

competency in the discipline of marine stationary organisms indigenous to Mississippi coastal waters. As organisms are available, at each specified area five separate sites will be sampled. The sampling methodology will follow the sediment sample collection methods except samples will be collected to a depth of 10 cm. Alternatively, a remotely operated grab sampler will be used as long as a similar volume of sediment, as specified in 2.2.4, is collected. Samples will be washed through a series of seives with the top seive being 1.0 cm and the bottom seive being 0.5 mm. All organisms retained on the large seive will be designated as macro-benthos and those on the small seive will be designated as small organisms. Small organisms of mixed species will be pooled and frozen for chemical analysis. Larger organisms (macro-benthos) from a given sample will be pooled on a species basis, frozen and chemically analyzed on this basis when specified. Long-term stationary organisms will be preferred for sample collection. Organisms will be "split" between Chevron and the DWC/BMR depending on the number and biomass obtained.

2.2.2(b) Stationary Organism Collection--Biological

Stationary organisms for biological analysis shall be collected within a 106.7 m (350 ft) radius of the drilling site and at 1500 feet from the drilling site. The sampling methodology will follow the sample collection methods described in 2.2.2.(a). Small organisms of mixed species will be pooled and preserved. Larger organisms (macro-benthos) will be preserved. All preserved small organism and macro-benthos samples will be given to DWC/BMR for archiving for possible species identification at some future time.

2.2.3 Pre-operational Samples Will Be Collected Prior To Initiation Of Drilling.

2.2.4 Sample Volume and Preservation

Sediment samples from each sampling site will be "split" between Chevron and the DWC/BMR as discussed in Section 2.2.1. Three 912 cm^3 (0.24 gal) volumes for a total of 2,736 cm^3 (0.72 gal) of sediment will be archived by Chevron. Identical volumes will be provided to DWC/BMR.

Organism samples (for chemical analysis) from each sampling site will be "split" between Chevron and the DWC/BMR as discussed in Section 2.2.2.(a). The decision on splitting will be made by the DWC/BMR representative depending on numbers and biomass obtained.

Organisms for possible biological identification will be properly preserved.

Archived samples will be properly stored to prevent or minimize deterioration of sample components.

2.2.5 The "Chain Of Custody" Procedures Will Be Approved And Supervised By The DWC/BMR. The procedure will be developed through cooperative efforts and completed prior to collection of field samples.

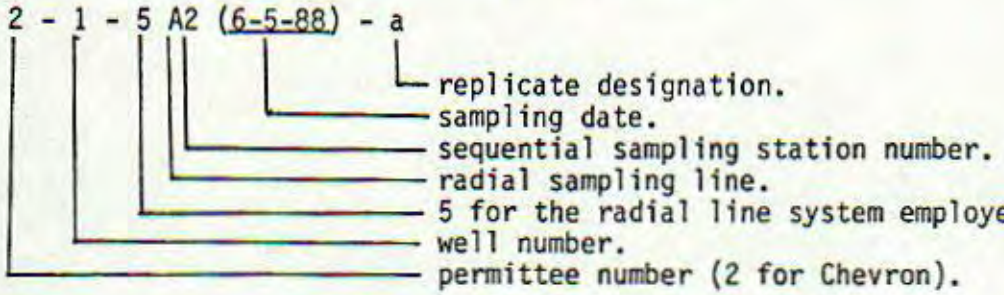
2.2.6 Sediment and Stationary Organism Labeling

The following information will be included with each sample for identification:

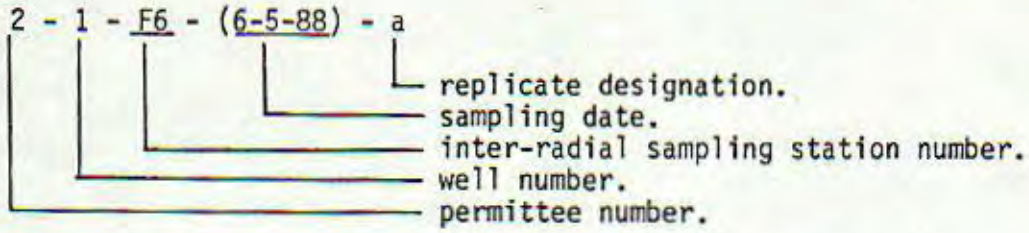
1) The name and location of the drill site.
2) The date and time the sample was collected.
3) The specific identification number of each sediment sample and the radial line on which each radial line sample was collected and the five inter-radial sites at which each of the five inter-radial samples was collected.

The radial line running due north from the drillsite will be designated as A. The remaining radial lines will be designated clockwise as B,C,D, and E. Each radial line site will be designated sequentially, starting with the site closest to the drillsite, from 1 to 8. Each radial line site will therefore be designated by a unique code for the radial line and distance from the drillsite, e.g., A1, A2, A3, etc.

For purposes of reporting, radial line sediment samples will be identified by the following standardized coding procedure:

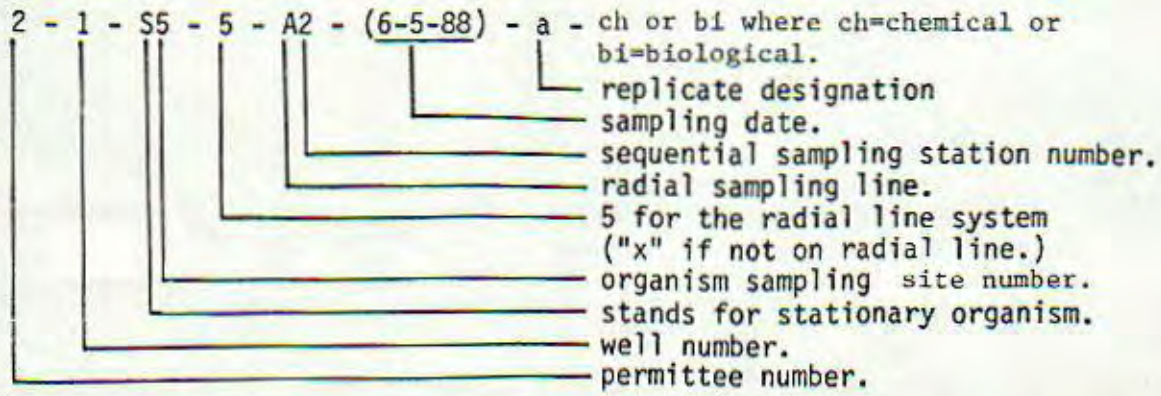


For purposes of reporting, sediment samples collected from the five inter-radial sites will be identified by the following standardized coding procedure:



4) Scientific names of the stationary organisms collected (those retained on 1.0 cm seive) and selected for chemical analysis will be reported. The locations of the stationary organism sampling sites will be reported, specifying the distance and direction from the drill hole site; sample numbers will be designated as S1, S2, S3, S4, and S5 (S designates stationary organisms). Stationary organisms will be collected from any appropriate location within a 106.7 m (350 ft) radius of the drillsite; however, if the stationary organisms are collected at the sites which correspond to the specified sediment sampling sites, the sediment sample numbers will also be provided, e.g., S5-A2.

For reporting purposes, stationary organism samples (chemical and biological) will be identified by the following standardized coding procedure:



2.2.7 Sediment and Stationary Organism Analysis

All specified samples under DAMP will be collected and archived. Initially, no archived DAMP samples will be analyzed other than the classification as specified herein of species retained on a 1.0 cm seive (macro-benthos). Archived samples will be subject to further analysis in the event of a spill or unauthorized discharge from the drilling rig or a support vessel (including barges) in marine waters in the vicinity of the drilling operation. Analytical procedures that may require implementation will be developed in a separate document.

2.2.8 Information Submission

The initial DAMP sampling will occur prior to the initiation of drilling operations. After completion of the initial sampling, information affirming that the DAMP samples have been collected will submitted to the Chief, Scientific-Statistical Division, Mississippi Department of Wildlife Conservation, Bureau of Marine Resources, Long Beach, Mississippi. The scientific names and numbers and/or biomass of the stationary organisms retained on a 1.0 cm screen will be submitted.

3.0 THE SELECTED ENVIRONMENTAL SITES MONITORING PROGRAM (SESMoP)

3.1 Introduction

Monitoring data obtained from the SESMoP will be used to determine whether or not spilled materials accumulate at selected environmental sites located at distances 457.2 m (1,500 ft) or greater from the drilling site. Particularly, the data will be used to determine if selected chemicals accumulate to levels considered to be above environmentally acceptable levels, both spatially and temporally, or to levels which unacceptably impair areas having recreational value.

3.2 SESMoP SPECIFICATIONS

3.2.1 Sediment and Stationary Organism Sample Collection

Sediment samples and stationary organism samples will be collected at specified environmental sites (Figure 2). The number of sites will not change but the location of all sites with a "I" may be changed prior to the initiation of field sampling.

3.2.1(a) Sediment Sample Collection

A total of 15 15.2-cm (6-in) diameter cores will be collected at each SESMoP sampling site by divers. Three groups of five cores will be collected. The upper 2.0 cm of sediment will be removed from each core. Within each group of five cores, the upper fraction will be composited and split into two separate samples. One of the samples will be archived by Chevron. The other samples will be provided to the DWC/BMR per the instructions of the Chief, Scientific-Statistical Division of the DWC/BMR.

3.2.1(b).1 Stationary Organisms Collection - Chemical

Samples are to be collected from SESMoP sites (Figure 2).

Collections of stationary organisms will be omitted, in part or in whole, if at the time of sampling, the stationary organisms are not readily available for collection from a reasonably small area. The decision of omission will be made and stated in writing by a biologist having recognized competency in the discipline of marine stationary organisms indigenous to Mississippi coastal waters.

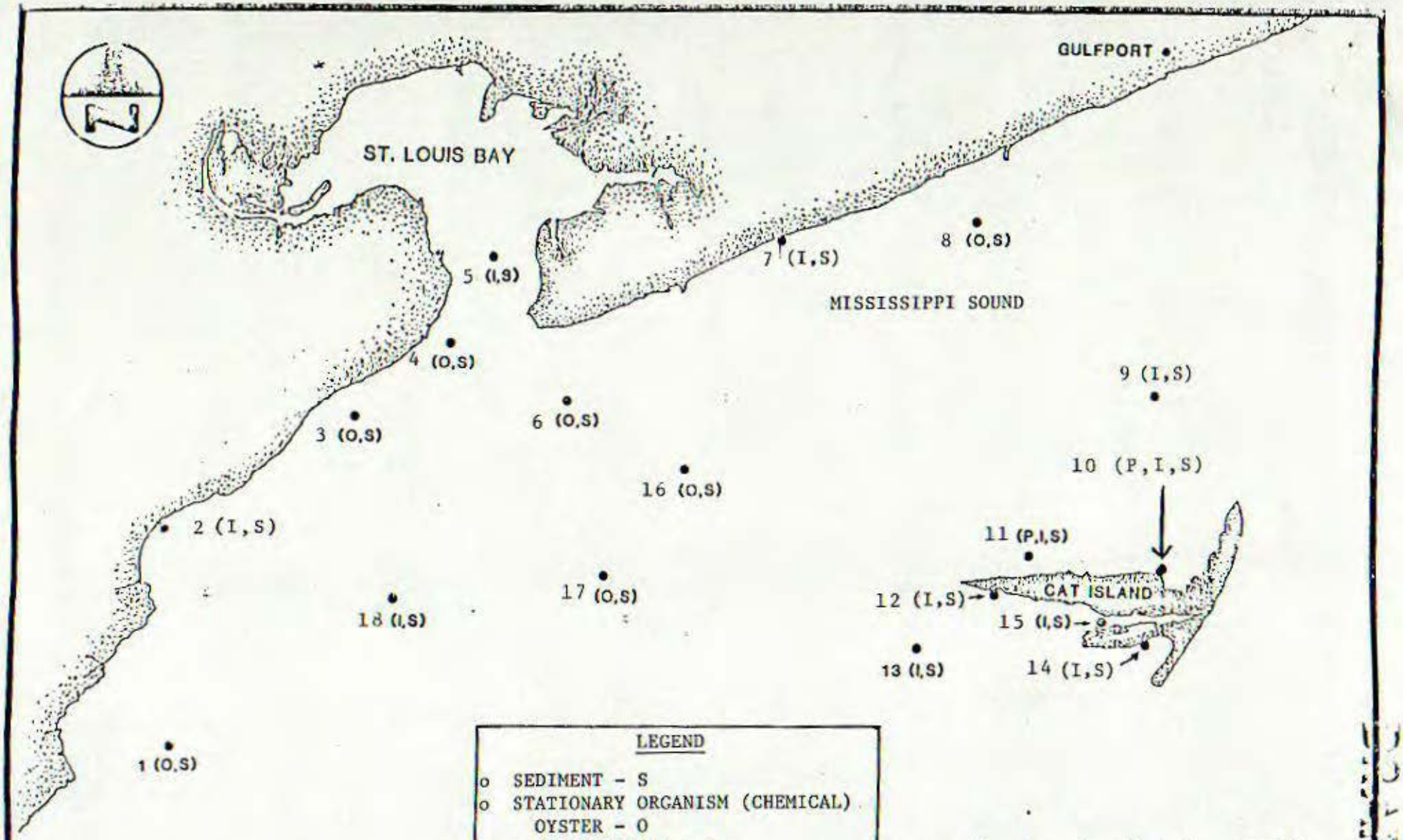


Figure 2. Sampling Components at SESMoP Stations.

The Legend in Figure 2 identifies the three categories of stationary organisms to be collected for chemical analysis, i.e. oyster (O), invertebrate (I) and plant (P). The letters adjacent to each SESMoP numbered site indicate the types of samples to be collected. The following are collection specifications for SESMoP sites:

O = Oyster samples shall be collected where shown. Fifty (50) oysters shall be collected from each site indicated.

P = A plant (submerged, attached aquatic vegetation) sample shall be collected where shown. Five (5) pounds of seagrass/attached macroscopic algae sample shall be collected and identified.

I = Invertebrate samples shall be collected where shown. The sampling methodology will follow the sediment sample collection methods previously stated in 3.2.1(a) except samples will be collected to a depth of 10 cm. Alternatively, a remotely operated grab sample will be used as long as a similar volume of sediment, as specified in 2.2.4, is collected. Samples will be washed only through a 1.0 cm seive. Of the organisms retained on the seive, the specimens of the single species which is apparently in greatest abundance are to be identified and frozen as a sample. All other organisms retained on the 1.0 cm seive are to be pooled and frozen as a separate sample.

Organisms from a given sample will be frozen and then chemically analyzed only when specified. Organisms will be "split" between Chevron and the DWC/BMR depending on the number and biomass obtained.

3.2.1(b).2 Stationary Organism Collection - Biological

Required data is the apparent predominant species and its numbers at the sites designated as invertebrate sample sites. Also the identification of the aquatic plants collected at the plant sample sites is required. The specified information will have been generated as a part of the informational requirements met in 3.2.1(b)1. Thus, no separate samples have to be taken for generating the required information unless sample preparation procedure precludes the obtaining of the required information. If separate samples are required, both groups of invertebrates as specified under 3.2.1(b)1 are to be collected and chemically preserved rather than being preserved by freezing.

3.2.2 Sample Volume and Preservation

Same as 2.2.4

3.2.3 The "Chain of Custody" Procedures Will Be Approved And Supervised By The DWC/BMR

3.2.4 Sample Identification and Information Requirements Under SESMoP

1) The name an location of the drillsite.
2) The date and time the sample was collected.

3) Samples and sampling locations will be uniquely identified using appropriate labeling codes to permit proper identification. Sample codes will not duplicate any standardized code numbers for samples collected under DAMP.
4) Scientific names of the stationary organisms (those retained on 1.0 cm seive) collected and selected for potential chemical analysis.

3.2.5 Sediment Sample and Stationary Organism Sample Analysis Under SESMoP

Samples collected under SESMoP will be archived and properly stored to prevent or minimize deterioration of sample components such as crude and refined oils and other degradeable chemical that may be contained in the samples. Samples will not be immediately analyzed for specific components other than the classification as specified herein of the species retained on a 1.0 cm screen. Any samples to be selected for analysis and the components to be analyzed will be specified by the DWC/BMR. These procedures are discussed in Section 5.1. Analytical procedures that will require implementation will be developed in a separate document.

3.2.6 Information Submission Under SESMoP

The initial SESMoP sampling will occur prior to the initiation of drilling operations. After completion of the initial sampling, information affirming that the SESMoP samples have been collected will be submitted to the Chief, Scientific-Statistical Division, Mississippi Department of Wildlife Conservation, Bureau of Marine Resources, Long Beach, Mississippi. Also the scientific names of the stationary organisms (the apparently predominant species retained on 1.0 cm screen) selected for potential chemical analysis are to be submitted.

4.0 SHEEN MONITORING PROGRAM (SMP) FOR SURFACE WATERS

Visual monitoring of the waters in the vicinity of the drilling rig shall be conducted daily during daylight hours to determine the presence of any sheen which is visible on the surface of the water and which is associated with drilling operations.

The Sheen Monitoring Program (SMP) is a "continuing" observation program to be carried out by rig personnel who shall report any sheen to Chevron's designated representative responsible for environmental matters or his designated assistant stationed on the rig. The responsibility of this individual includes the daily logging (recording) of any sheens observed by rig personnel. If a sheen(s) is observed, the daily report shall include: 1) the specific time the sheen was observed; 2) direction of sheen movement; and 3) source of the sheen. If no sheen is observed, results for the daily log are so reported.

SMP results shall be recorded on a daily basis during each month of continuing drilling operations. SMP results shall be submitted to the Chief, Scientific-Statistical Division of the DWC/BMR, Long Beach, Mississippi within thirty (30) days after each month of sheen monitoring.

5.0 OTHER INFORMATION APPLICABLE TO DRILLING PHASE ENVIRONMENTAL MONITORING PROGRAM

5.1 Analysis Of Selected Archived Samples, And Repeat Sampling And Analysis

All DAMP and SESMoP samples will be archived until additional analyses are specified by the DWC/BMR. Such specifications will be based, in part, upon reviews of data pertaining to drilling activities as submitted by Chevron. In the event that an unauthorized discharge of chemical occurs in association with the oil and gas exploratory activities, analysis may be specified by DWC/BMR; additional monitoring in terms of areas sampled, frequency of sampling and chemicals to be analyzed may be specified. If analysis of archived samples and/or repeat sampling and analysis are deemed necessary, Chevron will be notified of times by the DWC/BMR and proposed analytical procedures are to be submitted by Chevron to the DWC/BMR.

For compliance monitoring with no evidence of a spill, no more than fifteen percent of the collected samples may be subjected to analysis. Barium will be analyzed to determine if drilling muds have been discharged. Aluminum will be analyzed to aid in the interpretation of the barium data. Other tracer chemicals may the designated by DWC/BMR for analysis, and no more than two other tracer chemicals will be specified. However, in the event of a spill, analysis for other additional tracer chemicals may be required.

5.2 COMPACT SUMMARY OF ACTIONS AND TIMES

Prior to the implementation of field monitoring efforts, Chevron is to submit a compact summary of required actions, timing of the actions and the specified reporting times. This information is to be presented in a format, e.g. a table, that will be useful to both Chevron and the DWC/BMR. The format will be useful in readily noting the specified actions and their respective implementation times and in providing a check-off record for showing that actions were completed and their actual completion times.

5.3 NOTIFICATION OF SAMPLE COLLECTION

DWC/BMR, and in particular the Chief of the Scientific-Statistical Division, will be notified within seven working days of the initiation of the field sampling effort. Space will be provided onboard the sampling vessel for a representative of the DWC/BMR.

5.4 NUMBER OF COPIES OF REPORTS TO BE SUBMITTED BY CHEVRON

Chevron and their contractor will submit information specified in the Drilling Phase Environmental Monitoring Program to the Chief, Scientific-Statistical Division, Mississippi Department of Wildlife Conservation, Bureau of Marine Resources (DWC/BMR), Post Office Drawer 959, Long Beach, Mississippi 39560. Phone number (601) 864-4602. Six copies of each report containing the appropriate information will be submitted. Two copies of each photographic print will be provided in the submittal.

6.0 REFERENCES CITED

Ladner, C.M. and J.S. Franks. 1986. Environmental Monitoring Programs Applicable to Oil and Gas Activities in Coastal Waters of the State of Mississippi. Scientific-Statistical Division of the Mississippi Department of Wildlife Conservation, Bureau of Marine Resources.

Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560
(601) 864-4602

August 25, 1988

Mr. Richard Henderson
State Oil and Gas Board
Post Office Box 1332
Jackson, MS 39216

RE: Chevron U.S.A.

Dear Mr. Henderson:

As per the September 16, 1982 Memorandum of Agreement between our respective agencies, please be advised that the Department of Wildlife Conservation, Bureau of Marine Resources has completed authorizations necessary to allow Chevron U.S.A. to conduct hydrocarbon exploration in Mississippi Sound Lease Block 57. These documents are attached for your information and use.

If you have any questions regarding this correspondence or the attached documents, please feel free to contact me.

Sincerely,

Richard L. Leard, Ph.D.
Bureau Director

RLL:GJC:ab

Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560
(601) 864-4602

August 19, 1988

Mr. Mark Witten
Environmental and Regulatory Affairs
Chevron, U.S.A., Inc.
P.O. Box 6056
New Orleans, LA 70174

RE: Proposed Hydrocarbon Well, Lease Block 57, Mississippi Sound

Dear Mr. Witten:

The Department of Wildlife Conservation/Bureau of Marine Resources has coordinated a review of your project through the Mississippi Coastal Program review procedures and certifies that the project referenced above is consistent with the Mississippi Coastal Program, provided that the stipulations of the state authorization sent to you on August 18, 1988 are complied with.

If you have any questions regarding this correspondence, please contact this office.

Sincerely,

(for) Richard L. Leard, Ph.D.
Bureau Director

RLL:GJC:ph

cc: Mr. Marlan Baucum, A-95
Mr. Ronald Krizman, COE
Mr. Jim Morris, BPC
Wetlands, BMR

Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560
(601) 864-4602

August 18, 1988

Mr. Mark Witten
Division Coordinator
Environmental and Regulatory Affairs
Chevron, U.S.A., Inc.
P.O. Box 6056
New Orleans, LA 70174

RE: Proposed Hydrocarbon Well, Lease Block 57, Mississippi Sound

Dear Mr. Witten:

The Department of Wildlife Conservation/Bureau of Marine Resources has reviewed the above referenced project and your request for a variance to the Mississippi Coastal Program Guidelines dated March 4, 1987.

This request would allow the siting of the proposed Hydrocarbon Well within one mile of an oyster reef.

On March 10, 1987, the Commission on Wildlife Conservation voted to approve the variance request.

In view of the action by the Commission, and in view of your agreement to abide by the "Key Actions and Monitoring Program", we have determined that your proposal will comply with the public policy of wetlands protection.

If you have any questions regarding this action, please contact this office.

Sincerely,

Richard L. Leard, Ph.D.
Bureau Director

RLL:JIG:ph

cc: Vernon Bevill
Helen Wetherbee

DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

April 18, 1988

REPLY TO
ATTENTION OF:
Regulatory Branch

SUBJECT: Department of the Army Permit Number MS87-00615-F,
Chevron U.S.A. Inc.

CHEVRON U.S.A. Inc.
Post Office Box 6056
New Orleans, Louisiana 70174

Gentlemen:

PLEASE READ THIS LETTER CAREFULLY AND COMPLY WITH ITS PROVISIONS

There is enclosed a Department of the Army permit authorizing you to perform the work specified therein in accordance with the plans shown on the drawings attached thereto. This permit is issued under provision of the Federal laws for the protection and preservation of the navigable waters of the United States. These laws provide that after proposed work has been approved by issuance of a Department of the Army permit,

IT SHALL NOT BE LAWFUL TO DEVIATE FROM SUCH PLANS EITHER BEFORE OR AFTER COMPLETION OF THE WORK,

unless modification of said plans has previously been submitted to and received the approval of the Department of the Army.

You should study and carefully adhere to all the terms and conditions of the permit. The District must be notified of the commencement and completion of the permitted work. The enclosed cards may be used for that purpose. Also enclosed is a "NOTICE OF AUTHORIZATION" which must be conspicuously displayed at the site during construction of the permitted work. Any telephone inquiries relating to this permit should be directed to the Regulatory Branch, telephone number (205) 694-3788.

If for any reason it becomes necessary to make a material change in location or plans for this work, revised plans should be submitted promptly to the District Engineer in order that the revised plans may receive the approval required by law before work is begun.

Compliance with this and other conditions of the permit is essential. Failure to submit the notices requested may result in its revocation.

Sincerely,

Ronald A. Krizman
Chief, Regulatory Branch
Operations Division

Enclosures

DEPARTMENT OF THE ARMY PERMIT

Permittee CHEVRON U.S.A. INC.

Permit No. MS87-00615-F

Issuing Office Mobile District

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: Placement of a submersible oil drilling rig with fender pilings in Mississippi Sound Block 57, in order to drill an exploratory well to a depth of 22,000 feet. The intent of this well is to determine the potential for gas and oil production from the Jurassic Norphlet sandstone found at that depth.

Attachments:
1. Vicinity Map (sheet 1 of 4)
2. Proposed Well Location (sheet 2 of 4 revised)
3. Outboard Profile (sheet 3 of 4 revised 3-18-88)
4. Plan View (sheet 4 of 4 revised 3-18-88)

Project Location: Gulf of Mexico off Pass Christian, Mississippi Sound Block 57, Harrison County, Mississippi

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on 18 April 1991. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

BY: M. L. Witte _____ April 13, 1988

(PERMITTEE) *(DATE)*

Chevron U.S.A. Inc.
Post Office Box 6056
New Orleans, Louisiana 70174

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

LARRY S. BONINE, Colonel
Corps of Engineers

(DISTRICT ENGINEER)

BY: Ronald A. Krizman *(DATE)*

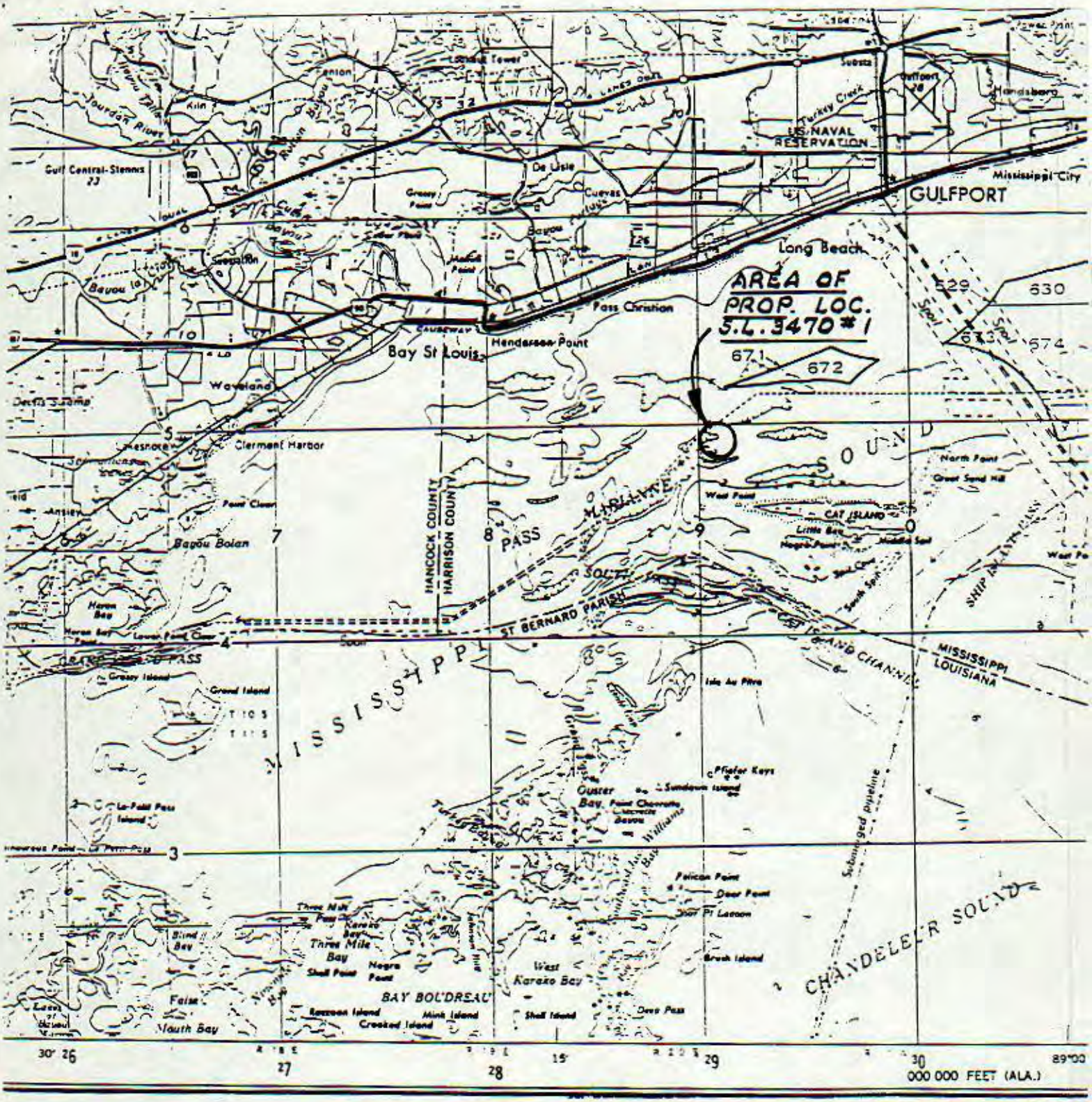
RONALD A. KRIZMAN
Chief, Regulatory Branch
Operations Division

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

_____ _____

(TRANSFEREE) *(DATE)*

☆U.S. GOVERNMENT PRINTING OFFICE: 1986 — 717-425



Scale 1:250,000

5 0 5 10 15 20 Statute Miles

APPROVED DRAWING
4/6/88

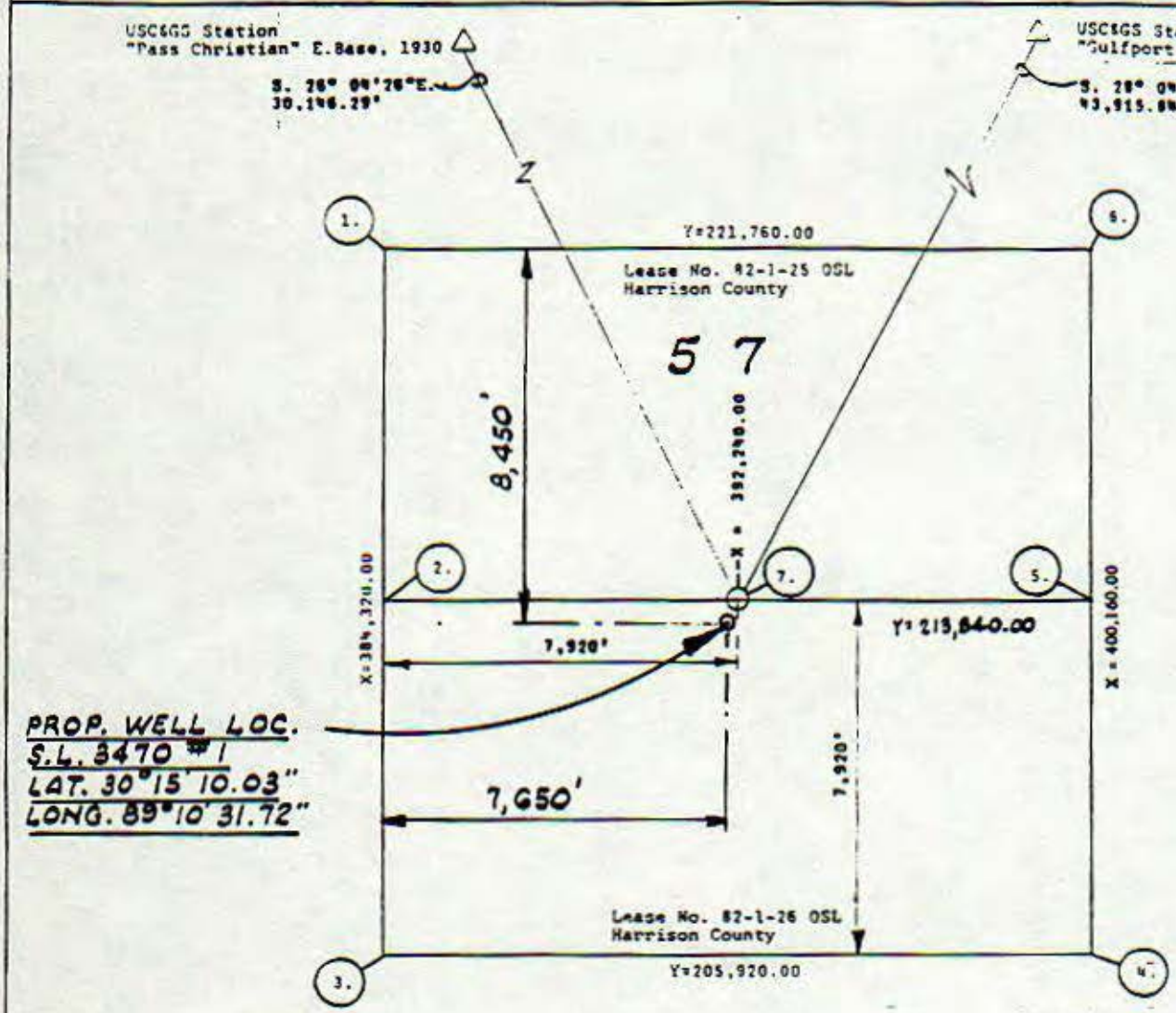
LOCATION NOTES:

1. FROM USC & GS STA. "MARKHAM" ON MAINLAND TO PROP. LOC. S.L. 3470 #1 S 92°48'54"W (APPROX. 9.4 MILES)
2. FROM USC & GS STA. "TOOT" ON CAT ISLAND TO PROP. LOC. S.L. 3470 #1 N. 83°01'06"W (APPROX. 6.3 MILES)

ATTACHMENT "A"
CHEVRON U.S.A. Inc.
MISSISSIPPI SOUND BLK. 57
PROPOSED WELL LOCATION
S.L. 3470 #1

HARRISON CO. MISS.

VICINITY MAP



Pt.	Latitude	Longitude
1.	30°15'33.4400"	89°11'59.2479"
2.	30°15'15.0421"	89°11'58.9568"
3.	30°13'56.6439"	89°11'58.6660"
4.	30°13'57.1141"	89°08'58.1043"
5.	30°15'15.5127"	89°08'58.3553"
6.	30°16'33.9112"	89°08'58.6065"
	Center Of Permit Area	
7.	30°15.2860"	89°10'28.6562"

NOTE: All bearings and coordinates refer to the Mississippi (Mercator) Plane Coordinate System, East Zone.

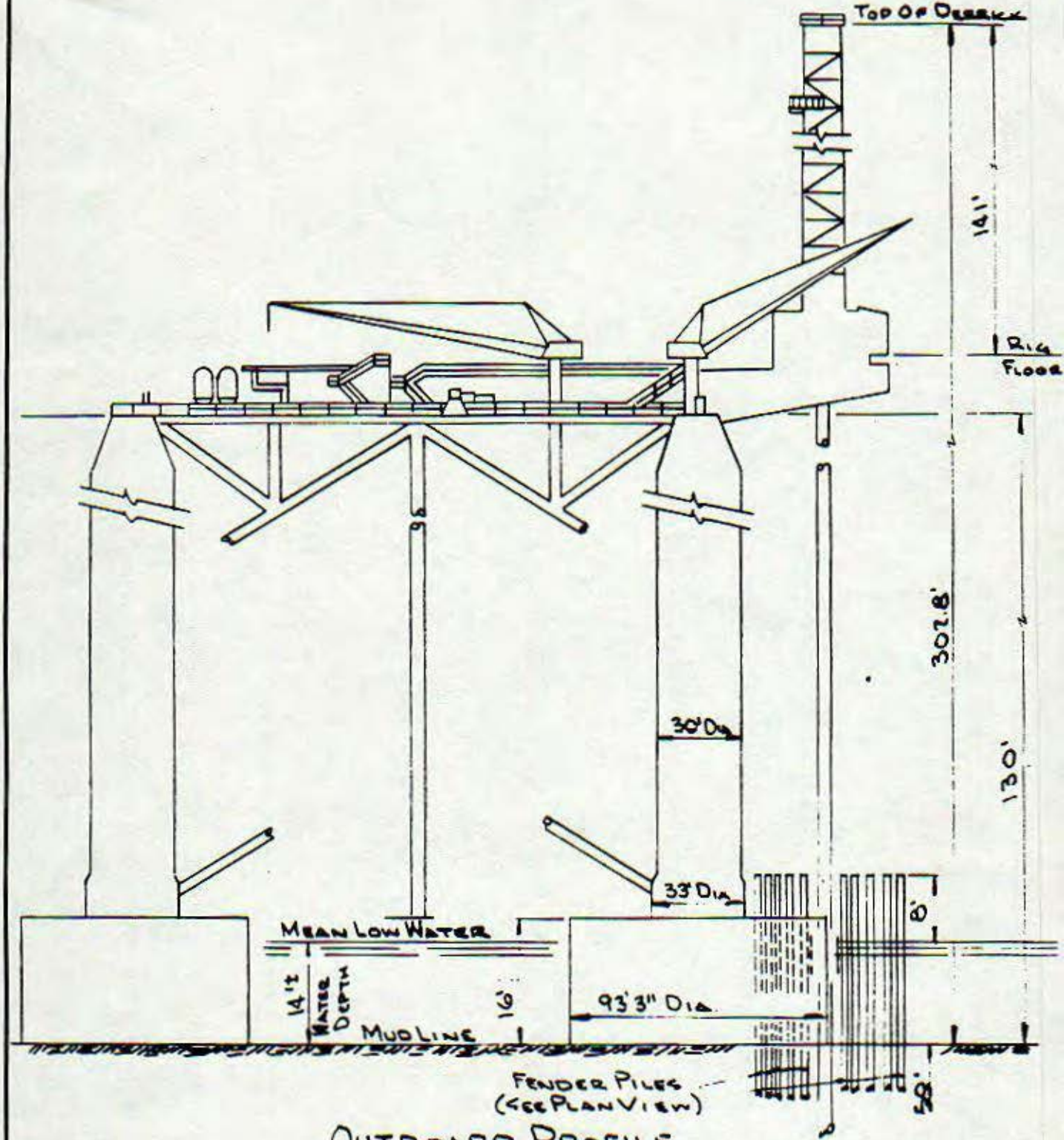
WATER DEPTH 12'

APPROVED DRAWING
4/6/88
(Revised)

CHEVRON U.S.A. Inc.
MISSISSIPPI SOUND BLK. 37
PROPOSED WELL LOCATION
S.L. 3470 #1

HARRISON CO., MISS.
SCALE: 1" = 4000'

SH. 2 OF 4



OUTBOARD PROFILE

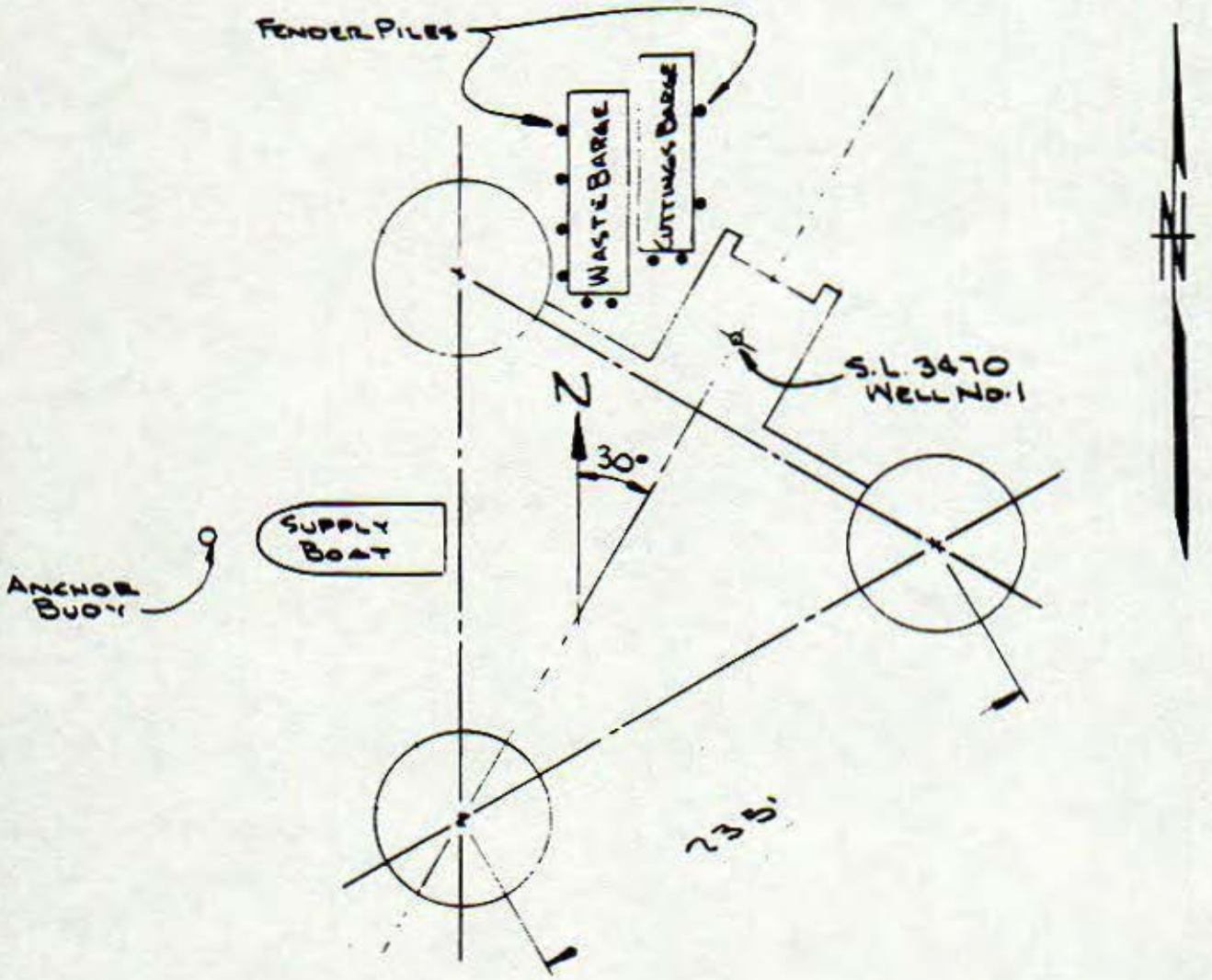
APPROVED DRAWING
4/6/88
ATTACHMENT "A"
REVISED 3-18-88

MISSISSIPPI SOUND BLOCK 57
S.L. 3470 WELL NO. 1
HARRISON CO. MISS.

Chevron U.S.A. Inc.
Eastern Region - Exploration, Land and Productic

SCALE NONE	FILE NO.
	DWG. NO. SHT 3 OF 4

NOTE:
ONCE IN PLACE ON THE SEAFLOOR THE TOTAL AREA COVERED BY THE FEET OF THE THREE (3) LEGS OF THE RIG WILL BE 20,488 Sq. Ft.



PLAN VIEW

APPROVED DRAWING
4/6/88
ATTACHMENT "A"
REVISED 3-18-88

MISSISSIPPI SOUND BLOCK 57
S.L. 3470 WELL NO 1
HARRISON CO. MISS.

Chevron U.S.A. Inc.
Eastern Region · Exploration, Land and Production

SCALE NONE	FILE NO. DWG. NO. SHT 4 OF 4
BY: WADE	DATE: 3-18-88

SP 12600A

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA. 70174

September 7, 1988

Mississippi Sound Block 57 Unit;
State of Mississippi #1

Mr. A. Richard Henderson
Mississippi Oil & Gas Board
P. O. Box 1332
Jackson, MS 39215-1332

Dear Mr. Henderson:

I have enclosed three documents for your review and files:

1. The Corps of Engineers permit.

2. Chevron's variance request to the Department of Wildlife Conservation.

3. The Exploratory Evaluation Document (revised rig information will be submitted with the Application for a Permit to Drill).

Please call me at (504) 364-2382 should you have any questions or need further information.

Very truly yours,

Mark

M. S. Witten
Coordinator
Environment, Safety, Fire, and Health
Eastern Production Division

LEP
Enclosures

6/ESFH5/142

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

September 13, 1988

Exploratory Evaluation Document Revision
Mississippi Sound Block 57 Unit

Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560

Attention Dr. Richard Leard

Gentlemen:

The initial Exploratory Evaluation Document for the subject unit was filed on March 6, 1987. Since that submittal, however, the choice of drilling vessel has been changed from the Temple Marine Drilling Company's "Seabee" to Transworld Drilling Company's Rig No. 70. Enclosed is updated information pertaining to the drilling vessel, including plans to collect waste fluids and cuttings, and a revised well location plat reflecting the well's name change.

A copy of this revision is also being forwarded to the Mississippi Oil and Gas Board to satisfy the requirements in Rule OS-4. Please call me at (504) 364-2382 should you have any questions.

Very truly yours,

M. S. Witten

M. S. Witten
Division Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

LEP
Enclosures

cc: Dr. A. Richard Henderson
Mississippi State Oil and Gas Board
P. O. Box 1332
Jackson, MS 39215-1332

3/ESFH6/46

2. Provide the Mississippi Bureau of Pollution Control with copies of;

   A. Notification to appropriate environmental agency of intent to dispose of wastes and/or wastewaters within said environmental agency's jurisdiction.

   B. Names, addresses and environmental permit numbers (if applicable) of disposal facilities.

3. Chevron shall maintain a manifest system which shall describe the following:

   A. Volume, date, and types of wastes generated.

   B. Volume, date, and types of wastes disposed and disposal method/facility.

4. Chevron shall submit copies of the aforementioned manifest to the Mississippi Bureau of Pollution Control on the 15th day of the month following the previous month.

5. Chevron shall receive all necessary permits and/or certifications from all other Mississippi regulatory agencies.

All of the preceding conditions have been discussed previously with Chevron. Please notify the Bureau, in writing, of your acceptance of these compliance conditions within 30 days of receipt of this correspondence.

We look forward to Chevron's drilling activities in the Mississippi Sound. We also anticipate Chevron's continued cooperation with the Bureau on environmental protection. If Chevron has any questions or comments on the foregoing, please contact me at 1-601-961-5073.

Respectfully,

Jerry W. Cain, P. E., Coordinator
Industrial Wastewater Control Section

JWC:hdp
cc: Dr. R. Leard, Bureau of Marine Resources
Mr. Robert Seyfarth, BPC

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA 70174

Exploratory Evaluation Document
Revision to Submittal of 3/6/87

MS Sound Blk 57 Unit; State of MS #1

I. Drilling Vessel and Waste Containment

As shown in attached Figures 1 through 3, the Transworld Rig No. 70 is a three-legged triangular submersible vessel. The detailed drilling unit specifications are provided in Figure 4. Standard on-site pollution prevention, emergency, and safety equipment will be supplemented with special features pertaining to the zero discharge containment system, and these are listed in Figure 5. Note that all deck drainage will be piped to the rig columns for use in the drilling fluids or washdown systems, and that the capability will also exist to pump out of these columns into a barge for disposal, if necessary.

All cuttings will be dehydrated as fully as possible in the drilling rig's solids control system, and slide down a chute into a Coast Guard Approved coverable hopper barge. When a barge load is obtained, barges will be exchanged, with the full vessel proceeding to an approved disposal site on land. If it becomes necessary to dispose of whole drilling fluid, this too will be piped to the hopper barge. It is estimated that between ten and fifteen trips to the disposal site will be necessary over the course of drilling the subject well.

II. Well Location

Attached as Figure 6 is a 1" = 5000' location plat showing the location of the sole well proposed at present in the drilling unit. As the prospect is programmed as a straight vertical well, the surface and bottom-hole locations are shown as one point. For reference, the approximate location of Cat Island is included on the plat.

RIG 70

TRANSWORLD DRILLING COMPANY

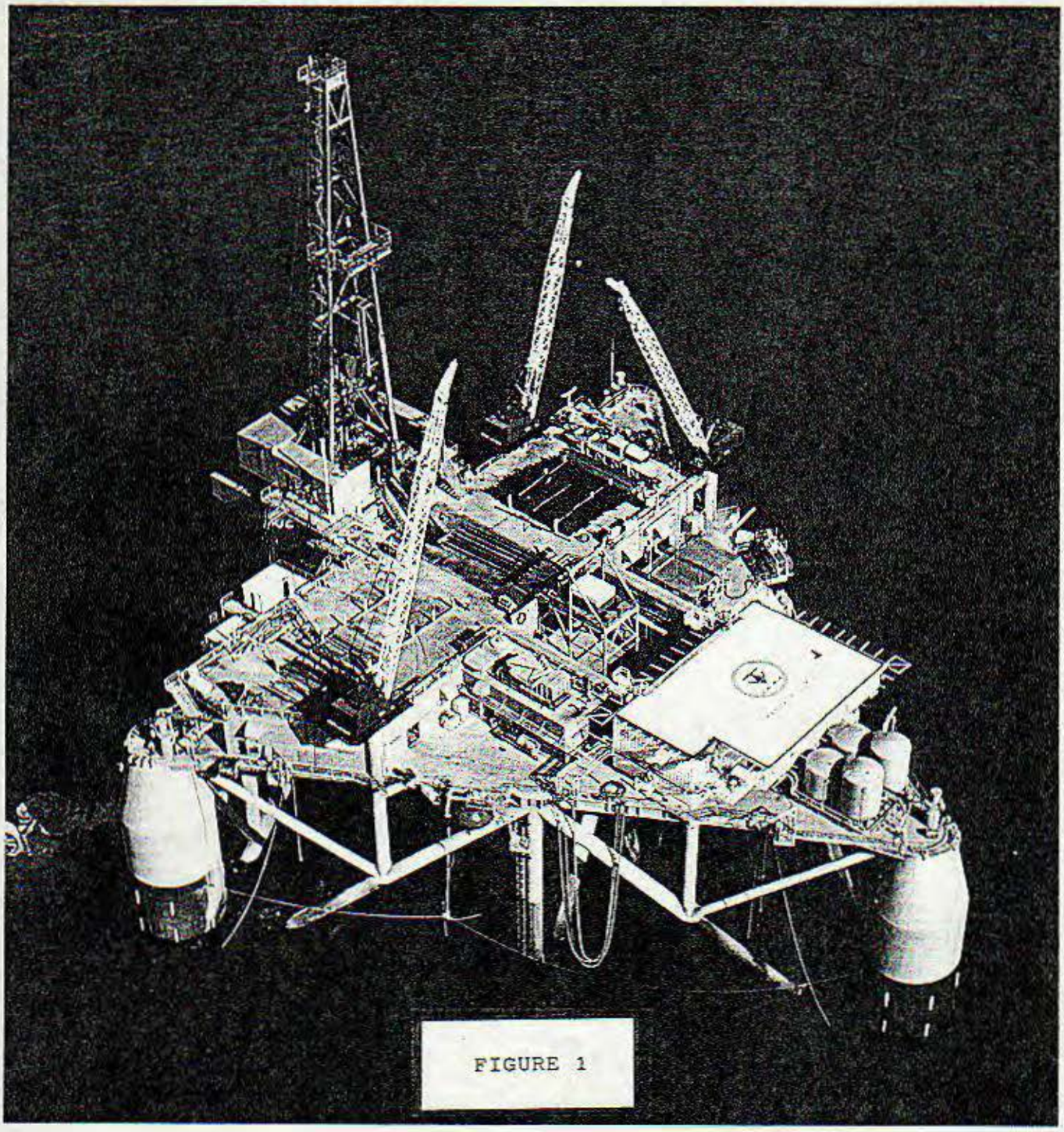
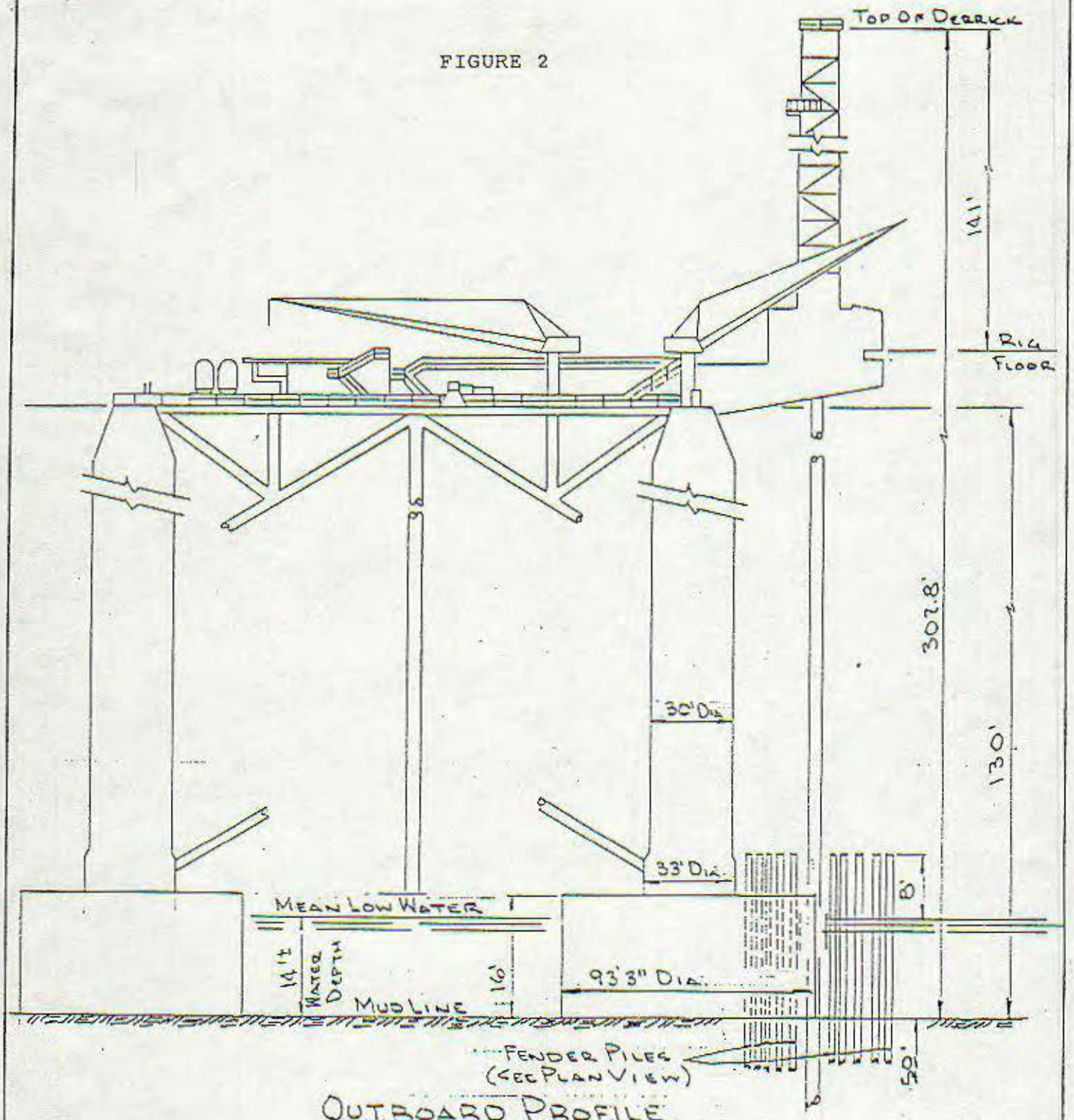


FIGURE 1

FIGURE 2



OUTBOARD PROFILE

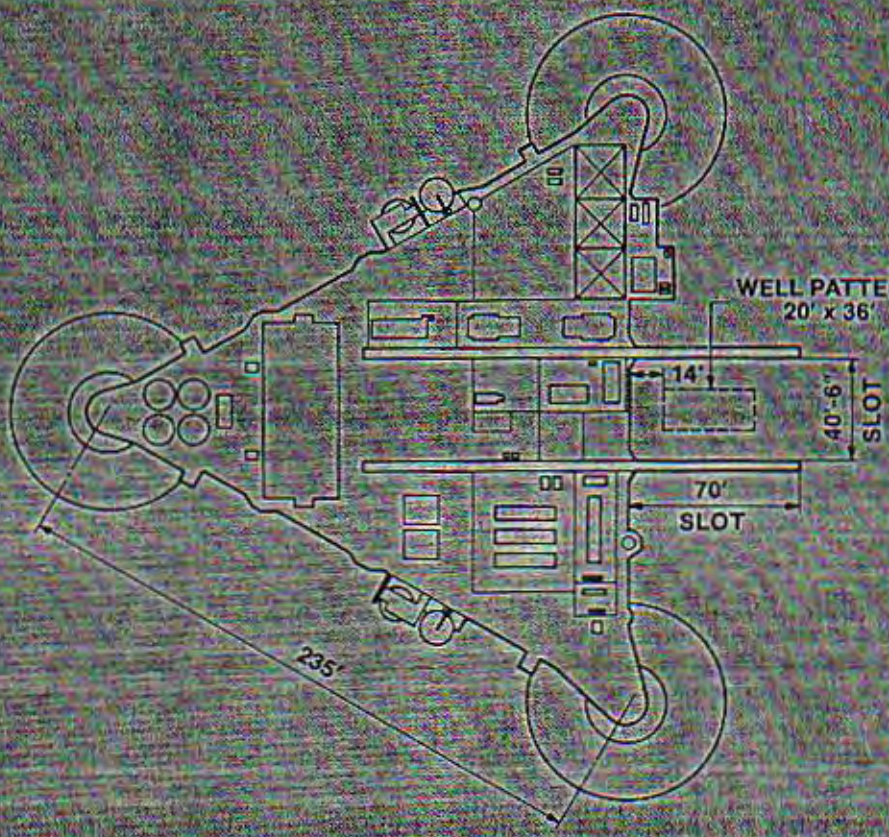
"ATTACHMENT "A"
REVISED 8-18-88

MISSISSIPPI SOUND BLOCK 57 UNIT;
STATE OF MISSISSIPPI No. 1
HARRISON CO. MISS.

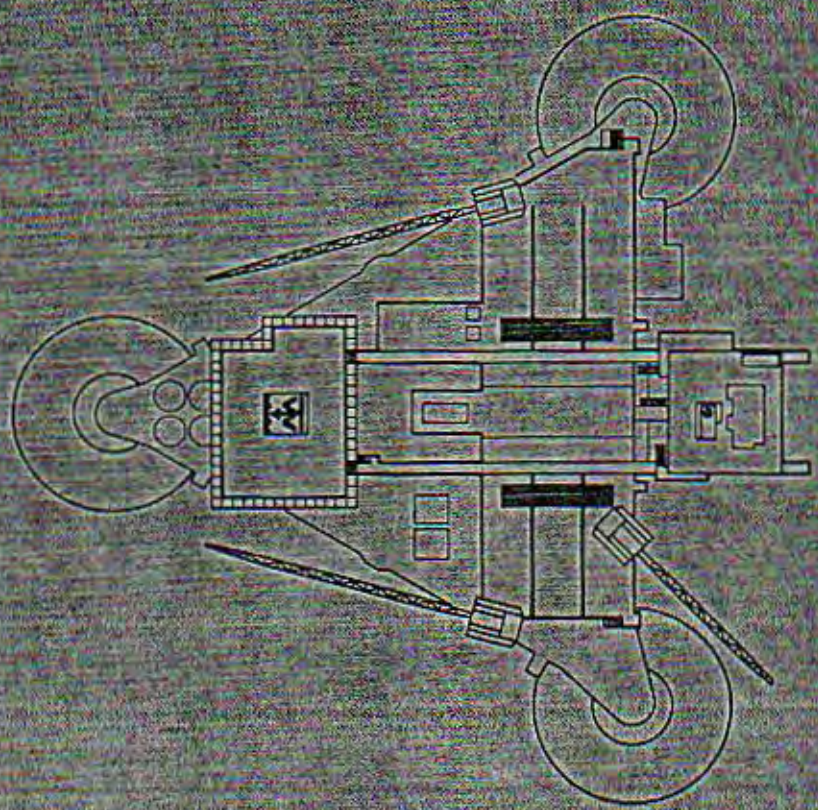
Chevron U.S.A. Inc.
Eastern Region - Exploration, Land and Production

SCALE NONE	FILE NO. DWG. NO. SHT 3 OF 4
BY: WADE	DATE: 8-18-88

FIGURE 3



MAIN DECK



PIPE RACK DECK

RIG 70

TYPE
Submersible.

DRAW WORKS
Oilwell E-3000, driven by two D-79 DC electric motors, with Baylor 7838 electric brake.

RIG POWER
Three General Motors 12-645 diesel engines, each rated at 1,650 HP and each driving an EMD AB-20-6 AC generator, with Ross Hill SCR rig-drive system.

MUD PUMPS
Two Oilwell A-1700 PT, 7½" x 12", 1,700-HP Triplex pumps, each driven by two EMD D-79, DC electric motors, with 5" x 6" centrifugal supercharging pumps.

MAST
Lee C. Moore 142' x 30' base, with 1,273-million-lb. hook-load capacity.

STRING-UP
Provision for stringing 12 1½" lines.

DRILL STRING
Per agreement.

ROTARY TABLE
Oilwell B37½", driven by an EMD D-79 DC electric motor.

BLOWOUT PREVENTERS
13⅝" — stack consisting of one Hydril GL 5,000-psi WP BOP, one Cameron Type "U" single ram, and one Cameron Type "U" double ram 10,000-psi WP BOP.
21¼" — 2,000-psi WP Hydril MSP annular preventer.

MUD MIXING
Two 5" x 6" centrifugal pumps, each driven by a 60-HP AC motor.

MUD TANKS
1,500-barrel active capacity, with electric-drive agitators.

DESANDER EQUIPMENT
Eight 8" cones supplied by a centrifugal pump.

DESILTER EQUIPMENT
16 4" cones supplied by a centrifugal pump.

DRY-MUD STORAGE
Two 1,500-cu.-ft., pneumatic storage tanks and two 2,000-cu.-ft. P-tanks. Additional space for 5,000 sacks of material.

CEMENTING UNIT
Halliburton Twin HT-400.

LOGGING UNIT
Standard offshore unit.

PERSONNEL QUARTERS
Air-conditioned accommodations for 52 persons.

ELECTRIC POWER
Two 1,000-KVA transformers supply 480-volt, AC power from main rig generators for auxiliary service. One Cummins KT-1150-GC diesel engine drives a 275-KW AC generator (emergency unit).

MATERIAL-HANDLING EQUIPMENT
Three Link-Belt API-218A cranes, each with a 26-ton capacity at 40' radius.

HELIPORT
Adequate for Sikorsky S-61 helicopter.

LIQUID STORAGE CAPACITY
4,000 barrels drill water, 1,382 barrels potable water, 58,000 gallons diesel fuel.

LOADING INFORMATION
Maximum deck load during normal moves — 750 tons.

CLASSIFICATION
Classed by American Bureau of Shipping as ✠A-1 Column-Stabilized Drilling Unit.

LIFESAVING EQUIPMENT
Four 20-person life rafts.
Two 28-person survival capsules.

FIGURE 4

FIGURE 5

Waste Containment on Transworld Rig No. 70 -- Special Features

1. All deck areas will have coaming and piping to collect all rainfall and washwater. Fluid collected will be piped to compartments within the three rig support columns for use in the drilling fluids or washdown system.

2. All mud troughs will have covers to prevent mud splashing.

3. All machinery and other oily items will have drip pans with bullplugs in place, and will be equipped for pumping out to waste oil tanks or manual cleaning with oil-absorbent material.

4. All sewage effluent will be treated in a Coast Guard Approved sewage treatment unit on the rig, and will then be contained for transport and disposal.

5. All paper, wood, plastic containers, kitchen garbage, etc. will be collected at the rig and transported to shore for disposal.

6. A drive pipe drip pan will be mounted below the wellheads to catch any mud or hydraulic fluid from the blowout preventer area. This will be piped directly to the hopper barge servicing the rig.

7. The drawworks brake unit and all engines will use water-to-air heat exchangers rather than seawater for cooling.

8. Bulk barite and cement tanks will have their vent lines piped so as to prevent airborne dust.

9. All drilled cuttings shall be collected and transported to shore for disposal.

10. All excess mud shall also be contained and transported to shore for disposal.

11. One Chevron Employee at the rigsite will have pollution control, waste containment, transportation and disposal as his primary responsibility.

Chevron U.S.A. Inc.
P. O. Box 6056 - New Orleans, LA. 70174

September 13, 1988

Exploratory Evaluation Document Revision
Mississippi Sound Block 57 Unit

Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560

Attention Dr. Richard Leard

Gentlemen:

The initial Exploratory Evaluation Document for the subject unit was filed on March 6, 1987. Since that submittal, however, the choice of drilling vessel has been changed from the Temple Marine Drilling Company's "Seabee" to Transworld Drilling Company's Rig No. 70. Enclosed is updated information pertaining to the drilling vessel, including plans to collect waste fluids and cuttings, and a revised well location plat reflecting the well's name change.

A copy of this revision is also being forwarded to the Mississippi Oil and Gas Board to satisfy the requirements in Rule OS-4. Please call me at (504) 364-2382 should you have any questions.

Very truly yours,

M. S. Witten

M. S. Witten
Division Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

LEP
Enclosures

cc: Dr. A. Richard Henderson
Mississippi State Oil and Gas Board
P. O. Box 1332
Jackson, MS 39215-1332

3/ESFH6/46

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056-New Orleans, LA. 70174

ATTACHMENT "D"

March 4, 1987

Request for Variance
Mississippi Coastal Program
Guidelines - Section 2, Part III.K.2

Dr. Richard L. Leard
Bureau Director
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560

Attention Mr. Gary Cuevas

Gentlemen:

This letter pertains to Chevron's Mississippi Lease Number S.L. 3470 and Lease Block 57 within the Mississippi Sound leased area.

Based upon the provisions of the Mississippi Coastal Program, we have found that our desired operations in Lease Block 57 conflict with the following guidelines of Section 2, Part III.K.2. (Revisions effective May 1, 1986.)

d. Sitting within one mile of an oyster reef.

Chevron U.S.A. Inc. hereby requests that a variance be granted by the Commission of Wildlife Conservation for this and any other guidelines found to be in conflict, based on the fact that the impacts on coastal wetlands would be no worse than if the guidelines were followed. The oyster reef in question is, at present, non-productive, however, the reef has been productive in the past and the bottom subtrate is suitable for oyster production. During the conduct of operations within Block 57, no toxic material will be discharged. In addition to the fact that the reefs are non-productive, we believe that the environmental assessment included in the Exploratory Evaluation Document would substantiate the justification of this variance request.

It should also be noted that the site location chosen by Chevron is the most practical, with alternative sites and construction techniques being technologically and economically infeasible. There is a significant public interest in this project at both the state and federal levels since the objective of this project is to aid in the recovery

6ESF&H2/595

of valuable fossil hydrocarbon resources and at the same time provide appropriate protection of the valuable renewable marine-related resources.

Should you have any questions regarding this submission, please contact Ms. Sandy Bergeron of this office at (504)364-2242.

Thank you for your consideration in this matter.

Very truly yours,

M. S. Witten

M. S. Witten
Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

SMB

6ESF&H2/595

I certify that this is a ue and correct copy of th March 10, 1988 minutes of the Commission on Wildlife Conservation.

Vernon Bevill, Executive Director

Martha Jean White
Notary Public
My Commission Expires May 24, 1990.

The Commission on Wildlife Conservation met Thursday, March 10, 1988 at 2:00 p.m. at Southport Center in Jackson, Mississippi. In attendance were Chairman S. T. Rayburn, Commissioner Joseph W. Gex, Commissioner David New, Executive Director Vernon Bevill, Bureau Director Richard Leard, Bureau Director Bill Quisenberry, Bureau Director Jack Herring, Attorney Helen Wetherbee and Attorney Tim Waycaster.

APPROVAL OF MINUTES

On a motion by Commissioner Gex, seconded by Commissioner New, the minutes of the January 27, 1988 meeting were unanimously approved.

RECOGNITION OF GUESTS

Chairman Rayburn introduced and welcomed James Pulliam and Ronnie Haynes, U. S. Fish and Wildlife Service; James Lane and Ray Lensing, Mississippi Saltwater Fisherman's Coalition; and Mark Witten and Mark Dando, Chevron, Inc.

CHEVRON, USA

Referring to the staff findings and recommendations previously distributed (attached is Exhibit A), Dr. Leard advised that the environmental findings presented at the last meeting remained unchanged. The Committee appointed by the Commission had, however, met on the Coast. The Committee had received additional information, flown over the proposed site and attended a public hearing.

Commissioner Gex, reporting for the Committee, recommended that the Commission consider a variance based upon the lack of a feasible alternative and the significant public benefits that might be derived from the proposed activity. He expressed his satisfaction that Chevron had established that there was no feasible alternative. Chevron then submitted further evidence of the public benefits of the proposed drilling.

It was agreed that the matter be tabled until later in the day when Commission members had had an opportunity to review the documents which Chevron had submitted.

1987-88
#5233 John Belk - $342.00
Belk's Grocery
Toccopola, Ms.

Mr. Belk reported that on October 13, 1987 $342 in unsold licenses had been stolen from his store. The incident was investigated by the Pontotoc County Sheriff's Department and our officer, Levi Hailey. Mrs. Briscoe recommended adjustment approval.

Commissioner Gex moved, Commissioner New seconded, that adjustment be granted Mr. Belk in the amount of $342. The motion unanimously carried.

Mrs. Briscoe listed 21 license agents whose account balance was less than $100 and requested approval to adjust their accounts rather than file on their bonds.

Commissioner New moved to adjust the accounts, with the stipulation as offered by Chairman Rayburn, that these agents no longer be allowed to sell licenses. The motion was seconded by Commissioner Gex and carried unanimously.

CHEVRON, USA

The Chevron variance was again addressed. Commissioner Gex moved that Chevron, USA be granted the requested variance; Commissioner New seconded, and the motion unanimously carried.

RECEPTION

Chairman Rayburn announced that the Mississippi Museum of Natural Science Foundation was holding a reception from 4:30 to 6:30 today honoring Elizabeth Hartfield, new director of the Museum, and celebrating the opening of the 3-2-1 Contact Exhibit.

EXECUTIVE SESSION

Commissioner Gex moved that the Commission consider entering executive session to discuss one matter of personnel and two matters of real property. The motion was seconded by Commissioner New and carried unanimously.

Commissioner Gex then moved, Commissioner New seconded, that the Commission enter executive session. The motion unanimously carried.

Following the session, Commissioner New moved, Commissioner Gex seconded, that the Commission resume open session. The motion carried without opposition.

STAFF FINDINGS AND RECOMMENDATIONS
FOR
THE PERMIT REQUEST BY CHEVRON, U.S.A., INC.

PROJECT DESCRIPTION

Chevron, U.S.A., Inc. proposes to drill a gas exploratory well in the Mississippi Sound in Lease Block 57. The proposed drill site is located on "Buoy Reef" and the proposal does not meet the Mississippi Coastal Program Guidelines (MCF).

Chevron has requested a variance from the MCP Guidelines and submitted a justification on the basis that the impacts to the coastal wetlands would be no greater than if the guidelines were followed.

Secondly, Chevron has requested a variance from the MCP Guidelines that no feasible, alternative site or construction techniques are available, there is a significant public benefit in the activity, and a public hearing has been held.

COMMENTS

The Staff of the Bureau of Marine Resources has reviewed the project and prepared a set of findings in accordance with the provisions of the Mississippi Coastal Program. These findings address the request for variance originally submitted by Chevron and the more recent request which is based on other criteria in the Mississippi Coastal Program.

Based on the information provided by Chevron, the information reviewed by the Staff and the comments from the public at the Public Hearing, the Staff has determined the following:

1. The environmental damages, procedents and potential for cummulative impacts are as previously addressed in the staff findings.

2. Chevron's most recent assessment of the Buoy Reef indicates that the location where the drilling rig will be placed has very little hard bottom. Adjacent areas on almost all sides have hard bottom (i.e. oyster shells).

3. Expressed public sentiment indicates opposition to granting of the variance. The mayor of the City of Gulfport, an ex-official with the Harrison County Development Commission, the president of a local fishing group and others expressed concern at the public hearing held by the BMR.

4. They have not adequately addressed the issue of public benefits to be derived from this project (i.e. jobs, royalities, taxes, etc.).

5. The majority of the BMR staff oppose siting at this location. The staff feels that allowing the variance would set the stage for allowing other variances for future operations in this area of the Mississippi Sound.

6. The Department of Natural Resources (DNR), primarily through the State Geologist agrees with Chevron on the "no feasible alternative" in directional drilling and that the site is the most likely one to encounter gas.

RECOMMENDATIONS

A. Staff has addressed environmental impacts present and future and stands by previous findings with regard to impacts being no greater than if the guidelines are followed and continues to recommend denial under this criteria.

B. Chevron has addressed alternatives and risks of drilling at another location or directionally and have adequately determined infeasibility.

C. With regard to public benefits - Chevron has not adequately proven this case. The CWC should address this issue perhaps in conjunction with other state agencies and their respective jurisdiction in the matter.

Additionally, the public input and private input to such an important project has been very slight.

This determination of public benefit in the absence of clear data to support same, forces staff to again recommend that the variance not be acted on affirmatively.

OPTIONS

1. Table and seek additional public benefit information from Chevron and coordinate with other agencies.

2. CWC make independent determination of public benefit and either approve or deny Chevron's request.

CLEAN GULF ASSOCIATES

OIL SPILL

CONTINGENCY AGREEMENT

Revised January 1, 1976

These articles of agreement between the parties constituting, as of December 31, 1975, the membership of Clean Gulf Associates, WITNESSETH:

That the parties hereto are the owners of and successors to the rights and obligations of the members under the Clean Gulf Associates Oil Spill Contingency Agreement dated August 1, 1972, as amended, and desire again to amend and revise same effective January 1, 1976.

NOW, THEREFORE, the parties hereto do hereby and by these presents agree that, effective January 1, 1976, the Clean Gulf Associates Oil Spill Contingency Agreement, as amended, is superseded and supplanted by these articles of agreement as follows:

ARTICLE 1.

NAME

QUALIFICATIONS FOR MEMBERSHIP

NON-PROFIT ASSOCIATION

1.1 Name. The parties hereto, acting in association under this agreement, shall be known as Clean Gulf Associates, which may hereinafter be referred to as CGA. The individual parties may be referred to as a member or members.

1.2 Qualifications for Membership. In addition to the undersigned membership, any party operating or contemplating operating oil and gas leases in the Area of Interest may be a member of CGA by the payment to CGA of the initial fee of Five Thousand Dollars ($5,000.00) and agreeing in writing to be bound by the terms of these articles or agreement.

1.3 Non-Profit Association. It is the intention of the members that this agreement shall not result in monetary profit to any member arising from its participation herein.

ARTICLE 2.

AREA OF INTEREST

2.1 Area of Interest. The Area of Interest of this agreement shall be that portion of the Gulf of Mexico lying offshore and seaward of the coastlines of the States of Texas, Louisiana, Mississippi, Alabama and Florida, and the bays, inside waters and estuaries adjacent to, or forming a part of, the Gulf of Mexico within said states.

ARTICLE 2.

PURPOSE AND SCOPE

3.1 Purpose. The purpose of this agreement is to establish a comprehensive plan for containing and cleaning up spills of liquid hydrocarbons that may occur where members are involved in activities in the Area of Interest.

3.2 Scope. This agreement shall apply to any type of activities of members (including any corporation owning 100% of any member and all wholly owned subsidiaries of such parent and member) involving facilities, equipment or material used by members in the Area of Interest in connection with exploratory work or in connection with drilling, producing, handling, treating, transporting and storing of liquid hydrocarbons; such as, but not limited to, loading docks, gathering systems, pipelines, producing equipment, drilling platforms, production platforms, storage tanks located on the coastline or on platforms or on the ocean floor, barges, barge loading equipment, tankers, boats, submersible equipment, and separation stations.

ARTICLE 4.

GOVERNING BODY

4.1 Members Representives. Each member may appoint one

representative and one alternate to the governing body of CGA, which shall be known as the members representatives. The alternate shall have no vote, except in his members representative's absence. The members representatives shall elect from their membership a chairman, a vice-chairman, a secretary-treasurer and six additional members who shall serve as the Executive Committee of CGA for one year, or until their successors are elected. In the event of a vacancy occurring in the chairmanship, vice-chairmanship, secretary-treasurer or other member of the Executive Committee, by resignation of otherwise, the vacancy may be filled for the unexpired term of appointment by the Executive Committee. During any interim when the chairmanship is vacant, the vice-chairman shall act as chairman. The members representatives may alter the size of the Executive Committee or terminate its tenure and elect a new Executive Committee.

4.2 Authority. The members representatives, acting through the Executive Committee, shall conduct all business and take all action required or authorized under this agreement.

4.3 Meetings. The members representatives shall convene annually in July in New Orleans, Louisiana, at such place and time as the chairman shall declare by 15 days' written notice to each of the members representatives. Special meetings of the members representatives may be called by the Executive Committee at any time by at least 24 hours' notice, which notice may be oral but shall be confirmed in writing as soon as practical.

4.4 Voting. At any annual or special meeting of the members representatives, the presence of a majority of the total of the then composite participation under this agreement shall constitute a quorum. The vote of each member shall have the weight of such member's composite participation percentage hereunder and the affirmative votes of the members representatives who together represent a majority of the total of such composite participation present shall be necessary to carry any proposal.

4.5 Composite Participation. To determine the weight of each individual member's vote on all business coming before and to be acted upon by the members representatives as well as the basis of allocation among members of the annual fee, each member's composite participation percentage shall be arrived at as follows:

(1) Such members' most recent cost participation percentage in each Cost Participation Area in which such member is a participant shall be applied to the net original cost to contractor of all active equipment and material in such Cost Participation Area.

(2) Such amount (or the sum of such amounts if such member is in more than one Cost Participation Area) shall be divided by the total net original cost to contractor of all active equipment and material hereunder.

ARTICLE 5.

EXECUTIVE COMMITTEE

5.1 Composite. The nine (9) member Executive Committee shall include at least three (3) members from each Cost Participation Area. One or more of such members may represent more than one Cost Participation Area. The Executive Committee may assign such duties and delegate such portion of the Executive Committee's authority to the chairman as the Executive Committee deems necessary and appropriate.

5.2 Authority. The Executive Committee is hereby constituted and empowered to represent and act for and on behalf of CGA in all appearances, dealings, and contracts within the scope of this agreement and, in general, shall carry out and effectuate the purposes and objectives of the members representatives under this agreement. The Executive Committee shall act in a prudent manner but shall not be liable for its actions to any member regardless of negligence.

5.3 Meetings. The Executive Committee may act at any meeting called at any time by its chairman, or by any members representative. Any such committee action may be also taken without a convened meeting by vote or agreement by telephone, wire or letter.

5.4 Voting. The affirmative vote or concurrence of a majority in number of the Executive Committee shall be sufficient for any action by such committee.

ARTICLE 6.

COST PARTICIPATION AREAS

6.1 Cost Participation Areas. To implement the purposes of this agreement, Cost Participation Areas may be established, modified and discontinued hereunder as needed. Each Cost Participation Area shall (1) consist of a described area within the Area of Interest and shall be composed of only those CGA members desiring to participate in the cost and uses thereof; (2) shall not overlap or conflict with or impede the purpose and scope of any other Cost Participation Area; (3) shall require the use of separate equipment and material designated for such Cost Participation Area and; (4) shall be subject to whatever conditions the member's representatives deem necessary or advisable.

6.2 Basis of Cost Participation. The basis of participation in the cost of each Cost Participation Area shall be at least 15% on a per capita basis with the remaining percentage on any basis as may be agreed by the participating members. If production of liquid hydrocarbons or leasehold acreage be used as any part of the basis of such participation, there shall be included with each member's wholly owned and operated activities those non-wholly owned activities of which such member is the operator.

6.3 Existing Cost Participation Areas and Bases of Participation. Heretofore there have been established two Cost Participation Areas, Cost Participation Area No. 1, Offshore, Louisiana, and Cost Participation Area No. 2, Offshore Mississippi, Alabama and Florida.

Cost Participation Area No. 1 consists of that portion of the Gulf of Mexico to the limits of the Outer Continental Shelf lying offshore and seaward of the coastline of the State of Louisiana, and the bays, inside waters and estuaries adjacent to, or forming a part of, the Gulf of Mexico within said state, as outlined on plat entitled "Cost Participation Area No. 1, August 1, 1972" attached hereto and made a part hereof, and including the entirety of all fields located partly within and partly outside the aforesaid outlined area.

The basis of cost participation in Cost Participation No. 1. is 15% per capita and 85% on production of liquid hydrocarbons operated the previous year by each member in the Cost Participation Area as reported by the Petroleum Information Corporation.

Cost Participation Areas No. 2 consists of that portion of the Gulf of Mexico to the limits of the Outer Continental Shelf lying offshore and seaward of the coastlines of the States of Mississippi, Alabama and Florida and the bays, inside waters and estuaries adjacent to, or forming a part of, the Gulf of Mexico within said states, with the western boundary of said area being the eastern boundary of Cost Participation Area No. 1.

The basis of cost participation in Cost Participation Area No. 2 is fifteen (15%) percent per capita and, until production commences, the 85% factor of cost participation shall be based upon each member's pro rata share of the number of leased acres* operated,

---

(*Certain leases within the three-league limit or between the shore line and the numbered OCS blocks are currently under litigation wherein drilling and production operations are not permitted. Until such time that the litigation is resolved and drilling operations are permitted, these leases shall be excluded from the percentage participation calculations.)

as amended annually such 85% factor of cost participation to be assumed in part or in whole by those conducting drilling operations, as follows:

a. Each drilling rig shall be assessed a maximum of One Thousand Dollars ($1,000.00) per day or fraction thereof, for each day from time of spudding until well-completion or move-off, whichever comes first. The total of such assessment during any month shall not exceed the 85% factor of cost participation for that month, and the responsibility of non-drilling members for said 85% factor shall be reduced pro-rata by the total assessment to drilling members during the same month; to the end that if the total assessment to drilling members for said 85% factor for any month covers said 85% factor in its entirety, the non-drilling members will not make any contribution to said 85% factor for such month.

b. It shall be the responsibility of each member to report such drilling days promptly at the end of each calendar month.

The Executive Committee shall review the cost participation parameters each July after production of liquid hydrocarbons has been established in Cost Participation Area No. 2 and agree upon the procedures and timing for phasing production into the cost participation formula.

The percentages of cost participation for the members in each of the two existing Cost Participation Areas as of December 31, 1975, under the CGA Agreement dated August 1, 1972, which this agreement supersedes shall also be the cost participation percentages at the effective date of this agreement, until revised.

6.4 Revision of Cost Participation Percentages. The percentages of cost participation of the members of each Cost Participation Area shall be revised as follows:

(a) Annually, effective August 1, for the ensuring year; and

(b) Whenever there be a change in membership in such Cost Participation Area, effective the first day of the month following such change; and

(c) When and as directed by any terms and provisions adopted by the members of such Cost Participation Area.

6.5 Exhibit Attached Setting Forth Cost Participation Percentages by Areas and Composite. A schedule showing the percentages of cost participation of the members in each Cost Participation Area as of January 1, 1976, and a schedule showing each subsequent revision and recalculation and the effective date thereof shall be prepared by the Executive Committee and be attached hereto and become a part hereof, and shall be identified Exhibit A. The Executive Committee shall be responsible for all revisions and recalculations of cost participation and for the preparation and distribution to each member of CGA and to each contractor affected thereby a copy of each revised Exhibit A. A schedule showing the composite participation percentages shall accompany the cost participation schedule and revisions.

ARTICLE 7.

CONTRACTS

7.1 Contracts. For each Cost Participation Area under this agreement, the chairman of the Executive Committee, with the approval of the Executive Committee members from such Cost Participation Area, in the name of and on behalf of CGA shall negotiate the terms of and enter into the following contracts:

(1) A contract (herein called Equipment and Material Agreement) under which a service company, as contractor, shall acquire certain equipment and material and make

same available for members use in the Cost Participation Area in consideration of members of such Cost Participation Area agreeing to a basis of reimbursement of the contractor therefor.

(2) An operating contract (herein called Contractor's Agreement) under which a service company, as contractor, shall (a) maintain such equipment and material at specified locations within the Cost Participation Area; (b) furnish experienced supervisory personnel and provide training concerning use of such equipment and material; and (c) furnish such other services including performance trials and demonstrations as may be requested by the Executive Committee.

ARTICLE 8.

COSTS AND EXPENSES

8.1 Costs and Expenses Under This Agreement.

(a) All members pay an initial fee of $5,000.00 apiece.

(b) On August 1 of each year each member shall pay an annual fee consisting of such member's share of an amount determined by the Executive Committee to be necessary to pay for the annual general and administrative costs and expense anticipated to be incurred by CGA during the following year. Any party who becomes a member between annual assessment dates shall pay its share of the annual fee then in effect, pro rated for the part of the year remaining.

All money received by CGA as fees shall be placed in a bank account and used to pay the general and administrative costs and expenses incurred under this agreement. Any excess money in the bank account on July 31 of each year shall be used to reduce the fees for the following year or, at the discretion of the Executive Committee, shall be applied ratably to reduce the equipment reimbursement accounts under the Equipment and Material Agreements or, shall be refunded and paid to the members in the proportions of their compositie participations as of the end of such year (July 31).

8.2 Delinquent Accounts. Any member which fails to pay its initial fee within 90 days after becoming a member, or fails to pay promptly when billed any other amount it is obligated to pay hereunder, shall at the discretion of the Executive Committee cease to be a member and cease to be entitled to any rights or benefits hereunder and shall not be entitled to any refund of monies or fees previously paid by such member pursuant hereto and shall remain obligated for all debts and accounts contracted theretofore. Such party may be readmitted as a member only upon payment of all delinquent amounts and upon vote of the members representatives upon such terms as they declare.

8.3 Other Costs and Expenses. Members of each Cost Participation Area shall bear the equipment reimbursement cost due and payable to contractor under the Equipment and Material Agreements for such area, and shall bear the operating expenses due and payable to contractor under the Contractor's Agreement for such Cost Participation Area, in accordance with the percentages of cost participation set out in Exhibit A of this agreement.

ARTICLE 9.

USE BY MEMBERS

9.1 Notice of Spill. In the event of an actual of threatened spill of liquid hydrocarbons originating within the Area of Interest, and if the affected member desires to utilize equipment, material and personnel of contractor under a Contractor's Agreement hereunder, then such member shall follow the notification procedure provided in the Contractor's Agreement, securing the approval of some member of the Executive Committee, for such use.

9.2 Use By Member. Upon such notification and approval, the requested equipment, material and personnel shall be made available to the affected member and during the time so committed, complete control thereof shall be in the using member. During such time, the other members, Executive Committee and officers shall have no responsibility therefor regardless of negligence. The using member shall

pay directly to contractor the charges for the use of said equipment and material as prescribed in the Contractor's Agreement and herein and shall return the equipment and material in as good a condition as when called into service or, if lost or damaged, and not covered by the insurance required and specified in the CGA Contractor's Agreement, at the discretion of those members of the Executive Committee from the Cost Participation Area from which such equipment and material came, such using member shall pay an amount of money equal to the insured (before deductible) or replacement value, whichever is greater, or the cost which would have been incurred in repairs, if damaged, If the equipment and material are used to contain and clean up a spill originating outside any Cost Participation Area in which the using member participates, or originating outside the Area of Interest, the rates charged to such member by contractor for use of said equipment and material shall be on the basis of four times the rates specified in the Contractor's Agreement (subject to reduction by vote of the members representatives) and the excess over the regular rate shall be applied by contractor to reduce the equipment reimbursement account of such equipment and material. Such excess payment shall be paid as an approximation of the expenses and risks incurred in having the equipment, material and personnel available.

9.3 Use Outside of Area of Interest. If the containment and clean-up of a spill requires use of such equipment, material and personnel by a member of CGA outside of the Area of Interest, then such equipment, material and personnel may be made available only at the discretion of the Executive Committee but if permitted will be at the rates that would have applied to the point of origin of such spill.

9.4 Multiple Use By Members. If two or more spills in the Area of Interest affecting different members require the use at the same time of the same equipment, material and personnel, the Executive Committee shall determine priorities.

9.5 Use By Contractor For Non-Members. In the event of a request by contractor to use any equipment, material and personnel subject hereto to contain and clean-up a spill or threatened spill of

liquid hydrocarbons in the service of any party who is not a member of CGA, including any governmental agency, the Executive Committee may release CGA's prior rights under an Equipment and Material Agreement or any portion thereof to the contractor on a temporary basis for such use, and during the time so committed, complete control thereof and full responsibility therefor shall be in the contractor and the non-member party, and the members and the Executive Committee shall have no repsonsibility therefor. As an approximation of the expenses and risks incurred in having the equipment and material available, contractor shall credit the appropriate CGA equipment reimbursement account a sum equal to three times the rate for member's use of usch equipment (subject to reduction by vote of members representatives). The equipment and material shall be returned in as good a condition as when called into service or, if lost or damaged, and not covered by insurance, at the discretion of those members of the Executive Committee from the Cost Participation Area from which such equipment and material came, contractor shall be required to pay an amount of money equal to the insured (before deductible) or replacement value, whichever is greater, if lost, or the cost of repairs, if damaged.

ARTICLE 10.

INDEMNITY

10.1 Indemnity for Costs and Charges of Members. Each member shall be solely responsible and liable to contractor for its participation percentage of all amounts due under Equipment and Material Agreements for Cost Participation Areas in which it is a members; for all user charges incurred by such members under any Contractor's Agreement for a Cost Participation Area in which it is a member or from which it shall have used equipment and material; and, for repairing and replacing any equipment and material, or reimbursement therefor at the discretion of the Executive Committee in the event of damage to or loss or consumption of same while in

use of such member; and such member shall indemnify each other member, subsequent members and the Executive Committee against all liability to contractor on account of such amounts, charges and costs.

10.2 General Indemnity. Each member shall hold harmless and unconditionally indemnify CGA, each other member, subsequent members, and the Execitve Committee and the individual members and subsequent members thereof, and the officers, agents, servants, and employees of the foregoing, herein collectively referred to as indemnitees, against and for all liability, and costs including, but not limited to, attorneys' fees, expenses, claims, fines and damges which the indemnitees suffer or sustain or become liable for by reason of accidents, damages, or injuries either to the person or property of the indemnifying member or of the contractor, or to the persons of property of any third party, including but not limited to federal and state governments and agencies thereof, in any manner arising out of or connected with work performed as a result of or pursuant to the Contractor's Agreement for the indemnifying member. The foregoing indemnity and hold harmless by a member shall be applicable whether or not the accident, damages, or injuries indemnified against were caused or contributed to in whole or in party by the negligence of said indemnitees or contractor, or any agent, servant or employee of contractor. The party furnishing this indemnity further agrees that said indemnitees shall have the right but not the obligation to tender the defense of any and all lawsuits arising out of or in any way connected with the matters which are the subject of this indemnity and hold harmless provisions but that failure to tender any such lawsuit for defense shall in no way or wise release or relieve the party furnishing this indemnity of his obligation hereunder. The indemnifying member also covenants and agrees that the indemnity and hold harmless hereinabove granted shall not be limited, restricted, or in any way affected by the amount of insurance carried

by the indemnifying member. In any case of the assertion under this general indemnity paragraph of a right ot indemnity from members of CGA as a group, based on their membership in CGA, the obligation of indemnity shall be shared and borne by such members in the proportions of their cost participation percentages.

ARTICLE 11.

TERM

11.1 Term. This agreement shall remain in effect as to each party hereto for three years from the effective date hereof, and thereafter on a month to month basis until terminated; provided, any party may withdraw at anytime by furnishing written notice to the Executive Committee of its desire to withdraw. The withdrawing party shall cease to be a member on the date of receipt of such notice; provided, however, such party shall not be entitled to any refunds hereunder and shall remain obligated for all charges it previously incurred under this agreement, including its share of the reimbursement account for equipment and material purchased by contractor prior to such date under the Equipment and Material Agreement. If and when such party withdraws as a member of CGA, its interest in the Equipment and Material Agreement and Contractor's Agreement shall automatically vest in the remaining members of CGA.

ARTICLE 12.

EFFECTIVE DATE

12.1 Effective Date. This agreement is in lieu of and supersedes and supplants, effective January 1, 1976, the Clean Gulf Associates Oil Spill Contingency Agreement dated August 1, 1972, as heretofore amended; provided, that in the vent members constituting 75% of the composite participation in said August 1, 1972 agreement

shall have not signed thses articles or otherwise indicated in writing their agreement to these articles by August 1, 1976, these articles of agreement shall be null and void and the said August 1, 1972 agreement shall remain unaffected by these articles.

ARTICLE 13.

EXECUTION

13.1 Execution. Any now or hereafter eligible entity may become a party to this agreement by signing the original of this instrument, a counterpart hereof, or other instrument agreeing to become a party hereto. The signing of any such instrument shall have the same effect as if all parties had signed the same instrument.

IN WITNESS WHEREOF, this agreement is executed effective as of the date specified above.

SAPPHIRE EXPLORATION & PRODUCTION, INC.

ATTEST OR WITNESSES:

By _____
Title
John L. Taylor, Jr., President

8/23/85
Date of Approval

AMENDMENT NO. 2 TO
CLEAN GULF ASSOCIATES
OIL SPILL CONTINGENCY AGREEMENT
ESTABLISHING COST PARTICIPATION AREA 2

Pursuant to and in furtherance of motion, unanimously adopted July 31, 1974 at the Annual Meeting of the Board of Directors of Clean Gulf Associates, this agreement is the instrument whereby a new Cost Participation Area, to be designated Cost Participation Area 2, is established, effective July 1, 1974, and included in and made subject to the Clean Gulf Associates Oil Spill Contingency Agreement dated August 1, 1972, as amended.

It is agreed as follows:

I.

Cost Participation Area 2 shall consist of that portion of the Gulf of Mexico to the limits of the Outer Continental Shelf lying offshore and seaward of the coastlines of the States of Mississippi, Alabama and Florida and the bays, inside waters and estuaries adjacent to, or forming a part of, the Gulf of Mexico within said states, with the western boundary of said area being the eastern boundary of the Initial Cost Participation Area.

II.

Only persons signing this agreement or agreeing in writing to be bound by its terms shall enjoy the privileges, share the obligations and be members of Cost Participation Area 2. A member of this Cost Participation Area 2 need not necessarily be a member in the Initial Cost Participation Area or any other Cost Participation Area created under said Clean Gulf Associates Oil Spill Contingency Agreement.

III.

Cost Participation Area 2 shall be under the authority of the Board of Directors and the Executive Committee now established for Clean Gulf Associates. Additional representatives to the Board of Directors may be added according to procedures outlined in the Clean Gulf Associates Oil Spill Contingency Agreement.

IV.

All obligations, costs and expenses incurred for and in connection with Cost Participation Area 2 and all income, property and rights acquired hereunder shall be separately accounted for and shared by the members of this Cost Participation Area.

V.

An initiation fee of $5,000.00 shall be paid by any company desiring to be a member of this Cost Participation Area 2 who is not already a member of and in Clean Gulf Associates Initial Cost Participation Area.

VI.

Fifteen (15%) percent of cost participation in Cost Participation Area 2 shall be allocated among the members on a per capita basis.

Until production commences, the 85% factor of cost participation shall be based upon each Member Operator's pro rata share of the number of leased acres* operated, as amended annually, such 85% factor of cost participation to be assumed in part or in whole by those conducting drilling operations, as follows:

a. Each drilling rig shall be assessed a maximum of One Thousand Dollars ($1,000.00) per day or fraction thereof, for each day from time of

---

(*Certain leases within the three-league limit or between the shore line and the numbered OCS blocks are currently under litigation wherein drilling and production operations are not permitted. Until such time that the litigation is resolved and drilling operations are permitted, these leases shall be excluded from the percentage participation calculations.)

CLEAN GULF ASSOCIATES
Post Office Box 51239 New Orleans, Louisiana 70151

September 10, 1985

Mr. John L. Taylor, Jr.
Sapphire Exploration & Production, Inc.
1725 One Dallas Centre LB 10
Dallas, Texas 75201

Dear Mr. Taylor:

This letter is to acknowledge receipt of:

1. your check number 230 in the amount of $5,000, and

2. the duly executed copy of:

   Clean Gulf Associates Oil Spill Contingency Agreement Revised January 1, 1976, and

   Clean Gulf Associates Oil Spill Contingency Agreement Establishing Cost Participation in Area II and Area III.

As noted in my letter of August 14, 1985, Mr. W. M. Ayers of Halliburton will supply you with copies of Clean Gulf Associates Operations Manual upon receipt of the completed questionnaire. Because of past difficulties in locating Operations Manuals sent to member companies' consultants, our policy now is to send the manual to a representative of CGA's member only.

If I can be of further service, please advise.

Very truly yours,

Paul W. Schmidt
Chairman

cc: Mr. W. M. Ayers (Halliburton Services)
Mr. J. Gabert (Chevron)

SEP 16 1985

CLEAN GULF ASSOCIATES
Post Office Box 51239 New Orleans, Louisiana 70151

August 14, 1985

Mr. John Taylor
Sapphire Exploration
& Production, Inc.
1725 One Dallas Centre
Dallas, Texas 75201

Dear Mr. Taylor:

This letter is to acknowledge receipt of your August 7, 1985 letter requesting membership in Clean Gulf Associates. The qualifications for membership in Clean Gulf are as follows: "any party operating or contemplating operating oil and gas leases in the Area(s) of interest may be a member of CGA by payment of the initial fee of Five-Thousand Dollars ($5,000) and agreeing in writing to be bound by the terms of these articles of agreement." (Clean Gulf Associates Oil Spill Contingency Agreement, Revised January 1, 1976).

Enclosed for your execution are the following:

2 Copies - CGA Oil Spill Contingency Agreement, Revised January 1, 1976 (One executed copy to be returned)

1 Copy - CGA Manual Questionnaire (Copy to be returned to Mr. W. M. Ayers for shipment of your manuals)

Enclosed for your information and file are the following:

1 Copy - Contractors Agreement (CPA Areas I, II, and III)

1 Copy - Equipment and Material Agreement (CPA Areas I, II, and III)

1 Copy - Mailing List

1 Copy - Sample Halliburton Invoice

1 Copy - CGA General Information

It is necessary to return only one copy of the executed agreements. You are requested to name a member and alternate representative to CGA and provide the mailing addresses and telephone numbers of these individuals.

All correspondence and Operations Manuals will be mailed to the member representative you designate, so please advise when this designation changes.

If I can be of further service, please advise.

Sincerely,

Paul W. Schmidt
Chairman
Executive Committee

Attachments

cc: Mr. W. M. Ayers (Halliburton Services)
Mr. L. G. Porter (Exxon)
P. Beron, Jr. (Sapphire Exploration & Production, Inc.)
326 Oil & Gas Building
New Orleans, Louisiana 70112

TWX: 810-951-5328 CABLE: PETMAR

SHIP AND BARGE CLEANING
OIL SPILL CLEANUP AND HAZARDOUS MATERIALS REMOVAL
HELICOPTER AND AIRPLANE CHARTER

PETERSON MARITIME SERVICES, inc.

14101 Old Gentilly Road
New Orleans, La. 70129
(504) 254-3600

1110 Howard Drive
Deer Park, Texas 77536
(713) 479-5295

1660 South Beltline Hwy.
Mobile, Alabama 36609
(205) 666-3500

HAROLD J. PECUNIA
PRESIDENT

New Orleans
October 18, 1985

Sapphire Exploration & Production,Inc.
Suite 1725
One Dallas Center
Dallas, Texas 75201

Attention: Mr. John Taylor

Gentlemen:

This letter will serve as an agreement between Sapphire Exploration & Production, Inc. and Peterson Maritime Services, Inc. whereby Peterson will provide to Sapphire trained oil spill personnel, containment boom and various oil spill cleanup materials and equipment during Sapphire's drilling operations off Ship Island.

Rates charged for these services will be as per our letter of March 4, 1985 and our latest published rate schedule. Our current Certificate of Insurance made to Sapphire was fowarded to you in an earlier mailing.

We appreciate being given the opportunity to be of service to your organization.

Yours very truly,

James W. Latiolais
Executive Vice President

JWL/st

ACCEPTED & ACKNOWLEGED
SAPPHIRE EXPLORATION & PRODUCTION, INC.

RECEIVED
NOV 18 1985
STATE OIL & GAS BOARD

NOV 01 1985

Chevron U.S.A. Inc.
P.O. Box 6056, New Orleans, LA. 70174

March 1, 1988

Request for Variance
Mississippi Coastal Program Guidelines
Chapter 8, Section 2, Part III k.2.d.

Dr. Richard L. Leard, Bureau Director
Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560

Dear Dr. Leard:

The purpose of this letter is to summarize information previously provided in Chevron's Exploratory Evaluation Document and in meetings with the Bureau staff. This information should assist the Bureau staff in preparing a recommendation to justify approval of the subject variance by the Commission on Wildlife Conservation. Additional information was reviewed by the Committee which met in Long Beach on February 24.

Chevron's initial submittal of evaluation documents and applicable completed permit applications on March 6, 1987, included the variance request which was attached to the Joint Application and Notification (see Attachment "A"). One basis for approval of the variance included in our request and provided for in the Mississippi Coastal Program is "No feasible, alternative sites or construction techniques are available, there is a significant public benefit in the activity, and a public hearing has been held."

Each part of this basis for the variance will be examined separately.

o **No feasible alternative sites are available.**

The following summarizes the information presented to the Committee on February 24:

Chevron's Mississippi Sound leasehold is located 42 miles west of the nearest Norphlet gas production in Mobile Block 861 Field. There are no nearby wells which have penetrated the objective sand interval. As a result, the primary tool utilized to justify lease acquisition and select drilling locations is seismic data. Chevron acquired approximately 350 line miles of seismic data at a cost of $1.68 million in the Mississippi Sound 57 area. After a lengthy and thorough review of this data by our technical experts, the permitted site was chosen. This location was deemed to be in the most suitable location on our leasehold to evaluate the hydrocarbon potential of the area. In order to justify the $28 million cost to drill this 23,500' well, Chevron must drill the best interpreted location possible.

- **No feasible construction technologies are available.**

  It has been suggested that Chevron consider directional drilling as an option to avoid drilling within the confines of Buoy Reef. As addressed in our Exploratory Evaluation Document on pp. 79-80 (see Attachment "B"), directional drilling of this deep well which may encounter abnormally high pressures and temperatures is not a viable consideration. Directional drilling of five wells in Alabama state waters, with the Norphlet as an objective, encountered problems. The downhole environment anticipated while drilling in Mississippi Sound is much more severe.

  To summarize, increased mechanical risks, extreme temperatures anticipated, and the additional costs which would be experienced while directional drilling makes the only feasible option for this project — drilling a straight hole.

- **There is significant public benefit in the activity.**

  Quoting from the statement read on behalf of Chevron at the Public Hearing in Gulfport on February 24 — "Economic benefits to the people of Mississippi, in addition to bonuses already received ($6,620,000), will include sales and use taxes, and supplies purchased from businesses in coastal countries." Approximately one million dollars in sales and use taxes will be generated by this project for Mississippi and Harrison County (see Attachment "C").

  "In the event a discovery is made, significant economic benefit will be derived. Substantial revenues would be generated by producing operations through the payment of royalties, severance taxes, sales taxes and potential bonuses from future lease sales. Revenues received by the state from oil and gas development would be dedicated to the Mississippi Educational Trust Fund." Attachment "C" provides information on potential income to be derived from a producing well in Mississippi Sound. As it is difficult to predict the success of a high risk exploratory well, the ultimate results to be expected are even more difficult to predict. Potential revenues to Alabama from Norphlet gas production exceed three billion dollars — lease sale bonuses $800 million and potential revenue from gas production — $2.5 billion (based on 1987 dollars and 4.17 trillion cubic feet of reserves).

- **A public hearing has been held.**

  A public hearing was held to consider the variance request on February 24 in Gulfport.

Although the permitted location is within the confines of Buoy Reef, Dr. David Gettleson, Continental Shelf Associates, Inc., reviewed additional data at the meeting on February 24 which indicated the drilling rig will actually be located on muddy bottom and not hard substrate. Also it appears the actual size of the reef may not be as extensive to the West as portrayed because of the limitations of side scan sonar which is used to delineate changes in bottom density.

If any additional information is required to assist you in preparing findings and a recommendation for approval of our variance at the Commission on Wildlife Conservation meeting on March 10, please advise.

It is appropriate to end this letter with the same words which concluded Chevron's remarks at the Public Hearing — "It has been a pleasure working with the Bureau of Marine Resources staff, Commissioners and the Executive Director of the Department of Wildlife Conservation on this project. The approval of the variance and issuance of the permit will allow Chevron to proceed with drilling to help determine the potential for the recovery of valuable fossil hydrocarbon resources and at the same time provide appropriate protection to the valuable renewable marine-related resources."

Yours very truly,

M. S. Witten, Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

MSW:7/ESF&H/77
Attachments

cc: Commissioner Joseph W. Gex - w/Attachments
Commissioner David New, Jr. - w/Attachments

Chevron

Chevron U.S.A. Inc.
P. O. Box 6056 · New Orleans, LA. 70174

ATTACHMENT "A"

March 4, 1987

Request for Variance
Mississippi Coastal Program
Guidelines - Section 2, Part III.K.2

Dr. Richard L. Leard
Bureau Director
Bureau of Marine Resources
P. O. Drawer 959
Long Beach, MS 39560

Attention Mr. Gary Cuevas

Gentlemen:

This letter pertains to Chevron's Mississippi Lease Number S.L. 3470 and Lease Block 57 within the Mississippi Sound leased area.

Based upon the provisions of the Mississippi Coastal Program, we have found that our desired operations in Lease Block 57 conflict with the following guidelines of Section 2, Part III.K.2. (Revisions effective May 1, 1986.)

d. Sitting within one mile of an oyster reef.

Chevron U.S.A. Inc. hereby requests that a variance be granted by the Commission of Wildlife Conservation for this and any other guidelines found to be in conflict, based on the fact that the impacts on coastal wetlands would be no worse than if the guidelines were followed. The oyster reef in question is, at present, non-productive, however, the reef has been productive in the past and the bottom subtrate is suitable for oyster production. During the conduct of operations within Block 57, no toxic material will be discharged. In addition to the fact that the reefs are non-productive, we believe that the environmental assessment included in the Exploratory Evaluation Document would substantiate the justification of this variance request.

It should also be noted that the site location chosen by Chevron is the most practical, with alternative sites and construction techniques being technologically and economically infeasible. There is a significant public interest in this project at both the state and federal levels since the objective of this project is to aid in the recovery

of valuable fossil hydrocarbon resources and at the same time provide appropriate protection of the valuable renewable marine-related resources.

Should you have any questions regarding this submission, please contact Ms. Sandy Bergeron of this office at (504)364-2242.

Thank you for your consideration in this matter.

Very truly yours,

M. S. Witten

M. S. Witten
Coordinator
Environment, Safety, Fire & Health
Eastern Production Division

SMB

6ESF&H2/595

VII. Alternatives to the Proposed Actions

The following information addresses the drilling alternative that was considered during formulation of the proposed action described in Section III - Description of the Proposed Actions. Three alternate methods of storing wastes at the rig site and transporting the wastes to disposal sites were also deliberated.

A. Directional drilling alternative

Consideration was given to directionally drilling the proposed well, but while this is an alternative, it is not truly a viable alternative. Chevron, U.S.A. investigated well paths with kicks of 1000 - 6000' from vertical. If one were absolutely required, for instance, for kill operations, a departure of 2500 - 3000' would be more desirable. Lesser departures require deep kickoffs in very firm rock at elevated temperatures and in smaller hole sizes where directional control becomes more difficult to maintain. Longer departures require higher hole angles with the attendant increase in the amount of hole to be drilled.

There are several things which in general make the drilling of directional wells to this deep of an objective a less than desirable means of reaching total depth. These are as follows and are not necessarily ranked in order of importance:

1. Increased mechanical risks

Torque and drag will increase significantly in the directional hole due to hole contact between the wellbore and the drill string. This can be predicted through computer programs, which give a general view of the relative values of torque and drag for various well path scenarios. These values can become sufficiently high to actually stall out the rotary or cause drill string failures due to twistoffs, thereby resulting in fishing jobs. Additional mechanical risks such as sticking of the drillstring, keyseating of the drill string, etc., are also increased in a deviated wellbore. Deep fishing jobs can become quite involved and are necessarity more expensive in nature.

Drill string contact with casing set in deviated wellbores can cause a significant increase in the amount of internal wear in the casing. This wear is generally related to the time spent rotating and tripping in the string, which is increased in a directional well because

of the additional hole drilled and time spent making direction and angle corrections. The wear in the casing reduces its overall strength, which can result in having to set an additional string prematurely in order to maintain the internal strengths necessary to handle anticipated well pressures. The anticipated pressure regimes to be penetrated in this well are such that the possibility exists that the objective depth might not be reached if any of the casing strings had to be set early. The currently proposed casing strings are set up to allow for proper pressure handling, with a wellbore size that allows for equipment selection that is readily available.

2. Temperature problems

The extreme temperatures that are anticipated to be encountered in this well (425°F+) greatly reduce the equipment selection necessary to drill in the directional portion of the well. Tools such as surveying instruments, drilling motors, steering tools, measurements while drilling (MWD), etc. are not designed to operate effectively in this type environment. Surveying tools can be protected by heat shields, but the hole sizes in the lower section of the wellbore might preclude their use due to the larger outer diameter requirements to accommodate the heat shields. At best, tool selection will be limited.

3. Additional costs

The drilling of this well directionally will greatly increase the overall costs of the project due to the increased amount of hole that has to be drilled which adds the time spent drilling, additional casing necessary, etc. It is estimated that the overall costs of drilling the well will be increased by a minimum of 40%, but could run much higher when one considers the attendant mechanical risks. The additional cost of directionally drilling the well could result in making this a noneconomic venture.

B. Marine vessel alternatives

1. Anchor barge and hopper barge (see Figure 2, Section XIII, Appendix B)

The anchor barge is primarily a fluid storage facility with a transfer pump package on board. All gray water (dirty deck drainage, sinks, showers) and black water (treated sewage effluent) would be stored on this barge for transfer to supply boats for transportation to shore. A third tank on the anchor barge would be used for waste mud and sluice

ATTACHMENT "C"

ECONOMIC BENEFITS

POTENTIAL ECONOMIC BENEFITS FROM DRILLING ONE WELL:

- State sales and use tax on value of drilling rig

  Estimated to be $ 100,000

- State and local sales and use taxes on tubulars, mud materials ($6,000,000)

  State tax (6%) $ 360,000
  Harrison county tax (2%) $ 120,000

- Mississippi gross receipts tax on all related services (3½%)

  Estimated to be $ 500,000

POTENTIAL ECONOMIC BENEFITS OF ONE PRODUCING GAS WELL IN MISSISSIPPI WATERS:

- One well, producing 15 million cubic feet a day (15 MMCF @ $2.00 MCF = $30,000 a day gross revenues), would amount to $10,950,000 in Annual Gross Revenues.
- State receives $2,190,000 in royalties from one well (20% royalty).
- State receives $525,600 in severance tax revenues (6% of net value).
- The state benefits from the exploration and development expenditures in sales taxes, income taxes, and benefits to local (ie., coast counties) economics.
- Additionally, the state via all the multiplier effects in the state's economy and local economies, benefits from the production revenues and production expenditures.
- The coast counties would obviously be the major benefactor of offshore production in terms of jobs, payrolls, etc.

7/ESF&H/77

DRILLING PROGRAM

TYPE WELL: 1. EXPLORATORY
2. STRAIGHT HOLE

WELL NAME: MS Sound Blk 57 Unit; State of MS #1 BLOCK: MS Sound Blk 57
CONTRACTOR: TRANSWORLD RIG: TRANSWORLD 70
SURFACE LOCATION: 8450'FNL & 7650' FWL OF MS. SOUND BLK 57; X=391,970 Y=213,310
WATER DEPTH: 14 FT. ELEVATION-KB TO MWL: 148 FT. TOTAL MEASURED DEPTH 23500FT.

	OBJECTIVES		TOLERANCE					
TARGETS	SAND	DIST.OUT / DIR.(GRID)	TVD	IN	OUT	LEFT	RIGHT	KOP: N/A FT.
#1	NORPHLET	STRAIGHT HOLE	23500	100	100	100	100	BUILD RATE N/A
								ANGLE UP N/A FT.
								AVERAGE ANGLE N/A DEG.
								DOUBLE DOGLEG- NO

CASING PROGRAM

DRIVE PIPE: 36 " WITH MINIMUM OF 125' PENETRATION

	HOLE SIZE	DEPTH MD/TVD	CSG SIZE	CMT: CLASS 'H' TO FILL THESE THEORETICAL VOLUMES:	SHOE TEST
CONDUCTOR	20"/32"	1000'	26"	2280 cu ft (20% washout)	MWE
					LEAKOFF
SURFACE	17-1/2"/ 24"	7500'	20"	8622 cu ft (20% washout)	LEAKOFF
PROTECTIVE	17-1/2"	16500'	14"/13-5/8"	TO BE DETERMINED (caliper)	LEAKOFF
PROTECTIVE	12-1/4"	21500'	10-3/4"/ 9-5/8"	TO BE DETERMINED (caliper)	LEAKOFF
PRODUCTION LINER	8-1/2"	23500'	7-5/8"	TO BE DETERMINED (caliper)	LEAKOFF

Note: All zones which contain oil, gas, or fresh water shall be fully protected by casing and cement.

BLOWOUT PREVENTERS

	NUMBER-TYPE	SIZE	RATING	TEST PRESSURE	DRILLING BHA D.PIPE	HWDP	DRILL COLLARS	STRING STAB	JARS
COND.HOLE	DIVERTER	30"	1M	200PSI	5"	18JTS	11"	AS REQ	
SURF.HOLE	DIVERTER	30"	1M	300PSI	5"	18JTS	11"	AS REQ	NO
BELOW:									
20" CSG	1-ANNULAR	21-1/4"	5M	250/3500	5-1/2"	18JTS	11"	AS REQ	NO
	3-RAMS	21-1/4"	5M	250/5000					
14"/13-5/8"	1-ANNULAR	13-5/8"	5M	250/3500	5"	18JTS	9"	AS REQ	NO
	3-RAMS	13-5/8"	10M	250/10000					
10-3/4"/ 9-5/8"	1-ANNULAR	11"	10M	250/7000	5"	18JTS	7"	AS REQ	NO
	4-RAMS	11"	15M	250/15000					

OTHER SERVICES START MUD LOGGING @ BSC ; GAS DETECTOR @ SPUD ; PVT & FLOW METER @ SPUD ;
ADJ.CHOKE @ SPUD ; CENTRIFUGE @ SPUD ; DEGASSER @ SPUD ; DRLG. RECORDER @ SPUD ;
DESILTER @ SPUD ; MUD CLEANERS@ SPUD ; TV MONITOR @ N/A ; TRIP TANK @ SPUD

MUD PROGRAM- BREAKOVER TO NON-DISPERSED MUD SYSTEM @ SPUD
BREAKOVER TO DISPERSED WATER-BASED MUD SYSTEM @ 16500'

DEPTH	WEIGHT	VIS.	WL		DEPTH	WEIGHT	VIS.	WL		DEPTH	WEIGHT	VIS.	WL	
1000'	9.0				16500'	11.0				23500'	17.5		8-10	
7500'	9.0				18000'	15.6								
10000'	9.5				21500'	16.0								

LOGGING PROGRAM COMPANY SCHLUMBERGER

ELEC. LINE LOGS PLANNED AT THE FOLLOWING DEPTHS:
SURFACE, PROTECTIVE, AND LINER SETTING DEPTH

RUN 1" SCALE ON ELECTRIC LOG SURVEY WHILE GIH.
REFER TO GEOLOGICAL LETTER FOR TYPE OF LOGS TO RUN.
GEOLOGIST ASSIGNED:
WELL CLASSIFICATION: RESTRICTED

Formation tops:(Estimated from seismic)

Het	5200'
Upper Cretaceous	8400'
Lower Cretaceous	10400'
Cotton Valley	18100'
Norphlet	23000'

SPECIAL REMARKS

1. CK.DRLG.BREAKS FOR FLOW BELOW 7500'
2. HAVE DRLR. INITIAL PVT EVERY 30 MINS. BELOW 7500 '. EXP.ANY LEVEL CHANGES.
3. FILL DP EACH 20 STANDS WHEN RUNNING FLOAT.
4. IMPLEMENT HYDROGEN SULFIDE CONTINGENCY PLAN AT 16500'.
5. USE TRANSWORLD 10M psi CHOKE MANIFOLD TO 16,500', RENTAL 15M psi MANIFOLD THEREAFTER.

PREPARED BY: W.M.WILLIAMS/A.T.RAWICKI DATE: 8-20-88 APPROVED BY:

DRILLING PROGRAM
GENERAL REMARKS (PAGE 2)

A. BLOWOUT PREVENTION

1. Applicable Federal and State regulations will be adhered to during the drilling of this well.
2. Test BOPs at low pressure (200-300 psi) and at high pressure above before drilling out, and at least every seven (7) days thereafter. Each test and pressure will be noted in Tour Report. Blind rams need only be tested before drilling out. Choke manifold need only be tested to high pressures. Work all pipe rams daily, blind rams each trip and annular preventer weekly. On subsea stacks, pipe rams need only be operated every other day, blind and annular same as surface stacks. Complete closure of rams is not required.
3 Hold pit drills for each crew at least every seven (7) days. Record results on Tour Reports and Morning Reports.
4. Tighten wellhead and BOP bolts weekly and record on Tour Report.
5. Do not reuse ring gaskets. Replace them with new ring gaskets.
6. Prior to drilling out, all casing, except drive or structural, will be tested as per pages 7 & 8 of this drilling program. Record on Tour Report.
7. Separate full opening safety valves and inside BOPs are required for each size drill pipe in use; test weekly with BOPs.
8. Run full opening valve below the kelly of a size that can be run in hole if necessary.
9. The maximum casing pressure which can be used during well killing operations is to be posted near the driller.
10. Use drill pipe floats at all times. Check with your supervisor before leaving a float out, if such becomes necessary.
11. Prior to spud, be sure all toolpushers, drillers and crews are thoroughly familiar with and understand Chevron procedures for handling well kicks and possible blowouts. A list of personnel on board the rig who have completed approved well control courses must be maintained. The list will show names, job titles, specific training, names and dates of courses completed.
12. Before a trip, mud shall be properly conditioned by circulating bottoms up, or if circulating is not considered necessary, document the Tour Report as required in 30 CFR Part 250.60.
13. On trips, the annulus shall be filled before the change in the mud level decreases the hydrostatic pressure 75 psi or every 5 stands of drill pipe, whichever gives a lower decrease in hydrostatic pressure. Post the number of stands of drill pipe and drill collars to be pulled and the equivalent fill-up requirements. Driller will constantly observe PVT and trip tank volume to ensure safe hole conditions. A trip book showing amount pulled and fill-up required will be maintained.
14. Have mud logger keep continuous record of amounts used to fill hole on trips.

B. DRILLING

1. When necessary to work pipe, keep pipe moving up and down. Rotating alone is not considered sufficient.
2. While drilling, use steel rotary hose or 7500 psi test rubber hose.
3. Describe fully, damaged or lost equipment on Tour Reports.
4. Maintain sufficient pipe lax and oil-faze to cover the BHA three times. Keep 5 lb/bbl each of fine mica and fine hulls on location at all times.

C CEMENTING

1. Have test run on all cement used in well.
2. Record on Tour and Morning Report number of hours circulating and conditioning mud prior to pumping cement on all casing strings.
3. Record on Tour and Morning Report if pipe was reciprocated and rotated during cement job.

D. POLLUTION PREVENTION AND CONTROL

1. Pollution and waste disposal in drilling operations shall follow guidelines spelled out in 30 CFR Part 250.40.

I. Well Control

A. Well control procedure while drilling below protective casing and during completion operations.

At first indication of a kick the Driller will:

1. Sound the alarm.

2. Pull the kelly out of the preventers and spot tool joint while stopping pumps.

3. Close the annular preventer and make certain well is shut in. If the casing pressure exceeds 2500 psi at shut in or during any part of the well control operation, a pipe ram will be closed and used to control well pressure. This action will ensure that the pressure below an annular preventer will never exceed 3500 psi.

The kick will be circulated out using the Engineer's Method (wait and weight method) whenever possible.

B. Well control procedures while tripping in protective casing or during completion operations.

At the first indication the well is flowing the Driller will:

1. Sound the alarm.

2. Install a full opening safety valve in the open position and spot the tool joint clear of the BOP sealing elements.

3. Close the annular preventer and safety valve, and make certain the well is shut in.

Appropriate action to kill the well depends on surface pressure, depth of bit, and size of influx. However, if the casing pressure should exceed 2500 psi at any time during the well control operation, a pipe ram will be closed and used to control the well pressure.

MAXIMUM ANTICIPATED SURFACE PRESSURES

Attachment to Drilling Program - Page 4

Well Name:MS SOUND BLK 57 UNIT; STATE OF MS #1 Field: MISSISSIPPI SOUND BLK 57

Maximum MW at 1st casing pt. 9.0 ppg

	COND	SURF	PROT	PROT	PROD
A. Casing (in.)	26	20	14	10-3/4	7-5/8
B. Setting Depth (TVD ft.)	1000	7500	16500	21500	23500
C. Depth to Next Casing (TVD ft.)	7500	16500	21500	23500	23500
D. Maximum Mud Weight (ppg)	9.0	11.0	16.0	17.5	17.5
E. Maximum Formation Pressure (ppg)	8.5	10.5	15.5	17.0	17.0
F. Maximum Formation Pressure (psi)	3315	9009	17329	20774	20774
G. Surface Press. Neglecting Shoe(psi)	1659	4516	9329	11327	11327
H. Fracture Pressure at Shoe (ppg)	9.5	12.5	16.5	18.5	18.5
I. Fracture Gradient at Shoe (psi/ft)	0.494	0.650	0.858	0.962	0.962
J. Fracture Pressure at Shoe (psi)	494	4875	14157	20683	22607
K. Surface Pressure when Shoe Breaks Down (psi)	397	3956	11811	17501	19129
L. Average Gas Gradient (psi/ft)	0.097	0.122	0.142	0.148	0.148
M. MAXIMUM ANTICIPATED SURFACE PRESSURE (psi)	397	3956	9329	11327	11327

Where: Example calculations are for the surface casing string.

D. From Offset Wells = 11.0 ppg

E. Assume 0.5 ppg less than Maximum Mud Weight = 10.5 ppg

F. (C)(E)(0.052) = 16500 * 10.5 * 0.052 = 9009 psi

G. F - (0.052*D*1/3C)-(2/3C*AGG)= 9009 - 3146 - 1347 = 4516

NOTE: AGG= Average Gas Gradient, See Step 'L'

H. Fracture gradient based on offset wells

I. (H)(0.052) = 12.5 * 0.052 = 0.650 psi/ft

J. (I)(B) = 0.650 * 7500 = 4875 psi

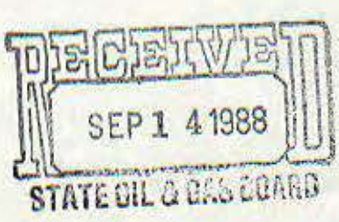
K. J-(L*B)

4875.0 - 919 = 3956 psi

L. AGG =(C1 * Pore Psi (EMW)) + (C2 * SG) -(C3/TVD)
where C1=0.0032, C2=0.161, C3=260 and SG (gas spec.gr.) =0.65

AGG= 0.122 psi/ft

M. Lesser of G or K = 3956 psi



MS Sound Blk 57 Unit; State of MS #1
Mississippi Sound Blk 57

7-5/8" Production Tieback (into 7-5/8" liner)

MASP = Formation Pressure - Gas Gradient x True Vertical Depth
MASP = 20774 psi - 0.148 psi/ft x 23,500 ft
MASP = 17,296 psi

where:
Formation Pressure is from MASP page 1

Gas Gradient is calculated to be 0.148 psi/ft, using an assumed specific gravity of 0.65 (approximately that of an 80/20 mixture of methane and ethane.) See below:

Average Gas Gradient =(C1 * pore psi (EMW)) + (C2 * 0.65) - (C3/TVD);

where C1=0.0032, C2=0.161, and C3 = 260; all empirical coefficients established by Young/Nagy in the guiding Chevron U.S.A. publication on the subject.

CASING DESIGN FACTORS

Attachment to Drilling Program - Page 6

WELL :MS Sound Blk 57 Unit; State of MS #1 FIELD :MS Sound Blk 57

RIG :Transworld 70 DATE :8/28/88

CASING SIZE (in)	26	20	14	13-5/8	10-3/4	9-5/8	7-5/8
DEPTH (ft)	1000	7500	10,000	16,500	10,000	21,500	23,500
WEIGHT (lb/ft)	205	133	109	88.2	109	53.5	59.2
GRADE	X-52	KO-80	MW-95SS	NT-125HS	MW-95SS	NT-125HS	Q-125
COUPLING	DQ H-60	GB-3P	HPC-8	NSCC	CMUST	NSCC-RS	NJO
WALL THICKNESS (in)	0.75	0.635	0.77	0.625	1.040	0.545	0.812
I.D. (in)	24.50	18.73	12.46	12.375	8.670	8.535	6.001
DRIFT (in)	coupling 24.25	18.542	12.25	12.25	8.50	8.50	6.876
BURST (psi)	2625	5253	11199	10030	19979	12390	23300
COLLAPSE (psi)	1000	2500	6860	5950	16600	10590	23790
TENSION PIPE (kips)	3093	3091	3040	3191	3014	1943	2172
TENSION COUPLING (kips)	4140	2877	3192	2300	2226	1890	1058
MASP (psi)	397	3956	9329	6069	11327	4966	17296
DSN FACTOR BURST	6.61	1.32	1.20	2.37	1.76	1.33	1.34
DSN FACTOR COLLAPSE	2.14	0.71	1.20	0.72	2.00	0.81	1.51
DSN FACTOR PIPE YIELD	17.5	3.58	2.20	6.69	2.35	4.19	24.5
DSN FACTOR COUPLING YIELD	23.4	3.34	1.62	4.82	1.73	4.08	18.6

MASP entries for strings that are not run to surface are the maximum anticipated differential pressures in that string.

Collapse load for production liner assumes abandonment pressure of 5000 psi.

PREPARED BY: A. T. Rawicki

CASING TEST PRESSURES

Attachment to Drilling Program - Page 7

Well Name: MS SOUND BLK 57 UNIT; STATE OF MS #1

Field: MISSISSIPPI SOUND BLK 57

A. Casing (in.)	26	20	14	13-5/8
B. Setting Depth (TVD ft.)	1000	7500	10000	16500
C. Mud Weight when Casing Set (ppg)	9	9	11	11
D. Depth to Next Casing (TVD ft.)	7500	16500	21500	21500
E. Maximum Mud Weight (ppg)	9.0	11.0	16.0	16.0
F. Maximum Formation Pressure (ppg)	8.5	10.5	15.5	15.5
G. Fracture Gradient at Shoe (psi/ft)	0.494	0.650	N/A	0.858
H. Casing Burst Pressure (psi)	2625	5253	11199	10030
I. 70% Casing Burst Pressure (psi)	1838	3677	7839	7021
J. 70% Burst - (MW/Form) Differential	1817	3521	6591	4962
K. Maximum Anticipated Differential in section (psi)	397	3956	9329	6069
L. Proposed Casing Test Pressure (psi)	400	3500	6500*	4900

E. From Offset Wells.

F. Assume 0.5 ppg less than Maximum Mud Weight

G. From MASP.

J. I - ((C - 8.6ppg) (B * 0.052))

K. MASP in all cases except 13-5/8", where K= MASP plus the gas gradient, minus the hydrostatic head behind csg at the top of the section (use 9.0ppg back-up at 10,000')

L. Proposed test pressures are based on the lesser of Lines 'J' or 'K'.

* NOTE THAT THE 14" AND 13-5/8" ARE TO BE RUN AS A SINGLE STRING, WITH 10,000' OF 14" ABOVE 6,500' OF 13-5/8". TEST FOR THIS TAPERED STRING SHOULD NOT EXCEED THE CASE 'L' PRESSURE OF THE WEAKER MEMBER.

CASING TEST PRESSURES

Attachment to Drilling Program - Page 8

Well Name: MS SOUND BLK 57 UNIT; STATE OF MS #1

Field: MISSISSIPPI SOUND BLK 57

A. Casing (in.)	10-3/4	9-5/8	7-5/8	
B. Setting Depth (TVD ft.)	10000	21500	23500	
C. Mud Weight when Casing Set (ppg)	16	16	17.5	
D. Depth to Next Casing (TVD ft.)	23000	23000	23500	
E. Maximum Mud Weight (ppg)	17.5	17.5	17.5	
F. Maximum Formation Pressure (ppg)	17	17	17	
G. Fracture Gradient at Shoe (psi/ft)	N/A	0.962	0.962	
H. Casing Burst Pressure (psi)	19979	12390	23300	
I. 70% Casing Burst Pressure (psi)	13985	8673	16310	
J. 70% Burst - (MW/Form) Differential	13985	3993	14477	
K. Maximum Anticipated Differential in section (psi)	11327	4966	17296	
L. Proposed Casing Test Pressure (psi)	11300*	4300	14400	

E,F, and G, as per page 1

J. I - ((C - 16.0ppg) (B * 0.052)), for 10-3/4"
I - ((C - 11.0ppg) (18,000' * 0.052)), for 9-5/8"
I - ((C - 16.0ppg) (B * 0.052)), for 7-5/8"

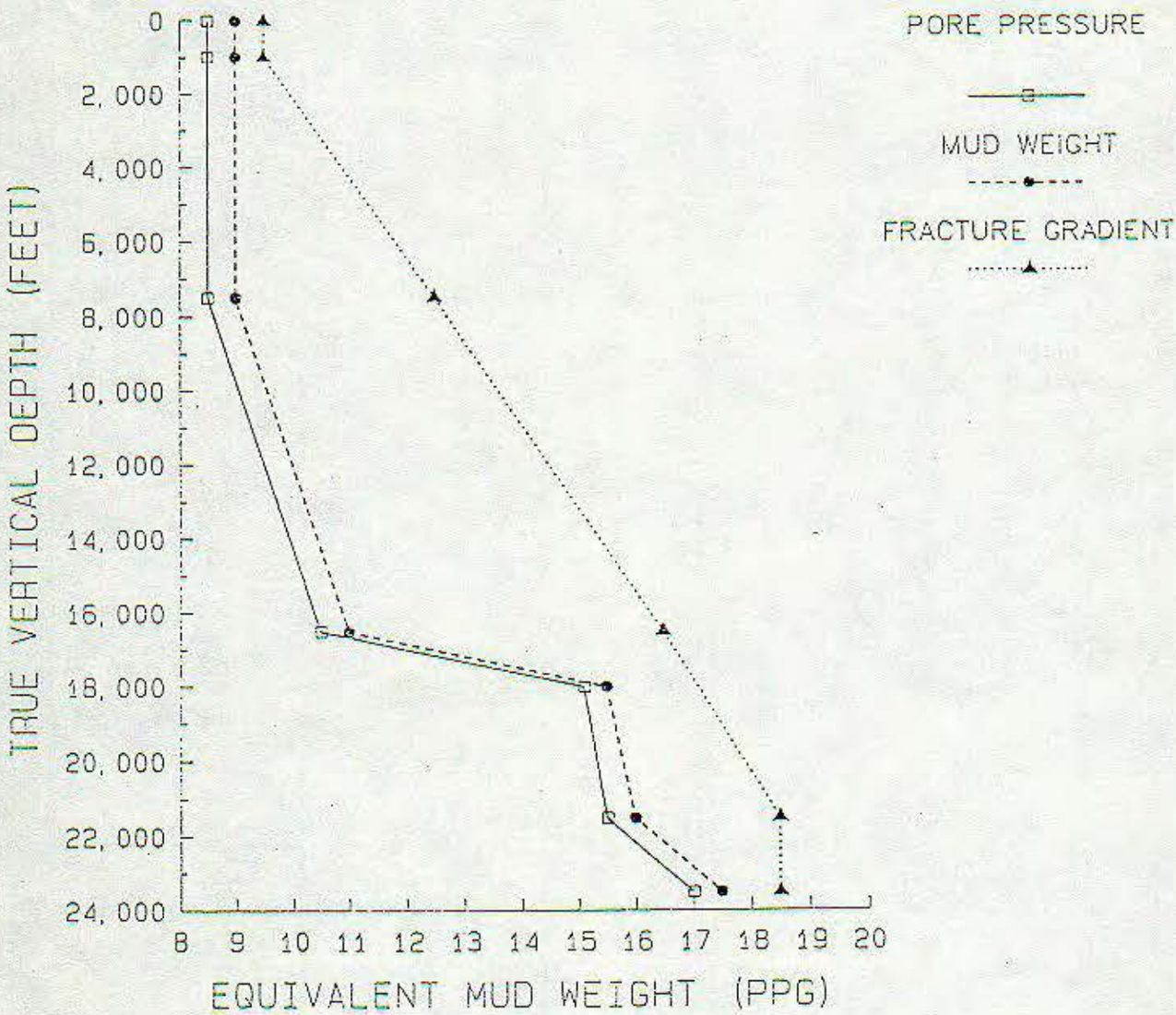
K. MASP for 10-3/4" and 7-5/8". MASP minus worst case differential for 9-5/8", that being at 16,500' w/11 ppg back-up and 2/3 void inside.

L. Proposed test pressures based on lesser of lines 'J' or 'K', except in the case of the 9-5/8" string, where this value would be slightly less than the 0.2 psi/ft required by the State. We propose to test this string to the specified 0.2 psi/ft, or 4300 psi

*NOTE THAT THE 10-3/4" AND 9-5/8" ARE TO BE RUN AS A SINGLE STRING, WITH 10,000' OF 10-3/4" ABOVE 11,500' OF 9-5/8". TEST FOR THIS TAPERED STRING SHOULD NOT EXCEED THE CASE 'L' PRESSURE OF THE WEAKER MEMBER.

THE 7-5/8" PRODUCTION LINER WILL HAVE ITS TOP @ +/- 21,000'

MS Sound Blk 57 Unit; State of MS #1



DIVERTER SYSTEM FOR CONDUCTOR AND SURFACE HOLES
Attachment to Drilling Program - Page 10

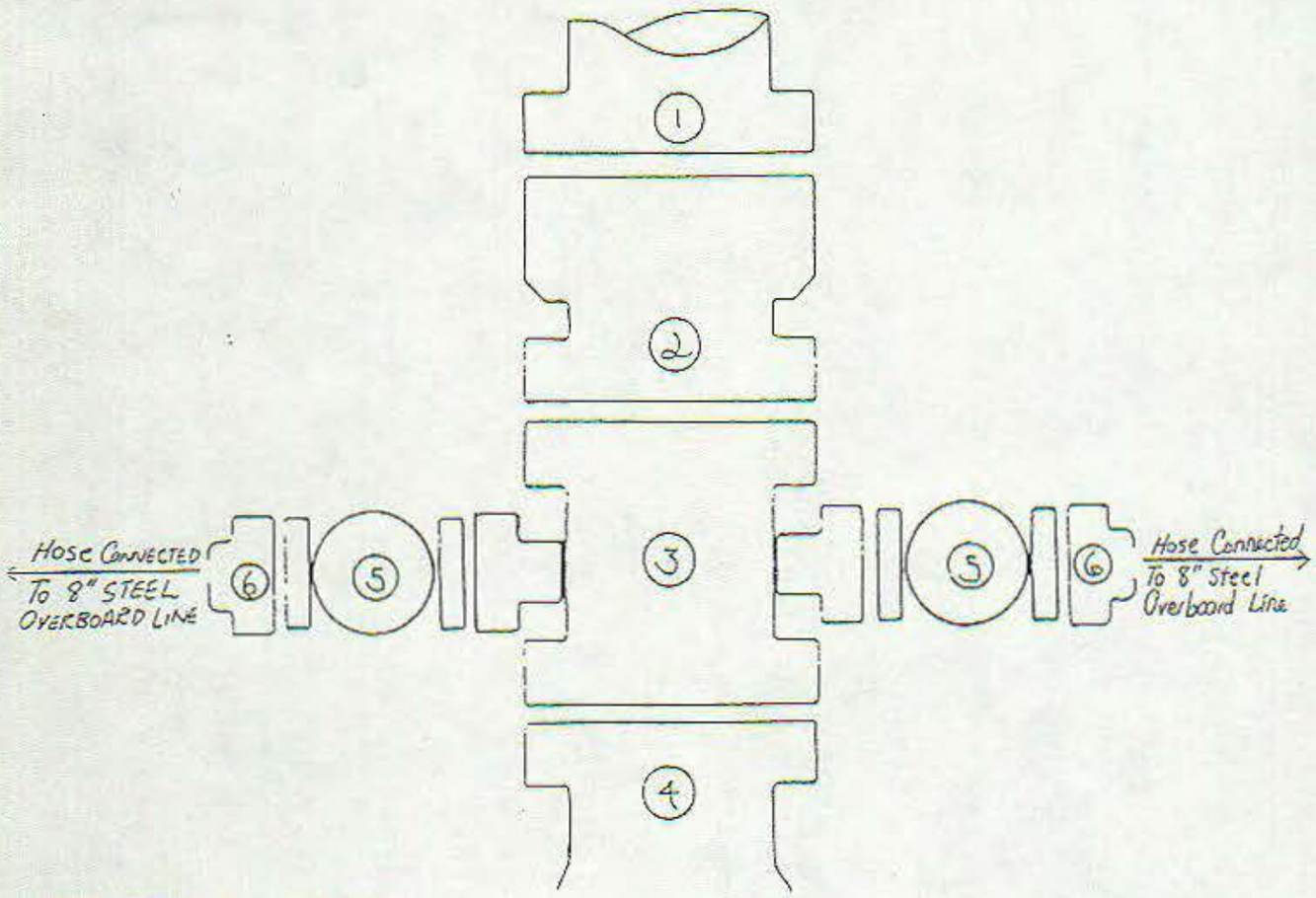
MS Sound Blk 57 Unit; State of MS #1
Mississippi Sound Block 57
Rig: Transworld 70

Attached is a sketch of the diverter system Chevron U. S. A. Inc. proposes to use on subject well.

After installation on the drive pipe and with drill pipe in the hole, the system will be function tested and pressure tested to 300 psi. The pressure test will be performed by blanking the two ends of the diverter lines closed and actuating the system. The annular preventer and both valves will be opened and closed independently to insure proper operation and all lines pumped through to insure they are not plugged. The two 8" overboard valves are rigged-up so that both valves will automatically open when the accumulator handle for the annular preventer is moved to the "closed" position. This will allow closure of the annular preventer without breaking down the formation. A two-way hydraulic selector valve will be utilized to override the overboard valves and close one overboard valve so that downwind dispersion is maintained.

DIVERTER SKETCH (Example)

Attachment to Drilling Program -- Page 11



LEGEND	QUANTITY	DESCRIPTION
1	1	Bell Nipple Flange, 30" 1,000# with 6' of Pipe Welded on
2	1	Annular Blowout Preventer, 30" 1,000# Hydril Type "MSP".
3	1	Drilling Spool, 30" 1,000# Flanged with (2) 8" 2,000# Flanged Outlets.
4	1	Drilling Swage, 30" 1,000# Flange x Drive Pipe
5	2	Ball Valves, 2,000# Flanged Hydraulic Operated.
6	2	Companion Flanges, 8" 2,000# x 8" Weld Neck.

MS Sound Blk 57 Unit; State of MS #1
MS Sound Blk 57

MINIMUM MUD QUANTITIES (sacks)

CHEMICAL	SURFACE HOLE	BELOW SURFACE HOLE
Barite	500	500
Gel	50	50
Caustic	25	25
Chrome lignosulfonate	--	25
Lignite	--	25
Lost Circulation Material	25	25

DRILLING MUD COMPONENTS

The drilling mud program will contain some or all of the following:

Fresh Water
Bentonite
Barite
Caustic Soda
Lignite
Chrome Lignosulfonate
Detergent
Ground Nut Hulls/Mica
Lime/Gypsum
Polyacrylate
Polyacrylamide
Polysaccaride
Pregelatinized Starch
Xanthum Gum

CERTIFICATE OF COMPLIANCE FOR HYDROGEN SULFIDE OPERATIONS

(File in triplicate)

NEW ☒ AMENDED ☐ ANNUAL ☐

NAME OF COMPANY OR OPERATOR: Chevron U.S.A. Inc.

DATE: September 8, 1988

Address: P. O. Box 6056 City: New Orleans State: LA

DESCRIPTION OF WELL/OPERATION

Name of well/Operation	Well number	Operation Type
MS Sound Blk. 57 Unit; State of MS #1	State of MS #1	Drilling

Well location (give footage from section lines): 8450' FNL & 7650' FWL of MS Sound Blk. 57

Section — township — range or block & survey: MS Sound Blk. 57 X = 391,970 Y = 213,310

Field & reservoir (if wildcat, so state): Wildcat; Norphlet objective

County: Harrison

Hydrogen Sulfide Source (reservoir/formation): Cotton Valley through Norphlet Sandstones

Hydrogen Sulfide Content (Mole fraction): Unknown

Maximum Escape Volume	Radius of Exposure (ROE)	Distance from Proposed Location to nearest Public Area
Unknown SCF/DAY	2640 feet	28,300 feet

RULE REQUIREMENTS

For the above described operation, the following requirements (paragraphs) are applicable and have been or will be implemented in accordance with Rule 66.

- ☒ Safety Program (3)
- ☒ Equip. & Mat. (4)
- ☒ Warning Systems (5)
  - ☒ Warn. Signs (5a)
  - ☒ Mon. & Alarms (5b)
  - ☒ Wind Direction Equip. (5c)
  - ☒ Danger Signals (5d)
- ☒ Training Requirements (6)
- ☒ Personnel Safety Equip. (7)
- ☒ Contingency Plan (8)

AMENDED CERTIFICATE

Reason(s): ☐ Operation modification ☐ Public Infringement ☐ ROE change ☐ Requirement change ☐ Other

Explain:

Contingency Plan
Previously required: ☐ Yes ☒ No — If yes, date approved by Oil & Gas Board: _____
Amendments required: ☐ Yes ☒ No — If yes, amendments attached ☐ Yes ☐ No

Person to contact regarding this certificate: Andrew T. Rawicki Phone Number: (504) 364-2080

Remarks: ROE assumed to be one-half mile (insufficient data exist for a Pasquill-Gifford calculation.)

Hydrogen sulfide contingency plan currently under Chevron review.

RECEIVED
SEP 14 1988
MISSISSIPPI OIL & GAS BOARD

The undersigned certifies that the above operator has compiled, or will comply, with all applicable requirements of the Rules and Regulations of the Mississippi Oil and Gas Board and the undersigned further certifies that the conservation laws of the State of Mississippi and all rules, regulations, and orders of the Board have been compiled with in respect to the area covered by this certificate.

Executed this the 13 day of Sept, 19 88

State of Louisiana

County of Orleans

M. S. Witte
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared M.S. Witten known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 13 day of September, 19 88

SEAL

My commission expires death

Stephen Patrick
Notary Public in and for Orleans
County, Louisiana

FOR OIL & GAS BOARD USE ONLY

Permit Number: _____

Approval Date: 9.20.88

Approved By: lm

Notice: Before sending in this form be sure that you have given all information requested

MISSISSIPPI STATE OIL & GAS BOARD

Form No. 19

A. P. I. Well Number

State County Well

Authorized by Order 24-86 Effective 1/15/1986

APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

AMENDED

APPLICATION TO DRILL X WORKOVER ☐ CHANGE OPERATOR ☐

NAME OF COMPANY OR OPERATOR				DATE
Chevron U.S.A. Inc.				October 2, 1989
ADDRESS	**CITY**	**STATE**	**ZIP**	**TELEPHONE**
P. O. Box 6056	New Orleans	LA	70174	504-364-2024

NAME OF WELL	WELL NUMBER	ELEVATION (GROUND)	CHECK THE TYPE OF PROPOSED WELL
MS Sound Blk. 57 Unit; State of MS #1	#1	-14'	OIL ☐ GAS X

WELL LOCATION (WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES)
8389.18' FNL & 7691.77' FWL of
Mississippi Sound Block 57 SECTION ____ T. ____ R. ____ OTHER (NAME) ____

FIELD & RESERVOIR (IF WILDCAT, SO STATE)	COUNTY	APPROXIMATE DATE WORK WILL START
Wildcat; Norphlet Objective		

PROPOSED DEPTH	PROPOSED LENGTH OF SURFACE CASING	NUMBER OF ACRES IN DRILLING UNIT	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING UNIT LINE	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL
24,500 FEET	7500 FEET	28,953	7650 FEET	+/- 93,000 FEET

NAME OF DRILLING CONTRACTOR Transworld Drilling Company

ADDRESS 100 Petroleum Drive CITY Lafayette STATE LA 70508

FOR CHANGE OF OPERATOR ONLY
SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL

AUTHORIZED REPRESENTATIVE SIGNATURE ____ NAME OF FORMER OPERATOR ____

H_2S OPERATIONS (FOR STAFF USE ONLY)
FORM NO. 19 DATE REQUESTED ____ DATE RECEIVED ____ DATE APPROVED ____

CONTINGENCY PLAN DATE RECEIVED ____ DATE APPROVED ____

NOTE: Notify area field inspector or field director (Jackson office) of dates of spudding and reaching total depth.
State Oil and Gas Board, P.O. Box 1332, Jackson, MS 39215-1332 601-359-3725

REMARKS: (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)

Note that this Amendment to the Original requests permission to change the proposed depth of the well from 23,500' to 24,500'. Note also that the actual well location replaces the originally proposed well location.

RECEIVED
OCT 09 1989
STATE OIL & GAS BOARD

X YES ☐ NO ARE THERE SEPARATELY OWNED TRACTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT?

X YES ☐ NO IF SO, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL?

EXECUTED THIS THE 4TH DAY OF October 19 89

STATE OF Louisiana
Parish
COUNTY OF Orleans

C. G. Canz
SIGNATURE OF AFFIANT

BEFORE ME THE UNDERSIGNED AUTHORITY, ON THIS DAY PERSONALLY APPEARED C. A. CANZONERI KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH STATES, THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT.

SUBSCRIBED AND SWORN TO BEFORE ME THIS 4TH DAY OF October 19 89

Loretta E. Dunbar

SEAL

MY COMMISSION EXPIRES At Death

NOTARY PUBLIC IN AND FOR Orleans Parish
COUNTY State of Louisiana

PERMIT NUMBER 81
APPROVAL DATE 10.9.89
APPROVED BY: ____
NOTICE: BEFORE SENDING IN THIS FORM BE SURE THAT YOU HAVE GIVEN ALL INFORMATION REQUESTED

SEE INSTRUCTIONS ON REVERSE SIDE OF FORM

MISSISSIPPI STATE OIL AND GAS BOARD

FORM NO. 2 (REV. 10-86)

A. P. I. WELL NUMBER

STATE	COUNTY	WELL
23	047	20010

DALLAS PRINTING COMPANY, INC. — JACKSON, MS

APPLICATION FOR PERMIT TO DRILL, WORKOVER OR CHANGE OPERATOR

APPLICATION TO DRILL X WORKOVER ☐ CHANGE OPERATOR ☐

NAME OF COMPANY OR OPERATOR: Chevron U.S.A. Inc.

DATE: September 8,1988

ADDRESS: P.O. Box 6056 | CITY: New Orleans | STATE: LA | ZIP: 70174 | TELEPHONE: 504-364-2090

NAME OF WELL: MS Sound Blk. 57 Unit; State of MS #1 | WELL NUMBER: 1 | ELEVATION (GROUND): -14'

CHECK THE TYPE OF PROPOSED WELL: OIL ____ GAS X

WELL LOCATION (WHEN POSSIBLE, GIVE FOOTAGE FROM SECTION LINES)

8450' FNL & 7650' FWL of Mississippi Sound Block 57 SECTION ____ T ____ R ____

OTHER (NAME) ____

FIELD & RESERVOIR (IF WILDCAT, SO STATE): Wildcat; Norphlet Objective | COUNTY: Harrison | APPROXIMATE DATE WORK WILL START: November 15,1988

PROPOSED DEPTH	PROPOSED LENGTH OF SURFACE CASING	NUMBER OF ACRES IN DRILLING UNIT	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING UNIT LINE	DISTANCE FROM PROPOSED LOCATION TO NEAREST DRILLING, COMPLETED OR APPLIED FOR WELL
23,500 FEET	*See Reverse 7500 FEET	28,953	7650 FEET	+/- 93,000 FEET

NAME OF DRILLING CONTRACTOR: Transworld Drilling Company

ADDRESS: 100 Petroleum Drive CITY: Lafayette STATE: LA 70508

FOR CHANGE OF OPERATOR ONLY
SIGNATURE OF FORMER OPERATOR REQUIRED FOR TRANSFER OF WELL

AUTHORIZED REPRESENTATIVE SIGNATURE ____ NAME OF FORMER OPERATOR ____

H_2S OPERATIONS (FOR STAFF USE ONLY)
FORM NO. 19 DATE REQUESTED ____ DATE RECEIVED ____ DATE APPROVED ____

CONTINGENCY PLAN DATE RECEIVED ____ DATE APPROVED ____

NOTE: Notify area field inspector or field director (Jackson office) of dates of spudding and reaching total depth
7500' State Oil and Gas Board, P.O. Box 1332, Jackson, MS 39215-1332 601-359-3725

REMARKS (IF THIS IS AN APPLICATION TO WORKOVER, BRIEFLY DESCRIBE WORK TO BE DONE, GIVING PRESENT PRODUCING ZONE AND EXPECTED NEW PRODUCING ZONE)

See reverse side and Certified Plats for information required by Docket 159-73, Order 294-73, Rule OS-4 of the Mississippi Statewide Rules and Regulations.

A $100,000 bond has been filed with the board as per Rule OS-11 of same. (Bond #U897611-265)

See accompanying Exploratory Evaluation Document revision for a description of the drilling vessel and plan for handling drilling fluids, cuttings and waste.

X YES ☐ NO ARE THERE SEPARATELY OWNED TRACTS IN THE DRILLING UNIT FOR WHICH THIS PERMIT IS SOUGHT?

X YES ☐ NO IF SO, HAVE THE PERSONS OWNING THE DRILLING RIGHTS IN SAID TRACTS AND THE RIGHTS TO SHARE IN THE PRODUCTION THEREFROM AGREED TO DEVELOP THEIR LANDS AS A DRILLING UNIT AND TO THE DRILLING OF THE WELL?

EXECUTED THIS THE 13 DAY OF Sept 19 88 M. L. Witt
SIGNATURE OF AFFIANT

STATE OF Louisiana
COUNTY OF Orleans

BEFORE ME, THE UNDERSIGNED AUTHORITY, ON THIS DAY PERSONALLY APPEARED M.L. Witten KNOWN TO ME TO BE THE PERSON WHOSE NAME IS SUBSCRIBED TO THE ABOVE INSTRUMENT, WHO BEING BY ME DULY SWORN ON OATH STATES, THAT HE IS DULY AUTHORIZED TO MAKE THE ABOVE REPORT AND THAT HE HAS KNOWLEDGE OF THE FACTS STATED THEREIN, AND THAT SAID REPORT IS TRUE AND CORRECT.

SUBSCRIBED AND SWORN TO BEFORE ME THIS 13 DAY OF September 19 88

SEAL

MY COMMISSION EXPIRES death

NOTARY PUBLIC IN AND FOR Orleans
COUNTY, Louisiana

PERMIT NUMBER 81
APPROVAL DATE 9.14.88
APPROVED BY ____
NOTICE: BEFORE SENDING IN THIS FORM BE SURE THAT YOU HAVE GIVEN ALL INFORMATION REQUESTED.

SEE INSTRUCTIONS ON REVERSE SIDE OF FORM

MISSISSIPPI STATE OIL AND GAS BOARD

FORM NO. 2 (REV. 10-86)

A. P. I. WELL NUMBER

STATE	COUNTY	WELL
23	047	20010

DALLAS PRINTING COMPANY, INC. — JACKSON, MS

RECEIVED
SEP 14 1988
STATE OIL & GAS BOARD

MISSISSIPPI STATE OIL & GAS BOARD
WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

Form No. 3

DESIGNATE TYPE OF COMPLETION:

New Well [X] Work-Over [ ] Deepen [ ] Plug Back [ ] Same Reservoir [ ] Different Reservoir [ ] Oil [ ] Gas [ ] Dry [X]

DESCRIPTION OF WELL AND LEASE

Operator	Address
Chevron USA Inc.	P.O. Box 6056, New Orleans, LA

Lease Name	Well Number	Field & Reservoir
MS-87-01-05	1	Wildcat/Norphlet Objective

Location: 8450 FNL & 7650-FWL of Miss Sd Blk 57 (Sec.—TWP.-Range or Block & Survey)

County	Permit number	Date Issued	Previous permit number	Date Issued
Harrison	81	9-14-88	NA	NA

Date spudded	Date total depth reached	Date completed, ready to produce	Elevation (DF, RKB, RT or Gr.) feet	Elevation of casing hd. flange feet
12/21/88	10/21/89	Rel Rig 11/15/89		110.1

Total depth	P.B.T.D.	Single, dual or triple completion?	If this is a dual or triple completion, furnish separate report for each completion.
23,550	21088'	P&A	

Producing interval (s) for this completion	Rotary or cable tools used (interval)	Drilling Contractor
N/A		Transworld

Was this well directionally drilled?	Was directional survey made?	Was copy of directional survey filed?	Date filed
Yes	Yes	Yes	7/11/91

Type of electrical or other logs run (check logs filed with the commission): GR-D/L-SP, Dual Induction Sonic DIL/CNT/Sonic/SP HLDT/CNT/GR/Array — Date filed: --

CASING RECORD

Casing (report all strings set in well—conductor, surface, intermediate, producing, etc.)

Purpose	Size hole drilled	Size casing set	Weight (lb./ft.)	Depth set	Sacks cement	Amt. pulled
Dive Pipe	-	36"	-	333'	-	177'
Conductor	32"	26"	203	1007'	2100	177'
Surface	24"	20"	169/133	8665'	11800	185'
Protector	17½"	13-5/8	88.2/109	16506'	9500	190'
Protector	14"/12¼	10-3/4-9-5/8"	53.5/109	21400	4050	315'

TUBING RECORD Size in.	Depth set ft.	Packer set at ft.	LINER RECORD Size in.	Top ft.	Bottom ft.	Sacks cement	Screen (ft.)

PERFORATION RECORD Number per ft.	Size & type	Depth Interval	ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD Am't. & kind of material used	Depth Interval

INITIAL PRODUCTION

Date of first production	Producing method (indicate if flowing, gas lift or pumping—if pumping, show size & type of pump:)
Plug & Abandoned	

Date of test	Hrs. tested	Choke size	Oil prod. during test bbls.	Gas prod. during test MCF	Water prod. during test bbls.	Oil gravity ° API (Corr)

Tubing pressure	Casing pressure	Cal'ted rate of Production per 24 hrs.	Oil bbls.	Gas MCF	Water bbls.	Gas—oil ratio

Disposition of gas (state whether vented, used for fuel or sold):

For Sour Gas or Oil: Amount H_2S: Amount CO_2:

Executed this the 30TH day of JANUARY 19 92

State of LOUISIANA
PARISH County of ORLEANS

B. S. Marcomb
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared B. S. Marcomb, Tech.Asst.-Drlg. known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 30th day of January 19 92

SEAL

My commission expires AT DEATH

Notary Public in and for ORLEANS PARISH, LOUISIANA

Casing tests as required by Statewide Rules 11 and 12 must be made.

RECEIVED FEB 05 1992 STATE OIL & GAS BOARD

RECEIVED MAR 02 1992 STATE OIL & GAS BOARD

MISSISSIPPI STATE OIL AND GAS BOARD

Form No. 3

A. P. I. Well Number: State 23 County 047 Well 20010

DETAIL OF FORMATIONS PENETRATED

Formation	Top	Bottom	Description*
HET Limetstone	5150' MD	5003' SS	Limestone
Vicksburg	5730' MD	5583' SS	Shale
Midway Shale	7190' MD	7043' SS	Shale
Top Upper Cretaceous (TUK)	8487' MD	8340' SS	Chalk
Base of Chalk	9372' MD	9225' SS	Shale
Top Basal Tuscaloosa (TBT)	10123' MD	9976' SS	Sand/Shale
Top Lower Cretaceous	11072' MD	10925' SS	Sand/Shale -Limestone/Sand/Shale - Limestone/Shale
Beta Lime	12224' MD	12077' SS	Limestone (Shale)
Paluxy	13417' MD	13270' SS	Limestone/Sand/Shale
Mooringsport	14277' MD	14130' SS	Limestone (Shale)
Base Ferry Lake	15361' MD	15214' SS	Limestone - Limestone/Shale
Top Hosston	16317' MD	16170' SS	Limestone/Shale - Limestone
Top Cotton Valley	18157' MD	18010' SS	Limestone
Base Knowles	19362' MD	19215' SS	Limestone/Sand/Shale
(Clastics)	19600' MD	19453' SS	Salt
Salt	23348' MD	23171' SS	Salt
Well TD	23323' MD	23176' SS	Salt

* Show all important zones of porosity, detail of all cores, and all drill-stem tests, including depth interval tested, cushion used, time tool open, flowing and shut-in pressures, and recoveries.

INSTRUCTIONS:

Attach electrical log if run.

This well completion or recompletion report and well log shall be filed with the Mississippi State Oil and Gas Board not later than thirty days after project completion.

Form No. 6

MISSISSIPPI STATE OIL AND GAS BOARD

NOTICE OF INTENTION TO PLUG AND ABANDON

Operator Chevron U.S.A., Inc. Address P.O. Box 6056, New Orleans, LA 70174

Lease Name MS-87-1-OS Well No. 1

Location of Well 8450' FNL & 7650' FWL of Mississippi Sound Blk 57

FIELD NAME

Sec. Twp. Rge. Or Block & Survey County Harrison

Date Plugging to Commence 10-21-89

Firm Engaged to Plug Well N/A Address Permit No. 81

Operators of Offset Leases Notified

Operator	Lease	Direction from this Well
N/A		

APPROVED 7.17.90
A. Richard Henderson
State Supervisor

Signature of Operator's Agent.

NOTE: Received verbal permission on 10/21/89 by Dr. Henderson - Miss. State Oil & Gas Board to Mr. B.A. Jones - Chevron U.S.A., Inc. to plug & abandon subject well.

STATE OF

COUNTY OF

Before me, the undersigned Notary Public on this day personally appeared R.A. Hill known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath, states that he is authorized to make the above instrument and that he has knowledge of the facts stated therein and that said instrument is true and correct.

Subscribed and sworn to before me this 11th day of July, 1990

My Commission expires AT DEATH

Notary Public

SEE REVERSE SIDE FOR ADDITIONAL DETAILS

PLUGGING RECORD

Operator	Address
Chevron USA, Inc.	P. O. Box 6056, New Orleans, LA 70174

Name of Lease	Well No.	Field & Reservoir
MS-87-1-OS	1	Wildcat/Norphlet Objective

Location of Well	Sec-Twp-Rge or Block & Survey	County
3450' FNL & 7650' FWL of Mississippi Sound Block 57		Harrison

Application to drill this well was filed in name of	Has this well ever produced oil or gas	Character of well at completion (initial production): Oil (bbls/day)	Gas (MCF/day)	Dry?
M. S. Witten	NO			X

Date plugged:	Total depth	Amount well producing when plugged. Oil (bbls/day)	Gas (MCF/day)	Water (bbls./day)
10/28/89	23,550'			

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used Indicate zones squeeze cemented, giving amount cement.
Cotton Valley	Gas	22,386'-22409'	406' cement plug f/ 22562'-22156'. EZSV set @ 21288'. Pump200 sxs below retainer. Spot 50 sxs on top of retainer BOC 22105' TOC-21088'.

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped etc)	Packers and shoes
36"	333'	177'	156'	177'-cut	Shoe @ 333'
26"	1007'	177'	830'	177'-cut	Shoe @ 1007'
20"	8665'	185'	8480'	185'-cut	Shoe @ 8665'
14"	16506'	190'	16316'	190'-cut	Shoe @ 16,506'
9-5/8"	21400'	315'	21085'	315'-cut	Shoe @ 21,400'

Was well filled with mud-laden fluid, according to regulations?	Indicate deepest formation containing fresh water.
Yes	5000 ppm NaCl Form. Wtr. 0'-2800'

NAMES AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well:

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

N/A

Use reverse side for additional detail
File this form in duplicate with

Executed this the 11th day of July 19 90.

State of Louisiana
County of Orleans

Signature of Affiant
R. A. Hill

Before me, the undersigned authority, on this day personally appeared _____ known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 11th day of July 19 90

Hugh H. Doran

SEAL

My commission expires AT DEATH

Notary Public in and for ORLEANS PARISH County, LOUISIANA

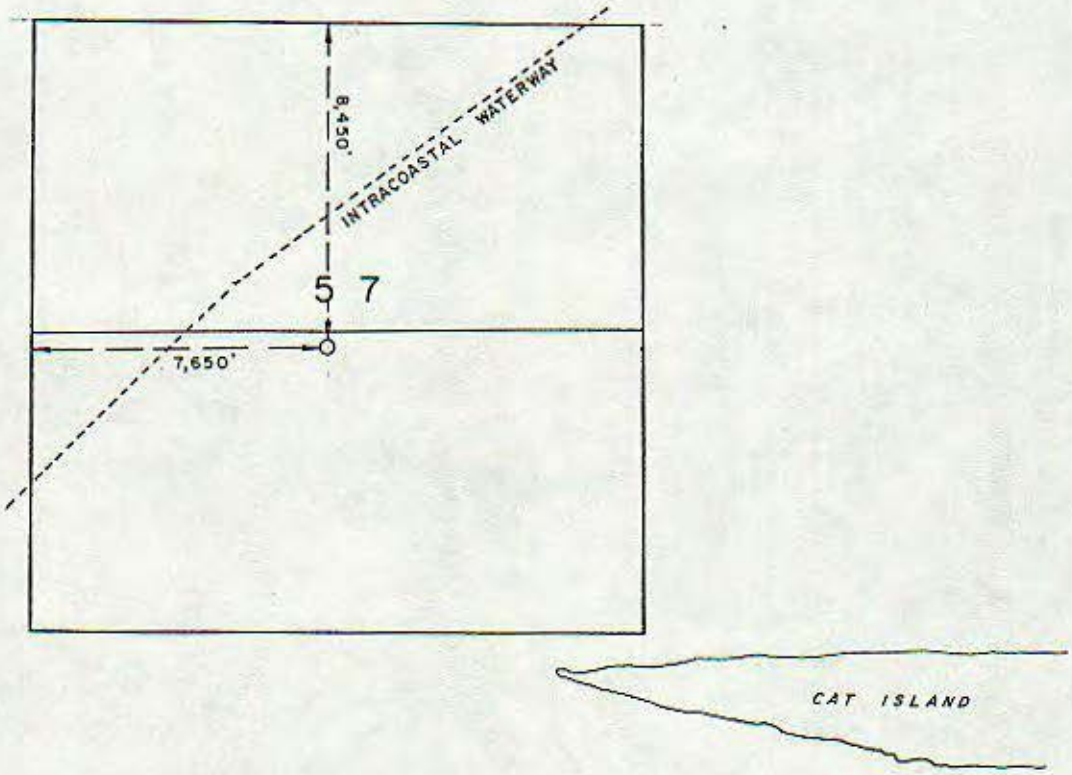
MISSISSIPPI STATE OIL AND GAS BOARD

Plugging Record
FORM 7 - IOCC P-15

Authorized by Order No. 118-58 Effective November 1, 1958

Additional cement plug information as follows:

Bridge Plug @ 16,695'
500' cement plug from 16,695'-16,195'
Bridge Plug @ 8410'
500' cement plug from 8410'-7910'
900' cement plug from 2160'-1260'
900' cement plug from 1260'-360'
150' cement plug from 360'-210'



CHEVRON U.S.A. INC.
MISSISSIPPI SOUND BLK. 57 UNIT, STATE OF MISSISSIPPI
MS-87-1-OS

Location is 8,450 feet from the north line and 7,650 feet from the west line of Blk. 57, Mississippi Sound Area. The state plane coordinates are X= 1,[illegible] and Y= 213,310.0. The geographic coordinates are Latitude: 30°15'10.03" and Longitude: 89°10'31.72". All coordinates refer to the Mississippi Transverse Mercator Coordinate System (East Zone).

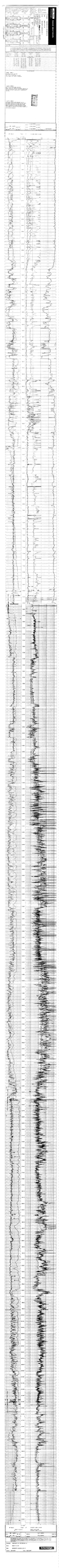
Note: This well will be drilled as a straight hole.

Harold E. King

MISSISSIPPI REGISTERED LAND SURVEYOR NO. 1979

HAROLD E. KING JR. REGISTERED LAND SURVEYOR LS 1979 STATE OF MISSISSIPPI

SEPTEMBER 9, 1988

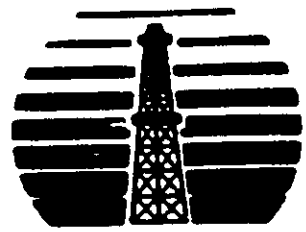


CLARK, J. E., HOWARD, M. R., AND SPARKS, D. K., 1987
FACTORS THAT CAN CAUSE ABANDONED WELLS TO LEAK AS VERIFIED BY CASE HISTORIES FROM CLASS II INJECTION, TEXAS RAILROAD COMMISSION FILES

INTERNATIONAL SYMPOSIUM ON SUBSURFACE INJECTION OF OILFIELD BRINES

Proceedings

Sponsored By



Royal Sonesta Hotel

New Orleans, Louisiana

May 4 through 6, 1987

FACTORS THAT CAN CAUSE ABANDONED WELLS TO LEAK AS VERIFIED BY CASE HISTORIES FROM CLASS II INJECTION, TEXAS RAILROAD COMMISSION FILES

J. E. CLARK, M. R. HOWARD, D. K. SPARKS

E. I. DU PONT DE NEMOURS & CO., INC.

P. O. BOX 3269

BEAUMONT, TEXAS 77704

ABSTRACT

An abandoned well is a well where use has been permanently discontinued or is in disrepair such that it cannot be used for its intended purpose nor for observation purposes. A properly plugged well is a well where upward migration of fluids does not occur as a result of increased reservoir pressures.

Abandoned wells are possible sources of pollution to water supplies if fluids are allowed to migrate into Underground Sources of Drinking Water (USDW) from the over-pressured injection zone. Federal Underground Injection Control (UIC) regulations require the critical identification and evaluation of all abandoned wells in the Area of Review (AOR) during the permitting process.

Case histories from the Texas Railroad Commission files on leaking abandoned wells reportedly caused by Class II injection wells (salt water and enhanced recovery) were studied. Important factors have been identified from these case histories that can cause an improperly plugged abandoned well to leak due to overpressuring the injection zone. The factors include: 1) depth of the injection zone, 2) casing left in the borehole which is open to the injection zone, providing a direct path for upward fluid migration, 3) reservoir properties and flow rates, 4) drilling method, and 5) boreholes in "hard" rock which tend to remain open indefinitely, as opposed to boreholes in "soft" rock where expandable clays or sloughing shales close the borehole.

An important finding of this study was that wells drilled in unconsolidated (soft) rock, such as the Texas Gulf Coastal Plain experience natural borehole closure, which drastically reduces the potential for leakage from these abandoned wells. This study showed that the most likely pathway for leakage is a production well improperly abandoned with the production casing left open to the injection zone.

All abandoned wells in the AOR must be identified to satisfy Federal UIC regulations. Abandoned wells that are satisfactorily plugged are dismissed from further review, and remaining wells are considered for plugging or modeling to determine the maximum permissible injection pressure. The maximum injection pressure is set to prevent the hydraulic lift of the injected fluid or other non-native

fluids into an overlying USDW from improperly plugged abandoned wells. During modeling it is important to consider the entire well field of surrounding injection or production wells which may affect the injection zone. From case studies of several Class II injection wells suspected of causing leakage through abandoned wells in Texas, we believe that operators can achieve responsible compliance through the use of historical records and available modeling techniques.

INTRODUCTION

Since 1859, when the first petroleum well was drilled in the United States, approximately three million oil and gas wells have been drilled and over two million have been abandoned (Anzzolin and Graham, 1984). According to 40 CFR 146, a well is considered abandoned if its use has been permanently discountinued or is in a state of disrepair such that it cannot be used for its intended purpose nor for observation purposes. Of particular concern to the Class II UIC program are improperly plugged wells that penetrate the injection zone or within 300 feet of the injection zone, because they have the potential for conveying fluid from the injection zone to an overlying Underground Source of Drinking Water (USDW).

Of the approximately 150,000 Class II (brine injection) wells operating in the United States (Fryberger and Tinlin, 1984), approximately 54,000 are in Texas (Roth, 1987). The State of Texas has recognized the need for proper plugging of abandoned wells since 1899 when the first regulations were passed. In 1919 the Texas

Railroad Commission (TRC) was given regulatory responsibility for proper well plugging. The TRC is also responsible for a program to remedy improperly abandoned wells where the operator is unknown or financially insolvent. Through this program approximately 1400 wells have been plugged since 1965 with state funds (Ross and Steed, 1984).

AREA OF REVIEW CONCEPT

The AOR is the main UIC requirement to protect an USDW against potential upward migration of fluid from boreholes that penetrate protective confining layers. Abandoned wells come under the current review process for a UIC permit. In Texas, the AOR encompasses the area within a 1/4-mile radius of the injection well. If unplugged wells are known to exist nearby, but outside the AOR, they may require reservoir simulations to determine the adequacy of the 1/4-mile radius (Engineering Enterprises, 1985).

This State UIC program requires that records of all artificial penetrations (boreholes that penetrate the confining/injection zone) be examined during the AOR to locate wells that are improperly abandoned. A properly completed or abandoned well is one where interformational movement of fluids will not occur as a result of an increased reservoir pressure.

We developed a protocol to identify and evaluate artificial penetrations in the AOR (Figure 1). All wells identified as being inadequately plugged must be modeled to verify that no upward migration will occur. If upward migration is possible, then one of the following steps must be taken before the injection well is allowed to operate:

1) Reenter and properly plug the potential problem well.

2) Lower the proposed injection rate to reduce the pressure (head) driving force.

3) Complete the injection well in a lower zone so that the abandoned well can tolerate a higher pressure without fluid migration.

4) Complete the injection well in a lower zone which the abandoned well does not penetrate.

5) Increase the density of the injection fluid to prevent upward migration.

6) Drill a monitor well next to the potential problem well to monitor possible upward fluid movement.

FACTORS RELATED TO LEAKAGE THROUGH IMPROPERLY ABANDONED BOREHOLES

Class II wells are generally constructed with surface casing cemented below freshwater aquifers, long-string casing perforated through the injection zone, and injection tubing to deliver brine to the subsurface. Figure 2 shows the construction of a Class II injection well and three improperly abandoned wells that provide potential fluid migration pathways. A leaking abandoned well can mean a leak at the surface or interformational flow of fluids which does not reach the surface (Figure 2). Injected fluids will move laterally through the injection zone and can migrate into an improperly plugged well. A discussion of important factors that relate to leaking abandoned wells follows.

For the purposes of the study, two rock types were identified: consolidated ("hard") rock and unconsolidated ("soft") rock. These two types are geologically distinct and their characteristics greatly influence the behavior of abandoned wells.

ROCK TYPES

Unconsolidated formations such as the geologically young Tertiary shales in the Texas Gulf Coastal Plain have hydration (expanding clays-smectities) and plastic properties which result in the natural closure of man-made boreholes (Johnston and Greene, 1979; Davis, 1986). Smectite exhibits a high amount of swelling when hydrated.

Non-expanding clays or illite swell much less on being wetted than expanding clays. Collins (1986) reported that shales penetrated by drilling fluids experience a significant water exchange due to an osmotic process which is dependent upon ionic activity of the mud and the brine in the shale. This water exchange can lead to swelling of the shale and sloughing into the borehole.

A change in mineralogy from smectite to illite occurs with increasing depth and temperature and is associated with squeezing water out of the clay lattice (Grim, 1968). This alteration is called clay diagenesis (See Figure 3). Powers (1967) found that when montmorillonite (smectite) is buried to a depth of approximately 3000 feet, most of the water is expelled from it, except for the last few bound layers that are along the basal layers between the unit layers of clay. At this depth, the effective porosity and permeability are essentially zero because all space is occupied by the solid layers of clay and the rigid water layers bound to the clay. In a laboratory experiment by Darley (1969) most of the free water in clays was squeezed out of the expanding clay members at a pressure of 2500 psi, approximately equivalent to 5000 feet of overburden.

Borehole closure by hydration occurs at depths less than 10,000 feet in the Gulf Coast. Alteration of smectite to illite (mixed-layer clay) begins at a depth of 6000 feet (Figure 3) and continues until a near total transition has occurred by a burial depth of approximately 10,000 feet in the Gulf Coastal Plain (Powers, 1967).

Below 14,000 feet in the Gulf Coast, there is no swelling component remaining in the illite (Burst, 1959).

Borehole closure by plastic flow is associated with high pore pressure shales being relieved of the overburden stress by penetration of the drill bit. This geopressured zone (plastic flow) occurs at approximately 10,000 feet in the Gulf Coastal Plain (Figure 3). Because the pore pressure and shale plasticity is abnormally high relative to the overburden strata, the shale is extruded into the borehole by plastic flow if the drilling fluid pressure (mud column weight) is less than the fluid pressure in the rock pores being drilled.

Drilling muds are generally conditioned to prevent borehole closure. If the mud breaks down or settles out, the borehole will seal itself by natural closure (Ammons, 1987). Johnston and Knape (1986) reported after interviewing several experienced drilling engineers that the geologically young and unconsolidated sediments of the Gulf Coast tend to slough and swell, and an uncased borehole will commonly squeeze shut within hours, resulting in natural borehole closure. According to Cheatham (1984), shale hydration has been one of the more significant causes of borehole instabilities in the past; however, improved drilling fluids in the last 20 years have provided better control of swelling shales. Therefore, old abandoned wells which typically did not have good drilling muds would have exhibited natural closure even more rapidly.

Reentering and plugging abandoned wells near Du Pont injection facilities in the Texas Gulf Coastal Plain has confirmed that the boreholes are closed by natural processes (Klotzman, 1986; Meers, 1987). Old abandoned boreholes have healed across shale sections to the extent that the reentering is like drilling a new hole. Natural borehole closure is also verified by day-to-day experience of field engineers who encounter difficulty in keeping boreholes open while drilling, running casing, and logging. Our experience in this area indicates that borehole closure while running casing can result in being stuck ("wall stuck") in the well and not able to bring circulation of fluids ("break circulation") to the surface. Generally a wiper trip is made (drill bit is run in the hole and the borehole is conditioned with mud) to keep the borehole open for logging if it needs to be left open for more than 24 hours.

Typically, dry holes drilled in the Gulf Coastal Plain have been abandoned with surface casing set and plugged, but without long string casing, thus providing ready opportunity for natural closure below surface casing.

Consolidated formations, such as in west Texas, are generally rigid ("hard rock") and lack the shale mineralogical properties that help the borehole to close by caving or sloughing (see Figure 4). Abandoned wells may remain open here indefinitely because the factors for natural closer are limited. Lost circulation zones are more common in consolidated rock areas where drilling fluids and cement may have been displaced from the borehole. Johnston and

Knape (1986) stated that abandoned wells in this region may remain open for many years, and reentering the boreholes for plugging may be done by merely washing down with a drill bit. Most reports of leaking abandoned wells or groundwater contamination have been reported as occurring in consolidated rocks (Johnston and Greene, 1979).

A major exception to the normal stability of the West Texas boreholes is exhibited in uncased sections of wells penetrating shale formations of the Triassic "red beds". These beds consist of water-sensitive clays which swell and slough in the borehole, causing well construction problems and total hole closure during and after well abandonment. This is typically below the base of the surface casing in a well where the long-string casing is absent or has been pulled for salvage prior to abandonment (Johnston and Knape, 1986).

DRILLING METHODS

The method used to drill a well can influence the potential for leakage after it is abandoned. Three dominant drilling methods examined were rotary mud, rotary air, and cable tool.

Rotary drilling with mud as the drilling fluid has been the preferred method, especially in the Gulf Coastal Plain, since its invention in 1901. It is almost impossible to drill shale with

other techniques in coastal plain areas and keep the borehole open to advance the bit and casing.

The rotary mud rig uses a water-based drilling fluid (mainly a suspension of bentonite, a swelling clay), weighting material, and chemical additives as a medium to carry drill cuttings to the surface, control pressures encountered in underground formations, and lubricate the bit.

In most wells drilled prior to the 1930's, rotary drilling fluid was a mixture of water and the drill cuttings. This was called "native mud", derived from the clay formations penetrated by the drill bit. Water was continually added to thin native muds, and the minimum weight for these drilling fluids was probably not less than 9 lbs/gal (Johnston and Knape, 1986).

When a well reaches logging depth, the mud is conditioned to keep the borehole open prior to running geophysical logs (a practice since the 1930's). The density of mud left in the borehole can be determined from plugging records or from the geophysical log header.

Rotary drilled dry holes can be assumed to have been left full of mud as a minimum condition because there is no economic reason to recover the drilling mud prior to abandonment (Johnston and Knape, 1986). However, if the mud were recovered for another project, the borehole would be filled with a bentonite type mud. Totally removing the mud system from the borehole with the drill pipe on

bottom of the well is taking an unnecessary risk of getting the drill pipe (salvagable material) stuck in the hole, because removing the mud can cause hole instability and caving.

Mud density, primarily used for well control while drilling, can also be used to prevent interformational fluid flow. Permeability of the mud left in the borehole is less than the surrounding productive formations and the pressure maintained by the mud column in the hole is high enough to prevent the displacement of the plugging material. Drilling fluid that is suitably conditioned after drilling can satisfy these requirements (Polk and Gray, 1984).

In plugging mineral exploration holes, Polk and Gray (1984) found that by increasing mud viscosity to 20 sec/quart, the exploration holes that were drilled were sealed with permeabilities less than 10^{-8} cm/sec. The sealing effectiveness of the mud conditioner treatment was confirmed by observations of surface hole intercepts made during the mining operations. This fact minimizes the chance of encountering a truly open conduit in an abandoned dry well which was rotary drilled using mud.

Cable tool drilling is sometimes used in consolidated rock formations, but it has not been used very much in unconsolidated rock regions for the past 50 years because caving sands and sloughing shales caused operating problems. If a well were drilled by cable tool or rotary air drilling methods, then the fluid in the hole is probably native water or brine. Generally, cable tool holes are

hard to locate because the surface casing was never cemented and was removed after drilling.

MUD WEIGHT

The mud column provides a downward force, or higher hydrostatic head, than the fluids in formations encountered by the drill bit to maintain well control (keep the well from "blowing out"). This same mud column can keep the abandoned well bore from "breaking out" due to injection in other wells, if the formation pressure is not increased above the hydrostatic head of the mud column. Figure 5 is an example of pressure resistance of a static mud column exerted at different depths and mud weights. Figure 6 represents normal formation pressure at depth for two pressure gradients. Figure 7 represents pressure resistance differential based on the hydrostatic pressure resistance of the mud column minus the formation pressure, for several different cases. Formation pressure must be greater than the pressure resistance of the mud column to cause movement of fluids in the improperly plugged borehole. This is a conservative calculation because it assumes no credit for borehole closure, gel strength, or pressure required to break the mud cake gel at the borehole face.

High-density muds undergo density changes due to gravitional settling. In a field experiment, Cooke, et al (1983, 1984) made direct determinations of change in the density of bentonite mud left standing in the annular space where pressure transducers at various

levels along the outer casing were located. The water-based mud weighted with barite to 11.0 lbs/gal was reduced to 9.1 lbs/gal in eleven months. The weight of natural and modern muds left in the borehole have a reported low range of 9 to 9.5 lbs/gal (Price, 1971; Johnston and Knape, 1986; Collins, 1986; Davis, 1986; and Alford, 1987). A 9 lbs/gal mud would be a conservative value to use in modeling calculations to predict upward migration in abandoned wells. This value of 9 lbs/gal would be valid for rotary mud-drilled dry holes and for cased holes with long string or production casing only if records indicate mud/cement left in the boreholes. Of course, if the records indicate lost circulation zones, or if casing is pulled from the borehole, the mud column cannot be assumed to fill the borehole.

GEL STRENGTH

A second mud parameter, gel strength (Gs), helps prevent upward fluid movement in a mud-filled borehole. Gel strength is the property which acts to suspend the drill cuttings in the static mud column when circulation stops. Drilling mud gels under static conditions as a function of the amount and type of clays in suspension, time, temperature, pressure, pH, and chemical agents in the mud system. The pressure required to displace the gelled mud can be significantly large.

Gel strength may be the main factor in preventing brine from migrating up abandoned wells from a fluid flow injection well driven

by pressure build-up (Collins, 1986; Johnston and Knape, 1986). Collins (1986), in simple laboratory experiments (pipe with collars or shoulders to simulate different hole sizes and filled with bentonite mud) to test gel strength, demonstrated that mud gel and hole irregularities interacted to yield a large contribution (five-fold or more increase in gel strength) to sealing pressure and help prevent upward migration.

Gel strength is increased by flocculation which enhances clay particle contact. Several studies were conducted which showed that gel strength increases with time (Garrison, 1939; and Gray, et al., 1980) at borehole conditions. An increase in pH (Garrison, 1939) increases gel strength. High pressures in thousands of psi (Hiller, 1963) pressures generally much greater than those encountered in Class II injection wells, decrease gel strength. The gelling nature of mud has been observed and reported in replugging abandoned wells (Johnston and Knape, 1986).

Minimum gel strength for drilling muds has been reported as 20 to 25 lbs/100 ft^2 (Barker, 1981; Johnston and Knape, 1986; Davis, 1986; Collins, 1986; and Gurke, 1987) and would provide a considerable safety factor in modeling most situations. Figure 8 is a plot of gel strength and pressure resistance to prevent upward migration. The added pressure resistance for a well 5000 feet deep with a gel strength of 20 lbs/100 ft^2 and a 6-inch borehole would equal 50 psi.

DEPTH OF INJECTION ZONE

Injection zone depth is important because a shallower borehole will have a lower hydrostatic head (downward force) due to the shorter fluid column weight in the abandoned well. A longer column of fluid (deeper injection zone) can counterbalance more formational pressure buildup in the injection zone. Table 1 shows the hydrostatic mud pressure for 9.0 lbs/gal mud at depths from 1000 to 5000 feet. The mud column has a pressure differential resistance to initiate upward flow (hydrostatic mud pressure minus formation pressure) of 18 psi at 1000 feet, and 90 psi at 5000 feet.

CASING LEFT IN BOREHOLE

Special attention should be placed on abandoned wells with long-string or production casing remaining in the borehole and left open to the production/injection zone. Generally, if production casing is intact, then a mud-filled hole cannot be safely assumed, unless records indicate the presence of mud or cement at abandonment to counterbalance higher injection pressures.

If an operator abandons a depleted well or dry hole without proper plugging, then injected fluid from a Class II well (Figure 2, Well A) could enter the improperly abandoned well from the same production zone (Figure 2, Well D). Another potential avenue for upward migration exists if the well is cemented across only part of the well bore, and drilling mud was displaced ahead of the cement from

the annular space between the casing and the open hole (Figure 2, Well B). If cement was not circulated to the surface, the annular space above the cemented portion would be filled with drilling mud. If driving pressures are high enough, fluids can enter the uncemented or mud annulus and migrate upward if not cemented above the injection/production zone.

The annular mud space provides resistance as in the mud-filled borehole to upward migration because of the increased hydrostatic head of the mud column and gel stength of the mud (Davis, 1986). In addition, in the Gulf Coastal Plain, shale can close around the casing and seal off the borehole.

RESERVOIR PROPERTIES

Transmissivity and injection rates are the main variables that control formation pressure buildup in an injection zone. Transmissivity is equal to permeability of the injection zone multiplied by the pay thickness (injection zone height). Figure 9 shows the relationship between pressure buildup and distance from the injection well for various transmissivities and injection rates. Higher disposal injection pressure buildups are related to zones of low transmissivity and higher flow rates. Because flow rates are important to formation pressure buildup, it is imperative to consider other nearby disposal and production operations utilizing the same injection zone when determining the potential for leakage through abandoned wells.

MODELING UPWARD MIGRATION

Well-established, conservative, engineering models are available for computing the pressure at which upward migration will begin. The formation pressure necessary to initiate upward flow (Pf) through an abandoned well is determined first by calculating the pressure exerted by the well's mud column and then adding the pressure for gel strength (note that no additional credit is taken for borehole closure resulting from shale hydration or the plastic nature of abnormal pressured shales). Second, the formation pressure prior to injection (Po) is subtracted from Pf. This difference (Pf-Po) represents the injection formation pressure buildup which must occur at an abandoned well to initiate upward flow. This difference is the key for limiting the maximum permissible pressure increase in an injection formation at the location of an improperly plugged abandoned well. An equation developed by Barker (1981) to calculate the pressure resistance in an improperly abandoned well is as follows:

$$Pf = Pt + 0.052*p*H + (0.00333*Gs*H/ Dw) \quad (1)$$

where : Pf = pressure required in the formation to initiate upward flow in an abandoned borehole (psi)

Pt = surface well pressure (psi)

p = density of mud (lbs/gal)

H = height of mud column (feet)

Gs = Gel strength of mud (lbs/100 ft^2)

Dw = maximum diameter of well bore (inches)

Davis (1986) reported an equation to calculate the opposing forces (mud hydrostatic head and gel strength) that act in resistance to upward fluid migration along a uncemented/mud casing annulus if not cemented above an injection or production zone:

$$Pf = Pt + 0.052*p*H + (0.00333*Gs*H/ Dw-Dc) \quad (2)$$

where : Pf, Pt, p, H, Gs, and Dw are defined as in equation 1 and

Dc = outside diameter of casing (inches)

The AOR for an injection well is dependent upon the following variables:

1. unit weight of mud plug, gel strength, and borehole diameter,

2. reservoir properties: permeability (k) and pay zone (effective injection zone) thickness(H),

3. injection rates (Q),

4. injection or production operations utilizing the same injection zone,

5. initial reservoir pressure and surface pressure,

6. depth of injection zone,

7. injection and formation fluid properties.

When pressure modeling calculations indicate that injection well operations are sufficient to cause fluid migration in an abandoned well, one of the alternatives previously discussed under AOR must be pursued.

Figure 10 shows cross-section modeling calculations for a reservoir and indicates that with a 9 lbs/gal mud at 5000 feet, the area of review for abandoned rotary drilled dry wells would be less than 1000 feet from the injection well. Figure 11 is a plan view for the above modeling calculations.

CASE HISTORIES FOR LEAKING ABANDONED WELLS IN TEXAS

Agency Information Consultants, Inc. (AIC) of Austin, Texas has examined records on file with the Texas Railroad Commission (TRC) for pollution problems associated with abandoned wells in the

following cases: 1) significant problem leaking abandoned wells in Texas cited by EPA (1975), (AIC, 1987a), 2) proper plugging hearings from selected counties along the Texas Gulf Coast (unconsolidated rock areas) to determine pollution problems in connection with the upward migration of fluids in improperly abandoned wells (AIC, 1987b), and 3) proper plugging hearings for fluid migration from improperly plugged wells in unconsolidated (TRC Districts 2, 3, and 4) and consolidated rock areas (TRC Districts 7-B, 7-C and 9) (AIC, 1987c).

CASE 1

The TRC gained authority and funds in 1967 to plug those wells causing a problem or presenting a potential pollution threat. EPA (1975) found approximately 830 wells that were plugged from 1967 to 1974 and identified approximately twenty-eight leaking, abandoned wells that were significant problems and reportedly caused by Class II injection wells (Figure 12, location map). These wells were found in a review of the TRC files on unplugged or improperly plugged wells that have been plugged by State authority. AIC (1987a) studied these 28 problem wells.

The AIC study identified the following as important factors that contribute to the potential for upward migration due to injection operations in the unconsolidated rock areas: 1) long-string casing left in the borehole and left open to the production or injection

zone, and 2) significantly overpressured injection zones because of the low reservoir transmissivity.

Out of 28 problem wells, only 4 leaking abandoned wells were from the unconsolidated rock area (Figure 12). Three improperly abandoned wells in the unconsolidated rock region had production casing set and left open to the injection zone, providing a direct pathway to the surface and eliminating possibilites for borehole closure. In one of these wells, a cause-and-effect relationship was shown when a suspect injection well reduced its flow by two-thirds and another suspect well was shut in, the problem well stopped leaking.

The fourth well cited in the unconsolidated rock area was drilled to a total depth of 1395 feet, abandoned with 21 feet of surface pipe in the borehole and filled with heavy mud. The well suspected of causing the problem injected between 1810 to 1900 feet, or 400 feet below the depth of the leaking well. Thus, this suspect well is not likely to have been the cause of the leaking well. The most likely source of salt water for the abandoned well is the fact that fresh groundwater at this location is very shallow (less than 100 feet). When the leaking well was entered to stop the leak, "A partial obstruction was encountered at approximately 20 to 25 feet and it was found that a solid obstruction of clay and shale was encountered at approximately 50 feet. It is obvious that this obstruction will have to be drilled out rather than washed out in order to properly plug the well" (Eikel, 1969). This record on the attempt at

reentering the abandoned well confirms that borehole closure can occur in unconsolidated formations.

In summary, improperly plugged abandoned wells in unconsolidated formations with long-string casing left open to the injection interval may have only mud and mud gel strength or formation brine to withstand pressure buildup. Thus, depth of injection is critical in these cases. It is important to review the records of all production wells within the AOR because they are commonly abandoned with casing intact and they have the greatest potential for upward migration.

In 21 of 24 cases in the consolidated rock area, leaking abandoned wells were again due primarily to injection by the suspect wells into the same interval to which the leaking wells had been open; but, it was through the production casing or the open borehole.

In the other three cases, AIC (1987a) could not find an injection well after searching a radius of 1.5 miles for well No. 25. In addition, the abandoned well was not leaking salt water but was identified as a well that was not properly plugged. A second leaking well was drilled to a depth of 4156 feet in consolidated formations and abandoned with 112 feet of surface casing in the hole with 75 sacks of cement and heavy mud. An injection well approximately 3/4 mile away (injection zone 518 to 535 feet) was suspected of causing the leak; however, when the injection well was shut down for a week, there was no change in the leaking well.

Thus, the suspect well was probably not the cause of the leakage. Additionally, the sand used for injection pinches out in the direction of the leaking well (Krusekopy, 1970). Lack of sand continuity prohibits lateral fluid migration. Thus, the suspect well was probably not the cause of this leakage. The third leaking well that did not fit the same zone as the suspect well was drilled to a total depth of 4,050 feet in consolidated formations and abandoned with 101 feet of surface casing in the hole and filled with mud. An injection well approximately 1700 feet away was suspected of causing the problem. This injection well was disposing of salt water through the annulus between 354 and 2302 feet. Modeling the suspect well based on the following limited reservoir parameters and sensitivity analysis:

where, Q (flow rate) = 110 bpd

H (pay zone) = 35 feet

p (injection pressure wellhead) = 175 psi

r (radius from well) = 1700 feet

indicated that pressure buildup due to injection was approximately 50 psi at the 530 foot depth injection zone. Assuming 9 lbs/gal mud in the abandoned borehole, the borehole can only support 10 psi buildup before fluid migrates upward (Figure 13, Case No. 3).

In all cases where there was sufficent reservoir data available to model pressure buildup at the leaking abandoned well, the reservoir

pressure buildup exceeded the calculated pressure resistance for 9 and 10 lbs/gal mud systems (Figure 13).

In nearly all 28 cases cited by EPA (1975), AIC (1987a) found that records pertaining to cement and/or mud plugs in the leaking wells were inadequate, incomplete, or non-existent. Plugging with mud was more common than plugging with cement, but in either case, details on the mud weight ("heavy") and cement (amount and location of plugs) are usually not given. If this information is unavailable, then conservative values should be used in modeling (9 lbs/gal mud and no cement).

Two other important mechanisms that are related to reservoir modeling include well depth and distance from leaking well to suspect injection well. Figure 14 shows that the average depth for a leaking well in this case study is less than 2500 feet. Figure 15 shows that the maximum reported distance from a leaking well to a suspect Class II injection well is less than 6000 feet and the average is less than 2000 feet. This is consistent with reservoir modeling where greater formation pressure buildup is associated closer to the injection well.

CASE 2

A second study also conducted by AIC (1987b) involved the examination of proper plug hearing files in selected Gulf Coast counties. Proper plug hearings are called by the TRC "when it comes

to their attention that a well has been abandoned or is not being operated and is causing or likely to cause pollution to freshwater above or below the below the ground or if gas or oil is escaping from the well, the commission shall determine at a hearing, after due notice, whether or not the well was properly plugged." These hearings are called under Statewide Rule 14 (b) (2) of the "Texas Statewide Rules For Oil, Gas, and Geothermal Operations."

This study was undertaken to determine the magnitude and mechanisms of pollution problems associated with improperly abandoned wells in unconsolidated sediments. From six selected counties along the Gulf Coastal Plain (Figure 16), 2531 oil and gas fields were examined. From these fields, 171 proper plug hearing orders were identified, only three involved actual leakage incidents of which only two were directly related to an injection well (Figure 17). These three pollution incidents were examined to verify the factors that caused the abandoned wells to leak.

Pollution incident No. 1 consisted of three wells on one lease that were in violation of proper plugging. Subsequent field investigations by the TRC revealed that surface pollution existed but was not the result of upward migrating fluids. Oil found in a pit near one well was leaking from a 250-barrel tank. Operator negligence was cited.

Pollution incidents Nos. 2 and 3 were the result of upward migration of fluids due to subsurface injection of Class II wells in San

Patricio County. Incident No. 2 involved an improperly abandoned production well leaking oil to the surface. This well had been drilled to 2590 feet. The well was abandoned with 885 feet of 8-5/8 inch surface casing, 2444 feet of 5-1/2 inch casing, and 2316 feet of 2-inch production tubing in the hole. The 5-1/2 inch casing was plugged back to 2345 feet and perforations were noted from 2446 to 2590 feet. The 2-inch tubing was cemented to the surface and mud-laden fluid was pumped into the well along with a 25 sack-cement plug (set at an unknown depth).

A suspect injection well was located approximately 2550 feet from the leaking well. This suspect well was probably not a likely cause of the pollution because its injection interval (5128 to 5132 feet) is far below the producing interval (2446 to 2590 feet). In addition, the leaking well never penetrated the injection interval. Oil migration has probably been the result of natural fluid migration from the production zone through the improperly abandoned production well.

Pollution incident No. 3 involved another improperly abandoned production well, cited for leaking oil and water to the surface from the thread of a "home-made" cap on the 5-1/2 inch casing. The well was abandoned with 210 feet of 8-5/8 inch surface casing, 1358 feet of 5-1/2 inch production casing, and 1355 feet of 2-inch tubing in the hole. No records of cement were found on this well indicating that it was ever plugged. The well was completed from 1321 to 1337 feet. A suspect injection well was located approximately 1300 feet

away and the injection interval was from 1110 to 1155 feet. The suspect well was permitted to operate at an average of 300 bbl/day with maximum surface pressure of 30 psi.

Both pollution incidents Nos. 2 and 3 involved actual upward migration of fluids and had protection/production strings left in the hole, eliminating any possibility of borehole closure.

It is important to note that out of 2531 fields examined (the number of abandoned wells may exceed the number of fields by a factor of ten) along the Gulf Coast, only two leakage incidents were found. This case study confirmed that the number of pollution problems in the unconsolidated rock areas is small and indicates that natural borehole closure is an important mechanism in eliminating upward fluid migration.

CASE 3

To enhance our understanding and defend the conclusions of the second study, a third study was conducted of proper plug hearings for pollution incidents in "hard" and "soft" regions in Texas (AIC, 1987c). TRC Districts 7-B, 7-C, and 9 were selected as the "hard rock" area and Districts 2, 3, and 4 comprised the "soft rock" area (Figure 18). Districts were chosen primarily for their rock environment and large number of oil and gas fields (i.e., production wells).

According to Anzzolin and Graham (1984, citing A. D. Little), 95% of all production wells and 78% of all abandoned wells (Anzzolin and Graham, 1984) fall within the AOR of Class II injection operations. Accordingly, because each district contains a substantial number of oil and gas fields, we can assume that a significant number of Class II wells exist in each region studied. The study concluded that pollution incidents resulting from Class II injection operations in "hard rock" areas outnumber those cited in "soft rock" areas by a factor of 10. Our conclusions are explained in the following paragraphs.

Proper plug hearing files for 12,461 oil and gas fields in the "consolidated rock" area were studied for pollution incidents (AIC, 1987c). Seven hundred and ninety (790) hearing files were located, and further examination of these files found that 112 hearings were called as the result of fluid migration from improperly abandoned wells (Figure 19).

On the other hand, hearing files for 34,512 oil and gas fields in the unconsolidated area were studied for leakage incidents. Six hundred, seventy-four (674) hearings were found and only 16 indicated fluid migration. Nearly three times as many fields were examined in unconsolidated rock areas as compared to consolidated rock areas, but only 13% (16) of the 128 proper plug hearings from both areas resulted from upward fluid migration in unconsolidated rock.

The 16 unconsolidated rock pollution incidents were studied to determine the factors which caused the abandoned wells to leak. Fourteen of the pollution incidents involved wells abandoned with production casing left in the hole; two pollution incidents had incomplete or nonexistent records.

It is important to note that all sixteen unconsolidated rock incidents (leaking wells) were once production wells, and most, if not all, were completed or abandoned with production casing intact. In turn, by improper cementing across production intervals, improper abandonment, or both, these wells were left open to upward migrating fluids. Thus, natural borehole closure, common in the Gulf Coastal Plain or unconsolidated rock areas, was restricted because of production casing left open to the injection zone.

Regarding the 112 pollution incidents in "hard rock" regions, AIC (1987c) noted that the producing zones were much shallower than in "soft rock" areas. Abandoned wells in "hard rock" areas would tend to have smaller hydrostatic heads due to the shorter static mud column. Thus, pressure differentials between injection or production intervals and static mud columns are small and more likely to allow upward fluid migration than deeper injection or production zones in "soft rock". "Hard rock" areas accounted for 87% of the total 128 leakage incidents resulting from upward fluid migration.

CONCLUSIONS

Case studies of Class II injection wells from the Texas Railroad Commission files showed that only a small number of pollution problems from leaking abandoned wells are associated with the Texas Gulf Coastal Plain. These studies also documented natural borehole closure as an important mechanism in preventing upward fluid migration in the unconsolidated rock of the Texas Gulf Coastal Plain.

The most important factors providing potential for upward fluid migration due to injection operations in the unconsolidated rock regions are: 1) production wells which had protection or production casings left in the hole left open to the injection zone, eliminating any possibility of borehole closure; and 2) significantly overpressurized injection zones because of low reservoir transmissivity.

The case studies for west Texas (consolidated rock) indicate a higher percentage of pollution incidents resulting from improperly abandoned wells. The important factors relating to upward migration are: 1) boreholes abandoned with or without casing remaining open to the injection zone, 2) significantly overpressurized injection zones because of low transmissivity, and 3) shallower production or injection zones resulting in shorter static mud columns to counterbalance increased formation pressure.

This study of case histories has shown that all of the leaking abandoned wells could have been identified as potential problem wells. Preventive measures could have been taken prior to injection operation. We believe operators can achieve responsible compliance through the use of historical records and reservoir modeling to conduct injection operations in a manner that protects the environment.

TABLE 1

MUD WEIGHT PRESSURE RESISTANCE

Assuming 9.0 lbs/gal mud and formation pressure gradient of 0.45 psi/ft:

Depth (ft)	Hydrostatic mud pressure (psi)	Formation pressure (psi)	Pressure differential (psi)
1000	468	450	18
2000	936	900	36
3000	1404	1350	54
4000	1872	1800	72
5000	2340	2250	90

PROTOCOL FOR IDENTIFYING ABANDONED WELLS IN AN AREA OF REVIEW

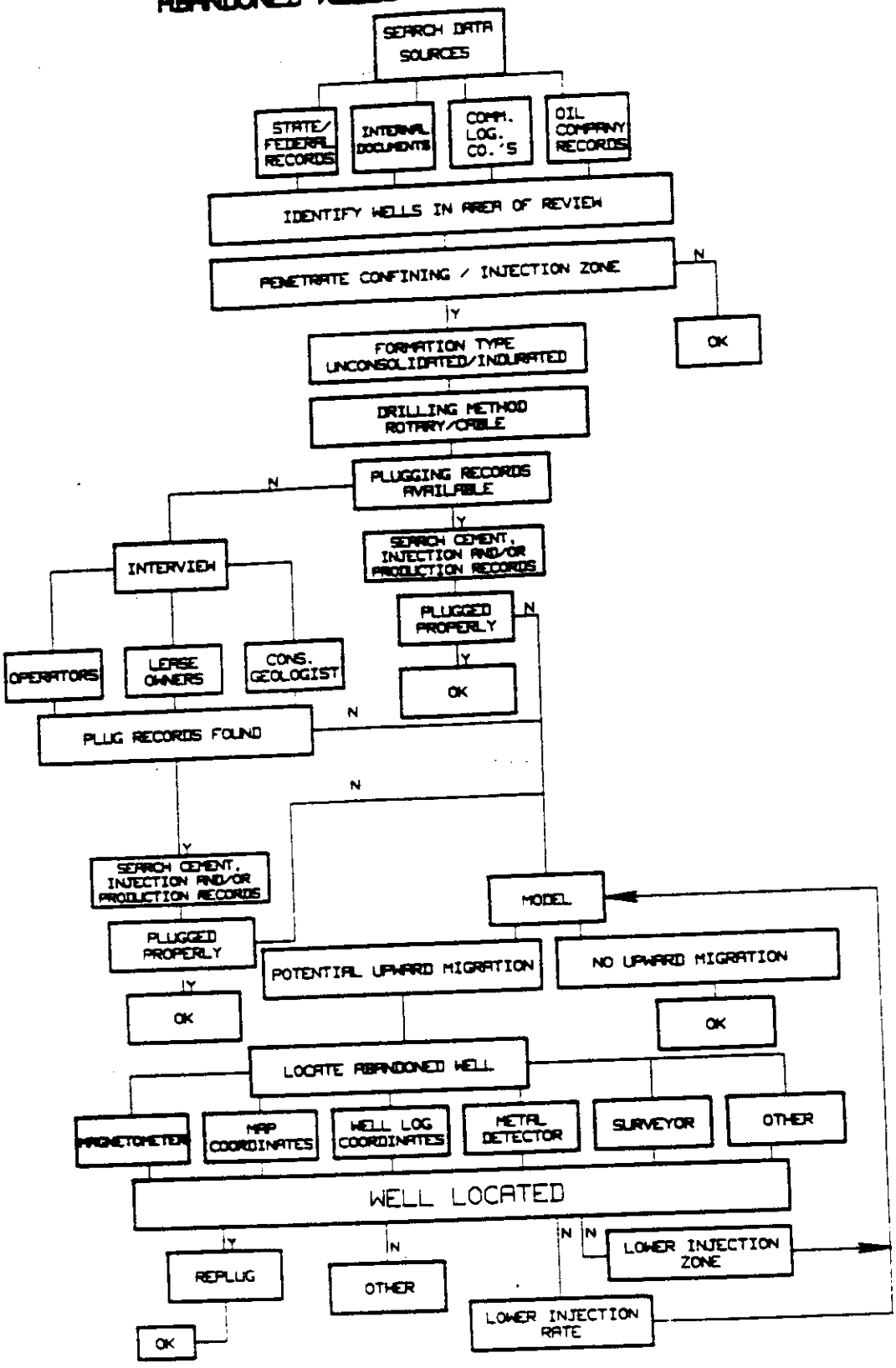
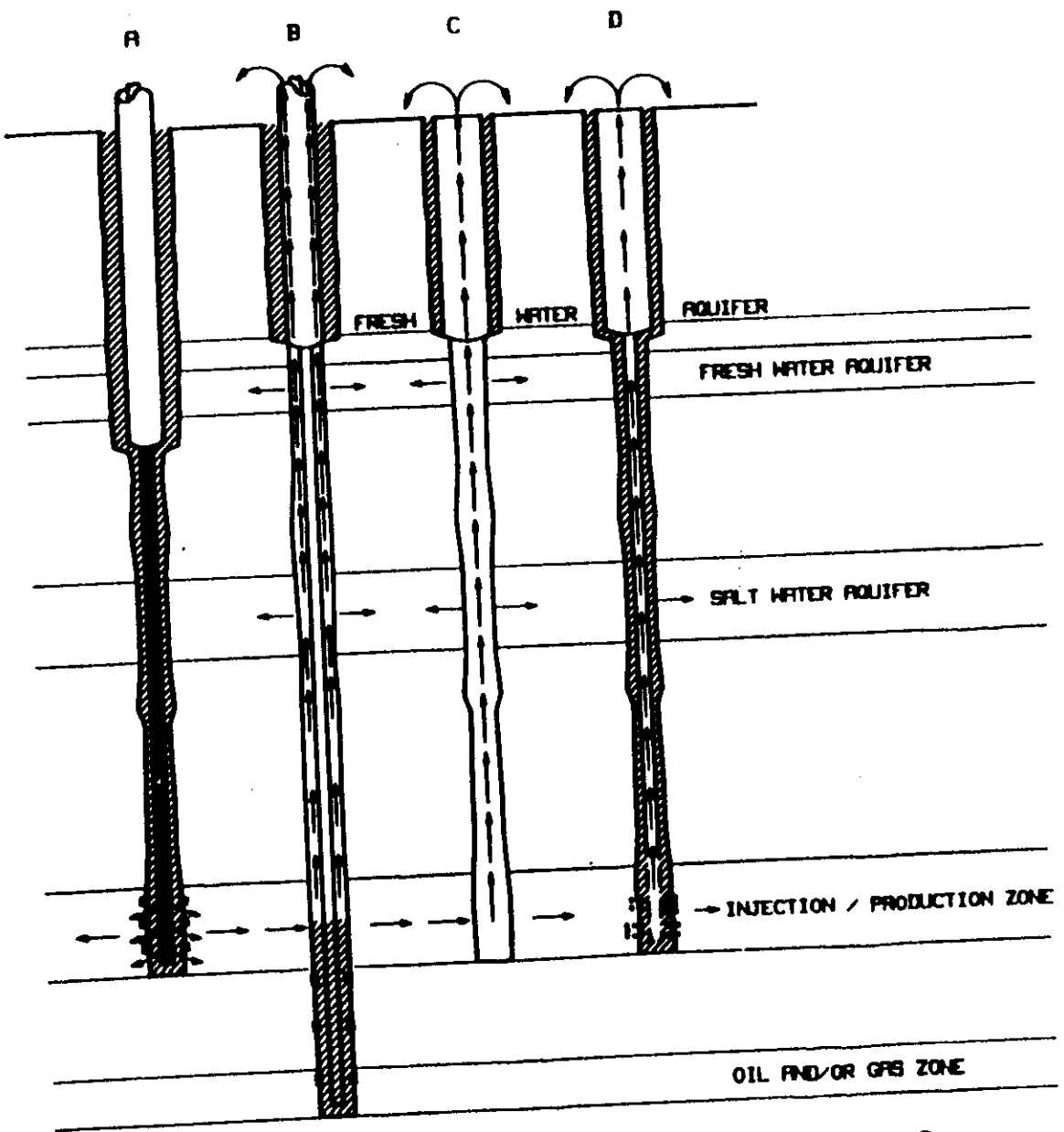


Figure 1

POTENTIAL PATHS OF FLUID MIGRATION FROM CLASS II INJECTION WELLS



EXPLANATION

A - CLASS II INJECTION WELL

B - PRODUCTION WELL - COMPLETED IN DEEPER ZONE, ANNULUS PARTIALLY UNCEMENTED TO SURFACE, FORMATION PRESSURE >> STATIC ANNULAR MUD COLUMN

C - IMPROPERLY PLUGGED AND ABANDONED DRY HOLE - PENETRATING THE INJECTION / PRODUCTION ZONE FORMATION PRESSURE >> STATIC FLUID COLUMN

D - IMPROPERLY ABANDONED PRODUCTION WELL - DEPLETED WELL WITH PRODUCTION STRING LEFT OPEN TO INJECTION ZONE, NO CEMENT OR MUD PLUGS

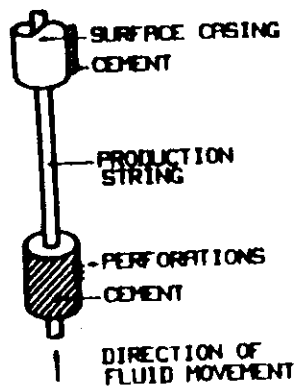


Figure 2

Stepwise Dehydration of Clay in Gulf Coast Well, Chambers County, Texas

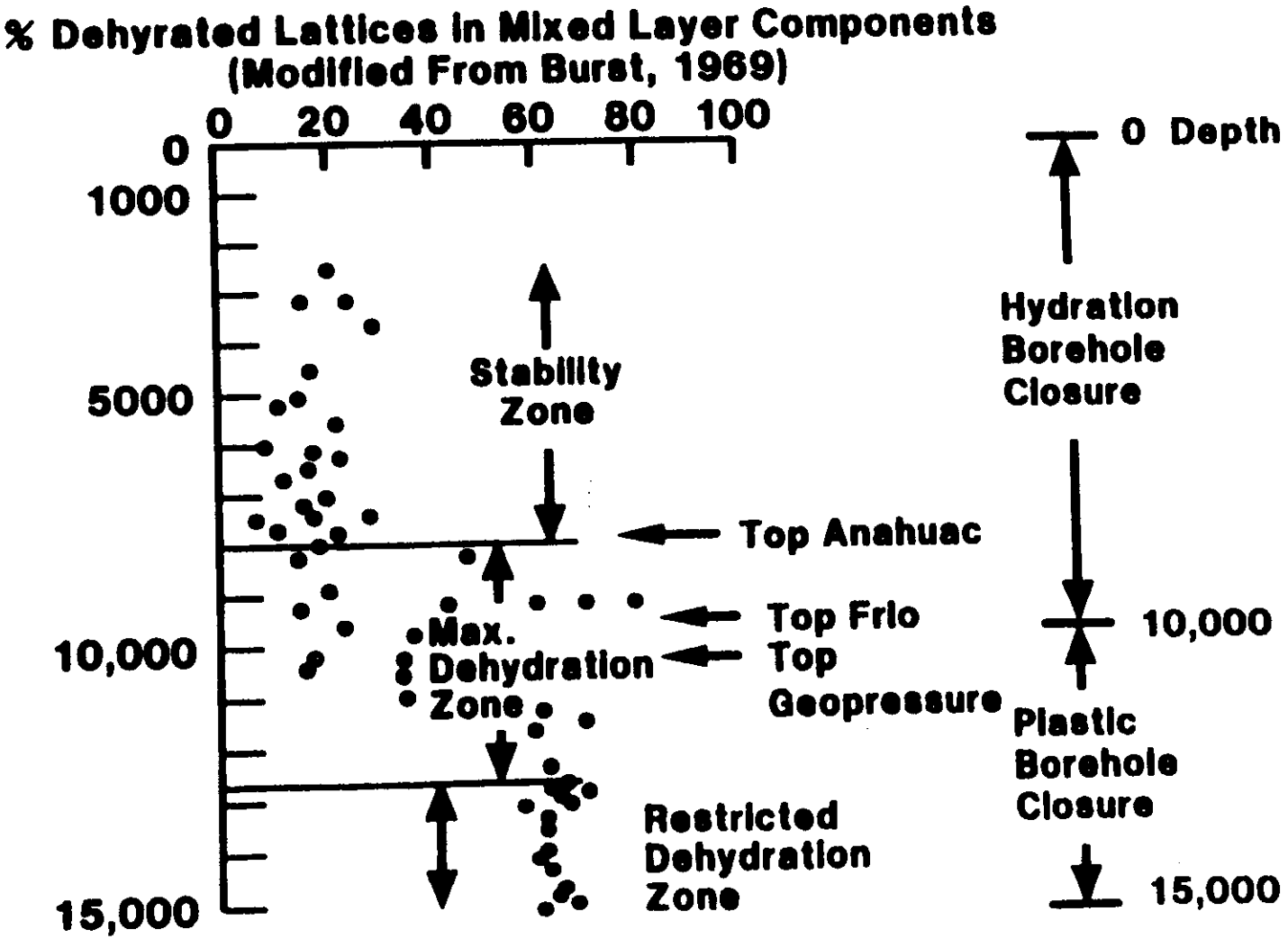


Fig. 3

CONSOLIDATED AND UNCONSOLIDATED ROCK TYPES IN TEXAS

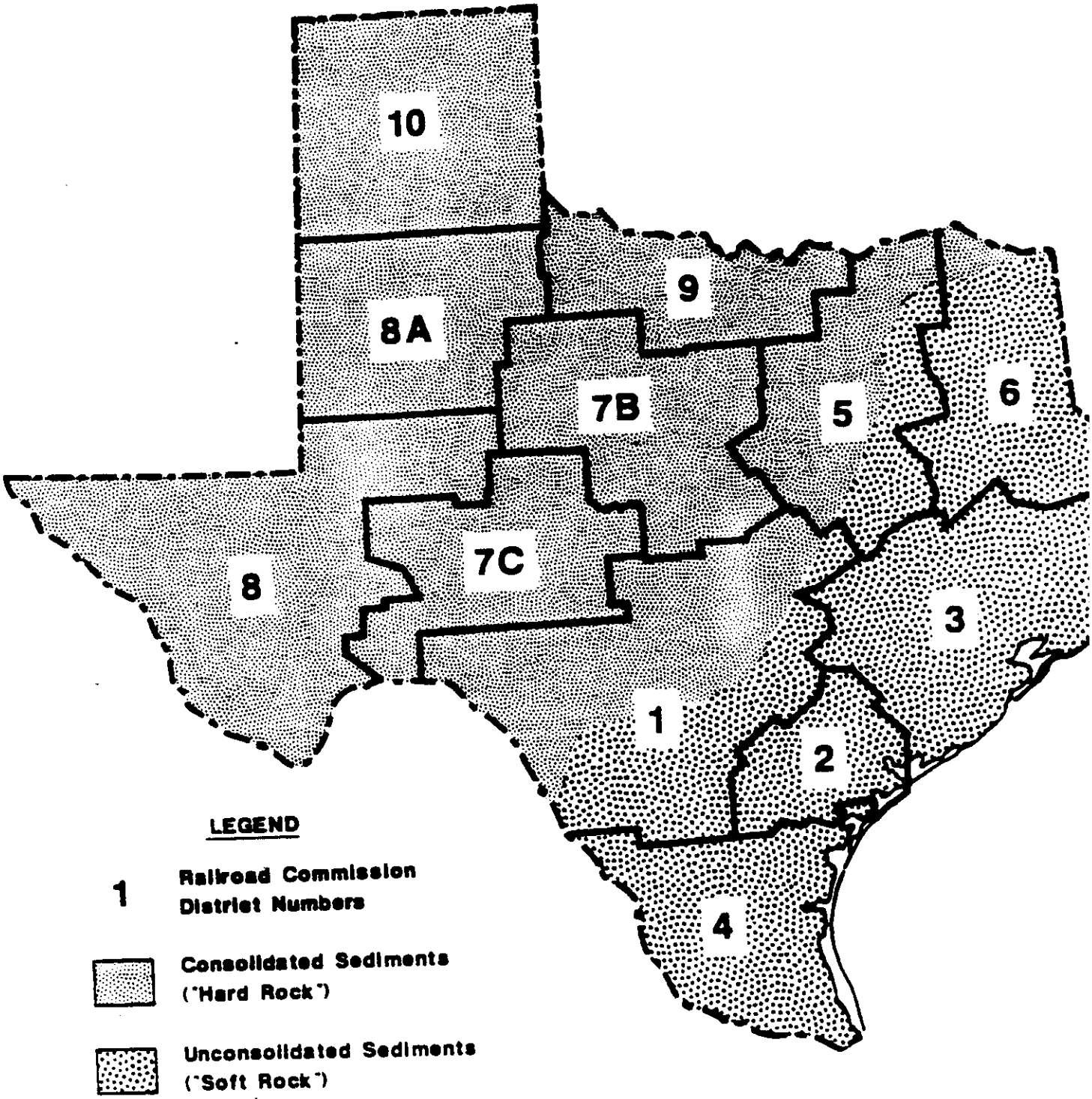


Figure 4

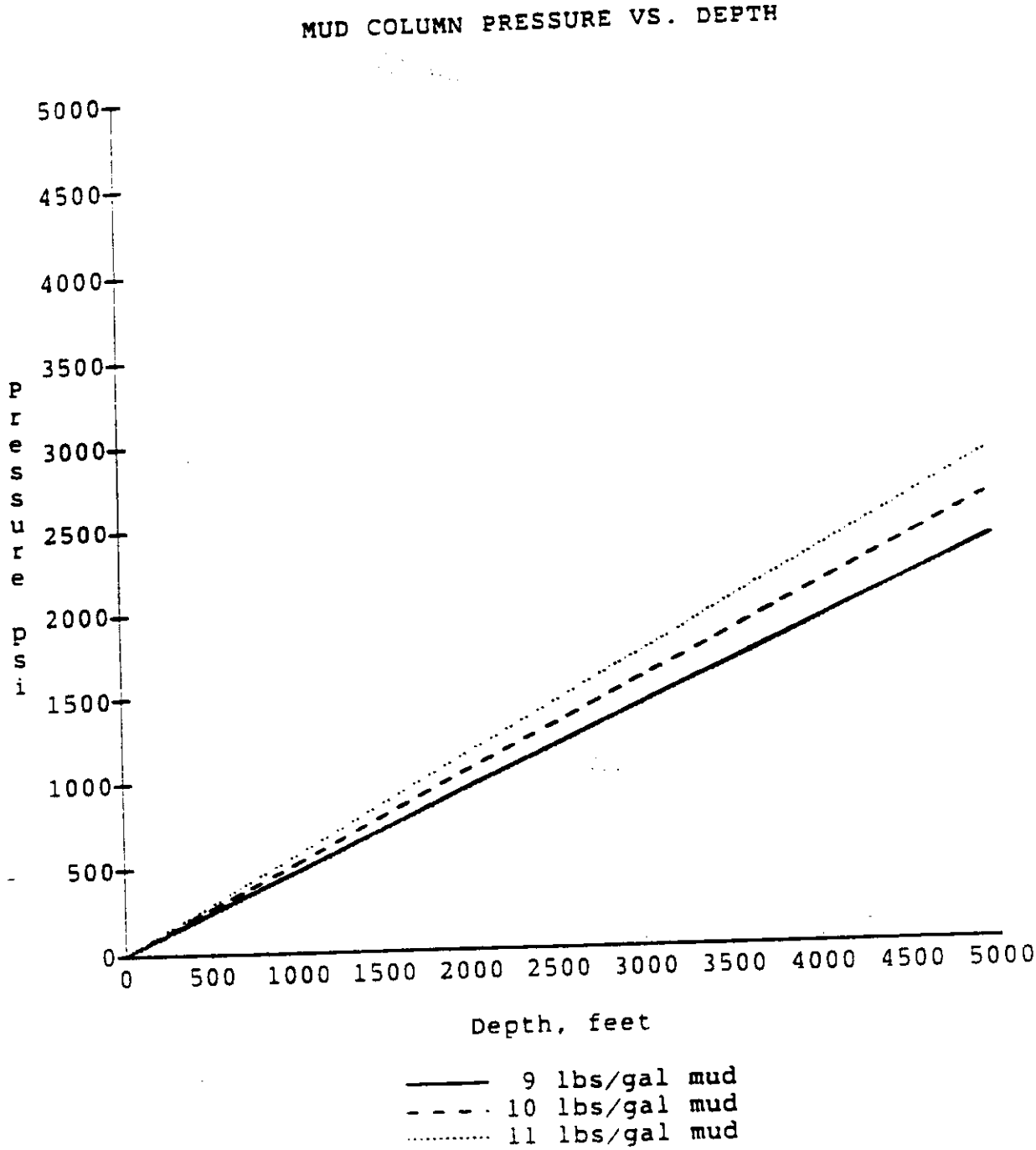

MUD COLUMN PRESSURE VS. DEPTH
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
pressure psi
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth, feet
9 lbs/gal mud
10 lbs/gal mud
11 lbs/gal mud

Figure 5

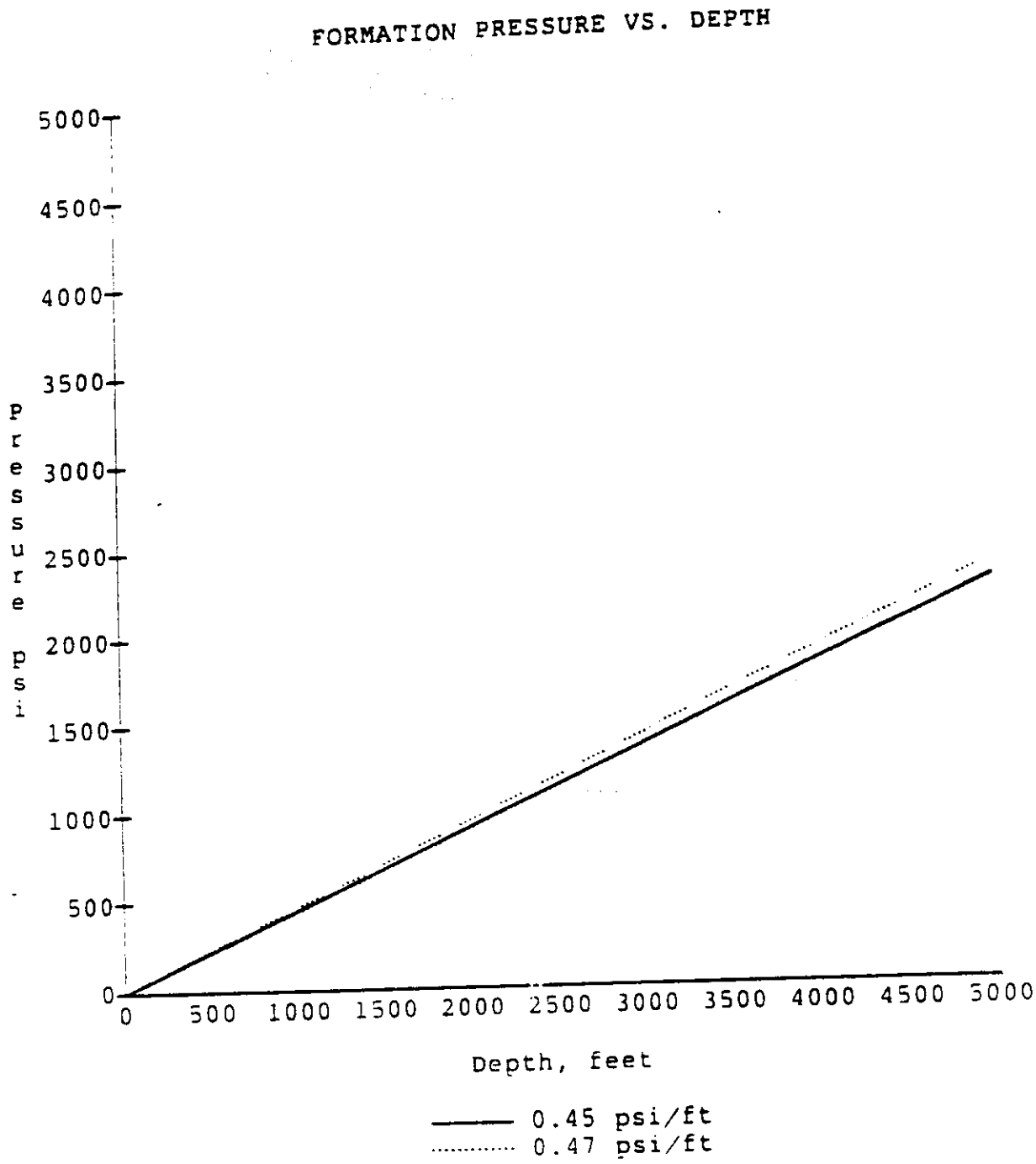

FORMATION PRESSURE VS. DEPTH
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
pressure psi
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth, feet
0.45 psi/ft
0.47 psi/ft

Figure 6

PRESSURE DIFFERENTIAL BASED ON MUD WEIGHT
AND FORMATION GRADIENT

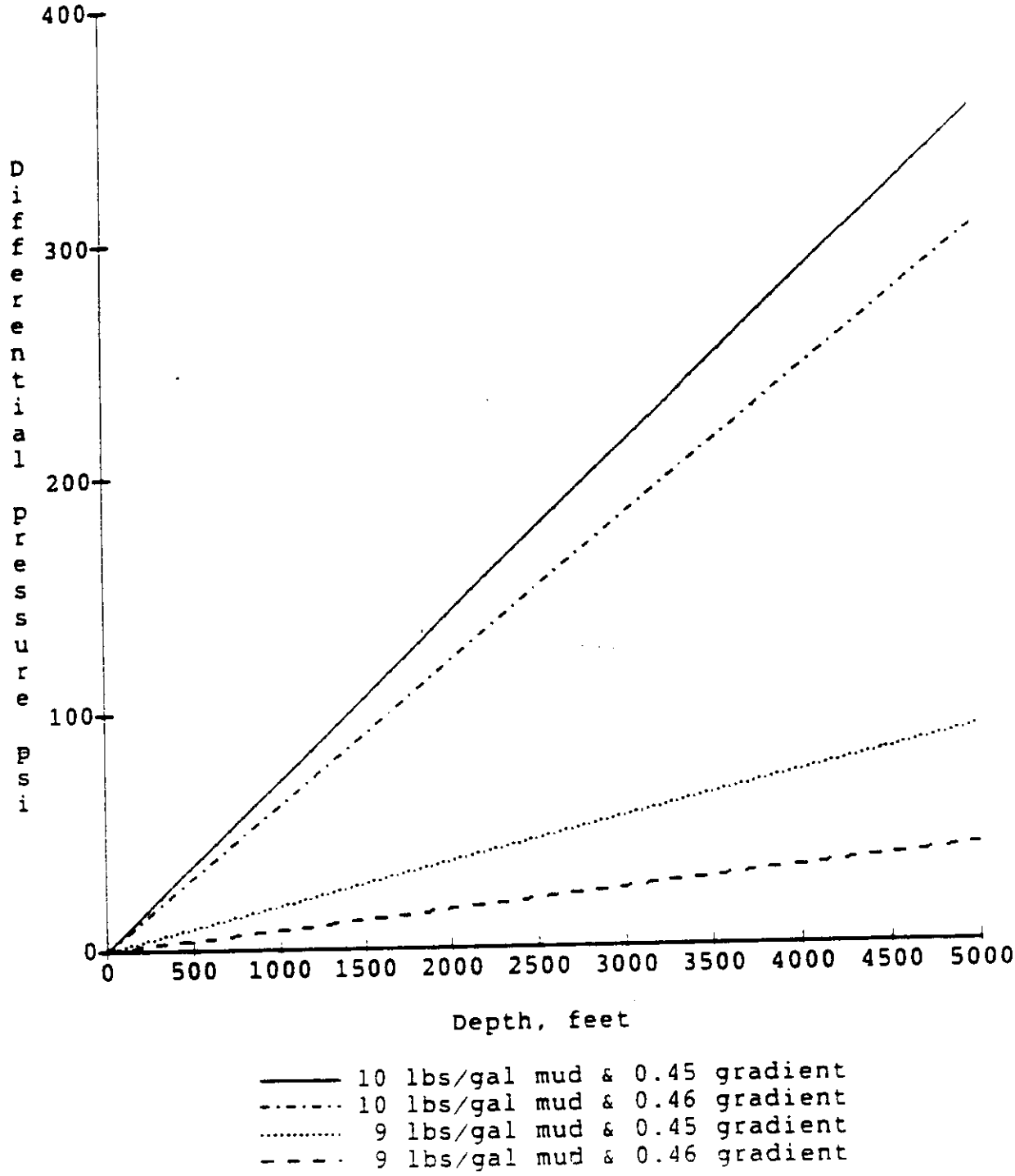


Figure 7

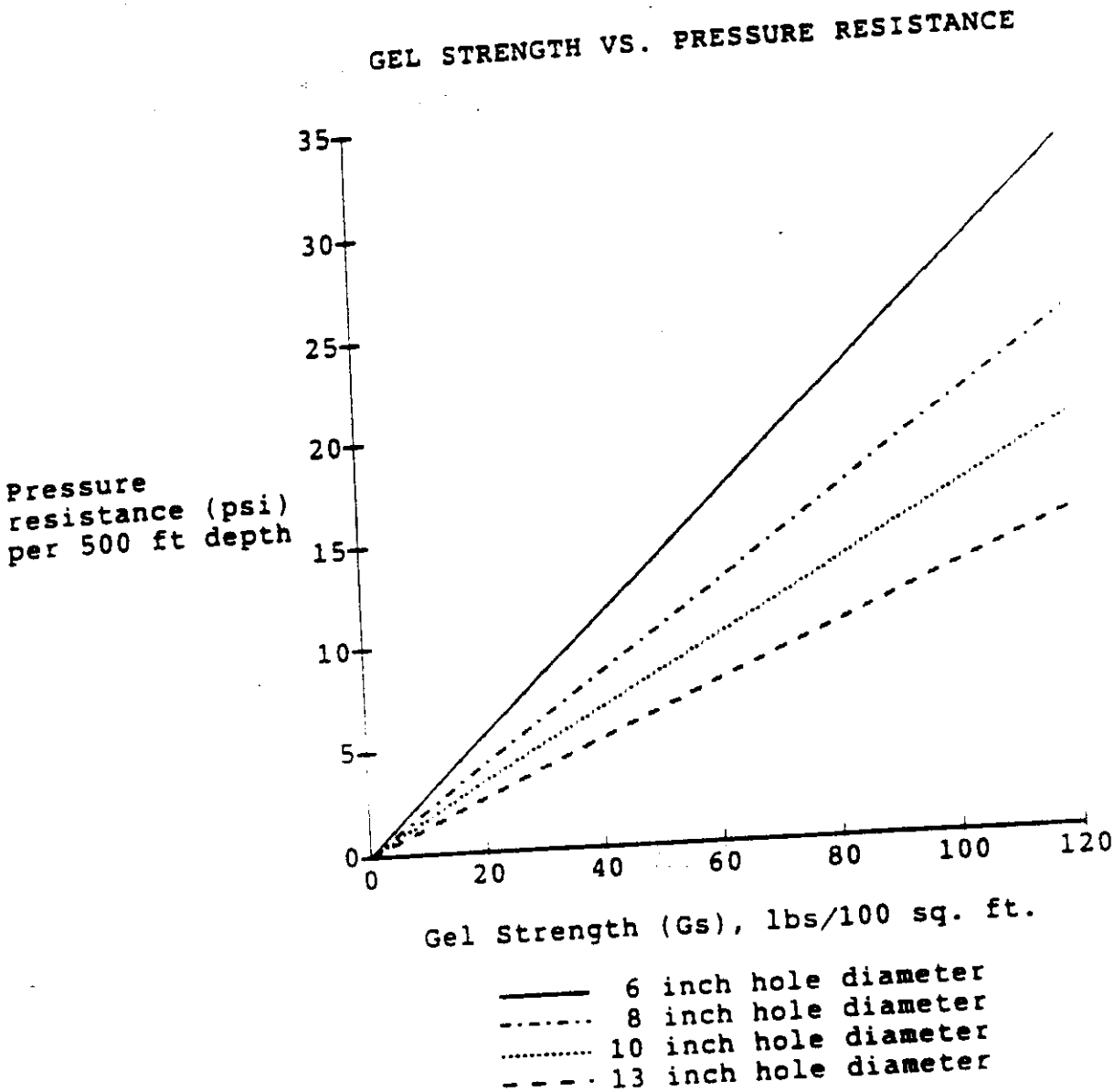
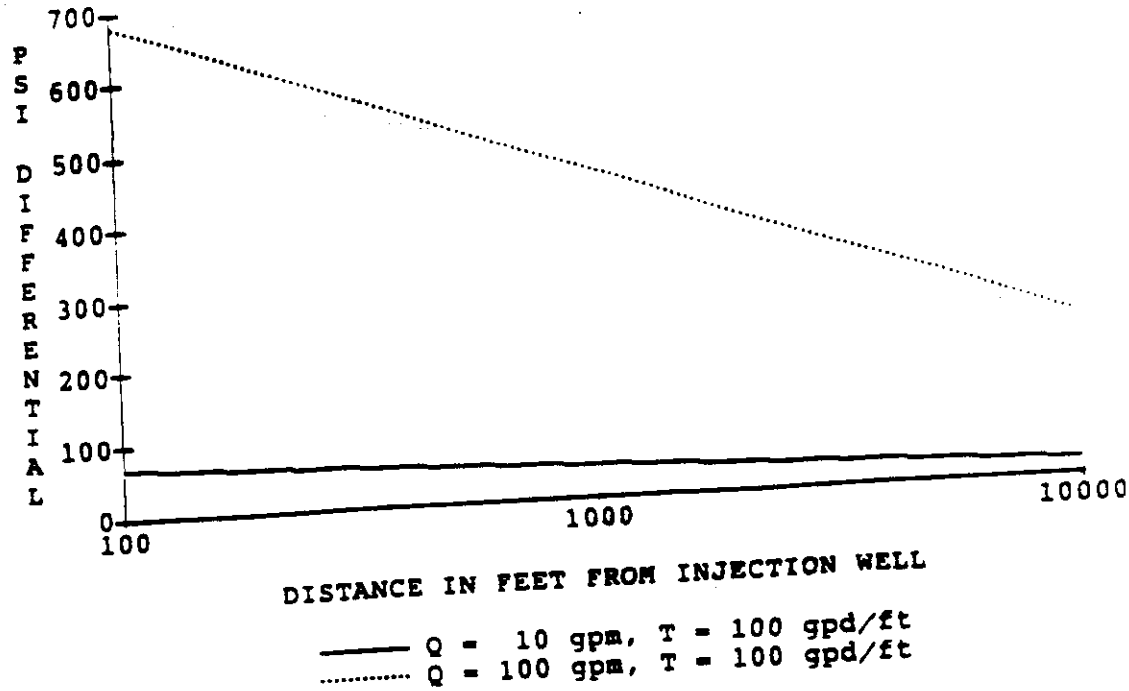
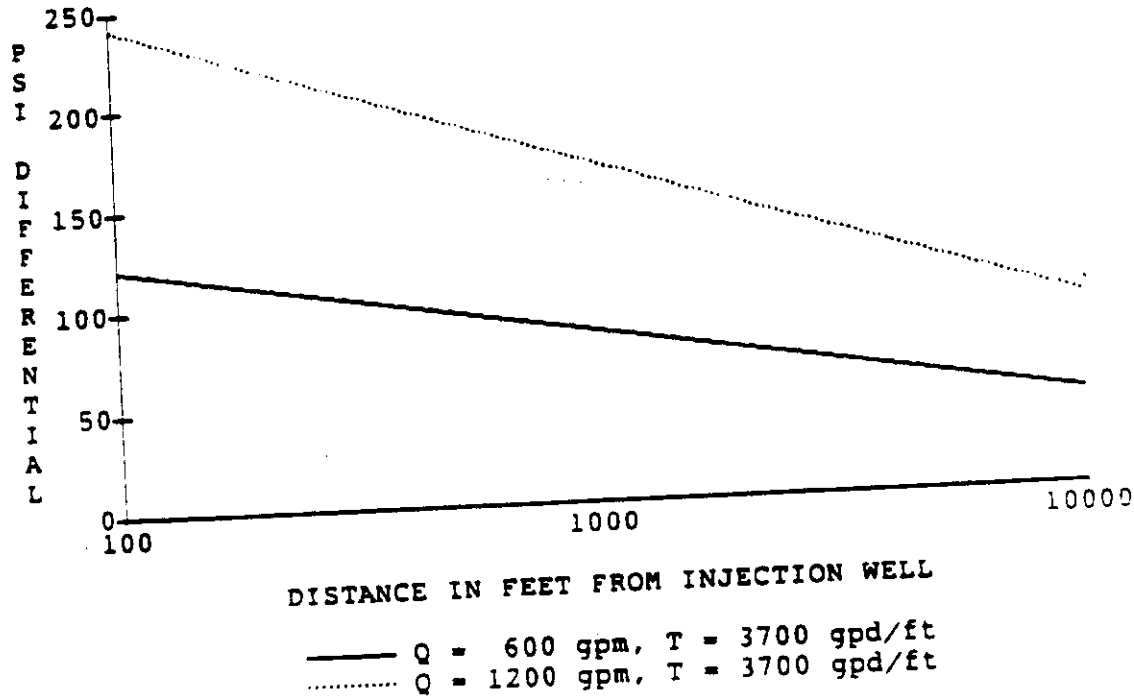

GEL STRENGTH VS. PRESSURE RESISTANCE
Pressure resistance (psi) per 500 ft depth
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
Gel Strength (Gs), lbs/100 sq. ft.
6 inch hole diameter
8 inch hole diameter
10 inch hole diameter
13 inch hole diameter

Figure 8

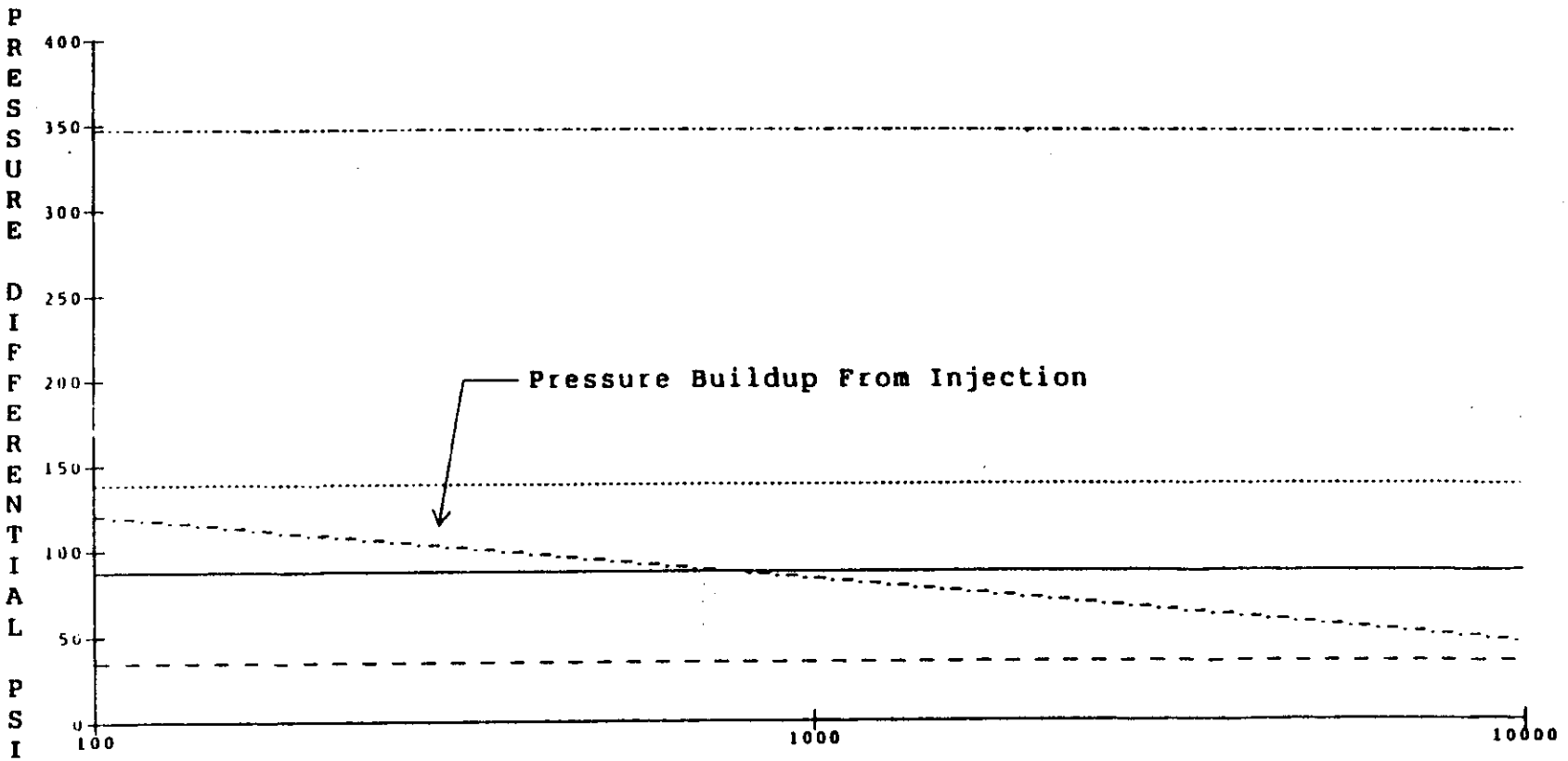




Injection Zone Pressure Buildup After 30 Years vs. Distan
and Relationship Between Transmissivity and Injection Rates.

Figure 9

AREA OF REVIEW CALCULATION



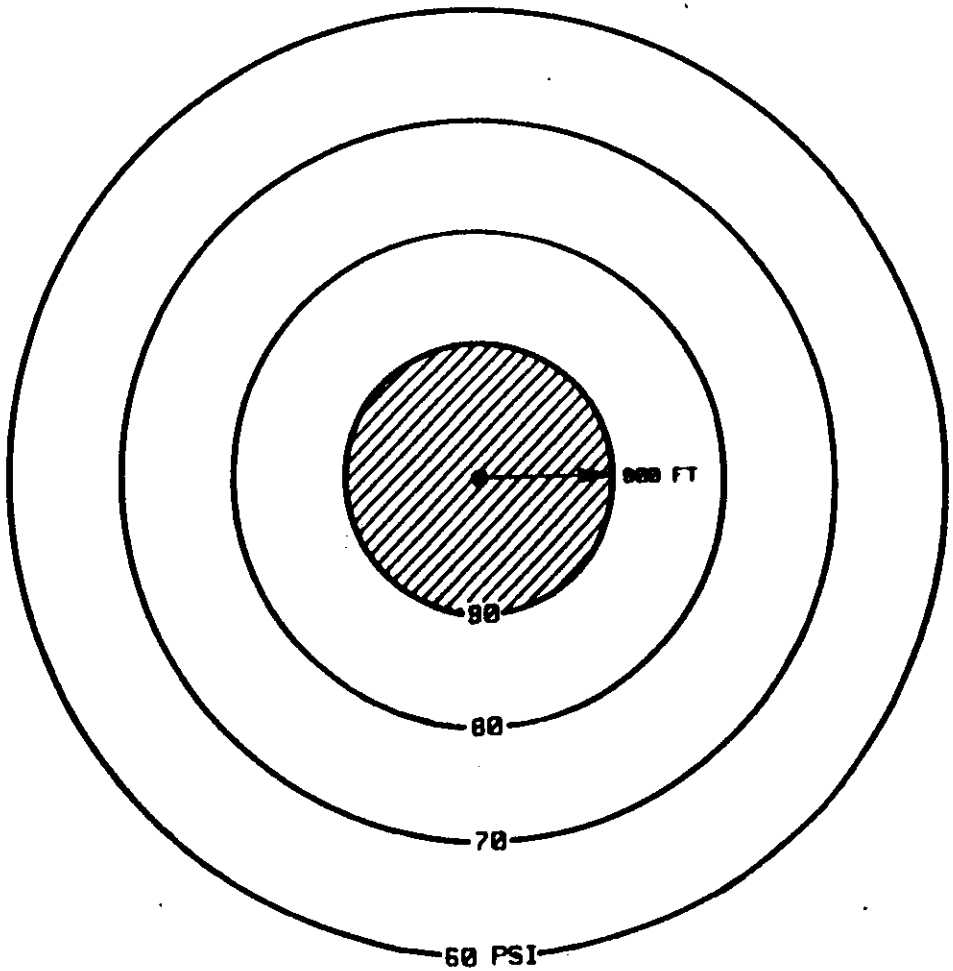
DISTANCE IN FEET FROM INJECTION WELL

Mud pressure resistance, 10 lbs/gal mud @ 5000 ft
Mud pressure resistance, 10 lbs/gal mud @ 2000 ft
Mud pressure resistance, 9 lbs/gal mud @ 2000 ft
Mud pressure resistance, 9 lbs/gal mud @ 2000 ft

Area of Review Calculation Based on Formation Gradient = 0.45 psi/ft, 9 lbs/gal Mud at 5000 ft Depth, and an Injection Zone where Q = 600 gpm and T = 3700 gpd/ft. Other Weight Muds at Various Depths Shown.

Figure 10

CALCULATED PRESSURE INCREASE DISTRIBUTION
AREA OF REVIEW CALCULATION



EXPLANATION

CALCULATED AREA OF REVIEW

PARAMETERS

Q = 600 gpm
T = 3700 gpd/ft
(30 yr. injection)
9 lbs/gal MUD @ 5000 FT

Figure 11

Case 1

CASE HISTORIES RESEARCHED

FROM TEXAS RAILROAD COMMISSION FILES

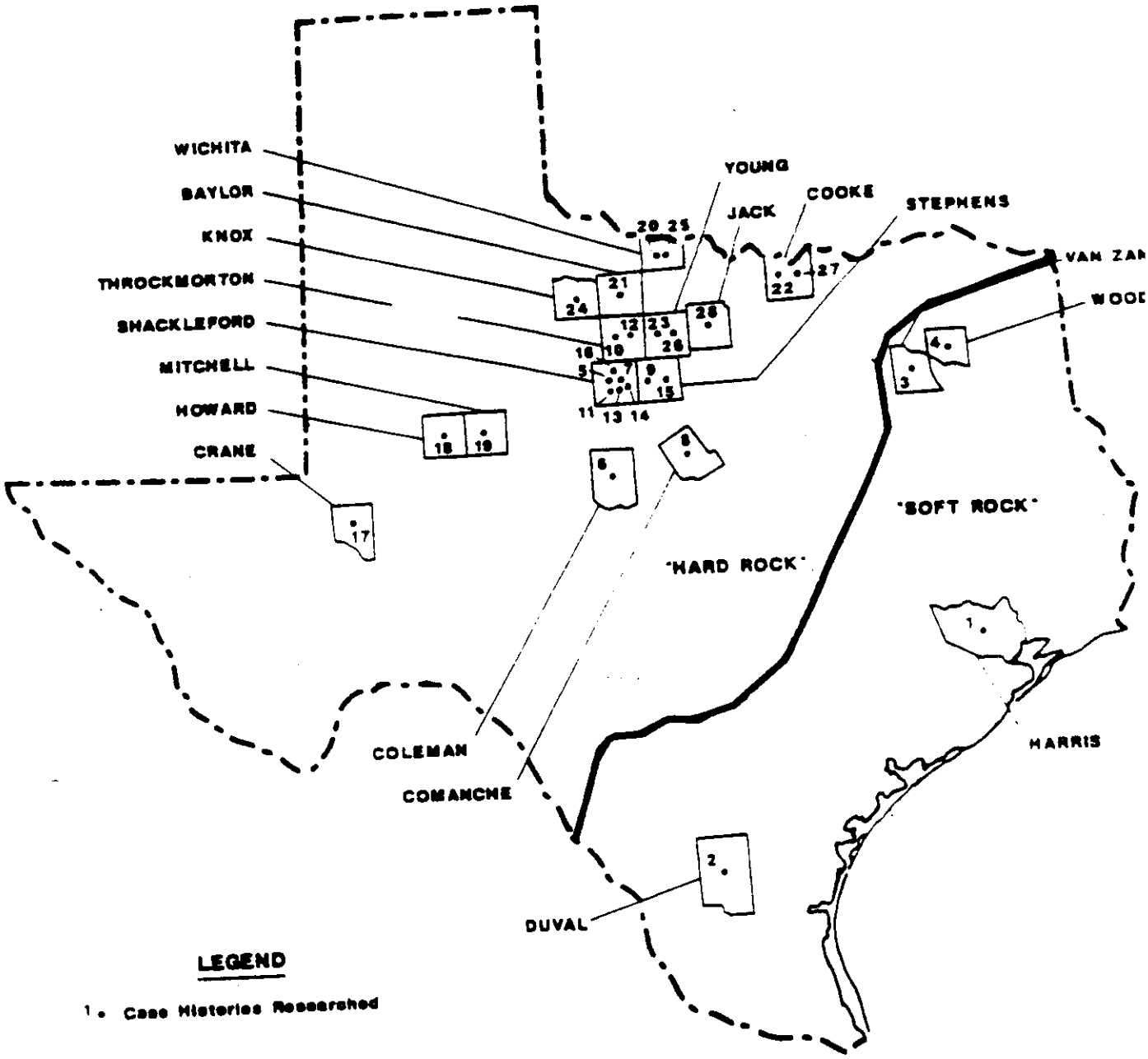
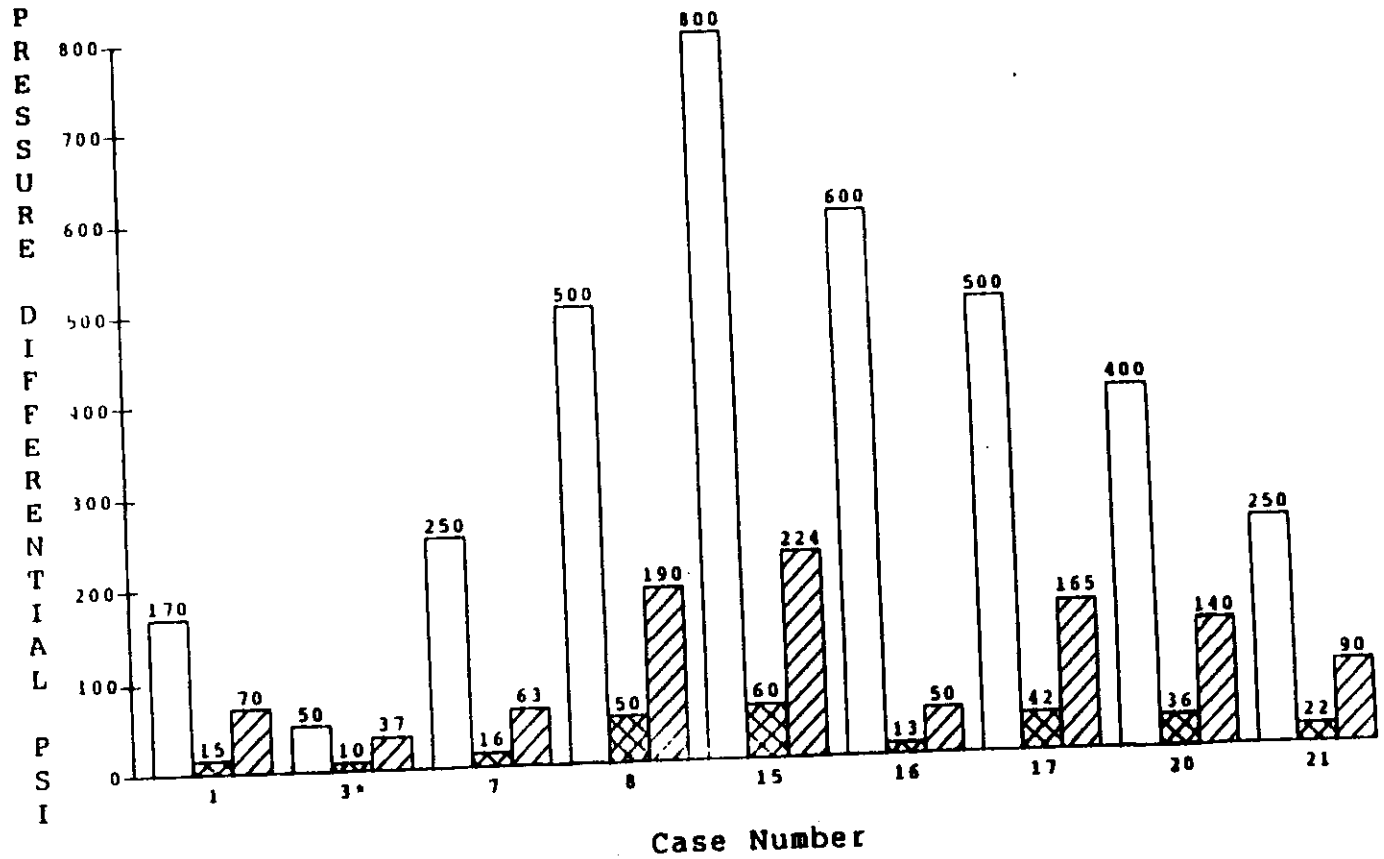


Figure 12

CASE 1
RESERVOIR PRESSURE BUILDUP VS. MUD PRESSURE RESISTANCE



reservoir pressure buildup

calculated pressure resistance for 9 lbs/gal mud

calculated pressure resistance for 10 lbs/gal mud

* limited reservoir data available

Figure 13

CASE 1
TOTAL DEPTH OF LEAKING WELLS VS. NUMBER OF OCCURRENCES

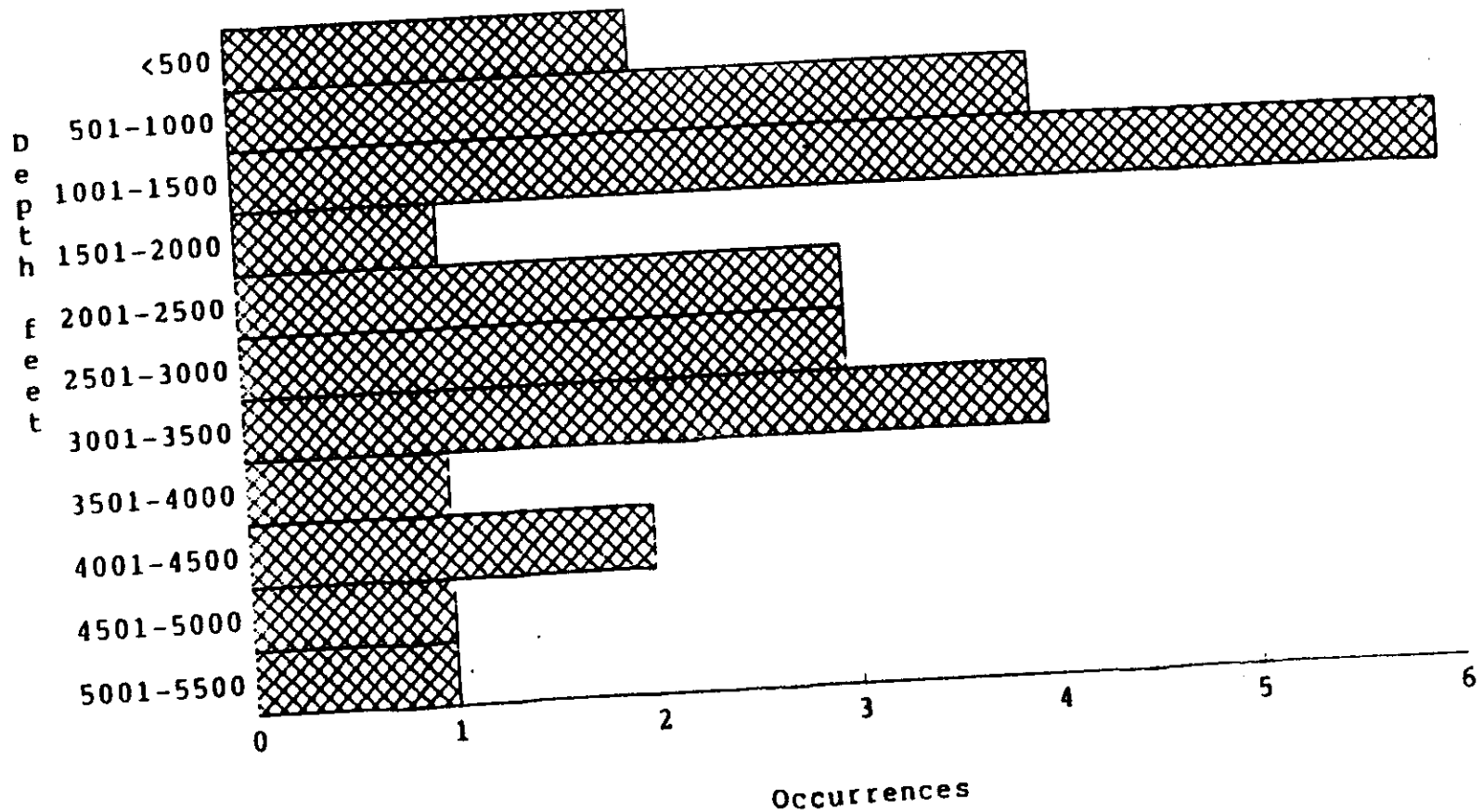


Figure 14

CASE 1
DISTANCE FROM LEAKING WELLS TO SUSPECT CLASS II WELLS

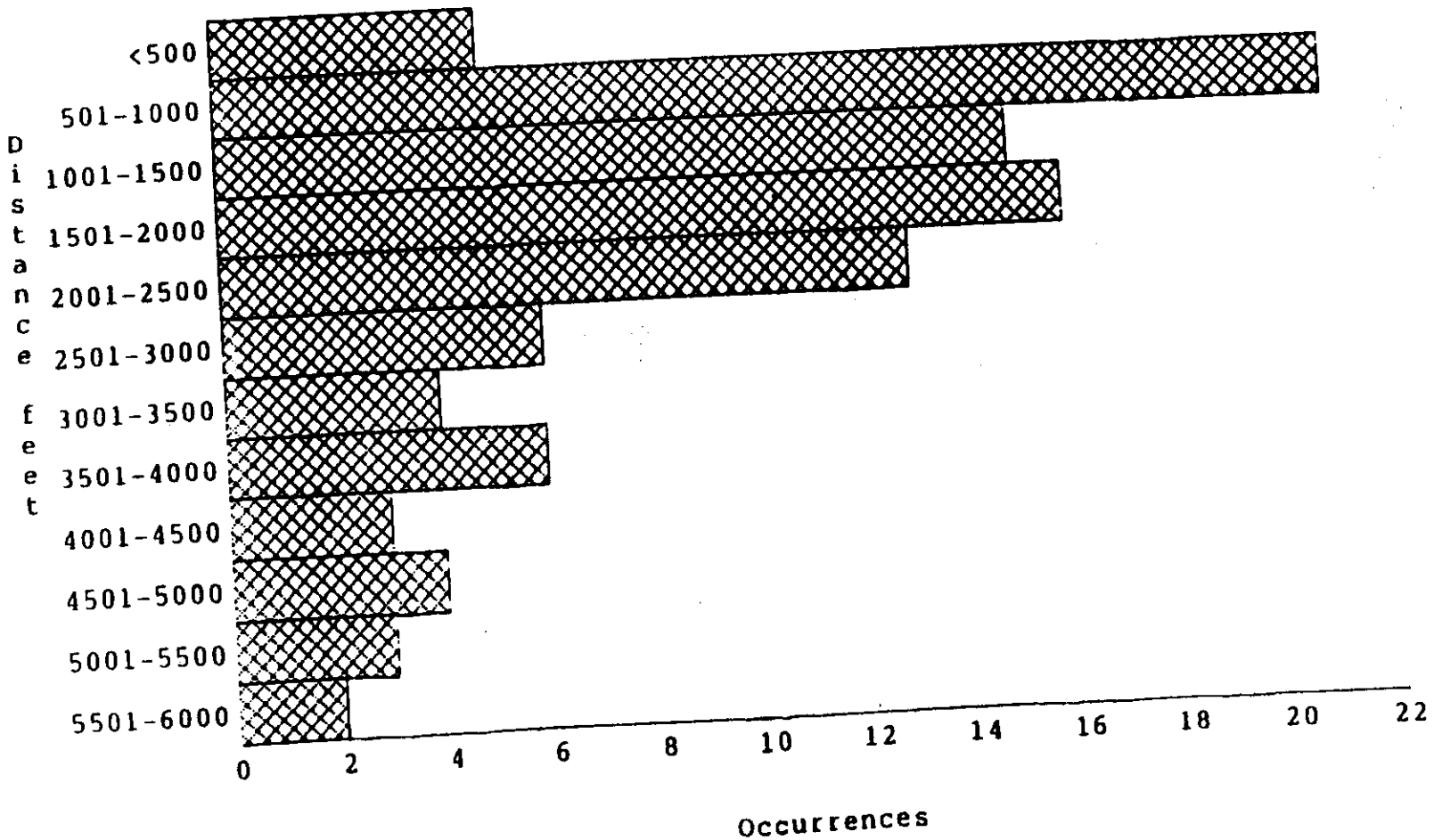


Figure 15

Case 2

PROPER PLUGGING HEARING SURVEY

SELECTED GULF COAST COUNTIES

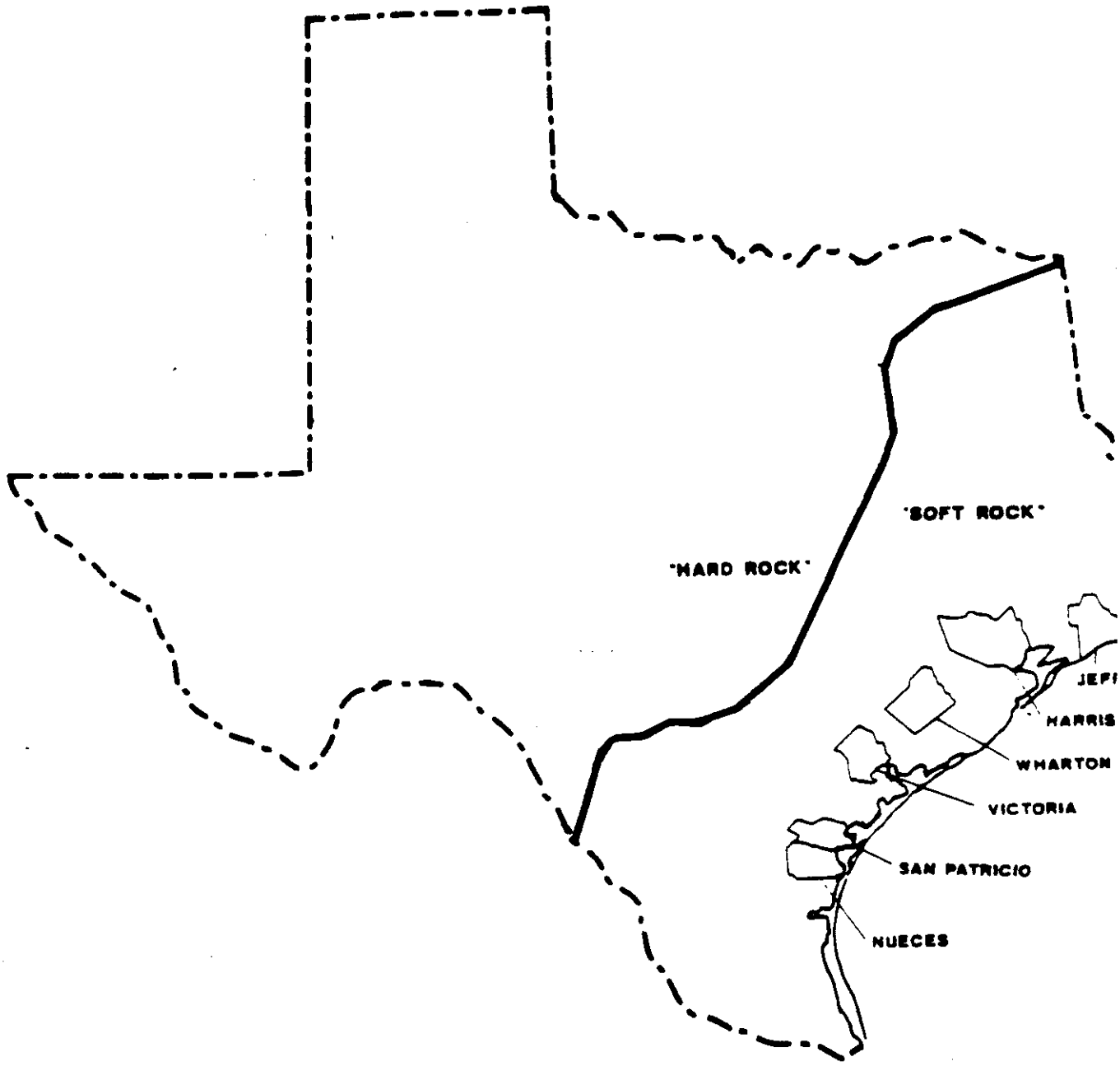
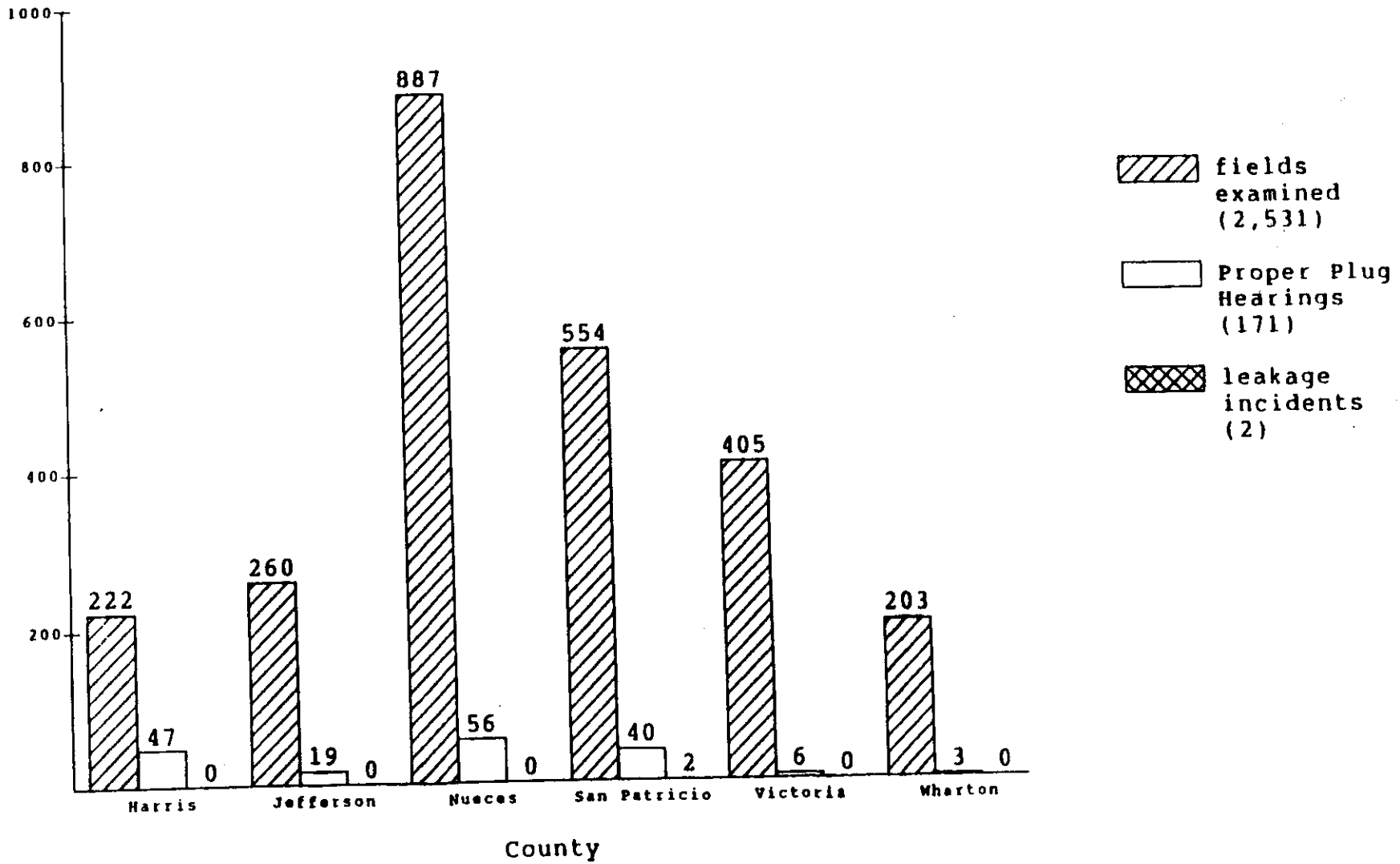


Figure 16

CASE 2
NUMBER OF FIELDS EXAMINED, PROPER PLUG HEARINGS, AND
POLLUTION INCIDENTS REPORTEDLY CAUSED BY CLASS II INJECTION



gure 17

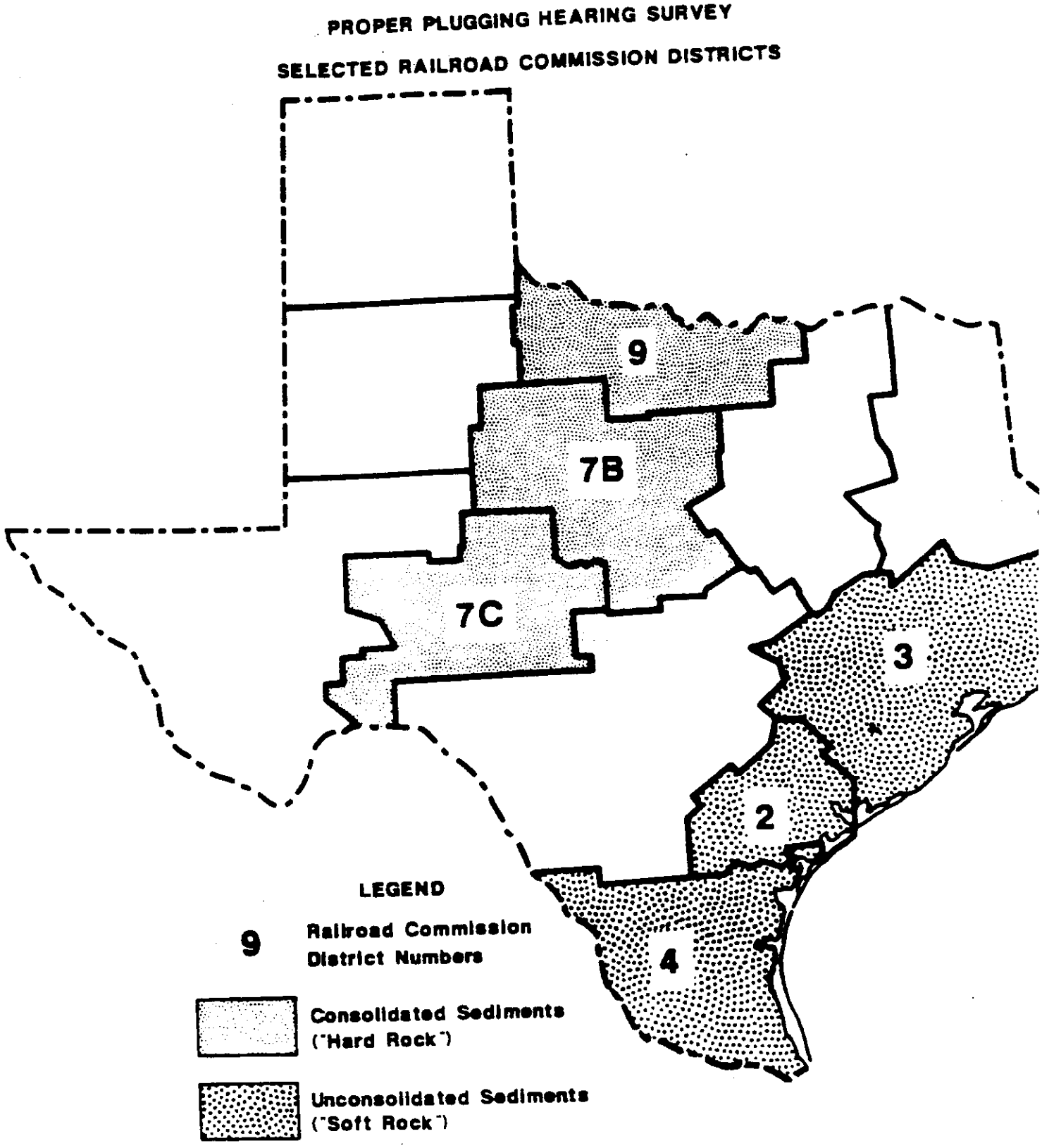

PROPER PLUGGING HEARING SURVEY
SELECTED RAILROAD COMMISSION DISTRICTS
9
7B
7C
3
2
4
LEGEND
9
Railroad Commission District Numbers
Consolidated Sediments ("Hard Rock")
Unconsolidated Sediments ("Soft Rock")

Figure 18

CASE 3
CONSOLIDATED VS. UNCONSOLIDATED FORMATIONS

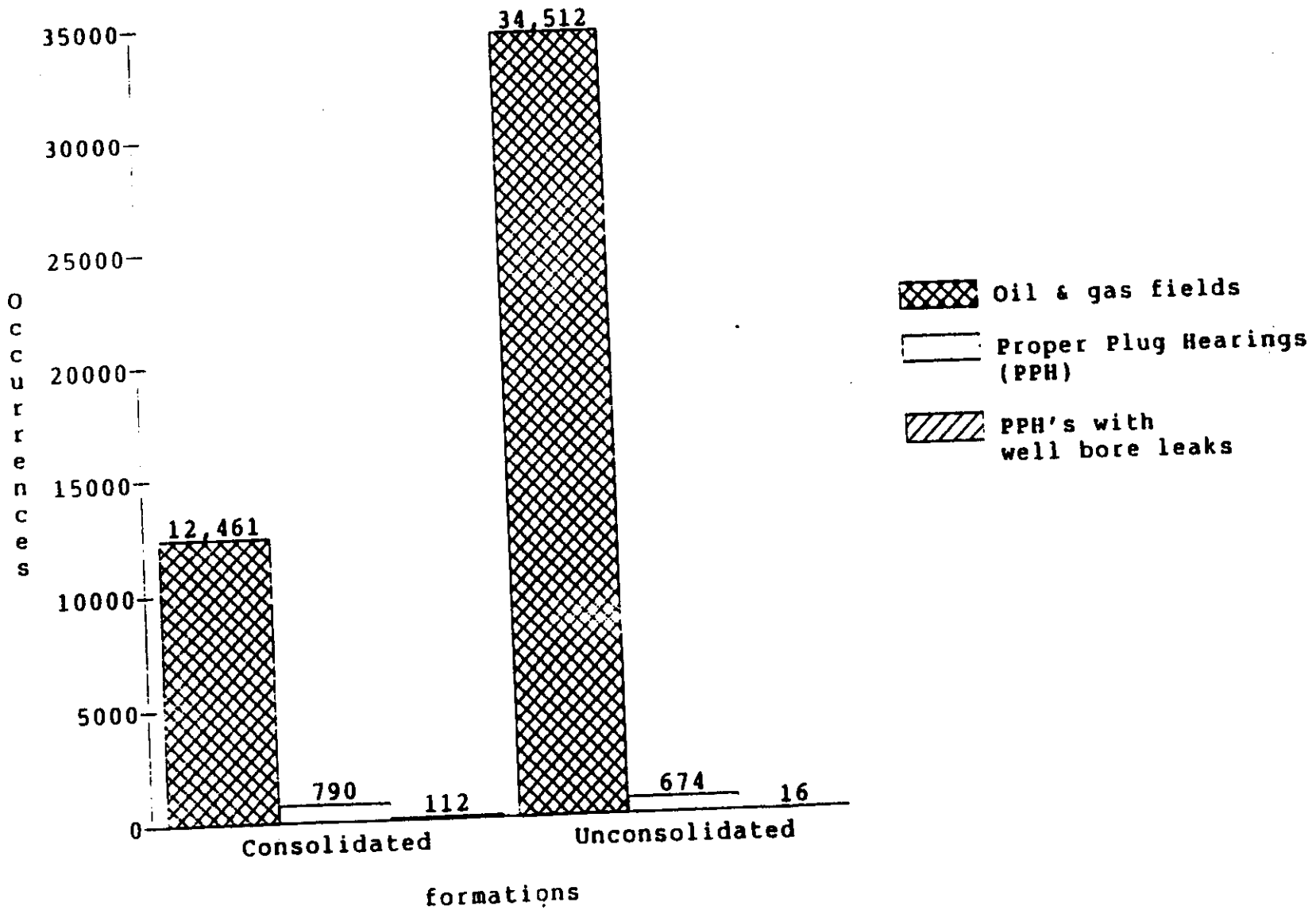


Figure 19

REFERENCES

AIC (Agency Information Consultants, Inc.), 1987a, Survey of Cited EPA Problem Leaking Wells in Texas: Prepared for E. I. Du Pont.

AIC (Agency Information Consultants, Inc.), 1987b, Survey of Pollution Abatement Hearings for Selected Counties Along the Texas Gulf Coast: Prepared for E. I. Du Pont.

AIC (Agency Information Consultants, Inc.), 1987c, Survey of Proper Plugging Hearings for Fluid Migration from Unplugged or Improperly Plugged Wells in Texas Railroad Commission Districts 02, 03, 04, 07B, 07C, and 09: Prepared for E. I. Du Pont.

Alford, S. E., 1987, Conoco, Senior Drilling Engineer (drilling mud specialist), Houston, TX; personal communication.

Ammons, C. T., 1987, Conoco, Drilling Engineer, Lafayette, LA; personal communication.

Anzzolin, A. R., and Graham, L. L., 1984, Abandoned Wells—A Regulatory Perspective, in D. M. Fairchild, ed., Proceedings of the First National Conference on Abandoned Wells: Problems and Solutions: Environmental and Ground Water Institute, University of Oklahoma, Norman, OK, p. 17-36.

Barker, S. E., 1981, Determining the Area of Review for Industrial Waste Disposal Wells: Master's Thesis, The University of Texas at Austin, Austin, TX, 146 p.

Burst, J. F., 1959, Postdiagenetic Clay Mineral Environmental Relationships in the Gulf Coast Eocene, in A. Swineford, ed.,

Clays and Clay Minerals: 6th National Clays and Clay Mineral Conference Proceedings, Pergamon Press, 411 p.

Burst, J. F., 1969, Diagenesis of Gulf Coast Clayey Sediments and Its Possible Relation to Petroleum Migration: American Association of Petroleum Geologists Bulletin, v. 53, p. 73-93.

Cheatham, Jr., J. B., 1984, Wellbore Stability: Journal of Petroleum Technology, V. 36, p. 889-896.

Collins, R. E., 1986, Technical Basis for Area of Review: Prepared for Chemical Manufacturers Association, 112 p.

Cooke, Jr., C. E., Kluck, M. P., and Medrano, R., 1983, Field Measurement of Annular Pressure and Temperature During Primary Cementing: Journal of Petroleum Technology, V. 35, p. 1429-1438.

Cooke, Jr., C. E., Kluck, M. P., and Medrano, R., 1984, Annular Pressure and Temperature Measurements Diagnose Cementing Operations: Journal of Petroleum Technology, v. 36, p. 2181-2186.

Darley, H. C. H., 1969, A Laboratory Investigation of Borehole Stability: Journal of Petroleum Technology, v. 21, p. 883-892.

Davis, K. E., 1986, Factors Effecting the Area of Review for Hazardous Waste Disposal Wells: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes, National Water Well Association, Dublin, OH, p. 148-194.

Eikel, B. C., 1969, Assistant District Director, Railroad Commission of Texas, letter of August, 20, 1969 to R. D. Payne, Director

of Field Operations, Railroad Commission of Texas: Railroad Commission of Texas file 00000101834.

Engineering Enterprises, Inc., 1985, Guidance Document for the Area of Review Requirement: Norman, OK, prepared for EPA.

EPA, 1975, Proposed Injection Well Regulations for Brine Produced with Oil or Gas: US EPA Document from J. T. Thornhill to E. Hockman, 24 p.

Fryberger, J. S., and Tinlin, R. M., 1984, Pollution Potential from Injection Wells via Abandoned Wells, in D. M. Fairchild, ed., Proceedings of the First National Conference on Abandoned Wells: Problems and Solutions: Environmental and Ground Water Institute, University of Oklahoma, Norman, OK, p. 84-117.

Garrison, A. D., 1939, Surface Chemistry of Clays and Shales: Petroleum Transactions of AIME, v. 132, p. 191-203.

Gray, G. D., Darley, H. C., and Rogers, W. F., 1980, Composition and Properties of Oil Well Drilling Fluids: Houston, Gulf Publishing.

Grim, R. E., 1968, Clay Mineralogy (2nd ed.): New York, McGraw-Hill, 596 p.

Gurke, R., 1987, Halliburton Service Training Course, Duncan, OK, personal communication.

Hiller, K. H., 1963, Rheological Measurements on Clay Suspensions and Drilling Fluids at High Temperatures and Pressures: Journal of Petroleum Technology, v. 15, p. 779-789.

Johnston, O., and Green, C. J., 1979, Investigation of Artificial Penetrations in the Vicinity of Subsurface Disposal Wells: Texas Department of Water Resources.

Johnston, O. C., and Knape, B. K., 1986, Pressure Effects of the Static Mud Column in Abandoned Wells: Texas Water Commission LP86-06, 99 p.

Klotzman, 1986, Consulting Geologist; Concerning Plugging Abandoned Wells Near Victoria, TX; personal communication.

Krusekopy, Jr., H. H., 1970, Geologist, Railroad Commission of Texas letter of January 22, 1970 to R. D. Payne, Director of Field Operations, Railroad Commission of Texas: Texas Railroad Commission file 00000300113.

Meers, R. J., 1987, Petroleum Consultant; Concerning Plugging Abandoned Wells Near Orange, TX; personal communication.

Polk, G., and Gray, G. R., 1984, Plugging Mineral Exploration Holes with a Drilling Fluid Conditioner, in D. M. Fairchild, ed., Proceedings of the First National Conference on Abandoned Wells: Problems and Solutions: Environmental and Ground Water Institute, University of Oklahoma, Norman, OK, p. 295-302.

Powers, M. C., 1967, Fluid-release Mechanisms in Compacting Marine Mudrocks and Their Importance in Oil Exploration: American Association of Petroleum Geologists Bulletin, v. 51, p. 1240-1254.

Price, W. H., 1971, The Determination of Maximum Injection Pressure for Effluent Disposal Wells, Houston, Texas area: Master's Thesis, The University of Texas at Austin, Austin, TX, 84 p.

Ross, C. C., and Steed, W. C., 1984, Well Plugging in Texas, in D. M. Fairchild, ed., Proceedings of the First National Conference on Abandoned Wells: Problems and Solutions:

Environmental and Ground Water Institute, University of Oklahoma, Norman, OK, p. 251-270.

Roth, T., 1987, Head of UIC Program (Class I) for State of Texas; Concerning Number of Class II Injection Wells; personal communication.

Biographical Sketches

James E. Clark holds a B.S. in geology (1972) from Auburn University an M.S. in geophysical sciences (1977) from Georgia Institute of Technolo As a geohydrologist with Law Engineering Testing Co., he worked on suitabili studies of salt domes as repositories for nuclear waste. He is a consultant with Du Pont's (E. I. du Pont de Nemours & Co., Inc., Engineering Department, P. O. Box 3269, Beaumont, TX 77704) solid waste and geological engineering group and is active in permitting and evaluation of disposal wells.

Milton R. Howard received his B.S. degree in geology from Texas A&M University (1985). He served as a petroleum geologist for SOHIO and Albaine, active in on-shore database evaluation and oil and gas exploration. In 1985 he joined the waste and geological engineering group of Du Pont as a contract consulting environmental geologist responsible for permitting and evaluation of the Federal UIC Class I disposal wells.

Diane K. Sparks received her B.S. degree (1977) in geology and her M.S. degree (1978) in geology from Bowling Green State University. She was petroleum geologist with Amoco Production Company and Helmerich and Payne, Inc. Sparks is now a consulting geologist and currently works as a contract geologist for the Engineering Service Division of Du Pont, in evaluation of Class I disposal wells and fluid migration studies.

Gulf Coast Borehole Closure Test
Well Orangefield, Texas

GULF COAST BOREHOLE CLOSURE TEST WELL ORANGEFIELD, TEXAS

by

J. E. Clark, P. W. Papadeas, D. K. Sparks, R. R. McGowen

E. I. du Pont de Nemours & Co., Inc.
P. O. Box 3269
Beaumont, Texas 77704

Presented at Texas Water Commission - Annual Meeting

October 24 - 25, 1991 - Austin, Texas

GULF COAST BOREHOLE CLOSURE TEST WELL ORANGEFIELD, TEXAS

J. E. Clark, P. W. Papadeas, D. K. Sparks, R. R. McGowen

E. I. du Pont de Nemours & Co., Inc.
P. O. Box 3269
Beaumont, Texas 77704

ABSTRACT

A borehole closure protocol for a Gulf Coast site near Orangefield, Texas was developed by Du Pont. These procedures were based largely upon recommendations provided by EPA Region 6 and created a borehole closure test to demonstrate that, under a worst case scenario, any artificial penetration will seal naturally. The borehole closure test successfully demonstrated natural sealing. Within one week of setting the screen, tubing and pressure transducers in the borehole, testing confirmed the absence of upward movement of fluid from the test sand. The documentation for the absence of upward movement included: 1) Schlumberger Water Flow Log* and 2) the absence of pressure response on the upper transducer located outside the tubing and inside the casing. Testing was conducted in accordance using specified procedures, with pressure testing conducted at even higher pressures to allow an added margin of confidence. The borehole closure test provides a significant additional margin of confidence that there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous.

INTRODUCTION

The borehole closure study was conducted to address concerns associated with the movement of injected fluids toward the Orange Salt Dome from the injection wells operated at the Du Pont Sabine River Works. The borehole closure test well (Orange Petroleum #35 Hagar) is located on the east bank of Cow Bayou on the eastern flank of Orange Salt Dome, east-southeast of the town of Orangefield, Texas (see Figure 1). The study was performed in response to EPA's request for additional information sufficient to demonstrate that, even assuming a worst-case basis that wastes might migrate across the faults at Orange Salt Dome, there would be no migration of hazardous constituents from the injection zone upward through artificial penetrations.

* Mark of Schlumberger

Previous studies (Johnston and Greene, 1979; Davis, 1986; Johnston and Knappe 1986; Clark et al., 1987) have reported qualitatively that wells drilled in unconsolidated (soft) rock, such as the Gulf Coastal Plain in Texas, experience natural borehole closure. This study was developed by Du Pont for a quantitative analysis on natural borehole closure and was based upon recommendations provided by EPA. The worst-case scenario developed for this study included: 1) a test interval within the injection zone consisting of a thin injection sand overlain by a thick, sand-free shale; 2) an open borehole with a diameter equal to the largest hole diameter expected to be encountered among the abandoned wells at Orange Salt Dome, 3) a mud program designed in accordance with drilling practices in general use at the time the abandoned boreholes in question were drilled (1919), and 4) actual testing with a 9.0 lb/gal brine since this is the worst-case condition for abandoned holes without plugging records. The test protocol provided that the test would be successful if, when a 100 psi pressure increase was applied, a Water Flow Log or oxygen activation (OA) log run at stations above the injection sand interval showed no upward channeling and an upper pressure transducer showed no pressure buildup.

The maximum calculated value for potential pressure increase at this site is <80 psi, which includes all possible sources of pressure increase: 1) maximum density contrast between natural formation fluid and the injected waste (0.075) and 2) a worst-case density drive if the plume extended from the plant to the dome (maximum dip 2400 feet). More likely, the long-term effect of buoyancy occurs where the plume has drifted from the plant to the dome and the number of feet of dip is considerably less, only 300 feet. In the latter case, the pressure due to buoyancy would be <10 psi. Thus, testing the borehole closure well to 100 psi increase is an extremely conservative approach.

If an artificial penetration had been abandoned with casing in place, the casing would corrode, thus 'exposing' whatever was in the borehole to the formation. This corrosion information was based on conservative data from Orange Salt Dome artificial penetration data and National Association of Corrosion Engineers data (Graver, 1985). Using a maximum casing wall thickness of 0.557 inch for 8 5/8-inch casing and a conservative corrosion rate of 20 mils per year, the casing would corrode in 28 years, which is long before waste reaches Orange Salt Dome in approximately 5,000 years. This value is consistent with casing corrosion data available from producing wells in the Orangefield area.

The geologic formations present at depths of 2000 ft to 8000 ft consist mainly of middle to upper Miocene sands, with lower Oligocene Anahuac Shale, and Frio sands at greater depth (see Figure 2). Tertiary sands and shales were deposited in a series of stacked progradational wedges, which dip and ultimately thicken toward the Gulf of Mexico. The lower Miocene Lagarto and the middle Miocene Oakville Formation are both characterized by very thick, fine to very fine grained sands, silts and shales deposited in a fluvial and deltaic environment. The regional geologic structural setting is one characteristic of salt tectonics, with salt dome intrusions, minor salt ridges and deep synclines. Orange Salt Dome is a piercement type salt dome (top of salt approximately 7000 feet) where considerable quantities of hydrocarbons have been produced since 1919.

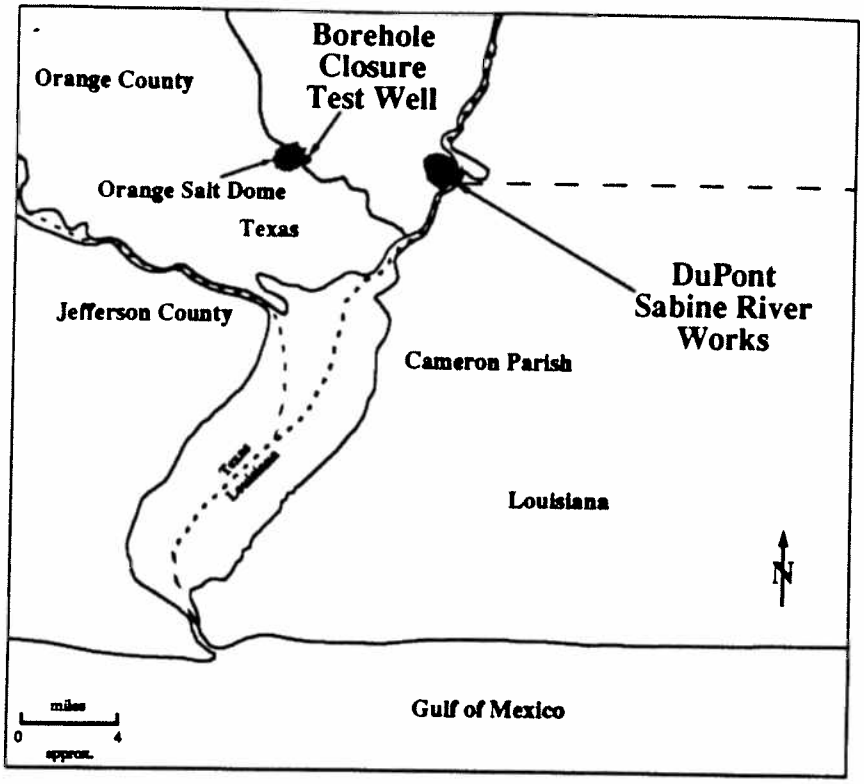


Figure 1 : Geographic Location Map of the Sabine River Works and the Borehole Closure Test Well

Period	Epoch	Stage or Group	Formation
QUATERNARY	HOLOCENE	Undifferentiated	
		12,000 YA	
	PLEISTOCENE	Houston L. Wisconsin	Beaumont
		Wisconsin E. Wisconsin	
		Sangamon L. Illinoian	
		Pre-Sangamon E. Illinoian	Lissie
		Yarmouth Kansan	
		Aftonian Nebraskan	Willis
		2.8 MYA	
TERTIARY	PLIOCENE	Citronelle Group	Goliad
		5.2 MYA	
	MIOCENE	Fleming Group	Lagarto
			Oakville
		24 MYA	
	OLIGOCENE	Catahoula Group	Anahuac
		Vicksburg Group	Vicksburg
		37 MYA	

Figure 2: Stratigraphic Column for Eastern Gulf Coast. Adapted from Jackson and Galloway, 1984.

PROCEDURES

Following evaluation and analysis of the mudlog, lithology samples, openhole logs, and visual examination of sidewall cores obtained from the test well, several sand and shale zones were determined to be potential candidates for the test interval. Using the protocol developed by Du Pont with recommendations from the EPA, the criteria for test interval selection called for a thin clean injection sand, overlain by a thick sand-free shale within the injection zone. The injection sand selected contains 30 net feet of clean sand (2932 feet - 2962 feet) with 88 net feet of clean shale (2838 feet - 2926 feet). The casing was set at 2838 feet into the shale of the test interval. This graphic is presented in the well construction schematic using the electric log as a base (see Figure 3).

Analysis of two sidewall cores for particle size distribution from the injection sand was an important factor in determining the screen size. Sidewall core plugs from 2937 feet and 2945 feet were analyzed for porosity, permeability and lithology. Silt and clay particle analysis indicated a median grain size of 0.0046 inches. Using this information, the size of the screen assembly selected was 0.006 inches, the best gauge of screen that would most closely fit the particle size of the formation for a natural completion. Porosity within the test sand ranges from 29.6 to 31.8% (neutron-density log porosity ranges from 29 to 31%), with permeabilities on the order of 900 to 1400 millidarcies (md).

In order to satisfy a further worst case condition, Du Pont, at EPA's request investigated and evaluated electric logs of representative wells located within the confines of the 10,000-year waste plume. These artificial penetrations were evaluated for continuity of shale overlying the test sand. The shale of the test interval was demonstrated to be continuous and correlatable in its areal extent across the highest point of Orange Salt Dome. In addition, this test interval was at a shallow depth which minimized the geologic overburden pressures and the forces causing shale creep into the open wellbore.

BOREHOLE CLOSURE TESTING

OVERVIEW

Borehole closure testing started April 21, 1991 and was completed May 4, 1991. This sequence of borehole closure testing consisted of the following general steps:

Step 1

With drill bit and drill string still in hole, condition 9.7 lbs/gal mud in the open borehole. See Figure 4 for a schematic diagram depicting the mud circulation in the open borehole.

Step 2

Pulled drill string into casing and displaced mud with 9.1 lbs/gal filtered brine near the casing shoe to clean up the well bore casing and fluids prior to running the screen, transducers, and tubing assembly. (See Figure 5).

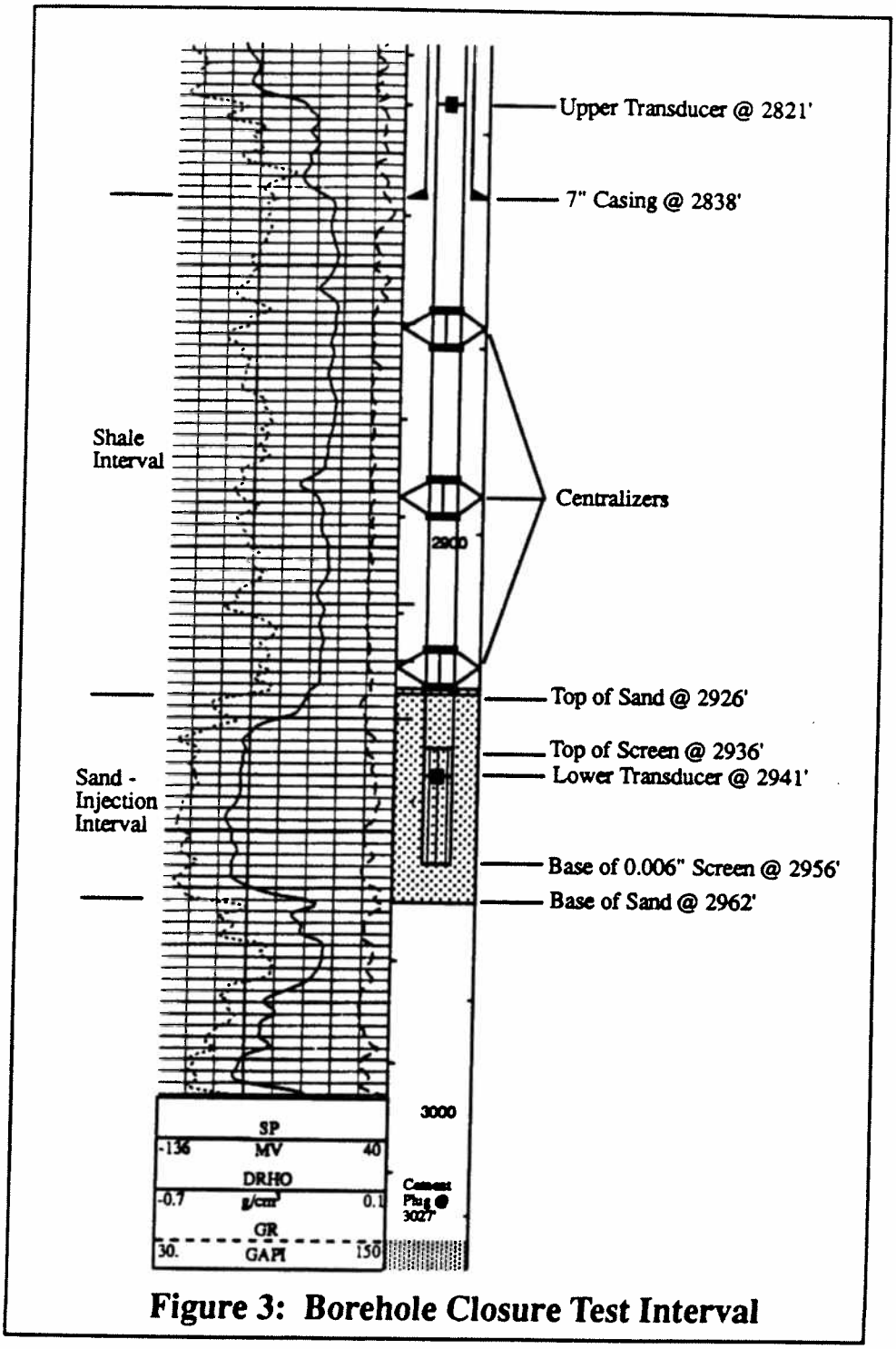


Figure 3: Borehole Closure Test Interval

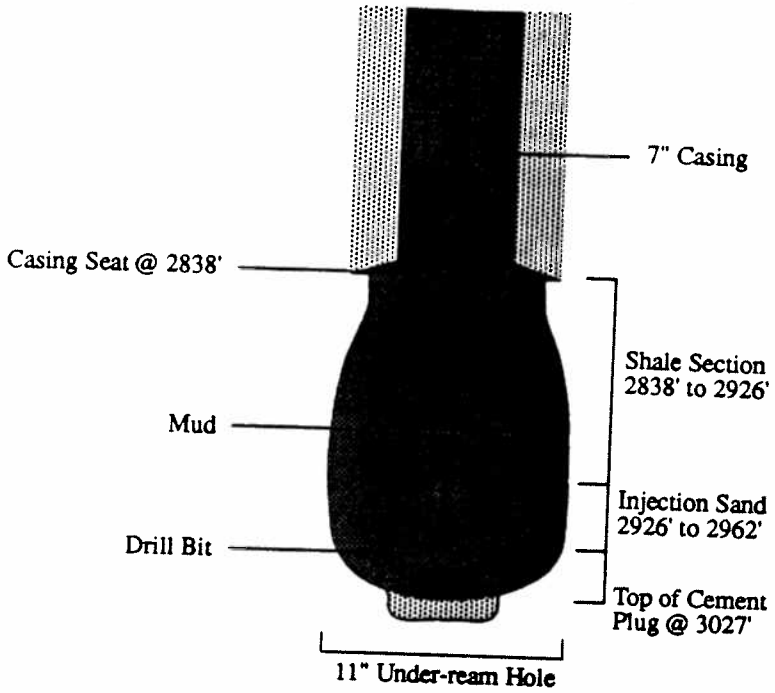


Figure 4: Mud Circulation

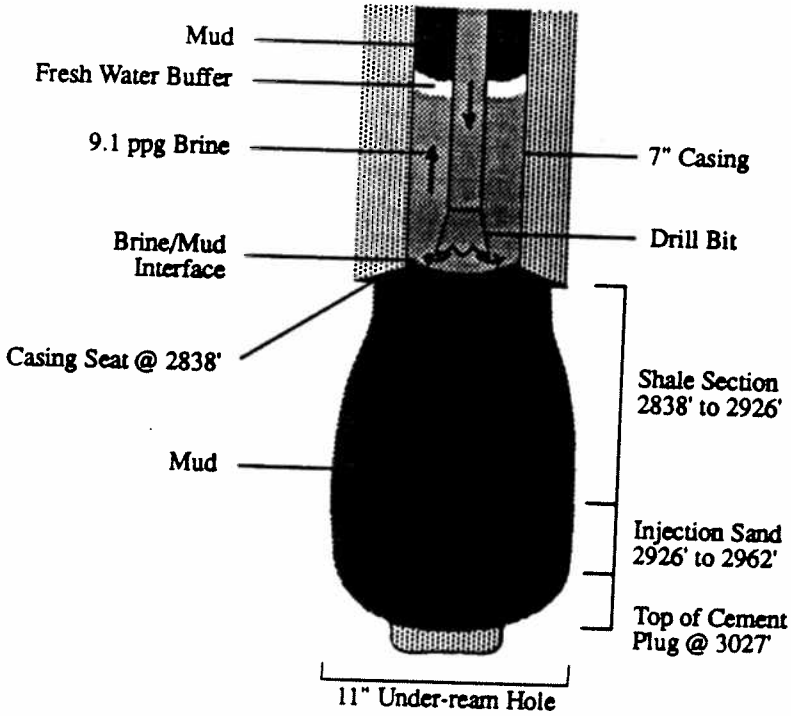


Figure 5: Mud Displacement with Brine Near Casing Shoe

Step 3

After the well bore casing was displaced with 9.1 lbs/gal filtered brine, the screen assembly, transducers, and tubing were placed near the bottom of the casing shoe. A transducer test was conducted to ensure that the electrical equipment was operating properly before running the screen assembly in the open borehole. In addition, filtered brine was pumped at various flow rates up to a maximum of 8.5 barrels per minute (bbl/min) to determine the friction loss in the screen section next to the lower transducer. See Figure 6, Transducer Test at Bottom of Casing.

Step 4

After the completion of the transducer test, the screen assembly was placed through the injection sand from 2936 feet to 2956 feet. Once this was completed, displacement of the remaining 9.7 lbs/gal mud with 9.1 lbs/gal filtered brine in the open borehole began immediately. See Figure 7, Screen Placement.

Step 5

A total of 401 barrels of 9.1 lbs/gal filtered brine was circulated to clean up the well bore. Mud returns from the open well bore occurred on the surface after pumping 85 barrels of brine down the injection tubing. The well bore discharge line started to clean up after 200 barrels of brine were pumped into the injection tubing. An additional 200 barrels of brine were pumped at decreasing flow rates until the discharge line indicated clean fluids in the return. See Figure 8, Brine Circulation After Mud Displacement.

Step 6

After displacement of the mud from the well bore with the 401 barrels of brine, the well was shut-in. See Figure 9, showing well shut-in with brine and recording falloff pressures.

Step 7

After waiting one week, during which time the formation pressure achieved equilibrium, a pre-injection slug test was conducted. The pre-injection slug test verified that the screen was open and that the injection formation was responding properly. Next, a Halliburton pump truck was placed on location along with a control valve to regulate the low flow rates anticipated for the pressure build-up testing. The initial injection testing indicated that borehole closure had occurred and Schlumberger was called out to run their Water Flow Log. Schlumberger performed the logging runs at various pressure rates and depths which indicated that there was no upward channeling of fluid and that borehole closure had indeed occurred. See Figure 10 for a schematic depicting Water Flow Log and Pressure Testing with Brine Injection.

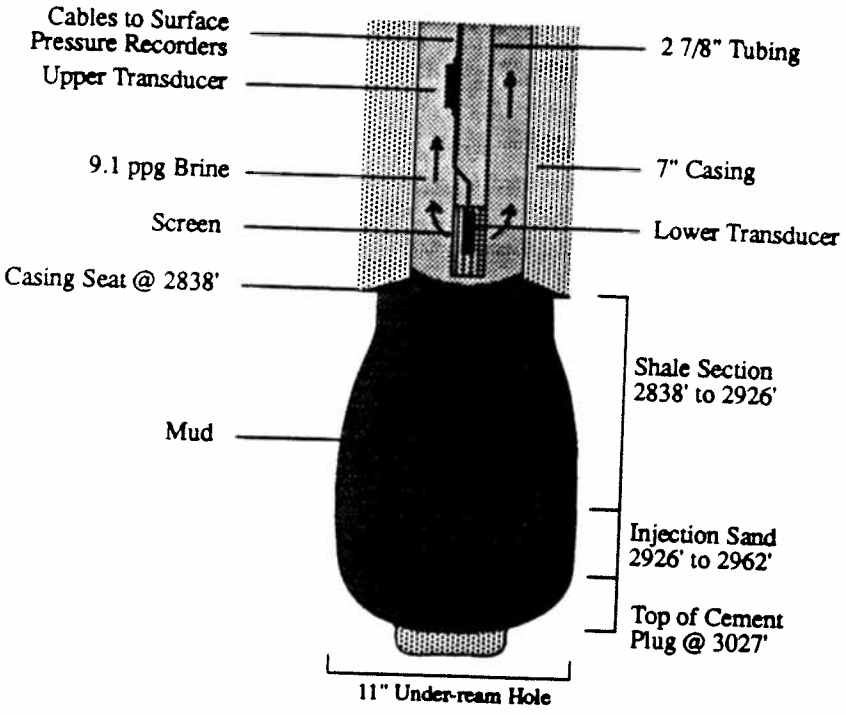


Figure 6: Transducer Test at Bottom of Casing

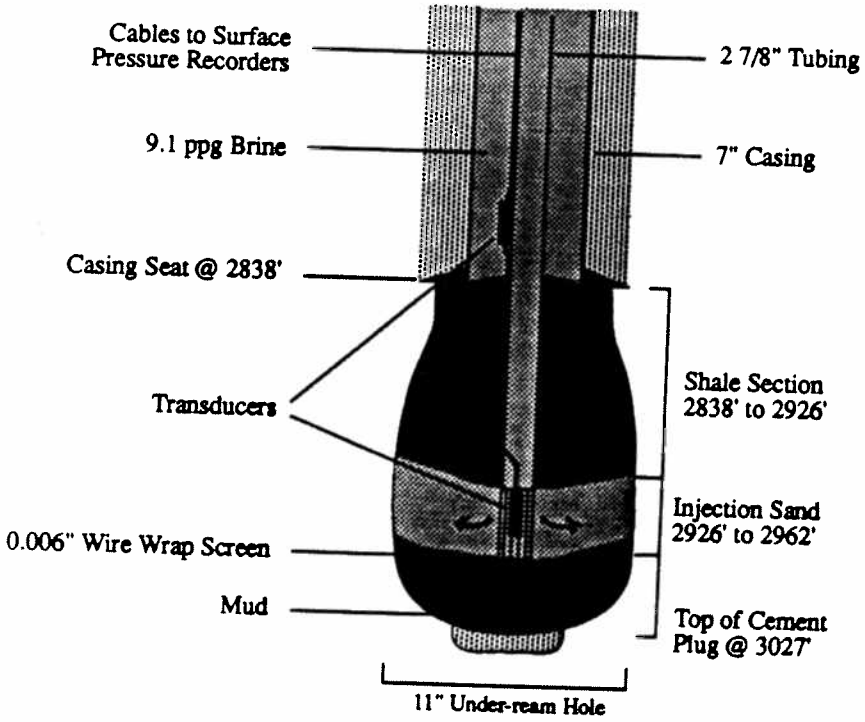


Figure 7: Screen Placement

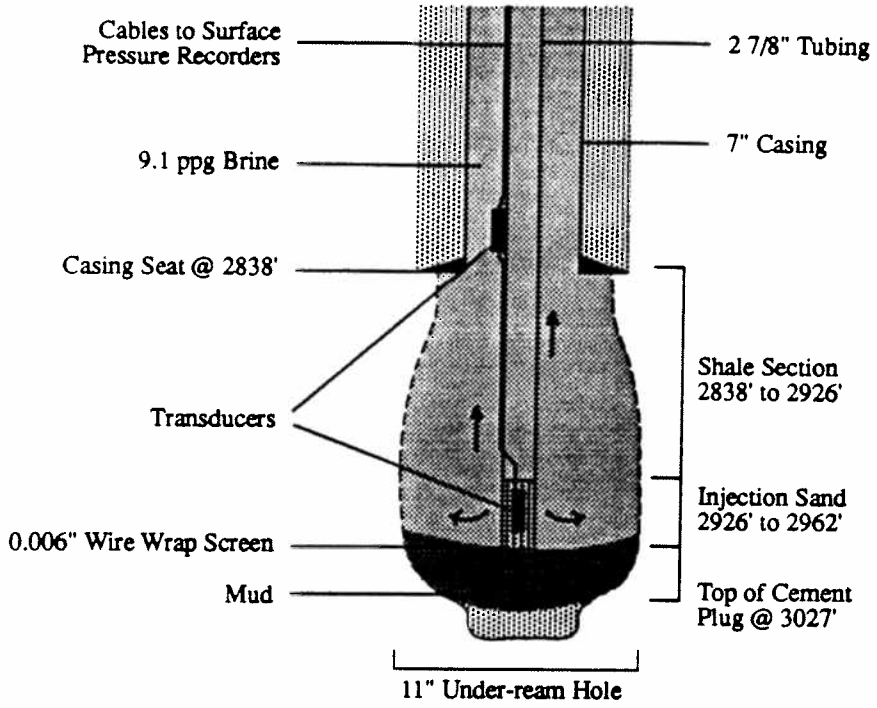


Figure 8: Brine Circulation After Mud Displacement

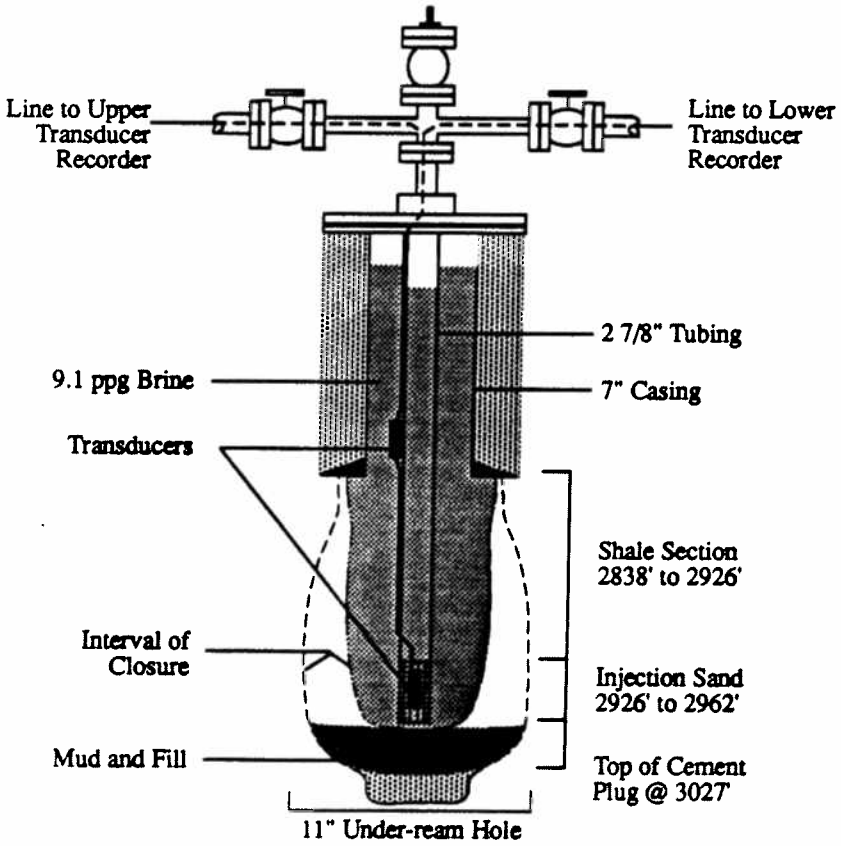


Figure 9: Shut Well In and Record Pressures

DETAILS FROM CONDITIONING HOLE TO MUD DISPLACEMENT

After the open borehole was conditioned with 9.7 lbs/gal mud the drill bit and pipe were tripped out of the open borehole and placed inside the casing above the casing shoe. Drilling mud inside the casing was displaced with 9.1 lbs/gal filtered brine near the casing shoe to limit mud invasion of the well screen. Once the mud was displaced from the casing and clear brine returns appeared on the surface, brine injection stopped, and the drill bit and pipe were tripped out of the casing. The lower transducer was installed inside the well screen, approximately four feet from the top of the screen openings. An upper transducer was attached to the outside of the 2 7/8 inch tubing approximately 120 feet above the lower transducer. Next, the screen, lower and upper pressure transducers, and the tubing assembly were lowered inside the well bore to a depth near the casing shoe.

A transducer test was conducted April 23, 1991, inside the well casing prior to running the screen assembly inside the open borehole. This tested both transducers under static and dynamic conditions and ensured that all electrical equipment (transducers) was functioning properly. The lower transducer at 2758 feet had a static pressure reading of 1305 psi (see Figure 11). Therefore, the pressure transducer was operating correctly by measuring the hydrostatic pressure of the 9.1 lbs/gal brine (0.052 x 2758 ft x 9.1 lbs/gal = 1305 psi). The upper transducer at 2638 feet (see Figure 12 also was operating properly by recording the static pressure of 1248 psi (0.052 x 2638 ft x 9.1 lbs/gal = 1248 psi). Another method verifying that the transducers were recording accurately is to state that (1305 psi - 1248 psi)/(0.052 x 9.1) = 120 feet, the distance that the transducers are separated.

A dynamic test was conducted after obtaining the static pressure measurements from the lower and upper transducers (see Figures 11 and 12). This test was conducted at several production rates (1.5 to 8.5 bbl/min) per EPA Region 6 requests to determine the pressure drop or friction loss across the screen assembly. The screen assembly consists of a wire-wrapped (0.006 inch) re-inforced tubing with a total of 120 holes per foot of screen (3/8 inch diameter per hole). This type of construction minimizes friction losses in the screen assembly. The dynamic test conducted near the casing shoe revealed that the pressure loss would be less than 12 psi for 2 bbl/min flow rate in the screen assembly. The upper transducer reflected a 10 psi buildup for this same time period showing that the 12 psi loss is not all attributed to friction loss inside the screen. The injection test itself was conducted at less than 0.5 bbl/min.

DETAILS FROM MUD DISPLACEMENT TO END OF TESTING

The pressures recorded from mud displacement to the end of testing for the lower and upper transducers are presented in Figures 13 and 14, respectively. Once the screen was properly placed, the 9.7 lbs/gal mud in the open borehole was displaced immediately with 9.1 lbs/gal filtered brine. Details for each of the major historical sequences comprising the borehole closure demonstration are described below.

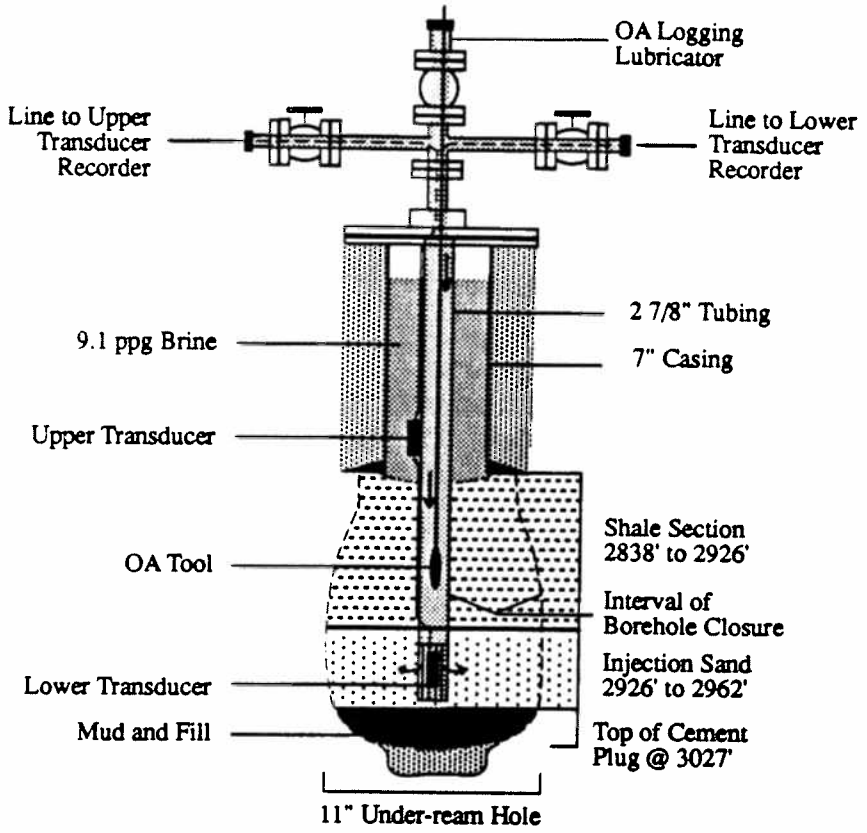


Figure 10: Water Flow Log and Pressure Testing with Brine Injection

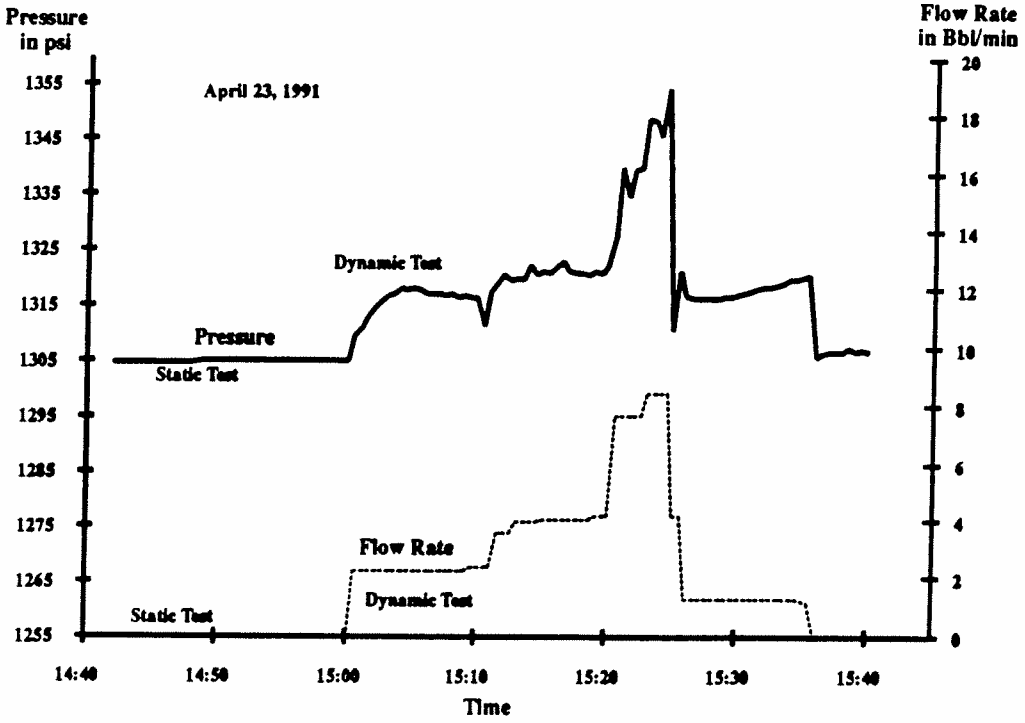


Figure 11: Transducer Test Near Casing Shoe With Lower Transducer at 2758 feet

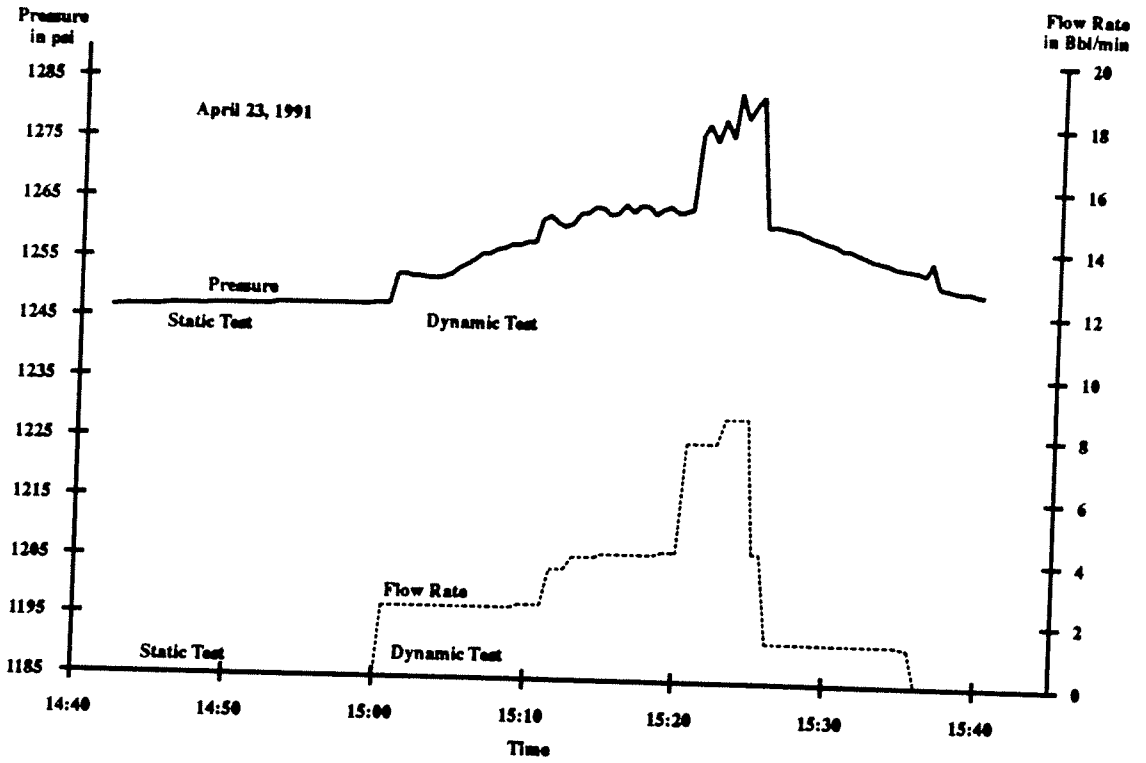


Figure 12: Transducer Test Near Casing Shoe With Upper Transducer at 2638 feet

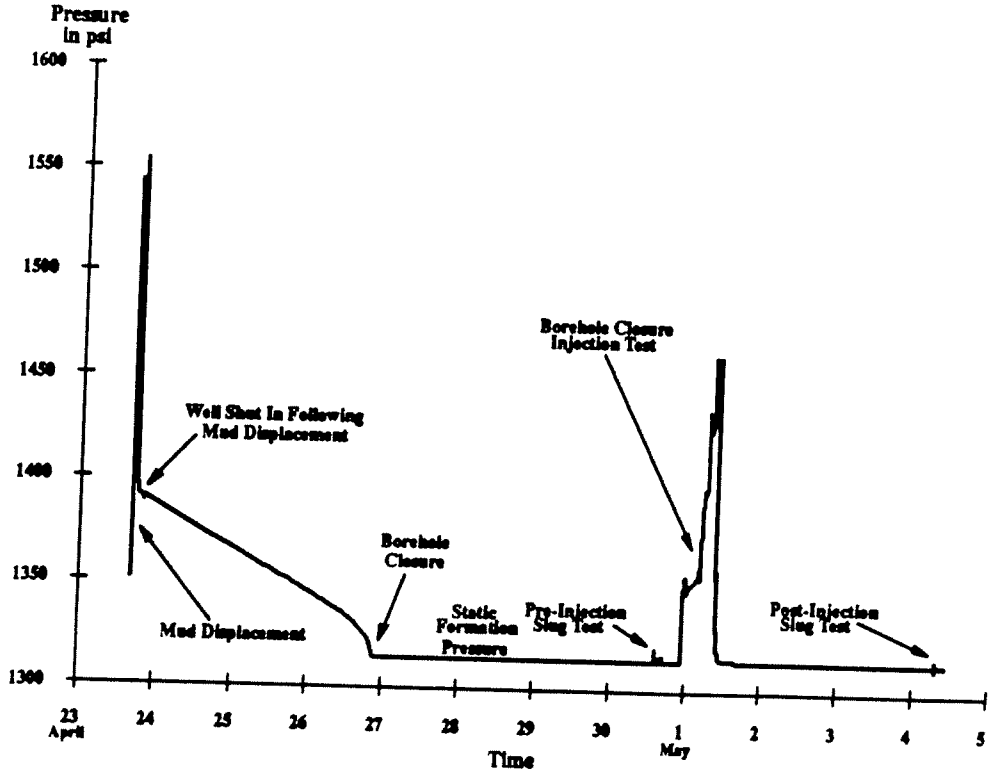


Figure 13: Lower Transducer Data From Mud Displacement to End of Testing

A total of 401 bbl of 9.1 lbs/gal filtered brine was pumped through the injection tubing with returns to the surface. Figure 15 shows that the mud displacement caused an increase in the pressure of the upper transducer at 2821 feet until mud was displaced from the well bore. After pumping 85 bbl of brine the drilling mud appeared on the surface and the discharge line was switched from the brine tank to the mud tank. The discharge rate near the end of the test was reduced gradually to prevent sudden well surges which could cause the well screen to fill with sand.

The final brine returns were clean with only minute traces of gumbo shale. After the mud displacement sequence, the well bore was shut-in and pressures were recorded. Recovery data (see Figure 16) show a slow pressure decline. Pressure data indicate that borehole closure occurred within 3 to 4 days after the well was shut-in following mud displacement. The screened interval or lower transducer reflects static formation pressure (1314 psi) within this time frame. Also, the upper transducer (inside the well casing) indicates a pressure-time slope change within this same time period. Only minor pressure changes occurred after this time period for the upper transducer, and this would be expected because the brine could still react with the shale below the casing shoe. Calculation of different fluid levels from the upper and lower transducers also show isolation of the two zones.

According to procedures agreed upon by Du Pont and EPA Region 6, it was Du Pont's decision to determine what duration to leave the well bore shut-in. Du Pont notifed EPA Region 6 after placement of the screen assembly that it would leave the well in a static condition for a time period of approximately one week before starting the injection test.

A pre-injection slug test (see Figure 17) consisting of two separate series of five slugs (each slug equaled 2.5 gallons of brine) was performed April 30, 1991, one week after shut in. The purpose of this test was threefold: 1) to determine if the screen was open and operating properly, 2) to determine the volume of water that might be needed to conduct a pressure buildup in the formation, and 3) to determine if there was a pressure response in the upper transducer. As shown in Figure 17, the fall-off curves in the lower transducer indicated that the screen was open (i.e., not filled with sand). There was no pressure response in the upper transducer from the slug testing, indicating that the two transducers were indeed isolated. Finally, the testing revealed that a pump truck would be required to control the low flow rate of brine injection. In addition, because the required flow rates could be lower than a truck could pump (less than 20 gpm), a valve was installed to regulate even lower flow rates. Halliburton computer flow monitoring and pumping services, Otis filters and brine fluids were ordered to the location for the borehole closure injection test.

Early testing data showed that the lower transducer was recording pressure buildup with no pressure increase observed in the upper transducer. The flow rate was increased slightly from 16 gpm to 22 gpm to obtain a 40 psi buildup. At this point, before reaching 50 psi of formation buildup, Schlumberger was called to run a Water Flow Log which would check for upward fluid channeling. Schlumberger was contacted for logging services at 23:30 hours on April 30, 1991. In order to conserve brine the flow rate was reduced to 16 gpm. The upper transducer continued to show no pressure change from injection, except for minor temperature anomalies associated

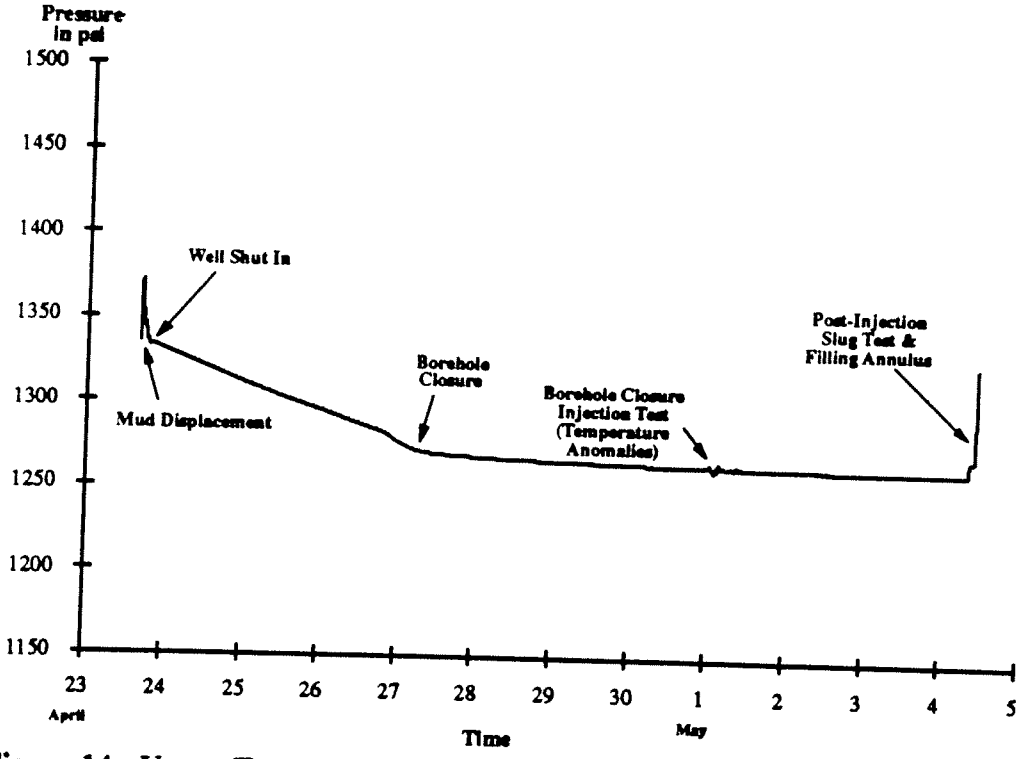


Figure 14: Upper Transducer Data from Mud Displacement to End of Testing

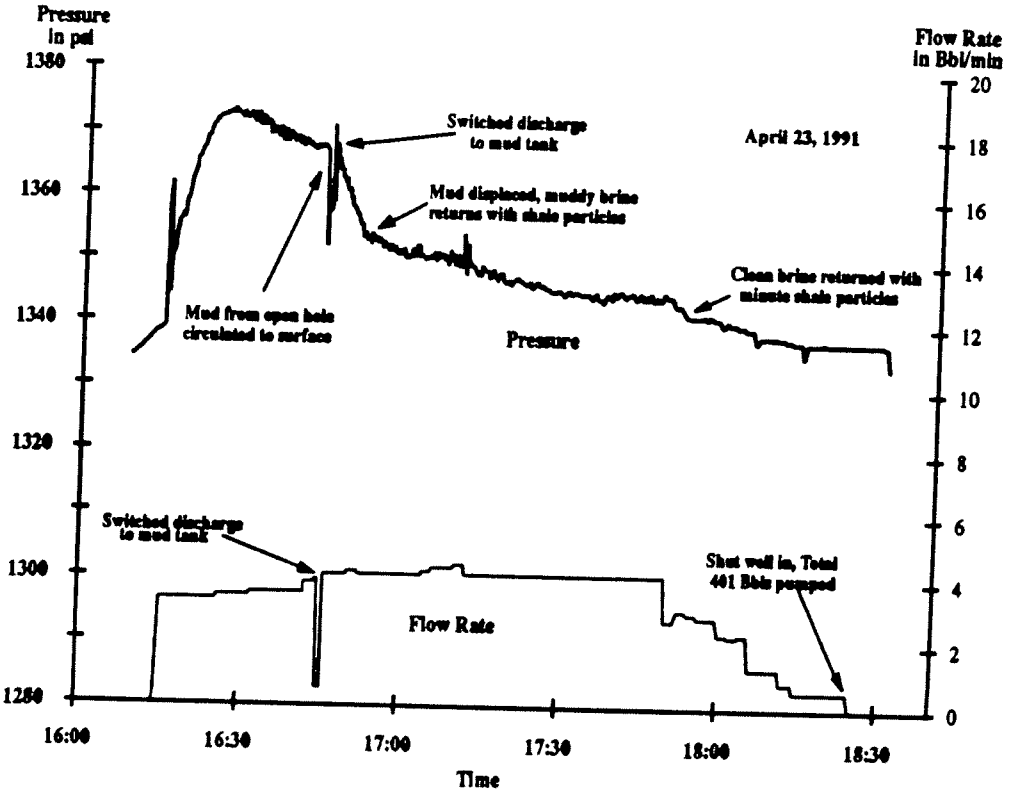


Figure 15: Mud Displacement With Upper Transducer at 2821 feet

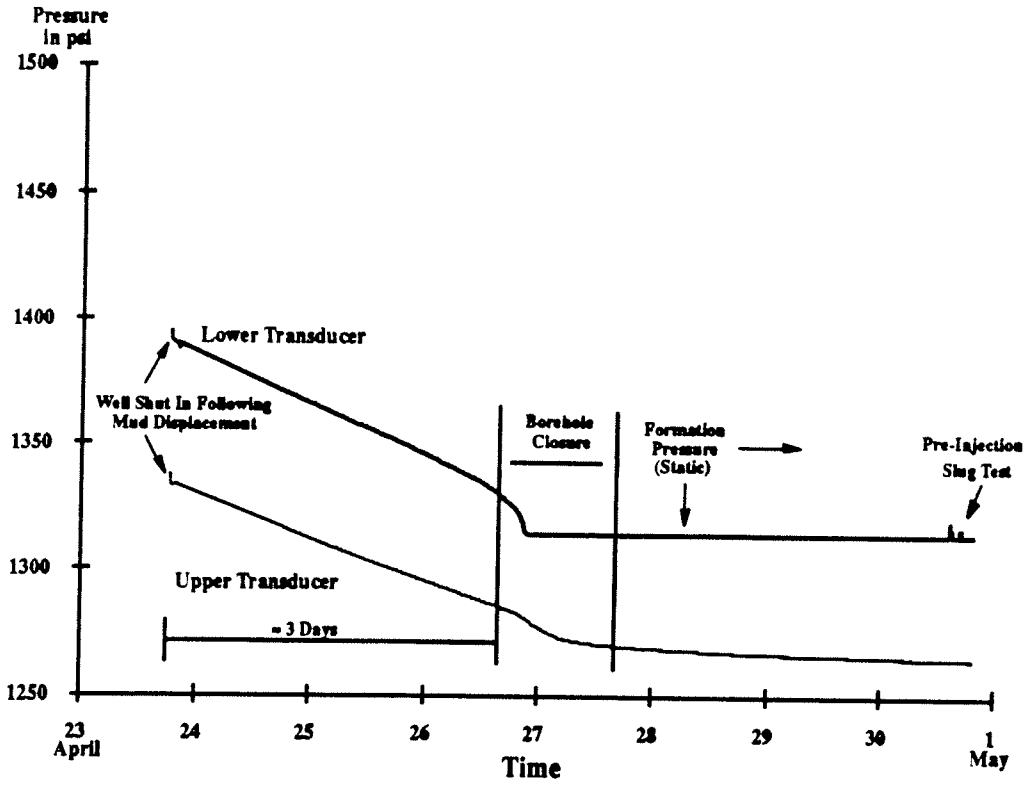


Figure 16: Recovery Following Mud Displacement

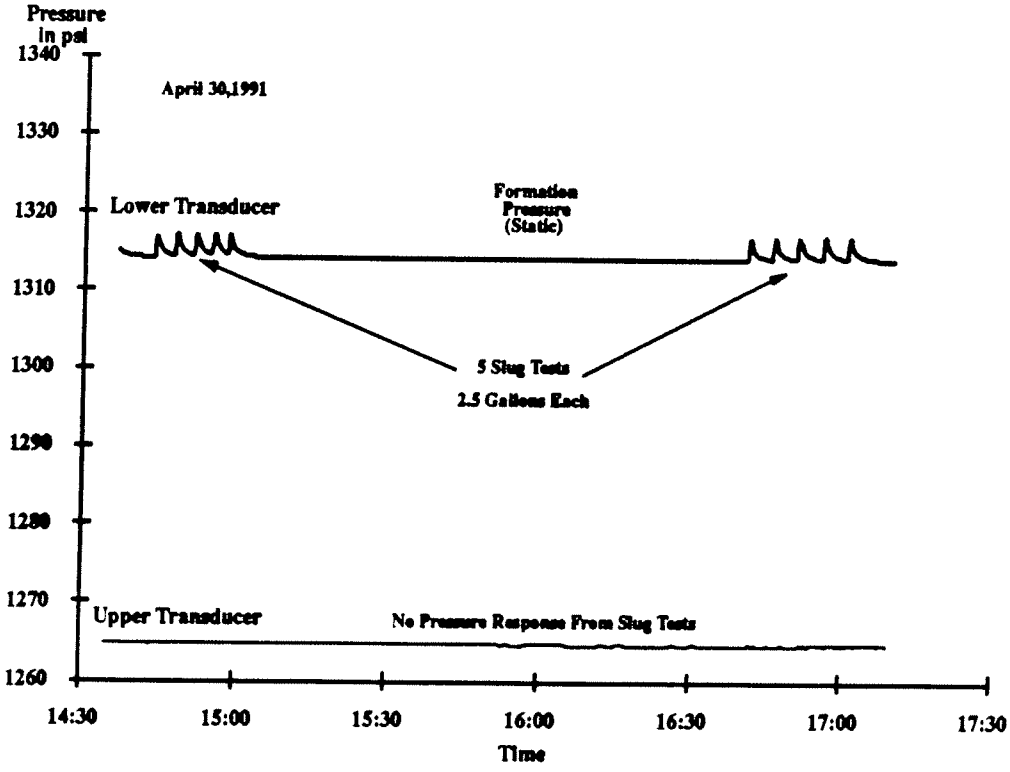


Figure 17: Pre-Injection Slug Test

with the cooling effect of injection fluids. Figure 18 presents an overview of the borehole closure injection test for the upper and lower transducer and a plot of fluid temperature. Figure 19 is an enlargement of fluid injection temperatures and the upper transducer pressures. This graph demonstrates the minute temperature anomalies associated with the cooling of fluids in the well bore.

Figure 20 is a plot of transducer pressure and flow rates during the borehole closure testing. The Water Flow Log was conducted within the tubing under pressure control conditions at 90 psi, 110 psi, and 140 psi above static formation pressure and at stations within the overlying shale interval at approximately 25 feet, 50 feet, and 75 feet above the test injection sand. In an attempt to maintain constant formation pressure during each OA log run, the flow rates were reduced. Flow rates were increased to obtain the next formation pressure OA log run; however, the formation pressures continued to increase and the flow rates were further reduced (see Figure 20) to maintain a consistent formation pressure increase over static. Both the upper transducer and the OA logging indicate no upward channeling of fluid. The final run of the Water Flow Log (OA) showed no upward movement of fluids even as shallow as 25 feet above the injection sand.

Du Pont conducted a post-injection test prior to cutting the transducer lines to the surface recorders and pulling the tubing and screen assembly. The purpose of this test was to verify that the lower transducer was still working and that the upper transducer would respond to fluid placed in the annulus. Figure 21 shows that the upper transducer was working and that there was no bleed-off of pressure into the lower transducer. This was the case even when the annulus was filled to the surface with fluid. This also demonstrated well closure and sealing of the shale section between the injection sand and the casing. Table 1 shows x-ray diffraction data for the test interval and indicates that the shale section consists of expandable smectite clay layers.

EPA was not only interested in whether natural borehole closure occurred, but also if a rate of borehole closure could be quantified. During this test, natural borehole closure was demonstrated, and a rate of borehole closure was 'quantified'.

CONCLUSION

The borehole closure test was designed and constructed according to EPA criteria for a worst-case scenario. This worst-case scenario assumes that hazardous waste migrates across a non-sealing fault and encounters an artificial penetration of maximum borehole diameter filled with 9.0 lb/gal brine. The test interval selected was a thin sand overlain by a thick, sand-free shale.

The test sand was pressured up to the pressure specified and greater with no upward fluid flow or channeling detected during oxygen activation logging station, even with a minimum of 25 feet of shale. Recorded pressures indicate no channeling of fluid because of the pressure differential between the two sensors. Results of the test provide conclusive evidence that a borehole closes naturally, even under a worst-case scenario.

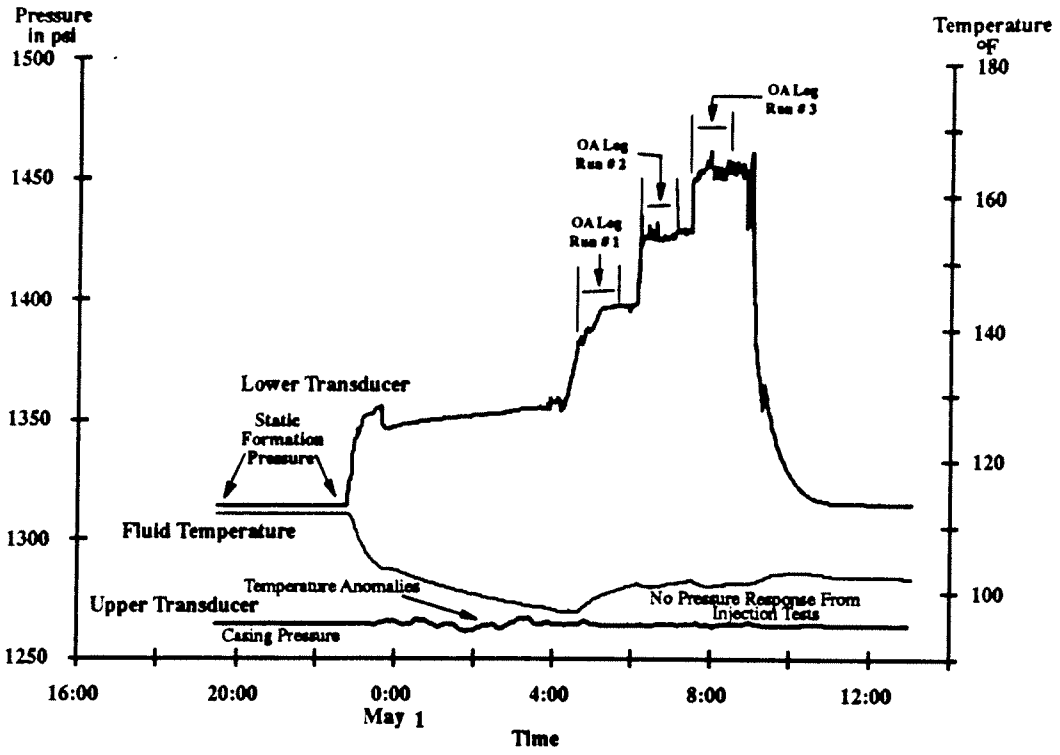


Figure 18: Borehole Closure Injection Test Upper and Lower Transducers- Pressure & Temperature

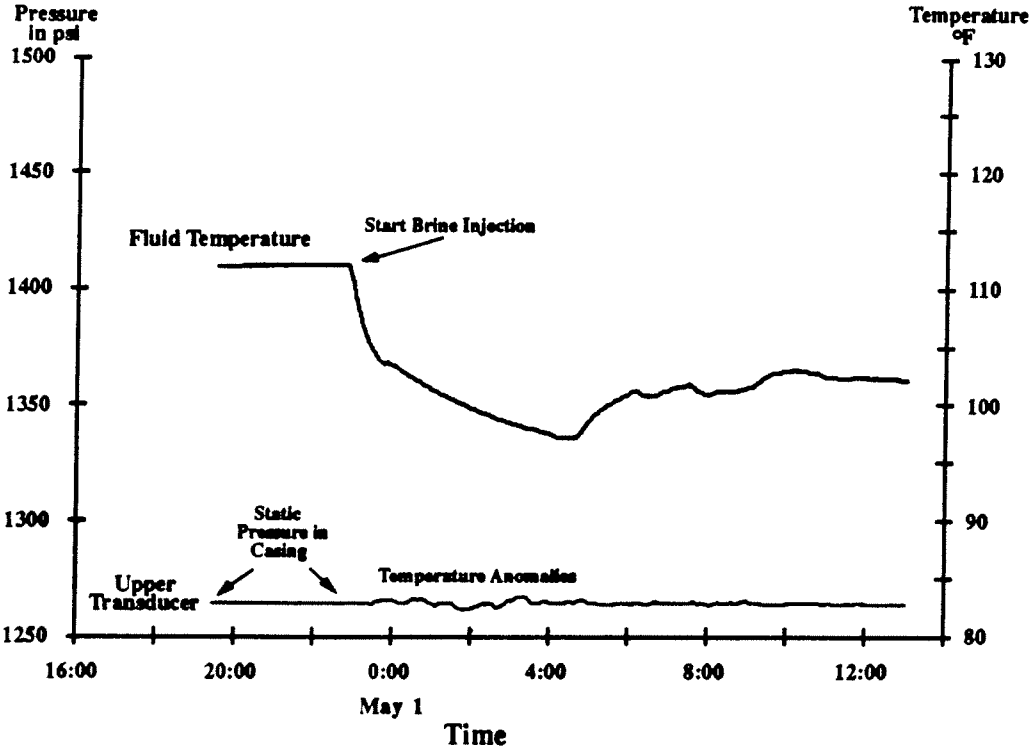


Figure 19: Borehole Closure Injection Test-Fluid Temperature Anomalies

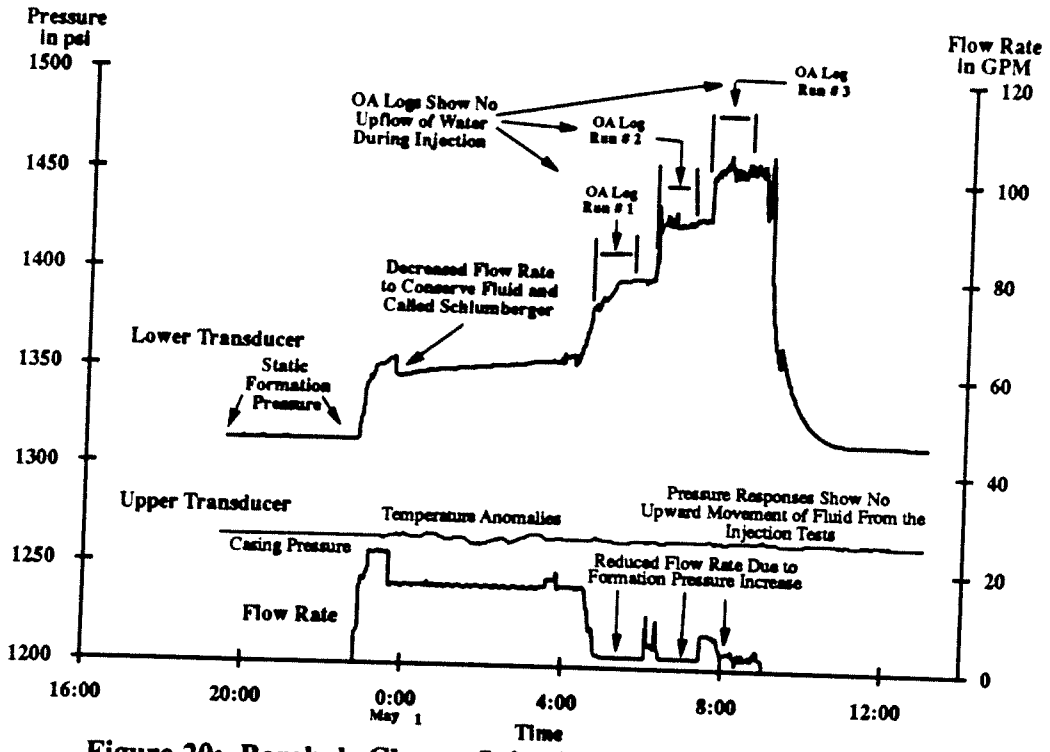


Figure 20: Borehole Closure Injection Test-Upper and Lower Transducer Pressure and Flow Rate

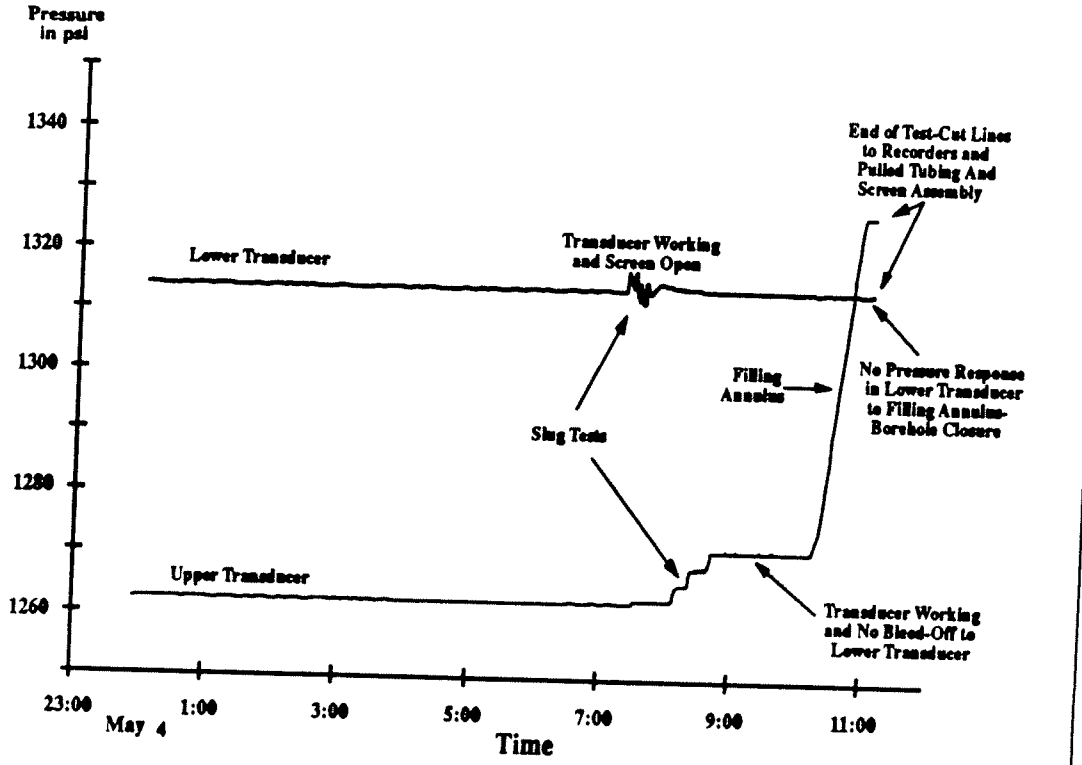


Figure 21: Post-Injection Transducer Testing

Table I

Du Pont Borehole Closure
Orange Petroleum No. 35 Hager

X-RAY DIFFRACTION (XRD) DATA
(Weight Percent)

Depth:	2737	2900	2925	2940	3110
		BULK MINERALOGY (Calculated)*			
Quartz	25	41	30	77	23
Total Feldspar	02	06	04	15	04
Plagioclase	01	03	02	06	02
K-Feldspar	01	03	02	09	02
Calcite	02	08	20	02	14
Dolomite	—	—	01	—	trace
Fe-Dolomite	—	trace	—	trace	—
Siderite	—	—	—	trace	—
Pyrite	04	01	08	—	trace
Total Clay	67	44	37	06	59
	100%	100%	100%	100%	100%
		Relative Clay Abundance (Normalized to 100%)			
Kaolinite	05	05	09	08	05
Chlorite	02	02	02	02	03
Illite	05	06	08	04	08
Mixed-Layer Illite/Smectite**	88(80)	87(85)	81(85)	86(85)	84(75)
	100%	100%	100%	100%	100%

* Bulk mineralogy is calculated from sand/silt-size and clay-size XRD data.
** Numbers in ( ) are percent expandable smectite interlayers in mixed layer clays.

ACKNOWLEDGMENTS

We acknowledge Joe Kordzi and Ronnie Crossland, EPA, who critiqued the test procedures and submitted recommendations which were incorporated into the borehole closure protocol. We thank Marion Miller for providing drilling engineering services at the borehole closure well.

REFERENCES

Clark, J. E., Howard, M. R., Sparks, D. K. 1987, Factors That Can Cause Abandoned Wells To Leak As Verified By Case Histories From Class II Injection, Texas Railroad Commission Files: International Symposium On Subsurface Injection Of Oilfield Brines, Underground Injection Practices Council, Oklahoma City, OK, p. 166-223.

Davis, K. E., 1986, Factors Effecting the Area of Review for Hazardus Waste Disposal Wells: Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes, National Water Well Association, Dublin, OH, p. 148-194.

Graver, D. L. (Ed.), 1985, Corrosion Data Survey - Metals Section (Sixth Edition): Houston, National Association of Corrosion Engineers, p. 7.

Jackson, M. P. A., and Galloway, W. E., 1984, Structural and Depositional Styles of Gulf Coast Tertiary Continental Margins: Application to Hydrocarbon Exploration: American Association of Petroleum Geologists, Continuing Education Course Note Series No. 25, 226 p.

Johnston, O., and Green, C. J., 1979, Investigation of Artificial Penetrations in the Vicinity of Subsurface Disposal Wells: Texas Department of Water Resources.

Johnston, O. C., and Knape, B. K., 1986, Pressure Effects of the Static Mud Column in Abandoned Wells: Texas Water Commission LP86-06, 99 p.

BIOGRAPHICAL SKETCHES

James E. Clark holds a B.S. in geology (1972) from Auburn University and an M.S. in geophysical sciences (1977) from Georgia Institute of Technology. As a geohydrologist with Law Engineering Testing Co., he worked on suitability studies of salt domes as repositories for nuclear waste. He is a consultant with Du Pont's (E. I. du Pont de Nemours & Co., Inc., Engineering Department, P. O. Box 3269, Beaumont, TX 77704) solid waste and geological engineering group and is active in permitting and evaluation of disposal wells.

Philip W. Papadeas received his B.S. degree in geology from the University of New Hampshire (1978). As a field engineer with Schlumberger he was active both offshore and onshore Texas, and later served as petroleum geologist for Omega International, Inc., generating oil and gas exploration prospects. In 1988, he joined Du Pont's geological engineering group in Beaumont, Texas as a consulting geologist responsible for geological and hydrological modeling and evaluation of UIC Class I disposal wells.

Diane K. Sparks received her B.S. degree (1977) in geology and her M.S. degree (1978) in geology from Bowling Green State University. She was a petroleum geologist with Amoco Production Company and Helmerich and Payne, Inc. Sparks is a consulting geologist (P. O. Box 7103, Beaumont, TX 77726) and since 1986 has consulted for the Engineering Service Division of Du Pont, in evaluation of UIC Class I disposal wells and fluid migration studies.

Ronney R. McGowen received his B.S. degree (1989) in geology from Lamar University in Beaumont, Texas. He is currently working toward his M.S. degree in geology at Texas A & M University. He has worked in the drilling industry for 9 years as a driller and rig superintendent in western Oklahoma and the Texas Gulf Coast. He is now working as a contract geologist for the Engineering Service Division of Du Pont, in evaluation of Class I disposal wells.

COLLINS, R. E., 1986
TECHNICAL BASIS FOR AREA OF REVIEW, AN ENGINEERING STUDY
PREPARED FOR CHEMICAL MANUFACTURERS ASSOCIATION

0119859

TECHNICAL BASIS FOR AREA OF REVIEW

An Engineering Study

Prepared for

Chemical Manufacturers Association

Washington, D.C.

by

REC

RESEARCH & ENGINEERING CONSULTANTS INC.

TECHNICAL BASIS FOR AREA OF REVIEW

An Engineering Study

Prepared for

Chemical Manufacturers Association
Washington, D.C.

by

R. Eugene Collins, Ph.D. P.E.
Research & Engineering Consultants Inc.
Butte, Montana

November 7, 1986

CMA Reference Number: 80-160-000-4

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This study of "area of review" procedures designed to protect underground sources of drinking water (USDW) in underground injection operations for waste disposal using deep wells, has examined two major areas:

(1) Potential pathways for contamination of USDW by underground wastes

(2) Factors affecting areal distribution of pressure increase in a brine aquifer used for underground injection of liquid wastes

Results of the study indicate that the most significant pathway for contamination of USDW is through abandoned, unplugged wellbores. However, the study has also shown that a major factor limiting entry of brine, or injected wastes into abandoned wells is the gel characteristics of mud in these wells. This study indicates that in most cases the contribution of the gel property to the critical pressure increase required for fluid entry into the wall may be more significant than previously thought.

The problem then in assigning an area of review for a deep well injection system is two-fold; first, one must determine locations of abandoned wells and assign realistic values for mud and hole properties which determine the critical pressure in the injection zone, P_{crit}, at each well, which determines on-set of leaking, and second, one must make realistic forecasts of pressure history in the injection zone at the location of each abandoned well. This forecast of pressure history should reflect effects of known near boundaries in the injection zone, sealing faults or non-sealing faults, leaky shale aquicludes and anisotropic permeabilities.

This study demonstrates that these geological features of the injection zone can sometimes result in pressure build-up significantly above that forecast by the simple "Theis" equation commonly used by most government regulatory bodies to estimate the "radius of endangered influence" of an injection well. We also show in this study that since shales have a small, but non-zero, permeability there can occur a pressure build-up less than this Theis equation forecast, but this is not generally very significant.

The existence, or non-existence of these geological features can usually be confirmed through detailed analysis of the transient pressure response of the injection well to a given injection rate history, and its interaction with neighboring wells communicating with the same injection zone (if such exist) after the well is put into operation for an extended period of time. However, prior to installation of the well the existence of such geological features cannot be ascertained with any confidence unless detailed pressure response data, in addition to well logs and similar data, are available on several near-by wells operating in the same zone.

Therefore we recommend an area of review process which exploits all available data as effectively as possible. Thus if there are not any nearby wells in the same injection zone then assignment of an area of review would be based upon the Theis equation using a dimensionless type curve, as set forth in this report, using best available estimates of pertinent injection zone parameters. However, if adjacent wells do exist, and injection rate and pressure histories on these wells can be obtained, then we recommend analysis of these pressure transient data to detect geological non-uniformities of the proposed injection zone. Then a computer program, similar to that used in this study, could be used to compute a more realistic "zone of endangered influence" due to the proposed well which incorporates these geological features.

After the proposed well is installed, and operated for an extended period of time, the actual injection rate - pressure history of the well could be used in a similar computer program to substantiate the existence of these geological features. This would be a history matching process achieved through adjustment of parameters in the computer program representing geological features in a simulation of well performance.

INTRODUCTION

I. Defining Area of Review

In compliance with the Safe Drinking Water Act of 1974, and subsequent amendments, the Environmental Protection Agency (EPA) has developed minimum requirements for state operated programs regulating subsurface disposal of industrial liquid wastes by injection through wells. Such underground injection control (UIC) regulation has the objective of protecting underground sources of drinking water from contamination by brine or injected wastes. These regulations define an "Area of Review" which is based upon the premise that within this area, centered on the injection well, pressures within the injection zone may cause migration of the injected fluid and/or formation brine into an underground source of drinking water (USDW) through some pathway breaching the sealing layer of the injection zone.

This area of review has been defined by regulatory agencies in terms of a radius of review assigning then a circular area centered at the injection well. This radius of review is defined by calculating a "zone of endangering influence" of the injection well or, as a fixed radius from the injection well, whichever is the larger. This fixed radius varies from state-to-state; in states where EPA has primacy, the fixed radius is 1/4 mile, while in states having primacy, the fixed radius varies from 1/4 mile to 2 1/2 miles. These various approaches to area of review specification are reviewed in a guidance document prepared by Engineering Enterprises (1985).

Calculations reported in the literature for estimating the "zone of endangering influence" have been based primarily on a single well of constant rate in an infinite aquifer using the "Theis Equation" (1935) but it is generally recognized that superposition of such solutions can be employed to treat multiple wells and wells with variable rate. (Collins, 1961).

Barker (1981) presented a systematic procedure for defining the area of review but his treatment was limited to a single, constant rate well and totally ignored effects of reservoir heterogeneities and boundaries. However, his treatment was the first to consider the contribution of mud gel strength as a sealing mechanism in abandoned boreholes.

Davis and Sengelmann (1986) presented a general overview of the area of review problem and expanded on the contribution of mud gel as a sealing mechanism. Their review discussed procedures for including multiple injection wells and variable injection rates in the analysis but again reservoir heterogeneities and boundaries were ignored.

With this background, the study described in this report was undertaken with the objective of providing a sound technical basis for definition of an area of review. Factors investigated were:

* Potential breaches of the sealing layer (potential pathways for contamination of USDW by fluids from the injection zone)

* Factors determining the temporal evolution and spatial distribution of pressure increase in the injection zone

II. Potential Pathways for Contamination of USDW From Deep Well Injection Operations

Pathways by which injected fluid, or brine from an injection zone, might migrate up to a fresh water zone are:

(1) A channel in the injection well grout (primary cement behind injection well casing)

(2) A hydraulically induced fracture at the injection well

(3) A natural fracture

(4) A fault

(5) A permeable sealing layer, or aquiclude, over the injection zone (a "leaky aquifer")

(6) An abandoned well bore

The first of these is readily ruled out if modern well completion practices are followed. The petroleum industry has been evolving cementing procedures for more than sixty years and a well-defined process exists to assure a cement sealed annulus between well casing and bore-hole. State and Federal regulations require that the well be cased and cemented to surface. Of course, old injection wells, installed prior to the introduction of these regulations, might not be constructed to these high standards and a pathway, or "channel" for vertical communication behind casing could exist. However, methods do exist to test such wells for the existence of vertical flow channels behind the casing; noise logs, temperature logs and radio-active tracer surveys are used for this purpose. (Schlumberger, 1973; McKinley, 1982) There is also a new type of logging tool, the oxygen activation radioactivity log (Arnold and Paap, 1979) which is extremely accurate and sensitive for detection of water flow channels but it has not been made commercially available. Some states do require periodic radio-active tracer tests of all Class I injection wells to confirm the absence of vertical communication of flow channels behind casing.

The second potential pathway, a hydraulically induced fracture, will not occur if a well is operated according to regulations because these require that injection pressure gradient never exceed the critical fracture gradient for breakdown of the formation. Furthermore, even if a hydraulic fracture did occur, field experience in the oil industry has demonstrated that vertical fracture growth is terminated in thick shale layers. (Williams et al, 1979)

Therefore if the aquiclude immediately above the injection zone is a thick shale, no pathway to USDW could occur by this process.

The third pathway, a natural fracture, could be a potential pathway to USDW only in an improperly selected site for an injection well. Generally, natural fractures do not extend great distances vertically except in areas that have been very active tectonically, e.g. in the vicinity of salt domes. Deep sedimentary basins in tectonically stable regions will be free of this threat to USDW. Major factors also contributing to this security are creep under overburden load and secondary mineralization which tend to eliminate fractures as fluid pathways.

For example, on the Texas Gulf Coast, faulting and associated fracturing, have been described by Edwards (1982), Han (1981), Bebout et al (1982), Bruce (1973), Ewing (1983) and many others as arising as growth faults. Such faults occur due to gravitational slumping of accumulating sediments along the continental shelf. Thus such faults and fractures evolve in young sediments. Subsequent compaction by accumulating overburden induces closure by creep and secondary mineralization as brines in deeper sediments are expelled upward along such fractures. Typical of clastic formations exhibiting such old fractures in this region is the Miocene age Oakville Sandstone. Evidence for ancient ground water movements through fractures in this formation, resulting in secondary calcite cementation filling the fractures is described by Galloway (1982). Thus, in most cases these fractures are no longer vertical fluid pathways. Furthermore, since these growth faults, and associated fractures develop in young sediments, they typically do not extend upward through subsequent deposits.

Faulting associated with salt domes may be very extensive and complex. There is perhaps less assurance of no vertical pathways for fluid movement in deposits overlying, or flanking a salt dome, than in basin deposits not disturbed by such intrusions. (Braunstein et al, 1968)

Faults may act as totally sealing lateral boundaries for an aquifer if shale is displaced to totally occlude the permeable aquifer, or as a partially sealing boundary if only a portion of the aquifer section is occluded by shale. For extreme cases, different sands can be juxtaposed.

In the petroleum industry, shales have generally been viewed as impermeable because oil and gas are found held in "traps" by shale layers, as for example in an anticlinal structure of a sandstone overlain by a shale layer. Clearly the upward migration of hydrocarbons is stopped by shales. However, this means only that the water saturated shales are more impermeable to oil and gas than to water.

In the case of oil and gas displacing water from a shale, there is an interface phenomenon which comes into play to inhibit upward permeation. This phenomena is not present for miscible displacement by water, and results from surface tension effects which produce a "capillary threshold entrance pressure" opposing oil or gas entry into the shale.

The existence of a uniform gradient of hydrostatic pressure down through sedimentary layers of sandstones and carbonates, alternating with shales, clearly demonstrates a non-zero permeability for water in shales. Also, a phenomenon termed "compaction drive" is used in the petroleum industry to describe expulsion of water from shales into an adjacent permeable sandstone oil reservoir as the reservoir is depressurized by oil production. A similar phenomenon is associated with subsidence due to water withdrawal from shallow aquifers as in the Houston, Texas ship channel area. There large volumes of water have been withdrawn from shallow sand aquifers for chemical plant use in the area. As these sands are depressured the overlying and underlying shale layers expel water into the sand by darcy flow with associated volume reduction in the shale - hence, subsidence of the surface occurs.

The phenomena just described, which indicate non-zero permebility to water in shales, do not require a large permeability in order to occur. Over geologic time, an almost infinitesimal shale permeability would permit establishment of a uniform hydrostatic gradient in pore-filling water (brine). Furthermore, calculations of the volumetric contribution of compaction drive in oil production indicate that shales need have permeabilities only as small as 10^{-6} md in order to account for a significant compaction drive contribution to oil recovery because of the very large sand-shale area involved.

A considerable body of literature has accumulated which treats problems of "leaky aquifers", meaning permeable shale aquicludes (see bibliography) but there does not seem to exist any public domain literature on actual measurements of shale permeabilities.

A personal communication from Dr. Paul Witherspoon, Director of the Earth Sciences Laboratory at Lawrence Berkeley Laboratory informed us that Prof. Neville Cook of that facility has just embarked upon a project to measure shale permeabilities using a transient flow technique. This is very similar to measurements carried out by Brace et al (1968) on permeabilities of granite and other "impermeable" rocks. Dr. Cook pointed out that most theoretical calculations of permeabilities of shales are on the order of 10^{-3} to 10^{-6} md. One method of making such calculations, uses the Kozeny equation (Kozeny, 1927), (Brooks and Purcell, 1952), (Collins, 1961) which relates permeability to specific pore surface area, and porosity with surface area in turn related to grain size and packing.

It is important to note that both permeability and thickness of a shale layer are significant in determining the effectiveness of the layer as a sealing aquiclude. This is expressed in the quotient of vertical shale permeability and thickness, K_{zs}/h_s. A very thick shale of moderate permeability overlying an aquifer could then augment the storage capacity of the aquifer through "leak-off" of brine into the shale yet still limit upward migration to USDW and serve as an aquiclude.

In our studies of "leaky" shales, we have therefore modeled this contribution to slowing an aquifer pressure build-up by specifying the quotient value, K_{zs}/h_s for such shales. Later we will see computer output using this in

which h_s is stated to be one foot but this is not to be taken literally; this simply means that the variability in the quotient K_{zs}/h_s for various runs was introduced as a change in K_{zs} only.

Without question, item (6) of our list of potential pathways for USDW contamination has been given central consideration by all government agencies having responsibility for UIC programs. Indeed, an abandoned and unplugged, uncased wellbore does seem, at first sight, to be an "open conduit" for flow from an injection zone up to USDW. However, this is really not the case but the main focus of our study has been on abandoned wells. Having essentially ruled out the first five potential pathways for contamination of USDW as very unlikely in a properly sited,constructed and operated injection well, it is indeed abandoned wells which should be addressed by further study.

III. The Abandoned Well Mud Seal

In most areas of the United States that are geologically suitable for deep well injection operations for industrial liquid waste disposal rotary drilling with drilling mud, as opposed to air rotary drilling or cable tool drilling, has been the method of choice since the early part of this century. Sedimentary basins which have extensive deposits of clastic layers separated by laterally continuous shale layers offer the most suitable sites for injection operations.

Shale formations, especially the geologically younger formations of the U.S. Gulf Coast, are very difficult to drill using cable tools. These have been termed "gumbo" shales, or sloughing, shales. Caving and sloughing of such shales causes great difficulty in cable tool drilling; as a consequence essentially every well drilled on the Gulf Coast since about 1920 has been rotary drilled (Suman, 1921). Furthermore, only a few wells were drilled to depths greater than 3500 feet prior to about 1920 and therefore essentially all abandoned dry holes on the Gulf Coast contain drilling mud.

Producing oil or gas wells which were subsequently abandoned would typically have at least one complete string of casing bottom-hole to surface and more modern wells would also have a shallow protection casing fully cemented from about 1500 feet to surface. The primary production casing would be cemented from bottom-hole to some point subsurface above the producing zone, with the remaining part of the annulus filled with drilling mud. Unfortunately old cementing techniques were not very satisfactory, so much of the annular seal would of necessity be contributed by mud in the annulus.

At abandonment, a well would typically be "killed" with mud and, in "modern" times, since about 1935 (Texas) cement plugs have been required by state regulations within the casing to "seal" hydrocarbon producing zones but cement plugs to protect fresh water have been required only since 1957 (Texas). This 1957 regulation stipulated that the short string (surface protection string) be cemented in its entirety and the deepest "useable" water be protected by a cement plug from 50 feet below to 50 feet above the zone (Steed, 1984).

Drilling mud is a suspension of finely divided bentonite (primarily montmorillonite type) clay in water (or brine) with weighing agents (principally barite) and additives to control rheology, density and filtration characteristics. Oil base muds have also been used with the objective of providing greater stability of shales against sloughing. Shales penetrated by the well can experience significant water exchange with the drilling fluid due, essentially, to an osmotic process dependent upon ionic activity of the mud and the brine in the shale. This water exchange (see Gray & Darley, 1981) can lead to expansion of the shale and sloughing off into the hole.

Because of the colloidal characteristics of these drilling muds, they exhibit the thixotropic property of a gel strength upon remaining in a quiescent, unsheared state for a period of time. This gel strength is defined as the maximum static shear stress sustained by the gelled mud without "breaking the gel". Gel strength is usually measured with a concentric cylindrical cup viscometer. With mud allowed to stand in the cup for a period of time, a measured torque is applied to the moveable cup while the concentric cylindrical boundary remains fixed. This torque is slowly increased until rotation occurs and this maximum torque then is used to compute gel strength from the geometry of the system. This instrument is usually referred to as a Fann Viscometer.

The significance of gel strength, G , in contributing to the mud seal of an abandoned well is seen by the following considerations. Assuming a bore hole of diameter D filled with mud of uniform weight density ρ_m we can write the force balance defining equilibrium, or no motion of the column, as indicated indicated in Figure 1 as follows:

$$\text{Pressure force, up} = \frac{\pi D^2}{4} P$$

$$\text{Weight force, down} = \frac{\pi D^2}{4} \rho_m d$$

$$\text{Shear force at wall, down} = \pi D G d$$

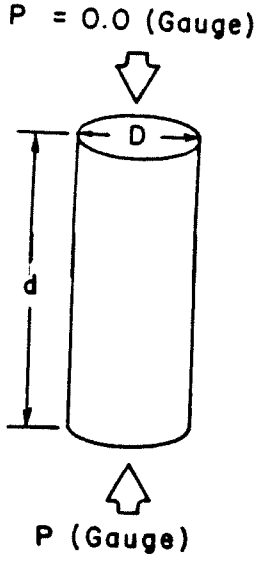


FIGURE 1

Thus equating upward forces to downward forces yields:

$$(1) \qquad \frac{\pi D^2}{4} P = \frac{\pi D^2}{4} \rho_m d + \pi D G d$$

where d is the total height of the mud column. (Typically from the injection zone to surface.) If this is expressed in conventional oil field units, we obtain for P in psi,

$$(2) \qquad P = 0.52 \rho_m d + 3.33 \times 10^{-3} \frac{Gd}{D}$$

where d is in feet, D is in inches, ρ_m is in lb/gal and G is in lb/(100ft^2). If we then subtract, from P, the normal original pressure in the injection zone, $P_o = .052$ where ρ_B is the density of slightly saline water, 8.4 lb/gal., we have the excess pressure contributed by the mud column

$$(3) \qquad P - P_o = .052 (\rho_m - \rho_B) d + 3.33 \times 10^{-3} \frac{Gd}{D}$$

Now a minimum mud weight for bentonite mud is about 8.6 lb/gal. (Gray & Darley, 1981) and for fresh water mud G will be about 50 lb/100 sq.ft. For a 5000 ft. of 9 5/8" diameter hole this yields

$$(4) \qquad P - P_o = 52 + 86.5$$

Thus gel strength contributes 86.5 psi as sealing pressure while mud weight contributes 52.0 psi. Even the lowest possible gel strength that could occur,

about 20 lb/(100ft^2), (Gray & Darley, 1981) would still yield 34.6 psi contributed by gel strength. Thus, gel strength provides a <u>significant portion</u> of the pressure differential $P - P_o$.

Now in the original state, prior to injecting into the disposal zone, reservoir pressure, in a normally pressured stratum in <u>any</u> sedimentary basin, will be that corresponding to hydrostatic equilibrium at the depth of the zone, i.e. P_o. Then we see $P - P_o$ as the <u>pressure increase</u> at the abandoned well that would be required to <u>initiate</u> brine leakage from the zone into the well. Therefore, the general criterion for leakage through the abandoned well is

$$\Delta P \geq 0.052 (\rho_m - \rho_B) d + 3.33 \times 10^{-3} \frac{Gd}{D} \quad (5)$$

where ΔP is the increase in pressure in the injection zone, caused by fluid injection in the zone, above original reservoir pressure at the location of the abandoned well. On the right, d is the subsurface depth, in feet, to the injection zone, at the abandoned well, ρ_m and ρ_B are average mud density in the abandoned well and average brine density from surface to the injection zone, both in lb./gal., G is effective gel strength of the mud in the hole, in lb./(100ft^2) and D is the average diameter of the abandoned hole in inches.

Now this is the same criterion used by Barker (1981) and subsequently elaborated to an annular configuration for pipe in the hole by Davis and Sengelmann (1986), and while physically plausible it had never been tested prior to this study.

This "leak criterion" is based on the hypothesis that fluid entry cannot occur until pressure over the base of the mud column is sufficient to lift the entire column but this may not be totally realistic. Thus some simple laboratory experiments were designed to test this criterion. An apparatus was first constructed as shown in Figure 2. This pipe was filled with a bentonite mud with some brine put into the viewing tube on top of the core after the Berea sandstone core plug in the bottom had been saturated with brine through a filling tube from below. This mud was allowed to gel for about 12 hours then brine pressure in the core was slowly increased until movement of the brine miniscus was detected in the transparent viewing tube on top of the column. The pressure increase at this point was compared to that predicted by Eq.(5). What was found was a bit surprising at first; it was found that if the gel strength, G, as measured on a sample gelled for 12 hours in a Fann instrument, was used in this equation, a value of ΔP much <u>less</u> than the observed value was calculated. A partial explanation for this was found in the effect of the irregularities in diameter of the pipe in the fittings shown above.

In fact, it was found in experiments with several variations of this apparatus, using larger diameter pipe, multiple diameter irregularities, etc., that the <u>effective</u> gel strength, G', that must be inserted into Eq.(5) to correctly predict the critical pressure increase for brine entry into the mud-

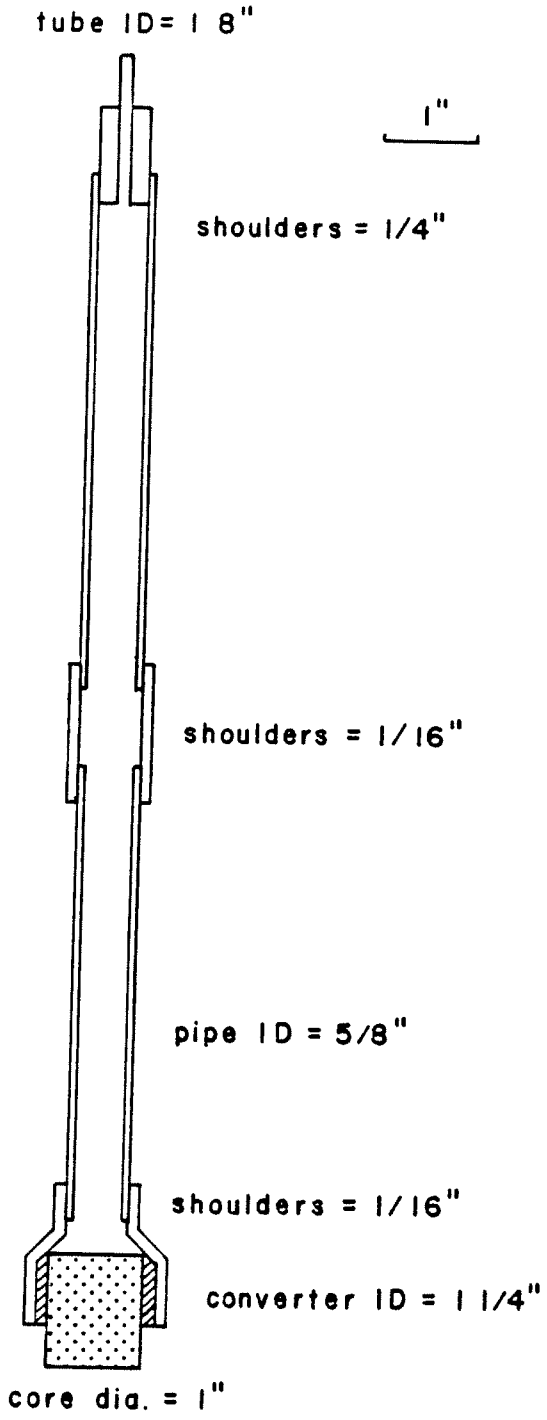


FIGURE 2

filled column was many fold larger than the actual gel strength. These experiments are described in detail in Appendix B.

These experiments suggest that there is an apparent <u>increase</u> in critical entry pressure contributed by hole irregularities roughly given by

(6) $$\Delta P_G = n\ \Delta P_{Gel}\ \varepsilon$$

Here ΔP_{Gel} is the calculated value for gel contribution for a straight cylindrical hole, as in Eq.(5), n is the number of hole-diameter irregularities and ε is a dimensionless parameter characteristic of the geometry of these irregularities, all assumed to be identical. With this, we would alter Eq.(5) to read

(7) $$\Delta P \geq 0.052\ (\rho_m - \rho_B)\ d + 3.33 \times 10^{-3}\ \frac{G'd}{D}$$

where G' defined by

(8) $$G' = (1+n\varepsilon)G$$

is the <u>apparent gel strength</u> for the mud in the irregular hole. In fact, this is the basis used to compare and evaluate various simulated hole geometries in Appendix B. There the ratio G'/G=R was found to fall in the range of 1.68 to 5.76.

Unfortunately, the data from these experiments was not free of ambiguities; for example, one experiment with a smooth pipe free of irregularities in diameter yielded a G'/G of 1.99 instead of unity as expected. Thus, additional study of factors contributing to the sealing pressure by mud in an abandoned hole is called for, but these data suggest that mud gel and hole irregularities interact to yield a <u>large</u> contribution to sealing pressure.

For example, in Eq.(4), the <u>minimum</u> mud weight contribution to sealing pressure in the 5000 foot hole was computed as 52 psi above ambient original pressure, and for a minimum mud gel of 20 lb/(100ft^2), a contribution of 34.6 psi was computed. In view of the experiments described here, we speculate that in a real wellbore with typical shale "washouts" and other irregularities, this number might be increased by as much as <u>ten fold</u>. Then mud gel would contribute 346 psi as compared to 52 psi by mud weight. However, much additional research is required before these results can be used quantitatively with confidence.

There are other questions to be answered with respect to the sealing role of mud in abandoned boreholes. First of all is the question of mud density. Muds used in rotary drilling are always selected to "over-balance" fluid pressures in penetrated formations thus

(9) $$\rho_m - \rho_B > 0$$

and a difference of 0.2 lb/gal is <u>very conservative</u>. However, mud left standing in an abandoned hole does undergo density changes due to gravitational settling of heavier particles as will be described shortly.

Gel characteristics of mud determined in the laboratory show a limiting gel strength achieved in a relatively short time, as seen in Figure 3. These data, obtained by Garrison (1939), are typical and the curves are well approximated by

$$(10) \qquad G = G_\infty \frac{at}{1 + at}$$

where G_∞ is the ultimate gel strength and "a" is a rate constant. Values of "a" and G are determined by replotting the data of one of these curves as t/G versus t.

$$(11) \qquad \frac{t}{G} = \frac{1}{G_\infty} t + \frac{1}{aG_\infty}$$

Thus slope, $1/G_\infty$, and intercept, $1/aG_\infty$ are determined. Table I shows some typical values for the parameters G_∞ and a as determined in this manner for bentonite suspensions. These data demonstrate distinct effects of bentonite concentration and pH of the mud.

Gel strength normally reported in drilling records is the 10-minute gel strength. The data of Figure 3 clearly show that this value may be many-fold smaller than the ultimate gel strength, G_∞. Furthermore, this "ultimate gel strength" is yet smaller than the gel strength actually developed by mud in an abandoned hole, because Eq. (11) is only an approximation to the true gel strength buildup, and does not accurately describe the experimently observed behavior at long times (beyond a few hours).

TABLE I
(From Garrison, 1939)

CONSTANTS IN GELLING EQUATIONS OF BENTONITE SUSPENSIONS

Bentonite Per Cent	Gel Strength and Rate	pH+ 9.2	pH+ 9.3-9.5	pH+ 9.9-10	pH+ 10.8-11
4.5	G_∞	34.4	40.1	48.5	69.6
4.5	a	0.047	0.071	0.076	0.063
5.5	G_∞	74.4	82.2	129.9	152.7
5.5	a	0.75	0.22	0.13	0.18
6.5	G_∞	114.0	141.0	250.0	268.0
6.5	a	0.79	0.30	0.10	0.25

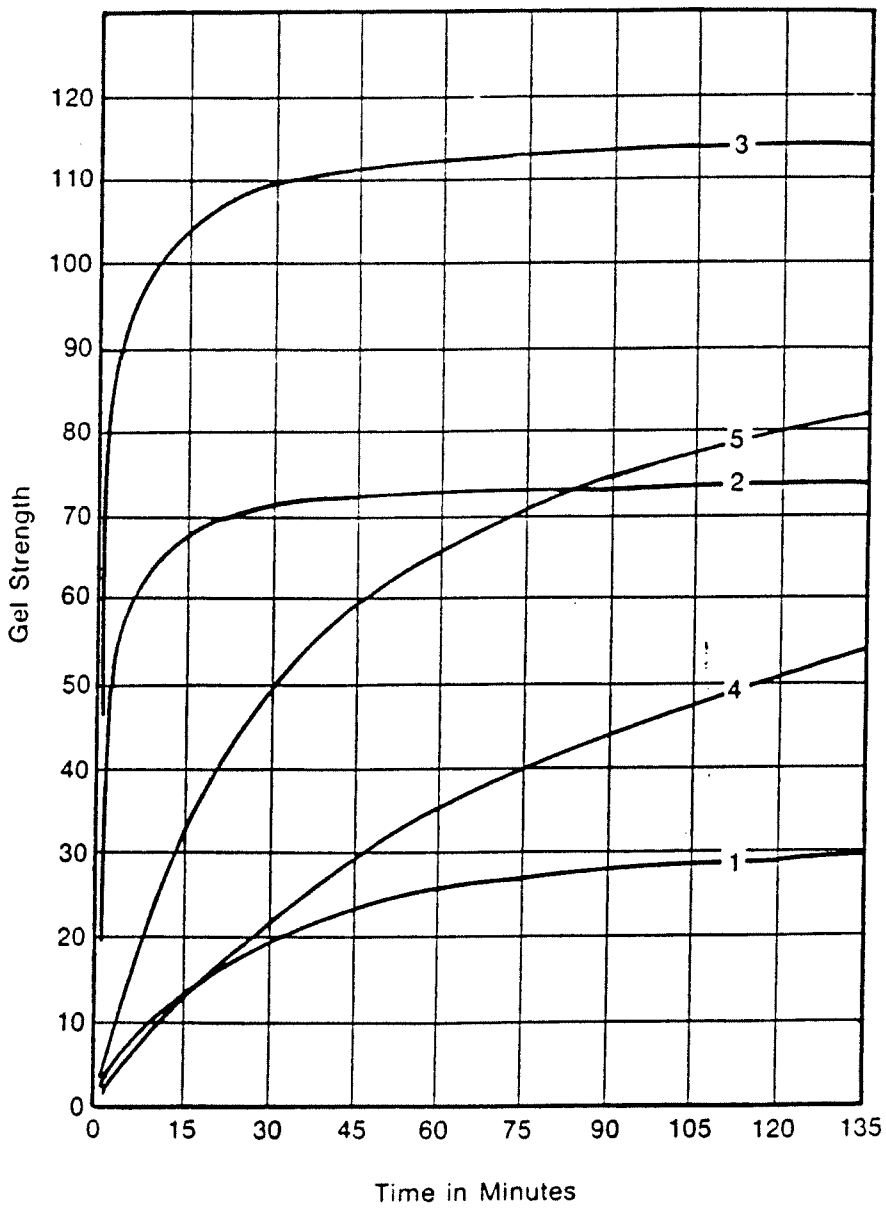

Gel Strength
120
110
100
90
80
70
60
50
40
30
20
10
0
0
15
30
45
60
75
90
105
120
135
Time in Minutes
3
5
2
4
1

FIGURE 3

The range of compositions that might be encountered in old muds is too great to try to categorize for this study but we can try to set some lower bounds expected for mud weight and gel strength.

There is some information available indicating the effect of "aging" on mud gel strength and this is critical in our assessment of the actual gel strength for old muds. Certainly the "ultimate" gel strength G_∞ defined above is not the value we expect in an abandoned well. Table II, from the work of Weintritt and Hughes (1965), illustrates to some degree the effect of aging on muds of different composition (see lower part of Table II) even though these progressive gel measurements were carried only to 16 hours.

Two sets of this data are plotted in Figure 4. It is very clear that gel strength continues to increase long after the "ultimate strength" plateau of Garrison's formula is apparently reached. Thus extrapolation of short-term gel measurements based upon the Garrison formula can be totally misleading. Gel strengths of truly old muds may be orders of magnitude greater than the "ultimate gel strength" indicated by the Garrison extrapolation, but more research is needed on this question.

Another aspect of aging of mud is settling of suspended solids and heavier particulates. Cooke, (1983) (1984), in the course of field experiments designed to evaluate processes occurring in primary cementing operations, made direct determinations of change in the weight density of mud left standing in a drill hole over the course of eleven months. Surface-recording pressure transducers were mounted at various points on casing prior to running and cementing in the hole in seven different wells. Since cement was not run to surface in the annulus, those sensors in this mud-filled portion of the annulus gave information on changing density of mud with time. This was a water-base, bentonite mud weighted with barite to 11.0 lb/gal. It was found that sedimentation reduced this to 9.1 lb/gal in eleven months.

The gel characteristics of old mud in abandoned wells have not been investigated quantitatively, but qualitative field observations of mud recovered from re-entered holes (Chenevert, 1986) indicate extremely high gel strength. Such old muds will be predominantly made up of finer particulates of bentonite (montmorillonite, illites and kaolinites) from the original prepared mud and shales penetrated by the hole. Heavier particulates and cuttings will have settled to the bottom of the hole.

Now in spite of the great variability in mud properties that might be found in abandoned wells, it is possible to assign lower bounds for mud weight and effective gel strength for purposes of looking at worst case scenarios. Thus we should expect that if a hole had been drilled with cable tools, it would contain only natural brine that seeped into the hole plus some solids that sloughed from the walls due to exposure to this water. Finer particles of montmorillonite would have remained in suspension to create some gel strength but heavier solids would have settled to the bottom of the hole. Such holes can be treated as "mud" filled holes with a ρ_m of about 8.5 lb/gal and a gel strength of roughly 15 to 20 lb(100 ft^2) which are typical for dilute bentonite muds (Gray and Darley, 1980). Note however, in computing the

TABLE II

Comparison of Mud Properties with Progressive Gel-Strength Tests

Gyp-Ferrochrome Lignosulfonate Emulsion Muds

	SAMPLE			
	Mud E	Mud F	Mud G	
			No Treatment	3 lb/bbl PCL
Weight, unstirred, lb/gal	11.0	10.7	10.6	
Weight, stirred, lb/gal	11.0	10.3	10.7	
Plastic Viscosity, cp	14	23	16	15
Yield Point, lb/100 sq ft	3	6	2	1
10-sec gel, lb/100 sq ft	1	2	1	0
10-min gel, lb/100 sq ft	8	8	7	3
API filtrate, ml	6.2	3.3	5.2	2.9
ph	10.9	10.6	10.5	10.4
Composition: Water % by vol	76	63	75	
Oil % by vol	5	11	9	
Solids % by vol	19	16	16	
Solids % by wt	39	36	37	
Solids, Sp.Gr.	2.7	2.9	3.0	
Filtrate Ion Analysis:				
Chlorides ppm	3500	400	3000	
Sulfate, epm	250	300	130	
Carbonate, epm	24	28	12	
Bicarbonate, epm	12	160	12	
Calcium, epm	44	52	44	

Progressive Gel Strengths (lb/100 sq ft)	Temperature (°F)							
Time	75°	180°	75°	180°	75°	180°	75°	180°
0 minutes	1	1	2	2	1	1	0	0
3 minutes	2	3	2	5	3	8	1	1
10 minutes	8	18	8	12	7	26	3	3
30 minutes	15	40	11	18	17	58	5	5
60 minutes	27	90	18	16	29	91	6	6
2 hours	31	145	22	22	29	104	7	7
4 hours	37	190	29	42	46	172	10	10
8 hours	46	190	33	42				
16 hours	880	320	40	57	95	320	25	25

critical pressure increase to initiate fluid entry, an effective gel strength due to hole irregularities of greater magnitude is suggested by the experiments described earlier.

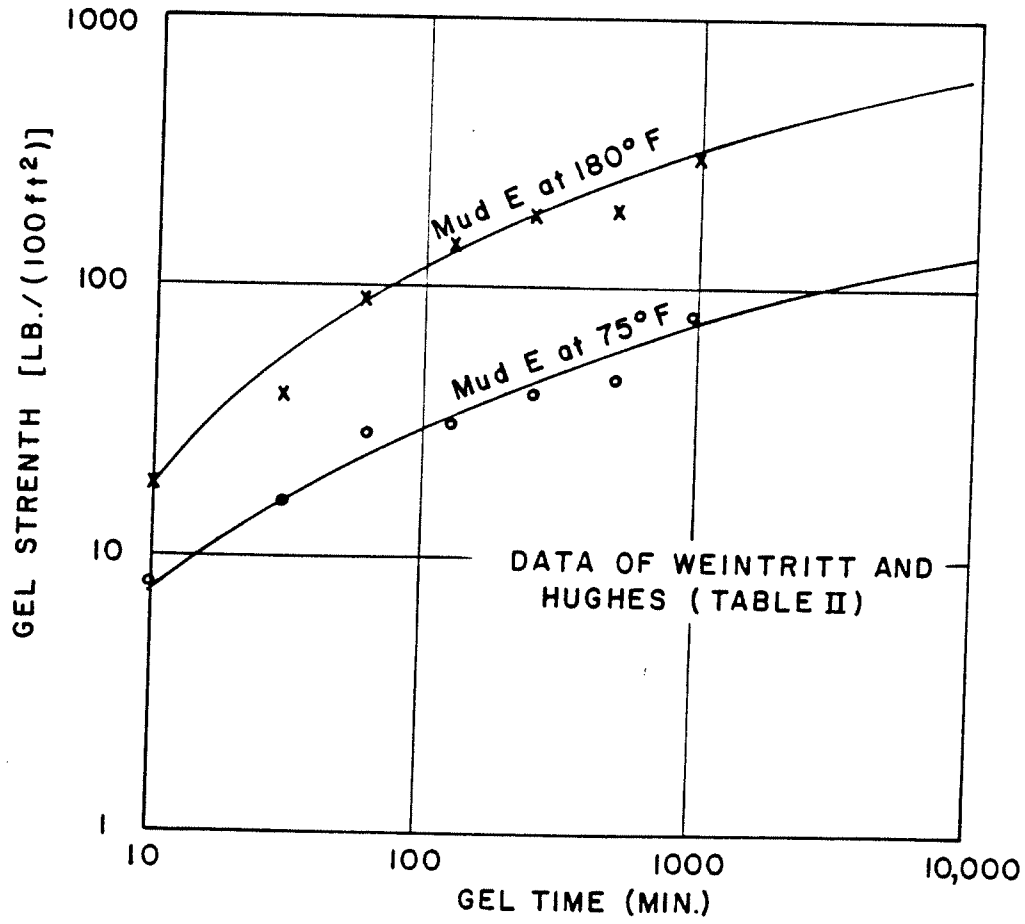


FIGURE 4

For rotary drilled holes, a minimum mud density of 8.6 lb/gal must exist but a probable mud density of 9 lb/gal is likely.

Actual gel strengths of 80 to 300 lb/(100 ft^2) are indicated from the previous discussion but a much larger effective gel strength is again suggested by our experiments.

IV. The Simulation Model; Mathematical Background

We have identified abandoned wells as the overriding potential pathway for contamination of USDW from deep well injection in a properly sited, properly constructed and properly operated injection well system. We have also established a criterion for on-set of leakage of brine, or injected fluid, in an abandoned well in terms of a critical pressure rise at the abandoned well site in the injection zone. Thus, we now come to the central consideration of this study, that is the forecasting of the distribution of pressure increase in the injection zone for the design lifetime of the well, and, for that matter, all future time. The forecast of pressure increase is designed to exhibit effects of sealed reservoir boundaries, anisotropic permeabilities, leaky shale aquicludes and partially sealing faults which permit flow transverse to but not tangent to the fault plane.

The method selected for these forecasts of pressure, or flow potential, distribution histories is a mathematical simulation based upon analytical solutions to the basic partial differential equation describing two-dimensional plane flow in the injection zone. It is assumed that the fluid is slightly compressible, of uniform density, and uniform viscosity within a permeable stratum of rock. This stratum may be anisotropic in the plane of the stratum, but is uniform in all other pertinent properties, except at transecting plane discontinuities. Thus the injection stratum may consist of one, two or several large "blocks", each with uniform porosity, ϕ_o, permeabilities K_x and K_y, thickness h, etc. joined at plane interfaces.

The reader should be aware that the approximation of a layered stratum of rock as a uniform stratum provides very accurate estimates of pressure or flow potential distributions; it is only required that the thickness-weighted average of the permeabilities of the layers be assigned as the permeability for the homogeneous stratum in any one direction. It is also necessary in the case of anisotropic permeability that the principal axes of permeability (direction of maximum and minimum permeability) be the same for all layers. Similar assignment of thickness-weighted average porosity is required.

The basic partial differential equation has the form

$$(12) \qquad \frac{K_x}{K}\frac{\partial^2 \bar{\psi}}{\partial x^2} + \frac{K_y}{K}\frac{\partial^2 \bar{\psi}}{\partial y^2} - \alpha(\bar{\psi}-\bar{\psi}_o) = \frac{\phi_o \mu c}{K}\frac{\partial \bar{\psi}}{\partial t}$$

where the coordinate axes, x, y are on a horizontal datum plane and oriented parallel to the principal axes of permeability in the formation. The derivation of this equation is given in Appendix A. The function ψ is the flow potential defined by

$$(13) \qquad \bar{\psi} = \bar{P} + \rho_o g H(x,y)$$

with $H(x,y)$ the height of the midpoint of the rock stratum above a datum plane, at location x,y. Here ρ_o is the fluid density at original average reservoir pressure and $\bar{P}$ the pressure at this location in the stratum at time time t. The bar over ψ indicates that this is the value of ψ averaged over the thickness h of the stratum. The other quantities appearing here are:

μ = fluid viscosity

$K = \sqrt{K_x K_y}$

ϕ_o = reservoir porosity at original pressure conditions

$c = c_\phi + c_f$ where

c_ϕ = pore compressibility of rock

c_f = fluid compressiblity

$\alpha = K_{zs}/Khh_s$

$\bar{\psi}_o$ = initial uniform potential

and

K_{zs} = permeability of shale sealing layer

h = thickness of injection zone

h_s = thickness of shale sealing layer

We should note here that the leaky shale coefficient, α, is just the reciprocal of the characteristic length, B, introduced by Hantush and Jacob (1955).

It is assumed that initially, prior to start of injection, hydrostatic equilibrium exists throughout the injection zone, the shale sealing layer and an overlying brine aquifer immediately on top of the shale sealing layer. Thus $\bar{\psi}_o$ is the uniform value throughout these bodies intially and it is assumed that even though flow through the "leaky shale" occurs at a rate

$$\text{(14)} \qquad \begin{matrix}\text{leak rate per} \\ \text{area of shale} \\ \text{overlayment}\end{matrix} = \frac{K_{zs}}{\mu} \quad \frac{\bar{\psi} - \bar{\psi}_o}{h_s}$$

the overlying aquifer is so thick and permeable that the potential in that aquifer remains at potential $\bar{\psi}_o$ everywhere for all time. Certainly this is an approximation, just as the "instantaneous steady-state" leak rate per unit

area, given in Eq.(14), is an approximation, but these approximations allow estimation of effects due to "leaky shales". Neglecting the buildup of back pressure in the overlying aquifer tends to underestimate the pressure increase in the injection zone at long times, while neglecting the compressional storage capacity of the confining shale layer tends to overestimate the pressure increase in the injection zone; thus the above approximation is conservative.

Other investigators used these same approximations, Hantush and Jacob (1955), Hantush (1960), Miller et al (1986), while there have been some more "sophisticated" approximations employed by others in the treatment of multiple leaky aquifers, Chen and Herrera (1982), Herrera (1970), and others. (See Bibliography) The advantage of this approximate description for the "leaky shale" problem is that we have been able to show that, by using the analytical solution for a single well of constant rate, we can use the superposition principle, and method of images, to write solutions for reservoirs having various boundaries and variable injection rates just as for the non-leaky shale case. The latter is well described in the text by Collins (1961).

At the other extreme of "leaky" shale approximations is that of an effectively <u>infinitely thick shale</u> in which we assume vertical but not lateral flow. In this case, we show in Appendix A that the leak rate of Eq.(14) is replaced by

$$(15)\quad \text{leak rate per area of shale overlayment} = \frac{K_{zs}\phi_s c}{\pi\mu}\int_0^t \frac{\bar{\psi}(x,y,\tau) - \bar{\psi}_o}{\sqrt{(t-\tau)^3}}\, d\tau$$

and it is clear here that the main contribution to the integral is in a <u>small</u> neighborhood $\Delta\tau$ of $\tau = t$. Thus this can be <u>approximated</u> as

$$(16)\quad \text{leak rate} \simeq \frac{K_{zs}}{\mu}\sqrt{\frac{\phi_s \mu c}{\pi K_{zs}\Delta\tau}}\,(\bar{\psi}(x,y,t)-\bar{\psi}_o)$$

which has the <u>form</u> of Eq.(14) with an h_s given as the reciprocal of the radical appearing here. Thus the leaky shale model we are employing is capable of simulating the storage effect due to leak off of brine into a <u>thick</u>, slightly permeable aquiclude, at least to an approximate degree.

We should note of course that a shale aquiclude <u>acts</u> as an infinitely thick layer so long as no pressure increase has occurred in the overlying aquifer. From the analytical solution for a step increase in injection zone pressure (see Carslaw & Jaeger,(1973) p.101) this will be valid for an injection time t such that $K_{zs}t/\phi_s\mu c h_s^2$ is less than 0.05.

The analytical solution to Eq.(12), for the non-leaky case, $\alpha = 0$, corresponding to a single well of constant rate q starting at time $t = 0$ and located at position x_w, y_w is: (Collins, 1961, p. 115)

$$(17)^{*} \qquad \bar{\psi} - \bar{\psi}_o = \frac{q\mu}{4\pi Kh} \{-Ei(-\frac{\phi_o \mu c}{4Kt} [(x-x_w)^2 \frac{K}{K_x} + (y-y_w)^2 \frac{K}{K_y}])\}$$

Then the coordinate substitutions

$$(18) \qquad x' = x\sqrt{\frac{K}{K_x}}, \quad y' = y\sqrt{\frac{K}{K_y}}$$

reduce this to the form

$$(19) \qquad \bar{\psi} - \bar{\psi}_o = \frac{q\mu}{4\pi Kh} \{-Ei(-\frac{\phi_o \mu c}{4Kt} [(x'-x'_w)^2 + (y'-y'_w)^2])\}$$

which has been called the "Theis equation" in hydrology literature after the publication by Theis (1935), but actually this should be called the "Kelvin equation", if it is to have an individual's name, because it was Lord Kelvin, the famed English physicist, who first published this equation in his transient heat conduction studies.

What is shown by this coordinate substitution is that the anisotropic solution, Eq.(17), looks exactly like the isotropic solution, $K_x = K_y = K$, in the transformed coordinates. Thus while the contours of equal potential are circles about the injection well in the isotropic case,

$$(20) \qquad (x-x_w)^2 + (y-y_w)^2 = r^2 = \text{constant}$$

these becomes ellipses

$$(21) \qquad \frac{(x-x_w)^2}{(K_x/K)} + \frac{(y-y_w)^2}{(K_y/K)} = \text{constant} = r^2$$

in the anisotropic case. Thus if for example $K_y > K_x$, then the ratio of maximum distance from the well, $(y - y_w)$, to minimum distance, $(x - x_w)$, at

* Here the Ei-function is defined by $-Ei(-z) = \int_z^{\infty} \frac{e^{-\lambda}}{\lambda} d\lambda$

which a given pressure increase will occur is

$$(22) \qquad \frac{(y - y_w)_{max}}{(x - x_w)_{min}} = \sqrt{\frac{K_y}{K_x}}$$

Thus in anisotropic reservoirs, which are appropriately described by equations of this type, pressure build-up from fluid injection will be greatest, and occur earlier in the direction of maximum permeability.

Ample field evidence of such anisotropy has been accumulated from studies of some oil reservoirs such as the Spraberry Field in northwest Texas. (McCarthy and Barfield, 1958; Elkins and Skov, 1960)

In Appendix A, we show how to add solutions of the type in Eq.(17) to simulate variable rate wells in domains bounded by linear lateral fault planes. This includes, for example, wells within a rectangular domain or in a semi-infinite reservoir bounded by fault planes making an angle θ_T with each other.

These same techniques are shown to apply to an injection well in a stratum bounded above, and/or below, by a "leaky shale" layer. This is based on the solution of Eq.(12) for a single well of constant rate q_a, starting at time zero, located at x_w, y_w in an infinite stratum. This solution, obtained by Collins (1986), has the form

$$(23) \qquad \bar{\psi} - \bar{\psi}_o = \frac{q_a \mu}{4\pi Kh} \left[e^{-\frac{\alpha}{\beta} t} \{-Ei(-\frac{\beta r^2}{4t})\} + \int_o^t e^{-\frac{\alpha}{\beta} \lambda} \{-Ei(-\frac{\beta r^2}{4\lambda})\} \frac{\alpha}{\beta} d\lambda \right]$$

where α is the leaky shale parameter defined for Eq.(12) above and β is $\phi_o \mu c/K$, the reciprocal of hydraulic diffusivity. The derivation of this solution is given in Appendix A. The pseudo steady-state form of this solution is also given there and it is shown that in the steady-state limit, $t \to \infty$, this reduces to the form published by Hantush and Jacob (1955).

$$(24) \qquad \psi - \psi_o = \frac{q_a \mu}{2\pi Kh} K_o(\alpha r)$$

Another particular solution for Eq.(12) that has been adapted in the simulator is one obtained by Yaxley (1985) to describe a well near a partially sealing

fault. His description is for a single well at distance B from the fault in an isotropic reservoir with a sealed aquiclude but by coordinate substitutions, as described above in Eq.(18), and elaborated in Appendix A, his solution can be adapted to anisotropic cases.

The partially sealing fault is contrasted to a totally sealing fault in the following diagram.

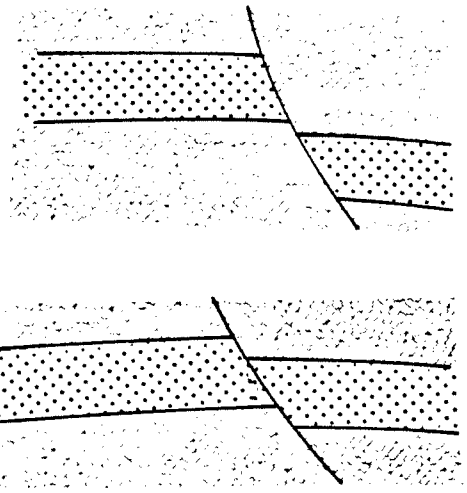


FIGURE 5

Yaxley describes the solution of this problem in terms of the geometry of Figure (6).

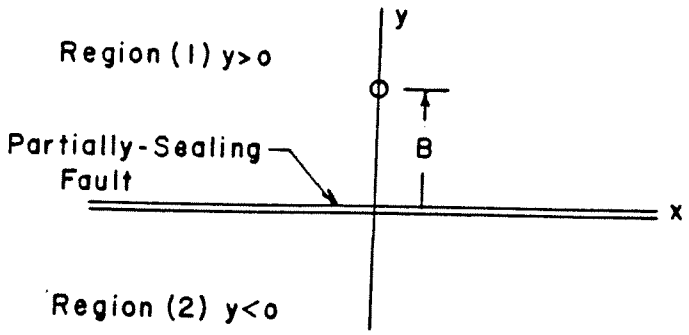


FIGURE 6

The presence of the fault introduces a discontinuity in flow potential, across the fault, proportional to the fluid flow rate normal to the fault at a given point. Thus with $\bar{\psi}_1$ (w,y,t) the solution in the domain y > 0 and $\bar{\psi}_2$ (x,y,t) that in the domain y > 0 the boundary condition along the fault, y = 0, is

$$(25) \qquad \frac{K_f}{\mu \ell_f} [\bar{\psi}_1(x,\ell_f,t) - \bar{\psi}_2(x,o,t)] = \frac{K}{\mu} \frac{\partial \bar{\psi}_1}{\partial y}(x,\ell_f,t)$$

where the fault is visualized as a strip of width ℓ_f having permeability $K_f<K$. This is employed in the limit $\ell_f \to 0$ with the dimensionless coefficient defined by

$$(26) \qquad \alpha_f = \frac{K_f}{\ell_f} \frac{B}{K}$$

i.e., Eq.(25) is as $\ell_f \to 0$ and $K_f \to 0$ with K_f/ℓ_f finite and non-zero,

$$(27) \qquad \frac{\alpha_f}{B} [\bar{\psi}_1 (x,o,t) - \bar{\psi}_2 (x,o,t)] = \frac{\partial \bar{\psi}_1}{\partial y} (x,o,t)$$

The forms for these solutions for $\bar{\psi}_1$ and $\bar{\psi}_2$ are given in Appendix A in a dimensionless format. These involve a rather complex integral involving a complimentary error function which must be evaluated numerically for each computation of $\bar{\psi}_1$ or $\bar{\psi}_2$. This has been implemented in our simulator.

Effects of spatially variable permeability are not incorporated in this simulator but in Appendix A, a mathematical model is described which permits assessment of effects of non-homogeneous permeabilities.

V. The Simulation Model; Practical Description

Input Data:

(1) Injection Reservoir Properties

K = permeability, md
h = thickness, ft
ϕ_o = porosity, fraction
μ = fluid viscosity, cp
c = effective compressibility, psi^{-1}

(2) Sealing Layer Properties

K_{zs} = shale vertical permeability, md

h_s = shale thickness, ft

(Note: these enter calculations only as K_{zs}/Khh_s

(3) Reservoir Geometry (Sealed Boundaries)

Box geometry, length L (ft), width W (ft)
or
Semi-infinite geometry bounded by two faults intersecting in vertex angle, θ_T , degrees
or
Infinite reservoir, no faults
or
Infinite reservoir transected by one partially sealing fault

(4) Injection Well Data

Injection well coordinates
Injection well rates and starting times
(A variable rate option is available)

(5) Abandoned Well Data

Abandoned well coordinates
Depth, subsurface, to injection zone
Mud weight density and effective gel strength
Borehole diameter

(6) Partially Sealing Fault

k_f = fault "permeability", md

ℓ_f = fault "width", ft

(Note: these enter calculations only as K_f/ℓ_f

(7) Total Run Time

This is the design lifetime of the injection wells under study.

(8) Time-Step

This is the time interval between evaluations of pressure build-up at all abandoned wells. When the critical pressure to leak is exceeded at a well on any time step interpolation using three steps is used to fix the time of onset of leaking.

Output Data

(1) Time (in years) for an abandoned well to begin leaking

VI. Case Studies

The problem in assigning an area of review for a deep well injection system is two-fold; first, one must determine locations of abandoned wells and assign realistic values for mud and hole properties which determine the critical pressures in the injection zone, P_{crit}, at each well, which determines on-set of leaking, and second, one must make realistic forecasts of pressure history in the injection zone at the location of each abandoned well. This forecast of pressure history must reflect effects of near boundaries in the injection zone, sealing faults or non-sealing faults, leaky shale aquicludes and anisotropic permeabilities.

The collection of case studies given in Appendix C is intended to provide clear examples illustrating the effect of various system parameters on the leak time, or time of on-set of leaking, in abandoned wells. Following is a list of studies.

Case Studies List

I. Effects of sealing fault boundaries and well locations

II. Effects of abandoned well parameters

III. Effects of partially sealing faults

IV. Effects of "leaky shale" aquicludes

V. Effects of anisotropic permeabilities

VI. Effects of finite reservoir volume

Format: Case Study Examples

In each case study, well and reservoir data are given as above, then a map is given indicating locations of wells and boundaries. On this map, an open circle is an abandoned well that did not leak during the lifetime indicated on the map while a solid circle indicates an abandoned well that did leak. The notation by a well such as t_L = 1.6 yr, indicates the time in years after initiation of injection when leaking began at that well. The injection well is marked by a circle with an arrow through it.

We have elected to use one set of abandoned well locations and a single injection well so that comparisons between various runs on the simulator are facilitated. However, in some instances, deviations from this pattern have been made.

Discussion of Case Studies

Case I - Effects of Sealing Faults

The examples given here clearly demonstrate that for any specified critical pressure for leaking of an abandoned well, the presence of no-flow boundaries near the injection well accelerates leaking by virtue of more rapid pressure increase in the reservoir. This phenomenon is sensitive to location of the injection well relative to these "fault" boundaries. One example of detailed pressure histories at wells is also shown.

Case II - Effects of Abandoned Well Parameters

The examples in this case study clearly demonstrate that the assumed values for effective mud properties in abandoned holes greatly affects the time for onset of leaking. Even in the worst case of two nearby fault boundaries (45^{o} angle between faults) an increased value of P_{crit} significantly delays onset of leaking.

Case III. Effects of Partially-Sealing Faults

Here, comparisons are made between the effect of a single, partially-sealing fault and a totally sealing fault traversing the reservoir near an injection well. Clearly, the totally sealing fault has greater effect in inducing earlier leaking of wells on the injection well side of the fault. However, even a partially-sealing fault is effective in preventing leakage of wells on the other side of the fault. The presented examples show a clear trend for the effect of the fault "conductivity factor", $\alpha_f = K_f B/K\ell_f$, on the time of onset of leaking of abandoned wells.

Case IV. Effects of Leaky Shales

The examples presented here show the potential for "leaky shales" to prevent leaking of abandoned wells. The first set of runs exhibits a worst case comparison for two faults at 45^{o}. With all other parameters equal, the times for onset of well leaking in the leaky shale case are two to six times longer than in the non-leaky shale case. It can be shown from the steady-state solution that leaky shales display a pressure build-up to a finite pressure at long times so an abandoned well may never leak in some cases.

Case V. Effects of Anisotropic Permeabilities

Only a limited demonstration of effects of anisotropic permeability is given here. The case of $K_x/K_y = 4$ has been illustrated in one well pattern. The higher permeability in the x-direction, and lower in the y-direction, with the same $\sqrt{K_x K_y} = K$ as in the isotropic runs, is equivalent to moving wells further apart in the y-direction and closer together in the x-direction. The resulting times for on-set of leaking reflect this very clearly.

In field operations, the only methods available for detecting effective anisotropy, or measuring it, are based upon well interference effects, or tracer techniques. Thus multiple wells must be available for such tests.

Case VI. Effects of Finite Reservoir Volume

Of all factors considered here, finite reservoir volume can be by far the most detrimental to injection well operations. The examples given demonstrate very clearly that pressure build-up is excessively rapid and leaking of abandoned wells occurs very early in reservoirs of small pore volume. Increasing reservoir area, thickness and porosity reduces the onset of leaking of abandoned wells. Fortunately such reservoirs essentially do not exist in large sedimentary basins. Moreover, their presence can be detected during the recommended initial post-construction test phase of the well operation.

VII. The Type Curve Concept

In view of the many factors affecting the onset of leaking in abandoned wells, we have considered the possibility of employing type curves for evaluating "area of endangerment" from injection operations. These would be families of curves generated as graphs of the dimensionless quantity

$$\Delta P_D = \frac{4\pi Kh}{q\mu} (\bar{\psi} - \bar{\psi}_o) \tag{28}$$

plotted versus a dimensionless distance, r_D, from the injection well in a specified direction. (Angle θ above a selected axis) These could be shown for various dimensionless times, leak parameters and reservoir geometries. Clearly this would require an enormous catalogue of curves in order to cover all possible cases.

Furthermore, in order to use such curves, one would need to know the subsurface geometry of faults and a very large list of parameters of the reservoir, leaky shales and partially-sealing faults. These data are never available at the design or construction stage of an injection well. Therefore, we propose only one type curve and this is described in the following section.

VIII. Recommended Area of Review Process

Our simulation studies have clearly demonstrated that the temporal evolution of the pressure distribution in an injection zone is greatly altered by a variety of geological features. We have exhibited effects of sealing and partially-sealing faults, leaky shales, anisotropic permeabilities and differences in porosity, permeability and thickness of the disposal zone as well as effects of well locations in the zone.

Since all of these factors do have an effect on the pressure distribution in the injection zone, and its evolution in time, we should determine their configuration, or values, prior to constructing the injection well but in most

cases this is impossible and we must employ an area of review process that does not require such prior knowledge.

Certainly we should use all of the best geological evidence available from all sources; logs from neighboring wells, seismic traces, and definitely pressure transient behavior of any neighboring wells operating in the planned injection zone, if such wells exist. Ideally, if enough appropriate data are available then simulation studies could be carried out, using a simulator similar to that developed for this study, to evaluate the pressure influence of the proposed well in the injection zone. Then a very accurate assessment of long-term pressure build-up at every abandoned well near the proposed well could be made.

The method of exploiting such a simulator would be to first establish a "pressure-history match" to well pressures of all existing neighboring injection wells, for their given rate histories, by adjustment of geological parameters of the injection zone in the simulator. Then injection rate histories for the proposed well, and all neighboring wells operating in the same injection zone, would be specified for the future and pressure history forecasts could be made. Thus the future pressure history at every abandoned well would be computed. With these data we would then apply the on-set of leaking criterion, described below, for each abandoned well.

Generally, sufficient pressure-rate data on neighboring wells will not exist for such a history matching process so we propose a two-stage area of review process; a pre-construction area of review study and a post-construction area of review process. These are described as follows.

Pre-Construction Area of Review

Best available estimates of the proposed injection zone porosity, ϕ_o, permeability, K, thickness, h, and effective fluid-rock compressiblity, c, must be made using information from other wells drilled and cored, or tested, in the same zone.

The design rate and lifetime of operation for the proposed well must be assigned. Then a minimum mud weight of 8.6 lb/gal and a minimum effective gel strength of 10 $lb/100ft^2$ is assigned.

These data are then to be used with the "Theis" equation

$$(29) \qquad \bar{\psi}-\bar{\psi}_o = \frac{q\mu}{4\pi Kh}\{-Ei(-\frac{\phi_o \mu c r^2}{4Kt})\}$$

to assign an initial area of review estimate, i.e. a well leaks at distance r from the injector during the lifetime, t, of the injector for rate q if

(30) $$\bar{\psi} - \bar{\psi}_o \geq (\rho_m - \rho_B)gd + \frac{\pi G'd}{D}$$

The implementation of this employs the dimensionless graph

(31) $$\Delta P_D = \frac{4\pi Kh}{q\mu} (\bar{\psi} - \bar{\psi}_o) = - Ei(- \frac{r_D^2}{4})$$

as

$$\Delta P_D \quad \text{versus} \quad r_D = \quad \phi_o \mu c r^2/Kt$$

as shown in Figure 7.

The step-by-step process is as follows:

Step 1

In field units, defined below, calculate the value of

(32) $$\Delta P_D = \frac{Kh}{2+20.6q\mu} (0.052(\rho_m - \rho_B)d + 3.33 \times 10^{-3} \frac{G'd}{D})$$

using 8.6 lb/gal for ρ_m, 8.4 lb/gal for ρ_B, 10 lb/100 ft^2 for G', 11 inches for D, and design values for all other parameters.

Step 2

Draw a horizontal line at this value of ΔP_D on the graph of Figure 7 and read off the value of r_D at the intersection of this line and the curve. This defines a value of r_D where

(33) $$r_D = \sqrt{\phi_o \mu c r^2/Kt}$$

Step 3

Using the numerical value of r_D found in Step 2 compute the initial estimate for r by solving Eq.(33) for r

(34) $$r = r_D \cdot \sqrt{2.31Kt/\phi_o \mu c}$$

along with design values for other parameters. This is the preliminary radius of investigation. Here the symbols and units are:

q = injection rate (gpm)

ϕ_o = injection zone porosity (fraction)

μ = brine viscosity (cp)

c = effective rock/fluid compressibility (psi^{-1})

K = effective permeability (md)

t = design lifetime of injection well (at rate q) (years)

r = radius from well (ft.)

h = injection zone thickness (ft)

ρ_m = minimum mud density (8.6 lb/gal)

ρ_B = brine density (8.4 lb/gal) (mean)

G' = effective minimum gel strength (assumed) 10 $lb/(100ft^2)$

d = depth to injection zone (ft)

D = largest hole diameter (assumed) 11 inches

Now this assigns a radius value, r_{1A}, (in feet) and we then must seek out records on every abandoned well within this circle. If it is ascertained that all such holes were rotary drilled with mud then we should assign a new effective gel strength of 400 $lb/(100ft^2)$ and use actual hole diameters to recompute ΔP_D. In this calculation we can use the reported mud density from the well record if the depth of the abandoned hole is not much greater than the depth, d, of the injection zone. This is because even though segregation of heavier solids to near bottom hole has occurred, there is still nearly the full weight of the column above the injection zone. However, if the abandoned well depth is much greater than depth to injection zone only bentonite mud remains in the hole above the injection zone level and we retain 8.6 lb/gal as mud weight in our calculation for ΔP_D.

If any well located by this record search was drilled with cable tools, or air-rotary, this well must be put on the list for plugging if adequate proof of plugging is not established.

Now out of the list of new ΔP_D values, computed as just described, we select the smallest and again draw a line on the P_D vs r_D graph at this value of ΔP_D. This will intersect the curve at a new, smaller value of r_D. This is used in Eq.(34) to compute a new value of $r = r_{2A}$. Now every well within this "radius of endangered influence" must be examined for record of adequate plugging. Of course, where adequate plugging is not clearly demonstrated, these wells must be re-entered and plugged.

Thus, the pre-construction area of review process we propose differs little from that described by Barker (1981). However, we stress that values we assign for mud density and effective gel strength in abandoned holes differ significantly from those identified by Barker.

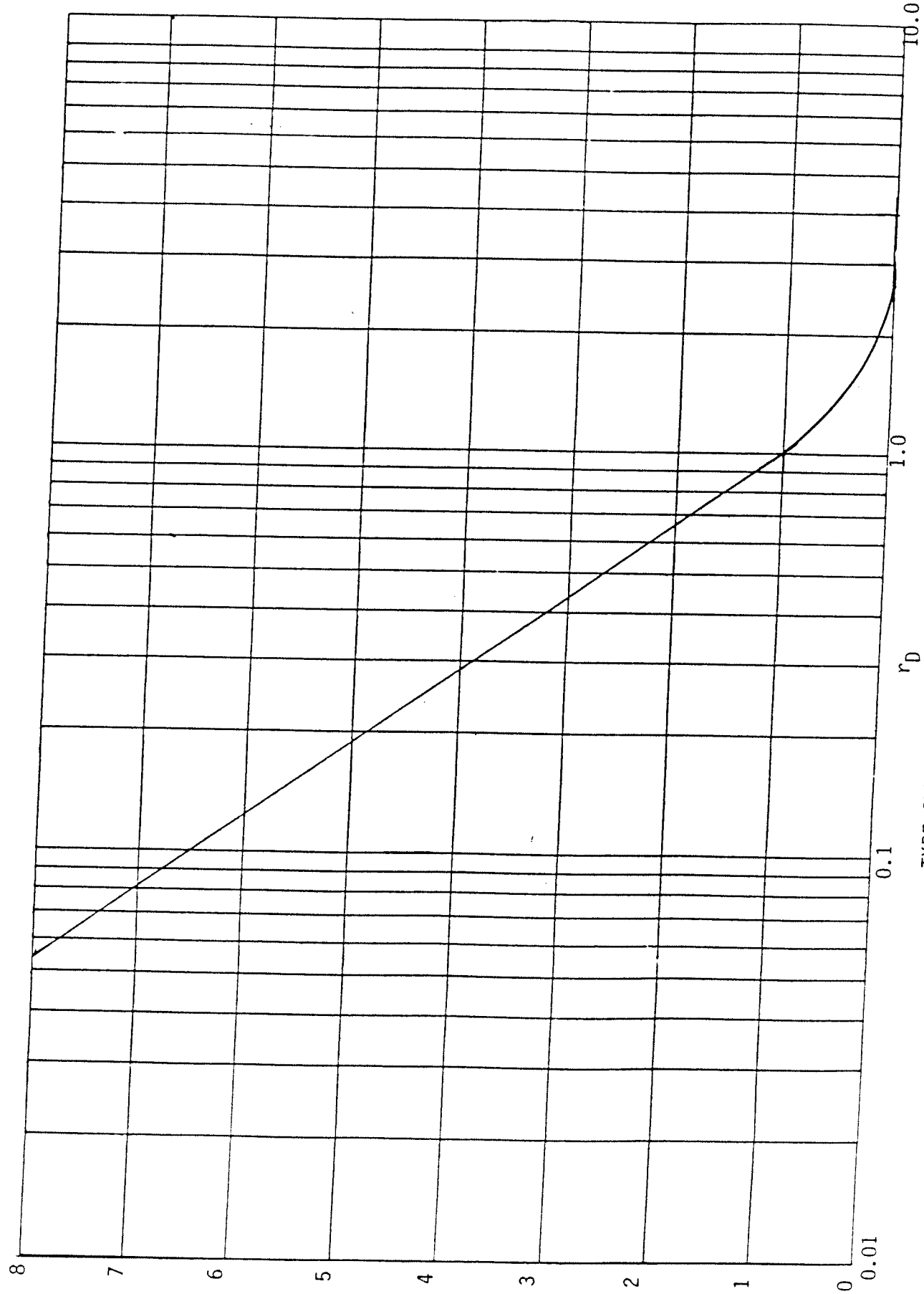
Post Construction Area of Review

The post construction area of review process we propose is designed to exploit the pressure-flow rate transient history of the injection well to define values for all pertinent injection zone parameters. Ideally, we would propose use of a simulator, such as that constructed for this study, and carry out a history match of injection well bottom-hole pressure versus time, for the recorded injection rate history over a long period of time, by adjusting parameters in the simulator.

Such techniques are widely used in the petroleum industry and are often complemented with short-term pressure transient testing. For example, Payne (1985) describes a technique for identifying effects of "no-flow" boundaries on pressure transient data when a well is shut-in and Yaxley (1985) provides similar procedures for partially-sealing faults.

If such a history match is successfully carried out, then the simulator can be used to forecast the onset of leaking of abandoned wells just as we have in our case studies. This reassessment may call for re-evaluation of abandoned wells previously considered to be outside the region of endangering influence.

We caution that a major limitation is that these history matching or pressure transient testing methods are "non-directional" when carried out with data from only one well. Thus, we might ascertain that a partially-sealing fault exists at a certain apparent distance from the well but neither the direction nor the nearest distance to the fault would be determined. Thus in assigning the new area of review, every direction would have to be considered as a possibility. If several injection wells, or monitor wells, are completed near the subject well in the same aquifer, then pressure transient interference tests are capable of determining not only $\sqrt{K_x K_y}$ but also K_x/K_y and therefore the orientation of the axes of permeability anisotropy. (Elkins and Skov, 1960; Pollock and Bennett, 1983)



TYPE CURVE FOR INFINITE RESERVOIR
FIGURE 7.

THIS PAGE

INTENTIONALLY

LEFT BLANK

BIBLIOGRAPHY

Annis, M.R.: "High Temperature Properties of Water-Base Drilling Fluids", J. Pet Tech., p. 1074, Aug. (1976)

Arnold, D.M. and Paap, H.J.: "Quantitative Monitoring of Water Flow Behind and in Wellbore Casing", J. Pet Tech., Jan. (1979) p. 121 - 130

Barker, S.E.: "Determining The Area of Review for Industrial Waste Disposal Wells", M.S. Thesis (Supervised by R. E. Collins), Univ. of Texas at Austin (1981)

N.L. Baroid Company, Manual of Drilling Fluids Technology, N.L. Industries, Inc., Houston, Texas (1979)

Bebout, D.G., Weise, B.R., Gregory, A.R. and Edwards, M.B.: "Wilcox Sandstone Reservoirs in the Deep Subsurface Along the Texas Gulf Coast", Report of Invest. 117, Bureau of Econ. Geol., The University of Texas at Austin (1982)

Brace, W.F., Walsh, J.B. and Frangos, W.T.: "Permeability of Granite Under High Pressure", J. Geophy. Res., 73, p. 2225, March (1968)

Braunstein, Jules and O'Brian, Gerald D.: Diapirism and Diapirs, Am. Association of Pet. Geol. Bull., v. 57 (1973) p. 878 - 886

Brooks, C.S. and Purcell, W.R.: Trans AIME, 195, p. 289 (1952)

Bruce, C.J.: "Pressurized Shale and Related Sediment Deformation; Mechanism for Development of Regional Contemporaneous Faults", Am. Assoc. Pet. Geol. Bull., 57, p. 879 (1973)

Carslaw, H.S. and Jaeger, J.C.: Conduction of Heat In Solids; Oxford; Clarendon Press, Great Britain, Second Ed. (1973)

Chen, B., Herrera, I.: "Numerical Treatment of Leaky Aquifers in The Short Time Range", Water Resources Research, 18, No. 3, p. 557 (1982)

Chenevert, M.E.: "Shale Control with Balanced Activity Oil-Continuous Muds", J. Pet Tech., p. 1309, Oct. (1970)

Chenevert, M.E.: Private Communication to R.E. Collins concerning field experiences on re-entering abandoned wells (1986)

Collins, R.E.: Mathematical Models for Physicists and Engineers, Reinhold Book Co., New York (1968)

Collins, R.E.: Flow of Fluids Through Porous Materials, 1st Printing, Reinhold Pub. Co., New York (1961), Reprint, PennWell Pub. Co. Tulsa, OK (1978)

Collins, R.E.: "A New Solution for the Leaky Shale Problem", Submitted to Water Resources Research (1986)

Cooke, C.E., Jr., Kluck, M.P. and Medrano, R.: "Field Measurement of Annular Pressure and Temperature During Primary Cementing", J. Pet. Tech., p. 1429, Aug. (1983)

Cooke, C.E., Kluck, M.P. and Medrano, R.: "Annuluar Pressure and Temperature Measurements Diagnose Cementing Operations", J. Pet. Tech., p. 2181, Dec. (1984)

Davis, K.E. and Sengelmann, G.D.: "Factors Affecting the Area of Review for Hazardous Waste Disposal Wells", Proc. Int. Conf. Underground Injection, New Orleans, LA., March (1986)

Edwards, M.B.: "The Live Oak Delta Complex: An Unstable Shelf-Edge Delta in the Deep Wilcox Trend of South Texas", Gulf Coast Assoc. of Geol. Soc. Trans., 30, No. 1, p. 54 (1982)

Elkins, L.F. and Skov, A.M.: "Determination of Fracture Orientation From Pressure Interference", Pet.Trans AIME, 219, p. 301, (1960)

Engineering Enterprises, Inc.: Guidance Document for the Area of Review Requirement, Norman, Oklahoma, May (1985)

Ewing, T.E.: "Decollement Zones for Texas Gulf Coast Growth Fault Trends", Abstracts and Programs GSA, 14, No. 7, p. 486 (1982)

Galloway, W.E., Finley, R.J. and Henry, C.D.: "South Texas Uranium Province Geologic Perspective", Guide Book 18, Bur. Econ. Geol., The Univ. of Texas at Austin, (1979)

Garrison, A.D.: "Surface Chemistry of Clays and Shales", Pet. Trans. AIME, 132, p. 191, (1939)

Gray, G.R. and Darley, H.C.H.: Composition and Properties of Oil Well Drilling Fluids, 4th Ed., Gulf Pub. Co., Houston, TX. (1981)

Green, C.J.: "Underground Injection Control Technical Assistance Manual", Texas Dept. of Water Resources, April (1983)

Hall, C.W. and Ballentine, R.K.: "U.S. Environmental Protection Agency Policy on Subsurface Implacement of Fluids by Well Injection", Underground Waste Management and Artificial Recharge (1973)

Han, J.H.: "Genetic Stratigraphy and Associated Growth Structures of The Vicksburg Formation, South Texas", Ph.D. Dissertation, The Univ. of Texas at Austin, (1981)

Hantush, M.S. and Jacob, C.E.: "Non-steady Radial Flow in an Infinite Leaky Aquifer", Trans. Am. Geophy. Union, 36, p. 95 (1955)

Hantush, M.S.: "Modification of The Theory of Leaky Aquifers", J. Geophy. Res., 65, No. 1, p. 3713 (1960)

Herrera, I.: "Theory of Multiple Leaky Aquifers", Water Resources Research, 6, No. 1, p. 185 (1970)

Illinois State of Rules and Regulations, Title 35, Subtitle G, Chapter I, section 730.106, "Area of Review", March 1, (1984)

Kozeny, J.: S.-Ber. Wiener Akad. Abt. IIa, 136, p. 271 (1927)

McCarthy, D.G. and Barfield, E.C.: "The Use of High Speed Computers for Predicting Flood-Out Patterns", Pet. Trans AIME, 213, P. 139 (1958)

McKinley, R.M.: "Production Logging", SPE 10035, 1982 SPE International Petroleum Exhibition, Bejing, China, March 18 - 26 (1982)

Miller, C., Fischer, T.A. II., Clark, J.E., Porter, W.M., Hales, C.H. and Tilton, J.R.: "Flow and Containment of Injected Wastes", Int. Conf. on Underground Injection, New Orleans, LA., March (1986)

National Archives of The United States, Code of Federal Regulations, Protection of Environment, 40, parts 100 - 149, 146.6, "Area of Review", revised as of July 1 (1985)

Payne, R.E.: "A Method to Identify the Effects of No-Flow Boundaries Upon Pressure Build-Up Data", SPE 14312, Annual Meeting SPE, Las Vegas, NV., Sept. (1985)

Pollack, C.B. and Bennett, C.O.: "An Eight-Well Interference Test in The Anschutz Ranch East Field", SPE 11968, Annual Fall Meeting SPE, San Francisco, Oct 5 - 8 (1983)

Price, W.H.: "The Determination of Maximum Injection Well Pressure for Effluent Disposal Wells", M.S. Thesis, Univ. of Texas (1971)

Schlumberger: Production Log Interpretation, pub. by Schlumberger Limited (1973)

Steed, W.C.: "Well Plugging in Texas", Abandoned Wells Conference, The University of Oklahoma, May (1984)

Suman, John R.: Petroleum Production Methods, Gulf Publishing Company, Houston (1923)

Theis, C.V.: "The Relation of The Lowering of the Piezometric Surface and The Rate and Duration of Discharge of a Well Using Ground Water Storage", Trans. Am. Geophy. U., p. 519, Aug. (1935)

Warner, D.L., Koederitz, L.F., Simon, A.D. and Yow, M.G.: Radius of Pressure Influence of Injection Wells, Prepared for the Robert S. Kerr Environmental Research Laboratory, Office of Research & Development USEPA, 600/2-99-170 (1979)

Weintritt, P.J. and Hughes, R.G.: "Factors Involved in High Temperature Drilling Fluids", J. Pet. Tech., p. 707, June (1965)

Williams, B.B., Gidley, John L. and Schechter, R.S.: Acidizing Fundamentals, SPE Monograph, Soc. of Pet. Engr. of AIME, Dallas (1979)

Yaxley, L.M.: "The Effect of a Partially Communicating Fault on Transient Pressure Behavior", SPE 14311, Presented at Annual SPE Conf. in Las Vegas, NV., Sept. (1985)

APPENDIX A

MATHEMATICAL MODELS FOR AREA OF REVIEW STUDY

APPENDIX A

Mathematical Models For Area of Review Study

The injection zone is here treated as a sedimentary deposit of uniform thickness, porosity and permeability bounded above and below by shale layers. There are two versions of the model described here, one in which the bounding shale layers above and below are both impermeable aquicludes and one in which one, or both of these have small, but non-zero permeability to brine.

For flow of brine and/or injected fluid, we neglect any differences in density and viscosity and assume a homogeneous, slightly compressible fluid flowing in the formation having density ρ depending on pressure, P, as

$$\rho = \rho_o e^{c_f(P-P_o)} \tag{A1}$$

where ρ_o is density at reference pressure P_o and c_f is the constant compressibility of the fluid. This is to be used in the equation of continuity for conservation of fluid mass

$$\frac{\partial}{\partial x}(\rho v_x) + \frac{\partial}{\partial y}(\rho v_y) + \frac{\partial}{\partial z}(\rho v_z) = - \frac{\partial}{\partial t}(\rho\phi) \tag{A2}$$

where ϕ is formation porosity fraction and v_x, v_y and v_z are the rectangular components of volume flux density of fluid flow in the formation. For these, we have from Darcy's law

$$v_x = - \frac{K_x}{\mu} \left(\frac{\partial P}{\partial x} + \rho g \frac{\partial H}{\partial x}\right) \tag{A3}$$

$$v_y = - \frac{K_y}{\mu} \left(\frac{\partial P}{\partial y} + \rho g \frac{\partial H}{\partial y}\right)$$

$$v_z = - \frac{K_z}{\mu} \left(\frac{\partial P}{\partial z} + \rho g \frac{\partial H}{\partial z}\right)$$

where H(x,y,z) is vertical height above a datum plane, g is the acceleration of gravity and μ is fluid viscosity. Here K_x, K_y and K_z are the principal values of the anisotropic formation permeability tensor and it is assumed that the coordinate axes are selected to coincide with the principal axes of permeability. The above expressions are to be approximated by replacing ρ in the gravity term by ρ_o. Also we note that $\partial H/\partial x$ is cos θ_x, $\partial H/\partial y$ is cos θ_x

and cos θ_z is similarly defined with θ_x, θ_y, θ_z being the direction angles of the vertical relative to the coordinate axes. Then $\cos^2\theta_x + \cos^2\theta_y + \cos^2\theta_z$ is unity.

This three-dimensional flow problem is reduced to a two-dimensional flow problem by defining average mass fluxes in the formation plane over the thickness, h, of the formation; thus, for example,

$$\overline{\rho v_x} = \frac{1}{h}\int_o^h \rho v_x \, dz \tag{A4}$$

Thus, Eq.(A2) is expressed as

$$\frac{\partial}{\partial x}(\overline{\rho v}_x) + \frac{\partial}{\partial y}(\overline{\rho v}_y) + \frac{1}{h}\left[(\rho v_z)_h - (\rho v_z)_o\right] = -\frac{\partial(\overline{\rho\phi})}{\partial t} \tag{A5}$$

with a bar denoting average value over $0 < z < h$.

In the version of the model with sealed, impermeable aquiclude above and below both v_z terms are zero and we deal with

$$\frac{\partial}{\partial x}(\overline{\rho v_x}) + \frac{\partial}{\partial y}(\overline{\rho v_y}) = -\frac{\partial(\rho\phi)}{\partial t} \tag{A6}$$

The term on the right is simplified to account for compressible rock and fluid using

$$\frac{\partial(\rho\phi)}{\partial t} = \rho \frac{d\phi}{dP}\frac{d\rho}{\partial t} + \phi \frac{d\rho}{dP}\frac{\partial P}{\partial t} \tag{A7}$$

which is equivalent to

$$\frac{\partial(\rho\phi)}{\partial t} = \rho\phi\,(c_\phi + c_f)\frac{\partial P}{\partial t} = \rho\phi c \frac{\partial P}{\partial t} \tag{A8}$$

where c_f is defined in Eq.(A1) and

$$c_\phi = \frac{1}{\phi}\frac{d\phi}{dP} \tag{A9}$$

is the pore compressibility of the formation. In the analysis to follow, it will be assumed that both c_ϕ and c_f are small so that the product $\rho\phi$ in the right member of Eq.(A8) can be approximated as $\rho_o\phi_o$; the values at $P = P_o$.

We next observe that when we insert Darcy's law for v_x and v_y in Eq.(A6), together with Eq.(A1) for ρ we obtain terms such as

$$(A10) \qquad \frac{1}{h}\int_0^h \frac{\partial}{\partial x}\left(\frac{K_x}{\mu}\rho_o e^{c_f(P-P_o)}\left(\frac{\partial P}{\partial x}+\rho g\frac{\partial H}{\partial x}\right)\right) dz$$

In this, we see that

$$(A11) \qquad \rho_o e^{c_f(P-P_o)}\frac{\partial P}{\partial x} = \frac{1}{c_f}\frac{\partial \rho}{\partial x}$$

and then for <u>small</u> c_f we have from Eq.(A1) to <u>first order in</u> $c_f(P-P_o)$

$$(A12) \qquad \rho - \rho_o \simeq c_f \rho_o (P - P_o)$$

so that

$$(A13) \qquad \frac{1}{c_f}\frac{\partial \rho}{\partial x} \simeq \frac{\partial P}{\partial x}$$

Therefore, if we approximate ρ as ρ_o in the gravity term in Eq. (A10) above, we have the form

$$(A14) \qquad \frac{1}{h}\int_0^h \frac{\partial}{\partial x}\left[\frac{K_x}{\mu}\rho_o\left(\frac{\partial P}{\partial x}+\rho_o g\frac{\partial H}{\partial x}\right)\right] dz$$

Therefore defining

$$(A15) \qquad \bar{\psi} = \frac{1}{h}\int_0^h (P + \rho_o g H)\, dz$$

we have the expression in Eq.(A10) as

$$(A16) \qquad \rho_o \frac{\partial}{\partial x}\left(\frac{K_x}{\mu}\frac{\partial \bar{\psi}}{\partial x}\right)$$

and then, with Eqs.(A8) and (A15), Eq.(A6) becomes

$$(A17) \qquad K_x \frac{\partial^2 \bar{\psi}}{\partial x^2} + K_y \frac{\partial^2 \bar{\psi}}{\partial y^2} = \phi_o \mu c \frac{\partial \bar{\psi}}{\partial t}$$

This follows because H is independent of t so $\partial\bar{\rho}/\partial t$ and $\partial\bar{\psi}/\partial t$ are equivalent. Now Eq.(A15) is the general form of our "working" differential equation for K_x and K_y uniform throughout the formation. In this case, we introduce the coordinate substitutions

$$(A18) \qquad x' = x\sqrt{\frac{K}{K_x}} \quad , \quad y' = y\sqrt{\frac{K}{K_y}} \quad , \quad K = \sqrt{K_x K_y}$$

to obtain the isotropic form,

$$(A19) \qquad \frac{\partial^2 \bar{\psi}}{\partial x'^2} + \frac{\partial^2 \bar{\psi}}{\partial y'^2} = \frac{\phi_o \mu c}{K} \frac{\partial \bar{\psi}}{\partial t}$$

This basic equation then describes both isotropic ($K_x = K_y$) and anisotropic ($K_x \neq K_y$) formations with uniform ϕ_o, h, c and K and small c_f. The reservoir need not be horizontal, nor for that matter "flat"; the function H(x',y') in the expression

$$(A20) \qquad \bar{\psi} = \bar{P}(x', y', t) + \rho_o g \bar{H}(x', y')$$

need only be specified.

Since Eq.(A19) describes both isotropic and anisotropic cases, we will delete primes on coordinates in all subsequent analysis with it understood that, for example, x is either just x or it is $x \cdot \sqrt{K/K_x}$ as appropriate to the system.

Returning now to the case of the "leaky" aquifer in which the shale aquiclude above and/or below the formation of interest has non-zero permeability. In this case, our analysis begins with Eq.(A5) rather than Eq.(A6). The only difference is in the presence of the terms in v_z. For simplicity, we describe the case in which v_z is zero at z = 0 (the bottom of the formation) but $v_z \neq 0$ at z = h.

Now

$$(A21) \qquad (v_z)_{z=h} = -\frac{K_{zs}}{\mu}\left(\frac{\partial P}{\partial z} + \rho_g \frac{\partial H}{\partial z}\right)_{z=h} = -\frac{K_{zs}}{\mu} \frac{\partial \psi_s}{\partial z}$$

where K_{zs} is permeability of the shale in the z direction (normal to the layer) and $(\partial\psi_s/\partial z)$ is the potential gradient in the shale at the shale-formation interface. Here we approximate this as the "instantaneous steady-state", linear form,

$$(A22) \qquad -\frac{\partial\psi_s}{\partial t} \simeq \frac{\bar{\psi} - \bar{\psi}_o}{h_s}$$

where $\bar{\psi}$ is the mean ψ in the injection formation at this location, $\bar{\psi}_o$ is the value of ψ in a permeable aquifer above the shale and h_s is the shale thickness. With this approximation, and $\rho \simeq \rho_o$ in the term (ρv_z) at $z = h$, we then see all other treatments of Eq.(A4) are being applicable to Eq.(A3), so there results

$$(A23) \qquad \frac{\partial^2\bar{\psi}}{\partial x^2} + \frac{\partial^2\bar{\psi}}{\partial y^2} - \alpha(\bar{\psi}-\bar{\psi}_o) = \frac{\phi_o\mu c}{K}\frac{\partial\bar{\psi}}{\partial t}$$

describing the aquifer formation with a "leaky" aquiclude on top. Here

$$(A24) \qquad \alpha = \frac{K_{zs}}{Khh_s}$$

and $\bar{\psi}_o$ is assumed as a uniform, constant value for ψ in the aquifer overlying the aquiclude. Furthermore, this must also be the uniform <u>initial</u> value for ψ in the formation of interest since these aquifers were initially in hydrostatic equilibrium. Observe that if <u>both</u> upper and lower aquicludes are "leaky", then α is replaced by the sum, $\alpha_u + \alpha_L$, of the α values of upper and lower shale bodies.

Now the above description of the leaky shales in terms of an <u>instantaneous steady-state</u> potential gradient within the shale, Eq.(A22), is admittedly a crude approximation. An extensive body of literature (see bibliography) is available which treats "leaky aquifers" in terms of transient, compressible flow in this shale. Unfortunately, these more sophisticated forms do not yield solution forms amenable to evaluation in the context of a practical configuration of wells. The form we have obtained on the other hand, Eq.(A23), will be shown to yield a <u>very</u> practical and useful solution form. Furthermore, this can be shown to be an approximation for another "leaky shale" system as follows.

In the case of a very thick shale layer, or other rock of low permeability, overlying the aquifer as aquiclude we can insert another approximation for $\partial\psi_s/\partial z$ at $z = h$ in Eq.(A21) in lieu of the steady-state form in Eq.(A22). We assume flow in the thick shale to be purely vertical and neglect all horizontal flow. Then the boundary value problem for ψ_s is

$$\text{(A25)} \qquad \frac{\partial^2\psi_s}{\partial z^2} = \frac{\phi_s \mu c_s}{K_{zs}} \frac{\partial \psi_s}{\partial t} \; ; \qquad \begin{aligned} \psi_s &= \bar{\psi}_o, \; t = 0 \\ \psi_s &\to \bar{\psi}_o, \; z \to \infty \\ \psi_s &= \bar{\psi}(x,y,t), \; z = h \end{aligned}$$

From the solution for this boundary value problem given by Carslaw and Jaeger (1973, p. 62) we have

$$\text{(A26)} \qquad \psi_s(z,t) - \bar{\psi}_o = \sum_{j=1}^{n} \Delta\bar{\psi}(x,y,t_j) \; \text{erfc}\left(\frac{z - h}{2\sqrt{\gamma(t-t_j)}}\right)$$

where γ denotes $K_{zs}/\phi_s \mu c_s$, $\Delta\bar{\psi}(x,y,t_j)$ is the increase in $\bar{\psi}(x,y,t) - \bar{\psi}_o$ occurring at time $t = t_j$ and erfc denotes the complimentary error function.

Here the continuous variation in $\bar{\psi}(x,y,t)$ in time has been approximated as a step-wise variation. We then find for $\partial\psi_s/\partial z$ at $z = h$ the result

$$\text{(A27)} \qquad \left(\frac{\partial\psi_s}{\partial z}\right)_{z=h} \simeq - \sum_{j=1}^{n} \frac{\Delta\bar{\psi}(x,y,t_j)}{\sqrt{\pi\gamma(t-t_j)}} = - \int_o^t \frac{\partial\bar{\psi}(x,y,\lambda)}{\partial\lambda} \frac{d\lambda}{\sqrt{\pi\gamma(t-\lambda)}}$$

with the integral form being the result for continuous variation in $\bar{\psi}(x,y,t)$. If we then approximate the sum by a single term as

$$\text{(A28)} \qquad \left(\frac{\partial\psi_s}{\partial z}\right)_{z=h} = - \frac{\psi(x,y,t) - \psi_o}{\sqrt{\pi\gamma\Delta\tau}}$$

with $\Delta\tau$ a constant parameter we see this as having the same form as Eq.(A22) with the "effective thickness", h_s being given as $\sqrt{\pi\gamma\Delta\tau}$.

An order of magnitude for $\Delta\tau$ to be inserted here can be estimated from another analytical solution given by Carslaw and Jaeger (1973) in Figure 11 on page 101; there the solution is plotted for a layer of finite thickness with a unit

step change at one surface. This indicates a variable $\Delta\tau$ would be required but for $\gamma t/h_s^2$ between 0 and .05 an average value of $1/\sqrt{\pi\gamma\Delta\tau}$ is seem to be 2.0.

Of course, these approximations are not rigorous and we could employ the integral form in Eq.(A27) in lieu of our Eq.(A22) as an almost exact description for the effect of a thick shale of finite permeability, but this yields an integro-differential equation for $\bar{\psi}$. Thus in all our analysis of "leaky" shales we employ Eq.(A23).

ANALYTICAL SOLUTIONS OF EQUATIONS OF FLOW

For the cases in which the disposal zone is approximated as a uniform aquifer having uniform values of ϕ_o, K_x, K_y, h, μ and c throughout, with a simple class of boundaries, to be described below, analytical solutions for the equation of flow, Eq.(A23), can be constructed for both the "leaky", $\alpha \neq 0$, and "sealed", $\alpha = 0$, cases. These solutions can accommodate any number of injection wells in the common aquifer each having any arbitrary variable rate history.

The Sealed Aquifer

The method of solution is illustrated first for the case of the sealed aquifer, $\alpha = 0$. The method employs a "line source" solution to represent an injection well of constant rate in an aquifer of infinite areal extent and exploits the fact that the differential equation for $\bar{\psi}$, Eq.(A23), is a linear equation so that solutions can be added to construct other solutions. Thus, solutions for "wells" of various rates, starting at various times can be "superposed" (added) with the wells at the same location to represent one well at that location with a variable rate history. Also "image" wells, identical to such a well, can be placed throughout the infinite aquifer to create lines of symmetry in the resulting areal array of wells which appear as no-flow plane boundaries in the aquifer.

The single, constant rate, line source in an infinite aquifer case is first solved by the method of Boltzman by placing the origin of coordinates at the well and writing the differential equation in polar coordinates, thus;

$$(A29) \qquad \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial\bar{\psi}}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2\bar{\psi}}{\partial\theta^2} - \alpha(\psi-\psi_o) = \frac{\phi_o\mu c}{K}\frac{\partial\bar{\psi}}{\partial t}$$

Then, by symmetry, flow is uniformly radial from the origin and does not depend upon θ, hence

$$\text{(A30)} \qquad \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial \bar{\psi}}{\partial r}\right) - \alpha(\bar{\psi}-\bar{\psi}_o) = \frac{\phi_o \mu c}{K}\frac{\partial \bar{\psi}}{\partial t}$$

For the case $\alpha = 0$, we then assume a solution with $\bar{\psi}$ a function only of the variable

$$\text{(A31)} \qquad \zeta = \frac{\phi_o \mu c r^2}{4Kt}$$

and this yields (see Dake [1980])

$$\text{(A32)} \qquad \bar{\psi} = A\int_{\zeta}^{\infty} \frac{e^{-\zeta}}{\zeta}\, d\zeta + B$$

with A and B being constants. Now as $r \to \infty$ we have $\zeta \to \infty$ and the integral must vanish. This also holds as $t \to 0$. Thus, we see that the constant B must be the initial value $\bar{\psi}_o$ of $\bar{\psi}$ and this is also the uniform value at infinite distance from the well for all finite time.

Next, note that the flow rate across the cylindrical shell of radius r and height h, concentric to the well is, from Eq.(A32)

$$\text{(A33)} \qquad q = (-2\pi r h \frac{K}{\mu}\frac{\partial \bar{\psi}}{\partial r})_r = A\frac{4\pi K h}{\mu} e^{-\frac{\phi_o \mu c r^2}{4kt}}$$

which yields for $r \to 0$

$$\text{(A34)} \qquad A = \frac{q\mu}{4\pi K h}$$

where q is the flow rate from the line source at the origin. This also holds in the anisotropic case where K is $\sqrt{K_x K_y}$. Thus the line source solution is the familiar form

$$\text{(A35)} \qquad \bar{\psi} = \bar{\psi}_o + \frac{q\mu}{4\pi K h}\left\{-Ei\left(-\frac{\phi_o \mu c r^2}{4Kt}\right)\right\}$$

where

$$-Ei(-\zeta) = \int_{\zeta}^{\infty} \frac{e^{-\lambda}}{\lambda}\, d\lambda \tag{A36}$$

is the well known exponential integral function. We note the approximation

$$-Ei(-\zeta) \simeq -\ln\gamma\zeta, \quad \zeta < .01 \tag{A37}$$

often applied with high accuracy. Here

$$\ln \gamma = 0.5772, \quad \gamma \simeq 1.781 \tag{A38}$$

is Euler's Constant.

By shifting the origin of coordinates so that the well (line source) is located at x_w , y_w instead of the origin, we have in the above solution

$$r^2 = (x-x_w)^2 + (y-y_w)^2 \tag{A39}$$

with x, y any point at which $\bar{\psi}$ is evaluated, and this solution is a solution of the general two-dimensional equation, Eq.(A19), or Eq.(A23) with $\alpha = 0$.

For a well with the variable rate history, (a step-rate history)

$$q = \sum_{j=1}^{n} \Delta q_j, \qquad t_n < t < t_{n+1} \tag{A40}$$

we simply add solutions like that above for multiple wells superposed at the same location, x_w, y_w, having rates Δq_j, j = 1, 2, ... with well number j coming on stream at time t_j. Thus the solution is

$$\bar{\psi} = \bar{\psi}_o + \sum_{j=1}^{n} \frac{\Delta q_j \mu}{4\pi Kh} \{-Ei(-\frac{\phi_o \mu c r^2}{4K(t-t_j)})\} \tag{A41}$$

Note that $t_1 = 0$ is usually the case with $q = \Delta q_1$ being the initial rate of the well and of course, r^2 is in general defined by Eq.(A39). Also observe that as t increases beyond t_{n+1}, then another term is added to the series, i.e. a term with Δq_{n+1} and t_{n+1} appearing as the last term for $t_{n+1} < t < t_{n+2}$, etc.

We can exploit additivity of solutions to represent aquifers with straight lateral boundaries as described above. Two particular cases are formulated, one the finite rectangular domain and the other a semi-infinite domain bounded by two straight boundaries intersecting at the origin. The latter case is described first.

The domain of the aquifer is represented as shown in Figure A1.1 as the hatched region with <u>one</u> well. To achieve the effect of the two boundaries shown, the lines shown are drawn by symmetry in 45^{o} segments with additional wells then "inserted" as marked by x's. These are image wells. In order for this symmetry to exist, the angle, θ_T , between the two boundaries at the origin must be an <u>even</u> integral fraction of 2π, i.e.

$$\theta_T = \frac{2\pi}{2n_T} , \quad n_T = 1, 2, 3, \ldots \tag{A42}$$

Then image wells are located such that the total collection of wells in the <u>infinite</u> reservoir are located at

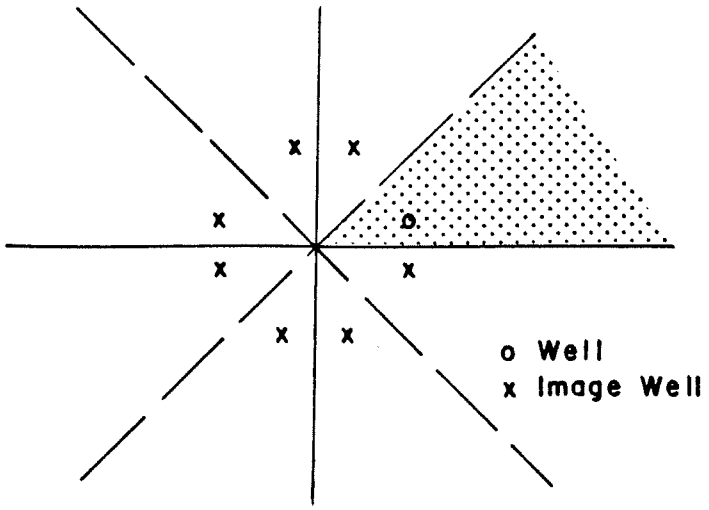


FIGURE A1.1

$$\begin{aligned} x_{wn1} &= R_w \cos(2(n-1)\theta_T + \theta_w) \\ y_{wn1} &= R_w \sin(2(n-1)\theta_T + \theta_w) \\ x_{wn2} &= R_w \cos(2(n-1)\theta_T - \theta_w) \\ y_{wn2} &= R_w \sin(2(n-1)\theta_T - \theta_w) \qquad n=1,2,\ldots n_T \end{aligned} \tag{A43}$$

where n_T is defined by Eq.(A40) and

$$R_w = (x^2_w + y^2_w)^{\frac{1}{2}} \tag{A44}$$

$$\theta_w = \sin^{-1}(y_w/R_w)$$

with x_w, y_w the actual coordinates of the original well.

Then if these wells are ordered and labeled by a single index i = 1, 2,... we can write the solution for one well with variable rate, as described above, in the bounded domain as

$$\bar{\psi} - \bar{\psi}_o = \sum_i \sum_{j=1}^{n} \frac{\Delta q_j \mu}{4\pi Kh} \{-Ei(-\frac{\phi_o \mu c r_i^2}{4K(t-t_j)})\} \tag{A45}$$

where r_i is the distance from the i^{th} well to the point x, y in the bounded domain where $\bar{\psi}$ is evaluated. Note that all of the wells here have an identical rate history. This is readily generalized to represent any number of actual wells in the bounded domain simply by adding a similar double sum on the right for each such well.

Observe a special case of "one" plane boundary when $\theta_T = 180^o$; then there is only one image well for each actual well, i.e. $n_T = 1$.

The other bounded case treated is the rectangular domain. In this case, we have for one well in the domain, the infinite array of lines of symmetry and image wells as shown in Figure A1.2.

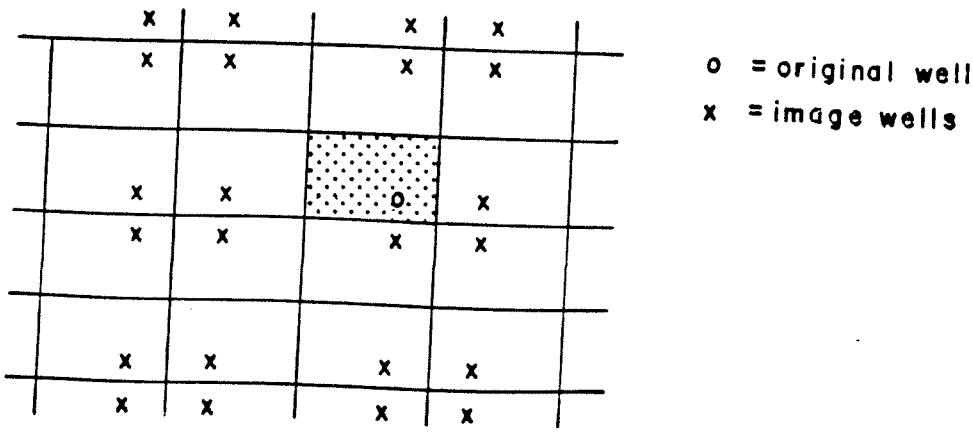


FIGURE A1.2

In this case, the original well located at $x = a$, $y = b$ is now replaced by the two-dimensional, infinite array with wells located at

$$
\begin{aligned}
x_{wn1} &= 2nL - (L-a) = (2n-1)L + a \\
y_{wn1} &= 2mw - (w-b) = (2m-1)w + b \\
x_{wn2} &= (2n-1)L - a \\
y_{wn2} &= (2m-1)w - b
\end{aligned}
\qquad (A46)
$$

$n = \pm 1, \pm 2, \ldots$

$m = \pm 1, \pm 2, \ldots$

Again, we can put these wells in correspondence with a single integer index, $i = 1, 2, \ldots$ and Eq.(A45) is then the form of the solution for one well with variable rate history in the rectangular domain. The addition of a similarly structured double sum on the right in Eq.(A45) for each additional well in the rectangular aquifer yields the solution form for multiple wells.

In practice of course, the infinite array of wells shown above is truncated to include only wells near enough to the rectangular domain of interest to contribute significantly to the value of $\bar{\psi}$.

The Leaky Aquifer

In the case of the leak-off of brine into a shale aquiclude, we begin with the case of a single line source (well) at the origin and hence must solve Eq.(A30). We seek a solution in terms of the dependent function

$$U = e^{\frac{\alpha}{\beta} t} (\bar{\psi} - \bar{\psi}_o) \qquad (A47)$$

where α is defined by Eq.(A24) and β is defined as

$$\beta = \frac{\phi_o \mu c}{K} \qquad (A48)$$

Thus Eq.(A30) becomes

$$\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial U}{\partial r} \right) = \beta \frac{\partial U}{\partial t} \qquad (A49)$$

which has the same structure as Eq.(A30) with $\alpha = 0$. Therefore, there is a

solution in terms of U, defined by Eq.(A31), of the same <u>form</u> as obtained for $\bar{\psi}$ in Eq.(A32); that is,

$$U = A \int_{\zeta}^{\infty} \frac{e^{-\zeta}}{\zeta} d\zeta + B \tag{A50}$$

which yields, with $U \to 0$ as $\zeta \to \infty$, and the quantity q defined by

$$q = \lim (-2\pi rh \frac{K}{\mu} \frac{\partial U}{\partial r}) = A \frac{4\pi Kh}{\mu} \tag{A51}$$

the form

$$e^{\frac{\alpha}{\beta} t} (\bar{\psi} - \bar{\psi}_o) = \frac{q\mu}{4\pi Kh} \{-Ei(-\frac{\phi_o \mu c r^2}{4Kt})\} \tag{A52}$$

Clearly, this <u>not</u> correspond to a well with constant flow rate at the origin. This situation is simply remedied by using <u>superposition</u> of solutions in the manner already described, namely replacing Eq.(A45) by the form

$$e^{\frac{\alpha}{\beta} t} (\bar{\psi}-\bar{\psi}_o) = \sum_j \frac{\Delta q_j \mu}{4\pi Kh} \{-Ei(-\frac{\phi_o \mu c r^2}{4K(t-t_j)})\} \tag{A53}$$

for $t_j < t < t_{j+1}$. Then, in the limit, $t_{j+1} - t_j \to 0$, for all j, this has the limiting form

$$e^{\frac{\alpha}{\beta} t} (\bar{\psi}-\bar{\psi}_o) = \frac{q(o)\mu}{4\pi Kh}\{-Ei(-\frac{\phi_o \mu c r^2}{4Kt})\} + \int^t \frac{\mu}{4\pi Kh} \frac{dq(\tau)}{d\tau}\{-Ei(-\frac{\phi_o \mu c r^2}{4K(t-\tau)})\}\frac{\alpha}{\beta} d\tau \tag{A54}$$

Now using

$$q_a = \lim_{r \to 0} (-2\pi rh \frac{K}{\mu} \frac{\partial \bar{\psi}}{\partial r}) \tag{A55}$$

as the equation defining the actual rate of the well at the origin, there results upon using Eq.(A54) for $\bar{\psi}$ the form,

$$(A56) \qquad q_a = e^{-\frac{\alpha}{\beta}t}\left[\int_o^t \frac{dq(\tau)}{d\tau}\,d\tau + q(o)\right] = e^{-\frac{\alpha}{\beta}}\,q(t)$$

This then requires the form,

$$(A57) \qquad q(t) = q_a e^{\frac{\alpha}{\beta}t}$$

in Eq.(A54) to yield the form for $\bar{\psi}$ for a well of constant rate q_a at the origin. Thus the solution of Eq.(A23) corresponding to a well of constant rate q_a at the origin, in an infinite reservoir, is

$$(A58) \qquad \bar{\psi} - \bar{\psi}_o = \frac{q_a\mu}{4\pi Kh}\left[e^{-\frac{\alpha}{\beta}t}\{-Ei(-\frac{\phi_o\mu cr^2}{4Kt})\} + \int_o^t e^{-\frac{\alpha}{\beta}(t-\tau)}\{-Ei(-\frac{\phi_o\mu cr^2}{4K(t-\tau)})\}\frac{\alpha}{\beta}d\tau\right]$$

or, with λ for $t - \tau$

$$(A59) \qquad \bar{\psi} - \bar{\psi}_o = \frac{q_a\mu}{4\pi Kh}\left[e^{-\frac{\alpha}{\beta}t}\{-Ei(-\frac{\phi_o\mu cr^2}{4Kt})\} + \int_o^t e^{-\frac{\alpha}{\beta}\lambda}\{-Ei(-\frac{\phi_o\mu cr^2}{4K\lambda})\}\frac{\alpha}{\beta}d\lambda\right]$$

Of course, the form in Eq.(A55) for q(t) can be inserted into Eq.(A51) to yield the approximate form for the solution in Eq.(A53)

$$(A60) \qquad \bar{\psi} - \bar{\psi}_o = \frac{q_a\mu}{4\pi Kh}\left[e^{-\frac{\alpha}{\beta}t}\{-Ei(-\frac{\phi_o\mu cr^2}{4Kt_n})\}\right.$$

$$\left. + \frac{q_a\mu}{4\pi Kh}e^{-\frac{\alpha}{\beta}t_n}\sum_{j=1}^{n-1}(e^{\frac{\alpha}{\beta}t_j} - e^{\frac{\alpha}{\beta}t_{j-1}})\{-Ei(-\frac{\phi_o\mu cr^2}{4(t_n-t_j)})\right.$$

for $\bar{\psi} - \bar{\psi}_o$ at time t_n.

Since Eq.(A23) for the "leaky" shale aquiclude is linear we may again add solutions of the form in Eq.(A59), or Eq.(A60), to create solutions for multiple wells, wells of variable rate and wells in domains bounded by plane fault boundaries using images. Hence all of the analysis given for the non-leaky aquifer can be generalized to the leaky aquifer.

Effects of Transmissibility Variations; Applications of Pseudo Steady-State Analysis

The primary simulator used in this study incorporates effects of fault boundaries, leaky shale aquicludes and multiple, variable-rate injection wells, although our basic study has focused upon a single, constant-rate injection well. In this primary simulator, the disposal zone was represented as having uniform, homogeneous porosity, permeability and thickness, so we now employ some analytical methods to assess the impact of variability in permeability, or transmissibility, on the spatial distribution of pressure build-up in the injection zone.

In the analysis to follow we will show that if we examine fluid flow in the aquifer in the pseudo steady-state approximation then we can exploit a method from potential theory to estimate the effect of plane discontinuities in permeability, transecting the aquifer, on pressure build-up in the aquifer.

The Non-Leaky Aquifer; Pseudo Steady-State

For the non-leaky aquifer, we have used superposition of solutions of the equation of diffusion type (Eq.A19),

$$\frac{\partial^2 \bar{\psi}}{\partial x^2} + \frac{\partial^2 \bar{\psi}}{\partial y^2} = \frac{\phi_o \mu c}{K} \frac{\partial \bar{\psi}}{\partial t} \tag{A61}$$

corresponding to a single constant-rate injection well in an infinite reservoir to describe various types of boundary configurations. This solution is of the form

$$\bar{\psi} - \bar{\psi}_o = \frac{q\mu}{4\pi Kh} \{-Ei(-\frac{\phi_o \mu c r^2}{4Kt})\} \tag{A62}$$

with r the distance from the injection well at time t after start of injection at rate q. For large values of t such that

$$\frac{\phi_o \mu c r^2}{4Kt} < 0.01 \qquad \text{(A63)}$$

this solution is well approximated by the pseudo steady-state form (see Magnus and Oberhettinger [1949])

$$\bar{\psi} - \bar{\psi}_o \simeq \frac{q\mu}{4\pi Kh} \{-\ln \frac{\gamma \phi_o \mu c r^2}{4Kt}\} \qquad \text{(A64)}$$

where $\gamma = 1.781$.

Now this functional form is in fact a solution of the LaPlace Equation

$$\frac{\partial^2 \bar{\psi}}{\partial x^2} + \frac{\partial^2 \bar{\psi}}{\partial y^2} = 0 \qquad \text{(A65)}$$

which is the steady-state form of Eq.(A61). Thus we infer that for large injection times we can use techniques applicable to solving this equation to evaluate long-term pressure distributions in disposal aquifers having sealed aquicludes. Observe that for the typical values:

$$\phi_o = .2, \quad \mu = 1 \text{ cp.}, \quad c = 5 \times 10^{-6} \text{ psi}^{-1} \quad K = 300 \text{ md}$$

with r in thousands of feet and t in years, the above inequality becomes,

$$\frac{r^2}{t} < 27.6 \quad \frac{(\text{thousands of ft.})^2}{\text{years}} \qquad \text{(A66)}$$

Thus for r on the order of 10 thousand feet, this gives

$$\frac{10^2}{t} < 27.6 \qquad \text{(A67)}$$

or

$$t > 3.62 \text{ years} \qquad \text{(A68)}$$

Hence for injection times in excess of 3.62 years, the pressure (or flow potential) distribution out to distances on the order of 10,000 feet, or more, has the same form as in a steady-state condition. For t on the order of 36

years, this holds out to distances of 32,000 feet, or about six miles, from the injection well.

Clearly the above time criterion will vary with spatial location in an inhomogeneous reservoir in which ϕ_o and K are not uniform but a lower bound on time to reach this "steady-state" condition can be estimated.

A consequence of this result is that techniques of potential theory (solutions of LaPlace's Equation) can be applied to access effects of non-uniform permeability on the distribution of pressure build-up in the disposal reservoir.

The Leaky Aquifer; Pseudo Steady-State

In the case of the leaky aquifer, we have employed superposition of solutions of the diffusion type equation with losses,

$$\frac{\partial^2 \bar{\psi}}{\partial x^2} + \frac{\partial^2 \bar{\psi}}{\partial y^2} - \alpha(\bar{\psi} - \psi_o) = \frac{\phi_o \mu c}{K} \frac{\partial \bar{\psi}}{\partial t} \tag{A69}$$

of the form

$$\bar{\psi} - \bar{\psi}_o = \frac{q_a \mu}{4\pi Kh} \left[e^{-\frac{\alpha}{\beta}t} \{-Ei(-\frac{\beta r^2}{4t})\} + \int_o^t e^{-\frac{\alpha}{\beta}\lambda} \{-Ei(-\frac{\beta r^2}{4\lambda})\} \frac{\alpha}{\beta} d\lambda \right] \tag{A70}$$

corresponding to a single well of constant rate q_a in an infinite, uniform, plane aquifer. We construct an approximate form of this solution valid for large t by the following device. We write the integral in Eq.(A70) as

$$\int_o^t f \, d\lambda = \int_o^\infty f \, d\lambda - \int_t^\infty f \, d\lambda \tag{A71}$$

where $f(\lambda)$ is the integrand appearing there. Then for the first integral on the right, we use the closed form (see Collins [1968] p. 127)

$$\int_o^\infty e^{-\frac{\alpha}{\beta}\lambda} \{-Ei(-\frac{\beta r^2}{4\lambda})\} \frac{\alpha}{\beta} d\lambda = 2 K_o (\sqrt{\alpha} r) \tag{A72}$$

where K_o is the modified Bessel function of the second kind, (a tabulated

function) while for the second integral on the right, we use the approximate form

$$(A73) \qquad \int_t^\infty e^{-\frac{\alpha}{\beta}\lambda} \{-Ei(-\frac{\beta r^2}{4\lambda})\}^{\frac{\alpha}{\beta}} d\lambda \simeq \int_t^\infty e^{-\frac{\alpha}{\beta}\lambda} \{\ln \frac{4\lambda}{\gamma\beta r^2}\}^{\frac{\alpha}{\beta}} d\lambda$$

with $\ln \gamma$ being Euler's constant as introduced earlier. This requires that $\beta r^2/Kt$ be sufficiently small as specified in Eq.(A63). Finally, this integral is evaluated using integration by parts to yield as the pseudo steady-state solution for a single well in a leaky aquifer

$$(A74) \qquad \bar{\psi} - \bar{\psi}_o \simeq \frac{q_a \mu}{4\pi Kh} [2 K_o(\alpha r) - e^{-\frac{\alpha}{\beta}t} \ln \frac{\gamma\beta r^2}{4Kt} + \{-Ei(-\frac{\alpha}{\beta}t)\}]$$

Here, just as for the sealed aquifer, we find that this is a solution of a steady-state equation; in this case Eq.(A74) is a solution of

$$(A75) \qquad \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} - \alpha(\bar{\psi} - \bar{\psi}_o) = 0$$

valid for $\phi_o \mu c r^2/4Kt$ specified as in Eq.(A60). Thus, all of our analysis given above for the sealed aquifer, concerning the radius r of the circle within which this solution is approximately valid, for a given t, is applicable here.

We note that as $t \to \infty$, the solution in Eq.(A74) approaches

$$(A76) \qquad \psi - \psi_o = \frac{q_a \mu}{2\pi Kh} K_o(\alpha r)$$

which is the steady-state solution for a single well of rate q_a in a uniform leaky aquifer given by Hantush and Jacob (1955).

A Discontinuity in Permeability

The first case we consider is that of a reservoir approximated as having two regions of distinctly different permeability. This gives insight into the effect of a trend, or gradient in transmissibility on the spatial distribution in pressure build-up.

We have the potential problem as shown in Figure A1.3.

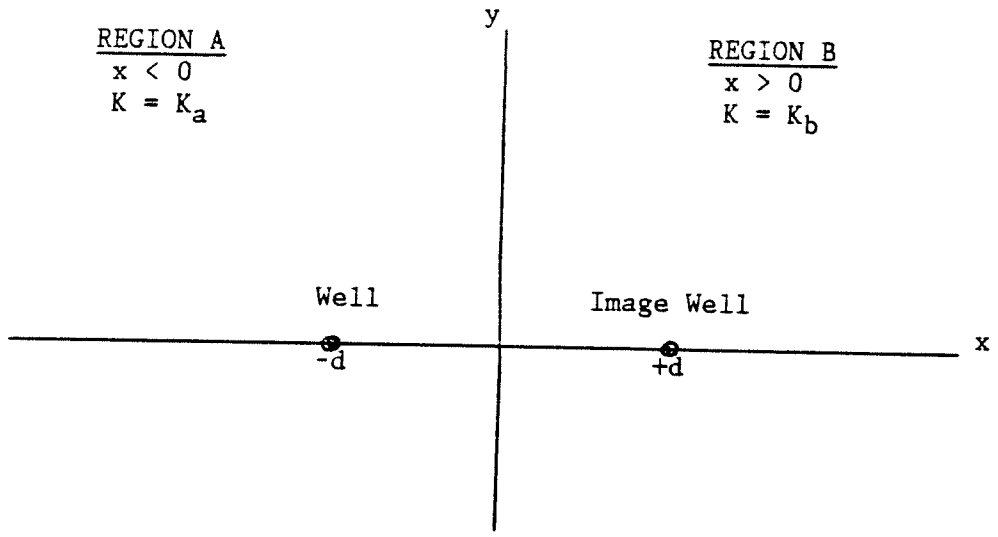


FIGURE A1.3

In Region A, the solution is written as

(A77)
$$\bar{\psi}_a - \bar{\psi}_o = - \frac{q\mu}{4\pi K_a h} \left[\ln \frac{\gamma\phi_o\mu c[(x+d)^2 + y^2]}{4K_a t} + A \ln \frac{\gamma\phi_o\mu c[(x-d)^2 + y^2]}{4K_a t} \right]$$

while in Region B, it is

(A78)
$$\bar{\psi}_b - \bar{\psi}_o = - \frac{q\mu}{4\pi K_a h} \left[B \ln \frac{\gamma\phi_o\mu c[(x+d)^2 + y^2]}{4K_a t} + A \ln \frac{\gamma\phi_o\mu c[(x-d)^2 + y^2]}{4K_a t} \right]$$

where A and B are constants to be determined by the boundary conditions on the separating plane at x = 0,

(A79)
$$\bar{\psi}_a = \bar{\psi}_b$$

$$K_a \frac{\partial \bar{\psi}_a}{\partial x} = K_b \frac{\partial \bar{\psi}_b}{\partial x}$$

These give

(A80)
$$A = \frac{1 - \frac{K_b}{K_a}}{1 + \frac{K_b}{K_a}}$$

(A81)
$$B = \frac{2}{1 + \frac{K_b}{K_a}}$$

With these constants inserted for A and B in the above expressions for ψ_a and ψ_b, we then have an approximate prediction formula for $\bar{\psi}$ everywhere for large injection times. This can be extended to include fault boundaries and permeability discontinuities by images, but here we use this result simply to compare the "ultimate" increase in pressure at an abandoned well in an injection zone having such a discontinuity in permeability with that which would exist in the absence of this discontinuity.

We have at the abandoned well at position x,y in Region B, the pressure increase for this inhomogeneous case

(A82)
$$\Delta P_{IH} \simeq - \frac{2}{1 + \frac{K_b}{K_a}} \frac{q\mu}{4\pi K_a h} \ln \frac{\phi_o \mu c[(x+d)^2 + y^2]}{4K_a t}$$

due to the injection well at position x = -d, y = 0 in Region A. This is to be compared to the increase

(A83)
$$\Delta P_H = - \frac{q\mu}{4\pi K_a H} \ln \frac{\gamma \phi_o \mu c[(x + d)^2 + y^2]}{4K_a t}$$

in the homogeneous case. This gives

$$(A84) \qquad \frac{\Delta P_{IH}}{\Delta P_H} \simeq \frac{2}{1 + \frac{K_b}{K_a}} \qquad \text{(Region B)}$$

Thus if $K_b > K_a$, the pressure build-up at an abandoned well in Region B is less than would occur in a homogeneous reservoir while for $K_b < K_a$, the pressure build-up is greater than in the homogeneous reservoir.

If the abandoned well at x,y is located in Region A, we find, in a similar manner, from the above solutions:

$$(A85) \qquad \frac{\Delta P_{IH}}{\Delta P_H} \simeq 1 + \frac{1 - \frac{K_b}{K_a}}{1 + \frac{K_b}{K_a}} \frac{\ln \frac{4Kt}{\gamma \phi_o \mu c r z^2}}{\ln \frac{4Kt}{\gamma \phi_o \mu c r^2}}$$

where r is the distance from the injection well to the abandoned well, while r_I is the distance from the image well to the abandoned well. Since both logarithms are positive and $r_I > r$, this ratio is less than unity for all time and any location in Region A.

Denoting the ratio of the two logarithms here by ε_t, we note that $0 < \varepsilon_t < 1$, with the upper bound of unity being achieved only as $t \to \infty$. Then the above equation appears as:

$$(A86) \qquad \frac{\Delta P_{IH}}{\Delta P_H} \simeq 1 + \varepsilon \frac{1 - \frac{K_b}{K_a}}{1 + \frac{K_b}{K_a}}$$

which shows that for any ε_t, in Region A

$$(A87) \qquad \frac{\Delta P_{IH}}{\Delta P_H} < 1 \quad \text{for} \quad K_b > K_a$$

and

(A88) $$\frac{\Delta P_{IH}}{\Delta P_H} > 1 \qquad \text{for } K_b > K_a$$

Now these results show that if an injection well is located in a higher permeability region of the reservoir, $K_a > K_b$, with reservoir permeability of lower value to the east, in Region B, then all abandoned wells to either the east or west, of the injection well, but lying in Region A, experience greater pressure build-up than would occur in a homogeneous reservoir. By contrast, if the injection well is located in a lower permeability region, $K_a < K_b$, with permeability of higher value in region B, then all abandoned wells to either east or west of the injector, but in region A, experience less pressure build-up than would occur in a homogeneous reservoir.

This result is more firmly established by examining the two limiting extremes for K_b, either $K_b = 0$ or $K_b \to \infty$. In these cases, exact solution of the diffusion type equation, Eq. (A61) by the method of images is possible.

For $K_b = 0$, the line $x = o$ is a no-flow "fault" boundary for Region A. There is no build-up in Region B but at any well in Region A, (by image)

(A89) $$\Delta P_{IH} = \frac{q\mu}{4\pi K_a h}\left[-Ei\left(-\frac{\phi_o \mu c r^2}{4K_a t}\right) - Ei\left(\frac{\phi_o \mu c r_I^2}{4K_a t}\right)\right]$$

or

(A90) $$\frac{\Delta P_{IH}}{\Delta P_H} = 1 + \frac{-Ei\left(-\frac{\phi_o \mu c r_I^2}{4K_a t}\right)}{-Ei\left(-\frac{\phi_o \mu c r^2}{4K_a t}\right)}$$

with r and r_I as defined above. This is clearly in complete accord with Eq. (A85) with $K_b \to 0$.

For Region B, Eq. (A84) would forecast a value of 2.0 for $K_b \to 0$ but this is inaccurate; the exact result for Region B in this case is forecast by a condition extracted from the differential equation, Eq. (A61), applied to Region B. Thus

$$(A91) \qquad \frac{\partial \bar{\psi}_b}{\partial t} = \frac{K_b}{\phi_o \mu c} \nabla^2 \psi_b$$

so for a finite value of $\nabla^2 \psi_b$, we see that as $K_b \to 0$, $\partial \psi_b / \partial t \to 0$ and of course there is no build-up of pressure in Region B.

The other extreme, $K_b \to \infty$, is also evaluated exactly using images. In this case, we have in Region A

$$(A92) \qquad \Delta P_{IH} = \frac{q\mu}{4\pi K_a h} \left[-Ei\left(-\frac{\phi_o \mu c r^2}{4K_a t}\right) + Ei\left(-\frac{\phi_o \mu c r_I^2}{4K_a t}\right) \right]$$

or

$$(A93) \qquad \frac{\Delta P_{IH}}{\Delta P_H} = 1 - \frac{-Ei\left(-\frac{\phi_o \mu c r_I^2}{4K_a t}\right)}{-Ei\left(-\frac{\phi_o \mu c r^2}{4K_a t}\right)}$$

which again is in complete accord with Eq. (A85), but in this case for $K_b \to \infty$. Here, of course, the line $x = 0$ acts as an equipotential boundary at original reservoir potential and the entire Region B remains always at original potential. There can be no potential gradients in Region B when $K_b \to \infty$. Thus in Region B, $x > 0$,

$$(A94) \qquad \frac{\Delta P_{IH}}{\Delta P_H} = 0$$

which is in complete accord with Eq. (A84) as $K_b \to \infty$.

We can summarize these various cases in the following table. In this table we consider the injection well always located in region A and examine the effect of the discontinuity in permeability on pressure buildup at an abandoned well which may be located in either region A or region B. The symbolic notations ↑, ↓, - indicate increase, decrease or no change in pressure buildup at the abandoned relative to a homogeneous reservoir case, caused by the discontinuity in permeability.

Effect of Permeability
Discontinuity on Pressure Buildup
(Injector in Region A)

Case	Location of Abandoned Well	Effect on Pressure Buildup at Abandoned Well
$K_A > K_B$	A	↑
$K_A > K_B$	B	↑
$K_A < K_B$	A	↓
$K_A < K_B$	B	↓

Partially-Sealing Faults

In all analyses thus far described, faults have been treated as totally sealing plane boundaries; here we examine effects of partially-sealing faults on the temporal history of the potential distribution in the injection zone. Specifically, we consider the problem of one linear, partially-sealing fault transecting a uniform, infinite aquifer. Yaxley (1985) has solved this problem for a single well of constant rate using the LaPlace transform in the time domain and the Fourier transform in the space domain. Here we describe his solution in terms of the same coordinate geometry employed earlier for other fault problems.

The nature of a partially-sealing fault is displayed in Figure A1.4.

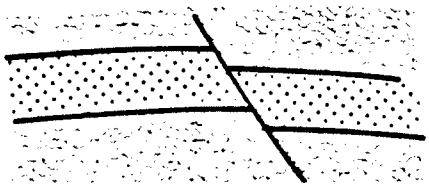


FIGURE A1.4

The "narrowed" flow pathway indicated at the fault is equivalent to a "thin" domain of lower permeability as shown in Figure A1.5.

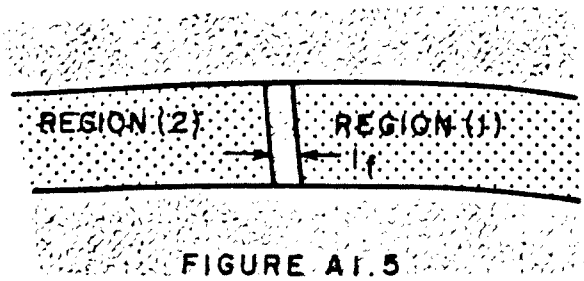


FIGURE A1.5

with the thickness ℓ_f being very small. Thus, the mathematical description of the problem takes the form as seen in Figure A1.6.

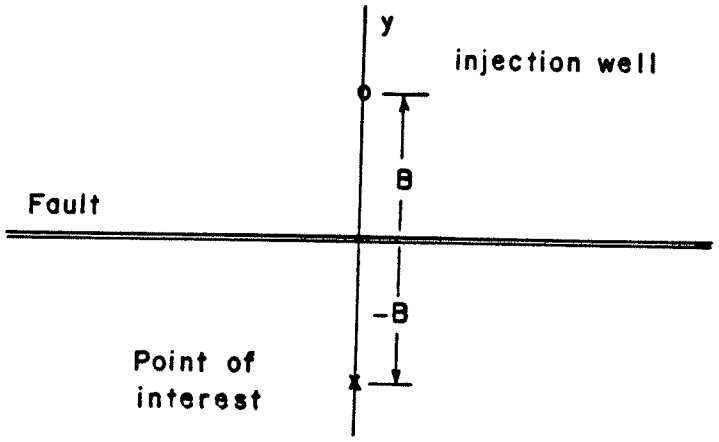


FIGURE A1.6

Then:

$$\frac{\partial^2 \bar{\psi}_2}{\partial x^2} + \frac{\partial^2 \bar{\psi}_2}{\partial y^2} = \frac{\phi_o \mu c}{K} \frac{\partial \bar{\psi}_2}{\partial t} \tag{A95}$$

$$\frac{\partial^2 \bar{\psi}_1}{\partial x^2} + \frac{\partial^2 \bar{\psi}_1}{\partial y^2} = \frac{\phi_o \mu c}{K} \frac{\partial \bar{\psi}_1}{\partial t} \tag{A96}$$

$$\lim_{\frac{x^2 + y^2}{t} \to \infty} \bar{\psi}_1 = \bar{\psi}_o \; ; \quad y > 0 \tag{A97}$$

$$\lim_{\frac{x^2 + y^2}{t} \to \infty} \bar{\psi}_2 = \bar{\psi}_o \; ; \quad y < 0 \tag{A98}$$

and there is a <u>point singularity</u> in $\bar{\psi}_1$, at the point (B,0) corresponding to a

line source of constant rate q in the reservoir of unique thickness, h. Also, at the fault, x = 0, we have

(A99) $$\frac{K}{\mu}\frac{\partial\bar{\psi}_2}{\partial y} = \frac{K}{\mu}\frac{\partial\bar{\psi}_1}{\partial y} = \frac{K_f}{\mu}\frac{\bar{\psi}_1 - \bar{\psi}_2}{\ell_f} \quad ; \; y = 0$$

Thus, there is a <u>discontinuity</u>, $\bar{\psi}_1 - \bar{\psi}_2$, at the fault, i.e. we let $\ell_f \to 0$ with also $K_f \to 0$ such that the ratio K_f/ℓ_f is finite and non-zero in the limit.

The solution of this boundary value problem is given by Yaxley (1985) as:

<u>For y > 0:</u>

(A100) $$\Delta P_D = -Ei\left(-\frac{(y_D - 1)^2 + x_D^2}{4t_D}\right) - Ei\left(-\frac{(y_D + 1)^2 + x_D^2}{4t_D}\right)$$

$$-2\pi\alpha_f e^{[2\alpha_f(|y_D| + 1)]} \int_0^{t_D} e^{\left(4\alpha_f^2\mu - \frac{x_D^2}{4\mu}\right)}$$

$$\cdot \operatorname{erfc}\left[2\alpha_f\sqrt{\mu} + \frac{|y_D| + 1}{2\sqrt{\mu}}\right] \frac{d\mu}{\sqrt{\mu}}$$

<u>For y < 0:</u>

(A101)

$$\Delta P_D = 2\pi\alpha_f e^{[2\alpha_f(|y_D| + 1)]} \int_0^{t_D} e^{\left(4\alpha_f^2\mu - \frac{x_D^2}{4\mu}\right)}$$

$$\cdot \operatorname{erfc}\left[2\alpha_f\sqrt{\mu} + \frac{|y_D| + 1}{2\sqrt{\mu}}\right] \frac{du}{\sqrt{\mu}}$$

where we define dimensionless quantities as

(A102) $$\Delta P_D = \frac{4\pi Kh}{q\mu}(\bar{\psi} - \bar{\psi}_o), \qquad x_D = \frac{x}{B}, \; y_D = \frac{y}{B}$$

$$t_D = \frac{Kt}{\phi_o\mu c B^2}, \qquad \alpha_f = \frac{K_f B}{K\ell_f}$$

The reader should note that our definition for ΔP_D is precisely $2 \cdot P_D$ where P_D is the dimensionless pressure defined by Yaxley and generally used in the petroleum engineering literature.

Both of the above forms for ΔP_D involve the function defined as

$$(A103)\quad I(\alpha_f, |y_D|, x_D, t_D) = 2\pi\alpha_f e^{2\alpha_f[|y_D+1|]} \int_0^{t_D} e^{(4\alpha_f^2\mu - \frac{x_D^2}{4\mu})} \cdot \operatorname{erfc}\left[2\alpha_f\mu + \frac{|y_D|+1}{2\sqrt{\mu}}\right] \frac{d\mu}{\sqrt{\mu}}$$

In fact, for $y_D < 0$, this is precisely ΔP_D. The integral here cannot be evaluated in closed form so numerical evaluation is necessary. Yaxley carried out such evaluations to provide results for limited cases but only one set of these results is applicable to problems of interest here. In Figure A1.7 his results are shown for $x_D = 0$ and $y_D = -1$. This places the "observation well", or an abandoned well in our study, at a point on the line normal to the fault at the same distance as is the injection well on the opposite side of the fault.

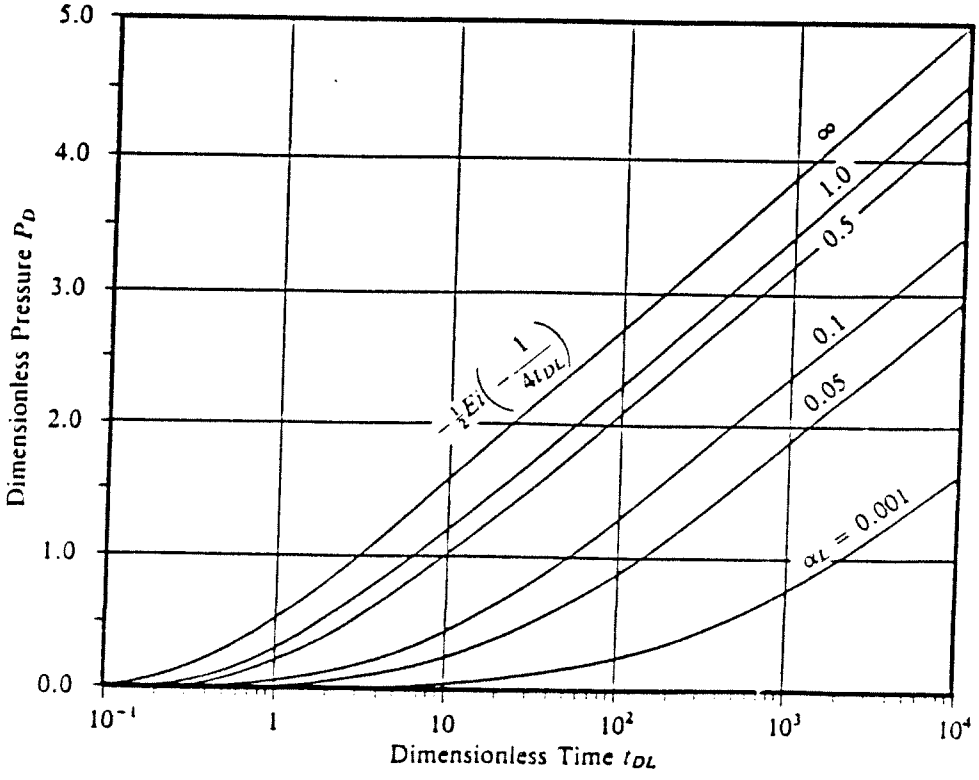


FIGURE A1.7

In Figure A 1.7, P_D is $\Delta P_D/2$, α_L is $2\alpha_f$ and t_{DL} is $t_D/4$ because Yaxley employed L = 2B in defining the dimensionless time and α_L for this calculation.

Note that for large values of time, and any value of α_L, the curve for P_D, (or ΔP_D), are all parallel to the curve for $\alpha_L = \infty$. This curve is simply the P_D vs t_{DL} that exists in the total absence of the fault. Thus, for large time, ΔP_D is simply shifted by an additive constant determined by α_f. This is very useful information but unfortunately it is applicable only to <u>one</u> abandoned well location; therefore, we have evaluated this solution for a general range of values for x_D, y_D, t_D and α_f. These results are described in the body of this report.

APPENDIX B

ON THE EFFECT OF BOREHOLE GEOMETRY ON APPARENT GEL STRENGTH OF DRILLING MUD IN ABANDONED WELLS

APPENDIX B

On The Effect of Borehole Geometry on Apparent Gel Strength of Drilling Mud In Abandoned Wells

ABSTRACT

A series of small scale experiments was carried out to determine the effectiveness of old, gelled drilling mud in abandoned wellbores in preventing brine from migrating up abandoned wells from a fluid injection zone driven by pressure build-up. It was found that in general the critical pressure for initiation of brine entry into the mud-filled wellbore is composed of two parts, one due to the weight of the mud column and the other due to the gel strength of the mud. For typical water-base bentonite muds and smooth, straight, uniform diameter holes, these contributions are comparable in magnitude. However, for holes of irregular shape, as with shale wash-outs, the contribution due to gel strength may be increased by five-fold or more.

Experimental Objectives

These small-scale experiments were conducted to determine criteria for brine entry into an abandoned, mud-filled bore hole from an aquifer due to increase in pressure from fluid injection into the aquifer. Specifically, we wish to define a critical pressure, P_{crit}, in the aquifer at the abandoned well which, if exceeded, will allow brine entry to the abandoned well.

General Description of Apparatus and Procedure

This study actually includes nine different experiments using the same basic apparatus with only minor alterations. Figure 1 shows the general configuration of laboratory equipment. A core was epoxied into a nipple and then attached to a pipe joint below the core which in turn was attached to a line carrying brine from a salt water reservoir. The pressure at the salt reservoir was recorded using a gauge or mercury manometer. Pressure was supplied to the brine using compressed nitrogen and a pressure regulator. Brine was pushed through the brine delivery system until no air existed in the lines and the rock was saturated with the brine. At this point, a pipe was attached to the core nipple and a column of bentonite mud (20 ppb bentonite with 3 ppb salt in run 1 and 30 ppb bentonite in all other runs) was placed in the pipe over the core.

A sample of this mud was also placed in a Fann viscometer cup to remain quiescent. A small diameter transparent tube was attached to the top of the mud column and filled with brine so that when the mud column moved, fluid movement could be noted at the top of the column. The mud was allowed to gel for approximately 12 hours, at which time, pressure was slowly applied to the brine delivery system until fluid movement was noted in the viewing tube at the top of the column. Concurrently, the gel strength of the mud sample in the viscometer cup was measured using a Fann V-G meter. Note that the relevant distances to calculate pressures are indicated by A, B, and C in

Figure 1. All physical dimensions of this apparatus are given in the appendix together with physical properties of fluids used.

Specific Description of Runs

Runs 1 & 2
The geometries for the various experimental runs are shown in Figure 2. In the first two runs, the pipe size was small (refer to Appendix). Two 1/16 inch shoulders were located along the length of the pipe, one just above the core and one midway up the length of the pipe. In addition, a fairly severe constriction occurred at the top of the column where the viewing tube was substantially smaller (diameter = 1/8") than the pipe itself and mud actually extended into this tube. Therefore, three constrictions existed along the mud column. The 1/16 inch shoulders were fairly large relative to the total diameter of the pipe.

Run 3
A large pipe was substituted for the small pipe (see Appendix). The pipe contained only one 1/8" shoulder located above the core. The adapter with brine viewing tube on top was used as shown in inset of Figure 2.

Run 4
The same set-up as run 3 was used; however, the pipe had an oily film over its entire surface. No specific data was collected since fluid flow responded immediately to changes in hydrostatics and no apparent gel strength was observed.

Run 5
Run 5 was similar to run 3 except that an additional constriction was placed o the mud column and the mud column extended into the smaller pipe on top and into the brine viewing tube. (see Figure 2 inset)

Run 6 & 7
Runs 6 & 7 were identical. These runs were identical to run 3 but instead of a smooth pipe being used, a series of five joints and nipples (in addition to the one located above the core mentioned in 3) were located along the length of the pipe. (see Figure 2)

Run 8
This rum employed the small pipe as in Run 1 and 2 but in this case the mud did not extend into the small viewing tube initially. The mud level was in the 5/8" ID pipe.

Run 9
This run was intended to test behavior in a pipe of uniform dimensions with no constrictions anywhere. A PVC pipe was mounted into the core containing the nipple used in Runs 3 and 4 with the pipe inserted flush to the core plug face. Thus no "shoulders" were present in the mud-filled pipe. The adapter with the brine-filled viewing tube was mounted on top but the mud level was in the uniform diameter pipe.