CDM Camp Dresser & McKee

SUN-I3

Report

City of Sunrise Injection Well No. 3 Hydrogeologic Evaluation Report

FDEP UC 06-212792

City of Sunrise Injection Well No. 3 Hydrogeologic Evaluation Report

FDEP UC 06-212792

August 1995

CDM Project No. 6505-01

CDM Camp Dresser & McKee Inc.

environmental services

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August 8, 1995

Mr. Alfred Mueller, P.E., P.G.
Chairman TAC-UIC
Florida Department of
Environmental Protection
1900 South Congress Avenue, Suite A
West Palm Beach, Florida 33416

Subject: Casing Setting Depth for Dual Zone Monitor Well No. 3
Sawgrass Utility Site - City of Sunrise, Broward County, Florida
FDEP Construction Permit UC 06-212792

Dear Mr. Mueller:

The construction of injection well No. 3 at the Sawgrass Utility Site of the City of Sunrise has been completed. The drillers (Youngquist Brothers) are ready to proceed with the construction of the dual zone monitor well just as soon as we receive FDEP approval for the casing depths of the two monitor zones.

Enclosed please find a copy of the Hydrogeologic Evaluation and of the accompanying data required by the permit's Specific Conditions 3.d and 3.e (page 8 of the permit). Copies of these documents are also being mailed at this time to all the TAC members so that they may review them before you contact them for concurrence of the recommended depths.

As you can see, in the recommendations section of the report, we are proposing a setting depth of 2,060 feet below land surface for the lower monitor zone casing and 1,700 feet below land surface for the upper monitor zone casing. A 50-foot monitoring interval is recommended for both zones. The lower monitor interval is positioned in a transmissive interval below the USDW (1,924 feet) and above the injection zone and major confining units (2,260 feet). The upper monitor interval is located in a transmissive interval immediately above the point of salinity increase (1,800 feet) as indicated by the resistivity log.

Attachment C of the report are the geophysical logs. Full size copies of these logs were sent to each of the TAC members last March 8 (see our letter of March 22). We are not including extra full size copies of these logs with this report because we need to save those copies for the final report. We have, however, duplicated at reduced scale the dual induction, the acoustic, and the gamma ray logs in Figure 5 of the report. Should any TAC member not be able to find the copies sent March 8 and if the reduced scale copy in Figure 5 is not adequate, we do have a couple of the full size copies that can be made available and still have enough copies left for the final report.

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We would like to have your consent on the setting depths as soon as possible so that the drilling can proceed without delays. Please contact me for consultation on this matter if there are any questions or if you or any of the TAC members require additional information. If you need to call a TAC meeting on August 22 to discuss this issue and would like to have us there to present any information or clarify any point, please let us know as soon as possible.

Very truly yours,

CAMP DRESSER & McKEE INC.

William A. J. Pitt, P.E., P.H.
Senior Hydrologist
Florida P.E. #12577

WAJP/sek

Attachments

File: 6505-01-GSC

cc: Mark Silverman, P.G.
J. P. Listick
Will Evans, P.G.
Richard Deuerling, P.G.
Jeanne Dove
Scott Hoskins
Steve Anderson, P.G.
Ronald Reese, P.G.
John Foglesong, P.E.
James S. Caldwell, P.E.
Chris R. Helfrich, P.E.
Victor J. Pujals, P.E.

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City of Sunrise Injection Well No. 3
Hydrogeologic Evaluation Report

Background

Specific Condition 3.d. of the September 2, 1994 Construction Permit for the City of Sunrise Injection Well No. 3 requires that the data and analysis supporting the selection of the monitoring intervals for the dual zone monitor well be submitted to the TAC as a hydrogeologic evaluation of the proposed monitoring zones. The Specific Condition also requires that this hydrogeologic evaluation report include interpretation and analysis of the pertinent cores, the geophysical logs, the packer tests and the fluid samples.

The recommended depth of casing settings for the upper limits of the monitor zones are required to be accompanied by technical justification in the form of approved geophysical logs with engineering and geological interpretations, and water quality.

Purpose

This hydrogeologic evaluation is presented to the Florida Department of Environmental Protection (FDEP) in fulfillment of the construction permit requirements (FDEP UC 06-212792).

The recommended casing settings and open intervals of the two monitor zones have been made to take into account the additional permit requirements found in Specific Condition 3.d. Those requirements state that the lower monitor interval should ideally be positioned in a transmissive interval below the USDW and at an appropriate point above the injection interval and major confining units to monitor for reasonable assurance of vertical confinement and external mechanical integrity. Similarly, the upper monitor interval should be ideally positioned in a transmissive interval immediately above and proximal to the base of the USDW.

Scope

This hydrologic evaluation report presents the laboratory data results of the analyses of the pertinent cores, the geophysical logs pertinent to the determination of the location of the confining zone, the laboratory results of the analyses of the packer tests water quality samples, and the results of the field testing of water quality during packer testing.

Finally it concludes with the recommendations for the setting of the casings of the upper and lower monitor zones for the dual zone monitor well for injection well No. 3 whose construction is pending FDEP approval of the monitor zones.

Geologic Cores

In compliance with the technical specifications and the permit conditions for the deep test/injection well, a total of 23 attempts to collect cores were made during the drilling of the pilot hole. The coring operations are outlined in Table 1, starting on February 21, 1995. Of the 23 attempts, 22 cores were recovered. The first eight cores were taken from above the casing depth of the intermediate casing. They were taken while the pilot hole for that casing was being drilled. Cores number 1 through 18 were taken from the Avon Park Formation, with no recovery on core number 2, and cores numbered 19 through 23 were taken from the Oldsmar Formation (see Figure 1). All 23 cores were four inches (10 cm) in diameter and up to 17 feet in length (100% recovery). One sample from each core was selected by CDM for analysis by Ardaman & Associates, Inc. (AAI) (see Figure 2 and Table 2). Geologic and lithologic descriptions of the cores are included as Attachment A to this document and the results of the special core analysis study conducted by AAI are presented as Attachment B.

Core Testing Results

As noted in Table 2, twenty-two samples obtained from the twenty-three corings attempted at the City of Sunrise IW-3 were submitted to AAI for testing. The depths from which the samples were selected are shown in the first column in Table 3.

The testing program on the samples included:

- Vertical coefficient of permeability
- Porosity
- Specific Gravity
- Compressive strength
- Modulus of elasticity

Vertical Coefficient of Permeability and Porosity

<u>Permeability Tests</u>

The permeability test results are presented in Table 3. Vertically oriented permeability test specimens were obtained by subcoring 5.1 cm diameter cylinders from the 10 cm diameter core samples . The specimens were then confined and permeated with deaired water. The inflow to and outflow form each specimen were monitored with time, and the coefficient of permeability was calculated for each recorded flow increment.

<u>Porosity</u>

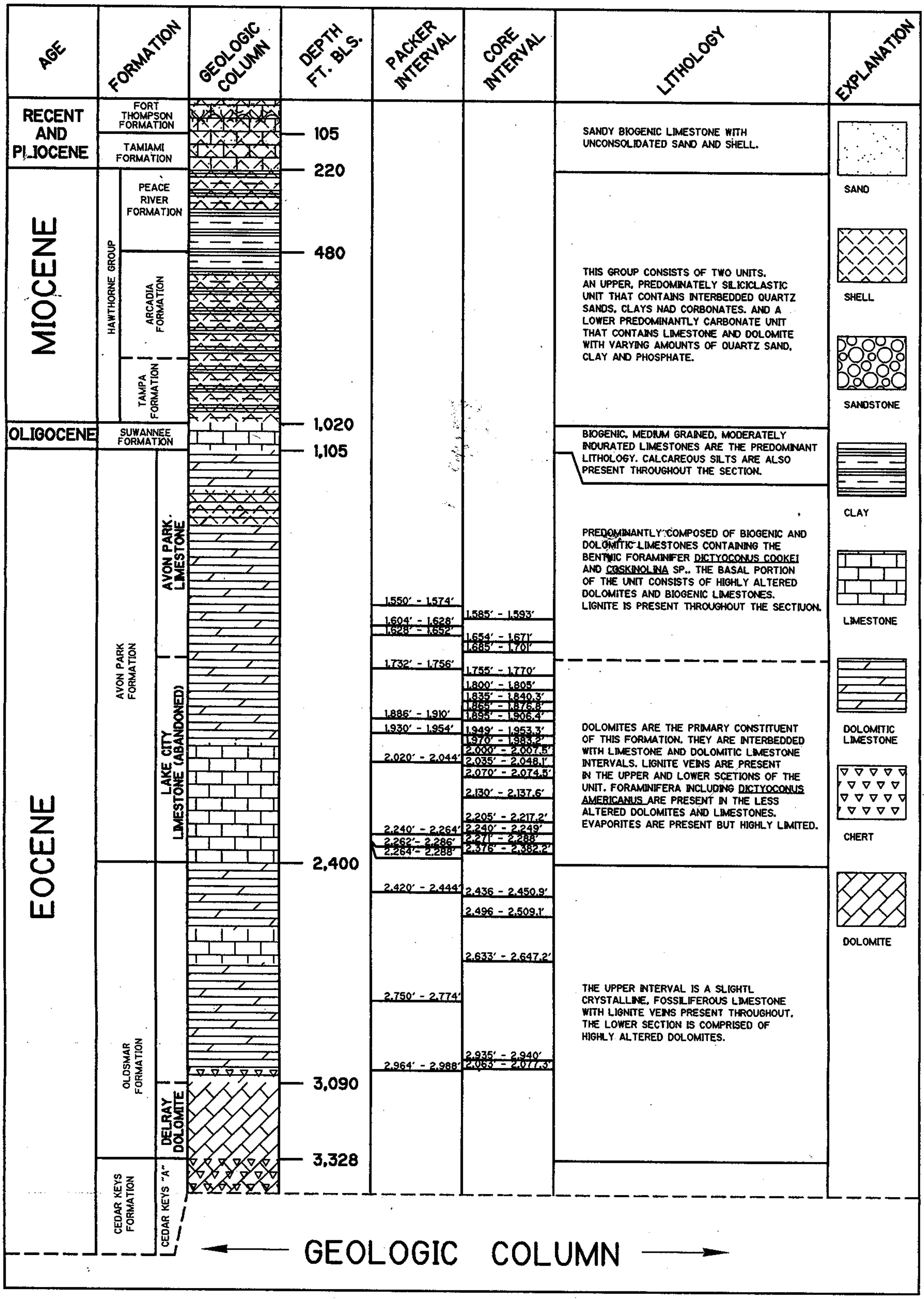
The porosity of each permeability test specimen was calculated using the measured dry density and specific gravity. The calculated porosities are presented in Table 3.

Table 1
SUMMARY OF IW-3 PILOT HOLE
GEOLOGIC CORING OPERATIONS

Date	Event
February 21, 1995	Collect core #1, (1,585 feet - 1,593 feet feet) from the Avon Park Formation. Recovered forty-seven percent.
February 21, 1995	Collect core #2 (1,654 feet - 1,671 feet feet) from the Avon Park Formation. No Recovery
February 22, 1995	Collect core #3 (1,685 - 1,701 feet) from the Avon Park Formation. Recovered ninety-four percent.
February 23, 1995	Collect core #4 (1,755 - 1,770 feet) from the Avon Park Formation. Recovered eighty-eight percent.
February 24, 1995	Collect core #5 (1,800 - 1,805 feet) from the Avon Park Formation. Recovered twenty-nine percent.
February 25, 1995	Collect core #6 (1,835 - 1,840.3 feet) from the Avon Park Formation. Recovered thirty-one percent.
February 26, 1995	Collect core #7 (1,865 - 1,876.8 feet) from the Avon Park Formation. Recovered sixty-nine percent.
February 26, 1995	Collect core #8 (1,895 - 1,906.4 feet) from the Avon Park Formation. Recovered sixty-seven percent.
February 27, 1995	Collect core #9 (1,940 - 1,953.3 feet) from the Avon Park Formation. Recovered seventy-eight percent.
February 27, 1995	Collect core #10 (1,970 - 1,983.2 feet) from the Avon Park Formation. Recovered seventy-eight percent.
February 28, 1995	Collect core #11, (2,000 - 2,007.5 feet) from the Avon Park Formation. Recovered forty-four percent.
March 1, 1995	Collect core #12 (2,035 - 2,048.1, feet) from the Avon Park Formation. Recovered seventy-seven percent.
March 1, 1995	Collect core #13 (2,070 - 2,074.5 feet) from the Avon Park Formation. Recovered twenty-six percent.
March 2, 1995	Collect core #14 (2,130 - 2,137.6 feet) from the Avon Park Formation. Recovered forty-five percent.
March 3, 1995	Collect core #15 (2,205 - 2,217.7 feet) from the Avon Park Formation. Recovered seventy-five percent.

Table 1 (continued)
SUMMARY OF IW-3 PILOT HOLE
GEOLOGIC CORING OPERATIONS

Date	Event
March 4, 1995	Collect core #16 (2,240 - 2,249 feet) from the Avon Park Formation. Recovered fifty-three percent.
March 4, 1995	Collect core #17 (2,271, - 2,288 feet) from the Avon Park Formation. Recovered one-hundred percent.
April 1,0, 1995	Collect core #18 (2,376 - 2,382.2 feet) from the Avon Park Formation. Recovered thirty-six percent.
April 1,1, 1995	Collect core #19 (2,436 - 2,450.9 feet) from the Oldsmar Formation. Recovered eighty-eight percent.
April 11, 1995	Collect core #20 (2,496 - 2,509.1 feet) from the Oldsmar Formation. Recovered seventy-seven percent.
April 13, 1995	Collect core #21, (2,633 - 2,647.2 feet) from the Oldsmar Formation. Recovered eighty-four percent.
April 15, 1995	Collect core #22 (2,935 - 2,940 feet) from the Oldsmar Formation. Recovered twenty-nine percent.
April 15, 1995	Collect core #23 (2,963 - 2,977.3 feet) from the Oldsmar Formation. Recovered eighty-four percent.



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SITE GEOLOGY

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FIGURE 1

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CORE SAMPLES
SENT TO LABORATORY

FIGURE 2

Table 2
CORE RECOVERY DATA

Core	Formation	Depth Cored (in feet feet)	Cored Footage	Recovery (% feet)	Laboratory Tested Interval* (in feet feet)
1	Avon Park	1,585 - 1,593	8	47	1,591.5
2	Avon Park	1,654 - 1,671	0	0	none
3	Avon Park	1,685 - 1,701	16	94	1,695.6
4	Avon Park	1,755 - 1,770	15	88	1,766.2
5	Avon Park	1,800 - 1,805	5	29	1,801.5
6	Avon Park	1,835 - 1,840.3	5.3	31	1,836.3
7	Avon Park	1,865 - 1,876.8	11.8	69	1,873.8
8	Avon Park	1,895 - 1,906.4	1.4	67	1,904.1
9	Avon Park	1,940 - 1,953.3	13.3	78	1,944.1
10	Avon Park	1,970 - 1,983.2	13.2	78	1,981
11	Avon Park	2,000 - 2,007.5	7.5	44	2,005.4
12	Avon Park	2,035 - 2,048.1	13.1	77	2,046.6
13	Avon Park	2,070 - 2,074.5	4.5	26	2,071.8

*Plug Interval Stored at AAI - Orlando, Florida

Table 2 (continued)
CORE RECOVERY DATA

Core	Formation	Depth Cored (in feet feet)	Cored Footage	Recovery (% feet)	Laboratory Tested Interval* (in feet feet)
14	Avon Park	2,130 - 2,137.6	7.6	45	2,132
15	Avon Park	2,205 - 2,217.7	12.7	75	2,212
16	Avon Park	2,240 - 2,249	9	53	2,245.6
17	Avon Park	2,271 - 2,288	17	100	2,275.9
18	Avon Park	2,376 - 2,382.2	6.2	36	2,379.5
19	Oldsmar	2,436 - 2,450.9	14.9	88	2,447.5
20	Oldsmar	2,496 - 2,509.1	13.1	77	2,502.2
21	Oldsmar	2,633 - 2,647.2	14.2	84	2,638.7
22	Oldsmar	2,935 - 2,940	5	29	2,936.7
23	Oldsmar	2,963 - 2,977.3	14.3	84	2,970.8

*Plug Interval Stored at AAI - Orlando, Florida

Table 3

PERMEABILITY TEST RESULTS
SUNRISE DEEP INJECTION WELL NO. 3

Sample Depth (feet)	G_s	Initial Conditions Length (cm)	Diameter (cm)	w_c (%)	γ_d (lb/ft³)	n	$\bar{\sigma}_c$ (lb/in²)	u_b (lb/in²)	B-factor	Range of Hydraulic Gradient	Final Conditions w_c (%)	γ_d (lb/ft³)	S (%)	Vertical Coefficient of Permeability (cm/sec)
1591.5	2.71	3.87	5.02	16.2	105.6	0.38	10	179	98	13 - 46	21.1†	106.6	98	5.8×10^{-6}
1695.6	2.70	10.22	5.11	9.3	102.1	0.39	10	179	96	12 - 15	22.0†	101.9	91	2.6×10^{-4}
1766.2	2.70	10.53	5.09	10.0	102.7	0.39	10	179	63*	5 - 15	19.5†	103.0	83	6.6×10^{-6}
1801.5	2.71	10.10	5.10	8.9	102.0	0.40	10	179	100	5 - 15	20.2†	102.0	83	1.8×10^{-5}
1836.3	2.70	9.80	5.12	10.2	101.2	0.40	10 10	89 179	38* 68	14 - 16 10 - 31	19.4†	102.6	82	4.0×10^{-5} 4.3×10^{-5}
1873.8	2.72	10.30	5.08	15.4	99.9	0.41	10 10	91 179	– 99	1 - 2 2 - 10	22.6†	100.5	89	1.7×10^{-3} 1.6×10^{-3}
1904.1	2.72	10.29	5.08	13.5	97.3	0.43	11 10	89 179	– 64	1 - 2 1 - 12	24.3†	97.5	89	4.4×10^{-4} 5.8×10^{-4}
1944.1	2.73	9.71	5.04	15.8	100.9	0.41	10	179	97	2 - 8	21.3†	100.4	83	3.2×10^{-3}
1981.0	2.71	10.36	5.08	12.2	104.5	0.38	10	179	98	1 - 8	20.8†	104.5	91	2.1×10^{-3}
2005.4	2.72	10.09	5.06	11.5	105.5	0.38	10	179	95	2 - 14	19.2†	104.4	83	9.1×10^{-4}
2046.6	2.70	9.60	5.08	11.3	109.4	0.35	10	178	96	4 - 33	19.2	109.0	95	8.4×10^{-7}
2071.8	2.74	10.05	5.07	15.9	97.1	0.43	10	179	96	10 - 12	25.8†	96.6	92	1.4×10^{-3}
2132.0	2.73	10.14	5.06	12.2	105.5	0.38	10	179	89*	8 - 18	20.7†	104.2	89	2.3×10^{-4}
2212.0	2.70	10.69	5.10	12.9	104.1	0.38	10	179	96	7 - 13	20.8†	104.9	93	1.5×10^{-3}
2245.6	2.72	9.86	5.08	15.3	103.1	0.39	10	179	97*	10 - 20	21.8†	103.4	92	2.0×10^{-4}
2275.9	2.66	10.08	5.10	0.3	168.9	0.05	10	175	98	10 - 70	0.8†	168.6	39	1.7×10^{-8}
2379.5	2.75	7.30	5.11	5.3	124.4	0.28	10	179	100	19 - 35	11.7†	124.5	85	3.4×10^{-5}
2447.5	2.85	9.95	5.09	1.3	166.2	0.07	10	175	96*	39 - 72	2.0	165.9	79	4.9×10^{-9}
2502.2	2.75	10.11	5.11	2.8	134.7	0.22	10	178	85*	7 - 27	7.5†	134.3	74	2.6×10^{-8}
2638.7	2.71	10.12	5.10	4.8	133.4	0.21	10	179	93*	4 - 23	7.9†	132.4	77	3.6×10^{-5}
2936.7	2.72	9.66	5.11	8.9	114.4	0.33	10	179	83*	6 - 20	14.7†	115.3	85	4.2×10^{-5}
2970.8	2.72	9.38	5.12	9.7	112.9	0.33	10	179	100	5 - 38	16.6†	114.2	93	2.0×10^{-5}

Where: w_c = Moisture content; γ_d = Dry density; n = Porosity calculated from equation: $n = 1 - (\gamma_d / G_s \gamma_w)$ where G_s = Specific gravity and γ_w = Unit weight of water; $\bar{\sigma}_c$ = Average isotropic effective confining stress; u_b = Backpressure; and S = Calculated degree of saturation.

* B-factor remained relatively constant for two consecutive increments of applied cell pressure.

† Final moisture content measured and corresponding degree of saturation calculated after performing unconfined compression test on the permeability test specimen.

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Analysis of the Core Data

Table 3 indicates a great range in permeability in the cores. Values range from 10^{-3} cm/sec to 10^{-9} cm/sec, and this difference can be quite significant in identifying confining intervals. However, despite the wide range of values, the vertical permeability in most samples is still low. Samples from 2,448', 2,276', and 2,047' are practically impermeable, and samples from 1,592', 1,766', and 2,502' are of extremely low permeability. Samples from 2,122', within the Lower Monitor Zone of Monitor Well No. 2 is showing the next to highest permeability, but even this one has a permeability of only 1.5 x 10^{-3} cm/sec (about 3 gallons per day per square foot), which is low. The other samples, with the exception of the one at 2,072', are all less than 3 gallons per day per square foot.

Sample porosity shows direct relationship to permeability. Figure 3 shows a plot of the porosity versus permeability of the core samples. A straight line relationship through the best fit of the points has a correlation coefficient of 0.73 and, if the samples with porosity above 35 percent and permeability above 0.001 cm/sec are removed, the fit is 0.92.

The plot in Figure 3 is not a mathematical or theoretical derivation, but only an empirical relationship and is applicable only to similar types of rock samples extracted from the general area in and near the Sunrise site. The porosity has a direct semilogarithmic relationship with the permeability for these samples, but this relationship might not hold true for other samples. The relationship developed in Figure 3 for porosity and permeability can be presented in the form of an equation, as follows:

$$\text{Log } y = mx + b$$

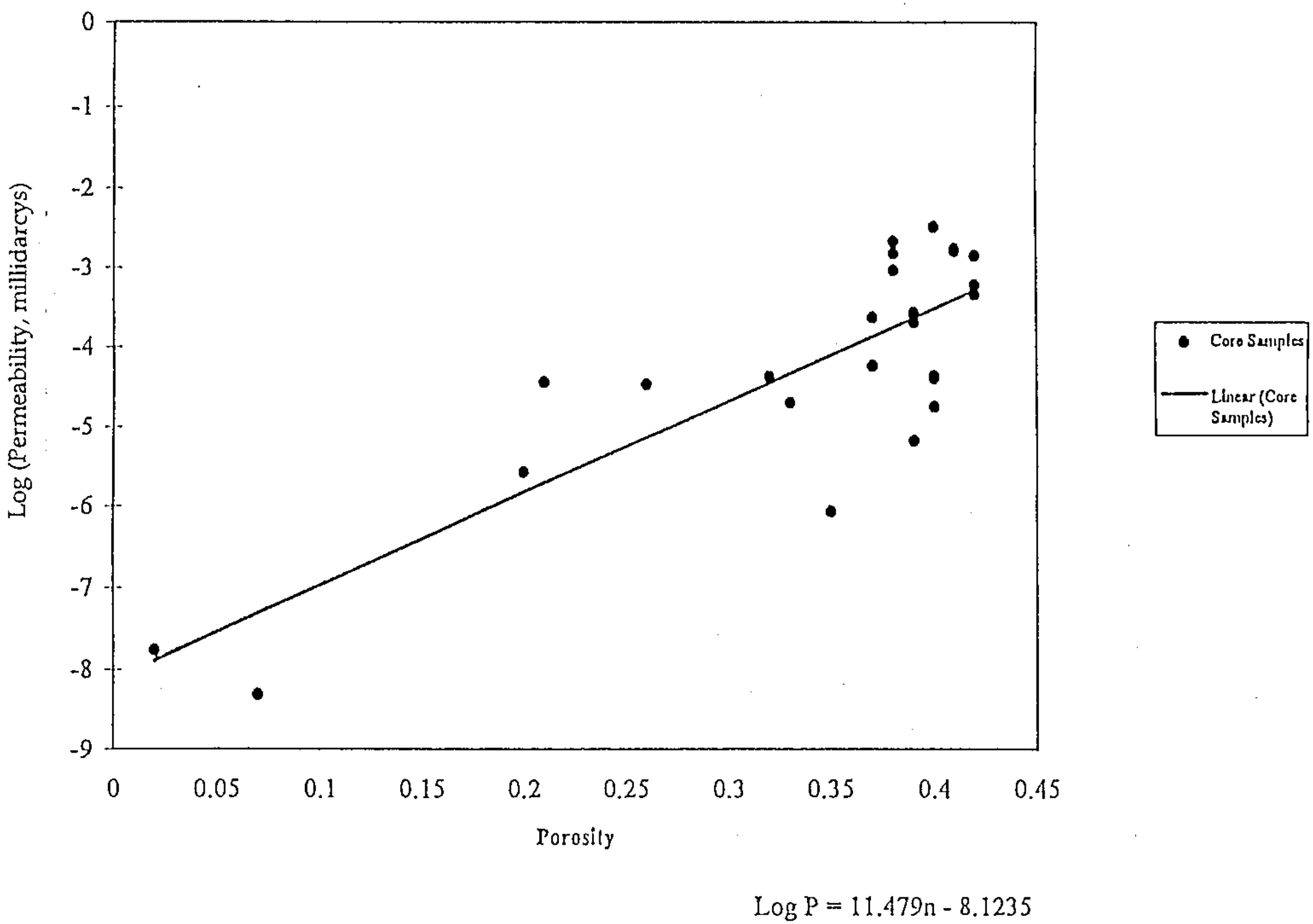
where b is the y intercept, and
m is the slope of the line

When expressed in the terms of permeability and porosity the equation becomes:

$$\text{Log } P = 11.479\, n - 8.1235$$

where P is the permeability (in millidarcies) and
n is the porosity (in percent)

From the sonic logs (see Attachment C), transit times (Acoustic Travel Time) were obtained for each cored sample depth; these are shown with the corresponding sample porosity in Table 4. Since the relationship between transit time and porosity is linear (Schlumberger, 1972) the two values for each sample were then represented in the form of a linear relationship and plotted in Figure 4.



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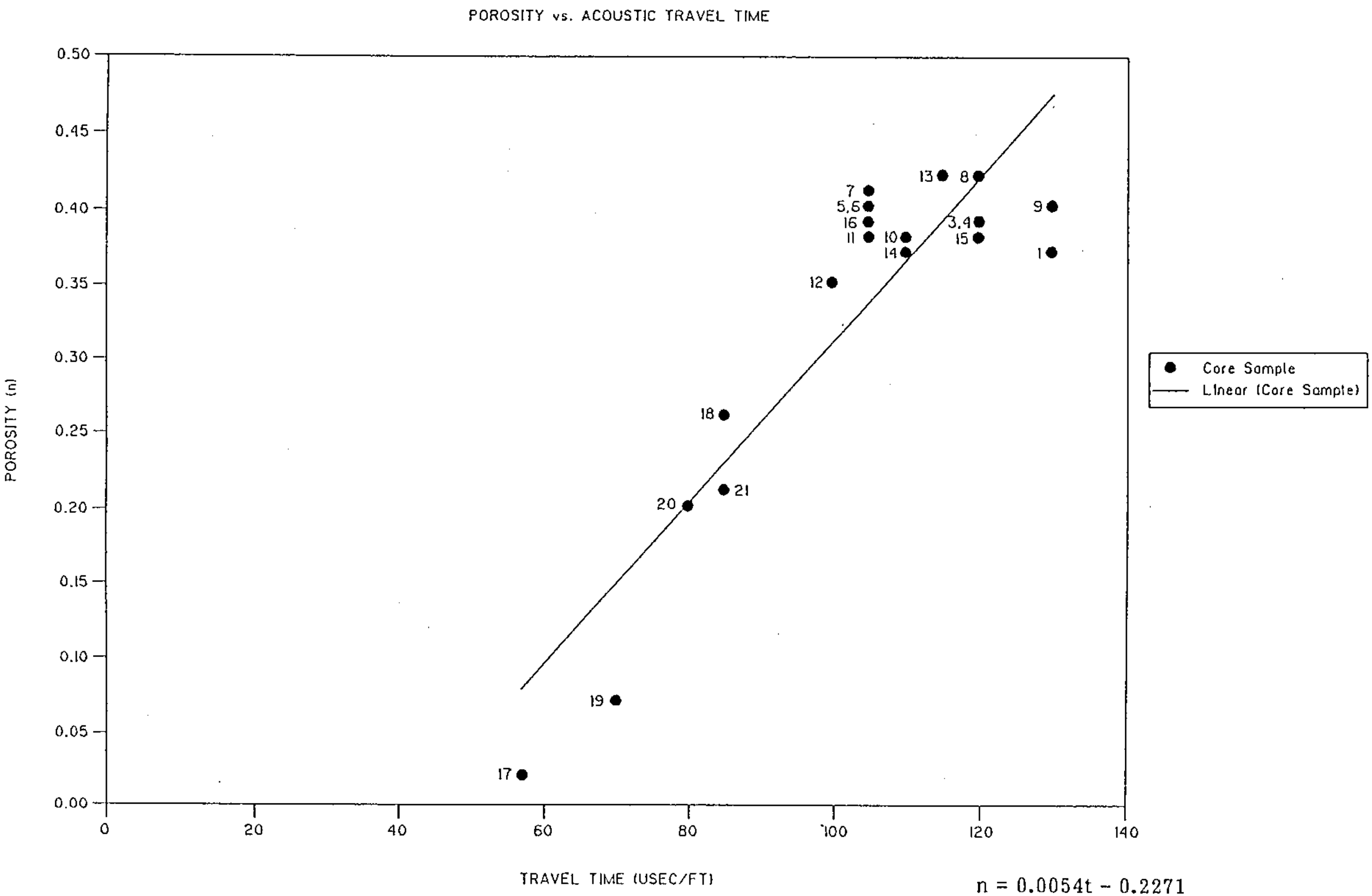
PERMEABILITY VERSUS POROSITY

Figure 3

Table 4
COMPARISON OF ACOUSTIC TRAVEL TIME AND POROSITY

Core Number	Depth (feet)	Acoustic Travel Time (usec/ft)	Porosity (n)
1	1591.5	130	0.38
2	no recovery	no recovery	no recovery
3	1695.6	120	0.39
4	1766.2	120	0.39
5	1801.5	105	0.40
6	1836.3	105	0.40
7	1873.8	105	0.41
8	1904.1	120	0.43
9	1944.1	130	0.41
10	1981.0	110	0.38
11	2005.4	105	0.38
12	2046.6	100	0.35
13	2071.8	115	0.43
14	2132.0	110	0.38
15	2212.0	120	0.38
16	2245.6	105	0.39
17	2275.9	57	0.05
18	2379.5	85	0.28
19	2447.5	70	0.07
20	2502.2	80	0.22
21	2638.7	85	0.21
22	2936.7	not logged	0.33
23	2970.8	not logged	0.33



$n = 0.0054t - 0.2271$

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POROSITY VS. ACOUSTIC TRAVEL TIME

FIGURE 4

A linear regression analysis of the data points shown in Figure 4 produced the following function:

$$n = 0.0054t - 0.2271$$

where n is the rock porosity (percent), and
t is acoustic transit time of saturated rock matrix (microseconds/foot).

The relationship expressed in Figure 4 shows that acoustic transit time increases with increasing void space within the rock, because of the longer transit time through the water in the saturated void spaces.

The equation derived from these data can now be utilized to evaluate the porosities of the different geologic strata from the sonic log. The use of this equation is, however, restricted to those formations from which it was originally developed (Schlumberger 1972) and extreme values of porosity and transit time should be viewed as less accurate and suspect.

The resulting empirical relationships between transit time and porosity and between porosity and permeability developed earlier from the laboratory analyses of the cores, and their comparison with the geophysical logs, can now be used and combined to better define the confining characteristic of the confining zone (see Figures 3 and 4). The equations for the lines in Figure 3 and Figure 4, can be solved together to yield a function as follows:

$$\text{Log } P = 0.05t - 3.19$$

where P is the permeability (in millidarcies), and
t is the transit time (in microseconds/foot)

Using this empirical relationship, and applying it to the confining layers, except where cavity-riddled zones and caverns are present, the permeability of the various layers of the confining zone can be calculated. For example, in the interval from 2,570 to 2,580 feet, the average sonic velocity transit time is about 75 microseconds/foot and the formula above yields a permeability of 1.75 millidarcys. This is equivalent to 0.01 gpd/ft^2.

Using this methodology to identify the confining zone as the zone shown to posses the lowest permeability (hydraulic conductivity) as determined by the evaluation of the geophysical logs, the actual value of conductivity is based on the core data most closely resembling the value representative of that zone. It will be seen in the geophysical logs, that the zone from 2,260 to 2,290 feet represented by core number 16 is the most confining layer above the injection zone and that it is represented by the hydraulic conductivity of 1.7×10^{-8} cm/sec of core number 16. In the geophysical log the integrated value for the acoustic travel time is 65 microseconds per foot, and when this value is inserted in the equation derived in Figure 4, the hydraulic conductivity is 0.06 millidarcies (6×10^{-5} darcies) or roughly 5.4×10^{-8} cm/sec which is as close to the laboratory value of 1.7×10^{-8} cm/sec as can be expected from the integration of the geophysical log with its inherent margin of error.

Geophysical Logs

The pilot hole geophysical logs whose interpretation adds to the understanding of the hydrogeology of the confining zone at the site of injection well No. 3 are included in Attachment C. For convenience in reviewing the geophysical logs data, a reduced scale copy of selected logs is shown in Figure 5.

BHC Sonic Log

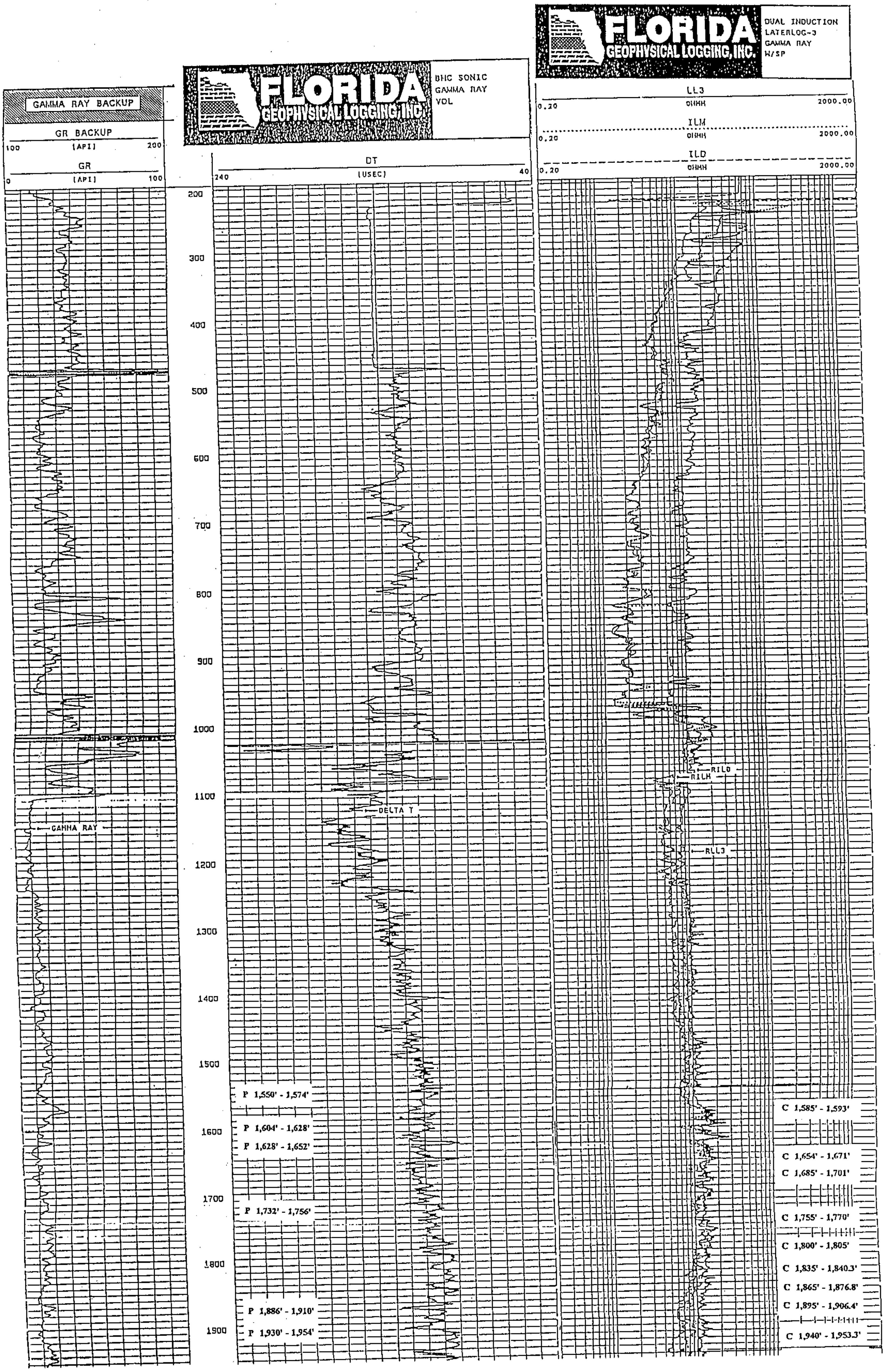
Acoustic logging involves the recording of the time required for a sound wave to travel through a definite length of formation. Speed of sound in subsurface formations depends upon the elastic properties of the rock matrix, the porosity of the formations, and their fluid content and pressure. (Refer to Tables 1 and 2 in Attachment B for porosity and modulus of elasticity values of the rock matrix in the cores tested.)

The sonic log records the arrival of the first sonic wave trains emitted from two transmitters located above and below the receivers; but the presence of secondary porosity can obliterate that first wave. Thus, the travel times recorded on the sonic log are more representative of the primary porosity than of the secondary porosity unless there is a trace of the first wave. Primary porosity reflects intergranular porosity and is dependent upon the pore structure and pore-size distribution. Secondary porosity often consists of vugs, fractures and large cavities with dimensions larger than the pores of the primary porosity. Large sonic travel times recorded on the sonic log would indicate largely secondary porosity because of the larger openings; hence, the sonic log results can also be used to identify the presence of high permeability zones, although a quantitative analysis for secondary porosity would not be possible. A sonic log reading equivalent to the formation fluid transit time or higher would obviously indicate the absence of formation matrix and, therefore, confirm the presence of a cavity or hole.

From approximately 2,260 to 2,290 feet, the transit time peaks from 60 to 50 microseconds/foot, which indicates a very low permeability zone within the Avon Park Formation.

The borehole compensated sonic log was run together with a variable density log (VDL). This log is also helpful in determining the relative tightness (confining characteristics) of formations. One of the benefits of this log is that by measuring the travel time at various distances from the well centerline horizontally into the formation it provides a visual presentation of the locations where the most confining sections are. In this particular case, the VDL log shows the very distinctive outline of the tight confining interval between 2,260 and 2,290 feet bls.

The derivation of the empirical porosity equation earlier (see Figure 4) is based primarily on the analysis of the core samples taken from the pilot hole. The equation is thus applicable locally only to those portions of the sonic log in which similar formations are encountered, that is, in the Avon Park at the Sunrise site. (It cannot be used for the clayey Hawthorn, the dolomitic Arcadia, the sandy Suwannee or any other different formation since the acoustic travel times in those zones would not necessarily fit the empirical relationship.)



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PACKER AND CORE INTERVALS

FIGURE 5 (continued)

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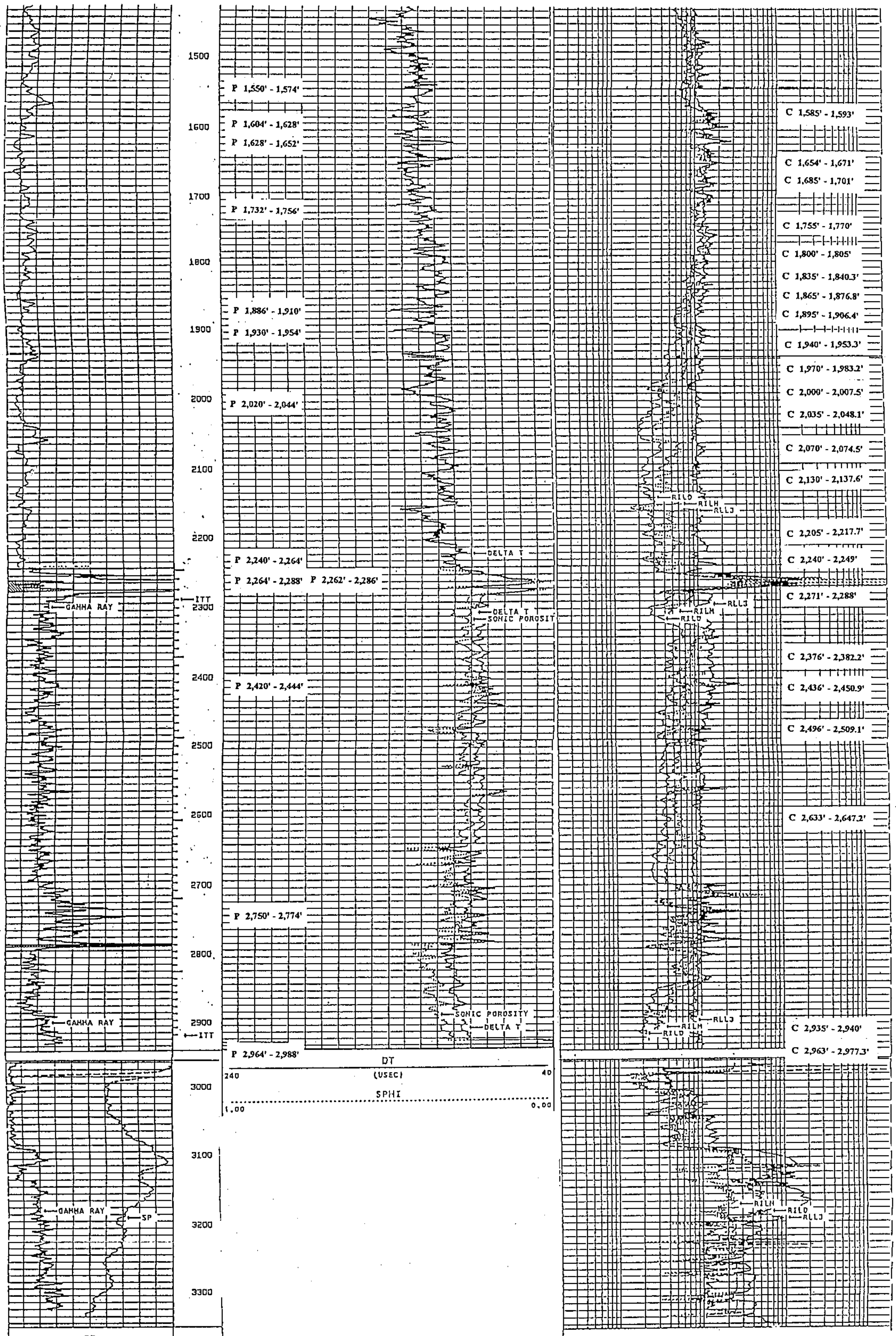

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PACKER AND CORE INTERVALS

FIGURE 5

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Based on the porosity equation, it is possible to calculate porosity from the acoustic log in the various zones penetrated, and using the porosity-permeability relationship (see Figure 3) to further convert it to permeability.

Dual Induction Log

Dual induction electric logging is a method of measuring the resistivity (reciprocal of conductivity) of formations by means of logging induced alternating currents (induction logging). Earlier resistivity tools (64-inch and 16-inch Normal Resistivity tools for example) measured the same resistivity properties of the formations, but the advantage of electric inductive logging is its ability to investigate the thickness of beds, due to its focusing properties and its greater radius of investigation.

One characteristic of resistivity logs is that, when a short (shallow) and a long (deep) penetration signal are sent out together, both encounter essentially the same resistance when the material through which they travel is soft and porous and invaded with conductive fluids such as salty water; however, when the material is very hard and dense (impermeable), or when the material is stratified and has porosity in only one plane (horizontally for clays), or the fluid is not conductive, the long penetration signal encounters greater resistance than the short penetration signal.

Using this characteristic of the log, it is possible to identify those zones where the denser structures of the formations (not invaded by conductive fluids) hinders the travel of the electric signal, and by comparing this log with other logs (the acoustic log, for example), it is possible to interpret the relative degree of confinement that a formation can provide.

The electric resistivity log utilizes three induction devices for measuring the resistivities of the formations: 1) a deep-reading induction device (ILD) whose signal penetrates deep into the formation, 2) a shallower or medium investigation device (ILM), whose readings are more influenced by the borehole and the invaded zone around it, and 3) LL3 which is a spherically focused inductive device. Variations in the signals from the three devices are good indicators of the degree of mud or drilling fluid invasion within the formations, with such invasions more likely to occur in the more permeable formations.

The induction log can be analyzed by utilizing the equations for Formation Factor and Resistivity Index, and assuming that the underlying formations are 100 percent saturated (as they undoubtedly must be) and, that the resistivities of the saturated formation and the clean formation are equal. For each of the selected depth ranges, the resistivity of the formation fluids may be averaged from the water quality data shown in the section dealing with the packer test sampling . Using this average, it is then possible to obtain a porosity value using Archie's equation. The Formation Factor and the porosity are interrelated. Both of these parameters are related to resistivity measurements as follows:

$$F = Ro/Rw$$

where F is formation factor (dimensionless),
Ro is resistivity of saturated formation (ohms-cm), and
Rw is resistivity of formation fluid (ohms-cm)

The formation factor can be redefined in terms of the formation porosity by Archie's Equation (Kovacs, 1981) as follows:

$$F = (a)n^m$$

where m is the cementation factor,
a is an empirical constant, and
n is the porosity

Therefore, the direct relationship between resistivity and porosity is:

$$Ro = Rw\ (a)\ n^m$$

where a is taken as unit because of the limited population
m is estimated at 2.0 based on ranges of 1.78 to 2.61 for South Florida limestones, and
Rw is a variable depending on depth of sample and was taken as the inverse of conductivity

Using these relationships and the geophysical logs for the formation resistivities corresponding to the cores whose porosities were determined in the lab, a relationship was developed between porosity and formation resistivity which can now be used to determine porosities from the geophysical log data (see Figure 6).

From the graph, the porosity versus permeability relationship derived in Figure 3 can now be entered with the specific values of porosity from the geophysical log entry in Figure 6. However, the relationship only holds valid where the formation fluids are highly conductive. In other words, only where the TDS contact exceeds 10,000 mg/l concentration (samples below 1,930 feet).

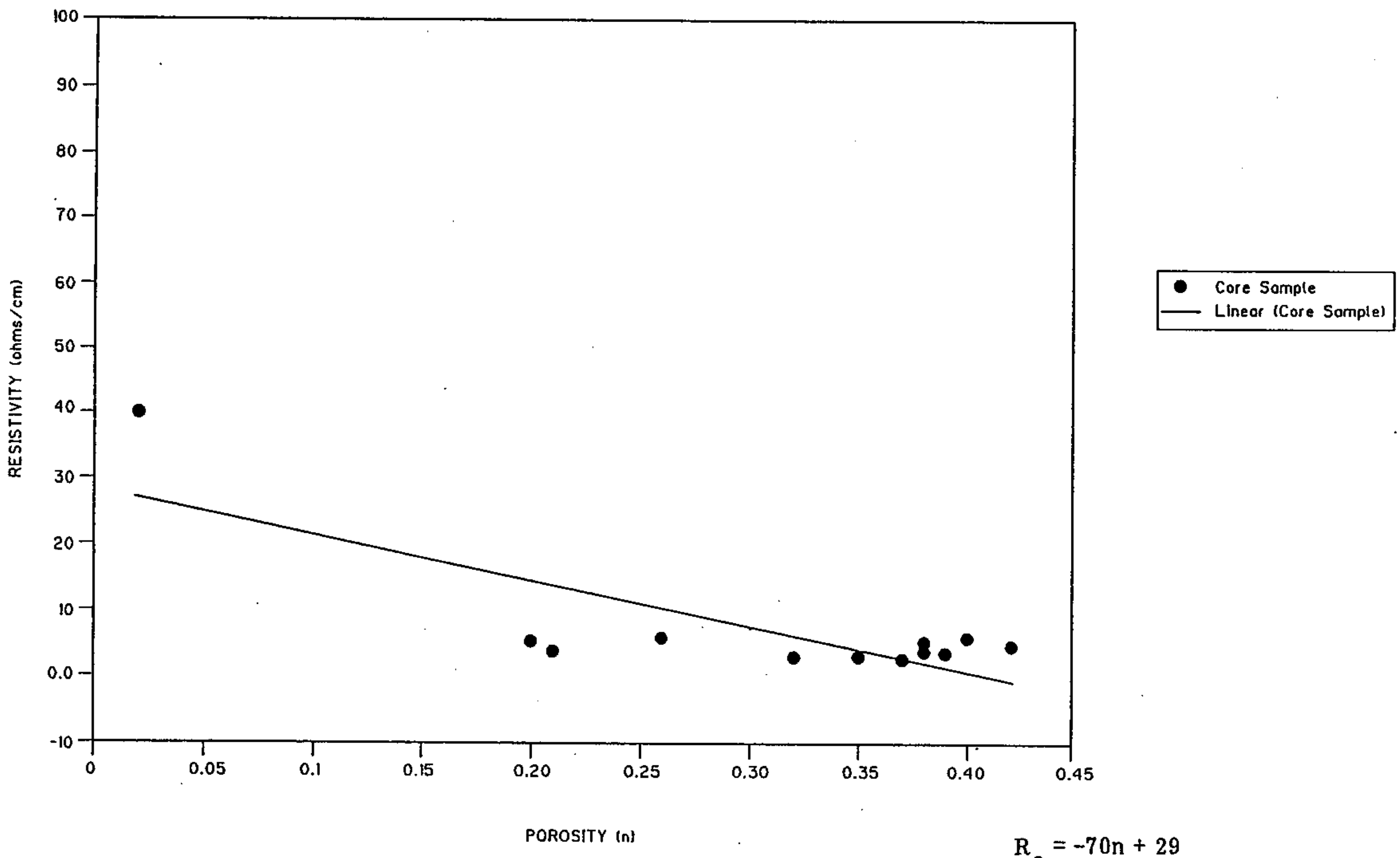
The induction log shows decreasing resistivity starting at about 1,800 feet below land surface indicating a salinity increase with depth starting at that point. An inflection point at the 1,850 foot depth below land surface and another at 1,920 feet are additional indication of salinity increases. This leads to the conclusions that between the inflection points the salinity increases above the 10,000 mg/l TDS level.

The distinctive segment, located from 2,260 feet to 2,290 feet, reflects a tight low permeability zone, in fact one of the lowest permeability zones in the well. Then, from 2,290 feet to 2,300 feet, the last segment of this section of pilot hole, the logs, included a zone with moderate porosity.

Packer Tests and Fluid Sampling

To develop a profile showing how water quality changes with depth, several types of water samples were collected. Some water quality samples were collected from the drill stem discharge at the end of each drill rod, beginning once the drilling operation switched from mud drilling to reverse air drilling on February 18, 1995 at 1,030 feet. The first such sample was collected at 1,118 feet and successive samples were collected at approximately 30-foot intervals.

RESISTIVITY vs. POROSITY



$R_o = -70n + 29$

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POROSITY vs. RESITIVITY

FIGURE 6

Also, as part of the testing process, straddle packer samples were collected at preselected depths (see Table 5 and Figure 5). In addition, while the packers were being pumped, periodic field samples were collected and analyzed in the field to make sure equilibrium had been reached before collecting the final packer test laboratory from that particular depth. Finally, the receiving zone water was equilibrium had been reached before collecting the final tested after well completion and development, water samples were collected in the open hole (the injection zone).

Drill stem samples yielded a mixed, and usually diluted, sample. More reliable results were obtained from the samples collected with the packers. These packers isolated the zones sampled and the samples were collected only after the water quality had stabilized as monitored by field conductivity measurements. The water samples collected with the straddle packer were analyzed by Savannah Laboratory, Inc. The results of the straddle packers laboratory analyses are contained in Table 5. In Table 6 are presented the field results of the final stabilized results prior to laboratory sampling of the packed off interval.

The TDS values shown in the packer test results of Table 5 indicate that in the interval between 1,732 to 1,756 feet the concentration of total dissolved solids (TDS) was 5,600 mg/l while at the next lower packer interval between 1,930 and 1,954 feet, the concentration is 17,000 mg/l. This places the 10,000 mg/l line that delimits the USDW somewhere between these two depths. A packer sample was collected between 1,886 and 1,910 feet but unfortunately it was lost by the contractor. However the field data for the determination of equilibrium (See Table 6) shows a TDS of 8,000 mg/l in the interval between 1,886 and 1,910 feet. The 10,000 mg/l TDS line is therefore narrowed to between 1,910 and 1,930 feet bls based solely on water quality information. This is probably as accurate as the USDW can be determined. Through a close inspection of the induction log in the general area indicated by the water quality it is possible to identify an inflection point at 1,924 feet bls which may be caused by the increase in salinity of the water. This then is as close as the USDW has been identified from the water quality and other data collected during the construction of Injection Well No. 3 at the City of Sunrise site.

Confining Zone

Chapter 62-528 (FAC) requires that a confining zone be present above the injection zone, and that it should be able to prevent the upward migration of injected fluid from the injection zone. In practice, however, no natural soil or rock is totally impermeable and, therefore, able to totally prevent the migration of fluid from any aquifer system (Todd, 1980; Bear, 1979; Freeze and Cherry, 1979; etc.). All rocks are permeable to one degree or another; therefore, the issue addressed in this section is the degree of fluid migration rather than its complete prevention. However, the confining layers of the confining zone are for all practical purposes impermeable.

In the following subsections, the confining layer located between 2,260 and 2,290 feet bls is discussed in terms of its hydraulic characteristics. The physical limits are also discussed.

Physical Limits

The boundary between the injection zone and the overlying major confining zone (that is, the bottom of the confining zone) was determined by the geologic cuttings, the geophysical logs and the water quality to be at a depth of about 2,290 feet. The top of this major confining zone was

Table 5

Stradle Packer Sample Laboratory Results

Analysis	1,550'-1,574'	1,604'-1,628'	1,628'-1,652'	1,732'-1756	1,930'-1954	2,020'-2044	2,240'-2264	2,262'-2286	2,264'-2288	2,420'-2444	2,750'-2774	2,964'-2988
Ammonia-N, mg/l	0.83	0.36	0.64	0.32	1.80	0.43	0.23	5.70	6.20	<0.030	2.80	<0.030
Total Organic Carbon, mg/l	1.9	1.4	2.1	2.0	3.5	1.2	1.2	8.4	9.7	1.4	4.7	1.5
Chloride, mg/l	3400	1300	1400	1600	7500	14000	18000	5200	5400	16000	6500	16000
pH, Lab	7.4	7.9	7.5	7.5	7.5	7.3	7.2	7.3	7.3	7.0	7.5	7.2
Total Phosphorous, mg/l	<0.10	<0.10	<0.10	<0.10	<0.10	0.16	0.15	1.40	1.20	<0.10	<0.10	<0.10
Specific Conductance, umhos/cm	11000	4700	5100	5600	23000	40000	41000	18000	16000	45000	21000	50000
Total Dissolved Solids (TDS), mg/l	8600	3600	3600	4100	17000	30000	30000	11000	12000	33000	11000	24000
Sulfate, mg/l	880	680	560	630	1300	2000	2000	910	720	1200	1000	1900
Total Kjeldahl Nitrogen, mg/l	1.20	0.73	0.65	0.75	5.20	0.49	0.38	11.00	11.00	<0.10	2.50	0.29

NOTE: Packer sample from 1886' to 1910' was unobtainable

Table 6

Stradle Packer Sample Results (Field)

Analysis	1,550'-1,574'	1,604'-1,628'	1,628'-1,652'	1,732'-1756	1,886'-1910	1,930'-1954	2,020'-2044	2,240'-2264	2,262'-2286	2,264'-2288	2,420'-2444	2,750'-2774	2,964'-2988
Chloride, mg/l	3375	1250	1250	1700	4250	8000	14500	15500	6000	6000	18500	7000	18500
Specific Conductance, umhos/cm	11000	5000	5000	6000	13300	21000	37000	39000	16400	16100	46000	19400	46000
Total Dissolved Solids (TDS), mg/l	6700	2500	2500	3000	8000	15000	26500	29300	12000	12000	34000	14000	34000

similarly identified at 2,260 feet. At 2,290 feet, a sharp decrease in signal velocity (long transit time) was seen in the acoustic log (see Attachment C), and in the dual induction electric logs, shallow induction signals indicate an increase in porosity and permeability. The deeper induction signals also begins to separate a little at 2,290 feet.

Hydraulic Characteristics

The resulting empirical relationships between transit time and porosity and between porosity and permeability developed from the laboratory analyses of the cores, and their comparison with the geophysical logs, can now be used and combined to better define the confining characteristic of the confining zone (see Figures 3 and 4). The equations for the lines in Figure 3 and Figure 4, can be solved together to yield a function as follows:

$$\text{Log } P = 0.05t - 3.19$$

where P is the permeability (in millidarcies), and
t is the transit time (in microseconds/foot)

Using this empirical relationship, and applying it to the confining layer, the permeability of the confining zone was calculated. For example, in the interval from 2,260 to 2,290 feet, the average sonic velocity transit time is about 65 microseconds/foot and the formula above yields a permeability of 0.06 millidarcies. This is equivalent to 0.001 gpd/ft^2.

Conclusions

Review and analysis of the coring, geophysical logging, packer testing, and field water testing performed as part of drilling and testing of the City of Sunrise's Injection Well No.3, has resulted in the following conclusions:

A tight major confining zone has been identified above the level at which a freshening of the formation waters has been recorded. This tight confining zone begins at a depth of 2,260 feet below land surface and has prevented any migration of injected fluids past it.

Water quality data indicate that above this confining zone the native formation fluids have not been affected by the injection at this site; while immediately below this confining layer there is evidence of upward migration of injected fluids up to that level.

Core testing data indicate a hydraulic conductivity of only 1.7X10-8 cm/sec (0.0004 gallons/ day/square foot) in cores taken from this zone.

Geophysical logs data indicate that this zone is the most impermeable one of all the low permeability zones encountered during drilling of the injection well. This is confirmed by both the induction logs and the acoustic logs, and is backed up by the gamma ray and VDL logs.

Packer test water quality field data indicate a TDS concentration of 8,000 mg/l in the interval from 1,886 and 1,910 feet below land surface. Packer test water quality laboratory data indicate a TDS concentration of 17,000 mg/l in the interval from 1,930 to 1,954 feet below land surface. A determination has been made regarding the position of the 10,000 mg/l TDS line that delimits the bottom of Underground Sources of Drinking Water. This line has been determined to be located at approximately 1,924 feet below land surface.

Recommendations

In order to meet the requirements of the FDEP permit for construction of IW-3 stating that *"...the lower monitor interval should ideally be positioned in a transmissive interval below the USDW and at an appropriate point above the injection interval and major confining units to monitor for reasonable assurance of vertical confinement and external mechanical integrity." ...and that "...the upper monitor interval should be ideally positioned in a transmissive interval immediately above and proximal to the base of the USDW.",* and based on the above conclusions, the following recommendations are made:

The lower and upper monitor zones should extend a minimum of 50 feet below the end of their respective casings in order to provide sufficient contact with the aquifer for adequate pressure and water quality monitoring.

The upper monitor zone should be located above the USDW. Since the USDW is expected to be located above 1,924 feet bls the monitor zone must monitor above that. The salinity transition zone begins at approximately 1,800 feet bls and it is our opinion that the upper monitor zone should be located above that transition zone otherwise slight natural fluctuations in salinity in the transition zone could result in frequent erroneous results in the monitored data. The zone recommended extends through the interval from 1,700 to 1,750 feet bls. The first 50 feet immediately below that interval is a low transmissive zone and is not recommended. The interval selected (1,700 to 1,750 feet bls) is in line with the upper monitor zone for injection well No. 1 (MW-1A).

The lower monitor zone should be located in a transmissive zone below the USDW (1,924 feet) and above the injection interval and major confining units (2,260 feet) in order to provide an early warning of any leakage across the zone. The most porous zone is located between 2,060 feet and 2,110 feet and is recommended as the lower monitor zone. The zone recommended starts 200 feet above the confining zone and extends 50 feet below that.

A final recommendation is that the TAC and the FDEP give their approval for the installation of the monitor well for injection well No. 3 (MW-3) with the upper and lower monitor casings set at 1,700 feet below land surface and at 2,060 feet below land surface respectively. A 50 foot monitoring interval is recommended for both monitor zones.

ATTACHMENT A

Geologic Description of Well Cuttings and Cores
(Test/Injection Well)

SAMPLE DESCRIPTION NOTES

George O. Winston

Cuttings and core chips were examined wet using a zoom stereo microscope and a 100 watt incandescent light.

The limestone classification is basically that of Dunham, with modifications such as substituting MICRITE for MUDSTONE (the latter is a variety of shale common in the Mesozoic of the Gulf Coast, and its application to carbonates can be confusing). Grain percentages are estimated to provide the reader with a picture of the rock, which the wackestone class of Dunham does not. As colors vary with the type of illumination, whether they are wet or dry, or with an individual's ability to differentiate shades, I have not used the GSA color chart which was designed for outcrop work in daylight.

The dolomite classification is my own, and contains these three varieties:

- Euhedral: rhombic crystals are visible.
- Anhedral: light reflections indicate a crystalline structure but rhombic crystals are not visible (they are interlocking).
- Cryptocrystalline: a smooth appearance with no crystal reflections visible; in some instances it may be lithographic with conchoidal fracture, thus resembling chert.

The sizes of limestone grains and dolomite crystals were determined by the Wentworth scale.

Porosity percentages are visual estimates of <u>effective</u> porosity. Although chalky limestone has high porosity, it is a poor reservoir for the extraction or injection of fluids.

As can be seen in the core descriptions, lithologic changes occur every foot or two. In a 10-foot sample of cuttings there are probably eight lithologic changes (some repeating the same lithology). As it is impossible from a 10-foot sample to place them in their proper order, I have selected the 3 most common lithologies and arranged them in a logical sequence of beds. This method provides at least a generalized picture of the lithologic sequence throughout the well.

The greatest problem in describing minor lithologic constituents is deciding whether they are in place or are contamination by previously drilled rock.

Cores were sampled at approximately the center of each foot. To emphasize this, in the core description each foot has only one depth number. Each foot is listed, even if the lithology remains the same.

DESCRIPTION ABBREVIATIONS

Composition

ls = limestone

ls/d = dolomitic limestone

ls/sdy = sandy limestone

dol = dolomite

dol/c = calcareous dolomite

dol/sdy = sandy dolomite

ss = sandstone

ss/c = calcareous sandstone

ss/d = dolomitic sandstone

sts = siltstone

sts/c = calcareous siltstone

sts/d = dolomitic siltstone

sts/c = calcareous siltstone

Classification

Gr = grainstone

Pk = packstone

Wk = wakestone

M = micrite

Coq = coquina

E = euhedral

A = anhedral

C = cryptocrystalline

etc

O = Operculinoides (Nummulites)

L = Lepitocyclina

C = cones

Da = Dictyoconus americanus

Dg = Dictyoconus gunteri

Glb = Globulina

For = forams

E[illegible] = Echinoids

ph = phosphate

cht = chert

gla = glauconite

sel = selenite

Porosity

gran = granular

xln = intercrystalline

pp = pinpoint

mold = moldic

chalky

vug

occ = occasional

tr = trace

DEP 44-3	Well Sunrise IW 3	Location 34-49S-40E	County Broward	Page 1

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
				FORT THOMPSON - surface		
0-105	ls/sdy	M		white & light gray with occasional orange (limonite?), very fine-fine grain sand, occasional skeletal debris	ph	occ mold
				TAMIAMI 105		
105-25	ls/sdy	M		gray with cream mottling, many loose shell fragments	ph	occ mold
125-30	d'silt			brown	ph	chalky
130-40	same			with some loose coarse to very coarse sand grains	ph	chalky
140-50	ls	?		shell fragments cemented with sandy ls, cream & brown, very fine to fine grain sand	ph	?
150-60	ls/sdy	M		white, gray/brown & cream, very fine to fine grain sand, occasional inclusions shell fragments	ph	--
160-67	sts/c			gray, loose shell fragments	ph	chalky
167-72	ls/sdy	M		orange with embedded shell fragments and very fine to fine grain sand	--	--
172-87	ls/sdy	M		gray, very fine-fine grain sand, occasional embedded shell fragments	ph	--
187-92	ls/sdy	M/S	20	white mottled with pink, fine grain sand, fine to medium skeletal grains	ph	--
192-203	ls/sdy	M		gray, chalky, very fine grain sand, shell fragments	ph	chalky
203-10	ls/sdy	M		cream, very fine grain sand, shell fragments	ph	chalky
210-20				cement		
				in HAWTHORN - PEACE RIVER		
220-25	d'silt			dark gray/brown with very fine grain sand	ph	chalky
225-30	sts			gray	ph	chalky
230-40	sts/c			light gray, many shell fragments	ph	chalky
240-70	ls			mostly shell fragments cemented with sts/c; much caving cement	ph	chalky

George O. Winston

DEP 44-3	Well	Location	County	Page 2

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
270-85	d'silt			dark gray/brown with very fine grain sand	ph	chalky
285-95	ls/sdy	M		light gray, very fine grain sand	ph	--
295-320	d'silt			brown with inclusions ls, light gray, chalky; very fine grain sand	ph	chalky
320-30	ls/sdy	M		light gray, very fine grain	ph	--
330-50	d'silt			gray/brown with very fine grain sand	ph	chalky
350-410	ss/d			gray/brown, very fine grain	ph	5 gran
410-80	same			slightly micaceous	ph	5 gran
				HAWTHORN - ARCADIA		
480-525	ls	M		chalky, soft, disintegrates, shell fragments	ph	chalky
525-40	ls/sdy	M		white, chalky, very fine grain sand, occasional shells	ph	chalky
540-50	c'silt			gray/tan	ph	chalky
550-60	ls	Wk	40	cream, very fine grain	ph	--
560-80	same			occasional shell fragments & inclusions	ph	--
580-90	ls	Wk	40	cream, very fine grain, occasional shell fragments	ph	tr mold
590-600	ls	Wk	60	cream, very fine-fine grain	ph	--
600-10	ls	Wk	30	cream, chalky, very-fine grain	ph	chalky
610-30	ls	Wk	50	cream, chalky, very fine grain	ph	chalky
630-40	ls	M		cream, chalky, occasional shell fragments	ph	chalky
640-730	ls	M		gray/cream, chalky, disintegrates	ph	chalky
730-50	same			with many shell fragments	ph	chalky
750-60	ls	Gr	100	cream, fine grain, shell fragments	ph	5 gran
760-63	ls	M		white mottled with gray	--	--
763-80	ls	Wk	50	cream mottled with gray, some medium skeletal but mostly shell fragments	--	--

DEP 44-3	Well	Location	County	Page 3

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
780-800	ls			shell fragments cemented with cream, chalky M ls; rare Operculinoides	--	--
800-20	ls	M		cream, chalky, soft, occasional shell fragments	--	chalky
820-40	ls			entirely shell fragments	--	?
840-65	ls	M		gray/tan, chalky, disintegrates	ph	chalky
865-95	ls	M		cream, chalky to microgranular, occasional shell fragments	ph	chalky
895-905	ls	Pk	70	cream, very fine grain	ph	5 gran
905-10	ls	M		cream, chalky & microgranular	ph	chalky
910-20	ls	M		gray/tan, chalky, shell fragments	ph	chalky
920-70	same			soft, disintegrates, no shell fragments	ph	chalky
970-80	same			with shell fragments	--	chalky
980-90	same			many shell fragments	--	chalky
990-1000	c'silt			greenish/gray	--	--
1000-10	ls	M		gray/tan, disintegrates	--	chalky
1010-20	ls			entirely shell fragments	--	?
				SUWANNEE		
1020-25	ls	Gr	100	cream & tan; shell conglomerate with orange/brown angular inclusions	--	tr mold
1025-30	ls/sdy	M		light gray & cream, very fine grain sand	ph	--
1030-40	same			very phosphatic	ph	--
1040-60				no samples caught		
1060-65	ls	Gr	100	white, very coarse cemented fossil fragments	--	--
1065-75	ls/sdy	M		white, very fine grain, occasional shell fragments	ph	--
1075-1100	ls/sdy	M		light gray, very fine grain, occasional shell fragments	ph	--
1100-05	ss/d	E		gray/brown, very fine grain sand, microcrystalline dolomite	ph	--

DEP 44-3	Well	Location	County	Page 4

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
				Avon Park 1105		
1105-30	ls	Gr	100	white, fine-medium grain	C	5 gran
1130-85	ls	Pk	70	white, fine-medium grain	E	5 gran
1185-95	ls	M		white	--	chalky
1195-230	ls	Pk	70	white, fine grain	CE	5 gran
1230-40	ls	M		white, chalky	--	chalky
1240-44	ls	M		cream, dense	--	--
1244-50	ls	Pk	70	tan, very fine to fine grain	CE	5 gran
1250-60	ls	Pk	70	white, very fine grain	C	chalky
1260-80	ls	M		tan, chalky to microgranular		chalky
1280-90	ls	Gr	100	orange/tan, very fine-fine grain		5 gran
1290-300	ls	M		tan, chalky		chalky
1300-25	ls	Pk	70	orange/tan, very fine grain		chalky
1325-30	ls	Pk	70	orange/tan, very fine to fine grain	E	5 gran
1330-43	ls	Wk	60	gray/tan, very fine grain		chalky
1343-46	ls	Gr	100	orange/tan, very fine to fine grain		5 gran
1346-51	ls	M		gray/tan, chalky		chalky
1351-64	ls	Wk	60	gray/tan & tan, very fine to fine grain	E	chalky
1364-68	ls	Gr	100	orange/tan & gray, fine grain	E	10 gran
1368-77	ls	Pk	70	tan & gray, fine to medium grain		5 gran
1377-80	ls	Wk	50	tan & orange/tan, very fine grain		chalky
1380-87	ls	Gr	100	tan, very fine to fine grain		10 gran
1387-92	ls	Gr	100	gray, fine grain		10 gran
1392-97	same			tan		10 gran
1397-1401	ls	Wk	60	orange/tan, very fine grain		chalky
1401-03	ls	M		light gray, dense		--
1403-10	ls	Gr	100	orange/tan, very fine to fine grain	C	10 gran

DEP 44-3	Well	Location	County	Page 5

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
1410-22	ls	M		cream & light gray	E	chalky
1422-30	ls	Gr	100	orange/tan, fine grain		10 gran
1430-47	same			with inclusions of micrite, cream & tan, chalky		10 gran
1447-50	ls	M		light gray & orange/tan, dense		--
1450-53	ls	Pk	70	gray/tan, very fine grain		chalky
1453-63	ls	Gr	100	gray & orange/tan, very fine to fine grain		5 gran
1463-68	ls	Pk	70	light gray, very fine to fine grain		chalky
1468-73	ls	M		tan, dense, relic skeletal texture		--
1473-82	ls	Gr	100	gray/tan & tan, fine to medium grain		5 gran
1482-94	ls	M		cream & tan, vague skeletal texture		chalky
1494-500	ls	Gr	100	orange/tan & tan, fine to medium grain		10 gran
1500-07	ls	Gr	100	tan mottled with gray, fine grain		5 gran
1507-12	ls	M		gray mottled with tan, chalky		chalky
1512-17	ls	Gr	100	tan mottled with gray, very fine to fine grain		5 gran
1517-23	ls	Gr	100	tan, medium grain		15 gran
1523-27	ls	Wk	20	gray mottled with tan, medium grain		chalky
1527-32	ls	M		mottled tan & gray, chalky		chalky
1532-35	ls	Pk	70	mottled tan & gray, very fine grain	E	chalky
1535-43	ls	Gr	100	tan, medium grain		10 gran
1543-47	ls	Gr	100	gray/tan, fine grain		5 gran
1547-55	ls	M		tan & gray/tan, chalky & microgranular		chalky
1555-60	ls	Gr	100	tan & gray/tan, fine grain		5 gran
1560-70	ls	Gr	100	orange/tan, fine grain		5 gran
1570-80	same			tan		5 gran
1580-85	ls	Gr	100	orange/tan & cream, loose medium grains	C	10 gran

DEP 44-3	Well	Location	County	Page 6

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
				CORE 1 1585-95, rec 10 feet		
1585	ls	Wk	60	cream, very fine to medium grain, chalky matrix		chalky
1586	ls	Gr	100	cream, very fine grain		5 gran
1587	same					chalky
1588	ls	Gr	100	cream, very fine grain		5 gr
1589	ls	Wk	30	cream, very fine grain		chalky
1590	ls	Gr	100	cream, fine to medium grain		5 gr
1591	ls	Pk	70	cream & light gray, very fine to fine grain		chalky
1592	ls	M		white		chalky
1593	ls	Pk	70	cream, fine grain mixed with		chalky
	ls	Wk	40	gray, fine grain, vague skeletal texture		5 mold
1594	ls	Gr	100	tan, very fine to medium grain		15 gran
				CUTTINGS		
1595-97	same					15 gran
1597-607	ls	M		gray, some cream		--
1607-15	ls	Pk	70	gray, very fine grain vague texture		chalky
1615-24	ls	Gr	100	tan, fine to medium grain		10 gran
1624-28	ls	Wk	40	white, cream & orange/tan, very fine grain		chalky
1628-30	ls	M		cream, chalky		chalky
1630-35	ls	M		light gray & tan, dense		--
1635-40	ls	Pk	70	gray & cream, fine to medium grain		5 gran
1640-50	ls	Wk	50	cream, fine grain CORE 1653-71 no rec		chalky
1650-56	ls	Pk	70	gray mottled with tan, very fine to fine grain		chalky
1656-68	ls	M		cream & gray, chalky		chalky
1668-71	ls	Gr	100	tan, fine grain	C	5 gran
1671-77	ls	Wk	60	gray, very fine grain		chalky

DEP 44-3	Well			Location	County	Page 7
Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
1677-83	ls	M		gray & tan, dense		--
1683-85	ls	Gr	100	orange/tan, loose very fine grains		5 gran
				CORE 2 1685-1701 rec 16 feet		
1685	ls	M		cream, chalky		chalky
1686	ls	Wk	40	cream, very fine to fine grain		chalky
1687	ls	Wk	50	cream, very fine to fine grain mixed with		chalky
	ls	M		gray mottled with cream		chalky
1688	ls	M		cream		chalky
1689	ls	Wk	60	tan, very fine grain, chalky matrix		chalky
1690	ls	Wk	50	cream, very fine grain, chalky matrix		chalky
1691	ls	Wk	60	cream, very fine grain, chalky matrix		chalky
1692	same					chalky
1693	ls	Wk	50	tan, very fine grain, chalky matrix		chalky
1694	ls	Wk	50	orange/brown, very fine grain, chalky matrix		chalky
1695	same					chalky
1696	ls	Wk	50	tan, very fine grain, chalky matrix		chalky
1697	same					chalky
1698	ls	Wk	40	tan, very fine grain, chalky matrix		chalky
1699-99.5	ls	Pk	70	cream, very fine to fine grain mixed with		5 gran
1699.5-.7	ls	M		gray, chalky		chalky
1699.7	ls	Wk	60	cream, very fine grain, chalky matrix		chalky
1701	ls	Gr	100	white, fine to medium grain, mixed with		5 gran
	ls	M		white, chalky		chalky
				CUTTINGS		
1702-06	ls	M		light gray, chalky		chalky
1706-12	ls	Wk	30	tan, very fine grain	C	chalky

DEP 44-3	Well	Location	County	Page 8

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
1712-16	ls	Gr	100	tan, very fine to fine grain		5 gran
1716-20	ls	M		light gray & cream, chalky	C	chalky
1720-23	ls	M		gray, chalky		chalky
1723-38	ls	Pk	70	tan, very fine to fine grain	C	5 gran
1738-41	ls	M		cream & white		chalky
1741-43	ls	M		gray, chalky		chalky
1743-50	ls	Gr	100	orange/tan, very fine grain	C	5 gran
1750-54	ls	Pk	70	orange/tan, very fine grain		chalky
1754-55	ls	M		gray/tan, chalky		chalky
				CORE 3 1755-70 rec 15 feet		
1755	ls	M		gray/tan, chalky		chalky
1756	same					chalky
1757	ls	Wk	60	tan, very fine grain, chalky matrix		chalky
1758	ls	Pk	70	gray/brown, fine to medium grain, white miliolids	C	chalky
1759	ls	Wk	60	light gray, fine to medium grain, chalky matrix		chalky
1760	ls	Wk	40	orange/tan, very fine grain, chalky matrix		chalky
1761	ls	Pk	70	orange/tan, very fine grain		5 gran
1762	same					5 gran
1763	ls	Gr	100	orange/tan, fine to medium grain		5 gran
1764	ls	Wk	50	tan, very fine grain, chalky matrix		chalky
1765	same					chalky
1766	ls	M		gray/tan, chalky		chalky
1767	same					chalky
1768	ls	M		gray/tan to microgranular		chalky
1769	ls	M		tan, chalky		chalky
1770	ls	Wk	40	cream, very fine grain, chalky matrix		chalky

DEP 44-3	Well			Location	County		Page 9

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
				CUTTINGS		
1771-74	ls	M		tan, chalky		chalky
1774-76	ls	M		gray, chalky		chalky
1776-80	ls	Wk	40	tan, very fine grain, chalky matrix		chalky
1780-87	ls	Gr	100	orange/tan, very fine to fine grain, some loose	C	5 gran
1787-97	ls	M		white, light gray & cream, chalky		chalky
1797-1800	ls	Gr	100	tan & gray, fine grain	C	5 gran
				CORE 4 1800-05 rec 5 feet		
1800	ls	M		white, chalky		chalky
1801	ls	M		cream, chalky		chalky
1802	ls	M		cream mottled with white		chalky
1803	ls	M		tan, chalky to microgranulat		chalky
1804	ls	M		cream, chalky		chalky
				CUTTINGS		
1805-10	ls	Pk	70	tan, fine grain		5 gran
1810-15	ls	Gr	100	orange/tan, fine to medium grain	C	5 gran
1815-20	ls	Wk	20	tan, very fine grain	C	chalky
1820-33	ls	Gr	100	cream, fine to medium grain	C	5 gran
1833-35	ls	Wk	20	white, very fine grain		chalky
				CORE 5 1835-40 rec 5 feet		
1835	ls	Wk	20	cream, very fine grain		chalky
1836	ls	Wk	60	cream, very fine grain		chalky
1837	ls	Pk	70	cream, very fine to fine grain		5 gran
1838	ls	Wk	60	cream, very fine grain		chalky
1839	ls	Pk	70	tan, very fine grain		5 gran
				CUTTINGS		
1840-44	ls	M		white		chalky

DEP 44-3	Well	Location	County	Page 10

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
1840-44	ls	M		white		chalky
1844-47	ls	Gr	100	white, fine to medium grain		5 gran
1847-50	ls	Gr	100	orange/tan, fine to medium grain, some loowe	C	10 gran
1850-55	ls	Wk	40	tan, very fine to fine grain	C	chalky
1855-62	ls	Wk	20	white, very fine to fine grain		chalky
1862-65	ls	Gr	100	orange/tan, very fine to fine grain	C	5 gran
				CORE 6 1865-76.8 rec 12 feet		
1865	ls	Gr	100	cream, very fine grain		10 gran
1866	ls	Gr	100	tan, very fine grain		10 gran
1867	ls	Pk	70	tan, very fine grain		chalky
1868	ls	Gr	100	cream, very fine to fine grain		10 gran
1869	same					10 gran
1870	ls	Pk	70	tan, very fine grain		5 gran
1871	ls	Gr	100	tan, very fine grain		10 gran
1872	ls	Gr	100	orange/tan, very fine to medium grain		15 gran
1873	ls	Gr	100	cream, very fine to fine grain		10 gran
1874	ls	Pk	70	cream, very fine to medium grain, occasional coarse		10 gran
1875	ls	Gr	100	cream, very fine grain		5 gran
1876	ls	Gr	100	cream, very fine to fine grain		5 gran
				CUTTINGS		
1877-93	ls	Gr	100	cream & tan, fine to medium grain	C	10 gran
1893-95	ls	Pk	70	cream, fine to medium grain, inclusions of gray M & Wk 20, very fine grain	C	5 gran
				CORE 7 1895-1906 rec 11 feet		
1895	ls	Gr	100	cream, very fine to fine grain	C	10 gran
1896	same					10 gran
1897	ls	Pk	70	white, fine to medium grain	C	5 gram

DEP 44-3	Well	Location	County	Page 11

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
1898	same					5 gran
1899	ls	Pk	70	white, very fine grain, chalky matrix	C	chalky
1900	ls	Gr	100	white, fine to coarse grain		20 gran
1901	ls	Pk	70	white, fine to medium grain		10 gran
1902	same					10 gran
1903	ls	Pk	70	white, very fine grain	C	5 gran
1904	ls	Gr	100	white, fine to medium grain	C	15 gran
1905	ls	Pk	70	white, very fine grain	C	chalky
1906	ls	Gr	100	white, fine to medium grain, recrystalized almost to obscurity		10 mold & gran
				CUTTINGS		
1907-30	ls	Gr	100	white, tan & light gray, fine to medium gray	C	10 gran
1930-40	ls	Gr	100	orange/brown, fine grain	C	10 gran
				CORE 8 1940-53.5 rec 13.5 feet		
1940	ls	Gr	100	tan, fine to medium grain		10 gran
1941	ls	Gr	100	tan, very fine to fine grain		5 gran
1942	ls	Gr	100	cream, very fine to medium grain		10 gran
1943	ls	Gr	100	cream, fine grain		20 gran
1944	ls	Gr	100	gray/tan, fine grain	C	10 gran
1945	ls	Gr	100	tan, very fine to fine grain, some dark gray grains		15 gran
1946	ls	Gr	100	tan, fine to medium grain		25 gran
1947	ls	Pk	70	tan, very fine to fine grain		5 gran
1948	ls	Gr	100	tan, very fine to fine grain		20 gran
1949	ls	Pk	70	cream, very fine grain, chalky matrix		chalky
1950	ls	Pk	70	same with some very fine gray grains		chalky
1951	ls	Gr	100	cream, very fine grain, some very coarse gray grain	C	5 gran

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Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
1952	ls	Gr	100	light gray, microgranular matrix with intervals of very fine to fine grain cream ls		10 gran V
1953	ls	Gr	100	cream mottled with tan, fine grain		5 gran
				CUTTINGS		
1953-57	ls	Gr	100	orange/tan, fine to medium grain	C	20 gran
1957-62	ls	M		white		chalky
1962-70	ls	Wk	60	white, very fine grain		chalky
				CORE 9 1970-83 rec 13.2 feet		
1970	ls	Wk	30	cream, very fine grain		chalky & pp
1971	ls	Pk	70	cream, very fine to fine grain		chalky
1972	ls	Pk	70	same		5 gran
1973	ls	Gr	100	cream, very fine to fine grain, occ medium grains		5 gran
1974	same					5 gran
1975	ls	Gr	100	tan, fine to medium grain	Da	15 gr
1976	ls	Pk	70	tan mottled with white, very fine grain		chalky
1977	ls	Pk	70	white, fine to medium grain; some 5 gran porosity	C	chalky
1978	ls	Wk	60	white, very fine grain		chalky
1979	ls	Pk	70	white, fine to medium grain		5 gran
1980	ls	Gr	100	white, fine to coarse grain		15 gran
1981	same				C	10 gran
1982	ls	Gr	70	cream, very fine grain, chalky matrix	C	chalky
				CUTTINGS		
1983-86	ls	Wk	10	white & cream, fine grain		chalky
1986-88	ls	Wk	50	orange/tan, fine grain	C	--

DEP 44-3	Well	Location	County	Page 13

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
1988-95	ls	Pk	70	tan, fine grain	C	chalky
1995-2000	ls	Gr	100	cream & white, fine grain	C	5 gran
				CORE 10 2000-2007.5 rec 7.5 feet		
2000	ls	Pk	70	white, very fine to fine grain; also 5% moldic porosity		5 gran
2001	ls	Pk	70	cream, very fine grain	C	chalky
2002	ls	Gr	100	cream, very fine to fine grain	C	5 gran
2003	same					5 gran
2004	ls	Gr	100	tan, very fine to fine grain		5 gran
2005	ls	Gr	100	tan, very fine to fine grain, occ coarse grain		10 gran
2006	ls	Gr	100	white, micritized vague very fine grain texture additional pinpoint & intergranular porosity		10 mold
2007	ls	Pk	70	tan, very fine to fine grain		5 gran
				CUTTINGS		
2007-25	ls	M		tan, very soft, disintegrates		chalky
2025-35	ls	Pk	70	white, cream & orange/tan, fine to medium grain	CDa	5 gran
				CORE 11 2035-47.8 13 feet		
2035	ls	Gr	100	cream, fine to coarse grain	C	10 gran
2036	ls	Pk	70	cream, fine to medium grain		5 gran
2037	ls	Gr	100	cream, very fine grain		5 gran
2038	ls	Gr	100	cream, very fine to fine grain		5 gran
2039	ls	Wk	60	white, very fine grain		chalky
2040	ls	Wk	60	light gray, very fine grain; trace mold porosity		chalky
2041	ls	M		white, chalky		chalky
2042	ls	Pk	70	cream, very fine to fine grain, chalky matrix		chalky
2043	same					chalky
2044	ls	M		light gray, chalky		chalky

DEP 44-3	Well				Location	County	Page 14

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
2045	ls	Pk	70	tan, very fine grain, chalky matrix		chalky
2046	ls	M		cream, chalky		chalky
2047	same					chalky
2048	ls	M		tan, chalky		chalky
				CUTTINGS		
2049-53	ls	M		white & cream, dense		--
2053-65	ls	Pk	70	tan, very fine to fine grain		chalky
2065-68	ls	Wk	30	light gray & cream, fine grain		chalky
2068-70	ls	Pk	70	light gray & cream, fine grain		5 gran
				CORE 12 2070-74.5 rec 4.5 feet		
2070	ls	Gr	100	orange/tan, fine grain		15 gran
2071	ls	Pk	70	cream, very fine to fine grain		5 gran
2072	ls	Gr	100	cream, fine grain		10 gran
2073	same					10 gran
2074	ls	Gr	100	cream, fine to medium grain		10 gran
				CUTTINGS		
2075-78	ls	Pk	70	orange/tan, fine grain	C	5 gran
2078-85	ls	Pk	70	white, fine grain	C	5 gran
2085-90	ls	Gr	100	tan, loose fine grains		10 gran
2090-100	ls	Gr	100	same	C	10 gran
2100-05	ls	Gr	100	cream, fine grain		10 gran
2105-13	ls	M		cream, chalky	C	chalky
2113-16	ls	Wk	20	white, fine grain		chalky
2116-25	ls	Gr	100	white, fine grain	C	5 gran
2125-30	ls	Pk	70	tan & cream, fine grain	C	5 gran

DEP 44-3	Well			Location	County	F :

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
				CORE 13 2130-37.5 rec 7.5 feet		
2130	ls	Wk	20	white, very fine grain		chalky
2131	same					chalky
2132	ls	Pk	70	light gray, very fine to fine grain, some dark gray medium grains		5 gran
2133	ls	Wk	30	cream, very fine grain		chalky
2134	SAME					chalky
2135	ls	Pk	70	cream, fine grain, large inclusions of cream, chalky M		5 gran
2136	ls	Pk	70	white, fine grain, chalky matrix		5 gran
2137	ls	M		white, chalky		chalky
				CUTTINGS		
2138-45	ls	M		white, chalky		chalky
2145-55	ls	Pk	70	cream, fine grain		5 gran
2155-60	ls	M		white, dense		--
2160-73	ls	Wk	20	cream & white, fine grain		chalky
2173-80	ls	Wk	10	tan, fine grain		chalky
2180-90	ls	Pk	70	cream, very fine to fine grain		5 gran
2190-94	ls	Wk	20	cream, very fine grain		chalky
2194-97	ls	Wk	40	gray/tan, very fine grain		chalky
2197-2203	ls	M		cream & tan, chalky		chalky
2203-05	ls	Pk	70	cream & orange/tan, fine grain	C	5 gran
				CORE 14 2205-2217.7 rec 12.7 feet		
2205	ls	Pk	70	cream, very fine to fine grain	C	5 gran
2206	same				C	5 gran
2207	ls	Pk	70	cream, fine to medium grain		5 gran
2208	ls	Gr	100	cream, fine grain		10 gran
2209	ls	Pk	70	cream, very fine grain		5 gran

DEP 44-3	Well		Location		County	Page 16
Depth	**Comp.**	**Cls.**	**%Gr**	**Description**	**etc.**	**%por/type**
2210	ls	Gr	100	cream, fine grain		5 gran
2211	ls	Pk	70	cream, fine grain	C	5 gran
2212	same					5 gran
2213	ls	Pk	70	cream, fine to medium grain, vague texture		5 gran & pp
2214	ls	Wk	40	white, very fine grain		chalky
2215	same					chalky
2216	ls	Pk	70	cream, very fine grain		10 gran
2217	ls	Pk	70	white, fine grain, chalky matrix		chalky
				CUTTINGS		
2218-34	ls	Gr	100	cream, fine grain	C	10 gran
2234-38	ls	M		white	C	chalky
2238-40	ls	Pk	70	tan, fine grain	C	5 gran
				CORE 15 2240-49 rec 9 feet		
2240	ls	Pk	70	cream, fine to coarse grain		10 gran
2241	ls	Gr	100	cream mottled with gray, fine to coarse grain, inclusions brown crystalline ls		20 gran
2242	ls	Wk	40	white, very fine grain		chalky
2243	ls	Pk	70	tan, very fine grain, chalky matrix		chalky
2244	same				C	chalky
2245	same					chalky
2246	ls	Pk	70	white, very fine to fine grain, brown, peaty blobs		5 gran & pp
2247	ls	Wk	60	white, very fine grain		chalky
2248	ls	M		white, chalky		chalky
2249	ls	Wk	60	white, very fine grain		chalky

DEP 44-3	Well	Location	County	Page 17		
Depth	**Comp.**	**Cls.**	**%Gr**	**Description**	**etc.**	**%por/type**
				CUTTINGS		
2250-64	ls	Wk	60	white, very fine grain		chalky
2264-65	dol/c	E		gray with inclusions white ls matrix		--
2265-68	dol	E		dark brown & gray, fine crystalline		--
2268-71	dol	C		gray		--
				CORE 16 2271-88 rec 17 feet		
2271	dol	A		brown		--
2272	dol	C		cream with numerous fine to medium grain clear inclusions		--
2273	dol	C		tan		--
2274	dol	A		tan mottled with cream		--
2275	dol	E		brown, microcrystalline		--
2276	dol	A/C		orange/tan mottled with cream cryptocrystalline		--
2277	dol	E		brown, very fine crystalline		--
2278	dol	A		brown		--
2279	dol	C		cream with inclusions brown A dolomite		--
2280	same					--
2281	dol	A		brown		tr pp
2282	dol	A		orange/brown		--
2283	dol	C		cream, lithographic horizontal vug chain liend microcrystalline orange/tan E dolomite		5 v
2283.2	dol	E		orange/brown, fine microcrystalline		chalky
2284	dol	C		cream, lithographic with occasional vugs lined with orange/brown fine microcrystalline dolomite		tr V
2285	dol	C		orange/tan		--
2286	same					--
2287	dol	A		gray/tan		5 pp V

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
				CUTTINGS		
2288-310	ls/d	Gr	100	orange/tan & cream, fine grain, occasional brown dolomite matrix		10 gran
2310-25	ls	Gr	100	cream, very fine grain		5 gran
2325-35	ls	Gr	100	cream, fine grain		10 gran
2335-40	ls	same		loose medium grains		15 gran
2340-57	ls	Gr	100	cream, fine to coarse grain, miliolids, occ shell fragments		10 gran
2357-59	ls	Gr	100	cream, medium to coarse grain, calcite cement		5 gran
2359-60	ls	Gr	100	gray, fine to medium grain		10 gran
2360-65	ls	Gr	100	cream, fine grain		10 gran
2365-73	ls/d	Gr	100	cream, fine grain with dol crystal inclusions		chalky
2373-74	ls	Pk	70	cream & light gray, very fine grain		5 gran
2374-76	ls	Gr	100	light gray, fine grain		10 gran
				CORE 17 2376-82.2 rec 6 feet		
2376	ls	Wk	20	cream, very fine grain		chalky
2377	ls	Pk	70	cream, medium to coarse grain, chalky matrix		5 gran
2378	ls/d	M		cream, very fine dol crystal inclusions		chalky
2379	ls	Gr	100	cream, fine to medium grain		15 gran
2380	same					15 gran
2381	ls/d	M		cream, fine dol crystal inclusions		chalky
				CUTTINGS		
2382-84	ls/d			same		chalky
2384-88	ls	Gr	100	cream, fine to medium grain		10 gran
2388-90	ls	Gr	100	cream, same, calcite cemented		--
2390-94	ls	Gr	100	cream, fine to medium grain		5 gran
2394-403	ls/d	Gr	100	cream, fine to medium grain, fine dol crystal inclusions & dol masses		--

DEP 44-3	Well	Location	County	Page 19

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
2403-06	ls/d	Gr	100	white, medium grain, fine dol crystal inclusions		5 gran
2406-18	ls	Gr	100	white, fine to medium grain		5 gran
2418-23	dol/c	E		orange/brown, fine crystalline, white ls matrix		--
2423-30	dol	E		orange/brown, fine crystalline		5 xln & pp
2430-33	ls/d	Gr	100	light gray, fine grain, very fine dol crystal inclusions		chalky
2433-36	ls	Gr	100	white, fine grain		10 gran
				CORE 18 2436-50.9 rec 15 feet		
2436	ls	Wk	60	white, very fine to fine grain, chalky matrix		chalky
2437	dol/c	E		orange/brown, fine crystalline cream ls matrix		--
2438	same					chalky
2439	ls	Pk	70	cream, fine to coarse grain		5 gran
2440	same					5 gran
2441	ls/d	M		cream, fine dol crystal inclusions		chalky
2442	ls	Gr	100	cream, fine grain		5 gran
2443	same					10 gran
2444	ls/d	Pk	70	cream, very fine to fine grain, scattered very fine dol crystal inclusions		chalky
2445	ls	Gr	100	cream, very fine to fine grain		5 gran
2446	ls	Pk	70	cream, very fine to fine grain, chalky matrix		chalky
2447	dol/c	E		brown, fine crystalline, cream ls matrix		chalky
2448	dol	E		brown, fine crystalline		tr pp & x
2449	dol/c	E		orange/brown, fine crystalline, cream ls matrix		chalky
2450	ls	Wk	50	cream, fine to medium grain, chalky matrix		chalky
2451	ls/d	M		cream, chalky, fine dol crystal inclusions		chalky
				CUTTINGS		
2452-54	same					chalky

DEP 44-3	Well	Location	County	Page 20

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
2454-57	dol	E		orange/brown, very fine crystalline		--
2457-60	ls	Gr	100	cream, fine to medium grain		15 gran
2460-77	ls	Gr	100	cream, medium to coarse grain		15 gran
2477-83	ls/d	M		cream, fine dol crystal inclusions		chalky
2483-92	dol	E		orange/brown, fine crystalline		10 xln
2492-96	dol	E		brown, very fine crystalline		5 xln
				CORE 19 2496-2509.1 rec.13 feet.		
2496	dol/c	E		black, very fine crystalline, white ls matrix		chalky
2497	ls/d	M		white, chalky, black very fine dol crystal inclusions		chalky
2498	ls	M		cream, microgranular		chalky
2499	ls	Pk	70	cream, very fine grain, chalky matrix		chalky
2500	dol/c	E		brown, fine crystalline with lumps very fine grain skeletal grainstone		chalky
2501	dol	E		brown, fine crystalline, sucrosic		10 xln&v
2502	dol/c	E		orange/brown, fine crystalline with cream, chalky ls matrix & ls fossils		--
2503	ls/d	M		chalky, fine dol crystal inclusions		chalky
2504	dol/c	E		orange/brown, fine crystalline, cream ls matrix		chalky
2505	ls/d	M		cream, chalky, microcrystalline dol crystal inclusions		chalky
2506	ls	Pk	70	cream, very fine to fine grain, chalky matrix		chalky
2507	ls/d	M		cream, fine dol crystal inclusions		chalky
2508	dol/c	E		orange/brown, fine crystalline, white ls matrix		chalky
2509	same					chalky
				CUTTINGS		chalky
2510-12	dol	E		orange/brown, fine crystalline		5 xln
2512-14	ls/d	M		cream, chalky, very fine dol crystal inclusions		chalky
2514-18	ls	Wk	20	cream, very fine grain		chalky
2518-21	ls	M		white		chalky

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Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
2521-40	ls	Pk	70	white, medium to coarse grain, some loose		10 gran
2540-57	ls	Gr	100	white, medium to coarse grain, occ shell		10 gran
2557-62	ls	Wk	50	cream, very fine grain, chalky matrix	E	chalky
2562-68	ls	Gr	100	cream, fine to medium grain	E	10 gran
2568-70	ls/d	M		cream, fine dol crystal inclusions	E	chalky
2570-75	dol/c	E		orange/tan, fine crystalline, occ ls inclusions		tr pp
2575-78	ls	Gr	100	white, fine to medium grain		5 gran
2578-85	ls	Wk	50	white, very fine grain		chalky
2585-88	ls/d	M		cream, fine dol crystal inclusions		chalky
2588-90	dol	E		orange/tan, fine crystalline, occ ls inclusions		--
2590-92	ls/d	M		cream, fine dol crystal inclusions		chalky
2592-603	ls	Wk	30	white, very fine grain		chalky
2603-07	ls	Gr	100	white, fine grain		5 gran
2607-10	dol/c	E		orange/tan, fine crystalline, white ls inclusions		--
2610-14	dol	E		orange/tan, fine crystalline		5 xln
2614-17	ls/d	M		cream, very fine to fine dol crystal inclusions		chalky
2617-22	ls	Gr	100	cream, fine grain		5 gran
2622-27	ls/d	M		cream, fine dol crystal inclusions		chalky
2627-31	dol/c	E		orange/brown, fine crystalline, white ls matrix		chalky
2631-33	ls	Gr	100	white, fine to medium grain		5 gran
				CORE 20 2633-47.2 rec 14 feet		
2633	same					10 gran
2634	ls	Gr	100	white, fine to medium grain mixed with Pk very fine cemented grains		10 gran
2635	ls	Gr	100	white, fine to medium grain		10 gran
2636	ls	Pk	70	cream, very fine to fine gran		5 gran
2637	ls	Gr	100	cream, fine to medium grain		5 gran

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
2638	ls	Pk	70	cream, very fine grain, chalky matrix		chalky
2639	ls	GR	100	cream, fine grain		5 gran
2640	same					10 gran
2641	same					10 gran
2642	ls	Pk	70	cream, very fine to fine grain, blobs of M		5 gran
2643	ls	Gr	100	cream, fine to medium grain, blobs of M, gastropod cast		5 gran
2644	ls	Gr	100	cream, fine to medium grain, some coarse grain, blobs M		10 gran
2645	ls	Gr	100	cream, fine to medium grain		10 gran
2646	ls	Pk	70	cream, fine grain, chalky matrix		chalky
				CUTTINGS		
2647-63	ls	Gr	100	white, fine grain		10 gran
2663-65	ls	Pk	70	cream, very fine grain		chalky
2665-71	ls/d	Gr	100	cream, fine dol crystal inclusions		--
2671-85	ls	Gr	100	cream, fine grain		5 gran
2685-95	same					10 gran
2695-700	same				Dg	5 gran
2700-14	ls	Gr	100	cream, fine grain		5 gran
2714-16	ls/d	M		cream, brown fine dol crystal inclusions & black dol crystal inclusions		--
2716-18	dol/c	E		gray/brown, very fine crystalline, white ls inclusions		--
2718-20	dol/c	E		orange/tan, fine crystalline, tr white ls inclusions		--
2720-22	ls/d	M		white, very fine dol crystal inclusions		==
2722-28	ls	Gr	100	cream, very fine to fine grain		chalky
2728-30	ls	Gr	100	orange/tan, medium to coarse grain, cemented		--
2730-32	ls	Gr	100	light gray, fine grain	C	5 gran

DEP 44-3	Well	Location	County	Page 23

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
2732-34	ls	Gr	100	gray, fine grain, miliolids		10 gran
2734-36	ls	Wk	40	gray, fine grain, dense		--
2736-38	ls	Pk	70	tan, fine to medium grain		tr mold
2738-40	ls	Gr	100	cream, medium grain		15 gran
2740-43	ls	M		dark gray mottled with tan, dense		--
2743-45	ls	Pk	70	cream, very fine grain		chalky
2745-55	ls	M		dark gray mottled with tan, dense		--
2755-60	ls/d	M		light gray, chalky with lumps dol E, orange/brown, fine crystalline		chalky
2760-83	ls	M		dark gray & orange/tan, lithographic		--
(2790-95	note: on Gr log the high reading is caused in other wells by a bright green waxy clay (?) or shale (?). In this well as in many others, none of this material was recovered.)					
2783-92	ls	Gr	100	cream, fine grain		10 gran
2792-94	ls	Wk	20	light gray, very fine grain		--
2794-98	ls	M		mottled gray, cream & dark gray, dense		--
2798-815	ls	Pk	70	cream, fine grain		5 gran
2815-25	ls	Gr	100	light gray, fine grain		5 gran
2825-30	ls	Gr	100	cream, very fine grain		5 gran
2830-40	ls	Pk	70	cream, very fine grain, chalky matrix		chalky
2840-45	ls	Gr	100	cream, very fine grain		5 gran
2845-50	ls	Gr	100	cream, fine to medium grain		10 gran
2850-60	ls	Gr	100	cream, fine grain		10 gran
2860-65	same					5 gran
2865-70	ls	Gr	100	light gray, very fine grain		5 gran
2870-80	ls	Gr	100	cream, fine grain		5 gran
2880-97	ls	Gr	100	cream, fine grain		10 gran

DEP 44-3	Well	Location	County	Page 24

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
2897-905	ls	M		cream, microgranular		chalky
2905-15	ls	Gr	100	tan, very fine grain		5 gran
2915-25	ls	Gr	100	cream, fine grain		5 gran
2925-29	ls	Wk	50	light gray, fine grain, chalky matrix		chalky
2929-35	ls	M		light gray, chalky		chalky
				CORE 21 2935-40 rec 5 feet		
2935	ls	M		cream, chalky		chalky
2936	same					chalky
2937	same					chalky
2938	same					chalky
2939	same					chalky
				CUTTINGS		
2940-45	same					chalky
2945-50	ls	Gr	100	cream & light gray, very fine grain		chalky
2950-63	ls	Pk	70	cream & gray, very fine grain		5 gran
				CORE 22 2963-77.3 rec 14 feet		
2963	ls	M		cream, microgranular		chalky
2964	ls	M		chalky		chalky
2965	same					chalky
2966	ls	M		cream, microgranular		chalky
2967	ls	Pk	70	cream, very fine grain		5 gran
2968	ls	M		cream, chalky		chalky
2969	same					chalky
2970	same					chalky
2971	ls	Pk	70	cream, fine grain, chalky matrix		chalky
2972	ls	Wk	50	cream, very fine grain, chalky matrix		chalky
2973	same					chalky

DEP 44-3	Well				Location	County	Page 25
Depth	Comp.	Cls.	%Gr	Description		etc.	%por/type
2974	ls	M		cream			chalky
2975	ls	Wk	60	cream, very fine to fine grain			chalky
2976	ls	Pk	70	cream, very fine grain			5 gran
				CUTTINGS			
2977-78	same						5 gran
2978-80	ls	Pk	70	cream, very fine grain			chalky
2980-85	ls	Gr	100	cream, fine grain			5 gran
2985-95	no sample						
2995-3000	mostly cement - some ls as above, some ls, M, white, chalky						
3000-03	ls	Gr	100	cream, fine grain			10 gram
3000-06	dol/c	E		gray, coarse crystalline, white ls matrix			--
3006-08	dol	A		tan mottled with gray			--
3008-13	dol	C		orange/tan			--
3013-15	ls/d	M		light gray, medium dol crystal inclusions			--
3015-23	ls	Gr	100	cream, fine grain			5 gran
3023-32	ls	Wk	60	white, fine grain, chalky matrix			chalky
3032-35	dol/c	E		gray, medium to coarse crystalline, white ls matrix			--
3035-37	dol/c	E		orange/tan, medium crystalline, white ls matrix			--
3037-40	dol	E		gray, fine to medium crystalline			5 vug
3040-42	same			fracture linings of coarse crystalline dol			5 vug
3042-47	dol	A		brown			--
3047-50	dol	C		tan and white, lithographic, clear tan very fine to fine grain dol inclusions; conchoidal fracture			--
3050-55	dol	A		gray/tan & gray			--
3055-58	dol/c	E		tan & light gray, fine to medium crystalline, white ls matrix			--

DEP 44-3	Well				Location	County		Page 26

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
3058-62	ls/d	M		white, fine to medium dol crystal inclusions		chalky
3062-68	dol/c	E		light gray, medium crystalline, white ls matrix		5 xln ?
3068-70	dol	A		light gray		--
3070-75	dol/c	E		tan, coarse crystalline, white ls matrix		--
3075-90	ls	M		white, vague skeletal texture		chalky
				DELRAY DOLOMITE		
3090-95	dol	E		light gray, fine crystalline		--
3095-3107	dol	E		tan, fine crystalline		--
3107-10	dol	C		cream, relic skeletal & miliolid grains		--
3110-12	dol	E		brown, fine crystalline		--
3112-19	dol	C		cream		--
3119-20	dol	Gr	100	cream, vague texture		5 xln&pp
3120-30	dol	E		cream, fine crystalline in brown matrix		--
3130-40	dol	A		orange/tan		--
3140-55	dol	C		cream & tan, lithographic, conchoidal fracture		--
3155-60	dol	A		orange/brown		--
3160-70	same			with fine crystalline dol fracture linings		--
3170-77	dol	E		light gray, fine microcrystalline		--
3177-80	dol	A		tan		--
3180-90	same					trace vug
3190-95	dol	A		cream & tan		--
3195-98	dol	A		orange/tan		--
3198-203	dol	C		cream, relic skeletal texture, medium crystalline dol fracture linings		--
3203-04	dol	A		light gray & orange/tan		--
3204-07	dol	E		light gray, fine microcrystalline		--

DEP 44-3	Well	Location	County	Page27

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
3207-12	dol	A		tan, coarse crystalline dol fracture & vug linings		tr vug
3212-15	dol	C		cream, lithographic, fine to medium grain clear dol inclusions, conchoidal fracture	/	--
3215-18	dol	A		gray/brown		--
3218-20	dol	E		orange/brown, fine to coarse crystalline		--
3220-23	dol	E		orange/brown, microcrystalline		--
3223-30	dol	Gr	100	orange/tan, fine to medium grain relic skeletal texture with white dol matrix		--
3230-32	dol	A		orange/tan		--
3232-34	dol	C		orange/tan, lithographic, conchoidal fracture		--
3234-38	dol	C		light gray, lithographic, conchoidal fracture, inclusions brown, fine to medium crystalline dol with appearance of one replacing the other; brown dol fine fracture filling & fine to medium grain brown dol includions		tr vug
3238-40	dol	E		light gray, very fine to fine crystalline		tr pp
3240-41	dol	E		tan varved with brown, fine microcrystalline		--
3241-51	dol	C		tan, some lithographic, clear fine grain dol inclusions		--
3251-53	dol	C		orange surface stain		--
3253-55	dol	C		light gray, medium to very coarse angular debris cemented with darker dol		--
3255-57	dol	C		white, vague relic skeletal texture, lithographic, conchoidal fracture		
3257-66	dol	A		orange/tan & orange/brown		--
3266-70	dol	C		light gray, relic skeletal texture		--
3270-75	dol	A		tan & orange/brown		--
3275-80	dol	C		white, lithographic, conchoidal fracture		--
3280-83	dol	C		light gray		--
3283-97	dol	A		orange/tan & tan		--

DEP 44-3	Well	Location	County	Page 28

Depth	Comp.	Cls.	%Gr	Description	etc.	%por/type
3297-305	dol	C		light gray, fine crystalline dol vug linings		tr vug
3305-07	dol	C		tan & cream, relic skeletal texture		--
3307-09	dol	C		tan, fine grain pellets		tr pp
3309-11	dol	C		light gray, lithographic, conchoidal fracture		--
3311-16	dol	C		orange/tan, lithographic, fine grain clear dol inclusions, conchoidal fracture		--
3316-18	dol	A		gray/brown & orange/tan		--
3318-20	dol	E		gray/tan, very fine crystalline		--
3320-26	dol	C		tan & orange/tan		--
3326-28	dol	C		orange/tan, relic skeletal texture		--
				CEDAR KEYS A		
3328-30	dol	C		gray, gray/brown & dark gray, relic sksletal texture		--
3330-32	dol	A		dark gray with inclusions light gray, some black		--
3332-35	dol	A		gray/brown & orange/brown		--
3335-43	dol	C		cream & orange/tan, lithographic, inclusions orange/tan dol & fine crystalline vug linings		tr vug
3343-46	dol	A		gray & gray/ brown		--
3346-50	dol	A		orange/tan		--
TD						

ATTACHMENT B

Special Core Analyses Study
(Core Laboratory Results)

Ardaman & Associates, Inc.

Geotechnical, Environmental and Materials Consultants

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CAMP DRESSER & McKEE INC. FT. LAUDERDALE, FL

RECEIVED JUL 1995

June 29, 1995
File Number 95-091

CDM/SFAO CONST. NRR

1	WAP	ACTION	✓
2		COMMENTS	
3		APPROVAL	
CORR.	✓	CALL ME	
FIELD	✓	SEE ME	
C.C.		F.Y.I.	
P.E.		..ITEM	
S.D.			

Youngquist Brothers, Inc.
15465 Pine Ridge Road
Fort Myers, Florida 33908

Attention: Mr. Bob Henshaw

Subject: Laboratory Test Results on Rock Core Specimens, Sunrise Deep Injection Well No. 3

Gentlemen:

Permeability, unconfined compression and specific gravity tests have been completed on 22 rock core samples provided by your firm from the Sunrise Deep Injection Well No. 3. The permeability tests were performed in general accordance with ASTM Standard D 5084 "Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible-Wall Permeameter". The unconfined compression tests were performed in general accordance with ASTM Standard D 2938 "Unconfined Compressive Strength of Intact Rock Core Specimens". The specific gravity was determined in general accordance with ASTM Standard D 854 "Specific Gravity of Soils".

If you have any questions or require any additional testing services, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Thomas S. Ingra

Thomas S. Ingra, P.E.
Senior Project Engineer
Florida Registration No. 31987

cc: Camp Dresser & McKee, Inc.
Will Pulsford

TSI/jcw

Table 1

PERMEABILITY TEST RESULTS
SUNRISE DEEP INJECTION WELL NO. 3

Sample Depth (feet)	G_s	Initial Conditions: Length (cm)	Initial Conditions: Diameter (cm)	Initial Conditions: w_c (%)	Initial Conditions: γ_d (lb/ft^3)	Initial Conditions: n	$\bar{\sigma}_c$ (lb/in^2)	u_b (lb/in^2)	B-factor	Range of Hydraulic Gradient	Final Conditions: w_c (%)	Final Conditions: γ_d (lb/ft^3)	Final Conditions: S (%)	Vertical Coefficient of Permeability (cm/sec)
1591.5	2.71	3.87	5.02	16.2	105.6	0.38	10	179	98	13 - 46	21.1†	106.6	98	5.6×10^{-6}
1695.6	2.70	10.22	5.11	9.3	102.1	0.39	10	179	96	12 - 15	22.0†	101.9	91	2.6×10^{-4}
1766.2	2.70	10.53	5.09	10.0	102.7	0.39	10	179	63*	5 - 15	19.5†	103.0	83	6.6×10^{-6}
1801.5	2.71	10.10	5.10	8.9	102.0	0.40	10	179	100	5 - 15	20.2†	102.0	83	1.8×10^{-5}
1836.3	2.70	9.80	5.12	10.2	101.2	0.40	10 10	89 179	38* 68	14 - 16 10 - 31	19.4†	102.6	82	4.0×10^{-5} 4.3×10^{-5}
1873.8	2.72	10.30	5.08	15.4	99.9	0.41	10 10	91 179	-- 99	1 - 2 2 - 10	22.6†	100.5	89	1.7×10^{-3} 1.6×10^{-3}
1904.1	2.72	10.29	5.08	13.5	97.3	0.43	11 10	89 179	-- 64	1 - 2 1 - 12	24.3†	97.5	89	4.4×10^{-4} 5.8×10^{-4}
1944.1	2.73	9.71	5.04	15.8	100.9	0.41	10	179	97	2 - 8	21.3†	100.4	83	3.2×10^{-3}
1981.0	2.71	10.36	5.08	12.2	104.5	0.38	10	179	98	1 - 8	20.8†	104.5	91	2.1×10^{-3}
2005.4	2.72	10.09	5.06	11.5	105.5	0.38	10	179	95	2 - 14	19.2†	104.4	83	9.1×10^{-4}
2046.6	2.70	9.60	5.08	11.3	109.4	0.35	10	178	96	4 - 33	19.2	109.0	95	8.4×10^{-7}
2071.8	2.74	10.05	5.07	15.9	97.1	0.43	10	179	96	10 - 12	25.8†	96.6	92	1.4×10^{-3}
2132.0	2.73	10.14	5.06	12.2	105.5	0.38	10	179	89*	8 - 18	20.7†	104.2	89	2.3×10^{-4}
2212.0	2.70	10.69	5.10	12.9	104.1	0.38	10	179	96	7 - 13	20.8†	104.9	93	1.5×10^{-3}
2245.6	2.72	9.86	5.08	15.3	103.1	0.39	10	179	97*	10 - 20	21.8†	103.4	92	2.0×10^{-4}
2275.9	2.86	10.08	5.10	0.3	168.9	0.05	10	175	98	10 - 70	0.8†	168.6	39	1.7×10^{-8}
2379.5	2.75	7.30	5.11	5.3	124.4	0.28	10	179	100	19 - 35	11.7†	124.5	85	3.4×10^{-5}
2447.5	2.85	9.95	5.09	1.3	166.2	0.07	10	175	96*	39 - 72	2.0	165.9	79	4.9×10^{-9}
2502.2	2.75	10.11	5.11	2.8	134.7	0.22	10	178	85*	7 - 27	7.5†	134.3	74	2.6×10^{-6}
2638.7	2.71	10.12	5.10	4.8	133.4	0.21	10	179	93*	4 - 23	7.9†	132.4	77	3.6×10^{-5}
2936.7	2.72	9.66	5.11	8.9	114.4	0.33	10	179	83*	6 - 20	14.7†	115.3	85	4.2×10^{-5}
2970.8	2.72	9.38	5.12	9.7	112.9	0.33	10	179	100	5 - 38	16.6†	114.2	93	2.0×10^{-5}

Where: w_c = Moisture content; γ_d = Dry density; n = Porosity calculated from equation: $n = 1 - (\gamma_d / G_s \gamma_w)$ where G_s = Specific gravity and γ_w = Unit weight of water; $\bar{\sigma}_c$ = Average isotropic effective confining stress; u_b = Backpressure; and S = Calculated degree of saturation.

* B-factor remained relatively constant for two consecutive increments of applied cell pressure.

† Final moisture content measured and corresponding degree of saturation calculated after performing unconfined compression test on the permeability test specimen.

1-95091.T01

Table 2

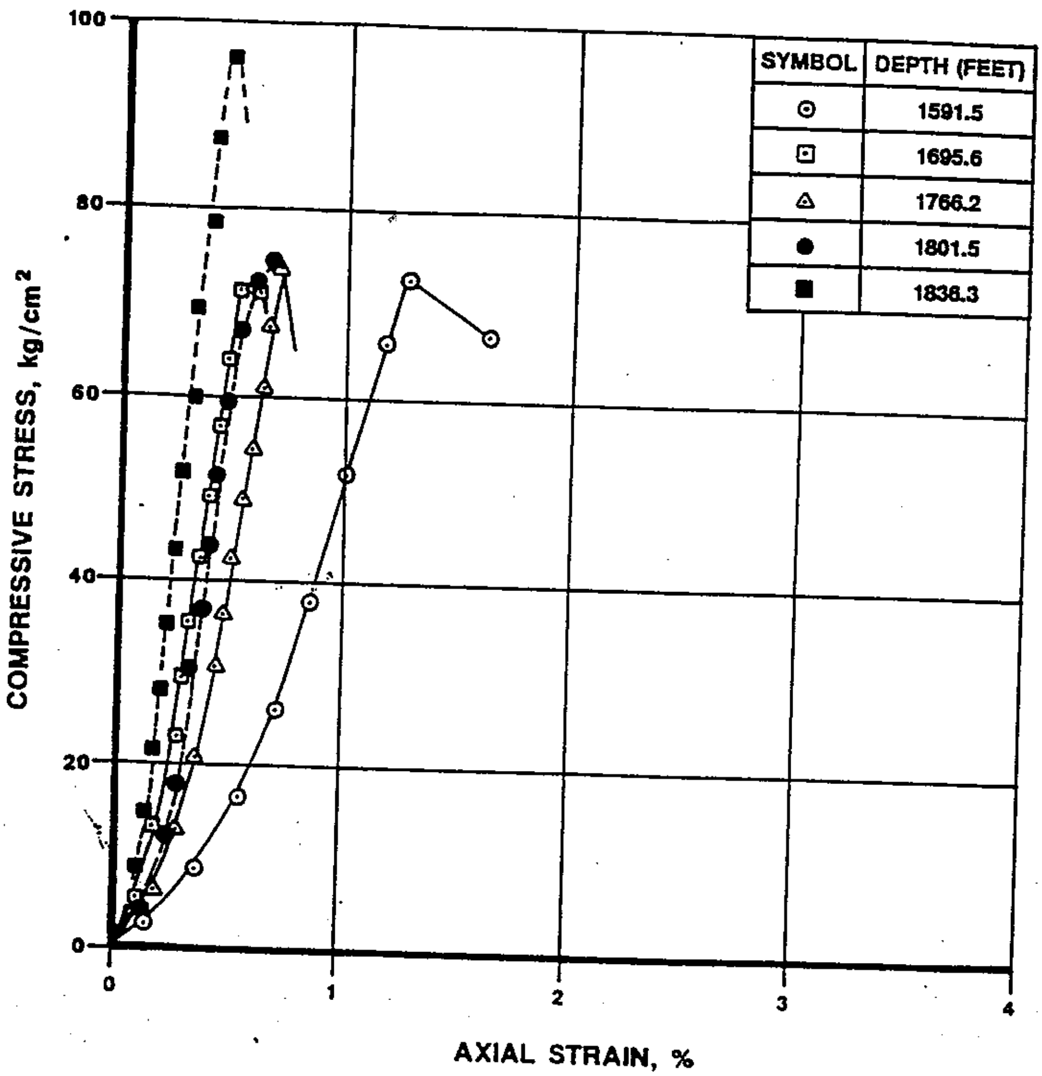
UNCONFINED COMPRESSION TEST RESULTS
SUNRISE DEEP INJECTION WELL NO. 3

Sample Depth (feet)	Specimen Dimensions			w_c (%)	γ_d (lb/ft³)	Loading Rate (cm/min)	Unconfined Compressive Strength (lb/in²)	Young's Modulus (lb/in²)††
	Length L (cm)	Diameter D (cm)	L/D					
1591.5	3.80	5.04	0.75	21.1*	106.6	0.025	1045†	$1.2x10^5$
1695.6	10.22	5.11	2.00	22.0*	101.9	0.025	1015	$2.6x10^5$
1766.2	10.54	5.08	2.07	19.5*	103.0	0.025	1051	$2.3x10^5$
1801.5	10.12	5.10	1.98	20.2*	102.0	0.025	1049	$2.7x10^5$
1836.3	9.77	5.09	1.92	19.4*	102.6	0.025	1376	$3.5x10^5$
1873.8	10.29	5.06	2.03	22.6*	100.5	0.025	753	$3.6x10^5$
1904.1	10.29	5.07	2.03	24.3*	97.5	0.025	827	$4.3x10^5$
1944.1	9.73	5.05	1.93	21.3*	100.4	0.025	1002	$3.5x10^5$
1981.0	10.38	5.08	2.04	20.8*	104.5	0.025	1190	$4.5x10^5$
2005.4	10.61 10.05	5.06 5.09	2.10 1.97	14.7 19.2*	102.7 104.4	0.025 0.025	1282 1128	$4.4x10^5$ $4.2x10^5$
2046.6	10.11	5.09	1.99	9.2	110.5	0.025	1958	$4.2x10^5$
2071.8	10.08	5.08	1.98	25.8*	96.6	0.025	977	$4.7x10^5$
2132.0	10.13	5.09	1.99	20.7*	104.2	0.025	1182	$4.4x10^5$
2212.0	10.68	5.08	2.10	20.8*	104.9	0.025	1437	$4.4x10^5$
2245.6	9.84	5.07	1.94	21.8*	103.4	0.025	1198	$3.5x10^5$
2275.9	10.09	5.10	1.98	0.8*	168.6	0.025	11,420	$8.1x10^5$
2379.5	7.32	5.10	1.44	11.7*	124.5	0.025	1913†	$2.3x10^5$
2447.5	10.18	5.10	2.00	1.2	164.5	0.025	10,912	$8.1x10^5$
2502.2	10.12	5.11	1.98	7.5*	134.3	0.025	3357	$4.7x10^5$
2638.7	10.21	5.09	2.00	7.9*	132.4	0.025	3373	$6.2x10^5$
2936.7	9.63	5.09	1.89	14.7*	115.3	0.025	2402	$4.1x10^5$
2970.8	9.35	5.10	1.88	16.6*	114.2	0.025	1750	$3.4x10^5$

Where: w_c = Moisture content and γ_d = Dry density.

* Moisture content measured after performing permeability test on the specimen.
† Computed compressive strength corrected for L/D = 2 equals 872 lb/in² for sample from 1591.5 feet and 1827 lb/in² for sample from 2379.5 feet.
†† Young's modulus calculated from the slope of the straight-line portion of the stress-strain curve.

1-95091.T01



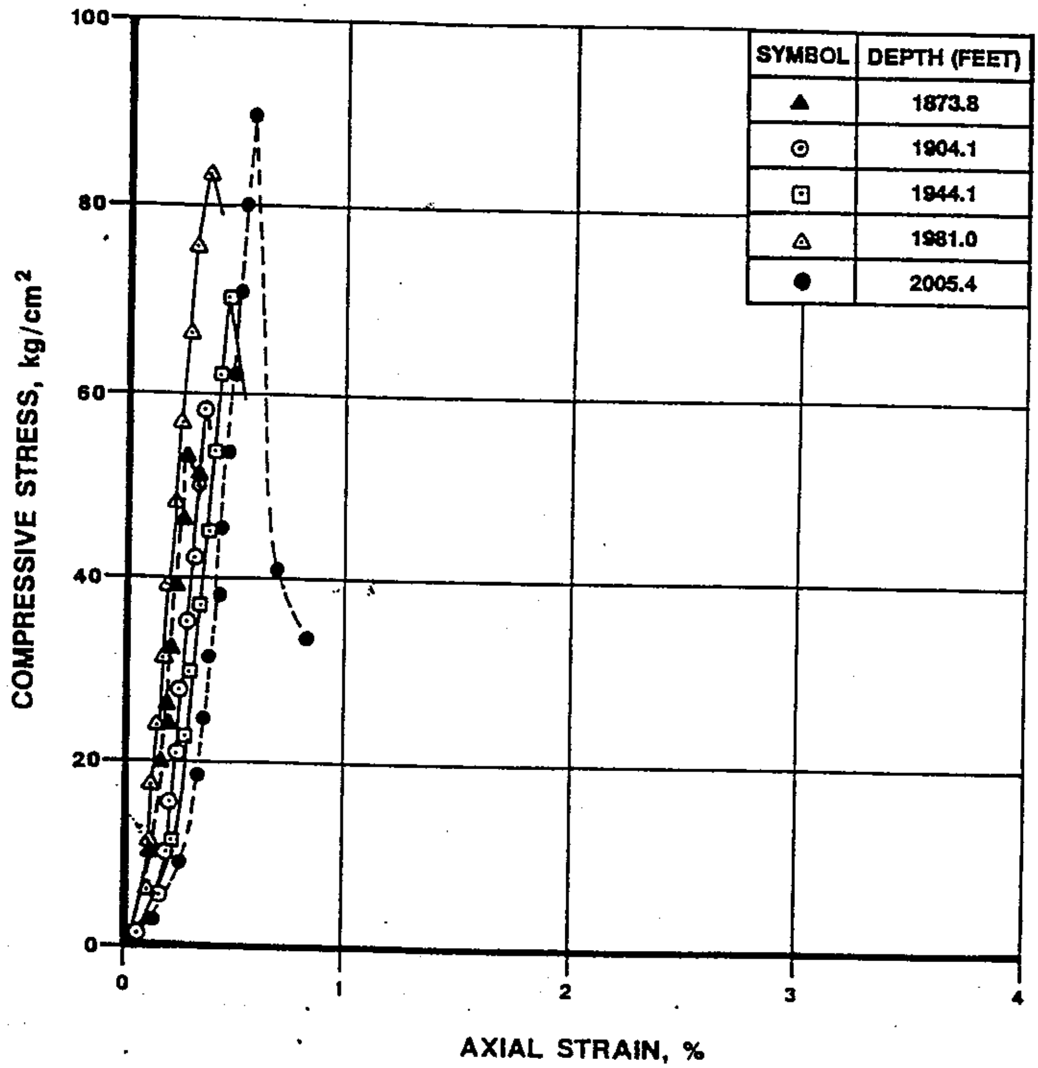
UNCONFINED COMPRESSION TEST RESULTS

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUNRISE DEEP INJECTION
WELL NO. 3
YOUNGQUIST BROTHERS, INC.

DRAWN BY SEF	CHECKED BY	DATE 06/27/95
FILE NO. 95-091	APPROVED BY	FIGURE 1

N22684



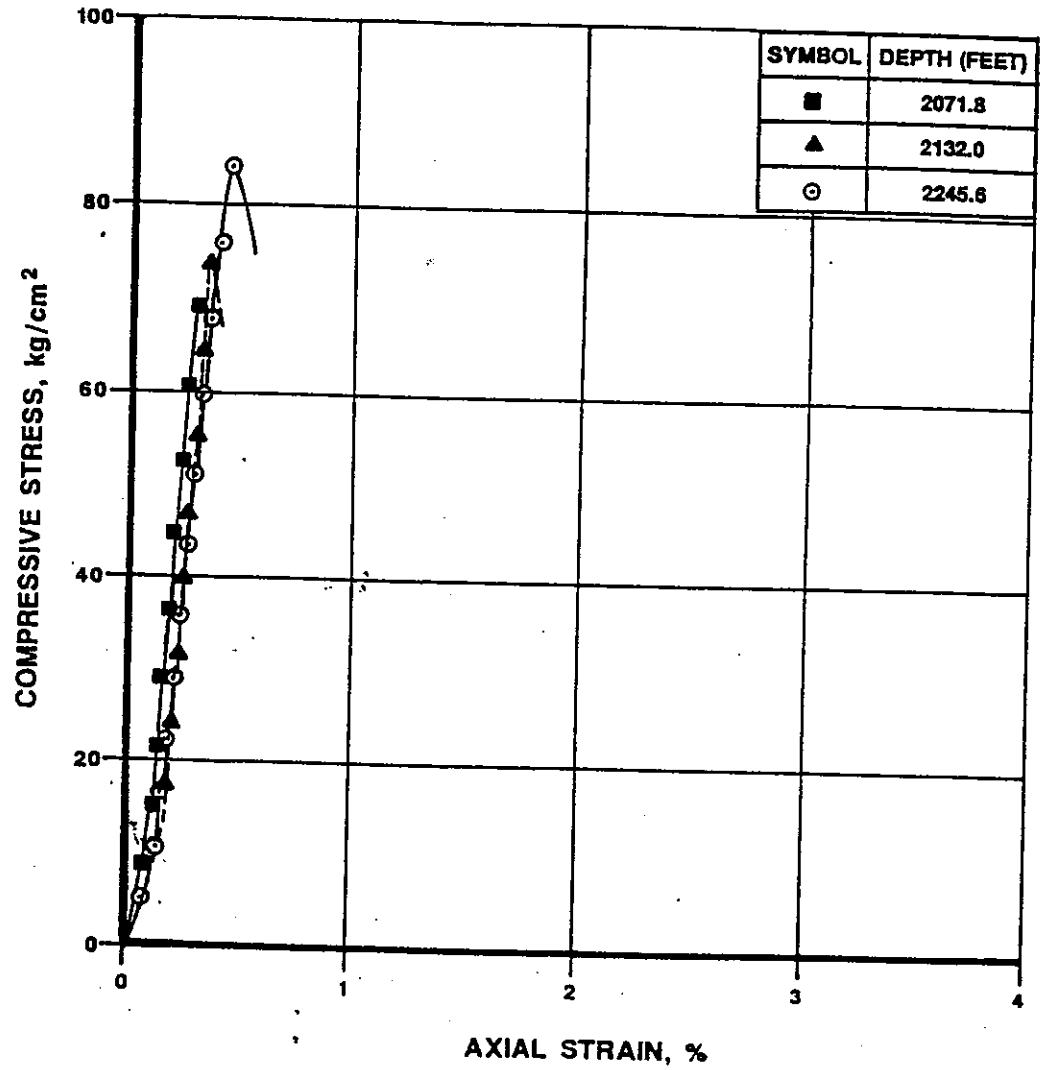
UNCONFINED COMPRESSION TEST RESULTS

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUNRISE DEEP INJECTION
WELL NO. 3
YOUNGQUIST BROTHERS, INC.

DRAWN BY SEF	CHECKED BY	DATE 06/27/95	
FILE NO 95-091	APPROVED BY	FIGURE 2	

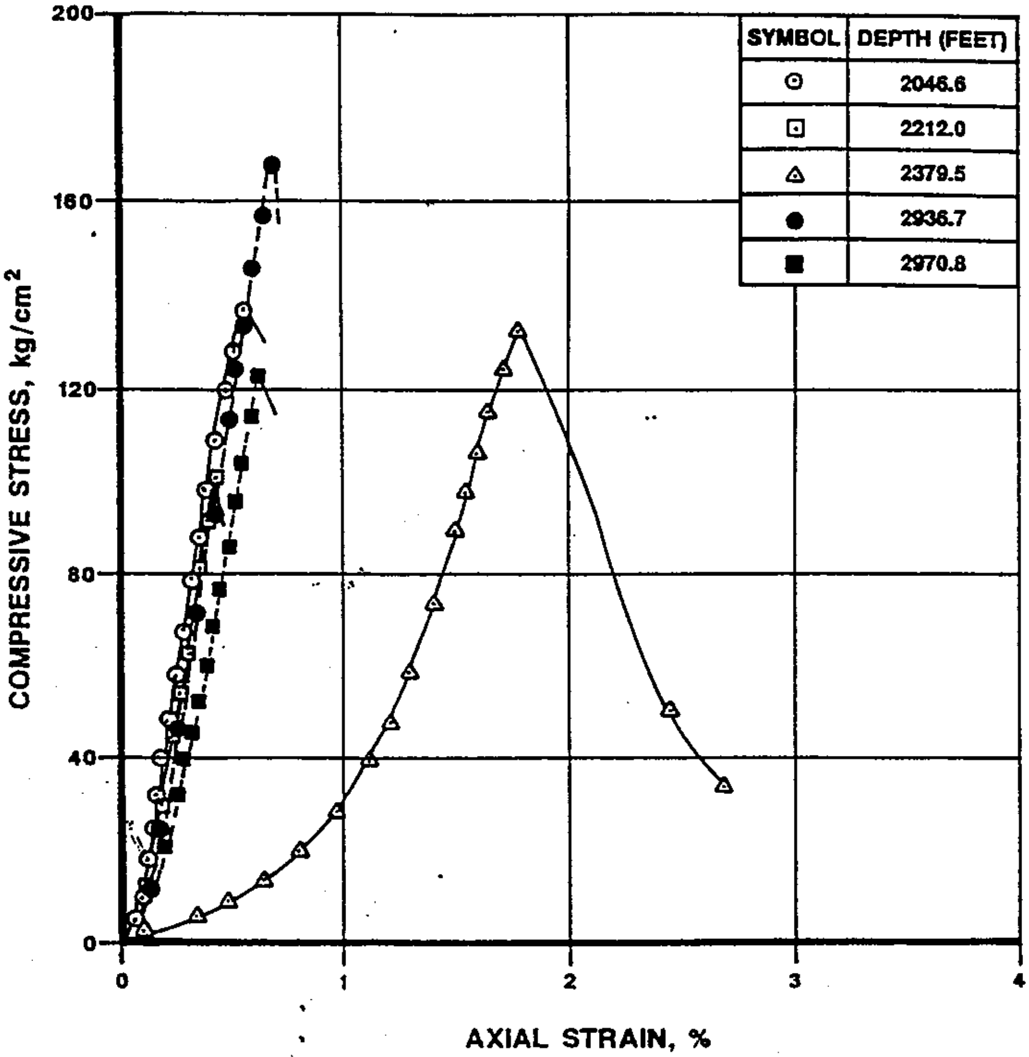
N22684



UNCONFINED COMPRESSION TEST RESULTS

Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants	
SUNRISE DEEP INJECTION WELL NO. 3 YOUNGQUIST BROTHERS, INC.	
DRAWN BY SEF	DATE 06/27/95
FILE NO. 95-091	FIGURE 3

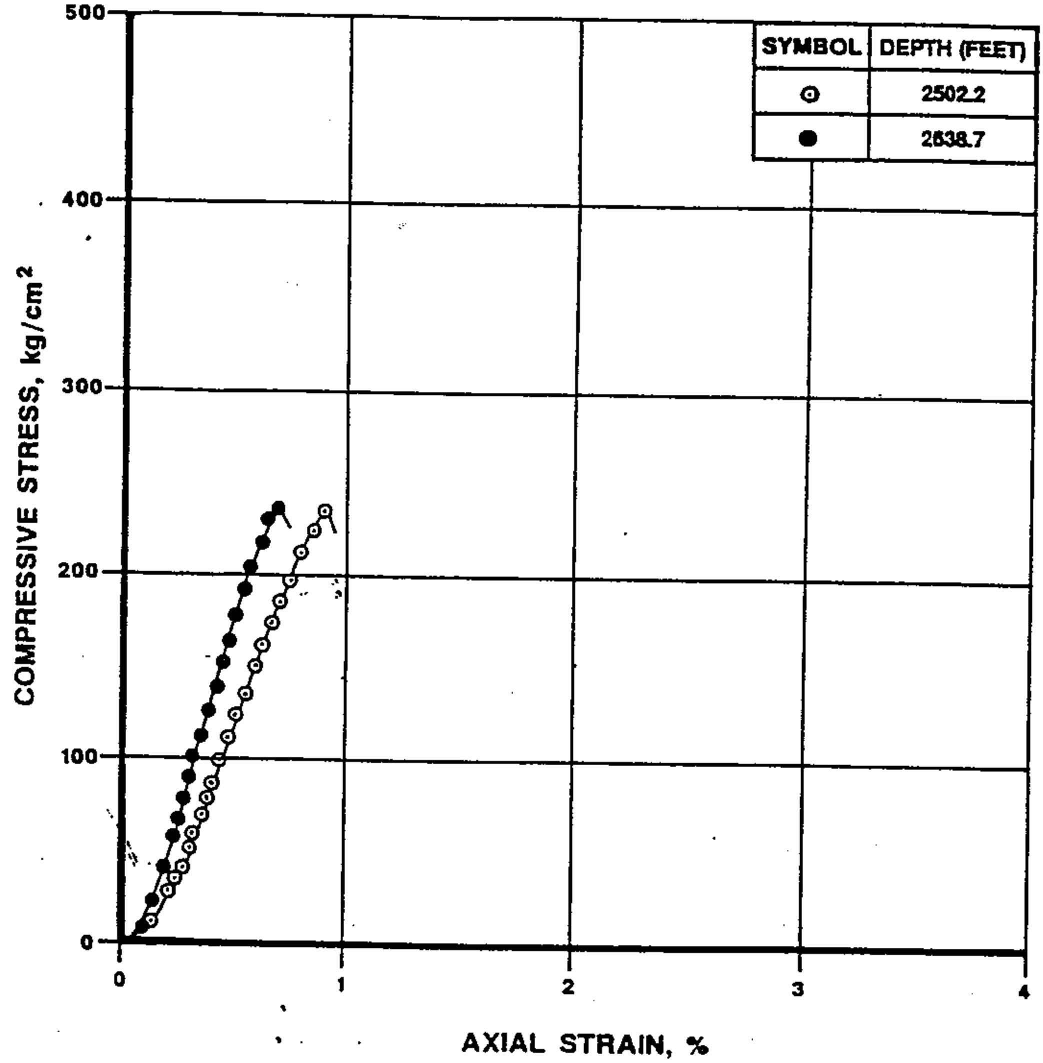
N22684



UNCONFINED COMPRESSION TEST RESULTS

Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants	
SUNRISE DEEP INJECTION WELL NO. 3 YOUNGQUIST BROTHERS, INC.	
DRAWN BY SEF	DATE 06/27/95
FILE NO. 95-091	FIGURE 4

N22684



UNCONFINED COMPRESSION TEST RESULTS

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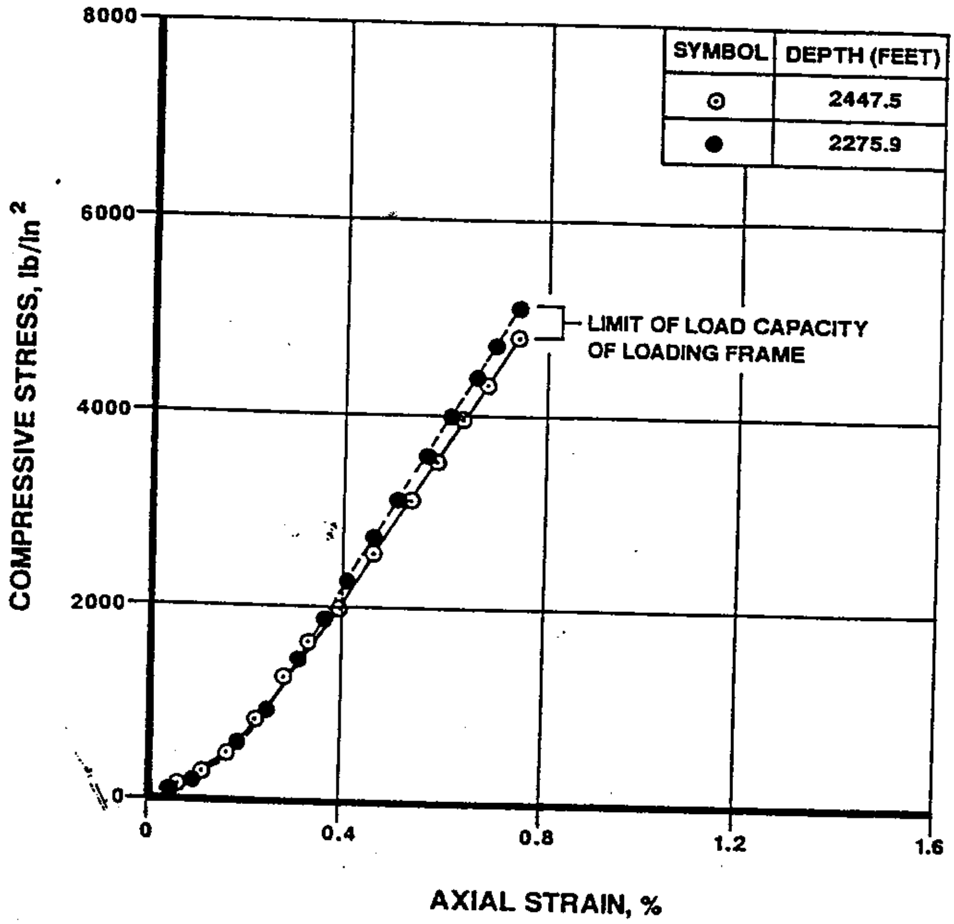
SUNRISE DEEP INJECTION
WELL NO. 3
YOUNGQUIST BROTHERS, INC.

DRAWN BY SEF	CHECKED BY	DATE 06/27/95	
FILE NO. 95-091	APPROVED BY	FIGURE 5	

N22684



UNCONFINED COMPRESSION TEST RESULTS

Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants	
SUNRISE DEEP INJECTION WELL NO. 3 YOUNGQUIST BROTHERS, INC.	
DRAWN BY: SEF CHECKED BY: [signature]	DATE: 06/27/95
FILE NO. 95-091 APPROVED BY: [signature]	FIGURE 6

N2284

ATTACHMENT C

Pilot Hole Geophysical Logs from 1,030' to 2,300' Depth

Gamma Ray
BHC Sonic (Acoustic Velocity)
VDL
Dual Induction (LL3, ILM, ILD)
SP

Attachment C of the report are the geophysical logs. Full size copies of these logs were sent to each of the TAC members last March 8 (see our letter of March 22). We are not including extra full size copies of these logs with this report because we need to save those copies for the final report. We have however duplicated at reduced scale the dual induction, the acoustic, and the gamma ray logs in Figure 5 of the report. Should any TAC member not be able to find the copies sent March 8 and if the reduced scale copy in Figure 5 is not adequate, we do have a couple of the full size copies that can be made available and still have enough copies left for the final report.