ENGINEERING REPORT
DEEP TEST/INJECTION WELL

ZEMEL ROAD LANDFILL
Charlotte County, Florida

Prepared for:

Charlotte County Solid Waste
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Engineering . Planning . Hydrogeology
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10-231.46

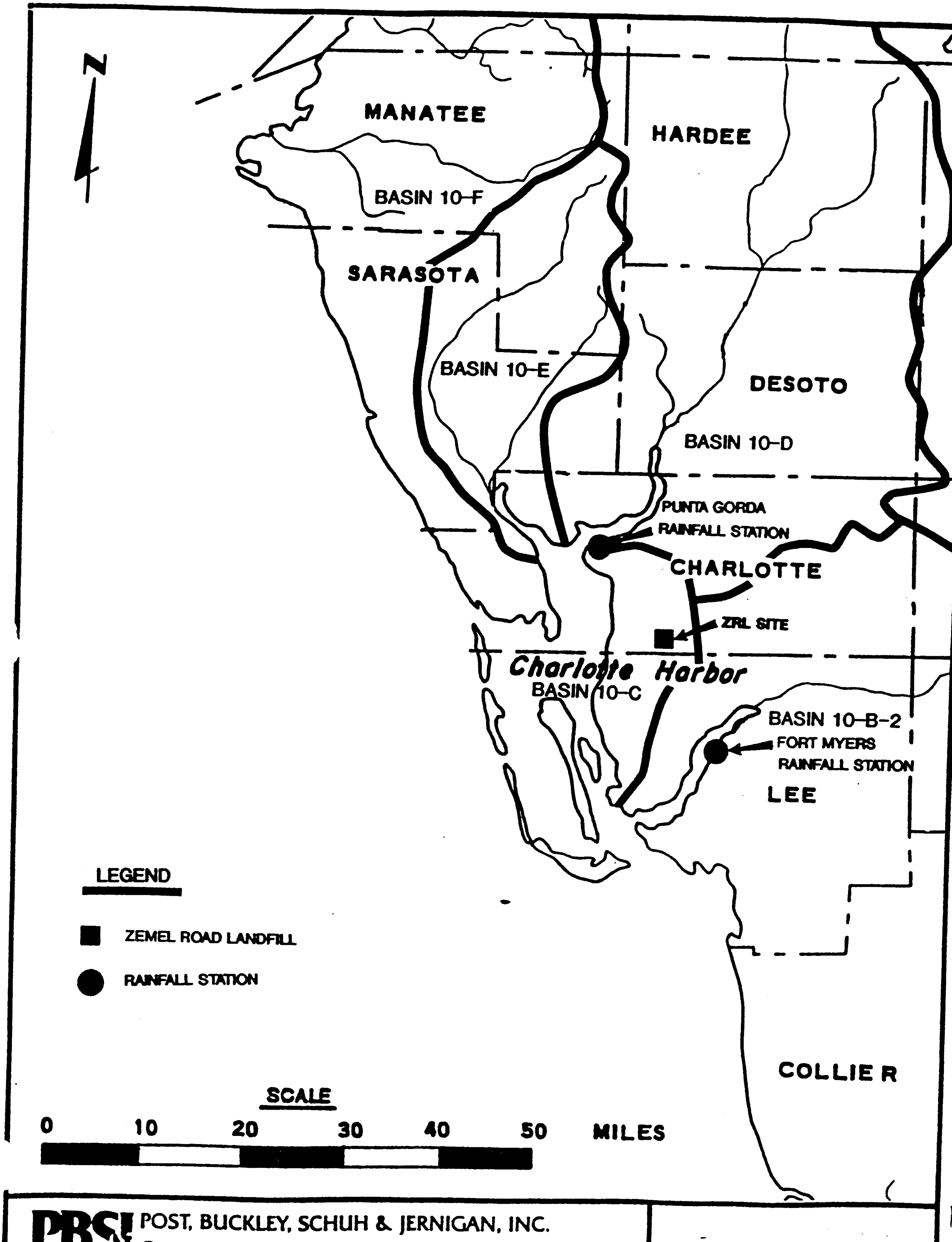
Section 1
INTRODUCTION

1.1 BACKGROUND

Charlotte County disposes of its solid waste in a sanitary landfill named the Zemel Road Landfill (ZRL) because of its location adjacent to Zemel Road in the southern part of the County. Early in 1989, the Charlotte County Board of County Commissioners approved a planned expansion of the then existing disposal area and on August 15 of that year hired Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) to design that expansion. Part of that design included developing a leachate collection system and a leachate disposal arrangement. After reviewing various disposal alternatives, it was concluded that deep well injection was the best alternative both economically and environmentally. Zemel Road Landfill is actually located within Drainage Basin 10-C (Kenner et al, 1967) (see Figure 1-1) about half a mile west of U.S. Highway 41 south of Zemel Road (see Figure 1-2). The landfill is in Section 25, Township 42 South, and Range 23 East. The landfill property includes all of Section 25 but at this time only the northeastern quarter of this section is actively used.

Deep well injection has been used by the oil industry for years in southwest Florida to inject returned brine from oil well drilling and production into deep formations. The use of this technology has been proven to be a viable disposal option in Sarasota County to the north, and in Lee County to the south. Nonetheless, to increase confidence that deep-well injection for disposal of treated leachate was feasible in this area of Charlotte County, the Charlotte County Board of County Commissioners approved construction of a deep test/injection well and testing program.

The results from the deep test/injection well and testing program are very positive and reasonably assure the existence of good overlying confinement and of an injection zone which can accept 300 gpm as proven by the twenty-four-hour injection test. With all the intensive testing completed, the DITW is ready and on line, anticipating DER approval to start operational testing using the treated leachate from the leachate treatment plant.

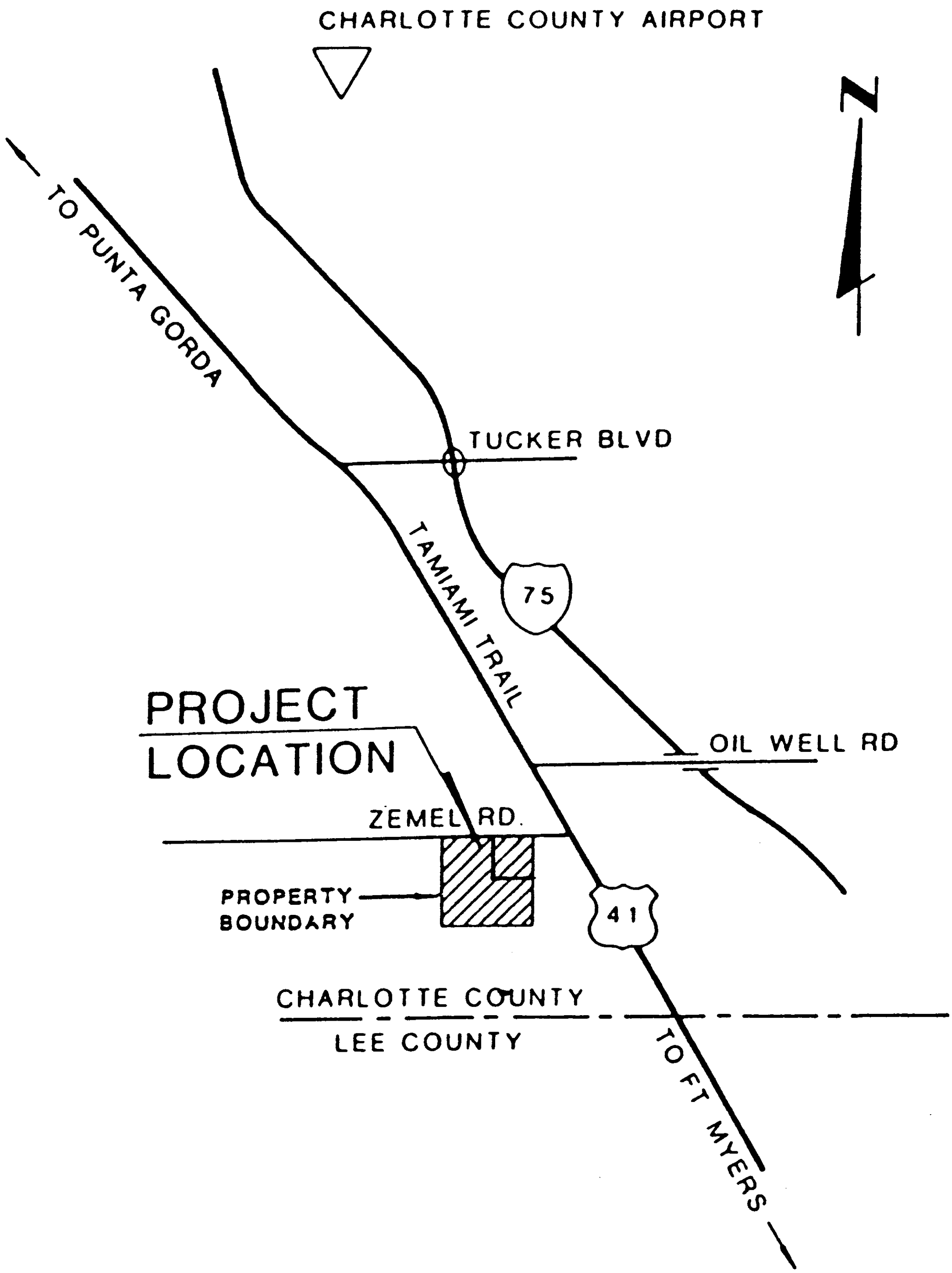


PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

GENERAL LOCATION MAP

FIGURE 1 - 1

1-3



PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

SPECIFIC LOCATION MAP

FIGURE 1 - 2

1.4 SITE DESCRIPTION

The ZRL facility occupies a site located adjacent to and south of Zemel Road in southern Charlotte County.

As shown in Figure 1-3, the existing landfill site is located in the northeastern quarter of Section 25, Township 42 South, Range 23 East. The leachate treatment plant facilities occupy the central area of the site, and the new landfill the western area (see Figure 1-3). The injection well and the monitor well are both located near the center of the site. The site contains undeveloped space to the south which will be used for future stormwater retention.

1.4.1 Topography

The immediate area of the plant site and the injection well has none of the original topographic relief and with the exception of a small undeveloped triangular area south of the plant site, the topography of this property consists totally of artificially raised land surfaces for buildings, structures, and roads.

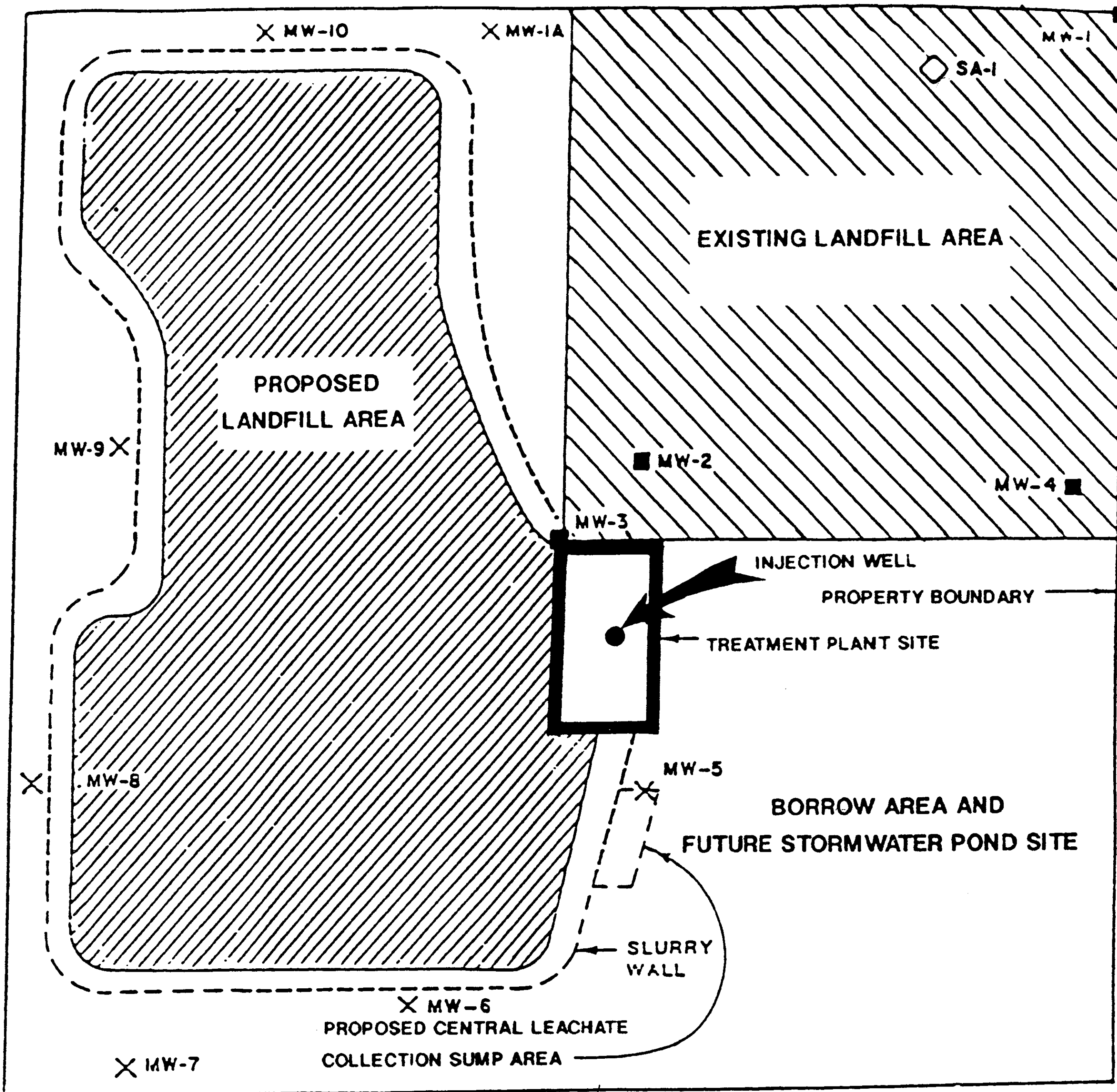
The man-made elevations range from 22 to 26 feet above mean sea level (msl) throughout the site except at the above-mentioned retention pond where the natural bottom is at 19 feet above msl. In the undeveloped area which forms the southeast corner of the property, natural elevations average 19 feet above msl. Artificially filled areas for buildings and structures are about 26 feet above msl.

Fill excavated from the lakes and drainage canals when they were constructed, was used to raise the land level to form the roads that parallel the canals.

The site lies fully within Basin 10C (Kenner, et al., 1967).

1.4.2 Soils

The soils in the area were mapped by the U.S. Department of Agriculture, Soil Conservation Service (SCS) between 1976 and 1981 and a report was issued in 1984 (SCS, 1984). The natural soils at the ZRL site consist primarily of Boca and Pineda loamy siliceous fine sandy soils (see Figure 1-4); but construction on the site has



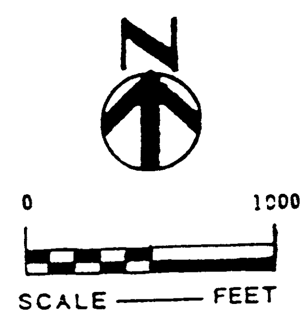
must be section 25 outline

LEGEND

■ EXISTING SURFICIAL AQUIFER WELLS

✕ PROPOSED NEW SURFICIAL AQUIFER WELLS

◇ PROPOSED SECONDARY ARTESIAN AQUIFER WELL



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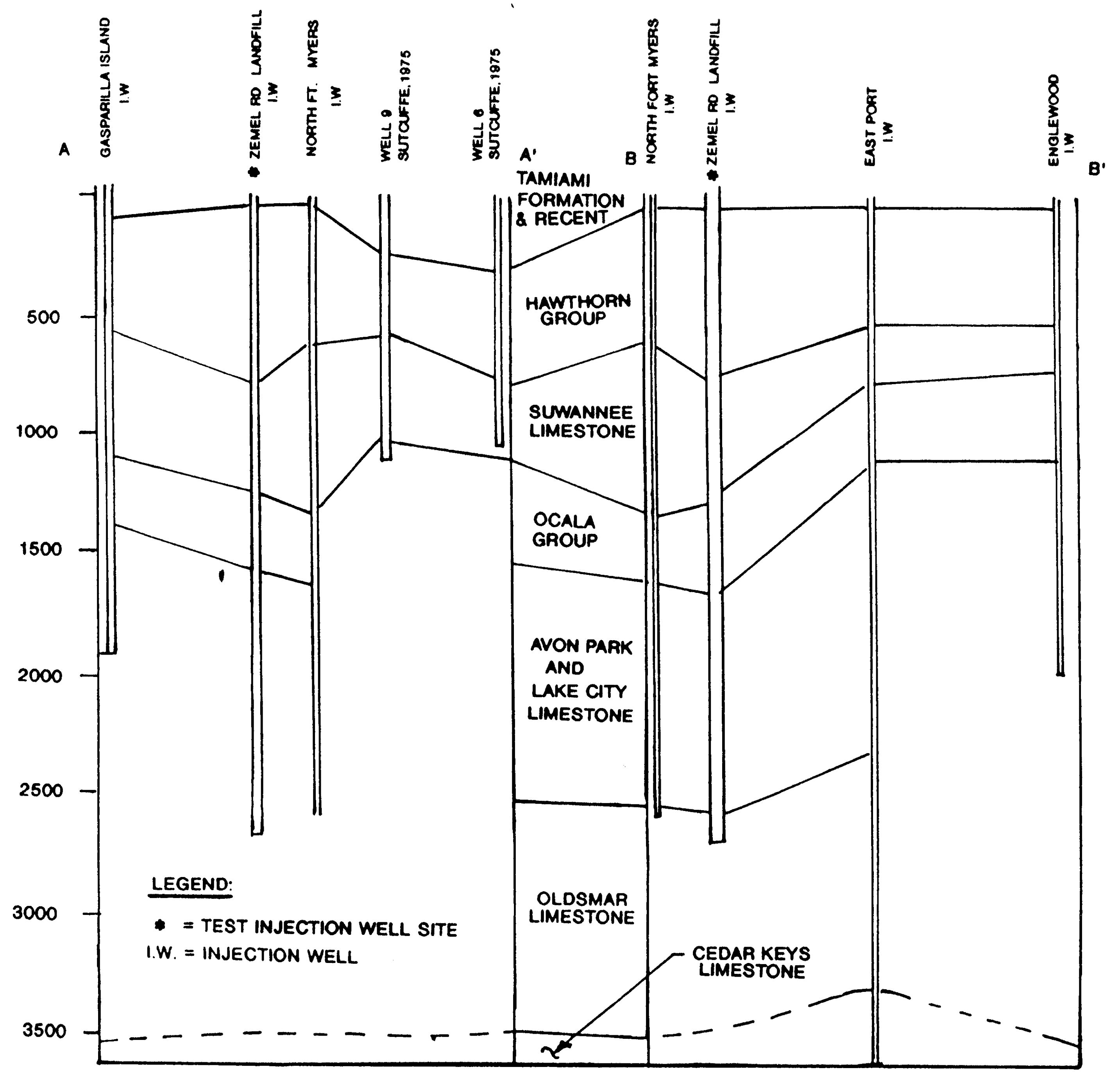
LANDFILL SITE LAYOUT

FIGURE 1 - 3



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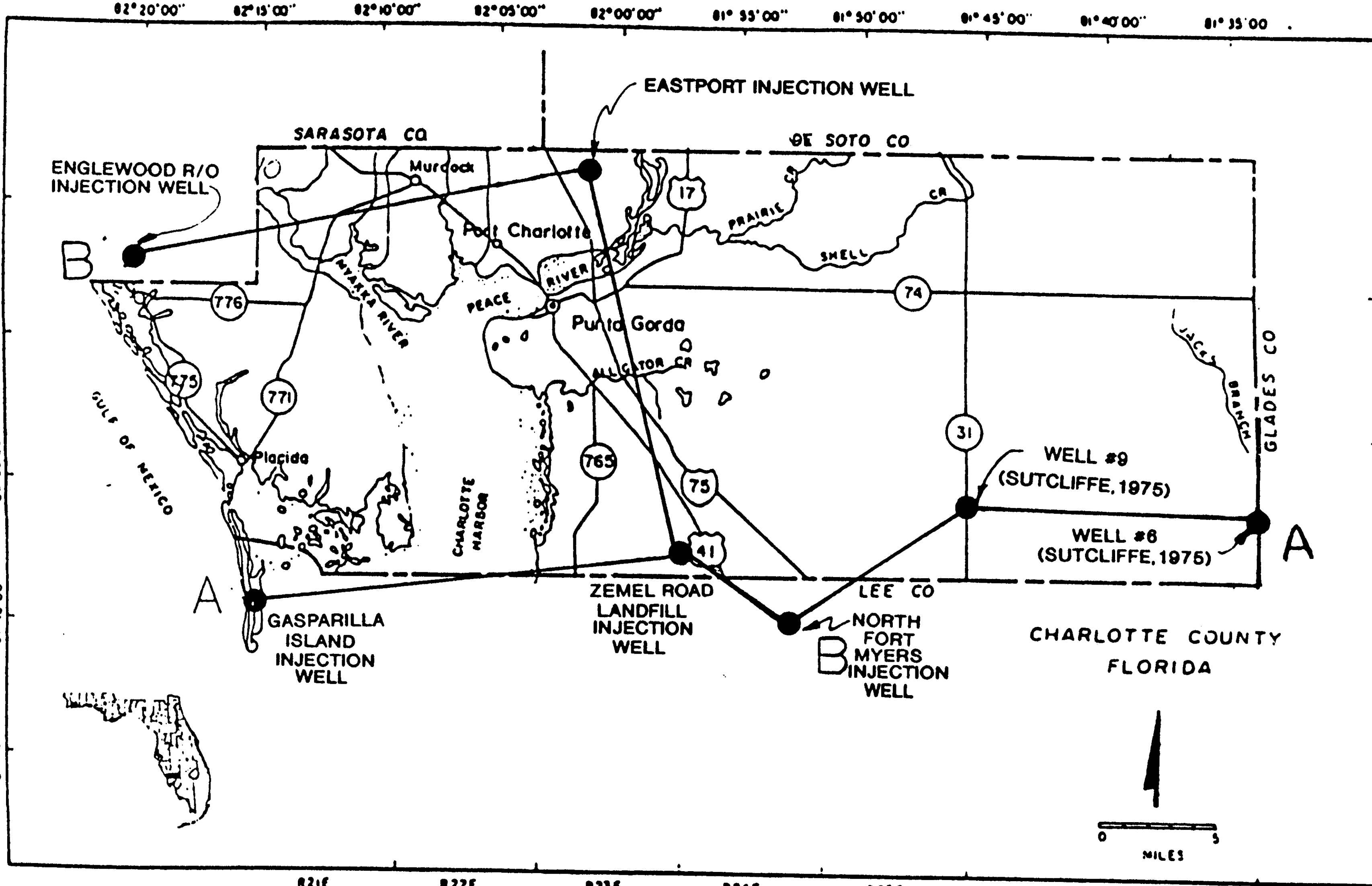
GEOLOGIC CROSS-SECTION OF THE CHARLOTTE COUNTY AREA

FIGURE 2 - 6

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

GEOLOGIC CROSS-SECTION LOCATION



● LOCATION OF DATA POINTS

FIGURE 2 - 7

2-17

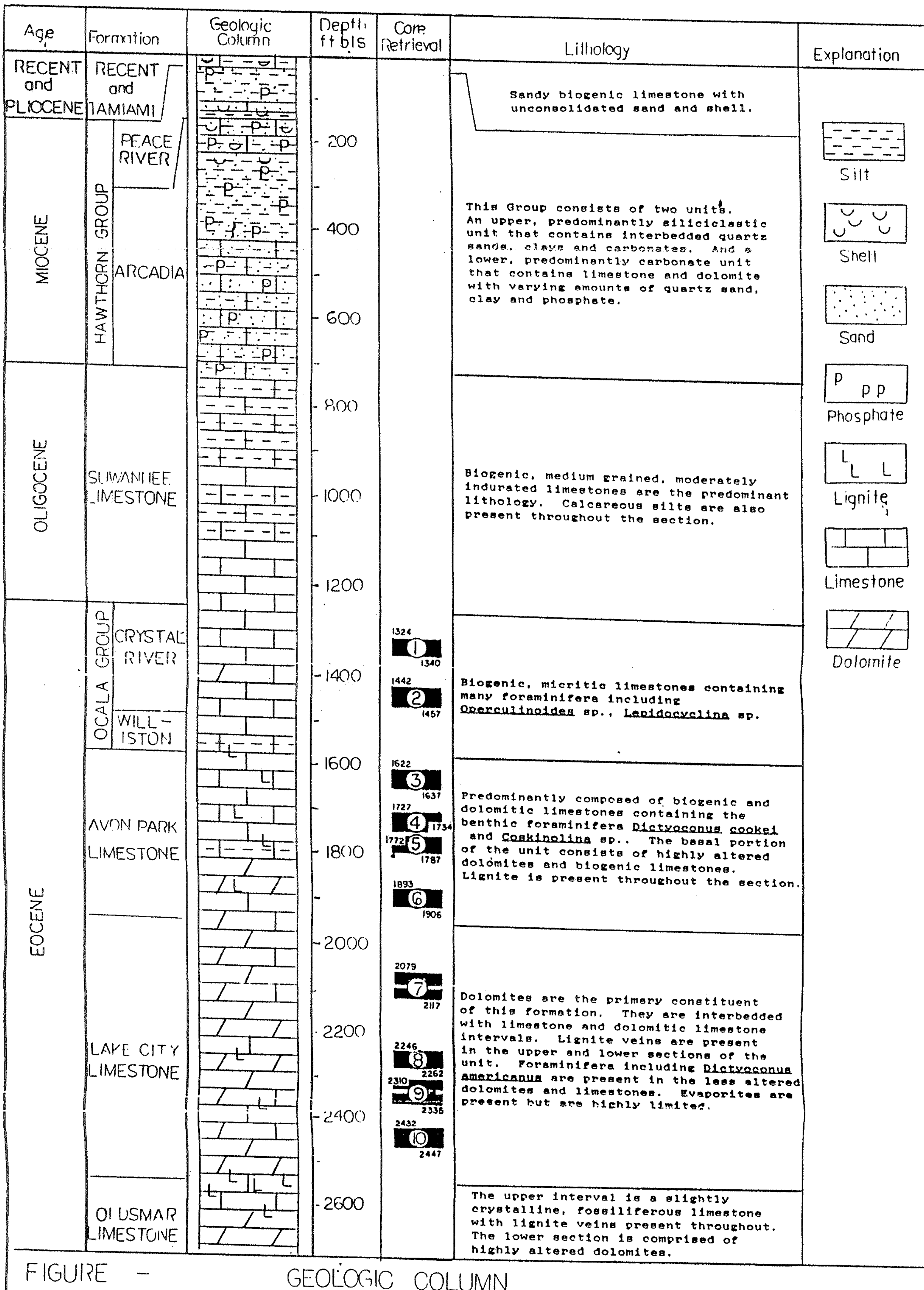


FIGURE - GEOLOGIC COLUMN

SITE GEOLOGY

FIGURE 2 - 8

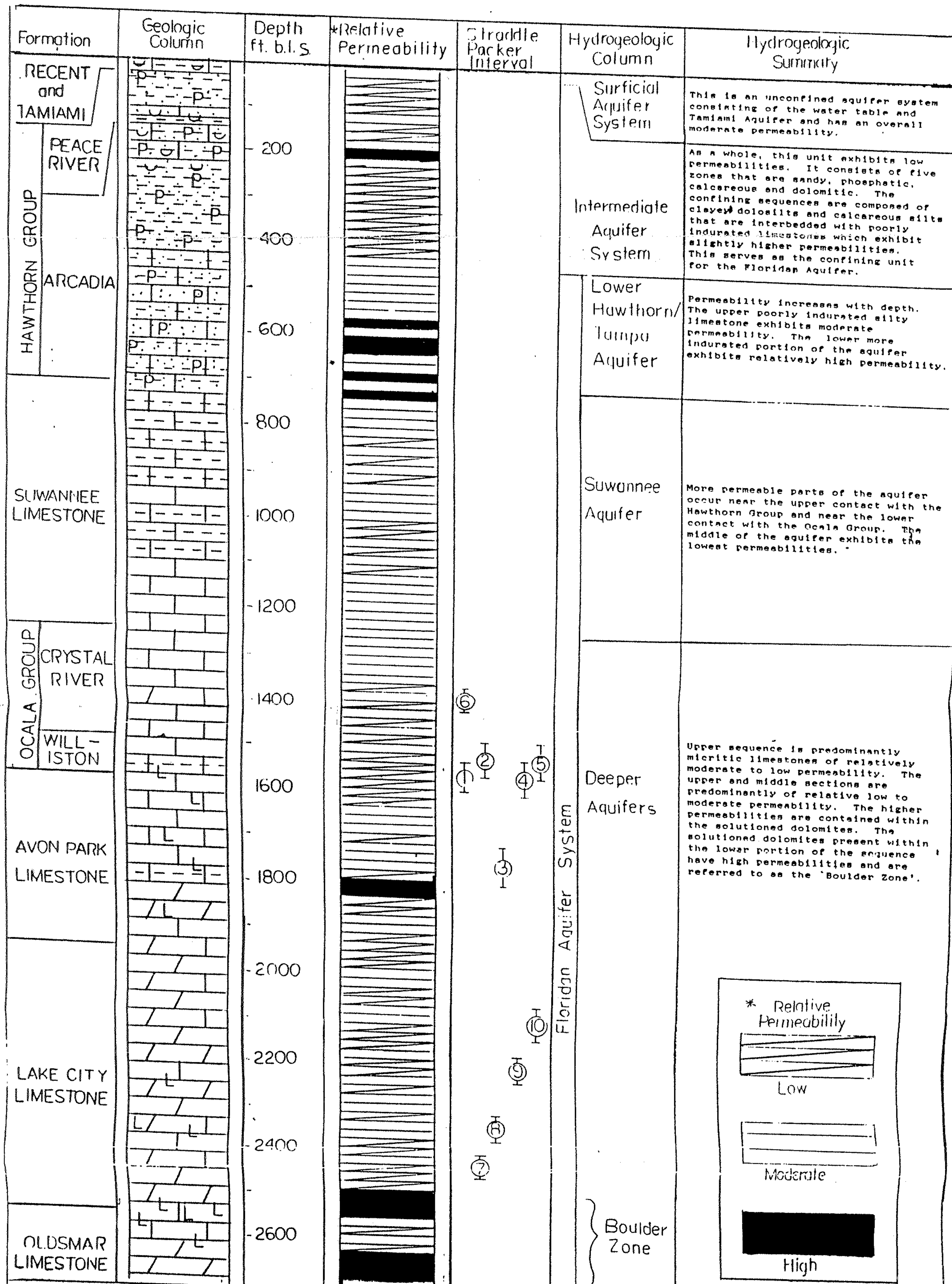


FIGURE - HYDROGEOLOGIC COLUMN

SITE HYDROGEOLOGY

FIGURE 2 - 9

1986 by PBS&J for a very similar site in North Ft. Myers, but has been slightly modified to include the most recent changes approved by the Committee on Hydrostratigraphic Nomenclature of the Southeastern Geological Society (Vechiolli et al., 1986), as shown in Figure 2-10.

The major hydrostratigraphic units in Florida, as proposed by the Southeastern Geological Society Committee on Hydrostratigraphic Nomenclature are the surficial aquifer system, intermediate aquifer system and/or confining unit, the Floridan Aquifer system, and the Sub-Floridan confining unit. Gilboy (1985) recognized these units in the SWFWMD area and assigned the Holocene, Pleistocene and Pliocene Age formations to the surficial aquifer system, the Miocene Age Hawthorn Formation to the intermediate aquifer system, the lower Miocene (Tampa), Oligocene and Eocene Age formations to the Floridan Aquifer system, and the Paleocene Age formations to the Sub-Floridan confining unit (Gilboy, 1985).

The nomenclature shown in Figure 2-9 applies to the hydrogeologic characteristics of Charlotte County. It can be tied in directly to the geology not only of the County in general (see Figure 2-5), but also of the ZRL site in particular.

2.4.2 Hydrogeologic Descriptions

There are three major aquifer systems in Charlotte County: the surficial aquifer system, the intermediate aquifer system and the Floridan Aquifer System.

The surficial aquifer system consists of Pliocene and younger poorly indurated limestones and unconsolidated sands and shells that blanket the area. In Charlotte County, the surficial aquifer contains the water table aquifer and permeable units of the Tamiami Formation. It is underlain by the intermediate aquifer.

The intermediate aquifer system is comprised of upper and middle Miocene quartz sands, clays and carbonates. This system is primarily a confining unit and effectively retards the exchange of water between the Floridan Aquifer and the surficial aquifer system. Within Charlotte County, the silty limestones of the lower Miocene are not contained within the intermediate aquifer system and are considered to be hydraulically connected to the Floridan Aquifer.

Table 2-5

DEPTH AND THICKNESS OF THE HYDROSTRATIGRAPHIC UNITS

Formation	Depth Feet	BPL	Thickness Feet
Surficial Aquifer System	0 -	38'	38'
Intermediate Aquifer System	38' -	418'	380'
Sandstone Aquifer	110' -	130'	20'
Mid-Hawthorn Aquifer	163' -	220'	57'
Floridan Aquifer System (Part)	418' -	2,712'	+2,294'
Lower Hawthorn/Tampa Aquifer	418' -	720'	302'
Suwannee Aquifer	720' -	1,250'	530'
Deep Aquifers Ocala ?	1,250' -	+2,712'	+1,462'
Highly transmissive zone	1,804' -	1,830'	26'
Boulder Zone (Part)	2,495' -	2,712'	+217'
Highly transmissive zone	2,495' -	2,560'	65'
Highly transmissive zone	2,605' -	2,712'	107'

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Table 3-2

WELLS PERMITTED BY SWFWMD AND FDER
(AT SECTION 25, T.42S., R. 23E)
SPECIFICALLY FOR THE INJECTION PROJECT

Owner	Site-ID	Latitude (Degrees)	Longitude (Degrees)	Depth of Well (Feet)	Depth of Casing (Feet)	Permit Number
Charlotte County	(DIW)	26°47'29"N	81°57'53"W	2,710	2,486 (2,465 liner)	UC08-193587
Charlotte County	(DZMW) Lower (Upper)	26°47'29"N	81°57'54"W	1,830 (1,340)	1,795 (1,415)	UC08-193587
Charlotte County	(Water Supply)	26°47'55"N	81°57'25"W	460	220	520463.01
Charlotte County	(Fire Well)	26°47'27"N	81°57'53"W	650	228	520461.01
Charlotte County	(SMW #1 (A or N.W.)	26°47'29"N	81°57'54"W	20	13 + 5 (Screen)	519844.01
Charlotte County	(SMW #2 (B or N.E.)	26°47'29"N	81°57'53"W	20	13 + 5 (Screen)	519844.01
Charlotte County	(SMW #3 (C or S.E.)	26°47'28"N	81°57'53"W	20	13 + 5 (Screen)	519844.01
Charlotte County	(SMW #4 (D or S.W.)	26°47'28"N	81°57'54"W	20	13 + 5 (Screen)	519844.01
Charlotte County	(Construction Supply)	26°47'28"N	81°57'53"W	400	210	519841.01*

*Plugged and abandoned.

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Table 4-1

DRILLING PROGRAM CHRONOLOGY: ZEMEL ROAD LANDFILL SITE

Date	Event
November 18, 1991	Charlotte County issued the notice to proceed to Youngquist Brothers, Inc. setting November 19, 1991 as the starting date and March 20, 1992 as the ending date.
December 9, 1991	Charlotte County issued updated notice to proceed resetting the starting date to December 11, 1991 and the ending date to April 11, 1992.
December 23, 1991	The drilling pad location was staked out in the field.
December 24-27, 1991	Soil compaction and filling. Preparation of forms and steel reinforcement for the pad.
Dec. 27 - Jan. 3, 1992	Poured first sections of the concrete drilling pad. PBS&J starts construction observation on January 2, 1992.
Jan. 3 - Jan. 6, 1992	Drilling pad completed and skid ramp was constructed.
January 8, 1992	Change Order No. 1 is issued changing the ending date to April 15, 1992.
January 7-8, 1992	Drilled shallow monitor wells around the drilling pad and construction supply well adjacent to pad.
January 10, 1992	Started construction of recirculation tank and began setting up the D.I.W. drilling rig on the pad.
January 15, 1992	Collected first set of weekly water samples from the shallow monitor wells around the drilling pad to establish pre-drilling background water quality (Appendix 26).
January 15-17, 1992	PBS&J starts daily construction observation. Field office is set up. DZMW rig being set up on site.
January 19-20, 1992	Began drilling the deep injection well. Reached 80 feet below land surface. Used 46-1/2-inch hole opener to ream the hole for the 38-inch surface casing. (Appendix 20)
January 20, 1992	Installed 38-inch surface casing to a depth of 73 feet. Pressure-grouted casing using 406 cubic feet of sulfate resistant type II neat cement (no additives). (Appendix 21)
January 23, 1992	Drilled pilot hole to 455 feet.

Table 4-1 (Continued)

Date	Event
January 24, 1992	Performed geophysical logging on pilot hole (Appendix 3).
January 25, 1992	Ream 38-inch nominal hole for the outer casing to 456 feet and performed geophysical logging on reamed hole (Appendix 4).
January 29, 1992	Installed and grouted the 38-inch outer casing to a depth of 427 feet. Used 1,176 cubic feet of sulfate resistant neat cement (no additives). Begin drilling DZMW (see Section 5).
January 30, 1992	Performed geophysical logging on cemented outer casing (Appendix 5).
February 1-8, 1992	Began drilling the 6' water supply well (fire well). Cased to 228 feet and and open hole to 650-feet. Complete development at 150 gallons/minute on Feb. 8, 1992.
February 5, 1992	Began drilling pilot hole for the intermediate casing. Drilling is now reverse-air drilling and water sample collection through the drill rod (every 30 feet) has begun (Appendix 27). Reach a pilot depth of 1,322 of February 8, 1992.
February 8, 1992	Drill first water supply well (at drill site) for pump test to 650 feet and develop it at 150 gpm.
February 10, 1992	Collect Core #1 (1,324 feet to 1,340 feet) from the Ocala/ Crystal River formation. Recovered 86 percent. See Figure 2-8 for locations.
February 12, 1992	Collect Core #2 (1,442 feet to 1,457 feet) from the Ocala/ Crystal River Formation. Recovered 96 percent.
February 13, 1992	Drill pilot hole to 1,626 feet. Run geophysical logs on pilot hole.
February 14 & 20, 1992	Straddle Packers 1 and 2 from 1,568 feet - 1,584 feet and 1,526 feet to 1,543 feet. See Figure 2-9 for locations.
February 21 & 22, 1992	Collect Core #3 (1,622 feet - 1,637 feet) from the Avon Park. Recovered 87 percent. Collect Core #4 (1,727 feet - 1,732 feet) from the Avon Park. Recovered 98% percent.
February 25, 1992	Collect Core #5 (1,772 feet - 1,787 feet) from the Avon Park. Recovered 46 percent.

Table 4-1 (Continued)

Date	Event
February 26, 1992	Drill pilot hole to 1,862 feet. Run geophysical logs on pilot hole.
February 27 & 28, 1992	Straddle Packer #3 from 1,729 feet to 1,765 feet. Then change interval from 1,726 feet to 1,762 feet. Straddle Packer #4 from 1,566 feet to 1,601 feet.
March 2-6, 1992	Straddle Packer #5 from 1,536 feet to 1,568 feet and #6 from 1,368 feet to 1,404 feet.
March 7-9, 1992	Dual zone monitor well pilot hole reaches 1,355 feet. Rig upper reaming on both DZMW and T/I well.
March 14-19, 1992	Drill second water supply well (at entrance to landfill) for pump test to 640 feet and develop it at 150 gpm.
March 15-19, 1992	Run geophysical logs on reamed T/I well. Install 24-inch casing to 1,566 feet. Cement casing and run geophysical logs. Used 3,319 $ft.^3$ of sulfate resistant cement.
March 26-28, 1992	Complete reaming of DZMW. Install 16-inch casing to 1,340 feet. Use 1,634 $ft.^3$ of sulfate resistant cement. Run geophysical logs on DZMW.
April 2, 1992	Collect Core #6 (1,893 feet - 1,906 feet) from the Avon Park. Recovered 81 percent.
April 3-5, 1992	Collect Core #7 in two parts (7-A from 2,078 feet to 2,095 feet and 7-B from 2,099 feet to 2,117 feet) from Lake City. Recovered 89 peercent on 7-B. Less than 10 percent on 7-A.
April 7, 1992	Collect Core #8 (2,246 feet - 2,262 feet) from Lake City. Recovered 78 percent.
April 8, 1992	Collect Core #9 (2,310 feet - 2,314 feet) from Lake City. Recovered 41 percent. Repeated Core #9 as #9-B on April 10. Core from 2,320 feet to 2,335 feet and recovered 55 percent.
April 11, 1992	Collect Core #10 (2,432 feet - 2,447 feet) from Lake City. Recovered 87 percent.
April 14-16, 1992	Complete T/I well pilot hole to 2,710 feet. Run gyro and geophysical logs. Pressure test 16-inch casing on DZMW. Plug water supply well at entrance to convert it to a supply well for the landfill offices.

Table 4-1 (Continued)

Date	Event
April 21, 1992	DZMW pilot hole reaches 1,854 feet. Reaming preparations.
April 22-26, 1992	Attempt Straddle Packers 7 through 10. Eventually completing them after many attempts fail due to equipment problems. Final SP as follows: #7 (2,423 feet to 2,438 feet); #8 (2,332 feet to 2,349 feet); #9 (2,197 feet to 2,212 feet); and #10 (2,086 feet to 2,101 feet).
April 25, 1992	Ream DZMW to 1,795 feet.
April 27 - May 6, 1992	Ream T/I Well to 2,490 feet. Run gyro. and geophysical logs.
May 7-8, 1992	Install 12-inch casing on T/I well to 2,486 feet.
May 9-19, 1992	Drillers walkout.
May 20-28, 1992	Cemented 12-inch casing in T/I well. Used 6,003 $ft.^3$ of sulfate resistant cement.
May 28-30, 1992	Run geophysical log on 12-inch casing and run pressure test.
June 1, 1992	Install 8-inch casing to 1,795 feet on DZMW.
June 5-9, 1992	Install packer and set injection liner on T/I well. Run annular and liner pressure tests.
June 11-13, 1992	Run final geophysical logs and T.V. survey on T/I well. Develop and collect samples.
June 13-19, 1992	Cement 8-inch casing on DZMW. Use 557 $ft.^3$ of sulfate resistant cement. Pressure test the 8-inch casing.
June 21-24, 1992	Develop both upper and lower monitor zones of the DZMW and collect samples.
June 25, 1992	Began background data collection prior to injection test.
June 27-29, 1992	Run injection and recovery tests.
June 29 & 30, 1992	Run integrity logs and radioactive tests.
July 2, 1992	Notice of Substantial Completion is issued.

Source: PBS&J Daily and Working Reports.

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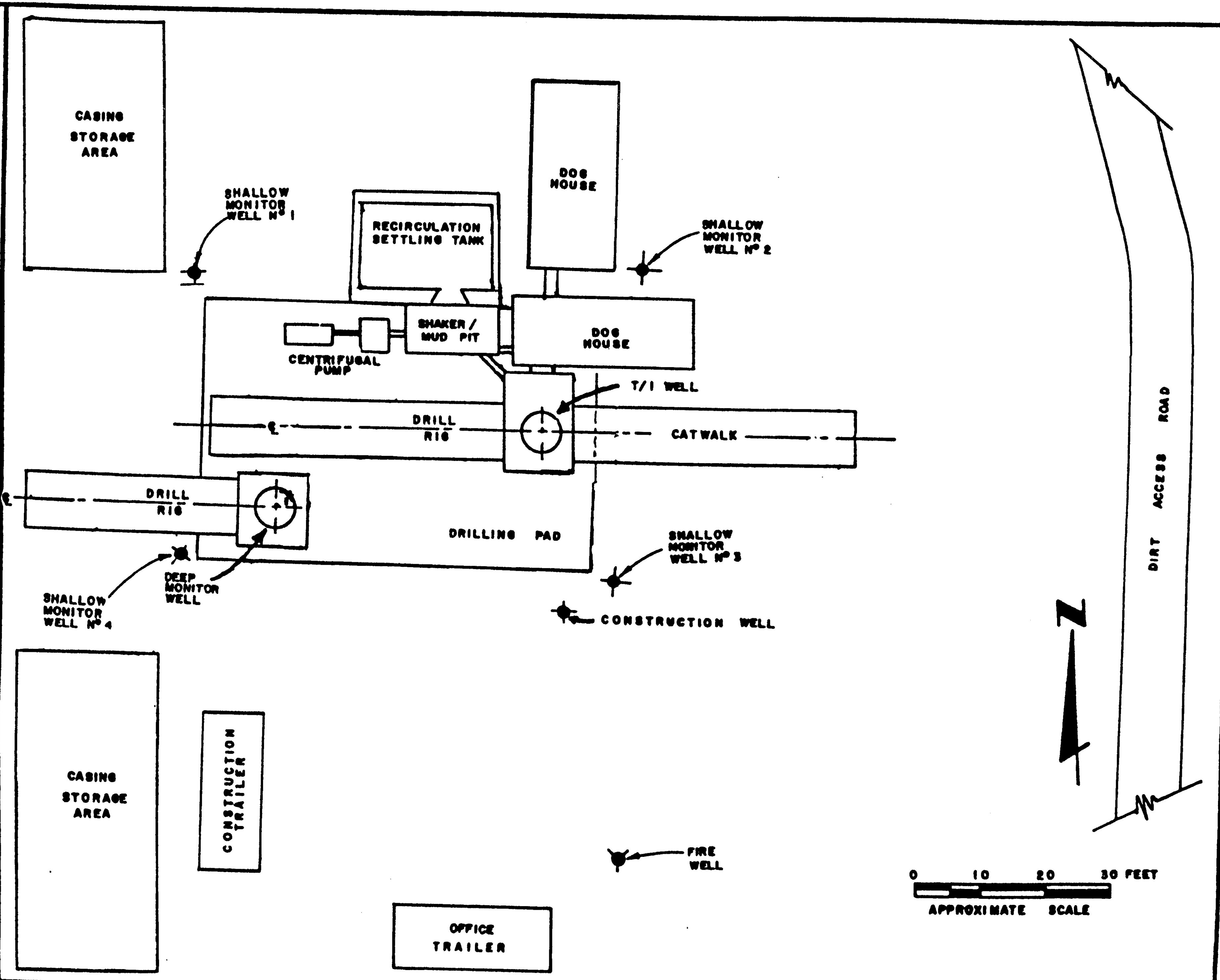

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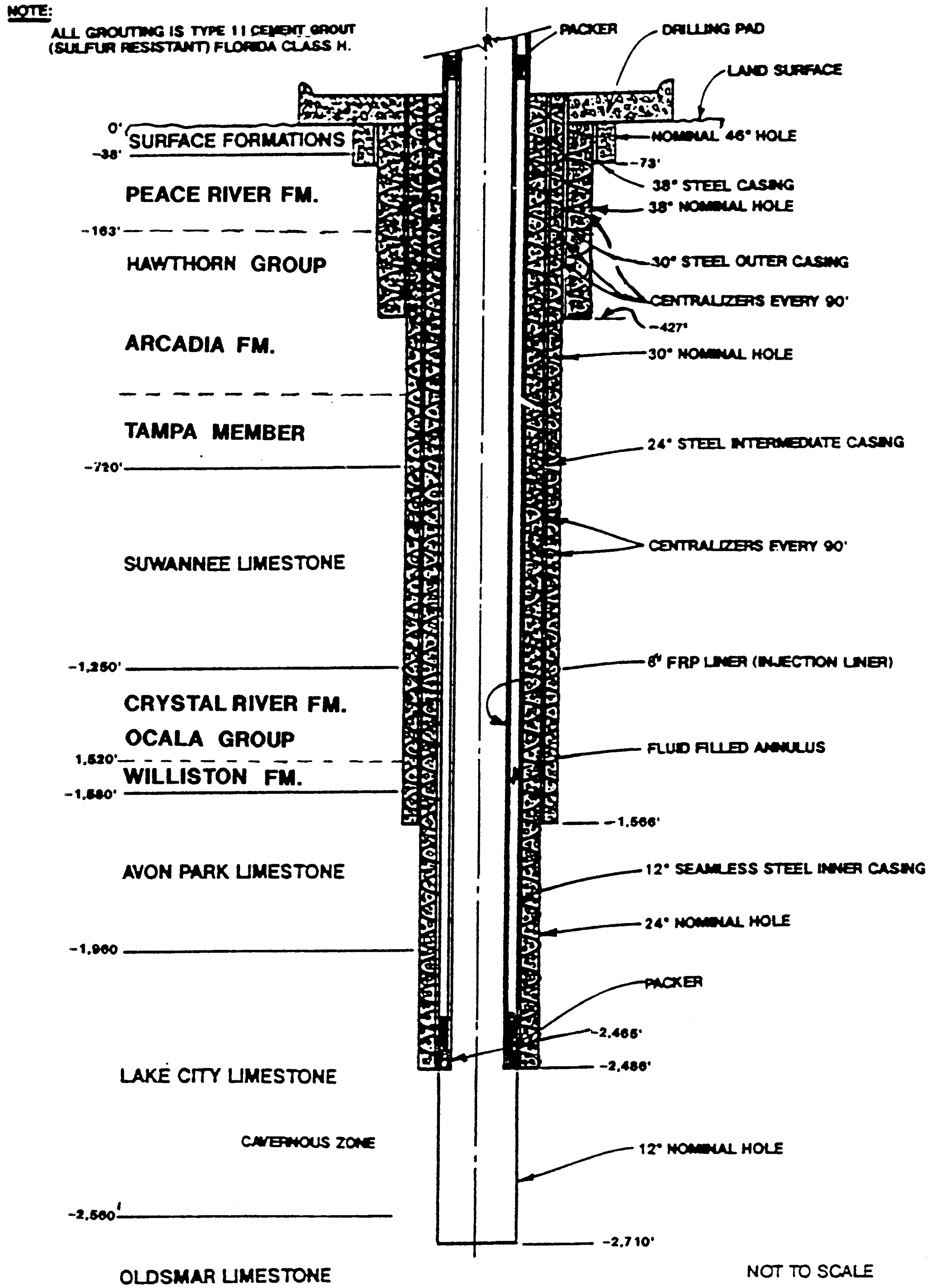
MAP OF DRILL SITE LAYOUT

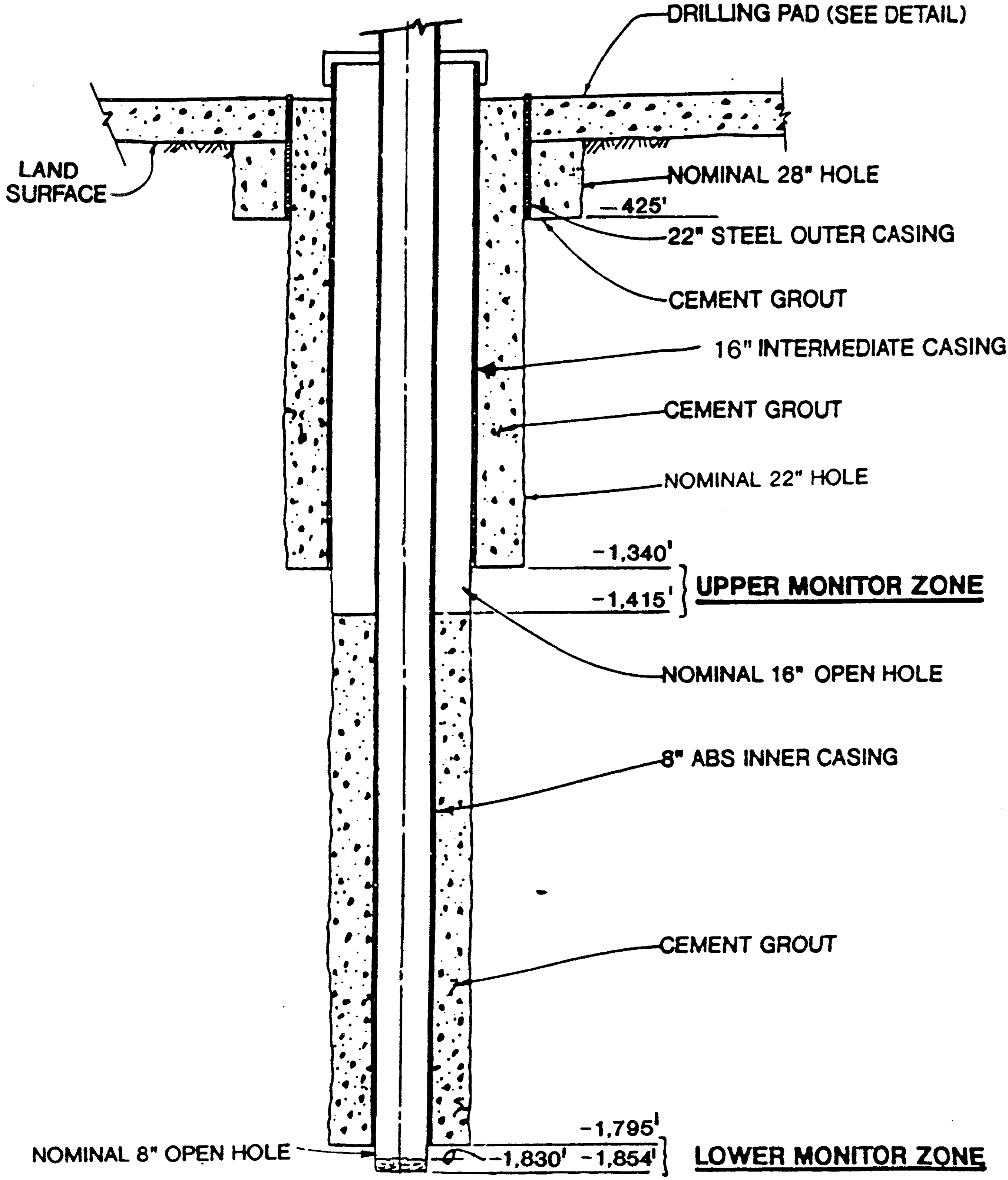
FIGURE 4 – 1



PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

DEEP TEST/INJECTION WELL (AS BUILT)

FIGURE 4 - 2



PBS&J POST, BUCKLEY, SCHUH & JERNIGAN, INC.

DEEP MONITOR WELL (AS BUILT)

FIGURE 5-1

Section 7
HYDROGEOLOGIC TESTING PROGRAM

The geolograph records, the geophysical logs, the lithologic samples, the geologic cores, and the water quality samples collected during the drilling operation were used in Section 2 to develop the detailed descriptions of the geology and hydrogeology of the formations underlying the site. In this section that data are analyzed.

Depth discrepancies exist in the location of various features from one set of data to the next. These discrepancies result from a different starting datum, cumulative errors, etc. For example, the different datum used by the drillers and by the geophysical and T.V. loggers at each visit affects the depth at which various geophysical features are located in the logs in the Appendices. Consequently, the depths of various formations, caverns, water quality changes, and other important hydrogeolgical features are sometimes slightly different from the true depths below land surface. These variations should not be viewed as mistakes in the data base, but rather as errors inherent to the data acquisition by different individuals. In any case, because they are usually never more than a couple of feet off, they do not reduce the accuracy of the conclusions and recommendations derived from the data.

7.1 LITHOLOGIC SAMPLES

The PBS&J site supervisors collected representative formation samples every ten feet during drilling of the pilot hole of both the T/I well and the DZM well, and each sample was described and recorded in the field in a preliminary lithologic log (see Appendix 23). These field descriptions were later supplemented by detailed in-office examinations under the microscope from which final descriptions were prepared (see Appendix 24a and Appendix 24b).

From the sample descriptions and the lithologic logs, and with the help of data from other investigations, the depths and nomenclatures of the various formations and hydrologic divisions were identified in Section 2. For the lower geological units, which are of primary interest in this study, few data from previous investigations were available and therefore cuttings from the lower parts of the T/I well provided the principal source of data. Although data from the monitor well were also used, these data were restricted to the 1,850-foot depth of the monitor well. Core samples collected by the drillers and sent to Core Laboratories Inc. (CLI) for analyses were also used. For the upper geologic units, of secondary concern in this study, geologic and hydrologic identifications were largely based on work at the site and on the lithologic descriptions in Appendices 23 and 24, but data from other nearby sites were also used.

From the examination of the lithologic samples, from the mineralogical analyses, and from existing literature, a column showing the geologic units penetrated at the ZRL site was developed. Figure 2-8 shows the estimated depth ranges of the geologic units underlying the ZRL site (see Section 2).

7.2 CORE ANALYSIS

In compliance with the technical specifications for the ZRL deep test/injection well, a total of ten cores were taken during the drilling of the pilot hole (see Figures 7-1A through 7-1F). The first two cores were taken from above the USDW zone in the Ocala Group Formations, cores numbered 3 through 6 were taken from the Avon Park Limestone, and cores numbered 7 through 10 were taken from the Lake City Limestone (see Figure 2-8). All ten cores were 4 inches in diameter. Two samples from each core were selected for analysis by Core Laboratories, Inc. (CLI) (see Figures 7-2A and 7-2B). These core sets are described in Section 7.2.1, followed by a detailed discussion of the core analysis in Section 7.2.2. The coring operations have been described in Section 4 as they occurred, and are outlined in Table 4-1 starting on February 10, 1992. Geologic and lithologic descriptions of the cores are included in Appendix 25 and the results of the special core analysis study conducted by CLI are presented in Appendix 19. Water samples from the same depth as each of the cored zones were either provided as part of the water sampling program or were analyzed by CLI (see Appendix 19); and based on the results of these analyses, synthetic formation brines were prepared for use with the appropriate core material in all the laboratory tests.

7.2.1 Core Description

The first coring was into the Crystal River Formation of the Ocala Group from a depth between 1,324 and 1,340 feet below land surface, where an 86 percent recovery was achieved. From the recovered section, samples were selected from

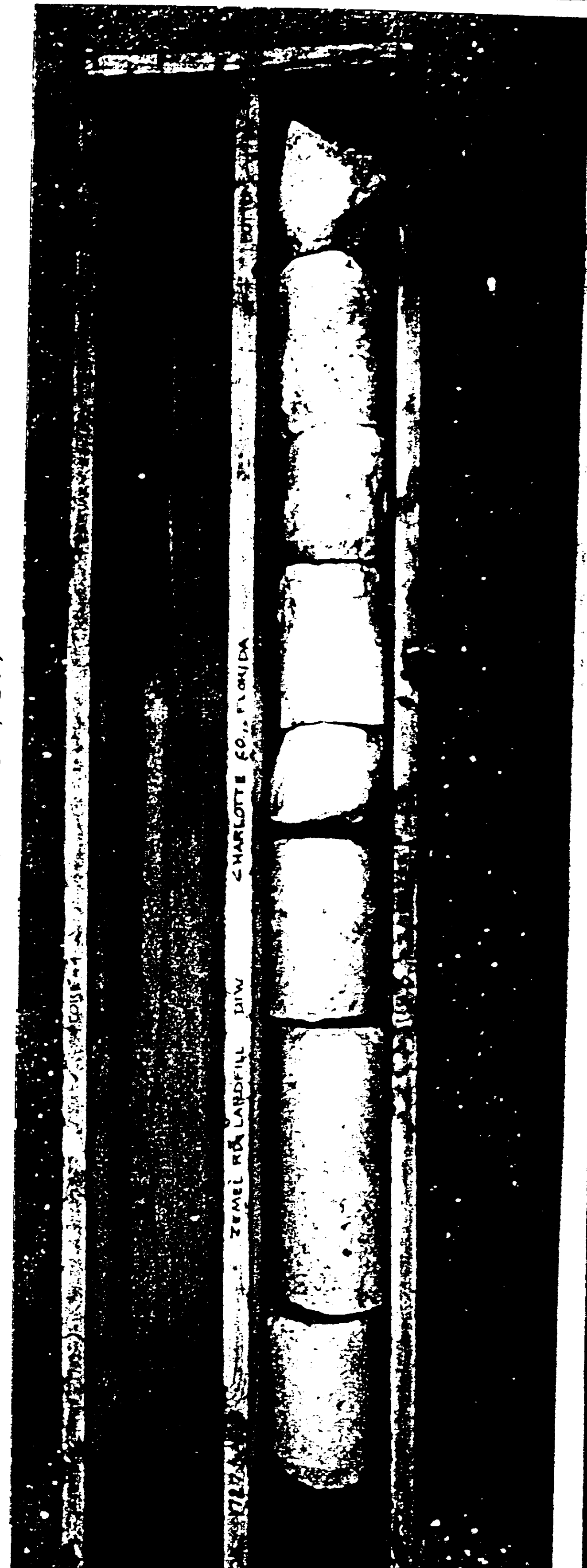
CORE #1 (1,324' TO 1,340')

CORE #2 (1,442' TO 1,457')

POST, BUCKLEY, SCHUH & JERNIGAN, INC.
GEOLOGIC CORES #1 & #2

FIGURE 7-1(A)

CORE #3 (1,622' TO 1,637')



CORE #4 (1,727' TO 1,734')

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.
GEOLOGIC CORES #3 & #4

FIGURE 7-1(B)

CORE #5 (1,772' TO 1,787')

CORE #6 (1,893' TO 1,906')

PBS&J POST, BUCKLEY, SCHUH & JERNIGAN, INC.
GEOLOGIC CORE #5 & #6

FIGURE 7-1(C)

CORE #7 (2,078' TO 2,117')

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GEOLOGIC CORE #7A & 7B

FIGURE 7-1(D)

CORE #8 (2,246' TO 2,262')
CORE #9 (2,310' TO 2,335')

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

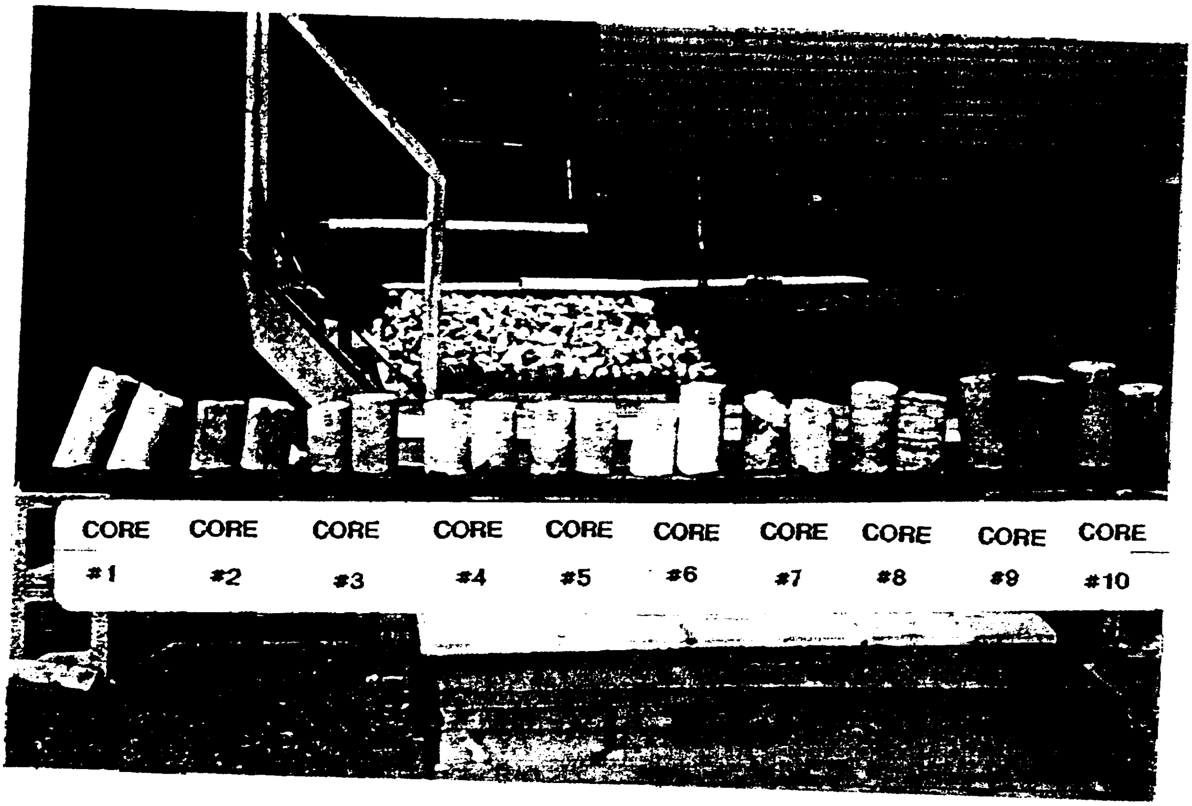
GEOLOGIC CORE #8 & #9

FIGURE 7-1(E)

CORE #10 (2,432' TO 2,447')

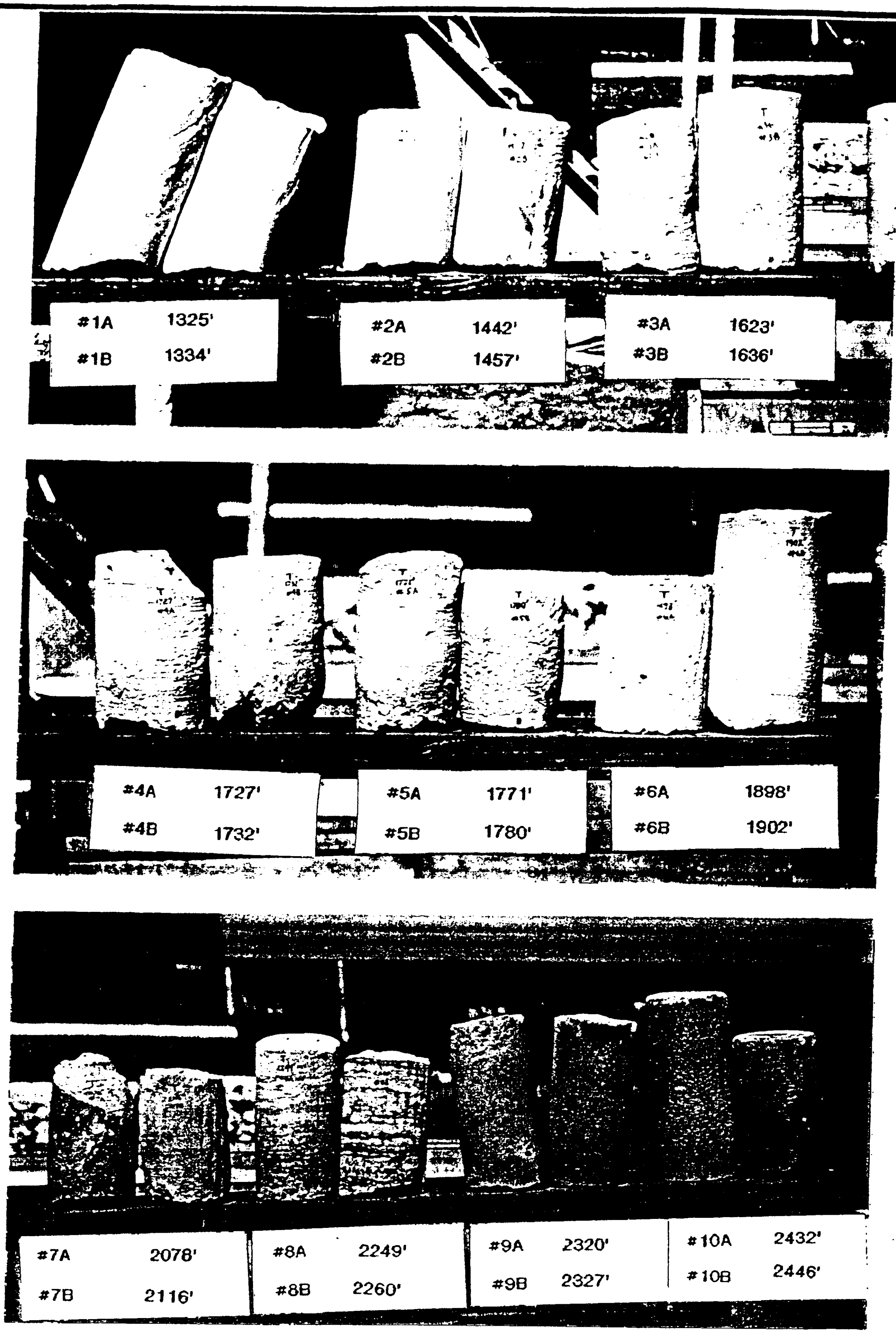
PBS&J POST, BUCKLEY, SCHUH & JERNIGAN, INC.
GEOLOGIC CORE #10

FIGURE 7-1(F)



POST, BUCKLEY, SCHUH & JERNIGAN, INC.
CORE SAMPLES ANALYZED AT LABORATORY

FIGURE 7-2(A)



PBS&J POST, BUCKLEY, SCHUH & JERNIGAN, INC.

CORE SAMPLES ANALYZED AT LABORATORY

FIGURE 7-2 (B)

1,325 and 1,334 feet (see Table 7-1) which were then sent to the CLI laboratory for analysis. Plugs from the section around 1,325 and 1,334 feet are stored at the Miami offices of PBS&J and are available for inspection. Core #1 is representative of the Upper Monitor Zone of the Dual Zone Monitor Well.

The second core was also drilled out of the Crystal River Formation. This core was obtained from between 1,442 and 1,457 feet below land surface, and 96 percent of the core was recovered. The portions of the core sent to the lab for analysis and the portion stored away for future reference are listed in Table 7-1. Core #2 is from the zone immediately above the 10,000 mg/l TDS contact for the USDWs. Plugs from the portions sent to lab for this and for all other cores are available for inspection at the PBS&J Headquarters Office in Miami.

The third core was taken in the Avon Park Limestone Formation from 1,626 to 1,637 feet and produced an 87 percent recovery. Core #3 is from just below the 10,000 mg/l TDS contact.

The fourth coring was also from the Avon Park and produced a 98 percent recovery. The sections from 1,727 and 1,732 feet were sent to the lab for analysis.

The fifth core came from a depth of between 1,772 and 1,787 feet in the Avon Park Limestone. Two separate coring samples were sent to the lab; the first, from 1,771 feet and the second from 1,780 feet. The cored section only produced 46 percent recovery. Core #5 is from just above the Lower Monitor Zone of the Dual Zone Monitor Well and is therefore representative of it.

The sixth core came from a zone between 1,893 to 1,906 feet below land surface and is the last core obtained from the Avon Park. It produced an 81 percent recovery.

The seventh coring was performed in two parts because the first attempt only produced 10 percent recovery. Core 7A was taken from 2,078 to 2,095 feet, and Core 7B, which yielded 89 percent recovery, was from 2,099 to 2,117 feet. Core #7 is the first core obtained from the Lake City Limestone Formation. Core #7A is representative of the confining layer at this injection site.

Table 7-1

CORE RECOVERY DATA

Core	Formation	Depth Cored (in feet)	Cored Footage	Recovery (%)	Plug Interval in Storage* (in feet)	Laboratory Sample Number	Laboratory Tested Interval (in feet)
1	Crystal River	1,324 - 1,340	16	86	1,325 and 1,334	1A 1B	1,325 1,334
2	Crystal River	1,442 - 1,457	15	96	1,442 and 1,457	2A 2B	1,442 1,457
3	Avon Park	1,622 - 1,637	15	87	1,623 and 1,636	3A 3B	1,623 1,636
4	Avon Park	1,727 - 1,732	5	98	1,727 and 1,732	4A 4B	1,727 1,732
5	Avon Park	1,772 - 1,787	15	46	1,771 and 1,780	5A 5B	1,771 1,780
6	Avon Park	1,893 - 1,906	13	81	1,898 and 1,902	6A 6B	1,898 1,902
7A 7B	Lake City Lake City	2,078 - 2,095 2,099 - 2,117	17 18	10 89	2,078 2,116	7A 7B	2,078 2,116
8	Lake City	2,246 - 2,262	16	78	2,249 and 2,260	8A 8B	2,249 2,260
9A 9B	Lake City Lake City	2,310 - 2,314 2,320 - 2,335	4 15	41 55	2,320 and 2,327	9A 9B	2,320 2,327
10	Lake City	2,432 - 2,447	15	87	2,432 and 2,446	10A 10B	2,432 2,446

*Stored at PBS&J - Miami, Florida

m:R-66B/B

The next two cores were collected in the confining zone. The eighth, came from a section of the Lake City Limestone between 2,246 and 2,262 feet below land surface. The ninth came in two parts, one from 2,310 to 2,395 feet and the other from 2,320 to 2,335 feet. These cores yielded 41 and 55 percent recovery. The last core collected, core number 10, also came from the confining zone. It came from near the bottom of the Lake City, from between 2,432 and 2,447 feet below land surface. This core, the closest one to the injection zone, was used to provide approximate laboratory results for the heat capacity and thermal conductivity of the rocks of the injection zone needed.

7.2.2 Core Testing Results

As noted in Section 7.2.1, twenty samples selected from the ten corings made at ZRL were submitted to CLI for testing. These core samples were accompanied by water samples from the zones the cores were taken from. The depths from which the samples were selected are shown in the last column in Table 7-1.

The testing program on the samples included:

- o Air permeability
- o Porosity
- o Liquid permeability
- o Formation resistivity factor
- o Resistivity index
- o Accoustic velocity (compressive velocity and shear velocity)
- o Dynamic moduli (shear modulus, bulk modulus, bulk density, Poisson's Ratio, and Young's modulus).

Core number 10, as stated earlier, was also tested for its rock heat capacity and thermal conductivity (see Section 9). In addition, rock compressibility (pore volume) was determined for Cores 2, 5 and 6 at the request of the USGS to help compare this test site with other sites investigated by USGS. Finally, X-ray diffraction (XRD) analyses were conducted on the twenty samples from the ten cores to determine the mineral content of the various cores.

7.2.2.1 Air Permeability and Porosity

Sample plugs from each core were obtained using a diamond drill bit with water as the bit coolant and lubricant. The sample plugs were cleaned in methyl alcohol and dried in a convection oven. Permeability to air and Boyle's law porosity (using helium) measurements were then taken on the cleaned and dried samples. The results for both measurements are shown in Table 7-2, and the laboratory report is shown in Appendix 19. The permeability to air in Table 7-2 is given in darcy units (millidarcys), and not in the usual gallons per day per square foot (gpd/ft2) because the dimensional requirements of the latter include the permeant characteristics. The darcy unit does not include permeant characteristics and different permeants can, therefore, be compared directly.

Table 7-2 indicates consistently greater permeability in the horizontal direction than in the vertical direction for all of the cores, except for Cores 6 and 7, and this difference can be as much as one order of magnitude. However, despite the higher horizontal than vertical permeability, both the vertical and the horizontal permeability in most samples is still extremely low. Samples 7, 8 and 9 are practically impermeable, and Samples 5 and 10 are of extremely low permeability. Sample 6 from just below the Lower Monitor Zone of the Deep Monitor Well is the one showing highest permeability, but even this one has a permeability of only about 9 gallons per day per square foot, which is very low. The other Samples, 1, 2, 3 and 4, are all less than 1 gallon per day per square foot.

Sample porosity shows an obviously direct relationship to permeability. Figure 7-3 shows a plot of the porosity versus permeability of the 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 30 percent and permeability above 11 millidarcies are removed, the fit is 0.92.

The plot in Figure 7-3 is not a mathematical or theoretical derivation, but only an empirical relationship and should be applicable only for similar types of rock samples extracted from the ZRL site. The porosity has a direct semilogarithmic relationship with the permeability to air for these samples, but this relationship might not hold true for other samples.

Table 7-2

AIR PERMEABILITY AND POROSITY

Sample Number[b]	Depth (feet)	Permeability to Air (millidarcys)[a]	Porosity (percent)
Ocala Formation			
1AH	1325	22.2	34.4
1AV	1325	18.0	33.3
1BH	1334	9.45	32.5
1BV	1334	7.59	34.4
2AH	1442	11.5	33.7
2AV	1442	6.06	33.5
2BH	1457	6.63	28.9
2BV	1457	12.9	25.4
Avon Park Formation			
3AH	1623	23.6	35.3
3AV	1623	22.3	33.1
3BH	1636	43.2	30.5
3BV	1636	23.1	28.8
4AH	1727	29.4	28.4
4AV	1727	16.2	29.0
4BH	1732	58.3	34.3
4BV	1732	34.6	27.8
5AH	1771	20.1	30.3
5AV	1771	5.97	27.7
5BH	1780	5.92	26.2
5BV	1780	1.28	24.3
6AH	1898	554.	31.4
6AV	1898	575.	32.2
6BH	1902	247.	30.1
6BV	1902	296.	30.1
Lake City Formation			
7AH	2078	<0.001	2.7
7AV	2078	<0.001	1.0
7BH	2116	4.14	20.2
7BV	2116	8.03	24.3
8AH	2249	0.401	15.5
8AV	2249	0.258	16.5
8BH	2260	2.40	20.6
8BV	2260	0.907	20.6

Table 7-2 (Continued)

Sample Number[b]	Depth (feet)	Permeability to Air (millidarcys)[a]	Porosity (percent)
Lake City Formation (Continued)			
9AH	2320	4.35	24.2
9AV	2320	0.705	20.1
9BH	2327	3.10	23.8
9BV	2327	2.13	23.8
10AH	2432	13.2	24.9
10AV	2432	24.0	26.4
10BH	2446	0.342	9.3
10BV	2446	<0.001	2.1

[a]600 psi confining stress. A millidarcy equals 0.0182 gallons per day per square foot.
[b]Letter V after the sample number represents vertical values.
Letter H after the sample number represents horizontal values.

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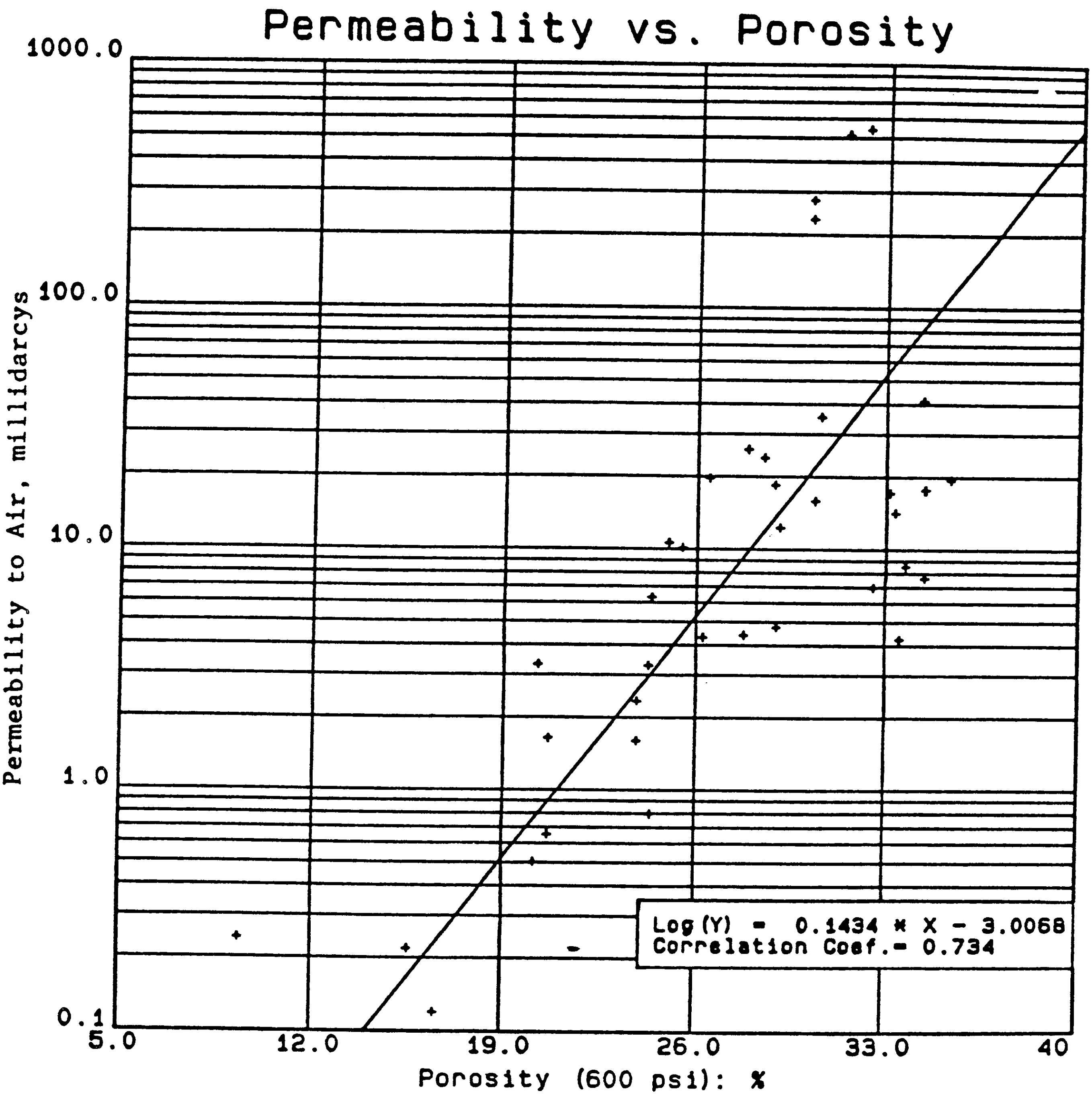

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POROSITY VERSUS PERMEABILITY TO AIR

FIGURE 7-3

Zemel Road Landfill

The relationship developed in Figure 7-3 for porosity and permeability can be presented in the form of an equation, as follows:

$$\text{Log } P = 0.1434\ \emptyset - 3.0068$$

where P is the permeability to air (in millidarcys) and
$\emptyset$ is the porosity (in percent)

7.2.2.2 Liquid Permeability (Permeability to Water)

The samples of formation water from the zones of interest were analyzed (see Appendix 19) and an equivalent TDS/sodium chloride brine was calculated from the water analysis for each zone and used in all subsequent core tests, including specific-permeability-to-water measurements.

The samples were then pressure-saturated with the corresponding formation brine equivalent. Each sample was individually placed in a hydrostatic core holder and injected, under back pressure, with the saturant to assure 100 percent saturation. Following this step, specific permeabilities to water were determined. The results of the tests for specific permeability to water are shown in Table 7-3. As expected, the laboratory analysis results for permeability to water were much less than the permeability-to-air results shown in Table 7-2 by an average of less than 2 to 1 (1/2). The water-to-air permeability ratios are also given in Table 7-3.

Cores 7 through 10 show a permeability to water that is between 0.7 and 0.3 times less than the already extremely low permeability to air, proving conclusively that these cored sections are truly confining and for all practical purposes impermeable.

7.2.2.3 Formation Resistivity Factor and Index

The next two parameters for which the samples were tested, the formation factor and the resistivity index, are interrelated. Both of these parameters are related to resistivity measurements as follows:

$$F = Ro/Rw$$

where F is formation factor (dimensionless)

Table 7-3

WATER PERMEABILITY

Sample Number	Depth (feet)	Specific Permeability to Water, (millidarcys)	Permeability to Air, (millidarcys)	Permeability Ratio, water/air
1AH	1325	14.8	22.2	0.667
1AV	1325	12.4	18.0	0.689
1BH	1334	5.94	9.45	0.629
1BV	1334	6.29	7.59	0.605
2AH	1442	7.01	11.5	0.610
2AV	1442	3.39	6.06	0.559
2BH	1457	3.63	6.63	0.548
2BV	1457	4.38	12.9	0.340
3AH	1623	15.1	23.6	0.640
3AV	1623	13.7	22.3	0.614
3BH	1636	28.1	43.2	0.650
3BV	1636	14.6	23.1	0.632
4AH	1727	19.4	29.4	0.660
4AV	1727	10.1	16.2	0.623
4BH	1732	28.1	58.3	0.482
4BV	1732	14.2	34.6	0.410
5AH	1771	8.36	20.1	0.411
5AV	1771	1.21	5.97	0.203
5BH	1780	1.86	5.92	0.314
5BV	1780	0.297	1.28	0.232
6AH	1898	273.	554.	0.493
6AV	1898	420.	575.	0.730
6BH	1902	172.	247.	0.696
6BV	1902	217.	296.	0.733
7AH	2078	<0.001	<0.001	-
7AV	2078	<0.001	<0.001	-
7BH	2116	2.95	4.14	0.713
7BV	2116	5.32	8.03	0.663
8AH	2249	0.150	0.401	0.374
8AV	2249	0.082	0.258	0.318
8BH	2260	0.938	2.40	0.391
8BV	2260	0.307	0.907	0.338

Table 7-3 (Continued)

Sample Number	Depth (feet)	Specific Permeability to Water, (millidarcys)	Permeability to Air, (millidarcys)	Permeability Ratio, water/air
9AH	2320	2.30	4.35	0.529
9AV	2320	0.314	0.705	0.445
9BH	2327	1.80	3.10	0.581
9BV	2327	1.23	2.13	0.577
10AH	2432	6.65	13.2	0.504
10AV	2432	14.5	24.0	0.603
10BH	2446	0.174	0.342	0.509
10BV	2446	<0.001	<0.001	-

F = Ro/Rw

Ro is resistivity of saturated formation (ohms-cm)

Rw is resistivity of formation fluid (ohms-cm)

$S^n = Ro/Rt = 1/RI$

where RI is resistivity index (dimensionless)

S is the fraction of the pore space occupied by formation water

n is saturation exponent

Rt is resistivity of clean formation (ohms-cm)

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

$$F = a\,\phi^{-m}$$

where m is the cementation factor

a is an empirical constant usually taken as unity

ϕ is the porosity

? not used in figures 7-4 to 7-9

The core samples were used for formation-resistivity-factor testing. A liquid resaturation porosity was calculated for each sample and was used in all electrical property evaluations. The resistivities of the brines and the brine-saturated samples were measured over a period of several days until stable, indicating that ionic equilibrium within the samples had been achieved.

Using the formation resistivity factor values developed by CLI (see Table 7-4 and Appendix 19), formation resistivity factor versus porosity graphs were plotted for the cores. Straddle Packer #6 data was used for Cores 1 and 2; Straddle Packer #4 data was used for Cores #3, 4 and 5; Straddle Packer #10 data was used for Cores #6 and 7; and Straddle Packers #9, 8 and 7 were used for Cores #8, 9 and 10, respectively (see Figures 7-4 through 7-9). The Archie parameter "a" was constrained to a value of 1.00 due to the limited sample populations. Cementation exponents, "m," ranging from 1.78 to 2.61, were calculated using Archie's relationship and the data trends generated by the best-fit-least squares method. These values were then used to evaluate the geophysical logs, as described in Section 7.3.

After the formation resistivity factor measurements were completed, one sample from each core was gradually desaturated. At selected saturations, determined

* increasing φ increases m

Zemel Road Landfill

Table 7-4

FORMATION RESISTIVITY FACTOR AND RESISTIVITY INDEX

Sample Number	Depth, feet	Water Permeability millidarcys	Porosity, percent	Formation Factor	Cementation Exponent m	Brine Saturation Fraction pore space	Resistivity Index	Saturation Exponent n
1AH	1325	14.8	34.4	9.03	2.06	1.000	1.00	1.55
						0.814	1.26	
						0.788	1.34	
						0.562	2.15	
						0.395	4.77	
1BH	1334	5.94	32.5	8.89	1.94	1.000	1.00	1.37
			35	8.89	2.08*	0.836	1.21	
						0.740	1.51	
						0.445	3.05	
						0.419	3.33	
2AH	1442	LS 7.01	33.7	8.65	1.98	1.000	1.00	1.50
						0.831	1.26	
						0.752	1.37	
						0.706	1.49	
						0.335	5.59	
2BH	1457	LS 3.63	28.9	11.60	1.97	1.000	1.00	1.48
						0.883	1.08	
						0.563	2.14	
						0.482	3.04	
						0.380	4.18	
3AH	1623	LS 15.1	35.3	8.39	2.04	1.000	1.00	1.27
						0.952	1.03	
						0.878	1.09	
						0.844	1.18	
						0.618	1.92	
3BH	1636	LS 28.1	30.5	11.29	2.04	1.000	1.00	1.68
						0.936	1.04	
						0.440	3.85	
						0.407	4.59	
						0.291	8.02	
4AH	1727	LS 19.4	28.3	10.77	1.88	1.000	1.00	1.72
						0.924	1.11	
						0.741	1.88	
						0.388	5.11	
						0.376	5.24	
4BH	1732	LS 28.1	34.3	7.43	1.87	1.000	1.00	1.78
						0.930	1.08	
						0.897	1.27	
						0.849	1.35	
						0.550	2.89	
5AH	1771	LS 8.36	30.3	9.07	1.85	1.000	1.00	1.37
						0.893	1.06	
						0.854	1.28	
						0.834	1.34	
						0.600	2.01	

0 for a = 1

$\log F = \log a - m \log \phi$

$m = -\log F / \log \phi$

Table 7-4 (Continued)

Sample Number	Depth, feet	Water Permeability millidarcys	Porosity, percent	Formation Factor	Cementation Exponent m	Brine Saturation Fraction pore space	Resistivity Index	Saturation Exponent n
5BH	1780	1.86	26.5	11.56	1.84	1.000	1.00	1.36
						0.905	1.02	
						0.833	1.34	
						0.284	6.34	
						0.485	2.15	
6AH	1898	273	31.4	14.20	2.29	1.000	1.00	1.53
						0.847	1.13	
						0.714	1.56	
						0.423	3.68	
						0.397	4.38	
6BH	1902	172	30.1	13.20	2.15	1.000	1.00	1.58
						0.895	1.15	
						0.799	1.29	
						0.368	4.69	
						0.310	6.67	
7AH	2078	0.001	2.7	1,474.65	2.02	1.000	1.00	2.72
						0.851	1.58	
						0.737	2.28	
7BH	2116	2.95	23.6	27.56	2.30	1.000	1.00	2.13
						0.634	2.42	
						0.535	4.12	
						0.398	6.97	
8AH	2249	0.15	15.5	27.59	1.78	1.000	1.00	2.40
						0.900	1.65	
						0.850	1.78	
						0.748	1.91	
						0.654	2.69	
8BH	2260	0.94	20.6	17.69	1.82	1.000	1.00	2.14
						0.809	1.48	
						0.696	2.01	
						0.645	2.58	
						0.591	3.30	
9AH	2320	2.30	24.2	31.09	2.42	1.000	1.00	1.89
						0.862	1.50	
						0.780	1.61	
						0.558	3.63	
						0.428	4.48	
9BH	2327	1.80	23.8	42.65	2.61	1.000	1.00	1.75
						0.859	1.24	
						0.621	2.46	
						0.297	8.23	
						0.244	11.64	
10AH	2432	6.65	24.9	15.43	1.97	1.000	1.00	1.50
						0.885	1.22	
						0.538	3.26	
						0.415	3.78	
						0.264	6.92	

Table 7-4 (Continued)

Sample Number	Depth, feet	Water Permeability millidarcys	Porosity, percent	Formation Factor	Cementation Exponent m	Brine Saturation Fraction pore space	Resistivity Index	Saturation Exponent n
10BH	2446 dolomite	0.17	9.3	91.70	1.90	1.000	1.00	1.97
						0.818	1.70	
						0.720	1.97	
						0.582	2.94	
						0.550	3.25	

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gravimetrically, the resistivities of the core plugs were measured to provide a correlation between the formation resistivity index and water saturation. The results are tabulated with the formation factor results in Table 7-4. Saturation exponents, "n," determined from the lines of best fit to the data points, ranged from 1.27 to 2.73 (see Figures 7-10 through 7-29).

7.2.2.4 Acoustic Velocity

A 1-inch-diameter vertically oriented plug from each of the 20 samples from the 10 cores was selected for use in acoustic velocity testing. The twenty samples were pressure-saturated with the formation brine equivalent, and mounted in acoustic velocity apparatus. Shear and compressional velocities were determined at a net hydrostatic stress equal to 600 psi at ambient temperature. Internal (pore) pressure was maintained to assure 100 percent saturation of the samples at all times. The results of these measurements varied (see Table 7-5) in proportion to the diverse lithologies of the samples. In general, the acoustic transit times both in compression and shear for all the samples showed a fair to good correlation to the sample porosities in Table 7-5.

From the sonic logs (see Appendices 7, 8 and 11, transit times were obtained for each test sample depth; these are shown with the corresponding sample porosity in Table 7-6. Since the relationship between transit time and porosity is linear (Schlumberger, 1972) the two values for each sample was then represented in the form of a linear relationship and plotted in Figure 7-30.

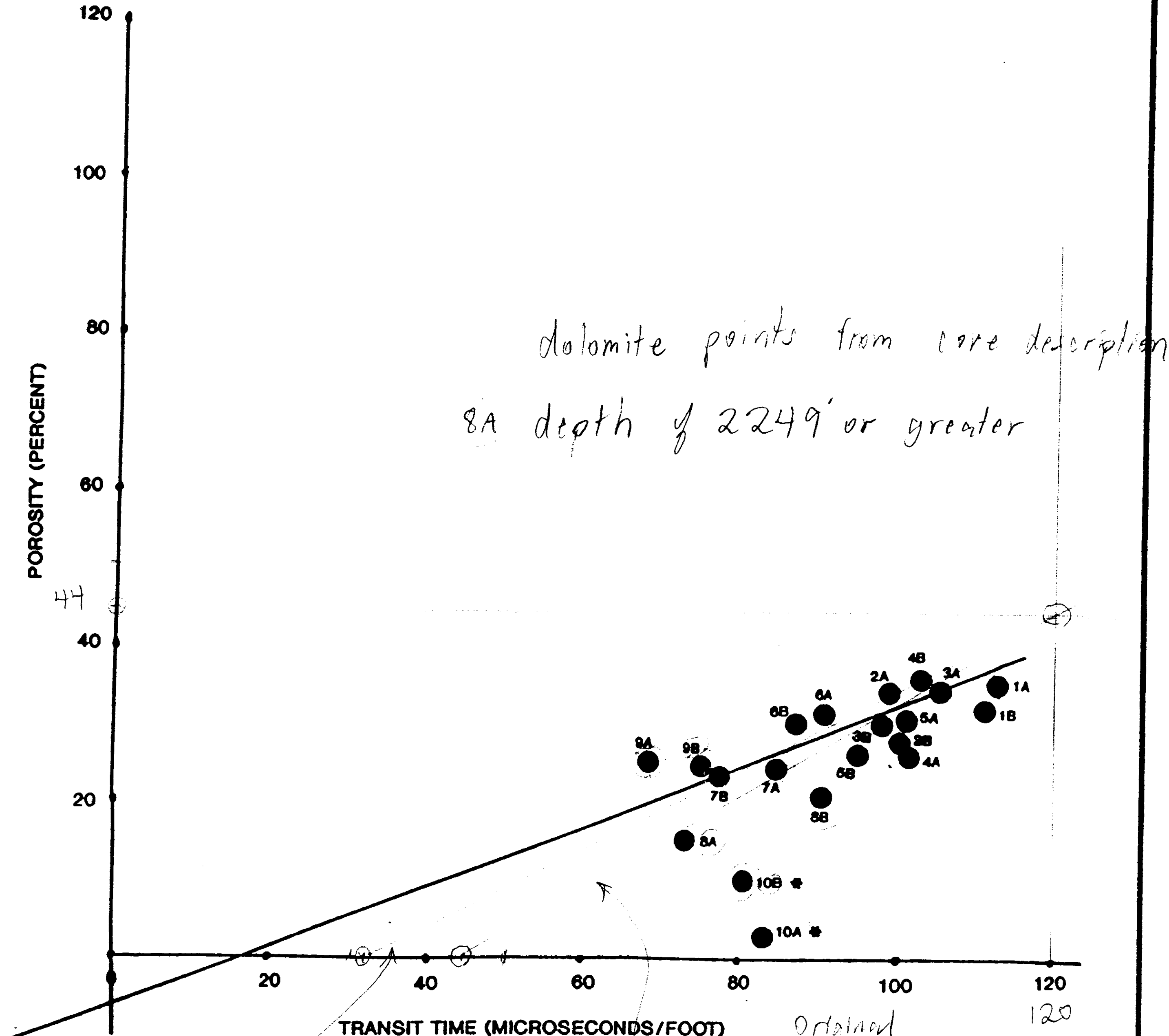
A linear regression analysis of the data points shown in Figure 7-30 produced the following function:

$$\phi = 0.389 (\Delta t) - 7$$

where ϕ is the rock porosity (percent)

Δt is acoustic transit time of saturated rock matrix (microseconds/foot).

The relationship expressed in Figure 7-30 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 is



Original line from Sonic-density cross-plot wells BF-3 and P 1085 using $\Delta t_{ma} = 45$

* EXTREME VALUES OF POROSITY AND TRANSIT TIME WERE NOT PLOTTED TO AVOID SKEWING THE LINE BY EXTREMES.

This line fits sonic-density data better but has $\Delta t_{ma} = 31.5$ (too low for limestone)

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ACOUSTIC TRANSIT TIME VERSUS POROSITY

FIGURE 7-30

Table 7-5

ULTRASONIC VELOCITY AND DYNAMIC MODULI

Zemel Rd. Test/Injection Well
Charlotte County, Florida

Sample ID	Depth	Porosity	Stress Net	Bulk Dens	Velocity Comp	Velocity Shear	Bulk Modulus	Young's Modulus	Shear Modulus	Poisson's Ratio
	ft	%	psi	gm/cc	ft/sec		psi	psi	psi	
1A	1325	34.4	600	2.12	10026	5148	1.86e+06	2.00e+06	7.56e+05	0.321
1B	1334	32.5	600	2.10	9787	4924	1.80e+06	1.83e+06	6.86e+05	0.331
2A	1442	33.7	600	2.12	9687	4753	1.82e+06	1.73e+06	6.45e+05	0.341
2B	1457	28.9	600	2.25	8540	4229	1.49e+06	1.45e+06	5.42e+05	0.338
3A	1623	35.3	600	2.09	10319	5290	1.95e+06	2.09e+06	7.89e+05	0.322
3B	1636	30.5	600	2.19	11290	5851	2.41e+06	2.65e+06	1.01e+06	0.316
4A	1727	28.3	600	2.20	10393	5360	2.07e+06	2.25e+06	8.52e+05	0.319
4B	1732	34.3	600	2.21	10656	5143	2.33e+06	2.12e+06	7.87e+05	0.348
5A	1771	30.3	600	2.20	11006	5362	2.46e+06	2.29e+06	8.53e+05	0.344
5B	1780	26.5	600	2.26	11142	5528	2.54e+06	2.49e+06	9.30e+05	0.337
6A	1898	31.4	600	2.13	10794	5460	2.21e+06	2.28e+06	8.57e+05	0.328
6B	1902	30.1	600	2.17	11592	5973	2.53e+06	2.75e+06	1.04e+06	0.319
7A	2078	2.7	600	3.18	18441	10762	7.96e+06	1.23e+07	4.97e+06	0.242
7B	2116	23.6	600	2.29	12106	6505	2.78e+06	3.39e+06	1.30e+06	0.297
8A	2249	15.5	600	2.44	14076	8040	3.68e+06	5.35e+06	2.12e+06	0.258
8B	2260	20.6	600	2.38	12051	6472	2.89e+06	3.49e+06	1.34e+06	0.297
9A	2320	24.2	600	2.45	16973	9400	5.63e+06	7.47e+06	2.92e+06	0.279
9B	2327	23.8	600	2.42	16148	8745	5.17e+06	6.44e+06	2.49e+06	0.293
10A	2432	24.9	600	2.26	11601	5976	2.65e+06	2.87e+06	1.09e+06	0.319
10B	2446	9.3	600	2.75	20958	12264	8.83e+06	1.38e+07	5.56e+06	0.240

m:R-66B/F

Table 7-6

ACOUSTIC TRANSIT TIME

Sample I.D.	Depth (feet)	Average Porosity %	Acoustic Transit Time - t (microseconds/foot)
1A	1325	34.4	112
1B	1334	32.5	111
2A	1442	33.7	99
2B	1457	28.9	99
3A	1623	35.3	105
3B	1636	30.5	95
4A	1727	28.3	100
4B	1732	34.3	105
5A	1771	30.3	100
5B	1780	26.5	92
6A	1898	31.4	90
6B	1902	30.1	87
7A	2078	2.7	83
7B	2116	23.6	77
8A	2249	15.5	73
8B	2260	20.6	90
9A	2320	24.2	68
9B	2327	23.8	75
10A	2432	24.9	85
10B	2446	9.3	80

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utilized in Section 7.3 to evaluate the strata porosities from the sonic log. The use of this equation is, however, restricted to those formations from which it was originally developed (Schlumberger 1972) and extremely low values of porosity and transit time should be viewed as less accurate and suspect. Lignite layers preclude the use of the equation anywhere throughout that material.

7.2.2.5 Heat Capacity

A sample from Core 10 was selected for heat capacity measurements. A calorimeter bucket was filled with a known mass of heat transfer oil and maintained at 75°F. After the sample weight, length, and diameter, were recorded, the sample was placed in a constant-temperature oven set to the test temperature of 100°F. Sample temperature was monitored continuously and, at temperature equilibrium, the sample was quickly lowered into the calorimeter bucket to minimize heat loss. The temperature of the heat transfer oil in the bucket was recorded every five minutes until consecutive readings were within 0.001°F. The final equilibrium temperature was then recorded and heat capacity calculated.

The result of the heat capacity measurement for the sample averaged 0.309 BTU/lb.-°F for the dry rock (see Appendix 19). Heat capacity for a water-saturated sample, derived by calculation, was also 0.300 BTU/lb.°F range. Standard average values of heat capacity for a water-saturated pure limestone, are somewhat lower, around 0.270 BTU/lb.°F, respectively (Hodgman, 1955), but still close to the value measured for this sample which is not a pure limestone at all, but rather a very dolomitic core.

7.2.2.6 Thermal Conductivity

A 1-1/2 inch-diameter horizontal plug was taken from Core 10 for thermal conductivity measurement. The sample was cut to approximately 1-1/4 inches in length and placed in a sample holder between pyroceram standards and saturated with the synthetic brine developed for that zone. The core assembly was then surrounded by a guard heater. The heat source and sink were mounted above and below the top and bottom standards and saturated with the synthetic brine developed for that zone. Axial and pore pressures of approximately 1,000 and 300 psi, respectively, were applied to the core sample. The guard heater was set to the initial test temperature (100°F), while the heat source and sink (top and bottom heaters) were set 30°F above and below the test temperature, respectively.

Temperatures were monitored and recorded at seven locations: inside the guard heater (midpoint of sample), at the top and bottom heater, below the top standard and above the bottom standard, and the top and bottom of the core sample. At a steady state condition (temperature equilibrium), temperature values were recorded and thermal conductivity values computed. The results of the measurement for the sample were 2.338 BTU/hr/ft/°F for the water-saturated sample (see Appendix 19).

7.2.2.7 Rock (Pore Volume) Compressibility

Three cored samples, 2A, 5A and 6A, were used in the rock-compressibility testing. The three vertical samples were restored to 100 percent saturation under vacuum, and then they were loaded into hydrostatic core holders and confining pressures were incrementally increased from 100 to 1,400 psi for samples 2 and 5 and from 100 to 1,700 psi for Sample 6. At each pressure, the volume of water produced from reduction in pore volume was monitored until stable. Pore volume reduction as a function of effective overburden was thus determined.

Rock compressibilities were calculated from these data. The results of these measurements are shown in Appendix 19.

7.2.2.8 X-ray Diffraction

The twenty samples from the ten cores were used for quantitative XRD analysis.

Quantitative XRD analyses were performed using an automated powder diffractometer. The weight percentages of minerals present in the sand/silt fractions were determined using internal standard ratio techniques. The weight percentages of the various minerals were determined by profile-fitting/empirical peak-area-ratio algorithms. The whole-rock compositions were calculated by mathematically combining the XRD data from all size fractions.

Compositions and species of clay minerals less than 1% could not be detected in the clay-size fractions using this method, but the detectability limit is 0.5 to 1.0 percent for crystalline phases present in the size fractions analyzed. The results of the analyses are tabulated in Appendix 19 and summarized in Table 7-7.

Table 7-7

X-RAY DIFFRACTION TEST DATA

Charlotte County Zemel Rd. Test/Injection Well
X-ray Diffraction Analysis
(weight %)

Orthorhombic $SrSO_4$ (Strontium Sulfate)

Depth, feet	Quartz	Calcite	Dolomite	Aragonite	Pyrite	Celestite	Hematite	Halite	Clay Minerals
1325	1	98	1	0	0	0	0	0	0
1334	1	98	1	0	0	0	0	0	0
1442	1	94	5	0	0	0	0	0	0
1457	1	87	12	0	0	0	0	0	0
1623	0	100	0	< 1	0	0	0	0	0
1636	1	99	0	0	0	0	0	0	0
1727	1	95	4	0	0	0	0	0	0
1732	1	97	2	0	0	0	0	0	0
1771	0	98	2	0	0	0	0	0	0
1780	1	98	1	0	0	0	0	< 1	0
1898	1	99	0	0	0	0	0	0	0
1902	1	99	0	0	0	0	0	0	0
2078	1	91	8	0	0	0	0	0	0
2116	1	0	48	0	0	51	0	0	0
2249	2	52	45	0	0	0	1	0	0
2260	2	72	26	0	0	0	0	0	0
2320	1	2	97	0	0	0	0	0	0
2327	1	1	98	0	0	0	0	0	0
2432	1	91	8	0	0	0	0	0	0
2446	1	34	65	0	0	0	0	0	0

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1,250 feet, now in the Ocala Group and in the Avon Park Limestone, the sonic log exhibited generally low values in transit time, although only to about 110 microseconds per foot, indicating low overall porosity. At 1,390 feet and at 1,560 feet, the trend reversed and the sonic log showed a sharp increase in transit time at those points. The higher porosity zones shown by the log at 1,390 feet, coincides with the middle of the upper monitor zone of the ZRL deep monitor well. An extremely low porosity zone extending from 1,400 to full depth of this log at 1,620 feet coincides with the tight zone in which the 10,000 mg/l TDS line occurs. This confirms that the deep monitor well, as constructed, monitors the first productive zone above the 10,000 mg/l TDS line and also confirms that the upper zone monitor well is in the first permeable zone above a confining zone that separates the upper and lower monitor zones.

Between 1,240 and the bottom of the pilot hole at 1,436 feet, the sonic log showed an average transit time of approximately 82 microseconds per foot, excluding a section between 1,290 and 1,310 feet where the acoustic log indicated high porosity.

The derivation of the porosity equation in Section 7.2.2.4 (see Table 7-6 and Figure 7-30) is based partially on the analysis of the core samples taken from the pilot hole between 1,329 and 1,340 feet in the Ocala, from 1,442 to 1,457 feet also in the Ocala, and from 1,622 to 1,637 feet in the Avon Park. The equation is thus applicable to those portions of the sonic log in which similar formations are encountered, that is, in the Avon Park and the Ocala. (It can not be used for the clayey Hawthorn, the dolosiltic Arcadia, or the sandy Suwannee since the acoustic travel times in those zones would not necessarily fit the empirical relationship.)

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 developed in Section 7.2.2 (see Figure 7-3) to further convert it to permeability. These calculations are in Section 9.

7.3.2.4 Temperature

The temperature of the water within the pilot hole increased from 76.5°F (24.7°C) just 50 feet below land surface to a high of 79°F (26.1°C) at a depth of 1,600 feet below land surface. One-half of a degree of this increase was a small and very gradual increase down to about 700 feet where no sharp temperature changes were identified, but at 700 feet, a sharp continuous increase started to be noticed.

The water temperature slowly increased with hole depth, rising 2.5 degrees Fahrenheit in 1,600 feet. This temperature change is the result of the natural increase in temperature with depth within the earth's crust; however, it is well below the widely accepted average rise of 10 degrees Fahrenheit per thousand feet. This lower than average temperature increase is frequently found to be the case in Florida due to the circulation of groundwater, and the proximity of the ocean on both sides of the peninsula.

7.3.2.5 Spontaneous Potential Log

The spontaneous potential log (with one exception in the bottom 50 feet) exhibited no highly noticeable deflections throughout the length of this portion of the pilot hole. It did, however, exhibit very subtle changes in potential from 440 to 620 feet, and from 1,050 to 1,250 feet as the tool traveled through the lower permeability zones. A sharp rise in potential at 1,540 feet is quite evident, and most likely is the result of the salinity of the water which begins to increase very rapidly, and as a result, the spontaneous potential voltage increased. This change, as discussed later, also showed up on the resistivity log, as a sharp drop in resistivity. The other electric log (16-64 Normals) also shows a change at that depth. This is obvious proof that the sharp change in the water quality from less than to more than 10,000 mg/l TDS occurs at this point and that there is good separation between the USDWS and the non-USDWS zones at this site.

7.3.2.6 Dual Induction Log

The induction log can be analyzed by utilizing the equations shown in Section 7.2.2.3 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 Section 7.4. Using this average, it is then possible to obtain a porosity value using Archie's equation.

The induction log for the pilot hole in the 440- to 1,610-foot depth range showed three distinctive segments, as discussed below.

In the section between 440 and 720 feet below land surface, both the deep and the medium depth inductive signals encountered very high resistivity and thus indicated that the formation offers almost just as much resistance as the near drilling fluid-filled wall. It was, therefore, concluded that the formations are not very porous in this section and that the drilling fluid did not penetrate deeply enough into them to affect the resistivity recorded by the deep penetrating signal. At 594 feet, 690 feet and 710 feet, there are higher porosity sections where the resistivity of both signals drop and come together.

Between 720 and 1,520 feet, the two induction signals are near each other and closely parallel each other. This is a very low porosity zone. In the 16-64 Normal Induction log from 1,250 to 1,500 feet, the medium depth signal actually met the deep signal, indicating that both signals were encountering similar resistance and probably extremely low permeability zones.

The next distinct section of the dual induction log occurred from 1,520 to 1,610 feet below land surface. This section showed even closer values for both sondes and a large drop in resistance which is normally indicative of higher overall porosity, but in this case is caused primarily by the high salinity of the water which makes it easier to conduct electricity and reduce resistance. This is the depth at which the salinity of the water begins to increase with depth. From that point down to the bottom of the pilot hole at full depth in this well, the high salinity greatly masks the data, although it is still possible to see thick alternating sections of high and low porosity.

The change at 1,520 feet and below would at first appear to be caused by highly permeable zones, but when the acoustic log for this zone was examined, no such indication was obvious. The alternative explanation for this drop in resistivity is indeed the water quality change. This is a case where the dual induction log alone is not sufficient to make conclusions regarding the permeability of a zone.

7.3.2.7 Fluid Resistivity Log

The fluid resistivity log did not provide any data to help analyze the well. The test had to be run with the hole filled with drilling fluids because there was no place to dispose of the salty fluids; consequently, the whole column was homogeneous and provided no change with depth or strata. Since no internal flow in the well is apparent, the resistivity of the water did not show change.

7.3.3 Pilot Hole - Third Stage

The third stage of the pilot hole to a depth of 1,860 feet was logged on February 26, 1992. This section of the pilot hole represents the data used to select the lower monitor zone. The geophysical logs run over this depth of the pilot hole included the following:

- Caliper
- Gamma Ray
- Acoustic
- Temperature
- Spontaneous Potential
- Fluid Resistivity
- Dual Induction
- Flowmeter
- Resistivity.

A copy of these geophysical logs is contained in Appendix 8.

All of the logs of this stage of pilot hole show a continuation of the conditions found at the bottom of the previous stage. The only difference is that as the hole advances deeper and deeper, the salinity of the water increases and therefore the resistivity logs show a decline with depth. At 1,810 feet, however, there is a significant change. There the first really permeable zone was encountered.

7.3.3.1 Sonic Log

The sonic log, run in the pilot hole prior to its being reamed out for the intermediate casing, provided additional information which indicated that the low permeability zones could be considered to extend another 250 feet below the USDW before the first permeable zone was reached at 1,800 feet. As a result, it was possible to select the lower monitor zone at 1,800 feet and take advantage of the greater monitor depth to increase the degree of reliability of the monitoring system.

In the section from 1,630 to 1,730 feet, the sonic log exhibited a zone of very low transit times (100 microseconds per foot or less); in another, between 1,764 feet and 1,800 feet below land surface, the transit time was even lower (75 microseconds per foot). These two sections have been identified as very confining, with permeabilities that calculate to values of less than 10^{-1} gpd/ft^2 (5 millidarcys) range (see Section 9). The interval within the lower monitor zone between 1,806 and 1,824 feet showed high transit times, and in fact, the sonic log showed a very high permeability at a depth where the transit time was 140 microseconds per foot. Since this high transit time is beyond the curve developed from the data (Figure 7-30) it is not possible to assign a permeability value to this zone, but it would be safe to say that it would be higher than 1,000 gpd/ft^2.

7.3.3.2 Dual Induction Log

Another log that was run in the pilot hole section from 1,500 to 1,860 feet also provided information on the confining qualities of the beds above the lower monitor zone. This log was also backed up with data from the 16-64 Normal Resistivity log. This resulted in much better differentiation between the deep and the medium induction signals and a much clearer showing of the low permeability of that zone.

The highly saline fluid in the section shown by the log is very conductive and easily transmits the induction signals. In the borehole itself, where the drilling fluid contains fresh make-up water, the conductive characteristic of the water is much lower. It is this characteristic that makes the induction log so reliable in identifying confining zones. Since the confining zones have low porosity and low permeability, the fresher drilling fluid does not invade the formation deeply. Therefore, the deeper inductive signal travels through the naturally high salinity water in the matrix, and produces a lower resistance in the log than the medium penetration induction signal which travels through the low conductivity fresher water in the borehole and produces a higher resistance in the log. This is represented in the log by the increase in distance between the lines.

The zone of high resistivity and thus low permeability was, therefore, easily identifiable from the dual induction log. The log showed an extremely resistive layer all the way down to 1,795 feet.

7.3.4 Pilot Hole - Fourth Stage

The hole for the last stage of the pilot hole was drilled after the installation and grouting of the intermediate steel casing and was subsequently logged on April 14-16, 1992. A television survey and a final set of geophysical logs were run on June 11-13, 1992. The geophysical logs run over the full length of the open hole to 2,710 feet below land surface, included:

- Caliper
- Gamma ray
- Temperature and fluid resistivity
- Spontaneous potential
- Acoustic (borehole compensated sonic)
- Dual induction and SP
- Flow meter
- Resistivity
- T.V. Video.

A copy of these geophysical logs is contained in Appendix 11.

7.3.4.1 Caliper Log

The caliper log was run in the pilot hole from below the intermediate casing to the full 2,710-foot depth. The pilot hole below the 1,860-foot depth of the pilot hole drilled for the intermediate casing was drilled with an 12-1/4-inch drill bit.

The caliper tool used to run the log had a long arm length and therefore, the caliper arms could not be fully extended to the size of a cavity when the distance from floor of cavity to roof of cavity was small. For this reason, the caliper was unable to record the full size of the smaller cavities found in the injection zone.

The caliper log, however, does provide good specific information in the areas with larger cavities and caverns. It shows, for example, a section with large hole size between 1,806 and 1,828 feet and two other similar large hole sections between 2,500 and 2,550 feet and between 2,604 and 2,710 feet. Cavernous zones are also indicated at 1,570 and at 2,373 feet. These caverns show well in the T.V. video (see Table 4-6). The cavity riddled zone between 1,806 and 1,828 feet is included in the Lower Monitor Zone, and the large caverns and small caverns below 2,500 feet are a significant part of the injection zone. There are also other high permeability intervals that, although they show no cavities, still provide good permeability due to primary porosity.

In addition, the caliper log shows a hole that is exremely tight in five parts of the well above the injection zone and below the Lower Monitor Zone. These are the sections of the strata that provide confinement of the injection zone. These five sections are from 2,380 to 2,490 feet from 2,296 feet to 2,350 feet, from 2,138 feet to 2,224 feet, from 1,970 feet to 2,050 feet, and from 1,840 feet to 1,850 feet.

7.3.4.2 Gamma Ray Log

The gamma ray log shows gamma ray counts averaging about 10 API units throughout the low permeability portion of the pilot hole. This is higher than in the highly permeable injection zone and backs up the contention that gamma ray sources are concentrated in the less permeable zones and are dissolved out by the moving groundwater in the higher permeability zones.

The only exception to this occurs at 2,374 feet where a cavern (see the caliper log) shows high gamma ray count. The reason for this is that the cavern is within a 4-foot lignite layer and the gamma count is produced by the lignite. In the tighter formations that make up the confining zones, the average gamma ray count increases beyond 20 API units, and in the most confining zones it averages about 30 API units. Following that observation, the gamma ray log indicates the existence of confining zones as follows: 1,820 to 1,850 feet, 1,970 to 2,052 feet, 2,140 to 2,224 feet, 2,300 to 2,324, and 2,400 to 2,474 feet; and the existence of highly permeable zones as follows: 1,806 to 1,816 feet, 2,500 to 2,542 feet, and 2,606 to 2,662 feet. Within the injection zone at a depth of 2,546 to 2,576 feet, the level of gamma activity picked up beyond 100 API units. This increase in gamma ray activity is associated with the lignite beds at those depths (see Figure 2-8 and Appendix 23).

7.3.4.3 Temperature and Fluid Resistivity

The temperature log run on the pilot hole on April 16, 1992 does not contribute to the evaluation of the injection zone, probably because the hole was still filled with the drilling fluids when the log was run. A much better analysis can be made of the June 27, 1992 temperature log that was run after the injection test had concluded. That second log shows a very sharp increase in temperature just above the upper monitor zone. This is probably caused by the greater groundwater flow in that permeable zone and the warming effects of it. Below that, in the confining zone where there is little circulation of groundwater to warm up the cool injection water, there is perfect evidence that the cooler injection test water is well insulated within the interval of the confining zone between 1,900 and 2,510 feet. Below that, from 2,510 feet to full depth there is obviously none of the injected water. The cavernous zone at around that depth has quickly dissipated the cooler water stored there and the natural warm water of the formation has taken over.

The temperature log, therefore, can be said to present excellent corroboration for the depth range of the confining interval and of the injection zone and is in full agreement with the data from the caliper and gamma ray logs.

One final item of interest gleamed from this log is a constant water temperature in the injection zone. This tends to confirm the theory of excellent water circulation in this zone and therefore the great permeability of the zone.

The fluid resistivity log showed no significant changes probably because of the same reason expressed earlier, and the June 29, 1992 log did not either because it was taken after homogeneous fresher water was injected. At the injection zone, however, we do see that there is some layering as evidenced by changes in fluid resistivity with varying depth.

7.3.4.4 Spontaneous Potential Log

The spontaneous potential log for the final pilot hole section of the well exhibited a pattern closely paralleled to that of the induction and the electric resistivity logs, but in opposite directions (potential vs. resistance). It clearly outlined the significant feature of high permeability in the injection zone and the low permeability features of the confining zone.

The signal deflections exhibited by the log appeared to be fully explainable by the lithologic changes, although some of the changes are attributable to water quality variations within the hole, since it is known that water quality gradually worsens with depth in the open hole (see Figure 9-1). Because of the great similarity with the conclusions for the dual induction log results, the reader should review these logs while studying Section 7.3.4.6 below.

7.3.4.5 Borehole Compensated Sonic Log

Use of the borehole compensated sonic log to qualify and quantify low permeability zones is one of the most reliable logs, but this log is not as reliable to quantify high permeability zones. The margin for error increases where there are cavities and caverns that introduce secondary porosity and destroy the relationship between transit time and porosity. Nevertheless, qualitatively the log is also ideal to identify those highly permeable zones.

The BHC shows four zones with very low transit times and one with extremely low transit times. They are from below the Lower Monitor Zone at 1,830 to 1,852 feet, from 1,978 to 2,050 feet, the lowest of all, from 2,138 to 2,240 feet, from 2,200 to 2,270 feet and the last one (just above the Injection Zone) from 2,380 to 2,492 feet. The BHC also shows three zones of moderate to medium permeability within the tighter zones. The first from 1,804 to 1,838 feet (the Lower Monitor Zones), the second from 2,248 to 2,300 feet and the third from 2,270 to 2,280 feet.

These high permeability zones are not continuous within the intervals shown. In reality, they are separated from each other by extremely impermeable but thin beds. Since these beds are thin, they are not likely to be very extensive (areawise), but their net effect is to increase the degree of confinement above the injection zone.

The sonic log identified the injection zone as consisting of two highly permeable zones separated by a lower permeability but still permeable zone. It also identified numerous thin layers within the highly permeable zones of the injection zone that are tight and of low permeability. Those zones straddle the previous zones described above. However, from 2,500 to 2,710 feet below land surface, the BHC shows no sections that can be described as impermeable. Consequently, the effective injection zone is estimated to be about 500 feet thick. Of this, one of the most permeable zones extends from 2,500 to 2,554 and the other from 2,600 to 2,710 feet.

7.3.4.6 Dual Induction

The induction logs run on this well and the 16-64 Normal Resistivity Log show excellent correlation with the acoustic log and with the caliper, gamma ray and temperature logs described earlier. The induction log has shown sufficient sensitivity and differentiation between signals to interpret both qualitatively and quantitatively the characteristics of the formation matrix from the induced currents traveling in the fluid inside the borehole and through the formations.

With this preamble in mind, the induction log of the confining and the injection zones are examined qualitatively in this section and quantitatively in Section 9. The most permeable zones appear to be from 1,806 to 1,828 feet, from 2,240 to 2,296 feet, and in the injection zone from 2,500 to 2,548 feet, and from 2,602 to 2,652 feet. The least permeable zones are from 1,830 to 1,850, from 1,972 to 2,050, from 2,134 down to 2,274 (the most impermeable zone) and from 2,296 down to 2,325 feet, all within the confining zone. Below the confining zone, at 2,550 feet to 2,580 feet, the induction log predicts low permeability as well. Below 2,652 feet to full depth at 2,710 feet, there is also a decrease in permeability indicated.

7.3.4.7 Flowmeter Log

The flowmeter log was run on April 16, 1992, but the well could not be pumped because there was no place to dispose of the water. Inside the open hole, small changes in velocity (RPM) can be seen in the log. These are due to uneven pulling on the cable drum and not to flow zones.

The only apparent flow in the well occurred at 2,654 feet, but lack of any other collaborating evidence makes it impossible to conclude whether this flow is or is not real and not just an extraneous event.

7.3.4.8 T.V. Video

The best method of identifying tight zones of low permeability, cavities and caverns is through a television survey. In conjunction with the dual induction log, the caliper log and the sonic log, confirmation of the presence of confining or producitive zones is a virtual certainty with the T.V. log. At ZRL, the sonic log and the induction log were in good agreement, confirming the majority of the caverns and cavities and confining layers identified in the television survey, but of the two, the sonic log was a better indicator. There was, however, a slight discrepancy in the depth indicator on the television videos. Therefore, the locations of the cavities and caverns, as shown by the geophysical logs and by the television survey differed. The difference is at times up to 2 feet. A description of the T.V. video can be found in Table 4-6 and in Appendix 1. A discussion has been presented in Section 4.6.2.

7.3.4.9 Summary

Besides the television survey log, the sonic and the induction logs are the best logs from which to interpret the presence of confinement and the presence of high permeability sections in the injection zone. Although neither of these logs can attach a numeric value to permeability when large openings are present, they nevertheless show where those openings are. The sonic log is particularly useful because the position of a single graph in this log provides an easy visual comparison. The induction log results are harder to visualize since both the positions of each of the three graphs and their relative positions to each other must be evaluated.

The sonic log of the injection zone of the ZRL deep test/injection well showed two sections where the transit time graph indicated the presence of highly permeable zones; but the principal one was found in the section between 2,498 and 2,548 feet. Another high permeability zone was shown by the graph between 2,610 and 2,700 feet, except for two tighter zones at 2,622 and 2,682 feet.

The sonic log also showed very slow transit times in the sections between 1,830 and 1,852 feet, between 1,972 and 2,042 feet, between 2,136 and 2,244 feet and 2,300 to 2,492 feet. The transit times between 2,136 and 2,244 feet indicated nearly impermeable conditions.

The dual induction log, like the sonic log, clearly identified the most permeable zones. It also identified all the low permeability confining zones shown by the acoustic log but was especially useful in identifying the extremely low permeability zone between 2,138 and 2,228 feet.

The tight confining zone and the high permeability injection zone identified in the television survey were also confirmed by the geophysical logs. The temperature log run after the injection test gave unusually good graphic representations of where the confing and the receiving zones are.

7.4 WATER QUALITY PROFILE

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 (see Appendix 27), beginning once the drilling operation switched from mud drilling to reverse air drilling on February 5, 1992 at 425 feet. The first such sample was collected at 454 feet and successive samples were collected at approximately 30-foot intervals. Also, as part of the core testing process, core laboratories also analyzed water from packer samples for use in the development of simulated brine needed for testing purposes. The straddle packer samples were collected at preselected depths (see Table 7-8). In addition, after well completion and development, water samples were collected in the open hole (the injection zone) using a point sampler. Finally, samples were collected at the end of development from the injection zone and from both the Upper and Lower Monitor Zones of the DZMW.

The drill stem water samples were analyzed for the following indicator field parameters at the drill site: conductivity, salinity, pH and temperature, and those field results were presented in the field notes (see Appendix 23). The samples were then shipped to Bionics Laboratory, Inc. for the more extensive analyses required and to double check in the lab the field parameters. The water samples collected

Table 7-8

STRADDLE PACKER SAMPLE RESULTS

Analysis	1,368'-1,404'	1,536'-1,568'	1,566'-1,601'	1,729'-1,765'*	2,086'-2,101'	2,197' 2,212'	2,332'-2,349'	2,423-2,438'
pH, Lab	7.77	7.59	7.03	7.71	7.15	7.30	7.03	6.19
Bicarbonate as $CaCO_3$, mg/l	60	90	99	33	86	108	97	40
Carbonate as CO_3, mg/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Chlorides as C1, mg/1	1,100	3,840	8,900	2,300	17,900	17,100	18,800	17,100
Conductivity umhos/cm	3,600	11,200	22,300	5,000	36,500	29,000	38,500	24,900
Flouride as F, mg/l	1.00	1.19	1.42	1.14	0.76	0.79	0.78	0.58
Sulfate as SO_4, mg/l	240	340	290	300	2,600	2,600	2,800	2,500
Total Dissolved Solids, mg/l	2,107	7,885	15,422	3,499	32,927	34,540	36,696	34,995
TOTAL METALS, mg/l								
Calcium as Ca	88.2	267	448	314	572	560	609	524
Iron as Fe	20.1	7.11	16.4	4.06	10.4	6.65	6.25	21.9
Magnesium as Mg	72.7	256	558	123	1,060	1,030	1,080	950
Potassium as K	16.3	56.2	95.5	28.0	344	330	352	328
Sodium as Na	398	1,780	3,800	728	9,940	9,420	9,500	9,290

*This packer reportedly leaked from above and the sample is probably contaminated with fresh water from the zones above.

m:R-66B/I

with the straddle packer and with the downhole sampler were also analyzed by Bionics. The results of the drill stem, straddle packers, and downhole point samples laboratory analyses are contained in Appendix 27. The samples collected at the end of development to represent pre-injection background conditions at the injection zone and at the two Monitor Zones were analyzed partly by Bionics and partly by PBS&J Environmental Lab. These results are included in Appendices 29 and 31, respectively.

All water quality data collected from the deep test/injection well and from the monitor well during construction are included in the above mentioned appendices (19, 23, 27, 29 and 31). There are, however, some important limitations on the accuracy of the data obtained from the drill stem samples. The formation water present at the depth of the drill bit was drawn into the drill stem along with the cuttings, but mixed with it was the uphole water. 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.

Two graphical methods were chosen to present the water quality data: the Stiff diagram and the Piper diagram. These diagrams are complementary in their respective presentations of water quality data.

The Stiff diagram is useful in showing both differences and similarities within the water composition (Hem, 1970), and readily expresses any trends in the water quality data with sampling depth. Stiff diagrams for the packer samples collected at various depths are displayed in Figure 7-31. Diagrams 1 and 2 at the top of the figure are representative of the USDW in the mid and lower portion of the Ocala Group (Crystal River and Williston Formations), respectively. Diagram 1 is also representative of the Upper Monitor Zone. Diagram 3 is from the zone immediately below the 10,000 mg/l TDS contact from the bottom of the Willison and the top of the Avon Park Formations. Diagram 4, which represents the Lower Monitor Zone, is from the Avon Park. Diagrams 5 through 8 are from the Lake City Formations. They represent water quality in the confining zone. Figure 7-31 also shows a Stiff diagram of typical seawater, number 10. This diagram is included for the purpose of comparison between seawater and water in the injection zone.

Table 9-2

INJECTION ZONE WATER QUALITY
(50-foot intervals)[a]

Parameter	2,500'	2,550'	2,600'	2,650'	2,700'	Injection Fluid	Pumping Composite	Sea* Water
Sodium	9,240	9,440	9,760	9,030	9,740	366	9,330	10,500
Magnesium	950	1,030	1,030	966	1,100	50	1,020	1,350
Potassium	339	358	353	334	369	240	352	380
Calcium	575	582	574	533	619	188	564	400
Chloride	17,600	19,000	19,100	18,800	18,600	109	18,850	19,000
Sulfate	2,300	2,800	2,400	2,400	2,680	170	2,300	2,700
Bicarbonate	97	123	123	129	138	-	109	142
Carbonate	.1	.1	.1	.1	.1	.1	.1	0
Iron	2.8	7.0	10.6	13.2	15.9	7.0	0.7	0.01

[a]Expressed as mg/l.
*Goldberg, 1963.

m:R-66C/F

Volume 2A

APPENDIX 1

T.V. SURVEY DESCRIPTIVE LOG

Zemel Rd Landfill

ZEMEL ROAD LANDFILL SITE
DEEP INJECTION WELL
T.V. SURVEY (APRIL 18 & 20, 1992)

DESCRIPTIVE LOG

The description of the T.V. survey of the formations penetrated by the test/injecton well is best accomplished by combining the T.V. surveys conducted at various times of the drilling process. This description uses the best and clearest pictures from each survey to describe the different zones. For example, it used the April 20, 1992 survey to describe the formations down to 2,495 feet, but used the April 18, 1992 tape to describe the open hole to 2,709 feet.

The following description begins with the zone immediately below the intermediate casing, including the lower monitor zone and passing through the confining zone. The description also includes the injection zone and ends at the bottom of the hole at 2,709 feet.

Depth (feet)	Comments
1,556	Out of casing.
1,568-1,573	Big hole diameter. Eroded.
1,573-1,692 (Core #3 1,622'-1,637')	Large diameter hole, but walls are smooth. This is a low permeability confining zone. One of the thickest continuously confining sequences.
1,692-1,701	Small, unconnected vugs; still a low permeability confining zone.
1,701-1,725	Very low permeability; confining.
1,725-1,730 (Core #4 1,727'-1,734')	Walls become rougher, but vugs and holes are not connected.
1,730-1,764 (Core #4 1,727'-1,734')	Increasing wall roughness; very rough 1,739'-1,744'.
1,764-1,782 (Core #5 1,772'-1,787')	Smooth well walls, low permeability.
1,782-1,792 (Core #5 1,772'-1,787')	Increasing roughness, but still of low permeability.
1,792-1,795	Very rough; large vugs, some holes.
1,795-1,803	Large vugs and small holes; broken walls.

1,803-1,813	Cavernous zone; large cavern whose walls are not visible. Lower Monitor Zone.
1,813-1,847	Numerous caverns; continuous and interconnected.
1,847-1,850	Rough walls; broken up in whole section; numerous holes.
1,850	Large cavity.
1,850-1,852	Rough walls; more cavities.
1,853-1,855	Large cavities; interconnected.
1,856-1,861	Smooth walls; low permeability.
1,861-1,864	Cavities and large interconnected holes.
1,865-1,868	Large cavities and all interconnected.
1,868-1,944 (Core #6 1,893'-1,906')	Extremely tight. Excellent confinement; one of the best confining sequences.
1,944-1,949	Some roughness, but still excellent confinement.
1,949-1,973	Extremely tight; possibly best confining zone.
1,973-1,975	Some holes and many vugs.
1,975-1,983	Many vugs; a few small holes, a few cavities.
1,985-1,990	Rough walls, some permeability.
1,990-1,994	Tight.
1,995-1,996	Small holes
1,998-2,001	Tight hole, very low permeability.
2,001-2,026	Extremely tight; excellent confinement; hole at 2,016 feet.
2,026-2,029	Several small vugs and holes
2,029-2,033	Very tight; good confinement.

2,033-2,040	Broken up zone; many fractures, holes and small cavities.
2,040-2,050	Very, very tight; one of the best confining zones.
2,050-2,053	Rough well walls; some holes.
2,053-2,055	Some roughness; a few holes.
2,055-2,080	Tight formation; good confinement, although walls are rough at a few places.
2,080-2,133 (Core #7 2,079'-2,117')	Very tight; extremely low permeability; good thick confining sequence.
2,133-2,137	Cavernous zone; small caverns and large cavities.
2,137-2,227	Long and continuous tight hole with good to excellent confinement.
2,227-2,228	Cavities not well interconnected.
2,228-2,240	Extremely tight and confining.
2,240-2,241	Cavity.
2,241-2,250 (Core #8 2,246'-2,262')	Very tight hole; very low permeability.
2,250-2,251	Cavity and holes.
2,251-2,660 (Core #8 2,246'-2,262')	Extremely tight; good confinement except for some fractures.
2,260-2,268	Some vertical fractures and connected cavities.
2,268-2,274	Cavities and interconnected holes and tunnels,
2,274-2,277	Great cavity and tunnels.
2,277-2,285	Very tight hole; good confinement.
2,285-2,291	Cavernous; broken well walls; tunnels across bore hole.
2,291-2,294	Very large series of interconnected caverns.

2,294-2,308	Caverns; broken up walls; high permeability zone.
3,308-2,312	Tightening hole.
2,312-2,357 (Core #9 2,310'-2,336')	Very tight, excellent confinement; one of best confining sequences.
2,357-2,359	Large holes, some may be considered cavities.
2,359-2,364	Tight, low permeability.
2,364-2,369	Holes, some cavities.
2,369-2,372	Tight hole, low permeability.
2,373-2,375	Black lignite zone.
2,375-2,404	Extremely tight hole; excellent confining zone; good thick sequence; one of the best.
2,404-2,495 (Core #10 2,432'-2,447')	Tight hole; very good confinement; good continuous sequence.
2,495-2,550	Very cavernous zone; very well interconnected; good injection potential. This zone consists of one cavern after the other.
2,550-2,564	Vertical fractures; otherwise a tight hole.
2,570-2,590	Lesser evidence of vertical fractures.
2,590-2,602	Extremely tight; low permeability.
2,602-2,709	All cavernous, with larger caverns from 2,602 feet to 2,618 feet, from 2,628 feet to 2,640 feet and from 2,641 feet to 2,649 feet.

Size classification for use with this description:

vug	Largest dimension 3" or less, round unless otherwise specified.
hole	Largest dimension 6" or less and of unspecified shape.
cavity	Largest dimension less than 2 feet, shape variable, usually discoid more than 3" high
cavern	Largest dimension more than 2 feet

SHAPE CLASSIFICATION

tunnel	2 cavities, essentially round, and so oriented that they probably extend across hole.
pancake cavities	A stack of flat cavities, usually larger than full hole size.

m:R-66A/Q

BASIC PROPERTIES AND LITHOLOGICAL DESCRIPTION

Zemel Rd. Test/Injection Well
Charlotte County, Florida

Sample I.D.	Depth, feet	Porosity, percent	Permeability to Air, millidarcies	Lithological Description
				Water Sample: Straddle Packer #6
1AH	1325	34.4	22.2	Ls, lt tan, fnly xln, mic, v foss
1AV	1325	33.3	18.0	Ls, lt tan, fnly xln, mic, v foss
1BH	1334	32.5	9.45	Ls, lt tan, fnly xln, mic, v foss
1BV	1334	34.4	7.59	Ls, lt tan, fnly xln, mic, v foss
2AH	1442	33.7	11.5	Ls, lt tan, fnly xln, mic, foss
2AV	1442	33.5	6.06	Ls, lt tan, fnly xln, mic, foss
2BH	1457	28.9	6.63	Ls, lt tan, fnly xln, mic, v foss, pyr
2BV	1457	25.4	12.9	Ls, lt tan, fnly xln, mic, v foss, pyr
				Water Sample: Straddle Packer #4
3AH	1623	35.3	23.6	Ls, lt tan, xln, mic, pel
3AV	1623	33.1	22.3	Ls, lt tan, xln, mic, pel
3BH	1636	30.5	43.2	Ls, lt tan, xln, mic, foss, pel
3BV	1636	28.8	23.1	Ls, lt tan, xln, mic, foss, pel
4AH	1727	28.4	29.4	Ls, lt tan, fnly xln, mic, sli foss
4AV	1727	29.0	16.2	Ls, lt tan, fnly xln, mic, sli foss
4BH	1732	34.3	58.3	Ls, lt tan, xln/sparry, mic, foss, pel
4BV	1732	27.8	34.6	Ls, lt tan, xln/sparry, mic, foss, pel
5AH	1771	30.3	20.1	Ls, lt brn, xln, congl, v mic
5AV	1771	27.7	5.97	Ls, lt brn, xln, congl, v mic
5BH	1780	26.2	5.92	Ls, lt brn, microxln, v mic, sli foss
5BV	1780	24.3	1.28	Ls, lt brn, microxln, v mic, sli foss
				Water Sample: Straddle Packer #10
6AH	1898	31.4	554.	Ls, lt tan, crlsy xln, mic
6AV	1898	32.2	575.	Ls, lt tan, crlsy xln, mic
6BH	1902	30.1	247.	Ls, lt brn, crsly xln, mic
6BV	1902	30.1	296.	Ls, lt brn, crsly xln, mic
7AH	2078	2.7	<0.001	Dol, dk brn, microxln, dns, tr pyr
7AV	2078	1.0	<0.001	Dol, dk brn, microxln, dns, tr pyr
7BH	2116	20.2	4.14	Ls, lt tan, xln, v mic, sli foss
7BV	2116	24.3	8.03	Ls, lt tan, xln, v mic, sli foss

BASIC PROPERTIES AND LITHOLOGICAL DESCRIPTION

Zemel Rd. Test/Injection Well
Charlotte County, Florida

Sample I.D.	Depth, feet	Porosity, percent	Permeability to Air, millidarcies	Lithological Description
			Water Sample: Straddle Packer #9	
8AH	2249	15.5	0.401	Ls, amber xls in lt gry mic matrix, lam
8AV	2249	16.5	0.258	Ls, amber xls in lt gry mic matrix, lam
8BH	2260	20.6	2.40	Ls, amber xls in lt gry mic matrix, lam
8BV	2260	20.6	0.907	Ls, amber xls in lt gry mic matrix, lam
			Water Sample: Straddle Packer #8	
9AH	2320	24.2	4.35	Dol, lt brn, fnly xlnto cryptxln, vug
9AV	2320	20.1	0.705	Dol, lt brn, fnly xlnto cryptxln, vug
9BH	2327	23.8	3.10	Dol, lt brn, fnly xln to cryptxln, calc
9BV	2327	23.8	2.13	Dol, lt brn, fnly xln to cryptxln, calc
			Water Sample: Stradlle Packer #7	
10AH	2432	24.9	13.2	Ls, lt tan, xln, mic, pyr
10AV	2432	26.4	24.0	Ls, lt tan, xln, mic, pyr
10BH	2446	9.3	0.342	Dol, lt tan, xln, mic, sli foss
10BV	2446	2.1	<0.001	Dol, lt tan, xln, mic, sli foss

APPENDIX 25

GEOLOGIC DESCRIPTION OF CORES

Zemel Rd Landfill

ZEMEL ROAD LANDFILL
TEST/INJECTION WELL
CORE DESCRIPTIONS

CORE SECTIONS SENT FOR ANALYSIS TO CORE LAB IN HOUSTON TEXAS AND HELD IN STORAGE AT THE PBS&J OFFICES

Core No.	Sample A (feet)	(To Lab)	Sample B (feet)	(To Lab)	Core Section (in feet)
1	1,325		1,334		1,324 - 1,340
2	1,442		1,457		1,442 - 1,457
3	1,623		1,636		1,622 - 1,637
4	1,727		1,732		1,727 - 1,732
5	1,771		1,780		1,772 - 1,787
6	1,898		1,902		1,893 - 1,906
7	2,078		2,116		2,078 - 2,117
8	2,249		2,260		2,246 - 2,262
9	2,320		2,327		2,310 - 2,314
10	2,432		2,446		2,432 - 2,447

LITHOLOGIC CORE DESCRIPTIONS

Core #1 A: Ls, lt tan, fnly xln, mic, v foss
Core #1 B: Ls, lt tan, fnly xln, mic, v foss

FOSSILIFEROUS LIMESTONE, very pale orange (10 YR 8/2), intergranular and moldic porosity (7-10%), grain type is micrite and biogenic, very fine grained, 40% allochems, poor to moderate cement with micrite matrix, mollusk molds, bryozoans, many forams, chalky.

Core #2 A: Ls, lt tan, fnly xln, mic, foss
Core #2 B: Ls, lt tan, fnly xln, mic, v foss, pyr

FOSSILIFEROUS LIMESTONE, very pale orange (10 YR 8/2) to yellowish gray (5 Y 7/2), grain type is micrite and biogenic, 45% allochems, very fine to medium grained, poor to moderate induration with micrite matrix, echinoids, benthic foraminifera.

Core #3 A: Ls, lt tan, xln, mic, pel
Core #3 B: Ls, lt tan, xln, mic, foss, pel

LIMESTONE, yellowish gray (5 Y 7/2), intergranular and moldic porosity (7%), grain type is micrite and biogenic, 40% allochems, moderate induration with micrite and sparry calcite cement, lignite veins present, forams including Dictyoconus.

Core #4 A: Ls, lt tan, fnly xln, mic, sli foss
Core #4 B: Ls, lt tan, xln/sparry, mic, foss, pel

LIMESTONE, yellowish gray (5 Y 7/2), intergranular porosity, grain type is micrite and biogenic, 10% allochems, moderate induration with micrite and sparry calcite cement, benthic foraminifera.

Core #5 A: Ls, lt brn, xln, congl, v mic
Core #5 B: Ls, lt brn, microxln, v mic, sli foss

LIMESTONE, yellowish gray (5 Y 7/2) to very pale orange (10 YR 8/2), intergranular and moldic porosity, grain type is micrite, interclast and biogenic, 10% allochems, moderate induration with micrite and sparry calcite cement, lignite veins.

Core #6 A: Ls, lt tan, crlsy xln, mic
Core #6 B: Ls, lt tan, crlsy xln, mic

FORAMINIFEROUS LIMESTONE, yellowish gray (5 Y 7/2) moldic, intergranular and intracrystalline porosity, possibly low permeability, grain type is biogenic, crystal and micrite, 55% allochems, poor to moderate induration with micrite and some sparry calcite cement, medium euhedral dolomite crystals in section (7%), benthic forams including Dictyoconus americanus and Coskinolina sp..

Core #7 A: Dol, dk brn, microxln, dns, tr pyr
Core #7 B: Ls, lt tan, xln, v mic, sli foss

DOLOMITIC LIMESTONE with DOLOMITE INCLUSIONS - limestone is very pale orange (10 YR 8/2) to yellowish gray (5 Y 7/2), intergranular, intercrystalline and moldic porosity, grain type is biogenic and micritic, 40% allochems, poor to good induration with micrite, sparry calcite and dolomite cement, forams, echinoids, the micrite and sparry calcite grade into each other, there are dolomite intervals but less than 10% of section. Dolomite crystals are located throughout the sample. The largest crystals are located in the micrite.

Core #8 A: Ls, amber xls in lt gry mic matrix, lam
Core #8 B: Ls, amber xls in lt gry mic matrix, lam

DOLOMITE LIMESTONE, very pale orange (10 YR 8/2), intergranular and intercrystalline porosity, possibly low permeability, medium euhedral dolomite crystals located throughout limestone, foraminiferous, some well preserved cones. Dolomite dense - dark yellowish brown (10 YR 4/2) in section, lignite also present in section (<2%).

Core #9 A: Dol, lt brn, fnly xln to cryptxln, vug
Core #9 B: Dol, lt brn, fnly xln to cryptxln, calc

DOLOMITE, dusky yellow (5 Y 6/4) to light olive brown (5 Y 5/6) to light olive gray (5 Y 5/2), intercrystalline and vugular porosity, highly altered, dolomitic limestone represents <10% of section - yellowish gray (5 Y 7/2).

Core #10 A: Ls, lt tan, xln, mic, pyr
Core #10 B: Ls, lt tan, xln, mic, sli foss

DOLOMITE (75%), dark yellowish brown (10 YR 4/2) and DOLOMITIC LIMESTONE (25%), very pale orange (10 YR 8/2), intergranular and intercrystalline porosity, moderate to good induration with sparry calcite and dolomite cement.

m:R-38D/I

Bionomics Laboratory, Inc.
4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
(407) 851-2560 FAX (407) 856-0886

UPPER MON. ZONE 1341'-1415'

YOUNGQUEST BROTHERS
15465 Pine Ridge Road
Ft. Myers, FL 33908

Attn: PBS&J MIAMI
Invoice Number: 10000304

Order #: B2-06-064
Date: 07/30/92 13:52
Work ID: MONITORING WELL
Date Received: 06/25/92
Date Completed: 07/28/92
Client Code: YOUNGQUEST_B

SAMPLE IDENTIFICATION

Sample Number	Sample Description
01	UPPER MON. ZONE 1341'-1415'
02	TRIP BLANK

Certified By
MARK KROMIS, CHEMIST

Zemel Road
Landfill
Water Quality Data

TEST RESULTS BY SAMPLE

Sample: 01A UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
FECAL COLIFORM	BDL	2	Colonies/100 mL	06/25/92	MJ
TOTAL COLIFORM	BDL	2	Colonies/100 mL	06/25/92	MJ

Sample: 01B UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
FECAL STREPTOCOCCI - MF	BDL	2	Colonies/100 mL	06/25/92	MJ

Sample: 01C UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
ACIDITY	NA		mg/L as CaCO3		
BIOCHEMICAL OXYGEN DEMAND	2.5	0.5	5 DAY: mg/L	06/26/92	MJ
CALCIUM HARDNESS	1,411	2	mg/L as CaCO3	07/22/92	ML
CARBON DIOXIDE	NA		mg/L		
CHLORIDE	925	5.0	mg/L	07/22/92	KS
COLOR	BDL	5	P-C UNITS	06/26/92	JK
CONDUCTIVITY	4,100	10.0	umhos/cm	07/02/92	JK
FLUORIDE	0.21	0.1	mg/L	06/29/92	LH
HYDROXIDE ALKALINITY	BDL	1	mg/L as CaCO3	07/22/92	ML
MAGNESIUM HARDNESS	69.6	3.0	mg/L as CaCO3	07/22/92	ML
METHYLENE BLUE ACT. SUBT.	0.07	0.05	mg/L	06/27/92	JK
NITRITE	0.07	0.02	mg/L	06/26/92	SB
ODOR	10	1	TON	06/26/92	KS
ORTHO PHOSPHOROUS	BDL	0.050	mg/L	06/26/92	SB
SATURATION INDEX	5.24		SAT. UNITS	07/22/92	ML
SILICA-H2O	178		mg/L	07/22/92	ML
SULFATE	432	1	mg/L	07/08/92	JK
pH	11.16	0.10	pH UNITS	06/26/92	LH

NEED: TOTAL Alkalinity

TEST RESULTS BY SAMPLE

Sample: 01D UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
TOTAL PHENOLICS	0.08	0.05	mg/L	07/08/92	KS

Sample: 01E UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
CYANIDE	BDL	0.02	mg/L	07/07/92	KS

Sample: 01F UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
CHEMICAL OXYGEN DEMAND	BDL	250	mg/L	07/01/92	BK

Sample: 01G UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
HYDROGEN SULFIDE	0.58	0.10	mg/L as H2S	06/26/92	KS

Sample: 01H UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
TOTAL ORGANIC CARBON	61.12	0.04	mg/L	07/07/92	JK

Sample: 01I UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
GROSS ALPHA	47+/-9.2		pCi/L	07/01/92	CG
GROSS BETA	195+/-11		pCi/L	07/01/92	CG
RADIUM 226	6.5+/-0.3		pCi/L	07/08/92	CG
RADIUM 228	0.6+/-0.4		pCi/L	07/10/92	CG

Sample: 01J UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
AMMONIA NITROGEN	0.40	0.03	mg/L	06/30/92	SB
NITRATE	BDL	0.02	mg/L	06/30/92	SB
TOTAL KJELDAHL NITROGEN	0.40	0.04	mg/L	07/01/92	SB
TOTAL ORGANIC NITROGEN	BDL	0.04	mg/L	07/01/92	SB
TOTAL PHOSPHORUS	1.00	0.050	mg/L	07/01/92	SB

Sample: 01K UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
ANTIMONY-FURNACE METHOD	BDL	0.005	mg/L	07/13/92	GDT
BORON-ICP METHOD	0.307	0.100	mg/l	07/13/92	GDT
COBALT-ICP METHOD	BDL	0.030	mg/l	07/13/92	GDT
LITHIUM-ICP METHOD	0.055	0.030	mg/l	07/13/92	GDT
MANGANESE-ICP METHOD	0.131	0.030	mg/l	07/13/92	GDT
STRONTIUM-ICP	6.30	0.050	mg/l	07/13/92	GDT
THALLIUM-FURNACE	BDL	0.005	mg/l	07/13/92	GDT
TITANIUM-ICP METHOD	1.06	0.100	mg/l	07/13/92	GDT

Test Description	Result	Limit	Units	Analyzed	By
TOTAL METALS					
Aluminum	20.2	0.1	mg/L	07/14/92	
Arsenic	BDL	0.02	mg/L	07/14/92	
Barium	0.151	0.03	mg/L	07/14/92	
Beryllium	BDL	0.005	mg/L	07/14/92	
Cadmium	BDL	0.0005	mg/L	07/14/92	
Calcium	565	0.5	mg/L	07/14/92	
Chromium	0.090	0.005	mg/L	07/14/92	
Copper	0.026	0.01	mg/L	07/14/92	
Iron	24.7	0.03	mg/L	07/14/92	
Lead	0.023	0.005	mg/L	07/14/92	
Magnesium	16.9	0.5	mg/L	07/14/92	
Mercury	BDL	0.005	mg/L	07/14/92	
Nickel	BDL	0.03	mg/L	07/14/92	
Potassium	31.1	0.5	mg/L	07/14/92	
Selenium	BDL	0.005	mg/L	07/14/92	
Silver	BDL	0.01	mg/L	07/14/92	
Sodium	498	0.5	mg/L	07/14/92	
Zinc	0.061	0.03	mg/L	07/14/92	

Sample: 01L UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
1,2-DIBROMO-3CHLOROPROPANE	BDL	0.02	µg/l	07/13/92	KL
ETHYLENE DIBROMIDE	BDL	0.02	µg/l	07/13/92	KL

Sample: 01M UPPER MON. ZONE 1341-1415' Collected: 06/24/92

Test Description	Result	Limit	Units	Analyzed	By
ACROLEIN	BDL	100	µg/l		
ACRYLONITRILE	BDL	100	µg/l		
REGULATED VOC/SOC 524.2					
VINYL CHLORIDE	BDL	0.5	ug/l	06/26/92	SWR
1,1-DICHLOROETHENE	BDL	0.5	ug/l	06/26/92	SWR
1,2-DICHLOROETHANE	BDL	0.5	ug/l	06/26/92	SWR
1,1,1-TRICHLOROETHANE	BDL	0.5	ug/l	06/26/92	SWR
CARBON TETRACHLORIDE	BDL	0.5	ug/l	06/26/92	SWR
BENZENE	BDL	0.5	ug/l	06/26/92	SWR
TRICHLOROETHENE	BDL	0.5	ug/l	06/26/92	SWR
TETRACHLOROETHENE	BDL	0.5	ug/l	06/26/92	SWR
1,4-DICHLOROBENZENE	BDL	0.5	ug/l	06/26/92	SWR
TOTAL TRIHALOMETHANES					
Chloroform	21	1	µg/L	06/29/92	SR
Bromodichloromethane	BDL	1	µg/L	06/29/92	SR
Dibromochloromethane	BDL	1	µg/L	06/29/92	SR
Bromoform	BDL	1	µg/L	06/29/92	SR
Total TTHMs	21	4	µg/L	06/29/92	SR

Bionomics Laboratory, Inc.

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(407) 851-2560 FAX (407) 856-0886

LOWER MON. ZONE 1795'-1854'

YOUNGQUEST BROTHERS
15465 Pine Ridge Road
Ft. Myers, FL 33908

Attn: PBS&J MIAMI
Invoice Number: 10000206

Order #: B2-06-034
Date: 08/04/92 09:22
Work ID: MONITORING WELL 1795FT-1854FT
Date Received: 06/24/92
Date Completed: 07/28/92
Client Code: YOUNGQUEST_B

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	MONITOR WELL DEEP ZONE 1795FT-1854FT		

Certified By
MARK KROMIS, CHEMIST

TEST RESULTS BY SAMPLE

Sample: 01A MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
FECAL COLIFORM	20	2	Colonies/100 mL	06/24/92	MJ
TOTAL COLIFORM	BDL	2	Colonies/100 mL	06/24/92	MJ

Sample: 01B MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
FECAL STREPTOCOCCI - MF	10	2	Colonies/100 mL	06/24/92	MJ

Sample: 01C MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
ACIDITY	NA		mg/L as CaCO3		
BIOCHEMICAL OXYGEN DEMAND	0.5	0.5	5 DAY: mg/L	06/26/92	MJ
CALCIUM HARDNESS	1,508	2	mg/L as CaCO3	07/22/92	ML
CARBON DIOXIDE	NA		mg/L		
CHLORIDE	17,473	5.0	mg/L	07/02/92	BC
COLOR	5	5.0	P-C UNITS	06/25/92	JK
CONDUCTIVITY	46,200	10.0	umhos/cm	07/02/92	JK
FLUORIDE	0.70	0.10	mg/L	06/29/92	LH
HYDROXIDE ALKALINITY	BDL	1	mg/L as CaCO3	07/22/92	ML
MAGNESIUM HARDNESS	4,365	3	mg/L as CaCO3	07/22/92	ML
METHYLENE BLUE ACT. SUBT.	BDL	0.05	mg/L	06/24/92	JK
NITRITE	BDL	0.02	mg/L	06/25/92	SB
ODOR	4	1	TON	06/24/92	KS
ORTHO PHOSPHOROUS	BDL	0.050	mg/L	06/25/92	SB
SATURATION INDEX	0.88		SAT. UNITS	07/22/92	ML
SILICA-H2O	10.0		mg/L	07/22/92	ML
SULFATE	2,700	1	mg/L	07/08/92	JK
TOTAL ALKALINITY	123	1	mg/L as CaCO3	06/26/92	LH
TOTAL DISSOLVED SOLIDS	34,858	0.5	mg/L	06/25/92	LH
TOTAL FIXED SOLIDS	4,182	0.5	mg/L	06/29/92	LH
TOTAL HARDNESS	5,873	5.0	mg/L as CaCO3	07/22/92	ML
TOTAL SOLIDS	34,866	0.5	mg/L	06/29/92	LH
TOTAL SUSPENDED SOLIDS	7.5	0.5	mg/L	06/29/92	LH
TOTAL VOLATILE SOLIDS	30,684	0.5	mg/L	06/30/92	LH
TURBIDITY	13	0.05	N.T.U.	06/25/92	JK
pH	7.51	0.10	pH UNITS	06/26/92	LH

TEST RESULTS BY SAMPLE

Sample: 01D MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
TOTAL PHENOLICS	BDL	0.05	mg/L	07/08/92	KS

Sample: 01E MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
CYANIDE	BDL	0.02	mg/L	07/07/92	KS

Sample: 01F MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
CHEMICAL OXYGEN DEMAND	BDL	250	mg/L	07/01/92	BK

Sample: 01G MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
HYDROGEN SULFIDE	BDL	0.10	mg/l as H2S	06/26/92	KS

Sample: 01H MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
TOTAL ORGANIC CARBON	20.85	0.04	mg/l	07/07/92	JK

Sample: 01I MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
GROSS ALPHA	74+/-46.4		pCi/L	07/01/92	CG
GROSS BETA	1260+/-71		pCi/L	07/01/92	CG
RADIUM 226	48+/-0.7		pCi/L	07/08/92	CG
RADIUM 228	1.2+/-0.4		pCi/L	07/10/92	CG

Sample: 01J MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
AMMONIA NITROGEN	BDL	0.03	mg/L	06/30/92	SB
NITRATE	0.20	0.02	mg/L	06/30/92	SB
TOTAL KJELDAHL NITROGEN	0.70	0.04	mg/L	07/01/92	SB
TOTAL ORGANIC NITROGEN	0.70	0.04	mg/L	07/01/92	SB
TOTAL PHOSPHORUS	0.50	0.050	mg/L	07/01/92	SB

Sample: 01K MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
ANTIMONY-FURNACE METHOD	BDL	0.050	mg/L	06/25/92	KS
BORON-ICP METHOD	3.26	0.5	mg/L	07/07/92	KS
COBALT-ICP METHOD	BDL	0.030	mg/L	07/07/92	GT
HEXAVALENT CHROMIUM	BDL	0.050	mg/L	06/25/92	KS
LITHIUM-ICP METHOD	0.169	0.030	mg/L	07/07/92	KS
MANGANESE-ICP METHOD	BDL	0.030	mg/L	06/30/92	KS
STRONTIUM-ICP	18.4	0.050	mg/L	07/07/92	KS
THALLIUM-FURNACE	BDL	0.025	mg/L	06/25/92	KS
TITANIUM-ICP METHOD	BDL	0.100	mg/L	07/07/92	KS

Test Description	Result	Limit	Units	Analyzed	By
TOTAL METALS					
Aluminum	BDL	0.1	mg/L	07/14/92	
Arsenic	BDL	0.02	mg/L	07/14/92	
Barium	0.039	0.03	mg/L	07/14/92	
Beryllium	BDL	0.005	mg/L	07/14/92	
Cadmium	BDL	0.0005	mg/L	07/14/92	
Calcium	604	0.5	mg/L	07/14/92	
Chromium	BDL	0.005	mg/L	07/14/92	
Copper	BDL	0.01	mg/L	07/14/92	
Iron	0.768	0.03	mg/L	07/14/92	
Lead	0.012	0.005	mg/L	07/14/92	
Magnesium	1,060	0.5	mg/L	07/14/92	
Mercury	BDL	0.005	mg/L	07/14/92	
Nickel	BDL	0.03	mg/L	07/14/92	
Potassium	355	0.5	mg/L	07/14/92	
Selenium	0.034	0.005	mg/L	07/14/92	
Silver	BDL	0.01	mg/L	07/14/92	
Sodium	9,300	0.5	mg/L	07/14/92	
Zinc	BDL	0.03	mg/L	07/14/92	

Sample: 01L MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
1,2-DIBROMO-3CHLOROPROPANE	0.353	0.02	μg/l	07/04/92	KL
ETHYLENE DIBROMIDE	BDL	0.02	μg/l	07/04/92	KL

Sample: 01M MONITOR WELL DEEP ZONE Collected: 06/23/92

Test Description	Result	Limit	Units	Analyzed	By
ACROLEIN	BDL	100	μg/l		
ACRYLONITRILE	BDL	100	μg/l		
REGULATED VOC/SOC 524.2					
VINYL CHLORIDE	BDL	0.5	μg/l	07/02/92	SWR
1,1-DICHLOROETHENE	BDL	0.5	μg/l	07/02/92	SWR
1,2-DICHLOROETHANE	BDL	0.5	μg/l	07/02/92	SWR
1,1,1-TRICHLOROETHANE	BDL	0.5	μg/l	07/02/92	SWR
CARBON TETRACHLORIDE	BDL	0.5	μg/l	07/02/92	SWR
BENZENE	BDL	0.5	μg/l	07/02/92	SWR
TRICHLOROETHENE	BDL	0.5	μg/l	07/02/92	SWR
TETRACHLOROETHENE	BDL	0.5	μg/l	07/02/92	SWR
1,4-DICHLOROBENZENE	BDL	0.5	μg/l	07/02/92	SWR
TOTAL TRIHALOMETHANES					
Chloroform	21	1	μg/L	06/29/92	SR
Bromodichloromethane	BDL	1	μg/L	06/29/92	SR
Dibromochloromethane	BDL	1	μg/L	06/29/92	SR
Bromoform	BDL	1	μg/L	06/29/92	SR
Total TTHMs	21	4	μg/L	06/29/92	SR

Zemel Road Landfill

APPENDIX 27

WATER QUALITY ANALYSIS

1. Drill Stem Water Quality Results (T/I Well)
2. Downhole Point Samples Water Quality Results (T/I Well)
3. Straddle Packers Water Quality Results (T/I Well)
4. Drill Stem Water Quality Results (DZMW)

Bionomics Laboratory, Inc.
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(407) 851-2560 FAX (407) 856-0886

March 5, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

Drill Stem Results.

ATTN: William Pitt

RE: Sample(s) Received 2/7/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

Casing set at 427'

LABORATORY REPORT

LAB I.D. NO.	9201301	9201302	9201303
MARKS	STA. 1 454 ft.	STA. 2 483 ft.	STA. 3 513 ft.
DATE SAMPLED	2/5/92	2/5/92	2/5/92
TIME SAMPLED	0415	0520	0620
pH, Lab	12.06	12.18	12.10
Bicarbonate as $CaCO_3$, mg/l	500	470	454
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	99	103	103
Conductivity umhos/cm	2,500	2,700	2,600
Flouride as F, mg/l	1.32	1.46	1.49
Sulfate as SO_4, mg/l	204	194	225
Total Dissolved Solids, mg/l	972	929	935
TOTAL METALS, mg/l			
Calcium as Ca	232	240	167
Iron as Fe	0.43	0.46	0.23
Magnesium as Mg	6.67	4.72	2.05
Potassium as K	12.3	13.0	10.7
Sodium as Na	132	137	109

(E) = Less than statistically valid number of colonies or greater than 200 colonies per plate or confluent growth precent.

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RE: Sample(s) Received 2/7/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201304	9201305	9201306
MARKS	STA. 4 543 ft.	STA. 5 572 ft.	STA. 6 602 ft.
DATE SAMPLED	2/5/92	2/5/92	2/5/92
TIME SAMPLED	0900	1130	1355
pH, Lab	11.84	11.81	11.78
Bicarbonate as $CaCO_3$, mg/l	344	259	192
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	151	273	248
Conductivity umhos/cm	1,900	2,000	2,200
Flouride as F, mg/l	1.65	1.63	1.50
Sulfate as SO_4, mg/l	204	265	275
Total Dissolved Solids, mg/l	855	856	1,049
TOTAL METALS, mg/l			
Calcium as Ca	244	458	164
Iron as Fe	0.55	0.56	0.20
Magnesium as Mg	10.1	16.4	2.42
Potassium as K	11.4	12.5	13.3
Sodium as Na	126	144	178

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March 5, 1992

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Miami, Fl. 33166-6622

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RE: Sample(s) Received 2/7/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201307	9201308	9201309
MARKS	STA. 7 632 ft.	STA. 8 662 ft.	STA. 9 692 ft.
DATE SAMPLED	2/5/92	2/5/92	2/5/92
TIME SAMPLED	1735	1939	----
pH, Lab	11.72	11.60	11.34
Bicarbonate as $CaCO_3$, mg/l	165	170	102
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	241	247	246
Conductivity umhos/cm	1,100	1,100	1,100
Flouride as F, mg/l	1.74	1.69	1.78
Sulfate as SO_4, mg/l	296	260	290
Total Dissolved Solids, mg/l	1,008	975	943
TOTAL METALS, mg/l			
Calcium as Ca	290	148	313
Iron as Fe	0.96	0.22	0.12
Magnesium as Mg	21.3	1.07	4.27
Potassium as K	13.0	12.7	13.4
Sodium as Na	163	156	167

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RE: Sample(s) Received 2/7/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201310	9201311	9201312
MARKS	STA. 10	STA. 11	STA. 12
	722 ft.	752 ft.	782 ft.
DATE SAMPLED	2/6/92	2/6/92	2/6/92
TIME SAMPLED	----	----	----
pH, Lab	10.96	8.40	8.08
Bicarbonate as $CaCO_3$, mg/l	64	66	138
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	216	178	147
Conductivity umhos/cm	1,000	1,100	970
Flouride as F, mg/l	2.12	1.65	1.36
Sulfate as SO_4, mg/l	280	250	150
Total Dissolved Solids, mg/l	849	703	661
TOTAL METALS, mg/l			
Calcium as Ca	369	454	539
Iron as Fe	1.53	1.34	0.13
Magnesium as Mg	26.0	33.3	15.9
Potassium as K	12.5	13.5	11.9
Sodium as Na	140	156	133

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RE: Sample(s) Received 2/7/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201313	9201314	9201315
MARKS	STA. 13 812 ft.	STA. 14 842 ft.	STA. 15 872 ft.
DATE SAMPLED	2/6/92	2/6/92	2/6/92
TIME SAMPLED	----	----	----
ʼH, Lab	7.69	10.96	10.97
icarbonate as $CaCO_3$, mg/l	223	63	63
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	114	221	219
Conductivity umhos/cm	860	1,400	1,400
Flouride as F, mg/l	0.80	2.05	2.02
Sulfate as SO_4, mg/l	85	290	300
Total Dissolved Solids, mg/l	569	841	855
TOTAL METALS, mg/l			
Calcium as Ca	163	123	207
Iron as Fe	0.54	0.29	1.19
Magnesium as Mg	6.20	2.41	9.95
Potassium as K	11.9	11.1	12.1
odium as Na	143	126	137

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RE: Sample(s) Received 2/10/92, Submitted By Client For Analysis.
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LABORATORY REPORT

LAB I.D. NO. MARKS DATE SAMPLED TIME SAMPLED	9201372 STA. 16 902 ft. 2/6/92 0700	9201373 STA. 17 932 ft. 2/6/92 0830	9201374 STA. 18 962 ft. 2/6/92 1020
pH, Lab	10.35	9.35	10.01
Bicarbonate as $CaCO_3$, mg/l	117	52	55
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	223	169	277
Conductivity umhos/cm	1,200	960	1,400
Flouride as F, mg/l	1.83	1.62	2.05
Sulfate as SO_4, mg/l	290	240	340
Total Dissolved Solids, mg/l	832	698	984
TOTAL METALS, mg/l			
Calcium as Ca	602	146	465
Iron as Fe	0.32	0.26	1.50
Magnesium as Mg	9.67	2.46	31.3
Potassium as K	10.8	11.4	8.54
Sodium as Na	147	164	118

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RE: Sample(s) Received 2/10/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201375	9201376	9201377
MARKS	STA. 19 992 ft.	STA. 20 1021 ft.	STA. 21 1052 ft.
DATE SAMPLED	2/6/92	2/6/92	2/6/92
TIME SAMPLED	1230	1430	1725
pH, Lab	10.46	10.24	9.62
Bicarbonate as $CaCO_3$, mg/l	52	50	55
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	301	281	320
Conductivity umhos/cm	1,400	1,300	1,400
Flouride as F, mg/l	2.15	2.05	1.97
Sulfate as SO_4, mg/l	320	290	300
Total Dissolved Solids, mg/l	959	879	873
TOTAL METALS, mg/l			
Calcium as Ca	140	359	211
Iron as Fe	0.11	0.87	0.59
Magnesium as Mg	1.95	19.8	6.22
Potassium as K	10.9	9.96	9.68
Sodium as Na	157	140	151

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Miami, Fl. 33166-6622

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T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201378	9201379	9201380
MARKS	STA. 22 1082 ft.	STA. 23 1112 ft.	STA. 24 1142 ft.
DATE SAMPLED	2/6/92	2/6/92	2/6/92
TIME SAMPLED	1830	1902	2133
pH, Lab	9.69	9.57	9.55
Bicarbonate as $CaCO_3$, mg/l	38	28	72
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	286	310	344
Conductivity umhos/cm	1,400	1,400	1,400
Flouride as F, mg/l	1.98	2.00	1.96
Sulfate as SO_4, mg/l	290	300	290
Total Dissolved Solids, mg/l	1,032	1,051	1,040
TOTAL METALS, mg/l			
Calcium as Ca	418	157	242
Iron as Fe	1.31	0.34	0.68
Magnesium as Mg	16.2	3.16	6.34
Potassium as K	9.70	9.55	12.6
Sodium as Na	155	152	159

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Bionomics Laboratory, Inc.

4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
(407) 851-2560 FAX (407) 856-0886

March 5, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 2/10/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201381	9201382	9201383
MARKS	STA. 25	STA. 26	STA. 27
	1172 ft.	1202 ft.	1232 ft.
DATE SAMPLED	2/6/92	2/7/92	2/7/92
TIME SAMPLED	2318	0045	0158
pH, Lab	9.60	9.53	9.36
Bicarbonate as $CaCO_3$, mg/l	30	38	38
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	307	335	378
Conductivity umhos/cm	1,600	1,600	1,600
Flouride as F, mg/l	2.00	1.96	1.86
Sulfate as SO_4, mg/l	275	310	300
Total Dissolved Solids, mg/l	1,064	1,135	1,251
TOTAL METALS, mg/l			
Calcium as Ca	184	204	203
Iron as Fe	0.31	0.44	0.46
Magnesium as Mg	5.52	8.38	5.39
Potassium as K	10.1	10.7	11.2
Sodium as Na	157	173	178

(E) = Less than statistically valid number of colonies or greater than 200 colonies per plate or confluent growth precent.

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LABORATORY REPORT

LAB I.D. NO.	9201384	9201385	9201386
MARKS	STA. 28 1262 ft.	STA. 29 1292 ft.	STA. 30 1322 ft.
DATE SAMPLED	2/7/92	2/7/92	2/7/92
TIME SAMPLED	----	----	----
pH, Lab	9.33	9.04	10.29
Bicarbonate as $CaCO_3$, mg/l	33	82	60
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	388	359	359
Conductivity umhos/cm	1,700	1,700	1,500
Flouride as F, mg/l	1.68	1.79	2.10
Sulfate as SO_4, mg/l	290	280	310
Total Dissolved Solids, mg/l	1,288	1,308	1,195
TOTAL METALS, mg/l			
Calcium as Ca	136	153	589
Iron as Fe	0.19	0.23	0.20
Magnesium as Mg	3.20	4.20	36.2
Potassium as K	9.64	10.3	11.5
Sodium as Na	167	180	179

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RE: Sample(s) Received 2/14/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201682	9201683	9201684
MARKS	STA. 31 1352 ft.	STA. 32 1382 ft.	STA. 33 1412 ft.
DATE SAMPLED	2/11/92	2/11/92	2/11/92
TIME SAMPLED	1040	1345	0250
pH, Lab	8.06	8.12	8.07
Bicarbonate as $CaCO_3$, mg/l	125	85	106
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	730	790	800
Conductivity umhos/cm	2,600	2,600	2,700
Flouride as F, mg/l	1.11	1.06	1.13
Sulfate as SO_4, mg/l	260	270	280
Total Dissolved Solids, mg/l	1,952	1,975	2,061
TOTAL METALS, mg/l			
Calcium as Ca	242	194	155
Iron as Fe	0.61	0.38	0.25
Magnesium as Mg	39.9	42.5	43.8
Potassium as K	13.6	148	15.2
Sodium as Na	287	311	310

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LABORATORY REPORT

LAB I.D. NO.	9201685	9201686	9201687
MARKS	STA. 34 1442 ft.	STA. 35 1475 ft.	STA. 36 1501 ft.
DATE SAMPLED	2/11/92	2/12/92	2/12/92
TIME SAMPLED	0345	2025	2225
pH, Lab	8.02	8.40	8.23
Bicarbonate as $CaCO_3$, mg/l	110	96	94
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	1,075	1,075	1,225
Conductivity umhos/cm	2,700	2,900	3,200
Flouride as F, mg/l	1.01	1.08	1.02
Sulfate as SO_4, mg/l	280	280	280
Total Dissolved Solids, mg/l	2,077	2,352	2,397
TOTAL METALS, mg/l			
Calcium as Ca	197	134	712
Iron as Fe	0.28	0.14	0.040
Magnesium as Mg	47.0	55.3	66.0
Potassium as K	14.9	15.8	15.8
Sodium as Na	316	364	374

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LABORATORY REPORT

LAB I.D. NO. MARKS DATE SAMPLED TIME SAMPLED	9201688 STA. 37 1531 ft. 2/13/92 0005	9201689 STA. 38 1561ft. 2/13/92 0255
pH, Lab	8.43	8.37
Bicarbonate as $CaCO_3$, mg/l	119	196
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	1,200	1,300
Conductivity umhos/cm	2,600	3,100
Flouride as F, mg/l	1.03	2.00
Sulfate as SO_4, mg/l	290	290
Total Dissolved Solids, mg/l	2,392	2,520
TOTAL METALS,mg/l		
Calcium as Ca	515	154
Iron as Fe	0.032	0.46
Magnesium as Mg	72.1	48.0
Potassium as K	396	14.8
Sodium as Na	16.5	331

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8600 N.W. 36TH ST.
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ATTN: William Pitt

RE: Sample(s) Received 2/18/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9201789	9201790
MARKS	STA. 39 1592 ft.	STA. 40 1622 ft.
DATE SAMPLED	2/13/92	2/13/92
TIME SAMPLED	0455	0621
pH, Lab	8.03	7.95
Bicarbonate as $CaCO_3$, mg/l	198	297
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	1,350	1,350
Conductivity umhos/cm	3,200	2,900
Flouride as F, mg/l	1.00	1.05
Sulfate as SO_4, mg/l	250	250
Total Dissolved Solids, mg/l	2,680	2,574
TOTAL METALS, mg/l		
Calcium as Ca	190	133
Iron as Fe	0.24	0.10
Magnesium as Mg	71.4	63.6
Potassium as K	167	15.9
Sodium as Na	411	387

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March 18, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 2/27/92, Submitted By Client For Analysis.
T/I WELL CHARLOTTE CO. ZEMEL RD. LANDFILL
DEEP INJECTION WELL PROJECT

LABORATORY REPORT

LAB I.D. NO.	9202264	9202265	9202266
MARKS	41 1652 ft.	42 1682 ft.	43 1712 ft.
DATE SAMPLED	2/21/92	2/21/92	2/21/92
TIME SAMPLED	0444	0605	0800
pH, Lab	7.94	7.98	8.01
Bicarbonate as $CaCO_3$, mg/l	284	173	131
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	940	950	1,070
Conductivity umhos/cm	3,200	3,100	3,200
Flouride as F, mg/l	1.20	1.01	0.98
Sulfate as SO_4, mg/l	220	225	235
Total Dissolved Solids, mg/l	2,213	2,208	2,341
TOTAL METALS, mg/l			
Calcium as Ca	212	159	128
Iron as Fe	0.22	0.12	0.038
Magnesium as Mg	88.8	86.4	86.5
Potassium as K	16.5	17.2	18.5
Sodium as Na	431	437	460

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DEEP INJECTION WELL PROJECT

LABORATORY REPORT

LAB I.D. NO.	9202267	9202268	9202269
MARKS	44 1742 ft.	45 1772 ft.	46 1802 ft.
DATE SAMPLED	2/24/92	2/24/92	2/25/92
TIME SAMPLED	1525	1735	1357
pH, Lab	8.05	8.04	8.20
Bicarbonate as $CaCO_3$, mg/l	278	210	100
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	860	1,040	920
Conductivity umhos/cm	3,300	3,300	3,400
Flouride as F, mg/l	1.15	0.99	0.52
Sulfate as SO_4, mg/l	240	260	245
Total Dissolved Solids, mg/l	2,117	2,279	2,175
TOTAL METALS, mg/l			
Calcium as Ca	178	461	146
Iron as Fe	0.18	< 0.030	0.060
Magnesium as Mg	78.8	82.4	79.5
Potassium as K	17.5	18.5	17.8
Sodium as Na	479	501	460

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DEEP INJECTION WELL PROJECT

LABORATORY REPORT

LAB I.D. NO.	9202270	9202271
MARKS	47 1831 ft.	48 1862 ft.
DATE SAMPLED	2/25/92	2/26/92
TIME SAMPLED	1735	0410
pH, Lab	7.99	7.92
Bicarbonate as $CaCO_3$, mg/l	105	273
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	2,120	9,500
Conductivity umhos/cm	6,300	26,300
Flouride as F, mg/l	0.52	0.44
Sulfate as SO_4, mg/l	230	1,250
Total Dissolved Solids, mg/l	4,808	19,004
TOTAL METALS,mg/l		
Calcium as Ca	319	446
Iron as Fe	0.25	0.24
Magnesium as Mg	159	614
Potassium as K	1,110	202
Sodium as Na	45.2	5,190

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June 4, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
3140 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 4/7/92, Submitted By Client For Analysis.
T/L WELL CHARLOTTE CO. ZEMEL RD. LANDFILL REVISED
WELL DEEP INJECTION WELL PROJECT #10-231.46

LABORATORY REPORT

LAB I.D. NO.	9204066	9204067	9204068
MARKS	STA. 49 1893'	STA. 50 1923'	STA. 51 1953'
DATE SAMPLED	4/1/92	4/2/92	4/2/92
TIME SAMPLED	1201	1345	1505
pH, Lab	8.07	7.89	7.97
Bicarbonate as $CaCO_3$, mg/l	68	79	79
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	11,550	11,800	12,700
Conductivity umhos/cm	32,900	33,000	33,800
Flouride as F, mg/l	0.46	0.61	0.60
Sulfate as SO_4, mg/l	1,800	1,600	1,600
Total Dissolved Solids, mg/l	23,152	23,585	23,951
TOTAL METALS,mg/l			
Calcium as Ca	839	1,050	1,113
Iron as Fe	0.060	0.069	0.11
Magnesium as Mg	621	667	689
Potassium as K	254	249	278
Sodium as Na	6,580	6,520	7,090

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WELL DEEP INJECTION WELL PROJECT #10-231.46

LABORATORY REPORT

LAB I.D. NO.	9204069	9204070	9204071
MARKS	STA. 52 1983'	STA. 53 2013'	STA. 54 2043'
DATE SAMPLED	4/2/92	4/2/92	4/3/92
TIME SAMPLED	1712	1910	2315
pH, Lab	8.19	8.08	7.90
Bicarbonate as $CaCO_3$, mg/l	56	63	89
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	13,400	13,800	14,900
Conductivity umhos/cm	35,900	38,300	41,600
Flouride as F, mg/l	0.51	0.54	0.62
Sulfate as SO_4, mg/l	1,800	1,800	2,000
Total Dissolved Solids, mg/l	25,556	26,816	28,933
TOTAL METALS,mg/l			
Calcium as Ca	533	629	538
Iron as Fe	0.24	1.46	0.72
Magnesium as Mg	710	721	814
Potassium as K	286	278	307
Sodium as Na	7,340	7,680	8,390

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WELL DEEP INJECTION WELL PROJECT #10-231.46

LABORATORY REPORT

LAB I.D. NO.	9204072	9204073	9204074
MARKS	STA. 55 2073'	STA. 56 2103'	STA. 57 2133'
DATE SAMPLED	4/3/92	4/3/92	4/5/92
TIME SAMPLED	0230	0530	2110
pH, Lab	7.79	7.94	7.84
Bicarbonate as $CaCO_3$, mg/l	152	95	105
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	16,400	15,500	16,600
Conductivity umhos/cm	45,400	43,000	44,400
Flouride as F, mg/l	0.62	0.59	0.63
Sulfate as SO_4, mg/l	2,400	2,200	2,400
Total Dissolved Solids, mg/l	31,991	29,507	32,175
TOTAL METALS,mg/l			
Calcium as Ca	1,070	952	543
Iron as Fe	1.15	1.34	0.83
Magnesium as Mg	957	843	886
Potassium as K	357	318	334
Sodium as Na	8,660	7,920	8,280

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LABORATORY REPORT

LAB I.D. NO.	9204075	9204076
MARKS	STA. 58 2163'	STA. 59 2193'
DATE SAMPLED	4/6/92	4/6/92
TIME SAMPLED	0255	1135
pH, Lab	7.88	7.96
Bicarbonate as $CaCO_3$, mg/l	116	130
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	17,800	18,400
Conductivity umhos/cm	48,600	48,100
Flouride as F, mg/l	0.69	0.67
Sulfate as SO_4, mg/l	2,500	2,600
Total Dissolved Solids, mg/l	34,359	34,881
TOTAL METALS,mg/l		
Calcium as Ca	445	1,110
Iron as Fe	0.26	0.90
Magnesium as Mg	770	1,190
Potassium as K	286	381
Sodium as Na	7,250	10,200

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May 1, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

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LABORATORY REPORT

LAB I.D. NO.	9204338	9204339	9204340
MARKS	STA. 60 2,223 ft.	STA. 61 2,253 ft.	STA. 62 2,283 ft.
DATE SAMPLED	4/6/92	4/8/92	4/8/92
TIME SAMPLED	1715	0246	0559
pH, Lab	7.84	7.69	7.72
Bicarbonate as $CaCO_3$, mg/l	130	144	122
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	18,500	18,200	18,700
Conductivity umhos/cm	39,000	47,800	48,900
Flouride as F, mg/l	0.78	0.82	0.68
Sulfate as SO_4, mg/l	2,650	2,650	2,750
Total Dissolved Solids, mg/l	38,149	37,409	37,767
TOTAL METALS,mg/l			
Calcium as Ca	704	674	795
Iron as Fe	4.82	8.20	3.76
Magnesium as Mg	1,040	1,030	1,050
Potassium as K	383	390	393
Sodium as Na	9,510	9,670	9,710

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LABORATORY REPORT

LAB I.D. NO.	9204341
MARKS	STA. 63 2,310 ft.
DATE SAMPLED	4/8/92
TIME SAMPLED	1010
pH, Lab	7.76
Bicarbonate as $CaCO_3$, mg/l	124
Carbonate as CO_3, mg/l	< 1
Chlorides as Cl, mg/l	18,500
Conductivity umhos/cm	47,200
Flouride as F, mg/l	0.76
Sulfate as SO_4, mg/l	2,700
Total Dissolved Solids, mg/l	38,772
TOTAL METALS,mg/l	
Calcium as Ca	600
Iron as Fe	2.82
Magnesium as Mg	1,030
Potassium as K	380
Sodium as Na	9,460

SIGNED: [signature]
Mark Kromis, Chemist

Bionomics Laboratory, Inc.
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May 4, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 4/15/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL, PROJECT # 10.231.46

LABORATORY REPORT

LAB I.D. NO.	9204451	9204452	9204453
MARKS	STA. 64 2,343 FT.	STA. 65 2,373 FT.	STA. 66 2,404 FT.
DATE SAMPLED	4/10/92	4/10/92	4/11/92
TIME SAMPLED	2328	2358	0150
pH, Lab	7.88	7.86	7.82
Bicarbonate as $CaCO_3$, mg/l	130	120	144
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	17,900	18,400	18,200
Conductivity umhos/cm	47,100	43,100	50,400
Flouride as F, mg/l	0.79	0.64	0.71
Sulfate as SO_4, mg/l	2,650	2,675	2,600
Total Dissolved Solids, mg/l	37,574	37,973	37,600
TOTAL METALS,mg/l			
Calcium as Ca	672	734	857
Iron as Fe	1.89	4.23	6.17
Magnesium as Mg	1,160	1,190	1,140
Potassium as K	344	354	337
Sodium as Na	10,000	10,100	9,730

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Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 4/15/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL, PROJECT # 10.231.46

LABORATORY REPORT

LAB I.D. NO.	9204454	9204455	9204456
MARKS	STA. 67 2,434 FT.	STA. 68 2,462 FT.	STA. 69 2,492 FT.
DATE SAMPLED	4/11/92	4/12/92	4/12/92
TIME SAMPLED	0445	0358	0558
pH, Lab	7.84	8.04	7.80
Bicarbonate as $CaCO_3$, mg/l	118	118	121
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	18,400	17,800	17,200
Conductivity umhos/cm	46,300	45,700	45,700
Flouride as F, mg/l	0.73	0.71	0.70
Sulfate as SO_4, mg/l	2,650	2,600	2,500
Total Dissolved Solids, mg/l	38,555	36,293	35,791
TOTAL METALS, mg/l			
Calcium as Ca	1,010	649	613
Iron as Fe	1.44	1.09	0.89
Magnesium as Mg	1,240	1,080	1,050
Potassium as K	346	333	314
Sodium as Na	10,100	9,380	8,970

Bionomics Laboratory, Inc.
4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
(407) 851-2560 FAX (407) 856-0886

May 4, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 4/15/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL, PROJECT # 10.231.46

LABORATORY REPORT

LAB I.D. NO.	9204457	9204458	9204459
MARKS	STA. 70 2,522 FT.	STA. 71 2,552 FT.	STA. 72 2,582 FT.
DATE SAMPLED	4/12/92	4/12/92	4/13/92
TIME SAMPLED	1548	2014	0142
pH, Lab	7.87	7.88	7.73
Bicarbonate as $CaCO_3$, mg/l	121	29	46
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	18,600	18,800	18,700
Conductivity umhos/cm	49,500	40,000	40,400
Flouride as F, mg/l	0.71	0.69	0.68
Sulfate as SO_4, mg/l	2,700	2,600	2,750
Total Dissolved Solids, mg/l	38,879	38,195	38,205
TOTAL METALS,mg/l			
Calcium as Ca	641	624	654
Iron as Fe	0.36	0.37	1.24
Magnesium as Mg	1,160	1,140	1,140
Potassium as K	363	347	348
Sodium as Na	9,940	9,770	9,640

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LABORATORY REPORT

LAB I.D. NO.	9204460	9204461	9204462
MARKS	STA. 73 2,612 FT.	STA. 74 2,642 FT.	STA. 75 2,672 FT.
DATE SAMPLED	4/13/92	4/13/92	4/13/92
TIME SAMPLED	0445	0640	2030
pH, Lab	7.66	7.78	7.72
Bicarbonate as $CaCO_3$, mg/l	43	50	32
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	18,700	19,000	18,700
Conductivity umhos/cm	40,900	39,500	40,000
Flouride as F, mg/l	0.74	0.75	0.75
Sulfate as SO_4, mg/l	2,700	2,700	2,700
Total Dissolved Solids, mg/l	38,399	38,025	38,653
TOTAL METALS,mg/l			
Calcium as Ca	697	689	672
Iron as Fe	2.03	1.01	2.20
Magnesium as Mg	1,160	1,170	1,200
Potassium as K	352	353	360
Sodium as Na	9,880	9,770	10,100

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Miami, Fl. 33166-6622

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LABORATORY REPORT

LAB I.D. NO.	9204463	9204464
MARKS	STA. 76 2,702 FT.	STA. 77 2,710 FT.
DATE SAMPLED	4/14/92	4/14/92
TIME SAMPLED	0035	2225
pH, Lab	7.49	7.77
Bicarbonate as $CaCO_3$, mg/l	32	30
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	18,700	19,000
Conductivity umhos/cm	40,400	39,000
Flouride as F, mg/l	0.82	0.82
Sulfate as SO_4, mg/l	2,550	2,700
Total Dissolved Solids, mg/l	38,547	38,427
TOTAL METALS,mg/l		
Calcium as Ca	678	681
Iron as Fe	8.56	2.89
Magnesium as Mg	1,190	1,180
Potassium as K	356	348
Sodium as Na	10,000	9,870

Bionomics Laboratory, Inc.
4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
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July 21, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 6/12/92, Submitted By Client For Analysis.
ZEMEL RD TEST INJECTION WELL PROJECT T/I WELL PROJECT # 10.231.46

Downhole samples?

LABORATORY REPORT

LAB I.D. NO. / MARKS	9207204 2500 FT.	9207205 2550 FT.	9207206 2600 FT.
Alkalinity as $CaCO_3$, mg/l	97	123	123
Bicarbonates as $CaCO_3$, mg/l	97	123	123
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	17,600	19,000	19,100
Sulfate as SO_4, mg/l	2,300	2,800	2,400
TOTAL METALS,mg/l			
Calcium as Ca	575	582	574
Iron as Fe	2.79	7.04	10.6
Magnesium as Mg	950	1,030	1,030
Potassium as K	339	358	353
Sodium as Na	9,240	9,440	9,760

Bionomics Laboratory, Inc.

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July 21, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 6/12/92, Submitted By Client For Analysis.
ZEMEL RD TEST INJECTION WELL PROJECT T/I WELL PROJECT # 10.231.46

LABORATORY REPORT

LAB I.D. NO. MARKS	9207207 2650 FT.	9207208 2700 FT.
Alkalinity as $CaCO_3$, mg/l	129	138
Bicarbonates as $CaCO_3$, mg/l	129	138
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	18,800	18,600
Sulfate as SO_4, mg/l	2,400	2,680
TOTAL METALS,mg/l		
Calcium as Ca	533	619
Iron as Fe	13.2	15.9
Magnesium as Mg	966	1,100
Potassium as K	334	369
Sodium as Na	9,030	9,740

Bionomics Laboratory, Inc.

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May 21, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 5/1/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9205197	9205198	9205199
MARKS	SP # 7 2423'-2438'	SP #8 2332'-2349'	SP # 9 2197'-2212
DATE SAMPLED	4/25/92	4/25/92	4/25/92
TIME SAMPLED	1228	2110	0600
pH, Lab	6.19 ✓	7.03	7.30
Bicarbonate as $CaCO_3$, mg/l	ok 40	97	108
Carbonate as CO_3, mg/l	< 1	< 1	< 1
Chlorides as Cl, mg/l	17,100 ✓	18,800	17,100
Conductivity umhos/cm	[redacted]00	3[redacted]	2[redacted]000
Flouride as F, mg/l	0.58	0.78	0.79
Sulfate as SO_4, mg/l	2,500	2,800	2,600
Total Dissolved Solids, mg/l	[redacted]95	3[redacted],696	[redacted]4,540
TOTAL METALS,mg/l			
Calcium as Ca	524	609	560
Iron as Fe	21.9	6.25	6.65
Magnesium as Mg	950	1,080	1,030
Potassium as K	328	352	330
Sodium as Na	9,290	ok 10 [redacted]	9,420

Possibly Invalid

Bionomics Laboratory, Inc.
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May 21, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 5/1/92, Submitted By Client For Analysis.
T/1 WELL CHARLOTTE CO. ZEMEE RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9205200
MARKS	SP # 10 2086'-2101'
DATE SAMPLED	4/26/92
TIME SAMPLED	1340
pH, Lab	7.15
Bicarbonate as $CaCO_3$, mg/l	86
Carbonate as CO_3, mg/l	< 1
Chlorides as Cl, mg/l	17,900
Conductivity umhos/cm	[redacted]
Flouride as F, mg/l	0.76
Sulfate as SO_4, mg/l	2,600
Total Dissolved Solids, mg/l	32,927
TOTAL METALS,mg/l	
Calcium as Ca	572
Iron as Fe	10.4
Magnesium as Mg	1,060
Potassium as K	344
Sodium as Na	9,940

APPENDIX 29

INJECTION ZONE BACKGROUND WATER QUALITY ANALYSES

Zemel Rd. Landfill

Bionomics Laboratory, Inc.
4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
(407) 851-2560 FAX (407) 856-0886

COVER PAGE - ANALYSIS DATA PACKAGE

CLIENT NAME: POST, BUCKLEY, SCHUH & JERNIGAN

ATTN: WILLIAM PITT

LAB NAME: BIONOMICS LABORATORY, INC.

ANALYSIS: T/1 WELL CHARLOTTE CO., ZEMEE RD. LANDFILL

LAB I.D. NO: 9207203

Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager, as verified by the following signature.

Mark Kromis
Mark Kromis, Chemist

August 12, 1992
Date

Bionomics Laboratory, Inc.
4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
(407) 851-2560 FAX (407) 856-0886

August 12, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 6/12/92, Submitted By Client For Analysis.
T/I WELL CHARLOTTE CO. ZEMEL RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9207203
MARKS	T/I WELL
DATE SAMPLED	6/11/92
TIME SAMPLED	0400
pH, Lab	7.69
Alkalinity as $CaCO_3$, mg/l	109
Bicarbonate as $CaCO_3$, mg/l	109
Carbonate as CO_3, mg/l	< 1
Hydroxide as $CaCO_3$, mg/l	< 1
Biochemical Oxygen Demand, 5 Day, mg/l	1.8
Chemical Oxygen Demand, mg/l	< 250
Chlorides as Cl, mg/l	18,850
Color, Pt/Co Units	< 5
Conductivity umhos/cm	49,100
Cyanide as CN, mg/l	< 0.02
Fluoride as F, mg/l	0.80
Foaming Agents, MBAS, mg/l	< 0.05
Hydrogen Sulfide as S, mg/l	< 0.10
Hardness, Total, as $CaCO_3$, mg/l	5,608
Calcium Hardness as $CaCO_3$, mg/l	1,408
Magnesium Hardness as $CaCO_3$, mg/l	4,200

POST, BUCKLEY, SCHUH AND JERNIGAN
August 12, 1992
Page Two

LABORATORY REPORT

LAB I.D. NO. MARKS	9207203 T/I WELL
Total Nitrogen as N, mg/l	< 0.80
Ammonia Nitrogen as N, mg/l	0.30
Nitrate Nitrogen as N, mg/l	< 0.20
Nitrite Nitrogen as N, mg/l	< 0.02
Organic Nitrogen as N, mg/l	< 0.40
Total Kjeldahl Nitrogen as N, mg/l	< 0.40
Odor, T.O.N.	NOD
Oil & Grease, mg/l	< 0.50
Ortho Phosphate as P, mg/l	< 0.050
Total Phosphorous as P, mg/l	< 0.50
Phenols, mg/l	0.06
Saturation Index	0.98
Sulfate as SO_4, mg/l	2,300
Total Solids, mg/l	37,871
Volatile Solids, mg/l	4,104
Fixed Solids, mg/l	33,767
Total Dissolved Solids, mg/l	37,861
Total Suspended Solids, mg/l	10
Total Organic Carbon, mg/l	12.23
Turbidity, N.T.U.	6.5
Hexavalent Chromium as Cr	< 0.050

LABORATORY REPORT

LAB I.D. NO. MARKS	9207203 T/I WELL
TOTAL METALS: mg/l	
Aluminum as Al	< 0.050
Antimony as Sb	< 0.025
Arsenic as As	< 0.025
Barium as Ba	0.048
Boron as B	3.28
Cadmium as Cd	0.0023
Calcium as Ca	564
Chromium as Cr	< 0.025
Cobalt as Co	< 0.030
Copper as Cu	< 0.010
Iron as Fe	0.71
Lead as Pb	< 0.010
Magnesium as Mg	1,020
Manganese as Mn	0.50
Mercury as Hg	< 0.005
Lithium as Li	0.16
Nickel as Ni	< 0.030
Potassium as K	352
Selenium as Se	< 0.025

LABORATORY REPORT

LAB I.D. NO.	9207203
MARKS	T/I WELL
Silver as Ag	< 0.010
Sodium as Na	9330
Strontium as Sr	18.0
Thallium as Tl	< 0.025
Titanium as Ti	< 0.030
Vanadium as V	< 0.030
Zinc as Zn	< 0.030

Bionomics Laboratory, Inc.

4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
(407) 851-2560 FAX (407) 856-0886

March 19, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 3/3/92, Submitted By Client For Analysis.
CHARLOTTE CO. ZEMEL ROAD LANDFILL T/I WELL PROJECT

Probable leakage not included in data base.

LABORATORY REPORT

LAB I.D. NO.		9202422	9202423
MARKS	straddle Packer	SP # 3 1,765'-1,729'	SP # 4 1,566'-1,601'
DATE SAMPLED		2/27/92	3/2/92
TIME SAMPLED		2115	1330

pH, Lab	7.71	7.03
Bicarbonate as $CaCO_3$, mg/l	329 ?.33	99
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	2300	89 ? 8900
Conductivity umhos/cm	5,000	22,300
Fluoride as F, mg/l	1.14	1.42
Sulfate as SO_4, mg/l	300	290
Total Dissolved Solids, mg/l	3,499**	15,422 0.57
TOTAL METALS, mg/l		
Calcium as Ca	314	448
Iron as Fe	4.06	16.4
Magnesium as Mg	123	558
Potassium as K	28.0	95.5
Sodium as Na	728	3,800

** Sample turbid after filtering through 934 Whatman Filter Paper EPA Method 160.1. Turbidity reflects high TDS values.

(E) = Less than statistically valid number of colonies or greater than 200 colonies per plate or confluent growth present.

Bionomics Laboratory, Inc.

4310 E. Anderson Road Orlando, Florida 32812 DHRS/DER # 83331, E 83012
(407) 851-2560 FAX (407) 856-0886

March 30, 1992

FOR: POST, BUCKLEY, SCHUH & JERNIGAN
8600 N.W. 36TH ST.
Miami, Fl. 33166-6622

ATTN: William Pitt

RE: Sample(s) Received 3/5/92, Submitted By Client For Analysis.
T/I WELL CHARLOTTE CO. ZEMEL RD. LANDFILL

LABORATORY REPORT

LAB I.D. NO.	9202625	9202838 *
MARKS:	SP #5 1536-1568 ft.	#6 SP 1368-1404 ft.
DATE SAMPLED:	3/3/92	
TIME SAMPLED:	1835	---
pH, Lab	7.59	7.77
Bicarbonate as $CaCO_3$, mg/l	90	60
Carbonate as CO_3, mg/l	< 1	< 1
Chlorides as Cl, mg/l	3,840	1,100
Conductivity umhos/cm	11,200	3,600
Flouride as F, mg/l	1.19	1.00
Sulfate as SO_4, mg/l	340	240
Total Dissolved Solids, mg/l	7,885	2,107
TOTAL METALS, mg/l		
Calcium as Ca	267	88.2
Iron as Fe	7.11	20.1
Magnesium as Mg	256	72.7
Potassium as K	56.2	16.3
Sodium as Na	1,780	398

TDS/COND = 0.70

TDS/COND = 0.58

* Sample(s) Received 3/10/92, Submitted By Client For Analysis.
T/I WELL CHARLOTTE CO. ZEMEL RD. LANDFILL