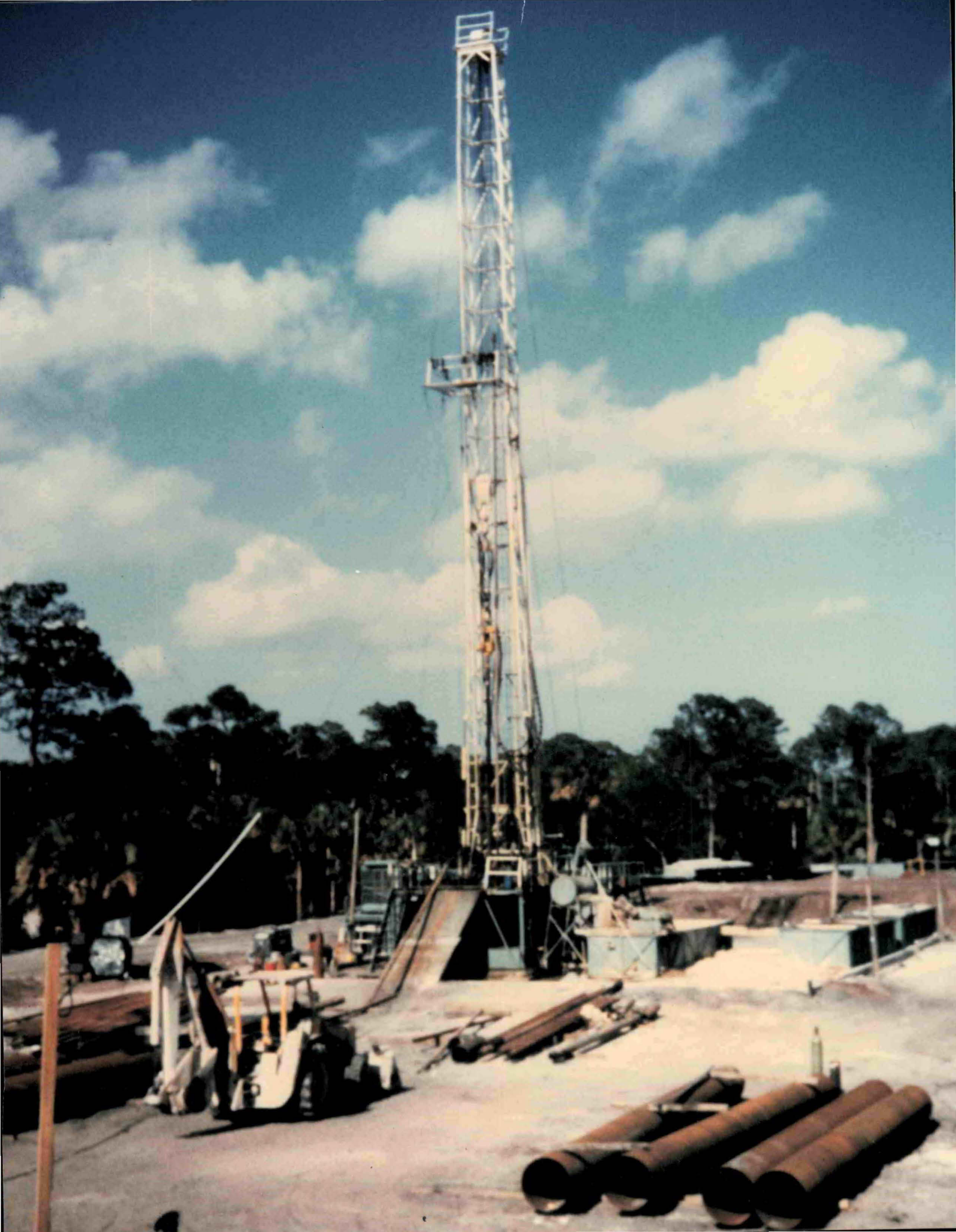

GERAGHTY
& MILLER, INC.
Ground-Water Consultants

24 November 1986
P658MI4

Mr. John Armstrong
Department of Environmental
Regulation
3319 Maguire Blvd., Suite 232
Orlando, FL 32803

Dear John,

Enclosed are two copies of the final report for the Merritt Island Injection Wells.

If you have any questions or need additional copies, please give me a call.

Sincerely,
GERAGHTY & MILLER, INC.

James A. Wheatley
Senior Scientist

JAW:bt

Enclosure

cc: Ann Bradner, U.S.G.S.
Rich Duerling, DER
Rick Levin, SJRWMD
John Mason, EPA

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GROUNDWATER
PROTECTION

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GERAGHTY & MILLER, INC.

CONSTRUCTION AND TESTING
OF THE
MERRITT ISLAND INJECTION WELLS
BREVARD COUNTY, FLORIDA

November 1986

Prepared for:
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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

FIGURES, TABLES AND APPENDICES

FIGURES

TABLES

APPENDICES

CONSTRUCTION AND TESTING OF THE MERRITT ISLAND INJECTION WELLS BREVARD COUNTY, FLORIDA

INTRODUCTION

In April 1985, the Florida Department of Environmental Regulation (FDER) issued a construction permit (No. UC05-094275) for two 18-inch-diameter, Class I Test Injection Wells to be installed at a location approximately one mile east of the Indian River, one mile north of the Canaveral Barge Canal, and two miles west of the Banana River in Brevard County, Florida. Refer to site location map, Figure 1 and well location map, Figure 2.

On August 19, 1985, contract documents and specifications prepared by Geraghty & Miller, Inc. (G&M) were made available to qualified contractors for bidding on the construction of the wells. A pre-bid conference took place on August 15, 1985. Bids were received by Brevard County on August 29, 1985. The contract was awarded to Layne-Atlantic Company, on September 5, 1985.

The specifications contained provisions for the drilling and testing of two 18-inch-diameter injection wells to a total depth of 2500 feet, collecting of cores to determine adequate confinement, and conducting injection testing on each well to demonstrate that the injection zone could accept the design flow rate of eight million gallons per day. Also a program for the plugging and abandonment of the well was presented in the event suitable conditions were not found.

Layne-Atlantic first mobilized manpower and equipment to the Merritt Island Wastewater Treatment Plant site on December 9, 1985. Both holes were completed to a total depth of 2500 feet by August 30, 1986. Final testing of the wells, including geophysical logging and injection testing was completed by September 10, 1986.

Tests were conducted at various intervals during the construction program. Core samples were obtained from discrete sections of the pilot hole of both wells between 1100 feet and 1900 feet. These cores were described in detail by the G&M on-site geologist, and portions of all but one core were sent to the Professional Service Industries, Inc., for analysis of specific parameters, including permeability and porosity. The one core not sent for analysis was from Injection Well 2 (IW-2) and taken from a depth of 1210 feet to 1229 feet. Only 15 percent of the core was recovered, and in pieces too small for analysis.

After completion of the pilot hole drilling to 2500 feet, geophysical logs were performed in the boreholes. The logging program included dual-induction, borehole-compensated sonic, caliper, temperature, gamma ray, long and short normal, and spontaneous potential. A gyroscopic survey of each completed pilot hole was also performed.

After the final string of casing was set and cemented in place in each of the wells, a pressure test was conducted on the casing before drilling out the cement plug. At the completion of drilling, cement bond logs were run inside the final string of casing in each well. Finally, injection tests were conducted in order to demonstrate that the wells could accept the volumes of effluent for which they were designed. Data from these tests were collected and evaluated by G&M personnel. G&M provided overall supervision of the drilling and testing program for each of the injection wells.

As a condition of the construction permit, FDER requested that upon completion of drilling and testing, a final report summarizing the information obtained during the program be submitted along with an application to operate the wells.

This report documents the results of the investigation and contains information collected during the construction and testing of the wells. Conclusions are drawn regarding the capability of the injection zones to accept effluent and the integrity of the confining sequence. A monitoring program that will provide information necessary to evaluate performance during operation of the disposal system is also presented. Copies of the various geophysical logs, geologic logs, and laboratory reports of chemical analyses of water samples, and core tests are included in the Appendices. This information is submitted in support of a permit to operate the Merritt Island wells in accordance with Section 17-28.26(1) Florida Administrative Code (FAC) and Specific Condition 3 of the construction permit.

FINDINGS

1. The data from both injection wells and the exploratory well demonstrate the presence of a highly transmissive injection zone saturated with saline water (contains more than 10,000 milligrams per liter (mg/L), total dissolved solid (TDS)).

2. The top of the injection zone occurs at 1900 ± feet below land surface with its base at 2500 ± feet, for a total thickness of approximately 600 feet.

3. The injection zone is capable of accepting effluent at the design flow rate with acceptable injection pressures.

4. The injection zone is highly transmissive and is estimated to be greater than 1,000,000 gallons per day per foot (gpd/ft).

5. The vertical permeability of the cores taken from the most significant confining sequence, (between 1600 feet and 1900 feet) range from 0.000000138 cm/sec to 0.000000151 cm/sec in Injection Well 1

(IW-1) and from 0.00000189 cm/sec to 0.00000572 cm/sec in Injection Well 2 (IW-2).

6. The presence of suitable geologic conditions, a highly transmissive injection zone filled with water having greater than 10,000 mg/L, TDS, an effective confining sequence, and monitor zones will permit the use of injection wells for disposal of treated effluent at the Merritt Island Wastewater Treatment Plant in accordance with existing State and Federal Underground Injection Control Regulations (UIC).

RECOMMENDATIONS

The following monitoring and testing requirements are recommended in order to fulfill the requirements of Chapter 17-28 FAC for the safe operation of the injection well disposal system. These procedures should be carried out rigorously to ensure compliance with the conditions of an operating permit and successful operation of the system.

1. Well-head injection pressures should be monitored and recorded continuously. Daily averages as well as maximum and minimum values should be reported to the FDER on a monthly basis.

2. The flow rate into the wells should be monitored and recorded continuously. Average daily flow rates as well as the total cumulative volume of effluent pumped into the wells should be reported to the FDER on a monthly basis.

3. Samples from the monitor tubes should be collected monthly and analyzed for fecal coliform, BOD (5-day), specific conductivity, pH, temperature, and chloride. The results of these analyses should be sent to the FDER on a monthly basis.

4. A specific injectivity test should be performed quarterly. The pumping rate should be established after the well is in operation. Well-head pressure versus injection rate should be recorded during this period. Test results should be reported to the FDER upon completion.

5. The well should be tested for mechanical integrity every five years in accordance with Chapter 17-28 F.A.C.

DATA COLLECTION

Data were collected during the construction of the injection wells using various methods. These methods are discussed in this section, along with comments on the application and usefulness of the relevant method.

Except as noted, measurements of footage in the well were referenced to the top of the cement pad.

Daily progress reports of the day-to-day activities during construction of the wells were compiled by the G&M personnel, who were present at all times. These reports met the requirements of Specific Condition 3 of the construction permit issued by FDER. Daily footage was recorded, along with other factors pertaining to drilling such as drilling speed, penetration rates, and the relative hardness of the formations. Problems encountered during drilling, such as lost circulation, were observed and noted. All activities connected with the installation of casing, cementing, and material quantities were included in these reports. Detailed descriptions of test procedures and data collection were recorded, including the performance of surveys to monitor hole straightness. A separate construction log was used to record material quantities by bid item; lengths and configurations of tools introduced into the borehole were noted. Copies of the daily progress reports and weekly summary of activities were forwarded to the Technical Advisory Committee (TAC) for this project on a weekly basis.

Samples of drilled cuttings were collected every ten feet and at each change in formation during pilot hole drilling. The samples were described after microscopic examination by the G&M on-site geologist and a geologic log was prepared. Copies of these logs are found in Appendix

A. A continuous summary log also was prepared which correlated lithology, weight on bit, penetration rate, and a summarized geologic description (all on a vertical scale of 20 feet to an inch), enabling correlation with all geophysical logs. This log helps to ensure that information from all sources is assimilated in order to properly evaluate the geophysical logs, borehole tests, and hole conditions during construction. One set of samples from each well was sent to the Florida Bureau of Geology in Tallahassee, Florida.

During the drilling of the pilot holes, four cores were collected from each well between depths of 1100 feet and 1900 feet. These cores supplement the information obtained from coring during construction of the exploratory well. The core barrel used was 20 feet in length by four inches in diameter. Coring lengths attempted were 10 feet. Each core was described in detail by a G&M geologist, then a portion of each core was selected and sent to a testing laboratory where it was tested to determine vertical permeability, porosity, specific gravity, and compressive strength. A copy of the laboratory report and core descriptions are included in Appendix B.

After the pilot holes were completed to a total depth of 2500 feet below pad level, a gyroscopic survey of the holes was run by the Eastman Whipstock Company. These surveys showed that the hole was straight (inclination less than one degree from true vertical); for IW-1 the final closure was a distance of 5.42 feet in the direction N62 32'E, and IW-2 was a distance of 10.51 feet in the direction N68 05'W, based on measurements calculated every 30 feet, using the Radius of Curvature method. A copy of the gyroscopic surveys of the pilot holes are found in Appendix C. The gyroscopic surveys provided evidence that the reamed holes for the injection casing strings had tracked the pilot holes.

A number of geophysical logs were conducted during the construction of the wells. Most logs were run at the completion of the pilot hole drilling. The purpose of these logs was to collect data on the presence and nature of the injection zone and the confining sequence above it. Dual Induction (shallow, medium, and deep investigation tools), temperature, caliper, natural gamma ray, long and short normal, spontaneous potential, and borehole-compensated sonic logs were made. Copies of the various logs are contained in Appendix D. Additionally, caliper logs were run in the nominal 34-inch-diameter open holes and the nominal 28-inch-diameter open holes to provide information on the volume of the hole prior to setting casing and cementing.

The Dual Induction log was used to differentiate between limestone and dolomite beds and, along with the gamma ray log, aided in the correlation of lithologic units in the hole. The borehole-compensated sonic log was useful in identifying the injection zone, monitor zones and the confining sequence, as well as in helping to identify possible zones which could cause problems during cementing.

When the installation and cementing of the injection casings was complete, a pressure test was conducted on the casings prior to drilling the open hole section through the injection zone. The casings were filled with water and placed under a pressure of 154 pounds per square inch (psi) for IW-1 and 150 psi for IW-2 for a one-hour period. This pressure is over 1.5 times the expected maximum well-head operating pressure. The injection casings held this pressure for the required period, and therefore passes the test for integrity testing specified in Section 17-28.24(6)(c) FAC. A copy of the pressure test data is found in Appendix E. Once the pressure tests had been successfully completed, the cement plugs at the bottom of the 18-inch-diameter casings were drilled out and the final open holes drilled to total depth.

Following completion of drilling of both wells, a pressure/temperature transducer was lowered into IW-1 to about 1860 feet below pad level. Thirty-two hours of background data were collected. At 3:48 a.m. on September 5, 1986, Layne-Atlantic began pumping water from IW-2 into IW-1 at an average rate of 5681 gallons per minute (gpm) for 24 hours. The bottom-hole pressure just prior to starting the injection pump was measured at 835.97 pounds per square inch, absolute (psia). The bottom-hole pressure was 838.83 psia just prior to shutting the pump off 24 hours later. Twelve hours of post-injection test recovery data were collected. Following completion of the injection test on IW-1, a pressure/temperature transducer was lowered into IW-2 to about 1860 feet below pad level. Twenty-four hours of background data were collected. At 8:42 p.m. on September 7, 1986, Layne-Atlantic began pumping water from IW-1 into IW-2 at an average rate of 5568 gpm for 24 hours. The bottom-hole pressure just prior to starting the injection pump was measured at 835.86 psia. The bottom-hole pressure was 838.86 psia just prior to shutting the pump off 24 hours later. Twelve hours of post-injection test data were collected. The results of the injection test are discussed in a subsequent section of this report. Figures 3 and 4 show a correlation between the data collected during the various testing operations and the geologic log.

Subsequently, television surveys were made of the completed wells. The picture quality was good and provided visual data on the condition of the wells and the nature of the injection zones. Copies of the tapes have been sent to those members of the TAC requesting the information.

WELL DRILLING AND CONSTRUCTION

Construction of the injection wells commenced on December 18, 1985 when Layne-Atlantic installed the pit casing for IW-2. On January 7, 1986, the pit casing for IW-1 was installed. Because well construction began with IW-2, it will be described first.

Injection Well 2

Well drilling of IW-2 began on January 31, 1986 with a nominal 40-inch-diameter hole to a depth of 141 feet. Layne-Atlantic elected to install the conductor casing deeper than the specified 120 foot depth due to possible lost circulation zones encountered when the exploratory well was drilled. Thirty-four-inch-diameter conductor casing was installed and cemented in place at a depth of 134 feet. After the conductor casing was in place, drilling continued to 950 feet using progressively larger drill bits and reamers, i.e, 12-1/4-inch-diameter bit, 17-inch-diameter reamer, 23-inch-diameter reamer and 34-inch-diameter reamer. While drilling this section of the hole with the 12-1/4-inch-diameter bit, operations were changed from mud rotary to reverse-air drilling at a depth of 392 feet.

Before installing the 28-inch-diameter casing, a caliper log and a dummy casing were run to assure the hole was of sufficient size to accept the casing string. Tight spots were encountered and rereaming was performed. Rereaming enlarged the hole to the required 34-inch-diameter and the 28-inch-diameter casing was set and cemented at a depth of 948 feet. Layne-Atlantic was permitted to use a 12-1/4-inch-diameter bit in place of the specified 7-7/8-inch bit for the pilot hole. This enabled Layne-Atlantic to use a larger drill pipe and thereby maintain better circulation of drilling fluid and efficient cuttings removal.

The 12-1/4-inch-diameter pilot hole was drilled to a depth of 2510 feet. All drilling was done using a closed circulation system and no mud or drilling fluids were discharged from the drilling pad. Four cores, approximately four inches diameter and 10 feet in length were taken during drilling of the pilot hole. The results of laboratory analysis of the cores and a geologic description of each is presented in Appendix B. Table 1 summarizes the core data obtained and lists the intervals which were cored. Upon completion of the pilot hole to a total depth of 2510 feet, the gyroscopic and geophysical logging phases of the program were initiated. Copies of the logs are presented in Appendices C and D, respectively.

After logging was completed, a drillable cement plug was set in the pilot hole at a depth of 1880 feet. The plug prevented cuttings from falling into and filling up the injection zone during reaming.

The 12-1/4-inch-diameter pilot hole was enlarged to a nominal 28-inch-diameter hole in progressive stages to a depth of 1852 feet. Upon completion of the reaming, a caliper log was run to assure the hole size was large enough in all areas to accept casing and assist in determining cement requirements for cementing the 18-inch-diameter injection casing.

The 18-inch-diameter, 0.500-inch wall thickness injection casing was set and cemented at a depth of 1850 feet. All other casings were 0.375-inch wall thickness pipes. Copies of the mill certificates are included in Appendix G. All casings were cemented with ASTM Type II cement with the bottom portion of the casing set in neat cement and the remaining portion set in 12 percent bentonite mix. (Refer to Appendix H)

Following the successful pressure testing of the 18-inch-diameter injection casing, drilling of the injection well was completed by drilling a nominal 18-inch-diameter hole from the base of the 18-inch-diameter casing to a depth of 2500 feet. Injection testing, a television survey and temperature logging were performed and construction of IW-2 was completed on September 9, 1986. An as-built diagram of the well is shown in Figure 5.

Injection Well 1

Drilling of IW-1 began on April 20, 1986 with a nominal 40-inch-diameter hole to a depth of 141 feet. Again Layne-Atlantic elected to install the conductor casing deeper than the specified 120 foot depth due to the possible lost circulation zones encountered while drilling the exploratory well. Thirty-four-inch-diameter conductor casing was set and cemented in place at a depth of 139 feet. Drilling continued to a depth of 951 feet using progressively larger nominal size bits and reamers of 12-1/4-inch-diameter, 17-inch-diameter, 25-inch-diameter, and 34-inch-diameter. At 449 feet while drilling with the 12-1/4-inch-diameter bit, the circulation system was changed from mud rotary to reverse air. Before installing the 28-inch-diameter casing, a caliper log and dummy casing were run in the nominal 34-inch-diameter hole to assure that the hole was of sufficient size to accept the casing without problems. The 28-inch-diameter casing was set at 950 feet and cemented.

As in IW-2, a 12-1/4-inch-diameter pilot hole was drilled instead of the specified 7-7/8-inch-diameter pilot hole. The 12-1/4-inch-diameter pilot hole was drilled to a depth of 2510 feet. Four cores, approximately four inches in diameter and 10 feet in length were taken during drilling of the pilot hole. The results of laboratory analysis of the cores and a geologic description of each is presented in Appendix B. Table 2 summarizes the core data obtained and lists the intervals which were cored.

Following completion of the pilot hole drilling, the gyroscopic and geophysical logging phases of the program were initiated. Copies of the logs are presented in Appendices C and D, respectively.

After logging, a drillable cement plug was set at a depth of 1917 feet. With the plug in place, the pilot hole was step reamed to a nominal 28-

inch-diameter so that the 18-inch-diameter injection casing could be installed.

Upon completion of the nominal 28-inch-diameter reaming to a depth of 1854 feet, a caliper log was run to assure the hole was of sufficient size for the 18-inch-diameter casing and to assist in determining cement requirements for cementing the casing. The 18-inch-diameter, 0.500-inch wall thickness injection casing was set and cemented at a depth of 1850 feet. All other casings were 0.375-inch wall thickness pipe. Copies of the mill certificates are found in Appendix G. All casings were cemented with ASTM Type II cement with the bottom portion of the casings set in neat cement and the remaining portion set in 12 percent bentonite mix. (Refer to Appendix H)

Following the successful pressure testing of the 18-inch-diameter injection casing, drilling of the injection well was completed by drilling a nominal 18-inch-diameter hole from the base of the 18-inch-diameter casing to a depth of 2500 feet. Injection testing, a television survey and temperature logging were performed and construction of IW-1 was completed on September 10, 1986. An as-built diagram of the well is shown in Figure 6.

Construction Problems

During construction of IW-2 some construction problems occurred. Only minor problems occurred at the onset of drilling through April 20, 1986. On April 21, 1986, a drill collar twisted off and part of the drill collar and the bottom-hole assembly were lost in the hole. This fishing job (retrieval of tools, etc., lost in the hole) consumed three and one-half days. From April 21 through July 23, ten fishing jobs were performed requiring from half-a-day to 16 days per fishing job to complete. All of the lost tools were retrieved except for a cutter lost off a 23-inch reamer, a piece of a milling tool, and a piece of a fishing tool. The lost cutter was visible in the television survey at the bottom of the hole. Other than time delays, the fishing jobs did not interfere with the successful completion and integrity of the well.

IW-1 was delayed in starting because a 2 to 10 foot thick layer of solid waste material (consisting of tree limbs, brush, and logs) was discovered underlying the intended site of the drill pad. Based on the results of soil boring tests and the anticipated loads on the drill pad, IW-1 was relocated outside the area where the waste material is present. Drilling of IW-1 commenced April 20, 1986 and progressed smoothly until June 16 when four drill collars and a 12-1/4-inch-diameter bit were lost in the hole. Between June 16 and August 17, seven fishing jobs were performed requiring from one day to five days per fishing job to complete. All of the lost tools were retrieved, (except for a cutter lost off a 27-inch reamer) and the well was successfully completed.

GEOLOGIC SETTING

Background

Subsurface data collected during the exploratory well program at the Merritt Island site (January through April 1984), in addition to the subsurface data collected during construction of IW-1 and IW-2, provided the information necessary for the final design of the injection well system.

The well construction program was set up to provide flexibility and allow for changes in the injection well completion in accordance with the site-specific geologic conditions encountered. The section on geologic setting is presented so the reader will obtain a good understanding of site-specific geologic conditions, the rationale for the final design of the system and information which demonstrates that the wells are constructed in compliance with the requirements set forth in Chapter 17-28 FAC.

A well-defined, areally-extensive sequence of limestone, dolomite and clay is present at the site and throughout the region. As shown on

Figure 7, the confining sequence and injection zone are present at similar depths in three injection well locations in Brevard County (the South Beaches Injection Well, the Harris Corporation Injection Wells, and the Merritt Island Injection Wells). The geologic units range in age from Paleocene to Recent. The Paleocene Age Cedar Keys Limestone was the lowermost geologic unit identified. Overlying the Cedar Keys are Eocene age formations including (from the oldest to the youngest) the Oldsmar Limestone, Lake City Limestone, Avon Park Limestone, and Ocala Group. The Miocene-age Hawthorn formation overlies the Ocala Group. Younger formations range in age from late Miocene/Pliocene to Recent and include the Tamiami formation and undifferentiated sand and shell deposits. A detailed stratigraphic description of the various units follows.

Paleocene Series

Ceder Keys Formation - The term "Cedar Keys formation" was originally proposed by Cole (1944) to designate subsurface carbonate rocks in peninsular and northern Florida "from the first appearance of the Borelis fauna to the top of the upper Cretaceous." Chen (1965) described the top of the formation as "consisting mainly of gray, microcrystalline, slightly gypsiferous and rarely fossiliferous dolomite" in the peninsular Florida. He also estimated that (in the Merritt Island area) the top of the formation occurred at approximately 2500 feet National Geodetic Vertical Datum (NGVD) and its thickness was approximately 1000 feet.

Although Chen had no control wells at this depth in this area, his estimates were very accurate.

The exploratory well penetrated 30 feet of sediments from a depth of 2670 feet to 2700 feet that are placed within the Cedar Keys Formation. Lithologically, the unit is marked at the top by a gypsiferous white clay containing grayish dolomitic limestone and crystalline gypsum. Evaporites account for over 50 percent of the sample from this interval. No Borelis-type fauna are encountered within this interval and the carbonates are essentially unfossiliferous. Due to secondary mineralization with evaporites, the Cedar Keys Formation acts as a confining unit below the injection zone. The Cedar Keys was not encountered during the drilling of IW-1 and IW-2.

Eocene Series

Oldsmar Limestone - Applin and Applin (1944) applied the name "Oldsmar Limestone" to a series of faunal zones overlying the Cedar Keys Formation, marked at the top by the benthonic foraminifera *Helicostegina gyralis*. In later work by Chen (1965), the unit was described lithologically as being predominantly dolomite and limestone with gypsum and anhydrite being minor components. He mapped the top of the Oldsmar Limestone between 1500 feet and 2000 feet NGVD and the thickness as approximately 800 feet in the Merritt Island area.

The Oldsmar Limestone penetrated in the exploratory and injections wells occurs principally as brownish dolomites with interbedded limestone. The top of the formation occurs at 1680 feet in the exploratory well and 1674 feet to 1678 feet in the injection wells. The top of the Oldsmar is marked by a calcareous and possibly glauconitic bluish-gray clay that is overlain by a thick dolomite sequence of the Lake City Limestone. A white to very pale orange micritic limestone underlies the calcareous clay. The limestone beds are thickest in the upper part of the formation where they are about 200 feet thick. Limestone with trace amounts of evaporites occurs near the base of the formation. The limestone sequences within the unit contain an abundance of foraminifera, especially Coskinolina elongate and Heliocostina gyralis. A thick dolomite sequence was penetrated from 1880 feet below land surface to within 100 feet or so of the contact with the Cedar Keys Limestone in the exploratory well. The dolomites are brown in color and vary textually from micro to coarsely crystalline in grain size. Carbonaceous material is common in the lower intervals. The total thickness of the Oldsmar Limestone in the exploratory well is 990 feet. The entire unit was not penetrated by the injection wells.

Lake City Limestone - Applin and Applin (1944) first used the term "Lake City Limestone" for rocks of early Middle Eocene age and described this unit as a dark brown and chalky limestone in northern and peninsular Florida. The Applins established the top of the Lake City at the highest appearance of the foraminifera Dictyoconus americanus. Chen (1965) showed the combined thickness of the Lake City and overlying Avon Park to be approximately 1200 feet in the Merritt Island area. Ceryak, Knapp, and Burnsen (1983) described the Lake City Limestone as "a gray-brown, dense microcrystalline dolomite with occasional thin beds of limestone, chert, and carbonaceous material" in the type area.

At the exploratory well site, the top of the Lake City Limestone was identified at 978 feet and is marked by a brownish dolomite containing peat and chert. The top of the unit was identified at 979 feet and 981 feet for IW-1 and IW-2, respectively; but peat and chert were not present at the Merritt Island site. The Lake City is composed of limestones and dolomite beds containing the foraminifera Dictyoconus americanus. The lower section of the formation is very dolomitic. The Lake City ranges from 695 feet to 702 feet thick at the three Merritt Island wells. The major lithologic difference between this unit and the overlying Avon Park is the predominance of dolomite throughout, with relatively thin interbedded limestone, whereas the Avon Park is principally limestone interbedded with dolomite.

Avon Park Limestone - The term "Avon Park Limestone" was proposed by Applin and Applin (1944) for sediments of late Middle Eocene age in Florida. Vernon (1951) described three different lithologies within this unit where it crops out in Citrus and Levy Counties, Florida. In general, these lithologies are a very fossiliferous limestone; a fossiliferous, peat-flecked limestone; and a very crystalline dolomite. Chen (1965) showed the top of this formation to occur between 200 feet and 400 feet below sea level in Merritt Island area.

The top of the Avon Park Limestone was logged at 235 feet below land surface at the exploratory well and at 237 feet and 240 feet for IW-1 and IW-2. The formation is 743 feet thick at the exploratory well and 742 feet and 741 feet thick at IW-1 and IW-2, respectively. The unit consists principally of biogenic limestones interbedded with dolomite. The limestone is moderately indurated, calcarenitic, and contains abundant specimens of the foraminifera Dictyoconus cookei. The contacts with the overlying and underlying formations are gradational and conformable. As pointed out previously, the major lithologic difference between the Avon Park and Lake City is the predominance of limestone within the Avon Park and dolomite within the Lake City. The contact between the Ocala Group and Avon Park Formation is marked by a calcareous sand and an abundance of the foraminifer Dictyoconus cookei.

Ocala Group - The term "Ocala Limestone" was first used by Dall and Harris (1892) for limestones being quarried near Ocala, Florida. Cooke (1915) established the Ocala Limestone as Eocene in age and proved that its fauna are essentially identical to that of the Jackson Stage of the Gulf Coast. Puri (1953) followed Vernon (1951) in recognizing three distinct units he believed were present within the strata of the "Ocala Limestone." He proposed for his units the names Crystal River Formation, Williston Formation, and Inglis Formation in descending order of age and suggested that the new formations should be included in the Ocala Group. This usage is followed in this report.

The top of the Ocala Group was penetrated at 130 feet below land surface in the exploratory well and at 138 feet and 123 feet in IW-1 and IW-2, respectively. The group is 105 feet thick in the exploratory well and 99 feet and 117 feet thick in IW-1 and IW-2. The Ocala group is composed of biogenic, very micritic limestone, containing many benthic foraminifera. The Crystal River Formation is not present; only the two lower formations within the Ocala Group are present at this location. A two-foot-thick sandy limestone bed lying directly above the Ocala Group could possibly be part of either the Suwannee or Tampa Limestones.

Miocene Series

Hawthorn Formation - The Hawthorn Formation overlies the Ocala Group. Dall and Harris (1892) first used the term "Hawthorn beds" for phosphatic sediments being quarried for fertilizer near the town of Hawthorn, Florida. In recent work by Scott and Knapp (1984 in review), continuous cores were described and correlated with the type and co-type sections.

They described the Hawthorn Formation as "consisting of various mixtures of clay, quartz sand, carbonate (dolomite to limestone) and phosphates."

At the exploratory well, the top of the Hawthorn Formation was identified at 100 feet below land surface and at 105 feet and 108 feet below land surface at IW-1 and IW-2, respectively. At the exploratory well the formation was found to be 28 feet thick and 33 feet and 15 feet thick at IW-1 and IW-2, respectively. The top of the unit is marked by a light olive gray, sandy and phosphatic limestone in all three wells. A clayey dolosilt occurs at 123 feet in the exploratory well and had a thickness of less than 5 feet.

Miocene/Pliocene Series

Tamiami Formation - Mansfield (1939) proposed the name "Tamiami Limestone" for a fossiliferous sandy limestone approximately 25 feet thick, which was penetrated in shallow ditches along the Tamiami Trail (U.S. Highway 41) in parts of Collier and Monroe Counties, Florida. At the exploratory well site, the Tamiami Formation was penetrated at 60 feet below land surface and extended to 100 feet below land surface. At IW-1 and IW-2, the formation was penetrated at 63 feet and 67 feet below land surface and extended to 105 feet and 108 feet, respectively. It is recognized as a sandy, very fine-grained limestone with very little phosphate.

Pleistocene to Recent Series

Undifferentiated Sand and Shell - The surficial deposits at the test site are composed predominantly of fine- to medium-grained quartz sand with intermixed shells. A shell bed was penetrated from 50 to 60 feet below land surface near the contact with the Tamiami Formation. Shell beds were penetrated at IW-1 and IW-2 from 45 feet to 55 feet and 67 feet to 75 feet, respectively.

HYDROGEOLOGIC SETTING

Subsurface conditions were determined by evaluation of the drill cuttings, drilling data, laboratory tests conducted on cores, through the interpretation of geophysical logs, and from exploratory well straddle-packer pumping tests. The straddle-packer tests provided information on the hydraulic conductivity of the confining sequences and on water quality. Core testing conducted in the laboratory yielded direct information on the vertical permeability of the rock in the confining sequence. Geophysical logs were useful in measuring the relative porosities and the vertical extent of individual units. This information is used in the following text to describe hydrogeologic properties of the various confining sequences, monitor zones and injection zones encountered during drilling at the Merritt Island site.

Confining Sequence

Based on interpretation of the various data, the injection zone is overlain by a confining sequence in the interval between 770 feet and 1900 feet. The most significant section of the confining sequence above the injection zone occurs between 1600 feet and 1900 feet below land surface. The limestone that comprises this sequence is a very fine-grained biomicritic rock with thin strings of dolomite and ten-foot thick layer of calcareous clay occurring between approximately 1680 feet and 1690 feet.

Seven straddle packer tests were conducted on the confining sequence in the exploratory well. Hydraulic conductivity values determined from these tests (Table 3) ranged from 0.0000075 cm/sec to 0.0005 cm/sec with the average being 0.00014 cm/sec. Primarily, these values represent the horizontal hydraulic conductivity of the section tested.

Within the most significant confining sequence, 1600 feet to 1900 feet below land surface, the vertical permeability of the limestone core collected from the exploratory well is 0.0000045 cm/sec. For the cores from IW-1 the average permeability is 0.000000077 cm/sec, and for IW-2 is 0.0000073 cm/sec. The core data is presented in Tables 1 and 2 (injection wells) and Table 4 (exploratory well).

The tops and bottoms of the confining sequences are indicated in a general way on the borehole-compensated sonic log. These sequences are distinguished by relatively uniform traces that vary in amplitude over a limited range and indicate formation material having consistency in composition (limestone) and porosity. Zones containing fractured dolomite show erratic variations in signal amplitude due principally to cycle skipping caused by rock fractures and borehole irregularities.

Monitor Zones

The exploratory well drilled in 1984 was converted to and is being used as a monitor well for this injection well system. The shallow monitoring zone is from 128 feet to 340 feet and the deep monitoring zone is from 1470 feet to 1501 feet. Refer to Figure 8 for well completion details.

Injection Zone

The presence of an injection zone was revealed during the drilling by a constant chattering of the drill string which is characteristic of fractured formation. Confirmation of the injection zone presence was made from the cuttings, geophysical logging, TV survey and injection testing. The results of the injection tests are reported in a subsequent section. Evidence gathered during drilling and testing confirmed that the injection zone consists of a fractured and cavernous dolomite. The top of the zone is approximately 200 feet into the Oldsmar Limestone of Lower Eocene Age. The depth to the top of the zone is 1900 feet. The bottom of the zone was encountered at a depth of 2500 feet.

Water Quality

Water samples were collected from the exploratory well during each straddle-packer pumping test and from the two zones of the completed monitor well. Water samples also were collected from the injection zones during the injection tests of IW-1 and IW-2. These samples were analyzed for selected ions in order to establish background water quality. The 10,000 mg/L TDS interface was estimated to occur between 340 feet and 950 feet from the exploratory well testing. Approximately 30 miles south of the Merritt Island site this interface has been estimated to occur at approximately 1200 feet (South Beaches Waste Water Treatment Plant for Brevard County, Florida; Dames and Moore, 1985, and Harris Corporation Injection Well System; Geraghty & Miller, Inc., 1986).

These water-quality data demonstrate that the injection zone, which starts at about 2000 feet, is well below water containing less than 10,000 mg/L TDS as required by Chapter 17-28 F.A.C. Results of the laboratory analyses of the IW-1 and IW-2 injection zone water samples are presented in Appendix F. Laboratory analyses of the water samples collected from the monitor zones are included in the final report prepared for the exploratory program.

INJECTION TEST

On September 3, 1986, an electronic pressure/temperature sensor was installed in IW-1. The sensor, manufactured by Geophysical Research Corporation, is capable of detecting pressure changes of as little as 0.01 psi. Background pressure and temperature readings were collected for a period of 32-1/2 hours. The sensor was positioned at 1860 feet (approximately 10 feet below the bottom of the casing) so that the data collected during the test would be representative of the injection zone. In addition to the bottom-hole pressures and temperatures recorded during the test, wellhead pressures were monitored, the flow rate into the well was recorded in gallons per minute, and the water levels in the monitor wells (exploratory well) were monitored.

The pressure and temperature data collected from the bottom-hole transducer during the test are shown on Figure 9. Initially, during the first 12-1/2 hours of taking background data, the pressure/temperature sensor was mistakenly set at a depth of 1660 feet. The pressure data has been adjusted for this period in order to correct the 200 foot difference in head.

The injection test began at 3:48 a.m. on September 5, 1986 and was terminated 24 hours later. After the test, 12 hours of recovery data were collected. The water for injecting into IW-1 was obtained from IW-

2, and was discharged from IW-2 via a pump powered by a diesel engine and gear drive. The flow rate was measured with a in-line flow meter which recorded both the cumulative volume pumped and the actual flow rate simultaneously. Flow to IW-1 was maintained at an average rate of 5681 gpm.

During the initial 45 minutes of the test, the pressure and temperature fluctuated as the flow control valve was adjusted and the test flow rate was established. After the rate stabilized, the bottom-hole pressure increased by 0.30 psi around 8:00 a.m. on September 5, due to an increase in the pumping rate. For the duration of the test, the pressure remained steady, changing by less than 0.20 psi. This small change could be attributable to tidal fluctuation. The well head pressure at the start of the injection test was 13 pounds per square inch (psi). After 30 minutes, the pressure stabilized at 11 psi changing by 1 psi throughout the remainder of the test because of flow rate adjustments. Some increase in well head pressure can be expected during actual injection operations due to the density differential between the fresh water effluent and saline water in the injection zone.

Water levels in the monitor zones were recorded prior to, during, and after the injection test. The deep monitor zone varied by 0.10 feet and the shallow monitor zone varied by 0.30 feet. These fluctuation are very small and probably attributable to tidal influences.

At 4:01 a.m. on September 6, 1986, the injection pump was shut off. A total of 8.25 million gallons of water had been pumped into the well over the test period. During the injection test, the bottom-hole pressure increased approximately 3.10 psi. Immediately after the pump was shut off, the pressure decreased 3.00 psi, then fluctuated for about 30 minutes before increasing 0.20 psi and leveling off. The pressure then slowly decreased 0.10 psi over the remainder of the recovery period.

Background bottom-hole temperature readings were a constant 88.6 degrees Fahrenheit. After the pump was turned on and water from IW-2 was injected into IW-1, the bottom-hole temperature decreased 2.2 degrees Fahrenheit.

Within the first 40 minutes of the pumping test, the bottom-hole temperatures had stabilized at 88.6 degrees Fahrenheit. For the duration of the test, the temperature remained steady, changing by less than 0.20 degrees Fahrenheit. The maximum change in temperature during the entire test, over the background level, was 0.30 degrees Fahrenheit. After the pump was shut-off, the bottom hole temperature increased very slightly to 89.2 degrees Fahrenheit for 30 minutes and then decreased to 88.9 degrees Fahrenheit and remained fairly constant throughout the entire recovery period.

Immediately following the recovery period data collection on IW-1, the test equipment, pumps, etc. were arranged in a likewise manner for IW-2 to conduct the injection test on that well. Following 24 hours of background data collection of bottom-hole pressures and temperatures, the injection test for IW-2 was initially attempted at 7:54 p.m. on September 7, 1986. Leaks in the pipeline between IW-1 and IW-2 delayed the actual start of the test until 8:42 p.m. on September 7. The test had no further problems and was terminated 24 hours later. The pressure and temperature data collected from the bottom-hole transducer during the test are shown in Figure 10.

During the initial 40 minutes of the test, the pressure and temperature fluctuated as the flow control valve was adjusted and the test flow rate was established. Flow to IW-2 was maintained at an average rate of 5568 gpm. After the rate stabilized, the bottom-hole pressure gradually decreased by 0.30 psi until around 6:10 a.m. on September 8, at which time the flow rate was increased, thereby increasing the pressure. For the remainder of the test, the pressure remained relatively steady, changing by less than 0.30 psi.

The well head pressure at the start of the injection test was 5 psi, the pressure was stable at 5 psi, changing by less than 1 psi throughout the remainder of the test which was caused by flow rate adjustments. Some increase in well head pressure can be expected during actual injection operations due to the density differential between the fresh water effluent and saline water in the injection zone.

Water levels in the monitor zones were recorded prior to, during, and after the injection test. The deep monitor zone varied by 0.16 foot and the shallow monitor zone varied by 0.30 foot. These variances are attributable to tidal influences.

At 8:58 p.m. on September 8, 1986, the injection pump was shut-off. A total of 8.11 million gallons of water had been pumped into IW-2 over the test period. During the injection test, the bottom-hole pressure increased approximately 3.0 psi. Immediately after the pump had been shut-off, the pressure decreased 3.20 psi, then fluctuated for about 35 minutes before increasing 0.25 psi and leveling off. The pressure then slowly decreased 0.20 psi over the remainder of the recovery period.

Background bottom-hole temperature readings were a constant 88 degrees Fahrenheit. After the pump was turned on and water from IW-1 was injected into IW-2, the bottom-hole temperature decreased. Within the first 35 minutes of the pumping test, the bottom-hole temperature had stabilized at 88.9 degrees Fahrenheit and remained constant throughout the remainder of the injection test. The maximum change in temperature during the entire test, over the background level, was 0.9 degrees Fahrenheit. After the pump was shut-off, the bottom-hole temperature increased very slightly to 89.3 degrees Fahrenheit and decreased slowly throughout the remainder of the recovery period to 88.7 degrees Fahrenheit.

The data from the injection tests, geophysical logs, and television survey all show that the injection zones in the Merritt Island wells have the high transmissivity characteristic of the "Boulder Zone". Because the fluid for the injection tests was obtained from the same zone into which it was pumped and there was no observation well, it was not possible to quantify the transmissivity of the injection zone. As shown by the television survey, large voids and cavities occur below about 2000 feet. In other aquifers where these voids and cavities have been extensive, the transmissivity usually exceeds 1,000,000 gallons per day per foot (gpd/ft). Two locations with injection wells in close proximity to Merritt Island have transmissivities in the aforementioned range. They are: South Beaches Wastewater Treatment Plant in Brevard County with a transmissivity of about 1,000,000 gpd/ft (Dames & Moore, 1985) and Harris Corporation in south Brevard County with a transmissivity of 1,700,000 gpd/ft (Geraghty & Miller, 1986).

OPERATION AND MAINTENANCE

When the injection well is operating during long-term injection testing and over its operational life, a variety of data will be collected to satisfy statutory/permit requirements and to assist in managing the system. This section presents a basic data collection program which will meet permit requirements during operation and initial testing of the system.

Injection-Well Data Collection

Records of the wellhead pressure, injection rate, and cumulative volume injected will be collected from the well on a continuous basis, beginning with the start of injection. Values of maximum and average injection pressure and rate will be recorded on a daily basis for monthly submission to the FDER. Also, daily average, maximum, and minimum values of injection pressure, injection rate, and volumes will be reported to the FDER. Measurements of the injection pressure and rate will be made at the same time and recorded so that correlations between these two values can be made. It is essential that performance data be collected from the start in order to establish baseline information to satisfy regulatory requirements and to serve as a benchmark for future data comparison and analysis of performance. These records will be maintained permanently.

Monitor-Zone Data Collection

The purpose of monitor-zone data collection is to detect changes in water quality in the monitor zones that could be attributed to the injection of treated effluent. The parameters established for analysis are chloride, specific conductance, pH, BOD and TDS. Following initiation of injection, these parameters will be analyzed weekly until the issuance of the operating permit, then monthly for the duration of injection. In order to collect the monitor-zone data, at least three well volumes will be pumped from the monitor zones before samples are taken. The water from the monitor zones will be discharged into the treated effluent wet well and pumped into the injection well.

Injectivity Testing

A wells injectivity is a function of (1) friction loss in the casing, (2) the bottom-hole driving pressure (injection zone transmissivity), and (3) the density differential between treated effluent and the formation water in the injection zone. The latter is a constant as long as the temperature and density of the injection fluid remains constant. Friction loss in the casing and bottom-hole driving pressure can vary as a result of changes in the flow rate, plugging of the injection zone, and the physical condition of the pipe. In general, pressures build slowly with time (for a given pumping rate) as the casing "ages." Similarly, plugging of an injection zone can cause a gradual pressure buildup with respect to time; this is not expected at the Merritt Island wells because of the cavernous nature of the injection zone.

Periodic determination of a well's injectivity can be used as a measure of a well's efficiency, and it is recommended as a management tool for the injection well system. Performing the test is relatively simple; it involves injecting into the well at two or more injection rates and recording the injection pressure for each rate. The injectivity is calculated by dividing the injection rate by the injection pressure (wellhead pressure minus the static or non-pumping pressure). The result is expressed as gallons per minute per psi of pressure. As noted, testing should be conducted at a minimum of two rates so that future comparison can be made.

A procedure for injectivity testing should be established as soon as the wells are placed in operation in order to collect baseline operating data. The procedure should be easily repeatable so that injectivities can be computed for the same injection rates. Testing should be conducted quarterly for the life of the well.

<u>Mechanical Integrity</u>

An injection well has mechanical integrity if there is no leak in the casing and no fluid movement through channels adjacent to the injection well bore. In accordance with the FAC 17-28.13(6) and 17-28.25(1), the mechanical integrity of the injection well must be demonstrated every five years. The injection casing will be pressure tested, or tested by other approved method, to demonstrate absence of leaks. A temperature or noise log, and monitoring of overlying aquifers will be conducted to demonstrate absence of fluid movement through channels adjacent to the injection well bore. The initial mechanical integrity of the Merritt Island injection wells was determined by pressure testing the final casing strings and temperature logging after the injection tests. The IW-1 injection casing was tested at 154 psi for one hour with no change in pressure and IW-2 was tested at 150 psi for one hour with no change in pressure. The pressure test data are shown in Appendix E and the temperature logs are included in Appendix D.

Plugging and Abandonment Plan

In the event a Merritt Island well has to be abandoned, it must be effectively sealed or plugged in order to prevent upward migration of fluid from the injection zone or interchange of formation waters through the borehole or along the casing. In order to effectively plug the well, it will be necessary to mobilize a drill rig, "kill" the well, and remove the valve from the wellhead. The well will be "killed" by filling the casing with drilling mud having a density of at least 9.0 pounds per gallon (ppg). After the valve is removed, a bridge plug assembly will be set at the bottom of the 18-inch-diameter injection casing. The plug assembly will consist of a short section of threaded pipe with a bottom plug and two cement baskets attached to the outside. Above this section of pipe will be approximately 100 feet of threaded pipe which contains cement ports and several sets of left-handed threaded couplings. This assembly will be lowered into the well to five feet above the bottom of the injection casing on a string of drill pipe.

The cement baskets will be expanded and set by adding about five cubic feet of crushed limestone to the well and allowing it to settle. A mixture of neat cement will be pumped into the hole through the drill pipe and the cement ports above the cement baskets in the bridge plug assembly. The quantity of cement pumped should be equivalent to the volume of slurry required to fill the casing from the top of the crushed limestone to one foot below the lowermost left-hand threaded coupling.

The cement will be allowed to set for 24 hours, and then "tagged" with a wire line to determine if fill-up has been achieved. If not, additional crushed limestone will be added and another stage of cement pumped (a single stage of cement usually is sufficient to build the first portion of the bridge plug). A strain of no more than 1000 pounds above drill string weight will be exerted. If no movement occurs (other than pipe stretching), the plug will be considered set and the contractor can proceed with disconnecting the assembly by rotating and "backing off" the drill pipe (right-hand rotation will unscrew the pipe from the left-hand threaded coupling). Then two successive small stages of no more than 100 feet of cement fill-up will be pumped and given time to set. The remainder of the casing will then be filled with neat cement.

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Respectively submitted,
GERAGHTY & MILLER, INC.

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November 1986

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TABLES

TABLE 1

Summary of the Results of the
Analysis of Selected Core Samples
Merritt Island Injection Well, 1986

INJECTION WELL 2

Core No.	Depth (feet)	Porosity (%)	Permeability (cm/sec)	Description
1	Pieces too small for analyses			
2	1350.80-1351.54	35.4	0.0000899	Limestone
3	1650.60-1650.90	31.2	0.0000089	Limestone
4	1820.00-1820.50	23.7	0.00000572	Limestone

Notes:

(1) Four-inch-diameter cores

(2) Analyses performed by Professional Services Industries, Inc., Clearwater, Florida.

TABLE 2

Summary of the Results of the
Analysis of Selected Core Samples
Merritt Island Injection Well, 1986

INJECTION WELL 1

Core No.	Depth (feet)	Porosity (%)	Permeability (cm/sec)	Description
1	1172.4-1172.77	34.6	0.00024	Limestone
2	1247.04-1247.54	25.8	0.00000189	Limestone
3	1784.26-1784.63	24.7	0.000000138	Limestone
4	1857.29-1857.43	9.8	0.0000000151	Dolomite Limestone and Dolomite

Notes:

(1) Four-inch-diameter cores

(2) Analyses performed by Professional Services Industries, Inc., Clearwater, Florida.

TABLE 3

Hydraulic Properties of
Straddle-Packer Test Intervals
Merritt Island Exploratory Well, 1984

Interval (feet)	Transmissivity (gpd/ft)	Hydraulic Conductivity (cm/sec)	Data Analyzed
950-1055	603	0.00027	Residual Drawdown t/t'
1150-1315	Invalid	Test	Data
1507-1612	175	0.000079	Residual Drawdown t/t'
1615-1660	11.5 (A)	0.000012	Residual Drawdown t/t'
	7.2 (C)	0.0000075	Residual Drawdown t/t'
1685-1730	474	0.0005	Residual Drawdown t/t'
1693-1798	320	0.00014	Residual Drawdown t/t'
1730-1775	156	0.00016	Residual Drawdown t/t'
1800-1905	163	0.000073	Residual Drawdown t/t'

Note:

Three tests were conducted in the interval 1615 feet to 1660 feet due to pump failures; test (B) was too short to be analyzed.

TABLE 4

Results of the Analyses of Selected Core Samples,
Merritt Island Exploratory Injection Well, 1984

Core No.	Depth (feet)	Porosity (%)	Permeability (cm/sec)	Description
1	525.5-525.5	33.6	0.0000021	Limestone
2	990.8-991.8	22.8	0.0000046	Dolomite
3	1160-1160.7	7.6	0.000000019	Dolomite
4	1198-1198.75	36.2	0.000088	Limestone
5	1578-1579	12	0.00000000017	Dolomite
6	1720.5-1721.5	27	0.0000045	Limestone

Notes:

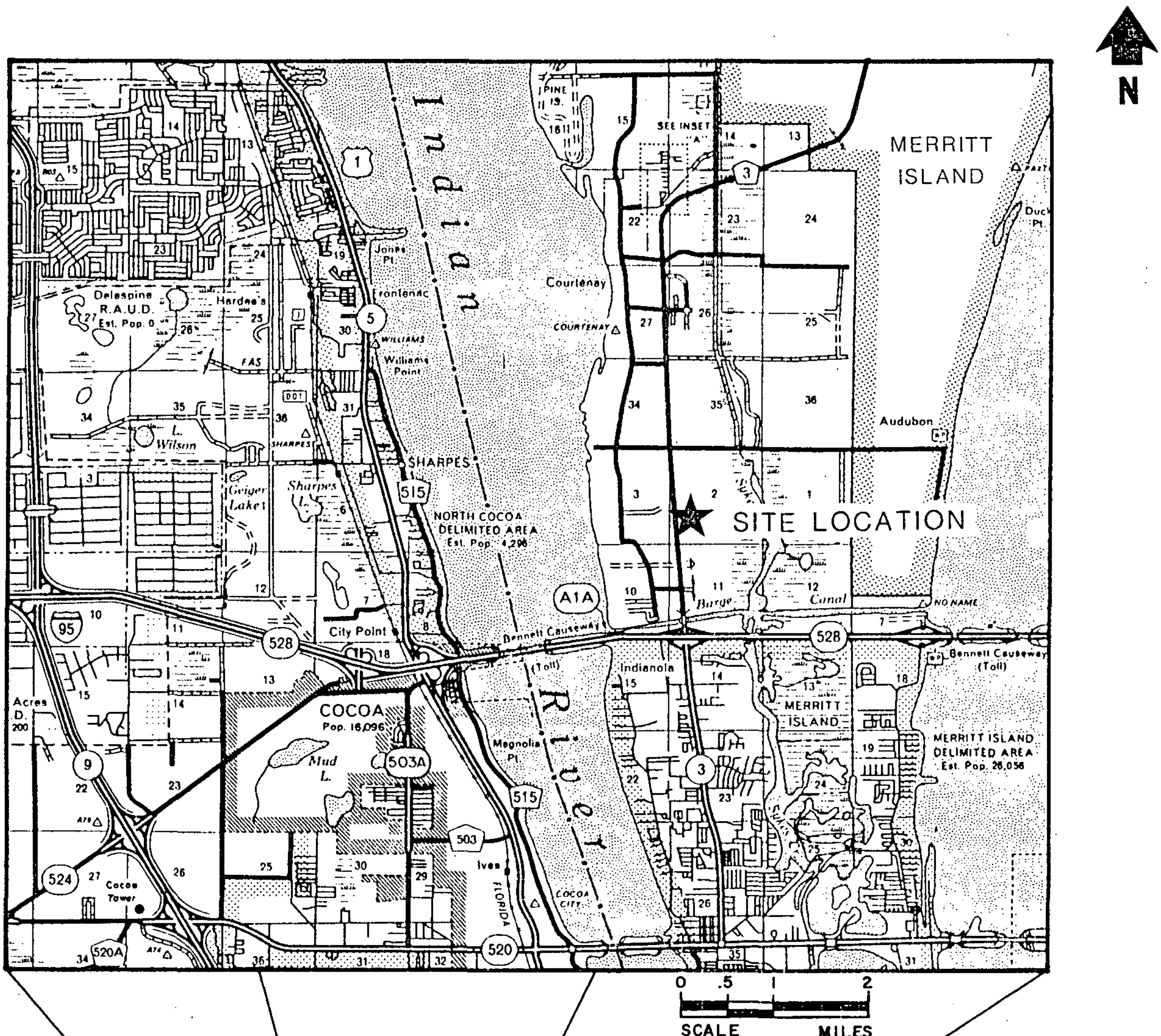
(1) Four-inch-diameter cores

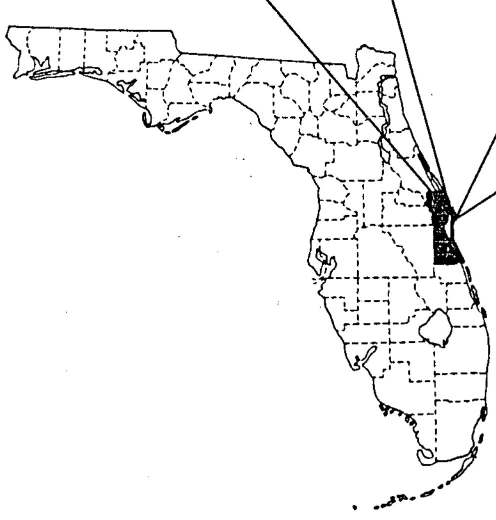
(2) Analyses performed by NSF Services, Inc., Clearwater, Florida.

FIGURES

Drawings are Exempt from s.119.07 and s. 24(a), Art. 1 of the State Constitution

If a figure has been removed from this document it will be filed in the Plans and Specifications Profile in the UIC Restricted Catalog.



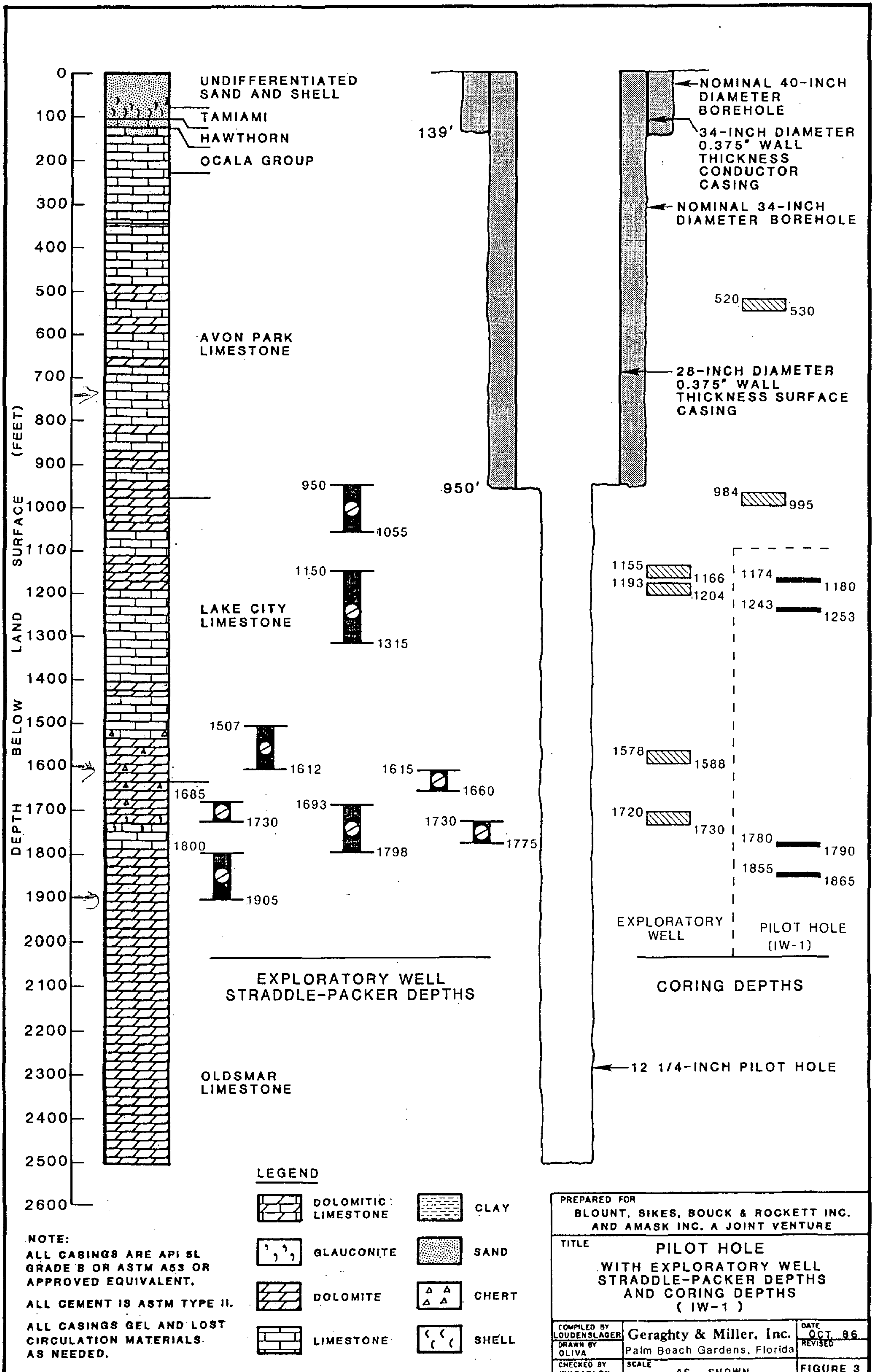


PREPARED FOR
BLOUNT, SIKES, BOUCK & ROCKETT INC. AND AMASK INC. A JOINT VENTURE

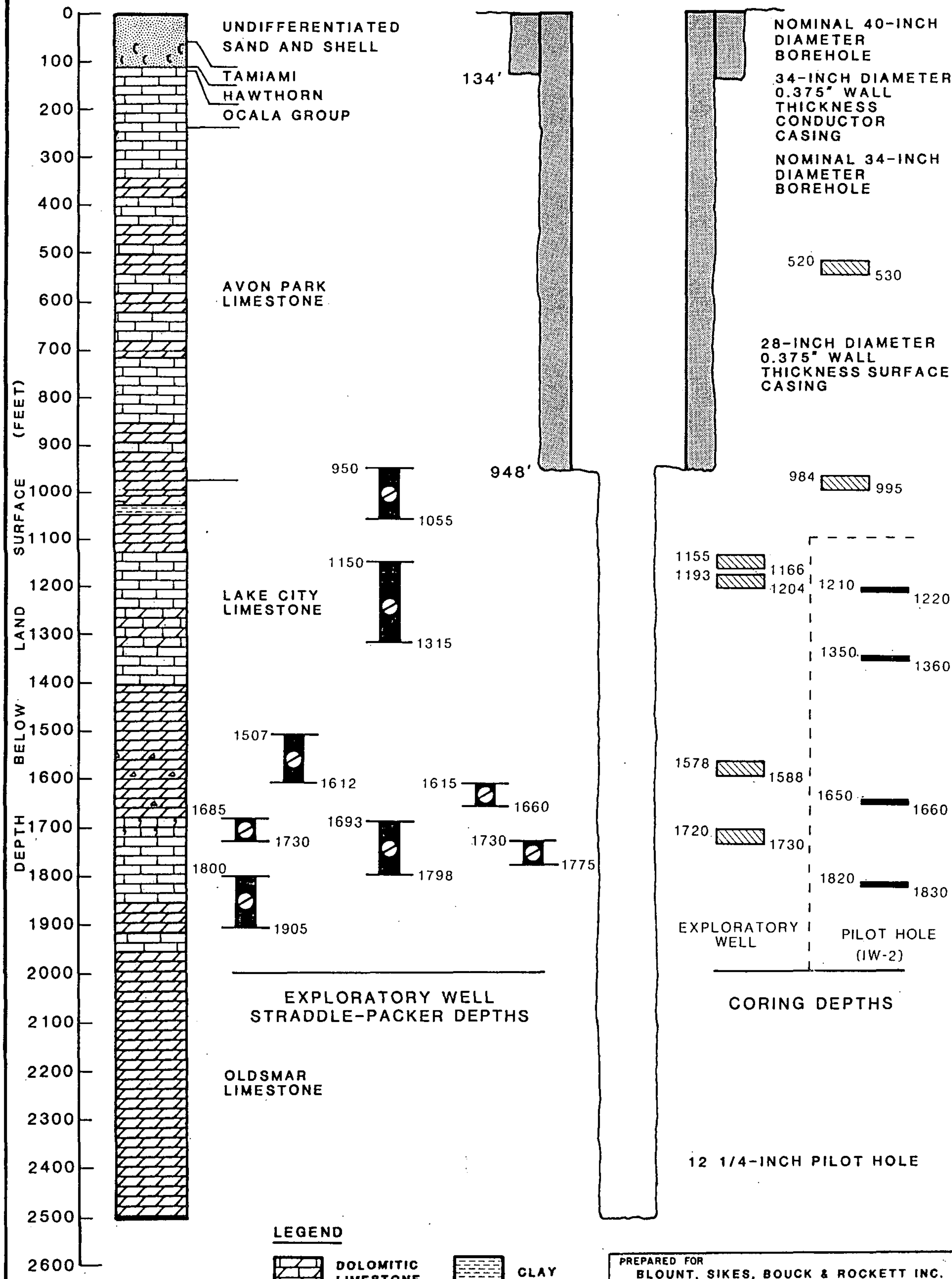
TITLE

SITE LOCATION MAP

COMPILED BY LOUDENSLAGER	**Geraghty & Miller, Inc.**	DATE OCT. 86
DRAWN BY OLIVA	Palm Beach Gardens, Florida	REVISED
CHECKED BY WHEATLEY	SCALE AS SHOWN	FIGURE 1


DEPTH BELOW LAND SURFACE (FEET)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
UNDIFFERENTIATED SAND AND SHELL
TAMIAMI
HAWTHORN
OCALA GROUP
AVON PARK LIMESTONE
LAKE CITY LIMESTONE
OLDSMAR LIMESTONE
139'
950'
950
1055
1150
1315
1507
1612
1615
1660
1685
1730
1693
1798
1730
1775
1800
1905
EXPLORATORY WELL STRADDLE-PACKER DEPTHS
NOMINAL 40-INCH DIAMETER BOREHOLE
34-INCH DIAMETER 0.375" WALL THICKNESS CONDUCTOR CASING
NOMINAL 34-INCH DIAMETER BOREHOLE
28-INCH DIAMETER 0.375" WALL THICKNESS SURFACE CASING
12 1/4-INCH PILOT HOLE
520
530
984
995
1155
1166
1193
1204
1578
1588
1720
1730
1174
1180
1243
1253
1780
1790
1855
1865
EXPLORATORY WELL
PILOT HOLE (IW-1)
CORING DEPTHS
LEGEND
DOLOMITIC LIMESTONE
CLAY
GLAUCONITE
SAND
DOLOMITE
CHERT
LIMESTONE
SHELL
NOTE:
ALL CASINGS ARE API 5L GRADE B OR ASTM A53 OR APPROVED EQUIVALENT.
ALL CEMENT IS ASTM TYPE II.
ALL CASINGS GEL AND LOST CIRCULATION MATERIALS AS NEEDED.
PREPARED FOR
BLOUNT, SIKES, BOUCK & ROCKETT INC. AND AMASK INC. A JOINT VENTURE
TITLE
PILOT HOLE WITH EXPLORATORY WELL STRADDLE-PACKER DEPTHS AND CORING DEPTHS (IW-1)
COMPILED BY LOUDENSLAGER
DRAWN BY OLIVA
CHECKED BY WHEATLEY
Geraghty & Miller, Inc.
Palm Beach Gardens, Florida
SCALE AS SHOWN
DATE OCT. 86
REVISED
FIGURE 3

P0658M13



NOTE:
ALL CASINGS ARE API 5L GRADE B OR ASTM A53 OR APPROVED EQUIVALENT.
ALL CEMENT IS ASTM TYPE II.
ALL CASINGS GEL AND LOST CIRCULATION MATERIALS AS NEEDED.

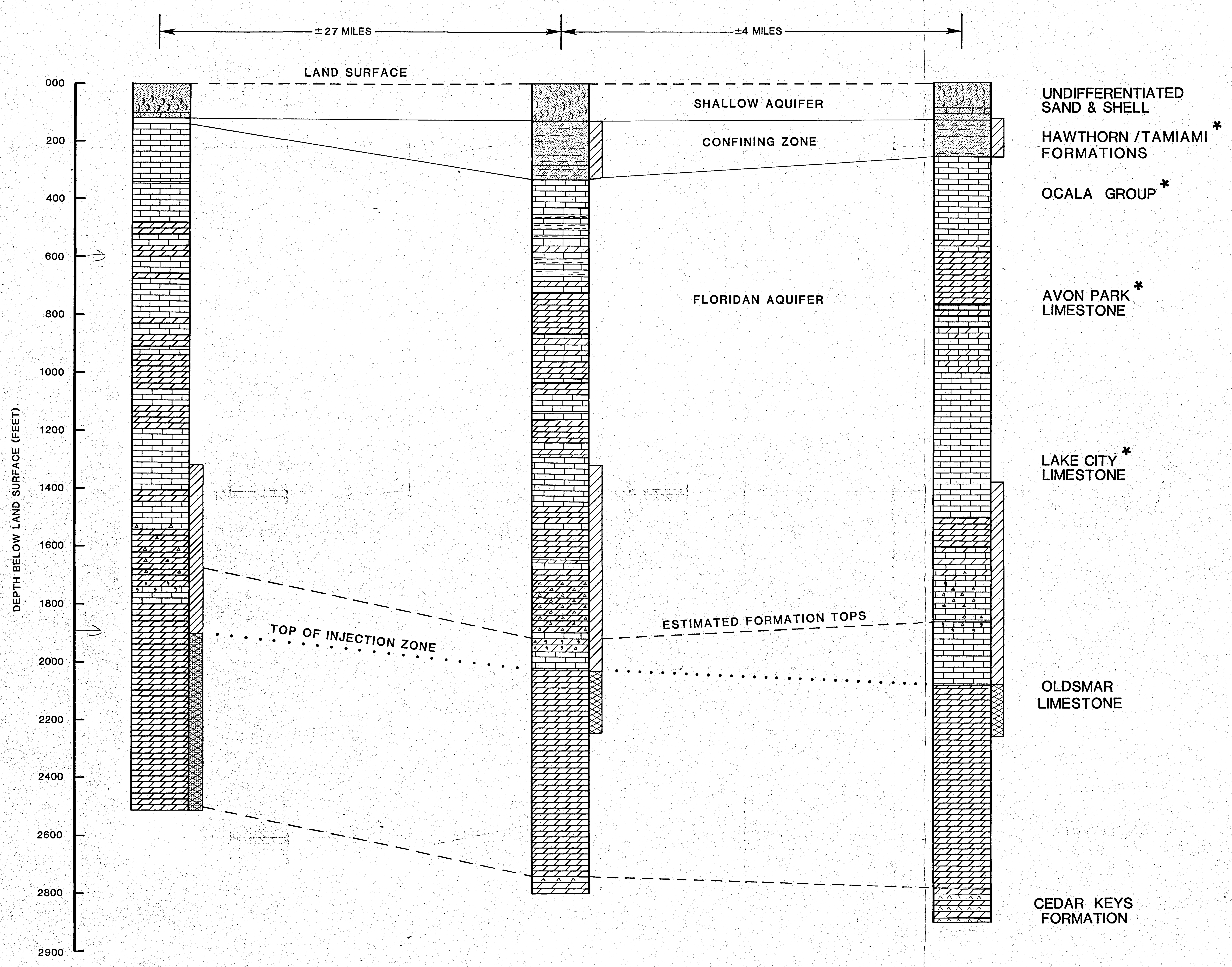
PREPARED FOR
BLOUNT, SIKES, BOUCK & ROCKETT INC. AND AMASK INC. A JOINT VENTURE

TITLE
PILOT HOLE
WITH EXPLORATORY WELL STRADDLE-PACKER DEPTHS AND CORING DEPTHS
(IW-2)

COMPILED BY LOUDENSLAGER	Geraghty & Miller, Inc.	DATE OCT. 86
DRAWN BY OLIVA	Palm Beach Gardens, Florida	REVISED
CHECKED BY WHEATLEY	SCALE AS SHOWN	FIGURE 4

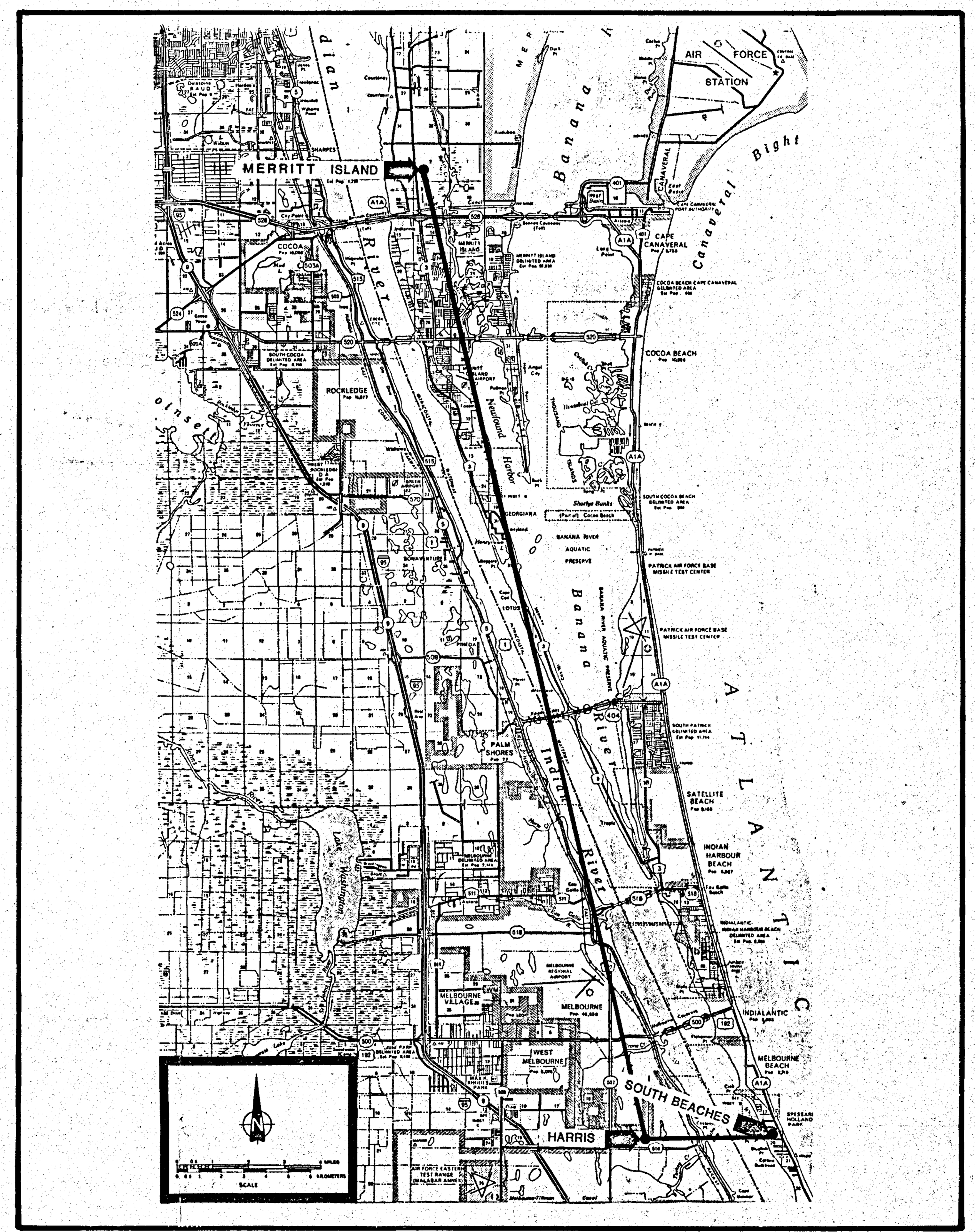
P0658M13

11 55448 (1)



NOTE:
* UNDIFFERENTIATED FORMATIONS.

SITE LOCATION



LEGEND:

SHELL	LIMESTONE
SAND	DOLOMITE
CLAY	ANHYDRITE
GLAUCONITE	INJECTION ZONE
CHERT	CONFINING SEQUENCE

GEOLOGICAL CORRELATION OF MERRITT ISLAND INJECTION WELL 1 WITH HARRIS CORPORATION INJECTION WELL 2 AND SOUTH BEACHES INJECTION WELL

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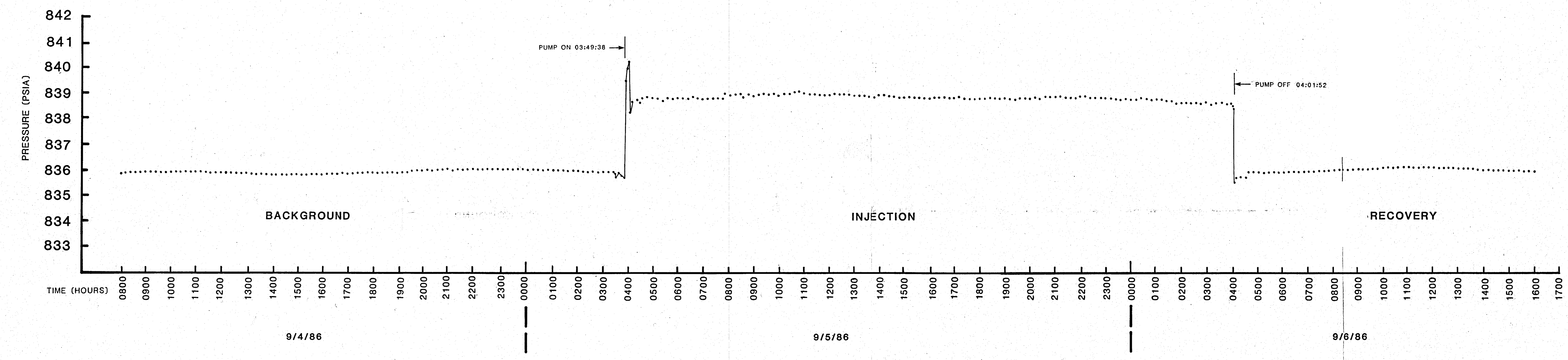
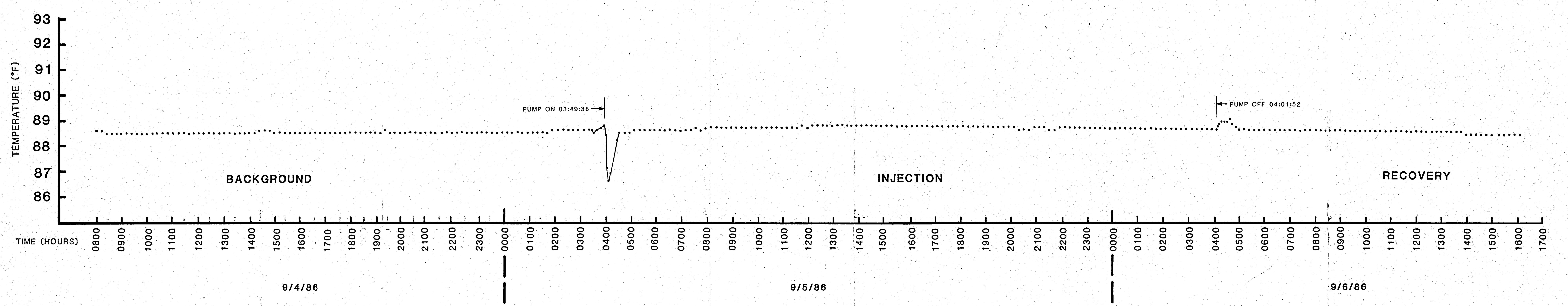
FIGURE 7

(2)



INJECTION TEST PRESSURE DATA

MERRITT ISLAND WELL IW-1



INJECTION TEST TEMPERATURE DATA

MERRITT ISLAND WELL IW-1

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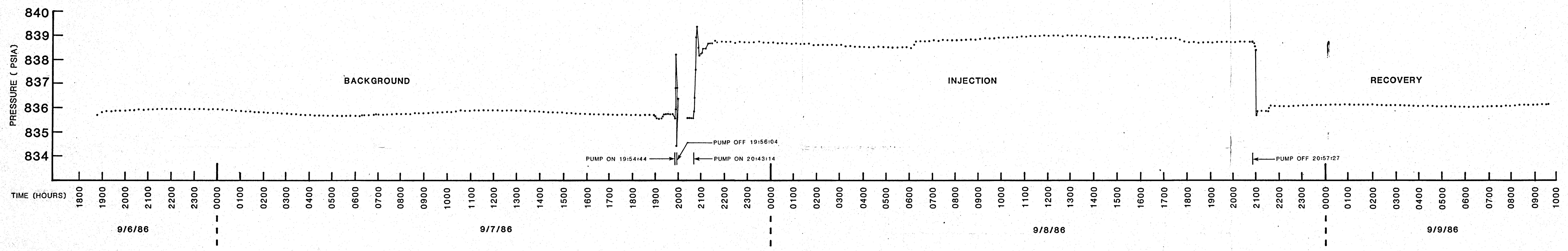
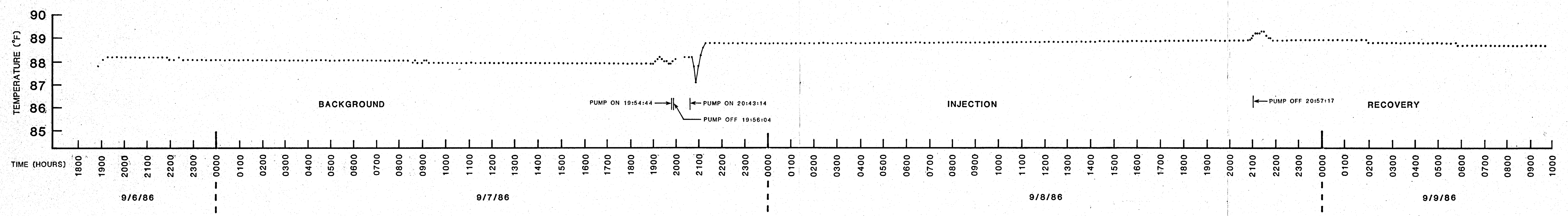
FIGURE 9



INJECTION TEST PRESSURE DATA

MERRITT ISLAND WELL IW-2



INJECTION TEST TEMPERATURE DATA

MERRITT ISLAND WELL IW-2

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FIGURE 10