U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Lithology and geophysics of the surficial aquifer system in western Collier County, Florida

by

Suzanne D. Weedman[1], Frederick L. Paillet[2], G. Harley Means[3], and Thomas M. Scott[3]

[1]U.S. Geological Survey, Reston, VA
[2]U.S. Geological Survey, Denver, CO
[3]Florida Geological Survey, Tallahassee, FL

Open-File Report 97-436

Prepared in cooperation with the Florida Geological Survey, Tallahassee, Florida

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards nor with the North American Stratigraphic Code. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

1997

TABLE OF CONTENTS

FIGURES

Appendix:

TABLES

Appendix:

ABSTRACT

Seven coreholes (about 200 ft deep) were drilled in western Collier County into the surficial aquifer system. Coreholes were logged with natural gamma-ray, induction, resistivity, neutron, caliper, temperature, spontaneous potential, televiewer, and heat-pulse flowmeter logs, where feasible. Cores have been described and sampled for thin sections, XRD analysis, and Sr dating of shells, and for mollusk, foraminifer, ostracode, pollen, and dinoflagellate cyst content.

After coreholes were completed with fully screened plastic casing, flow profiles under ambient and steady injection conditions were used to identify flow paths within the aquifer system and infer locations of confining units. Flowmeter data indicate that permeability is the highest in the rocks under the caprock, from a depth range of about 30 to 50 ft; that zone is characterized by estimated permeabilities of >1000 ft/day.

Preliminary lithologic analysis of cores indicates that the surficial aquifer system comprises a mixed carbonate-siliciclastic deposit of an unnamed carbonate and siliciclastic unit at the base which is overlain by the Tamiami Formation and younger units. The most permeable portion of the aquifer system occurs from 30 to 50 ft depth, in highly leached, moldic and sandy limestones. Locally, tightly cemented beds and poorly sorted sands confine these porous units. The surficial aquifer system is compartmentalized into aquifers of increasingly more saline (with depth) ground water by thin (<1m) horizons of tightly cemented limestone, dolostone, and(or) sandstone, and by thicker (>3m) zones of poorly sorted, unconsolidated siliciclastics.

The current model for the surficial aquifer system comprises the lower Tamiami aquifer that is separated by a semi-confining unit from the overlying water-table aquifer. The base of the surficial system is generally considered to be the low permeability clays of the Hawthorn Group, however, the Hawthorn Group was not recognized in any of the cores drilled for this study. In general, the results of this study support the current model however, some areas appear more complexly compartmentalized than the simple two aquifer system.

INTRODUCTION

At the turn of the century, the Kissimmee River-Lake Okeechobee-Everglades wetland ecosystem in south Florida covered about 2.9 million acres (Davis, 1943), and seasonal flooding of the lake sent water flowing over its southern rim as overland sheet flow on a sluggish journey to Florida Bay and the Gulf of Mexico. In the early part of this century, the state of Florida began the construction of canals, and later levees, to control flooding of Lake Okeechobee and to drain the wetlands for residential and agricultural use. In the 1930's and 1940's, cross-peninsula highways, like the Tamiami Trail and Alligator Alley, not only brought development and cypress logging into southwest Florida, but also created obstructions to that sheet flow to the southwest coast. In the 1960's, drainage of the Big Cypress swamp of southwest Florida accelerated with the construction of the Golden Gate-Faka Union canal system, designed for residential and recreational use. Consequently, in southwest Florida there has been a reduction in aquifer storage, increased saltwater intrusion, invasion of upland vegetation, and an increase in frequency of fresh-water shock loads to coastal estuaries (Abbot and Nath, 1996). By the 1990's, nearly half of the greater Everglades wetlands had been drained and the size of the ecosystem was drastically reduced, diminishing wildlife habitats and seriously threatening commercial aquatic habitats along the coasts.

Public concern over this long-term degradation of the south Florida ecosystem recently has mandated local, state, and federal agencies, as well as private businesses, to halt some of their detrimental practices and to begin the long process of restoration of the ecosystem toward the pre-development state. The U.S. Geological Survey (USGS) has joined with the Army Corps of Engineers, the Environmental Protection Agency, the National Park Service, the South Florida Water Management District (SFWMD), the Florida Department of Environmental Protection, and other state and local agencies, to re-establish a more natural water regime and to manage and maintain the wetlands of south Florida so that the natural ecosystem can recover.

Restoration of the ecosystem requires restoration of the natural hydrologic system. The return of natural sheet flow is predicted to have several beneficial effects: hydroperiods should lengthen, habitats should expand, recharge of the water table aquifer should increase, and the fresh-water lens should enlarge and suppress saltwater intrusion along the coasts. Long-term land and water management decisions in south Florida will be based, in part, on computer models that simulate both the natural hydrologic system, i.e., both ground- and surface-water flow, and the engineering structures that have been added to that system. Local and state agencies depend on these models to assess restoration plans and to predict their effect. However, current models, such as the South Florida Water Management Model and the Natural System Model, do not cover the entire ecosystem area; sufficient subsurface data are available only in southeastern Florida (Causaras, 1985; 1987; Fish, 1988; Fish and Stewart, 1991).

The purpose of this joint USGS and Florida Geological Survey (FGS) project is to acquire subsurface geologic and hydrologic data in southwest Florida to extend current ground-water models to the southwest coast, thereby expanding the utility of these models for land and water management. Improving hydrologic models involves several tasks. The first goal of this study is to develop a geologically reasonable conceptual model for the surficial aquifer system in southwest Florida, the first step in designing a mathematical model. Previous studies have mapped the limits of this system and have demonstrated that the base of the system is a wide-spread clay, presumed to be in the Hawthorn Group, and that the rocks and sediments of the system are highly variable and have highly variable transmissivities. The second goal is to provide reasonable permeability values for the different sediment and rock types in the aquifer system and to map their spatial distribution.

Past geologic studies have been based on samples derived from widely spac exploratory and water wells that yielded primarily drill cuttings. In this study, we improve sam quality by drilling continuous cores through the aquifer system. A challenge to all subsurface dies is the correlation of strata from widely spaced coreholes. We will demonstrate continuity discontinuity) of lithologic units as well as hydrologic (i.e., aquifers and confining its, using a multi-disciplinary approach. Continuity of lithologic units can be demonstrated by ilar age from fossils and with the strontium isotopic composition of shells, and by similar sedim ologic sequence; continuity of hydrologic units will be demonstrated with hydrologic te g and geophysical methods.

This report summarizes the first year of a four-year project and describ rehole drilling and geophysical logging in western Collier County during FY 1996. These ini sks have identified the primary lithologies, the aquifers and confining units at each site, and their geophysical signature. The first year's work is reported in two parts: In part one, herein the lithology and geophysics are given, and in part two, lithostratigraphy, biostratigraphy, diagenesis, and geochemistry will be presented. Aquifer tests and other hydrologic testing are planned for the second and third years and will be reported later.

The current conceptual model for the surficial aquifer system in southwest Florida has evolved over the last 50 years, and is currently, in western Collier County, a two-aquifer system of a water-table aquifer separated by a discontinuous semi-confining unit from the deeper lower Tamiami aquifer (Bennett, 1992). How discontinuous is this semi-confining unit, and what is the connectivity of the aquifer? How can the geologic history of the area help us understand the distribution of permeability in the subsurface? We hope to answer these questions with a multidisciplinary approach that utilizes hydrology, sedimentology, stratigraphy, paleontology, geochemistry, and geophysics.

Acknowledgments

This project has benefited from the contributions of numerous individuals and agencies. Tim Howard of SFWMD in Naples, Florida, assisted in site selection in western Collier County. Also, we thank Bob Henry from Collier-Seminole State Park, Mike Owen, Jolen Mabry, Jim Nelson, and the late Eddy Lowery from Fakahatchee Strand State Preserve, Erv Crosby and Sonia Durrwachter of the Florida State Division of Forestry, Mel Fisher and Mike Quigley of the Southern States Utilities Company, Gary Susdorf of Viro Group, Inc., and Kevin Rohrer of SFWMD in West Palm Beach, Florida. We have benefited from discussions with Mike Bennett from the SFWMD in West Palm Beach, Florida, Ron Reese from the USGS in Miami, and Don Weeks of Big Cypress National Preserve. Our drillers were Jim Trindell (FGS), Don Queen (USGS), Alex Howell (FGS), Frank Rush (FGS), and Roger van Landingham (FGS). Fred Paillet was assisted in the field by Dick Hodges, Roger Morin, and Barbara Corland; Peter Dauenhauer and David Demonstranti (SFWMD) logged the Southern States Utilities corehole.

Previous geologic and hydrologic studies

The first detailed observations of the geology in Florida occurred in the late 1800's on surface exposures from the central and northern parts of the state, such as Dall (1887; 1890 - 1903); geologic investigations extended into the subsurface in the 1920's and 1930's. Some important subsurface units of the surficial aquifer system in southern Florida were first described and named in these early studies. A generalized column for southern Florida is shown in Figure 1, and is currently under revision. Numerous changes in the stratigraphic terminology of south Florida have led to considerable confusion among both geologists and hydrologists. The lithostratigraphic definitions, the unit boundaries, and the assumed ages of the stratigraphic units cored have evolved since the first descriptions in the early part of this century as new data have

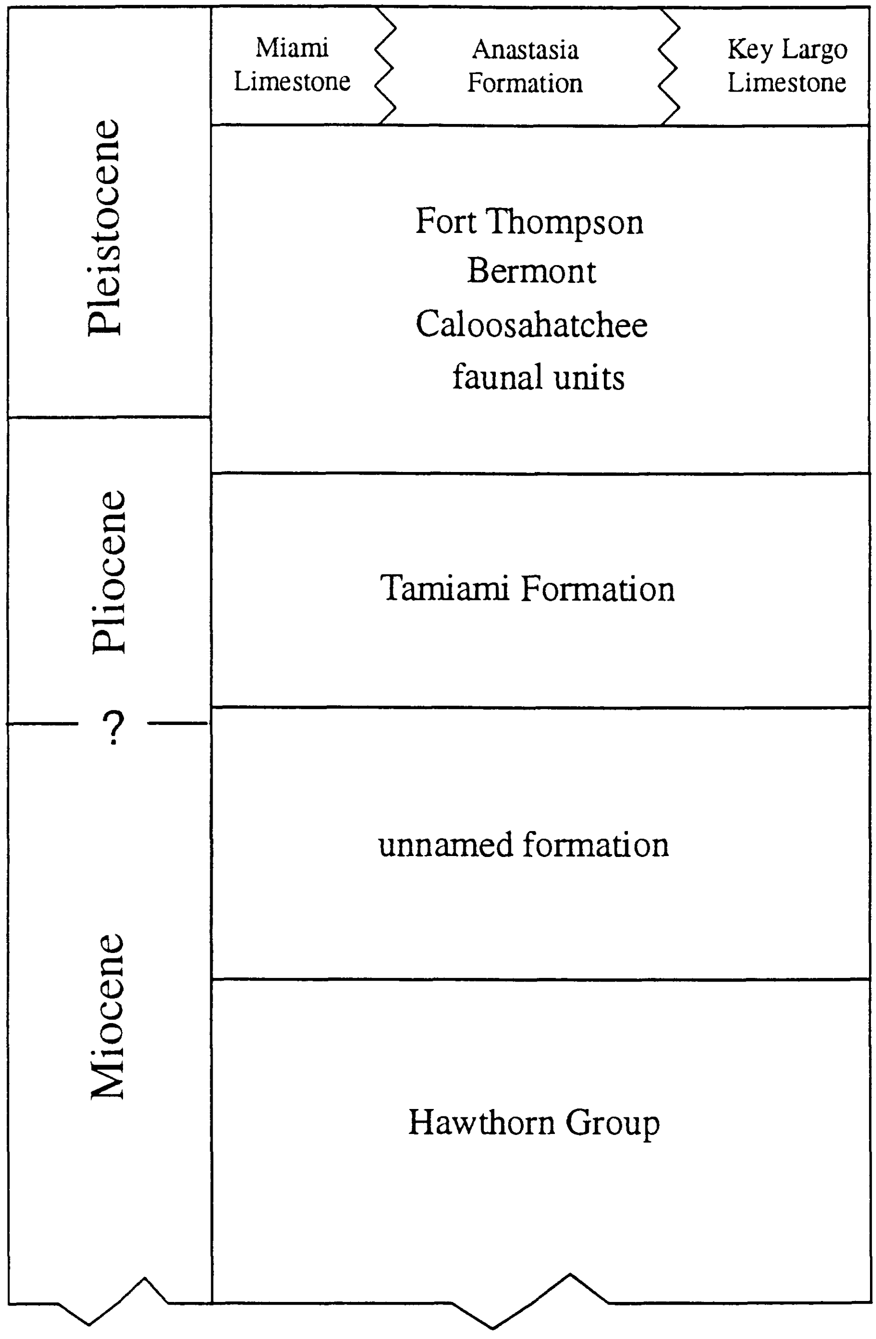

Figure 1 . Generalized stratigraphic column for south Florida. Of the late Pleistocene interfingering units, only the Miami Limestone might be expected in the study area. The lithostratigraphic classification for the section from the Tamiami Formation to the Hawthorn Group is currently being revised by the Florida Geological Survey (figure is modified after Allmon, 1992 and Scott, 1992).

become available. We will discuss the definition of the stratigraphic units of the surficial aq[illegible]ifer system more thoroughly in a later report, with age, composition, and diagenetic data.

In this study we tentatively have identified the Caloosahatchee faunal unit and the T[illegible]ami Formation, and recognize an unnamed unit below the Tamiami Formation that may be corre[illegible]ve with a newly described and proposed formation recognized in the Florida Keys to the sout[illegible]e proposed Long Key formation (K. Cunningham and others, unpublished data). The Hawt[illegible]n Group and its constitutents the Peace River and Arcadia Formations were not recognized i[illegible]ny of the cores drilled in FY96.

The Tamiami Formation is the primary stratigraphic unit of the water table aquife[illegible]d perhaps some of the lower Tamiami aquifer in southwest Florida. It was first describe[illegible]m exposures in the shallow canal excavated during construction of the Tamiami Trail, by [illegible]ke and Mossom (1929), and later named the Tamiami Limestone by Mansfield (1939). The unit has been redefined in numerous studies since that time (e.g., Parker, 1942; Parker and others, 1955; Olsson, 1964; Hunter, 1968; Missimer 1978, 1992; Meeder, 1979; Hunter and Wise, 1980). Its definition and boundaries are still in dispute (Missimer, 1992) because of lack of good exposures, insufficient faunal and geochemical dating, uncertain correlation, and regional variability.

The Caloosahatchee Formation was described and formally named in Matson and Clapp (1909) and thought to be Pliocene. It is a highly variable unit of carbonate mud, limestone, quartz sand, and shell beds. The Matson and Clapp (1909) definition held until Dubar (1958) expanded both the lithologic definition and age estimate, and both have been in dispute ever since. No accepted lithologic boundaries have been specified for this unit; it is recognized primarily by its fossil content (Missimer, 1984). Scott (1992) proposed an informal lithologic unit, the Okeechobee, that incorporates the Caloosahatchee, Bermont, and Fort Thompson faunal units. The purpose of this proposed lithologic unit is to comply with the guidelines of the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983), which recommends defining lithologic units on the basis of lithology and stratigraphic position, and not on fossil content or age.

Ground-water and geologic investigations began to be integrated as the population began to expand in southern Florida and interest in ground-water resources increased. Several early ground-water studies determined the approximate spatial extent of the surficial aquifer system, which was then called the shallow aquifer of southwest Florida (e.g., McCoy, 1962, 1967, 1972; Sherwood and Klein, 1961; Klein and others 1964, 1970; Klein, 1972) However, many of these early studies were based on drilling to depths of no more that 80 ft. Stewart (1982) completed a surface resistivity survey and and demonstrated its application to water resources in Collier County. Jakob (1983) investigated the hydrogeology of the shallow aquifer south of Naples. The geology of the surficial and intermediate aquifer systems of southern Collier County was investigated by Peacock (1983), the hydrologic resources of western Collier County by Knapp and others (1986), and a three-dimensional ground-water model was developed for western Collier County by Bennett (1992).

The current model for the surficial aquifer system of southwest Florida comprises two aquifers: the water-table and the lower Tamiami aquifers, separated by a semi-confining unit (Southeastern Geological Society, 1986; Bennett, 1992). In addition, the gray limestone aquifer has been identified within the surficial system, and described from Dade County by Fish and Stewart (1991). The gray limestone aquifer is assumed to extend westward into Collier and perhaps Monroe counties, and may be correlative with the lower Tamiami aquifer. The base of the system is considered to be the laterally extensive fine-grained, clayey sediments of the Hawthorn Group (Knapp and others, 1986; Bennett, 1992). Hydraulic conductivity of the surficial aquifer (water table aquifer) is reported to vary from 500 to 2500 ft /day in Collier County. The transmissivity of the lower Tamiami aquifer is reported to range from 10,000 to 1,900,000 ft^2/day (Bennett, 1992).

Study area

Seven cores were drilled in western Collier County from February 1996 through September 1996, in the area between Alligator Alley (I-75), Tamiami Trail (U.S. Highway 41), State Route 29, and State Route 951, and are the subject of this report (Figure 2). Sites were chosen for their accessibility and coverage of the study area. Most drill sites were, of necessity, drilled on surfaces of artificial land fill to support the drill rig and other vehicles.

Several canals have had a major impact on the natural drainage of the study area. Six of the seven corehole sites in this study are located near, and probably influenced by, these canals. They include the Golden Gates Estates and Faka Union canal systems near the Old Pump Road and Picayune Strand corehole sites, the Tamiami Canal that runs along the Tamiami Trail, near Southern States, Collier-Seminole State Park, Old Pump Road, and the Fakahatchee Strand Ranger Station corehole sites, the Barron Collier Canal that runs along Route 29, near Fakahatchee Strand Ranger Station corehole site, and the Alligator Alley Canal, that runs along I-75, within about half a mile of the Jones Grade and Picayune Strand coreholes sites (Figure 2). Only the Gate 12 corehole site is removed from canal influence.

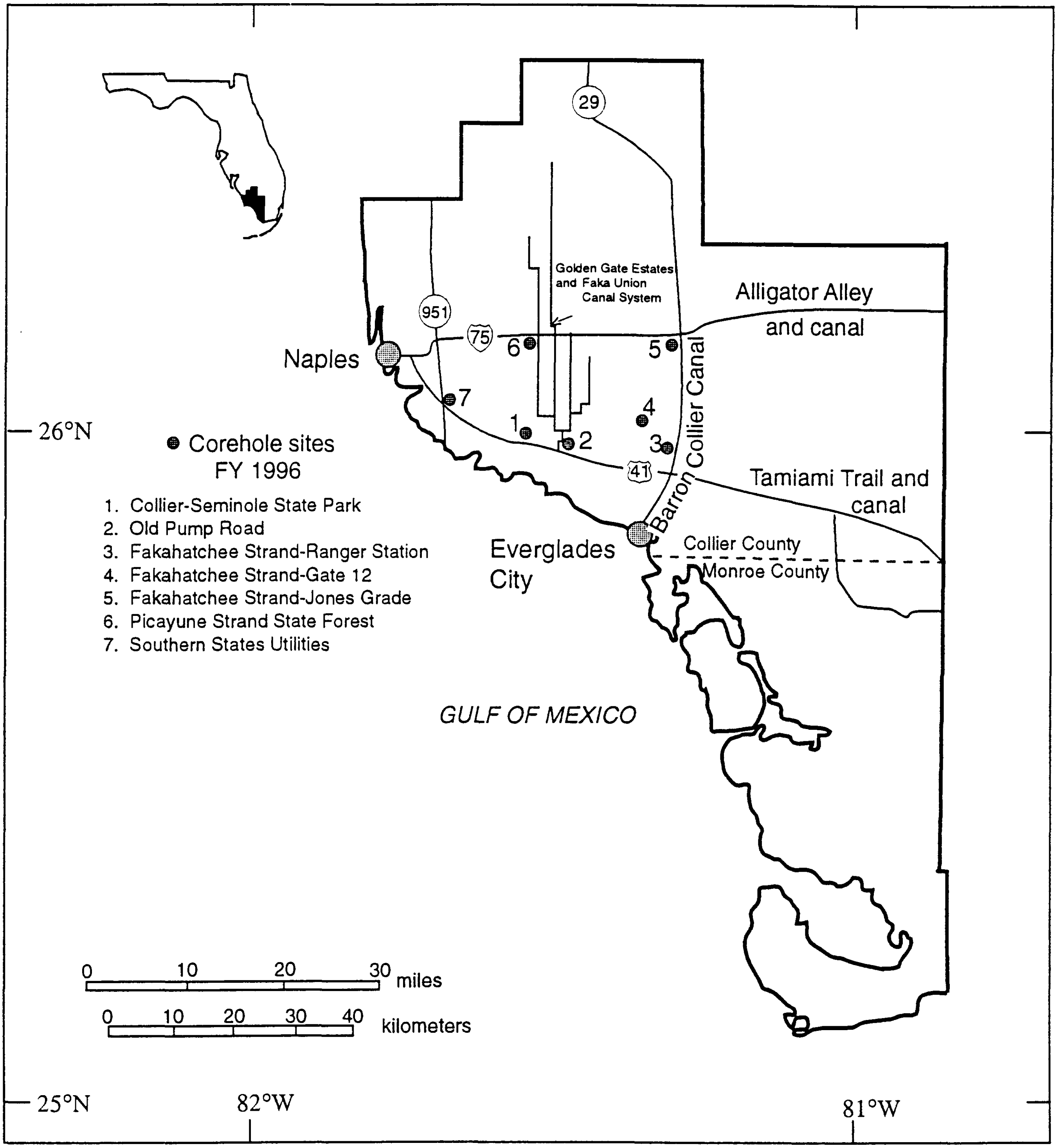

Figure 2. Study area in south Florida (inset). Corehole locations are shown as numbered dots.

METHODS

Coring and lithologic descriptions

The coreholes were drilled by the FGS with a Failing 1500 water-well mobile drill rig using both drill stem and wireline coring methods. Cores were recovered, boxed, and initially described on site, and further examined and described in Tallahassee, by personnel of FGS and USGS, where they will be permanently stored. Core descriptions presented in Appendix 1 are part of the FGS GEOSYS litholog database, and follow their classification system. Lithologs are available, currently, on the World Wide Web at:

http://www.dep.state.fl.us/ geo/index.html

Most sites have a 3 to 5 ft veneer of man-made fill that is necessary to provide well drained access to vehicles into the wetland environment. Because fill material is excavated locally from borrow pits, the rock and sediment comprising the fill is the same as the material of the local natural surface. Therefore, the contact between man-made fill and the natural surface in the lithologic logs is an estimate and is based on relative degree of disruption of the bedrock and sudden color change. In some cases, the natural surface could be seen close to the drill site and the thickness estimated from topographic rise.

Hydraulic conductivity

Selected core samples were chosen for vertical hydraulic conductivity testing. Generally, the samples were well indurated and contained a minimal amount of moldic pore space. Zones of interest are cut in 2- to 2.4-inch lengths from the 1.9 inch diameter cores. These samples are set in a hardening resin which seals the sides but leaves the ends open. The prepared samples are next placed in falling-head permeameters which allow deionized water from a graduated buret to flow through the samples from bottom to top; water column diameter, sample diameter and ambient temperature are then recorded. Once a sample is saturated with water, data such as start time, stop time, water column height are recorded. Three runs were performed on each sample, and the data were entered into a program developed by the Florida Geological Survey called Permcalc, which calculates the hydraulic conductivity in units of ft per day.

Drilling mud removal

Some corehole geophysical measurements depend in a critical way on the removal of drilling mud from the corehole fluid column and the development of formation permeability immediately around the well . Drilling mud flushing was performed by injecting fresh water into the corehole. The turbulent agitation of this water flow was assumed to develop the formation adjacent to the corehole. The amount of "surging" and the length of time over which the flushing was applied was necessarily more limited in open corehole intervals to minimize corehole collapse. More extensive and intensive flushing was applied when the corehole was lined with a slotted casing. However, it remained impossible to determine whether the annulus between casing and formation was completely filled with collapsed sediments or whether intervals of connected voids remained as a possible flow path over certain intervals. It was also uncertain whether drilling mud was flushed uniformly from the formation adjacent to the corehole, or whether flushing occurred discontinuously over limited intervals. During flushing injected water initially returned to the surface within the screened pipe, and, after displacement of drilling mud there, returned from the annulus between the pipe and the corehole wall. This flow pattern indicates that water circulated from within the pipe, through the screen slots and up the annulus, removing drilling mud from within the pipe, from the screen openings, and from the annulus. Flushing time varied from 2-3 hours duration, until water ran nearly clear.

Geophysical logging

The seven coreholes were logged with a suite of geophysical well logs consisting of gamma-ray, electric, neutron porosity, caliper, and fluid column resistivity and temperature; these are all of the logs that could be run under the given corehole conditions (Hearst and Nelson, 1985; Keys, 1990). In addition, two geophysical logs, not normally run in shallow, unconsolidated formations, were run in some of the coreholes: (1) the acoustic corehole televiewer (BHTV), a corehole wall image device (Paillet et al., 1987); and (2) the heat-pulse flowmeter (HPFM), a high resolution corehole flowmeter (Hess, 1986). All logs were run within days of completion of drilling.

All geophysical logs, except the televiewer and heat-pulse flowmeter logs, were obtained using a PC-based digital logging system as described by Keys (1986). Depth scales on the digitized logs are given in ft below land surface, and were verified by ensuring that the depth indicator returned to the zero point within an error of 0.4 ft (0.2 percent error for typical corehole depths of about 200 ft) at the end of each logging run. Depth scales also were checked to ensure that all obvious contacts indicated on the logs occurred at the same depth for all of the logs run. Logs such as gamma-ray and neutron porosity obtained with nuclear counters were run at logging speeds (20 ft per minute) that were slow enough to ensure that nuclear statistical errors were negligible. Nuclear statistics were suppressed by using an N-point averaging filter such that

$$(N-1)\,\Delta z = 1.0 \qquad (1)$$

where N is the number of points in the filter, Δz is the log digitizing interval, and the sample volume for the nuclear log is assumed to be slightly larger than one foot. This averaging applies as much smoothing to the nuclear logs as possible without degrading the spatial resolution by averaging over intervals larger than the sample volume of the logging tool.

Natural gamma-ray log The natural gamma-ray log provides a measure of the natural gamma-ray activity of a formation produced by the radioactive decay of naturally occurring isotopes of uranium, thorium, and potassium. It was acquired from a multifunction probe which also collects data for other logs listed below, logging up from the bottom of the hole to maintain steady tension on the measuring wheel. This log is used as an indicator of formation lithology, where the measurement responds to differences in abundance of radioactive elements in different combinations of minerals. The gamma-ray log measurement is often taken as an indication of the relative amount of phosphatic or clay minerals present in the formation under the assumption that the radioisotopes occur as exchange cations associated those minerals.

Induction log The induction log measures the electrical conductivity of the formation by measuring the electromagnetic signal from a torroidally-shaped volume around the corehole. The log is acquired with the induction probe, which makes both gamma-ray and formation restivity measurements using the induction method. The gamma-ray log thus acquired with the induction tools is similar to the gamma-ray log acquired from the multi-function probe in that the scale (in counts per second) differs by a constant determined by gamma-ray detector size and efficiency. This measurement can be made in air or water-filled coreholes, and through electrically non-conductive (plastic) casing. The measurement needs no correction for the salinity of corehole fluid, and is automatically corrected for skin effect (the partial shielding of minerals by their own electrical conductivity).

Normal resistivity log The normal resistivity measurement is made using sets of electrodes in an open, fluid-filled corehole and is acquired by the multi-function probe. This measurement is similar to the induction log, except that a correction is needed to account for the effects of corehole fluid (the departure effect), and normal electric logs cannot be run in air-filled or cased coreholes.

Neutron log The neutron log measures the ability of the formation to attenuate and absorb high-energy neutrons emitted by a radioactive source. The neutron log is obtained from a dual-detector neutron probe which contains a 3-Curie AmBe neutron source and two He^3 neutron detectors located at different spacings on the probe. The log records the flux of neutrons at each detector (in counts per second). Neutron-log data (the two count rates) are calibrated in units of formation porosity. The calibration is based on the ratio of the count rates (far detector count rate divided by near detector count rate) using limestone calibration blocks of known porosity maintained by the American Petroleum Institute at the University of Houston. Therefore, porosity estimated by the the neutron log applies to limestone, and may be as much as 2 and 4 percent, respectively, in error for strata containing dolomite and quartz sand. Much larger porosity errors are induced by the presence of corehole wall openings and "washouts" where the effectively 100 percent porosity of the openings is averaged with the much lower porosity of the undamaged formation. The presence of such errors is often indicated by variations of diameter on the caliper log. If neutron logs are run inside of plastic casing, the casing introduces a slight systematic error (apparent increase) in porosity, and voids in the incompletely filled annulus between casing and formation cannot be distinguished from formation porosity. The reduction in neutron flux is caused primarily by the hydrogen in water, so that the measured neutron counts given by the log can be calibrated in units of fluid-filled porosity. The hydrogen in plastic or steel casing and corehole enlargements can produce spurious measurements, so that neutron logs are routinely corrected for casing and diameter effects.

Caliper log The caliper log gives a single measurement representing the variations in corehole diameter by recording the extension of spring-loaded arms attached to a centralized, single function logging probe. Conventional three-arm caliper logs such as the caliper log used in this study measure the average extension of three separate arms.

Fluid column resistivity log The resistivity of the fluid filling the corehole column is measured by electrodes installed on the electric logging probe, logging down the hole from the top, into the undisturbed fluid column. This measurement applies to the fluid (mud or water) in the corehole, and not necessarily to the water saturating the formation at the same nominal depth. The effectiveness of the fluid column resistivity measurement is influenced by the plugging of ports that allow corehole fluid to circulate around the logging probe as the probe is moved along the corehole.

Fluid temperature log The fluid temperature log is similar to the fluid column resistivity log, with temperature measured by a small probe protruding from the bottom of the multi-function probe. Temperature logs are most effective when the logging tool is run into undisturbed corehole fluid. However, this mode of operation can cause minor depth errors when the smooth lowering of the logging probe is prevented by the probe lodging on a "ledge" or other obstruction.

Spontaneous potential log The spontaneous potential log measures naturally occurring electric potentials which develop between a specific depth in the corehole and a reference electrode located on the surface, using the multi-function probe. These potentials develop when there are differences in salinity between the formation and corehole fluids, but only when there are electrically conductive clay minerals present in the formation. Under those conditions, the measured spontaneous potential can be used to estimate the ratio of resistivity of the formation water to the corehole fluid (R_w/R_f), and the bulk fraction of clay mineral present in the formation. As noted in the analysis of logs below, electrically conductive clay minerals are not present in the formations logged, and spontaneous potential logs are not discussed in the analysis for that reason.

Single-point log The single point log measures the total resistance between a single downhole electrode and a reference electrode at the surface, and is acquired by the multi-function probe. Because the same electrodes are used to measure both current and potential, the measurement cannot be used to give an estimate of formation resistivity.

Acoustic televiewer The acoustic televiewer (BHTV) is a single-function corehole image logging device that produces a photograph-like image of the pattern of acoustic reflection from the corehole wall. The BHTV image can indicate changes of corehole wall texture and openings intersecting the corehole with a resolution better than one quarter of an inch.

Heat-pulse flowmeter The heat-pulse flowmeter (HPFM) is a high-resolution flow measurement device that can detect vertical flow in coreholes as small as about 0.01 gallons per minute (Hess, 1982; Paillet et al., 1996). The HPFM detects the velocity of flow through the central section of the logging probe, but probe response is calibrated in units of corehole discharge using flow columns of various diameters. The HPFM is most often used with a flexible cylindrical disk to block the annulus between probe measurement section and the corehole wall. This disk increases the sensitivity of the flow measurement, but the HPFM response can be calibrated for use either with or without the annulus blocking disk. The buoyancy of the heat pulse induces a very small upflow bias in the measurement, so that a very weak upflow (less than 0.02 gpm) may be indicated in a static environment. Thermally-driven convection within coreholes is rare because the narrow diameter of coreholes inhibits convective cells which have small aspect ratios (ratio of vertical to horizontal scales). However, thermally driven convection can occasionally be mistaken for net vertical flow. Abrupt changes in the vertical temperature gradient on the temperature log may sometimes be identified to indicate the presence of thermal convection in the corehole. In this study, we found the best flowmeter logs were obtained with a flow measurement section centralized in the slotted casing without the flow diverter. The presence of the diverter often seemed to distort streamlines in borehole flow, forcing flow to accelerate in areas where formation collapse left voids outside of casing. We used a flowmeter measurement section sized to nearly fill the inside of the casing, so that the lower limit of flow detection without the diverter was only slightly greater than it would have been with the diverter working as designed, while providing minimal disturbance to the ambient flow field.

Other logs One of the coreholes logged in this study (Southern States Utilities site) was logged with non-USGS equipment for logistical reasons by the South Florida Water Management District. These logs consisted of a long and short normal and single point resistance combination, and a gamma-ray-neutron combination. The short normal was converted to an approximate induction log by digitizing the original analog output and plotting the data in conductivity units after correction for departure effect (Hearst and Nelson, 1985). The gamma-ray log was modified by a scale factor so that the non-USGS gamma-ray log has approximately the same depth averaged gamma-ray counts as the USGS gamma-ray log. The non-USGS neutron log was made with a single detector probe, and the output is given in counts per second. This log was calibrated in porosity units by assuming that the upper and lower porosity limits in the uncased portion of the corehole corresponded to the upper and lower porosity limits in the other coreholes (50 and 5 percent respectively). Therefore, the non-USGS neutron log is plotted in approximate porosity units, using a scale that is comparable to that on the other logs. This is important, because the calibration equation for single-detector neutron logs indicates that count rates are inversely proportional to the logarithm of porosity (Keys, 1990).

Casing configuration of coreholes

Corehole stability was a major concern for all aspects of geophysical logging. In this study, corehole stability was affected by the casing configuration, by the amount of flushing with fresh water used to remove mud from the corehole, and by the degree of consolidation of the formation. We experimented with various methods for corehole stabilization to obtain the most complete set of logs throughout the course of drilling. The first few holes, with minor amounts of unconsolidated sediment, were logged with only surface casing in place; however, later holes, with thicker sections of unconsolidated sediment, were cased with screened PVC pipe to hold the hole open but allow flow of water into the corehole from the formation. Three different combinations of casing and corehole flushing were used with various results.

(1) Surface casing with open corehole. A steel surface casing (needed for effective drilling) was left in the upper part of the corehole to support the most poorly consolidated sediments in most holes drilled. Under those conditions, logs were run in the lower part of the corehole after drilling but before flushing. Fluid column resistivity was therefore not representative of formation water, and the heat-pulse flowmeter logs could not be run. However,

the open corehole allowed acoustic images of the corehole wall to be obtained. Then drilling mud was removed by flushing, the open corehole logged for fluid column properties, and with the flow meter under ambient and injection conditions. Some of the lower part of the open corehole filled in with loose sediment as expected, but much of the open hole remained available for logging. In this logging approach, the upper part of the corehole never remained open after the surface casing was removed. The chief drawback of this approach is that a steel surface casing prevents electric, flow meter and acoustic image logs in the upper, possibly most permeable, interval of the formation.

(2) Plastic casing. The outer, steel surface casing could be removed, and the entire corehole made available for logging through the plastic casing. The casing has a small effect on neutron porosity logs; fluid column resistivity, caliper, flow meter, and acoustic imaging logs cannot be run under these conditions. The main advantage of this approach is that all of the corehole is available for logging with electric induction logs.

(3) Fully screened plastic casing. Using a screened plastic casing the full length of the corehole keeps the corehole open, but permits the drilling mud to be removed and the formation developed. However, there are potential problems in that the annulus between the casing and the formation may not fill in uniformly with unconsolidated materials. Also, we experienced problems when the surging during well flushing caused the casing to separate and part of the corehole to be filled with debris, and finally, the screened casing precludes caliper and acoustic imaging logs. The flow meter log can be run under ambient and injection conditions, but at some sites, there were indications that part of the ambient and injection flow was being conducted through intervals of open annulus, as well as within casing, giving spurious results.

In general, we found the third approach to be the best compromise between making most of the corehole available for logging while interfering with the operation of the logging equipment the least. The exact sequence of logs run and the casing condition of the corehole at the time of logging was determined by the specific corehole conditions, and by the availability of equipment at the time of drilling.

TABLE 1. Corehole site locations

Corehole site (1:24,000 USGS map)	Latitude Longitude*	Section/ Township/ Range	Elevation (ft)
Collier-Seminole State Park (Royal Palm Hammock)	25° 59' 20" N 81° 34' 43" W	S35 T51S R27E	5
Old Pump Road (Royal Palm Hammock)	25° 58' 37" N 81° 30'19" W	S4 T52S R28E	5
Fakahatchee Strand Ranger Sta. (Ochopee)	25° 57' 06" N 81° 21' 39" W	S12 T52S R29E	5
Fakahatchee Strand Gate 12 (Deep Lake SW)	26° 00' 26" N 81° 24' 44" W	S21 T51S R29E	9
Fakahatchee Strand Jones Grade (Miles City)	26° 08' 36" N 81° 21' 04" W	S6 T50S R30E	13
Picayune Strand State Forest (Belle Meade NE)	26° 08' 36" N 81° 33' 43" W	S1 T27E T50S	13
Southern States Utilities (Belle Meade)	26° 04' 04" N 81° 41' 43" W	S34 T50S R26E	7

*Latitude and longitude measurements are subject to revision with more precise instrumentation within the duration of the project.

COREHOLE SITES

Continuous cores were drilled at seven sites in western Collier County listed in Table 1. Descriptions of the cores are given in Appendix 1.

Collier-Seminole State Park

This corehole was drilled beside a pond near the head of a nature trail in Collier-Seminole State Park, at lat 25° 59' 20"N. and long 81°34'43"W. Access to the trail is through a locked gate across a gravel road, on the north side of Rte. 41, about 1.5 miles east of the park entrance. The corehole was drilled to a depth of 194 ft in February, 1996. The corehole was logged with caliper, gamma-ray, induction, neutron, televiewer, heat-pulse flowmeter and fluid conductivity geophysical tools. The core has been sampled for thin sections, x-ray diffraction, and for strontium dating of shells, and for foraminifer, ostracode, mollusk, dinoflagellate, and pollen content. Permeability has been measured on selected core samples (Table 2).

The upper five feet of this core is man-made fill consisting primarily of unconsolidated quartz sand (Figure 3). Below the fill material is an unnamed quartz sand unit, probably of Pleistocene age. From 20 to 111 ft depth, is the Ochopee Member of the Tamiami Formation. This unit is a white, moldic, molluscan wackestone to packstone with high permabilitites measured as 3.5×10^{-3} to 3.2×10^{-1} ft/day. Zones where there has been extensive dissolution have much higher permeabilities. From 111 to 129.5 ft, there is an unconsolidated calcareous quartz sand of an unnamed unit, and from 129.5 to 194 ft, is a well lithified, very sandy dolostone and(or) limestone, to calcareous sandstone. This siliciclastic-dominated unit below the Ochopee Member of the Tamiami Formation is currently being investigated by the Florida Geological Survey, the University of Miami, and members of this project, for its spatial and temporal relationship to the overlying Tamiami Formation and the underlying Hawthorn Group.

At 129.5 ft, is a tightly cemented, bored, dolomitic, phosphatic zone, which is underlain by a clayey fine to medium, dolomitic and calcareous quartz sand. A sample at 130 ft depth, has extremely low permeability, transmitting no flow on the falling-head permeameter after thirty one days. A few feet deeper, where the rocks are slightly less cemented, a very low permeability was measured of 134.2 ft to 8.7×10^{-4} ft/day.

The low permeability zone beginning around 165 ft comprises a series of several tightly cemented zones that appear as banding on the core. The rock type is calcarous sandstone to very sandy limestone, with discoidal quartz pebbles. A sample from the banded zoned at 171.8 ft showed no flow after 31 days on the falling-head permeameter.

Our data indicate that aquifer compartmentalization at this site appears to be attributed solely to diagenetic processes. Extensive dissolution and lithification have developed the high permeability aquifer rocks, and precipitation of pore-filling cements have created confining units. Compaction of calcareous unconsolidated quartz sand has reduced porosity and permeabilty in those units under the moldic limestones.

Knapp and others (1986) drilled a well for their study about a mile to the east (their C2029) of this site, and determined that the surficial aquifer system is about 150 ft thick, that the water table aquifer occurs in the depth range of 0 to 110 ft, and that the lower Tamiami aquifer occurs from 120 to 150 ft. At the corehole site for this study, there is a water table aquifer from 0 to 129.5 ft, and another aquifer from 140 to 165 ft, with a zone of very low permeability in between. The depth ranges from the two studies are quite similar and indicate probable lateral continuity of aquifers and confining units between the two sites.

There are no recently reported aquifer tests performed within 5 miles of Collier-Seminole State Park, and none were done this year for this study.

TABLE 2. Hydraulic conductivity of selected core samples.

	Depth (ft)	Hydraulic conductivity ft/day
Collier-Seminole State Park		
	54	3.47×10^{-3}
	92	3.18×10^{-1}
	130	no flow after 31 days
	134.2	8.67×10^{-4}
	171.8	no flow after 31 days
Old Pump Road		
	45.5	no flow after 31 days
	65.5	no flow after 31 days
	177	no flow after 31 days
	189.9	no flow after 31 days
Falahatchee Strand Ranger Station		
	23.5	sample too porous for method
	54	sample too porous for method
	62	3.82×10^{-5}
	141.6	sample too porous for method
	158.5	sample too porous for method
Fakahatchee Strand Gate 12		
	24	sample too porous for method
	27	sample too porous for method
	50	sample too porous for method
	78.5	sample too porous for method
	133.5	3.9×10^{-3}
Picayune Strand		
	84.1	sample too porous for method
	88.7	sample too porous for method
	169.1	no flow after 31 days
	182.1	no flow after 31 days
	193	7.47×10^{-3}

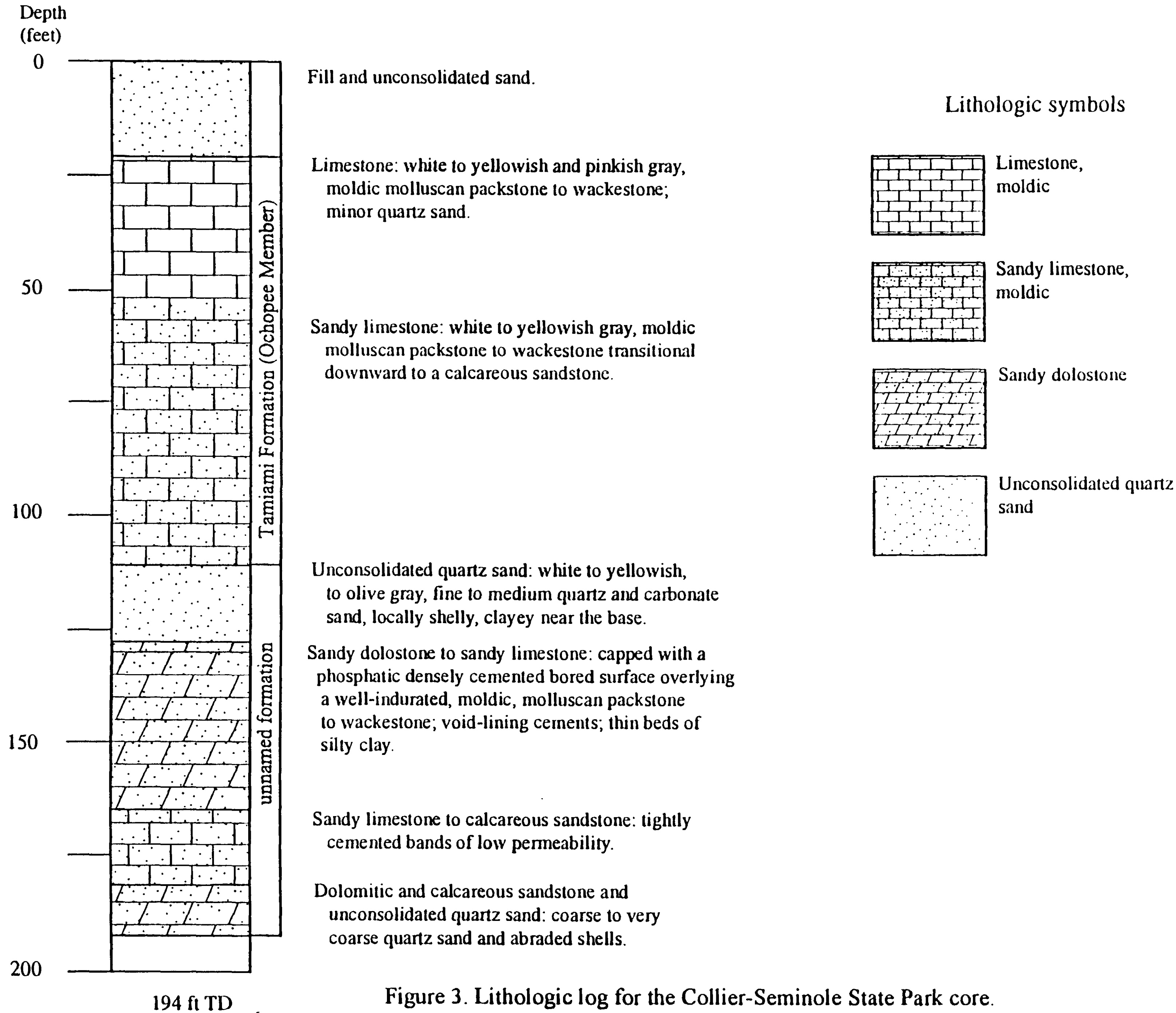

Figure 3. Lithologic log for the Collier-Seminole State Park core.

Old Pump Road

The corehole site is near the intersection of Union Road with Old Pump Road, on the SFWMD easement on the east side of the Faka Union Canal, about 1/4 mile behind the Port of the Islands Resort, north of Rte. 41, at lat 25° 58' 37"N. and long 81° 30' 19"W. The corehole was finished in March, 1996, to a depth of 196 ft . The geophysical logs run were caliper, induction, gamma-ray, gamma-ray spectral, neutron, fluid conductivity, and the heat-pulse flowmeter. The core was sampled for thin sections, x-ray diffraction, and for strontium dating of shells, and for its foraminifer, mollusk, ostracode, pollen, and dinocyst content.

The upper 3 feet of sediment in this core appears to be man-made fill, which is underlain by an unconsolidated sand and a well lithified limestone at about 17 ft (Figure 4). Core recovery was very poor in this corehole and depths are uncertain. Fairly well lithified limestone occurs at about 25 ft and extends down to about 101 ft where it is underlain by an unconsolidated calcareous quartz sand. The very coarse to pebble-sized quartz grains observed in the lower portion of the Collier-Seminole State Park core were not seen in this core. Moderately well lithified rock occurs at 171 ft, and extends to the base of the core.

All samples submitted for permeability testing yielded no flow after 31 days, from depths of 45.5, 65.5, 177 and 189.9 ft. Despite high permeability in the samples from 45.5 and 65.5 ft, the sample preparation of resin impregnation fully filled all porosity. However, the sample from 177 ft, was naturally tightly cemented with sparry calcite, and no resin penetration was noted.

Confining units were not identified, or perhaps not recovered, in this core, but were inferred by the formation resistivity logs that indicate compartments of differing salinity (see section of geophysical logging). The confining unit at about 22 ft may be a clay as indicated by the spectral gamma-ray log, which shows U, K, and Th at that depth. Water-quality logs suggest another confining zone around 45 ft, which occurs within a limestone with no apparent tight zones, at least none that were recovered. A third confining zone may occur at around 100 ft, at the transition from sandy limestone to unconsolidated quartz sand. This was an unstable hole and collapsed before we could finish logs; core recovery was very poor.

The Knapp and others (1986) study drilled a core (C2030) about three miles to the southeast of this corehole, and identified the surficial aquifer system to be about 250 ft thick, the water table aquifer to range from 0 to 90 ft depth, and the lower Tamiami aquifer to range from 130 to 250 ft depth. Poor recovery and hole instability prevent a direct comparison of aquifer and confining units of this site with the Knapp and others (1986) study, but the inferred confining zone at around 100 ft, may correlate with the confining zone between the water table aquifer and the lower Tamiami aquifer at site C2030.

Fakahatchee Strand-Ranger Station

The corehole site is to the east of a group of cypress trees in the front yard of a mobile home between the ranger's residence and the headquarters office of the Fakahatchee Strand State Preserve, at lat 25°57'06"N. and long 81°21'39"W. It was drilled to 161 ft in April, 1996. The geophysical logs run were gamma-ray, induction, fluid conductivity, and the heat-pulse flowmeter. The cores were sampled for thin sections, x-ray diffraction, and for strontium dating of shells, and for mollusk, foraminifer, pollen, dinoflagellate, and ostracode content.; permeability was measure on selected core samples (Table 2).

There are about four feet of fill at the top of the core, which is underlain by about 43 ft of white to gray to yellowish gray moldic, molluscan packstone to wacketone with minor quartz sand (Figure 5). This unit is probably the Ochopee Member of the Tamiami Limestone but is poorly recovered in this core. At about 48 ft, the limestone grades into a very sandy limestone to calcareous sandstone. At 64 ft, there is a tightly cemented sandstone at the contact between acarbonate-dominated unit above and an unnamed, unconsolidated, siliciclastic unit below. The sandstone is only about 6 inches thick, but it may play a major role in the compartmentalization of the aquifer at this site. Below the sandstone, there are about 75 ft of medium to coarse

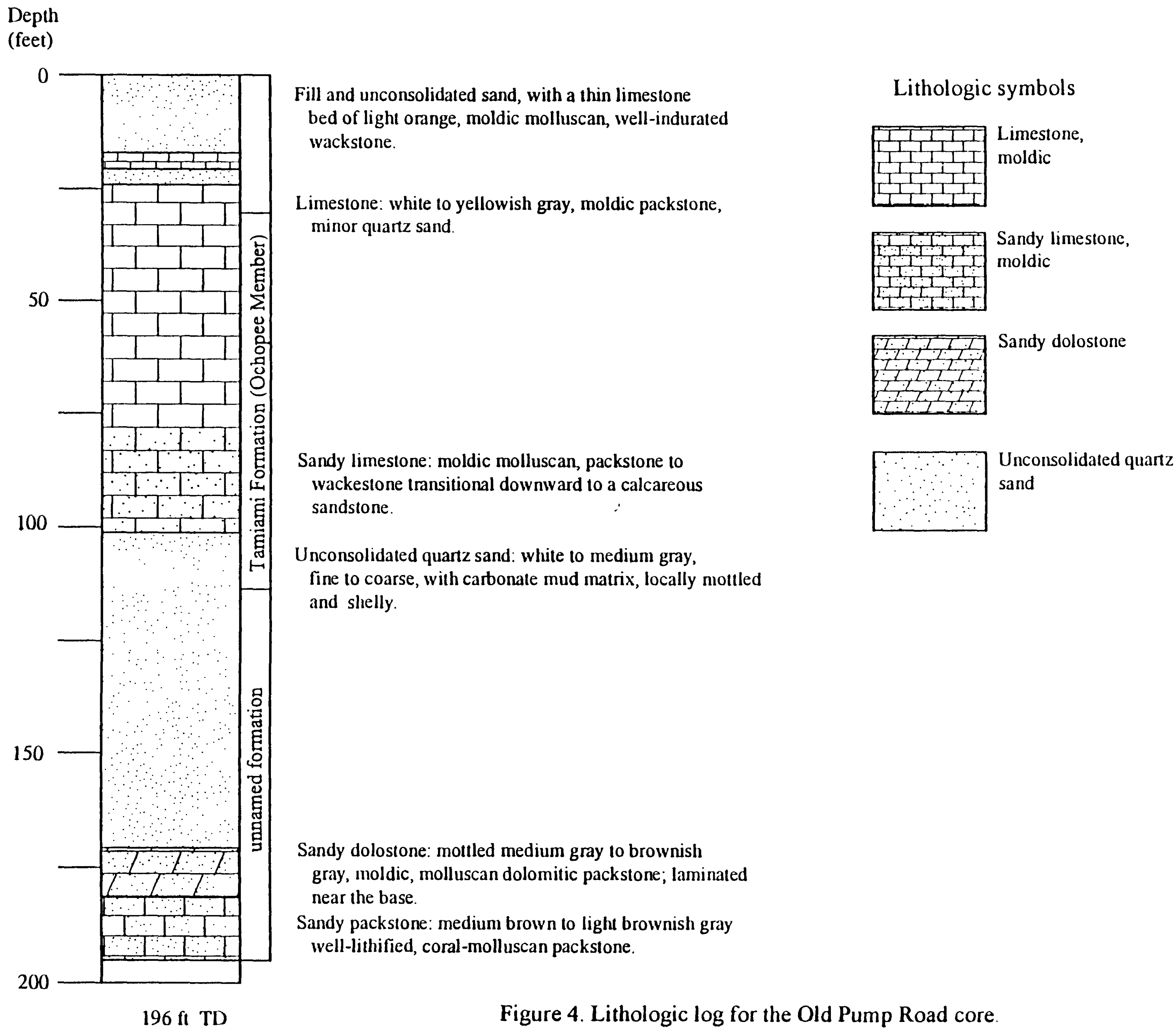

Figure 4. Lithologic log for the Old Pump Road core.

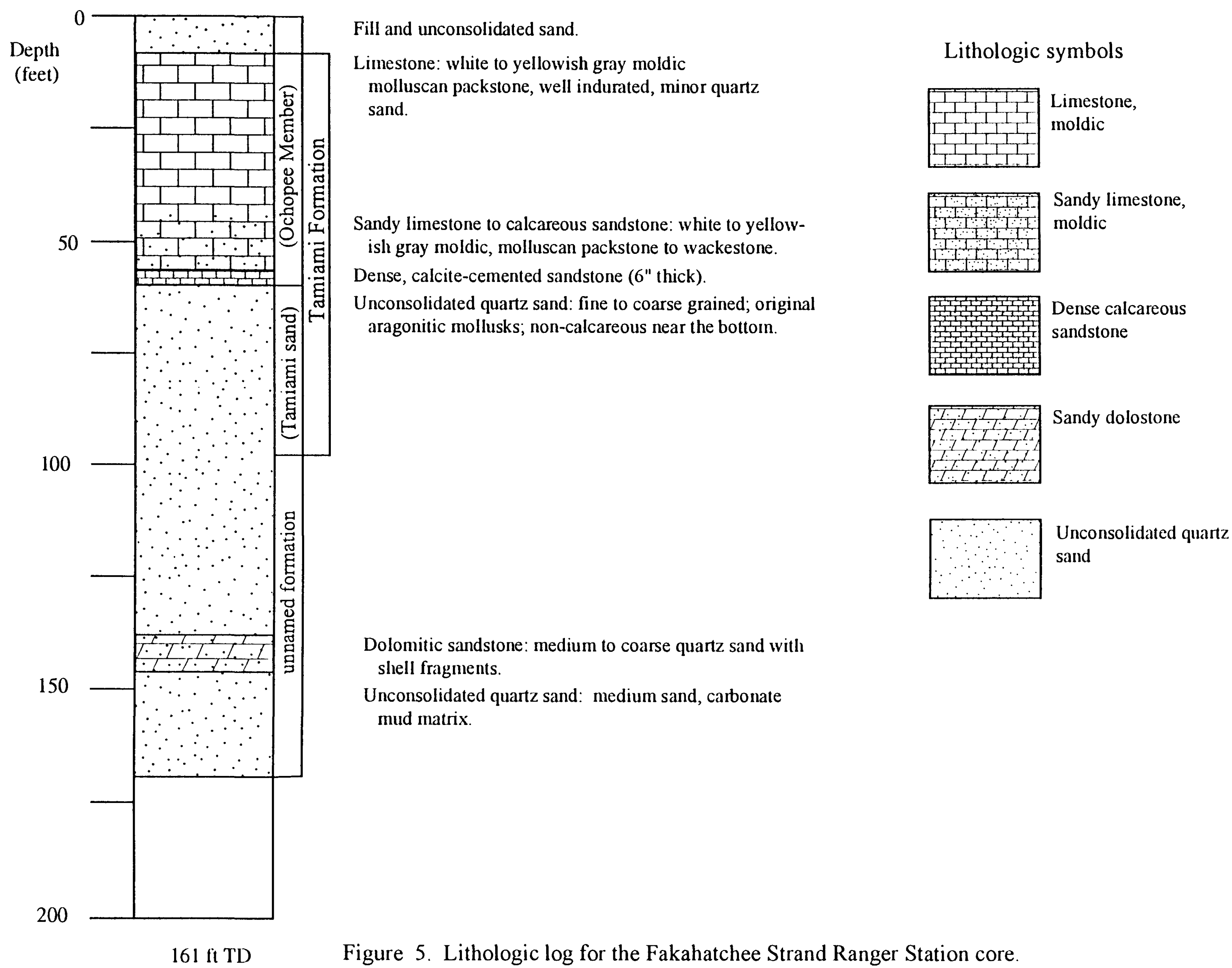

Figure 5. Lithologic log for the Fakahatchee Strand Ranger Station core.

unconsolidated quartz sand, that is variably shelly and calcareous; the sand becomes finer near the base, at a depth of about 134 ft, but from 137 to 140 ft, quartz and phosphate pebbles were observed. At 140 ft, there is a relatively thin (11 ft) dolomite-cemented sandstone which is underlain by more unconsolidated calcareous medium to coarse quartz sand.

Four falling-head permeability tests (at 23.5, 54 ft., 141.6, and 158.5 ft depths) from this core failed because the samples were too porous (Table 2). Resin used to seal the outside surface of each core piece flowed into the interior of each sample blocking off all permeability. One sample at 62 ft, within the tight confining zone, flowed 3.82 x 10^{-5} ft/day (essentially no flow), but showed no evidence of resin penetration; therefore, the low permeability is natural. A consultant's report for a nearby site (Missimer and Associates, 1981) reports transmissivity of the water table aquifer there (from 0 to 60 ft) to be 1.2 - 3.5 x 10^{6} gpd/ft, corresponding to an interval-averaged permeability of about 3000 ft/day.

A well was drilled and described by Knapp and others (1986) about a mile to the northeast (C2031), where they determined that the surficial aquifer system is about 160 ft thick, the water table aquifer ranges from 0 to 80 ft, and the lower Tamiami aquifer ranges from 80 to 160 ft depth, with no identifiable confining unit. The tightly cemented sandstone, noted at 64 ft in this study, was not described in the study by Knapp and others (1986) at C2031, nor from the Missimer and Associates, 1981, study very close to the Fakahatchee Strand Preserve headquarters, although aquifer separation (water table aquifer from the lower Tamiami aquifer) was noted in both reports at about that depth. At the Fakahatchee Strand Ranger Station corehole site, we estimate that the surficial system is about 140 ft thick, the water table aquifer ranges from 0 to 60 ft, and a lower aquifer ranges from about 65 to about 137 ft, with perhaps another confining zone around 75 ft.

Fakahatchee Strand-Gate 12

The corehole site is on Janes Memorial Scenic Drive, about 6 miles past the Fakahatchee Strand State Preserve headquarters, at a wide grassy area on the east side of the road, at lat 26°00'26"N. and long 81°24'44"W., near a USGS monitor well. Gate 12 is at the northeast end of that grassy area, at the entrance to an old logging road (tram). The corehole was drilled to 227 ft in June, 1996. The corehole was logged down to about 100 ft with the gamma-ray, induction, and fluid conductivity tool, and the heat-pulse flow meter. After drilling, the hole was reamed to about 5 inches in diameter and cased with a screened PVC pipe the entire length of the corehole. However, during flushing to remove the mud, the casing became disconnected around 100 ft, and sand poured into the casing filling up the hole making it impossible to log any deeper.
The core was sampled for thin sections, x-ray diffraction, and for strontium dating of shells, and for mollusk, pollen, foraminifer, ostracode, and dinocyst content; permability was measured on selected core samples (Table 2).

The upper 4, and perhaps 6 ft in this core are artificial fill, and are primarily silt and quartz sand (Figure 6). The Tamiami Formation extends from about 6 to 90 ft in this core. Below the artificial fill is a weathered yellowish gray, moldic, molluscan packstone which extends down to about 33 ft depth, and from 33 ft to about 40 ft depth is a very sandy limestone to calcareous sandstone (both units form the Ochopee Member of the Tamiami Formation). At the contact between the lithified, carbonate-dominated unit in the upper part of the core and the unconsolidated, siliciclastic unit at the base is 5 to 6 inches of cemented sandstone at about 40 ft, which is similar to the sandstone at observed at about 64 ft in the Fakahatchee Strand Ranger Station core, and may be correlative. There are original aragonitic mollusks preserved from 46 to 50 ft in the unconsolidated quartz sand in the unit informally called the Tamiami sand (40 to 90 ft in this core). Quartz pebbles were observed in the unconsolidated sand from about 187 to 212 ft.

This corehole site differs from cores drilled to the west in this study in that there is no lithified sediment below the transition from rock to unconsolidated quartz sand in the upper 40 ft. However, within the unconsolidated sand are two zones that are dolomitized: one from 127 to 133 ft, and another clayey dolomitic zone from 217 to 220 ft. Dolomite was encountered at other sites,

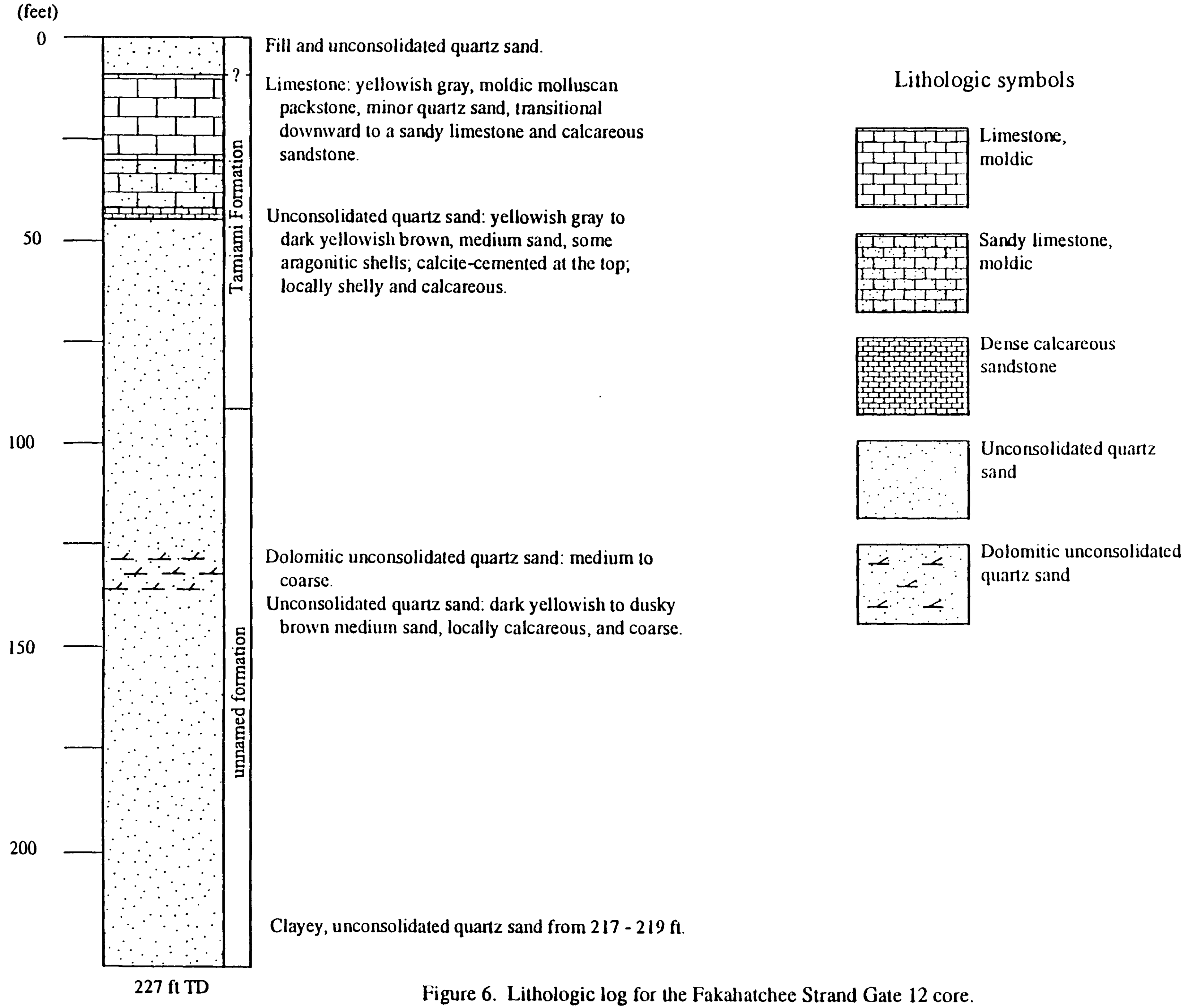

Figure 6. Lithologic log for the Fakahatchee Strand Gate 12 core.

such as Collier-Seminole, Old Pump Road, Fakahatchee Strand Ranger Station, below the unconsolidated sand in lithified portions of the core.

Permeability test on four core samples from this core failed because all four were too porous to produce meaningful measurements, at 24, 27, 50, and 78.5 ft depths. A sample from the lower Tamiami aquifer at 133.5 ft, has a permeability of 3.9×10^{-3} ft per day.

Fakahatchee Strand-Jones Grade

The corehole site is in the driveway of the first house on the south side of a gravel road off Rte. 29, at lat 26°08'36"N. and long 81°21'04"W., about 1/2 mile south of the intersection of I75 and Rte. 29 (Miles City). The core was drilled to 200 ft in July, 1996. Geophysical logs run include the gamma-ray, induction, fluid conductivity, and heat pulse flowmeter. This core has been sampled for thin sections, x-ray diffraction, and for strontium dating of shells, and for mollusk, dinoflagellate, pollen, ostracode, and foraminifer content.

The upper 3 ft of this core is clay and quartz sand which is probably artificial fill brought in for the residence (Figure 7). From 3 to about 70 ft is a poorly recovered, moldic molluscan limestone and sandy limestone, which is partially unconsolidated. From 70 ft to the bottom of the hole, at 200 ft, is an unconsolidated, medium to coarse quartz and phosphatic sand, with scattered quartz pebbles, and is dolomitic from 140 to 150 ft. The limestone from 5 to 46 ft is of questionable Ochopee Member, but perhaps the Golden Gate Member of the Tamiami Formation, as described by Missimer (1992), and from 46 to 70.9 ft is the Ochopee Member. An unnamed unit occurs from 70.9 ft to the bottom of the core at 200 ft.

The surficial system is about 175 ft thick at this site, with the water table aquifer ranging from 0 to about 50 ft depth, and a deeper aquifer from about 135 to 175 ft depth. There may be a productive zone in the 60 to 80 ft depth range. Knapp and others (1986) drilled a well about 6 miles (their C2024) to the west and recognized the water table aquifer from 0 to 50 ft and the lower Tamiami aquifer from 80 to 180 ft, therefore the confining units appear to be correlatable over that distance. However, the confining zone, inferred in this corehole from 80 to 135 ft, was not reported in the Knapp study.

Picayune Strand State Forest

The corehole site is in the back pasture of the residence of a state forest employee, at 2121 52nd Ave. S.E., south of I75, in the Golden Gate Estates, at lat 26°08'36"N; long 81°33'43"W. Access is from two directions: take Janes Memorial Scenic Drive through Fakahatchee Strand State Preserve, go west on Stewart Blvd., north of Everglades Blvd., west on 52nd. Ave.; from Rte. 951 going north, turn east on Golden Gate Blvd., south on Everglades Blvd., and west on 52nd. Ave. The core was drilled to 201 ft depth in August, 1996. Geophysical logs run include the gamma-ray, induction, neutron, fluid resistivity, and heat-pulse flow meter. The core was sample for thin sections, x-ray diffraction, and for strontium dating of shells, and for mollusk, pollen, dinoflagellate, foraminifer, and ostracode content; permeability was measured on selected core samples.

The upper 5.2 ft of this core is artificial fill, and from 5.2 to 13 ft may be part of the Caloosahatchee faunal unit (Figure 8). From 13 to 106 ft is the Ochopee Member of the Tamiami Formation, a moldic molluscan packstone grading downward into a very sandy moldic limestone and calcareous sandstone. From 106 to 165 ft, is an unnamed, unconsolidated poorly sorted quartz sand, becoming more clay rich at the base, and from 165 to 201 ft is a sandy, dolomitic, moldic packstone with scattered quartz pebbles from 181 ft to the bottom of the core.

The confining unit between the water table aquifer and the lower Tamiami aquifer is a poorly sorted calcareous unconsolidated siliciclastic unit, but the base of the deeper aquifer is a tightly cemented low permeability dolomite. The upper confining zone occurs within the limestone around 55 ft, and the lower one occurs near the sandy limestone and unconsolidated sand contact.

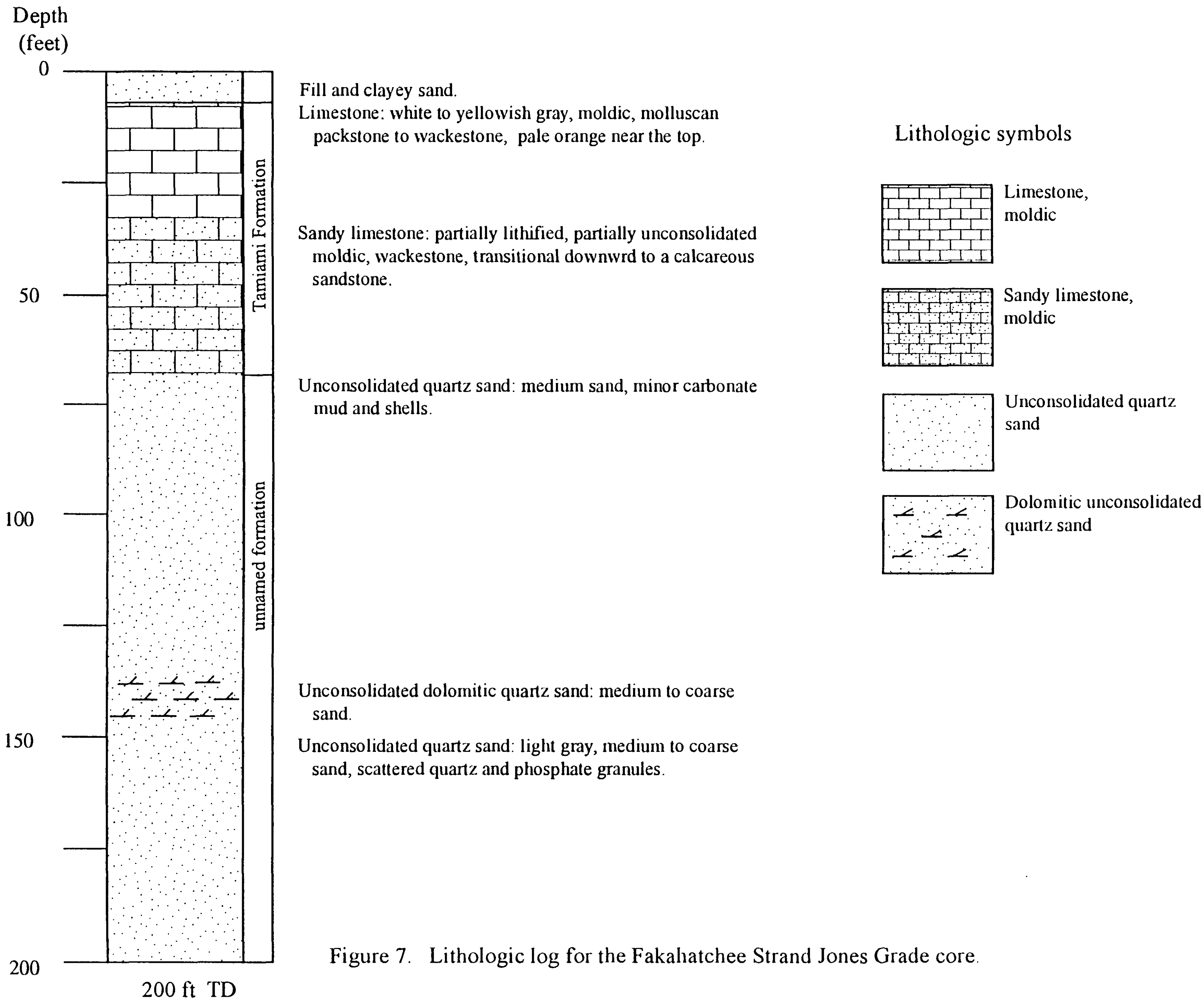

Figure 7. Lithologic log for the Fakahatchee Strand Jones Grade core.

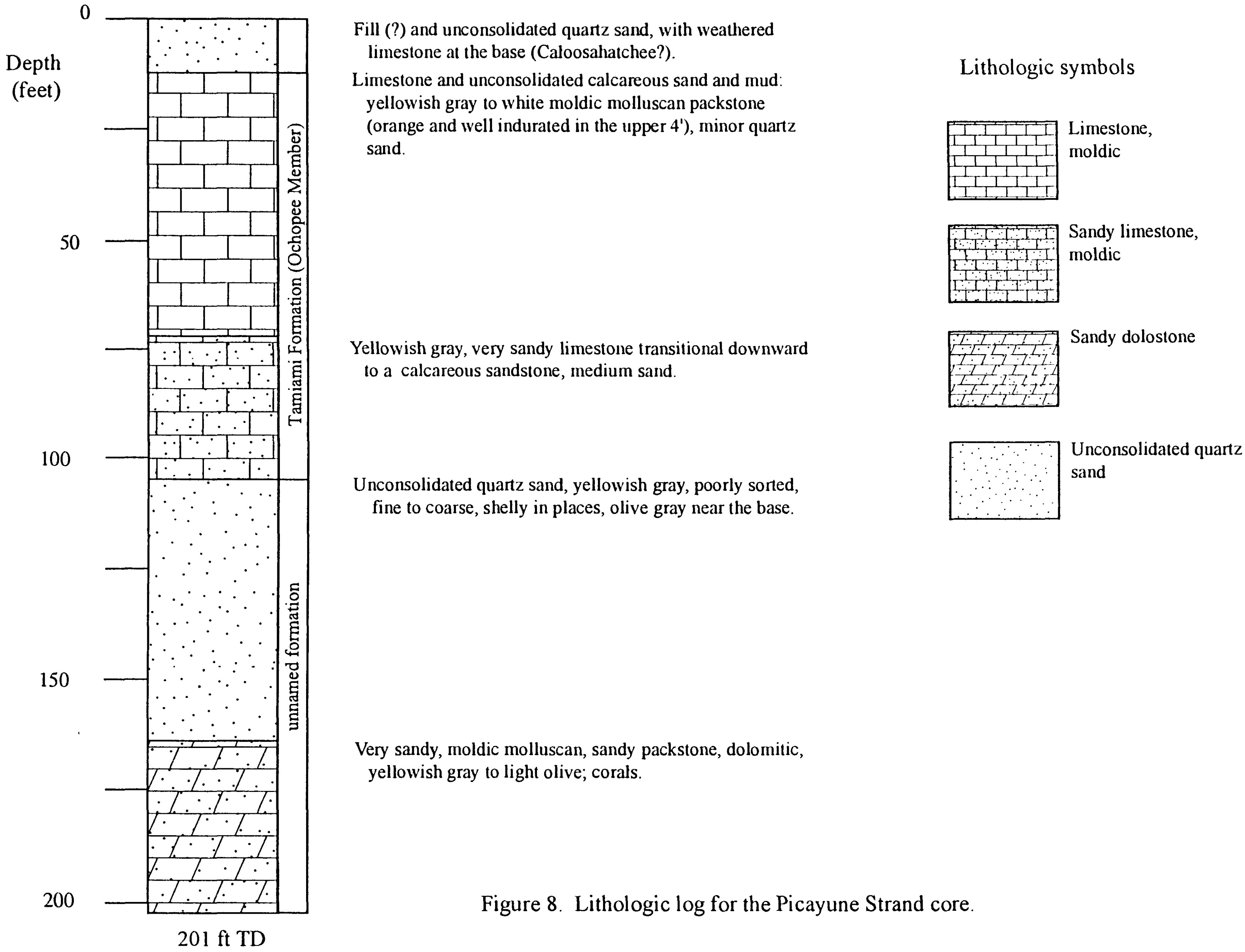

Figure 8. Lithologic log for the Picayune Strand core.

The surficial aquifer system appears to be about 180 ft thick at this site. The Knapp and others, 1986, study drilled a well (C2034) about 2 miles northwest of this site, and determined that the surficial system is about 160 ft thick in the area. They recognize a water table aquifer from 0 to 60 ft, and the lower Tamiami aquifer from 80 to 160 ft. In this study, we recognize the water table aquifer from 0 to 54 ft, and lower aquifer from about 60 to 90 ft, and perhaps another one from 160 to 180 ft.

Permeability testing gave reliable results on three samples from this core, from 193 ft depths, the permeability is 7.47 x 10^{-3} ft per day. This sample is from the basal confining zone in a clayey, sandy dolostone. Other samples from 84.1 and 88.7 ft absorbed too much resin for meaningful results, and the tightly cemented dolostone samples from 169.1 and 182.7 ft showed no flow afer 31 days, due to extremely low permeability.

Southern States Utilities

The corehole site is on the property of Southern States Utilities, at the northeast quadrant of the intersection of Rts. 951 and 41, at lat 26°04'04"N. and long 81°41'43"W. Access is gained by turning left after entering the gate to the property on a gravel road, and driving about 100 yards. This area is recently under construction and the roads may have changed. The corehole was on the left side of the gravel road, just before it divides. The corehole was drilled to 210 ft in September, 1996. The corehole was logged by the South Florida Water Management District using gamma-ray, single point resisitivity, and neutron tools. The core has been sampled for thin sections, x-ray diffraction, and strontium dating of shells, and for dinoflagellate, pollen, mollusk, foraminifer, and ostracode content.

The upper 7 ft in this core appears to be a natural soil which is underlain by about 2.5 ft of tightly cemented limestone (Figure 9), which may be the Caloosahatchee faunal unit. The Ochopee Member of the Tamiami Formation extends from 9.5 to 121.5 ft in this core and is underlain byt an unnamed unit from 121.5 to the bottom of the core. From 10 to 21 ft there is poorly recovered clay and with carbonate concretions, and from 21 to 38 ft, poorly consolidated moldic limestone. From 38 to 86 ft, is a well lithified, moldic limestone that forms the main part of the aquifer, locally referred to as the lower Tamiami aquifer (Gary Susdorf, pers. comm.). From 86 to 122 ft is an unconsolidated calcareous quartz sand, which is underlain by a dolomite cemented sandstone and a sandy phosphatic dolomitic clay; quartz pebbles were observed from 97 to about 120 ft. It is this tight dolomite-cemented sandstone and clay that seems to form a confining zone. From 132 to 140 ft is poorly recovered phosphatic rubble, which is underlain by a sandy dolostone with very coarse sand to pebbles, and from about 160 to the bottom of the hole is unconsolidated dolomitic clay, silt, and quartz sand.

The surficial aquifer system is about 150 ft thick at a nearby site (Knapp and others, 1986) where the water table aquifer occurs from 0 to 25 ft, and the lower Tamiami aquifer from about 50 to 150 ft depth. From geophysical data we recognize at least three aquifers in this hole, a water table aquifer from 0 to about 60 ft, another second permeable zone from 62 to 130 ft, and a third below 135 ft to the base of the corehole at 210'. (Depths from the geophysical logs may vary slightly with depths from core descriptions.) The sandy dolostone may form a confining zone between the middle and lower aquifers.

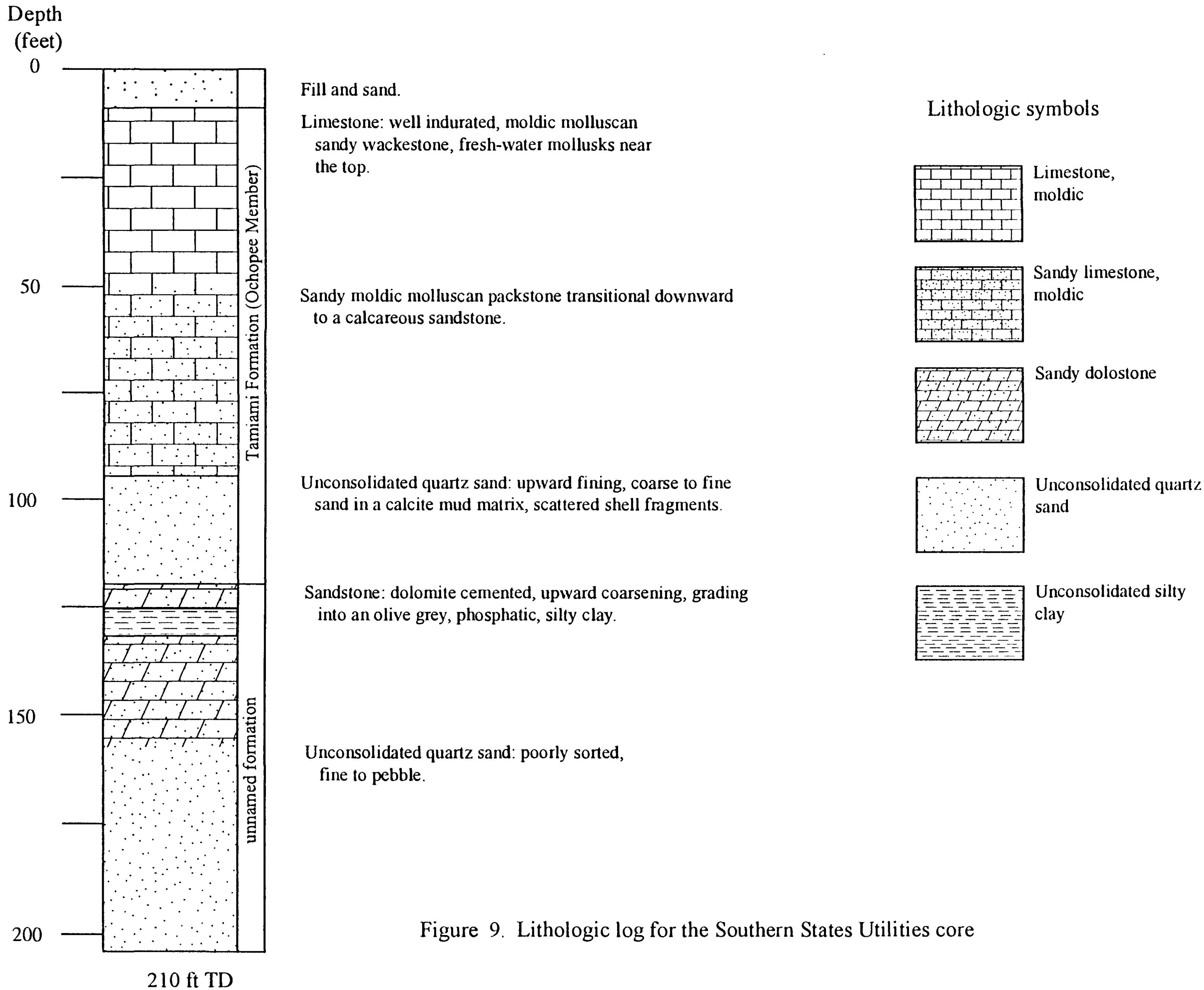

Figure 9. Lithologic log for the Southern States Utilities core

GEOPHYSICAL LOGS

Lithologic, water quality, and flow meter logs were run at each of the corehole sites and are given in Figures 10 through 16. Details of the logging tools used, logs run, and logging conditions are given in Appendix 2.

Lithology logs

The geophysical logs expected to be most indicative of formation lithology in this study are the gamma-ray, induction, neutron, caliper, and BHTV. The full set of these logs was run in only one of the coreholes, Collier-Seminole (Figure 10A). Although core recovery was only about 60percent in this corehole, the logs can be used to extrapolate the generalized lithology column to indicate the depth where changes in lithology occur. Only the gamma-ray log is given above 50 ft because steel surface casing was present when the logs were obtained, and the corehole collapsed completely when the casing was removed.

The gamma-ray log in Figure 10A shows considerable variation within lithologic units and relatively little difference across some lithologic boundaries. Almost all lithologic units are free of clays, so that gamma-ray response would be expected to be low in quartz or carbonate sediments. However, there is no consistent difference in the average gamma-ray activity of sand or carbonate units. Very high gamma-ray counts occur near 130 ft in depth in Figure 10A, corresponding to the presence of uranium in phosphatic sands. However, there is relatively little contrast between the gamma-ray activity of the sandy dolomite and the adjacent sandstone near 160 ft in depth. At the same time, there is no positive correlation between gamma-ray and electrical conductivity as would be expected if the gamma-ray log indicated the presence of electrically conductive clay minerals. These results suggest 1) that the gamma-ray log is only a weak indicator of lithology, with the exception of large gamma-ray counts being associated with phosphatic sands; and 2) there are little or no electrically conductive silicate clays present in the formations adjacent to the corehole. Similar conclusions apply to the logs in Figures 11A-16A. These results are very similar to those presented for other studies in the south Florida area (Kwader, 1985; Stewart et al., 1982; Jakob, 1982)

The caliper and BHTV logs in Figure 10A together provide information on the contacts between formations, and on the way corehole conditions affect the neutron porosity log. The BHTV log indicates sharp changes in corehole wall texture at depths of 125, 140, and 163 ft which mark the precise depths of major lithologic contacts. The televiewer log also shows dark areas near 138, 163, 170, and 184 ft. The caliper log indicates that these are corehole enlargements that are not symmetrically distributed around the corehole. They appear to be locations where brittle failure has allowed chunks of formation to fall into the corehole. These openings induce erroneous values on the calibrated porosity log. Otherwise, the porosity log probably provides a fairly accurate indication of formation porosity. Porosity in Figure 10A is uniformly high in the 25 to 30 percent range above 125 ft in depth, lies at or below 20 percent from 125 to 180 ft, and rises to about 25 percent below 180 ft. The very large porosity values given on the log in the 130-145 and 163-170 foot intervals are caused by local corehole enlargements and do not measure formation porosity.

Comparison of the neutron and conductivity logs in Figure 10A indicates two intervals of very low formation conductivity and low porosity (130-135 ft and 170-180 ft). Similar intervals of low conductivity are apparent in Figure 11A (10-12 ft, 40-50 ft, and 110-115 ft) and Figure 15A (130-135 ft). These correspond with intervals of core that appear very well cemented and otherwise of low permeability. The calibrated porosity values appear reasonable when the numerous fine scale fluctuations are smoothed out of the logs, and where the spurious large porosity values associated with surface casing and cement or open-hole washouts are disregarded.

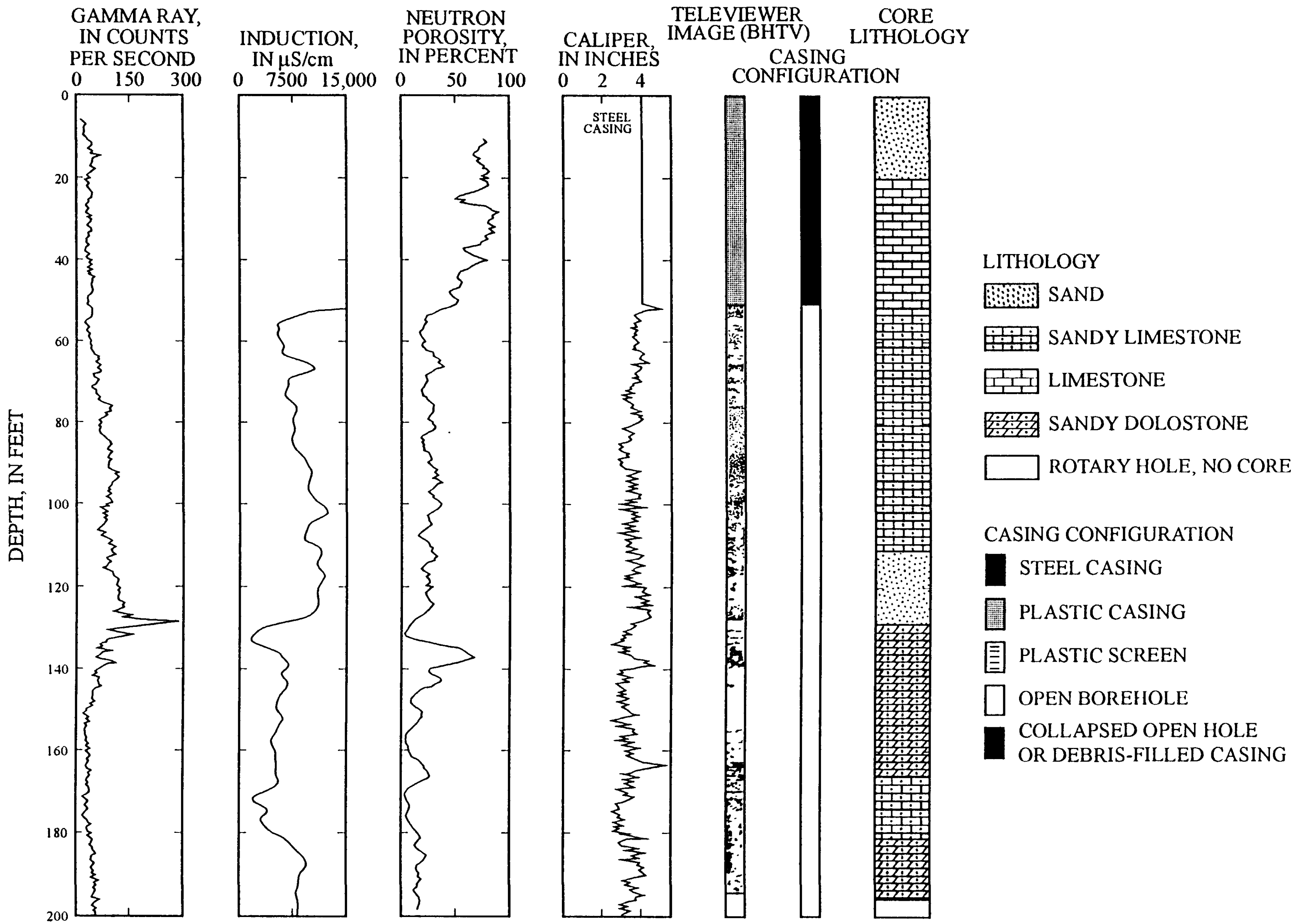

Figure 10 Geophysical logs for the Collier-Seminole State Park corehole. A. Logs related to lithology (g[illegible]duction, neutron porosity, caliper, and televiewer) compared to a schematic illustration of the corehole conditions during logging (casing configuration) and core lithology.

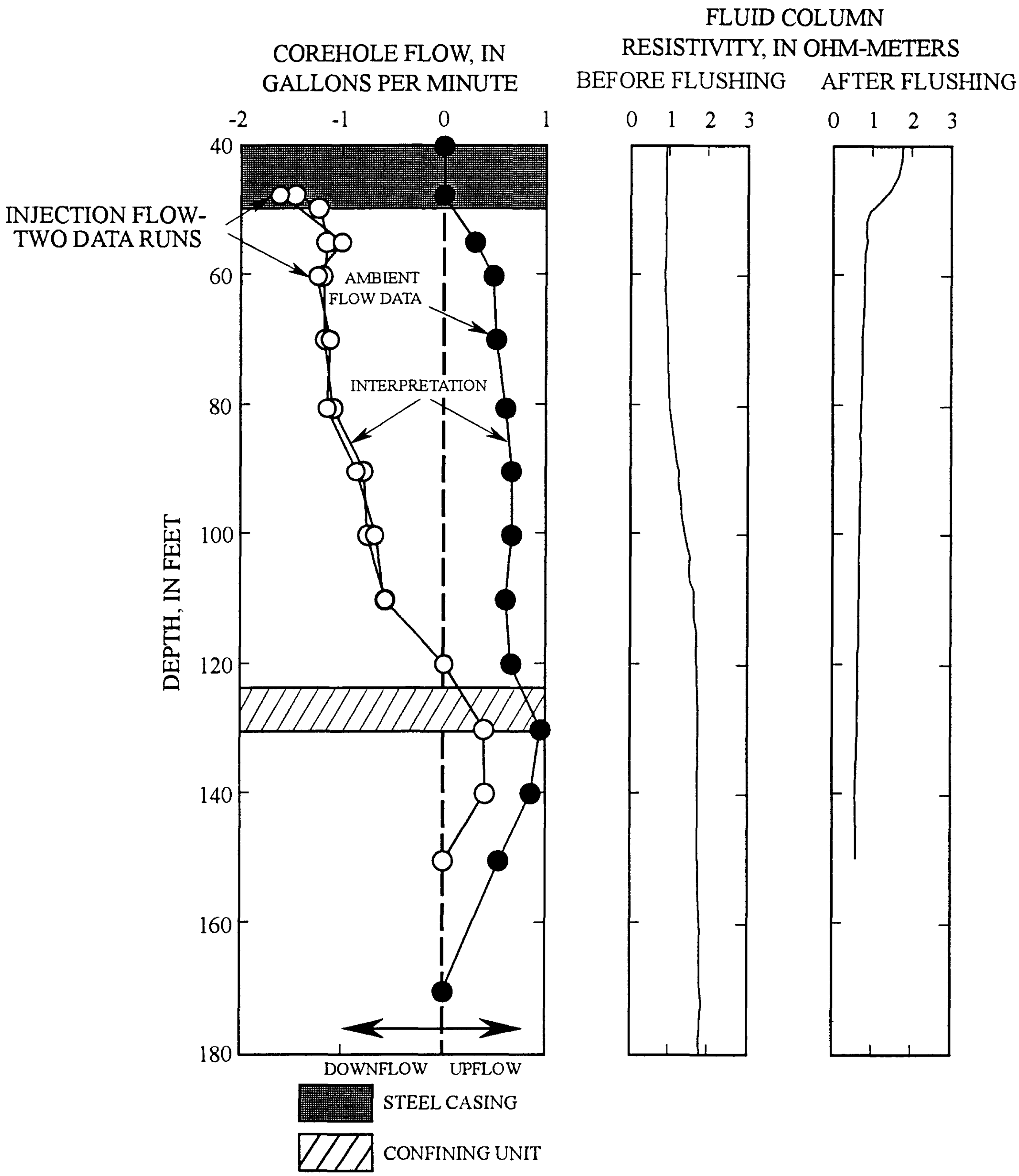

Figure 10B. Heat-pulse flowmeter (HPFM) profiles of flow under ambient and injection condition for the Collier-Seminole corehole compared to fluid column logs before and after flushing mud from the corehole.

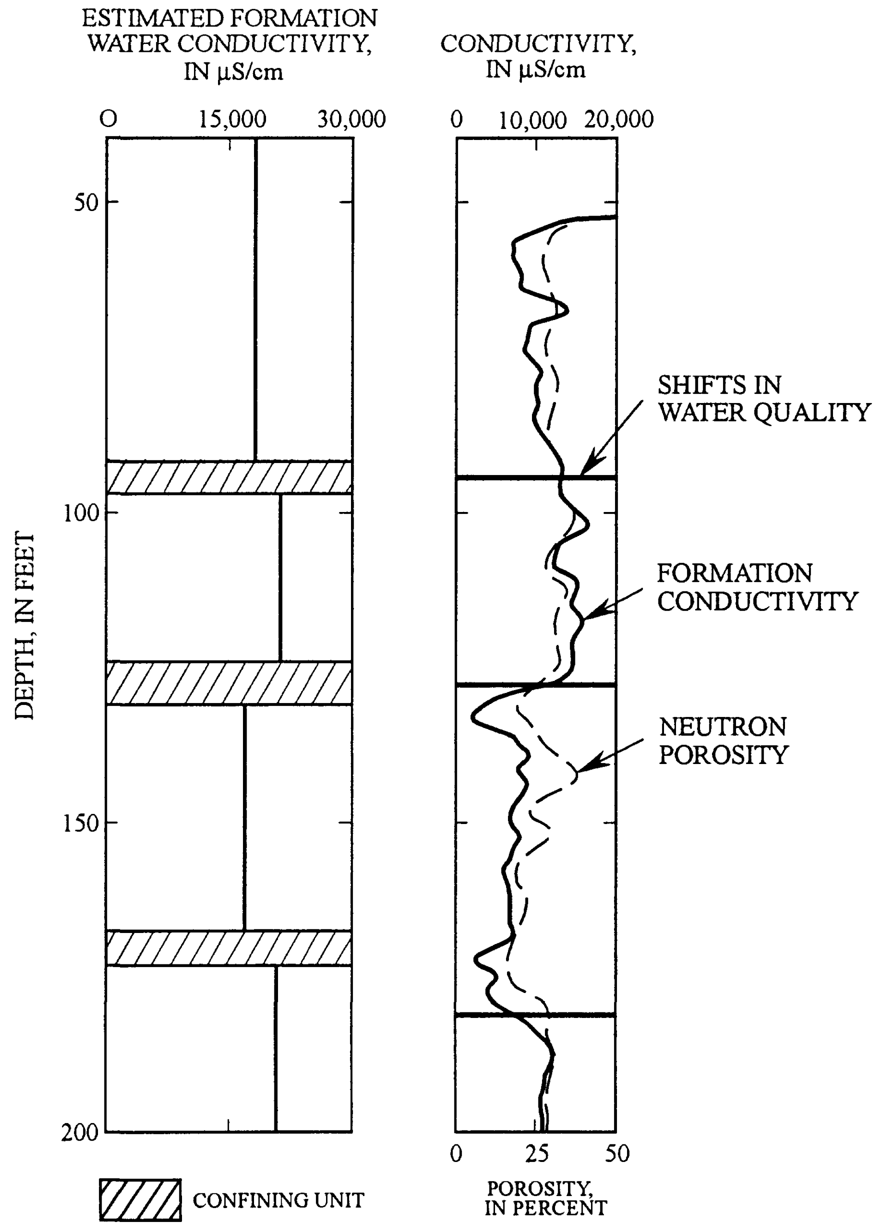

Figure 10C. Pore-water conductivity and the location of confining units separating zones of different water quality inferred from induction logs in the Collier-Seminole State Park corehole.

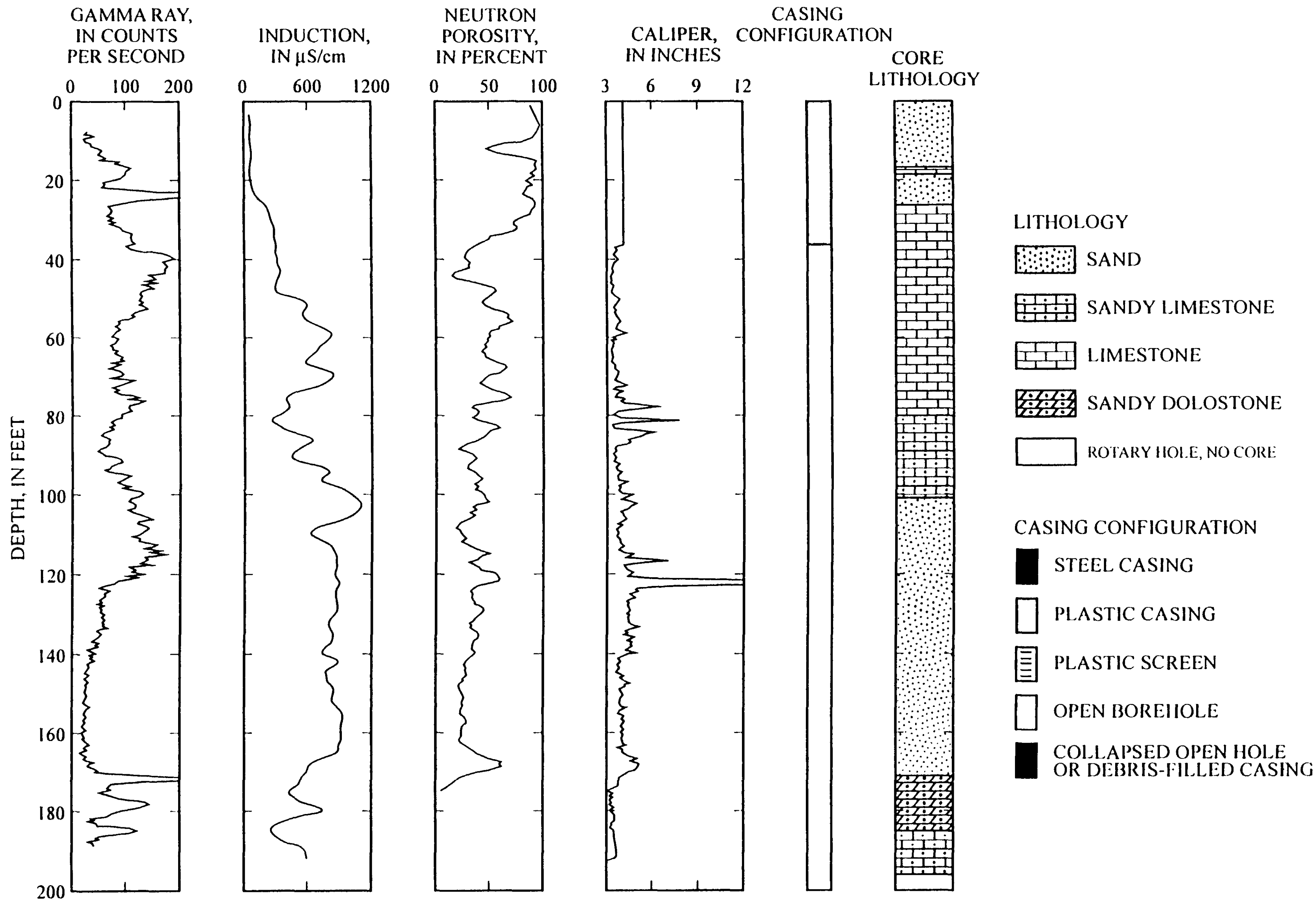

Figure 11. Geophysical data from the Old Pump Road corehole. A. Logs related to lithology for the Old Pump Road corehole (gamma-ray, induction, neutron porosity, and caliper) compared to a schematic illustration of corehole conditions during logging (casing configuration) and core lithology.

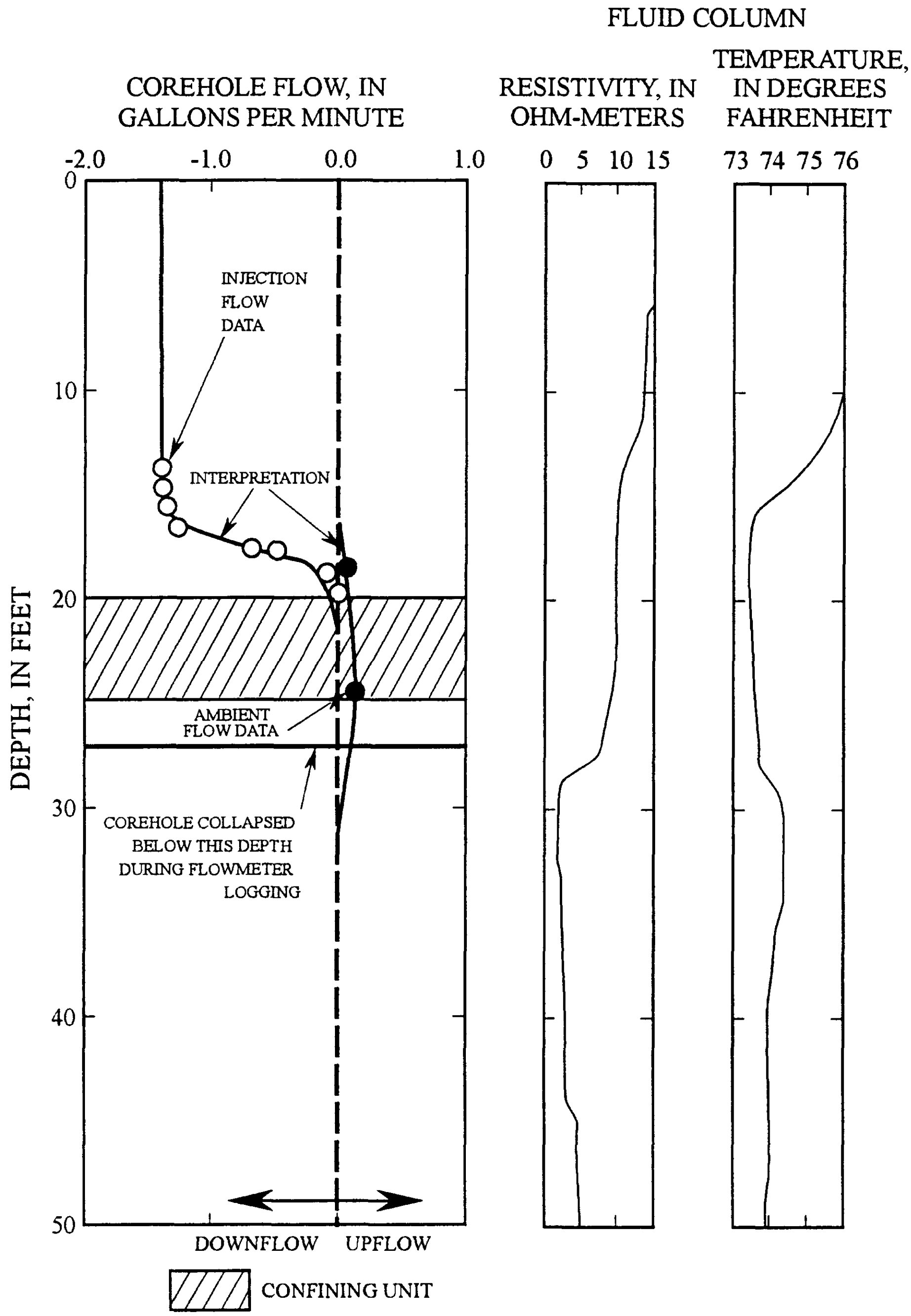

Figure 11B. Heat-pulse flowmeter (HPFM) profiles of flow under ambient and injection conditions for the Old Pump Road corehole compared to fluid column logs after flushing mud from the corehole.

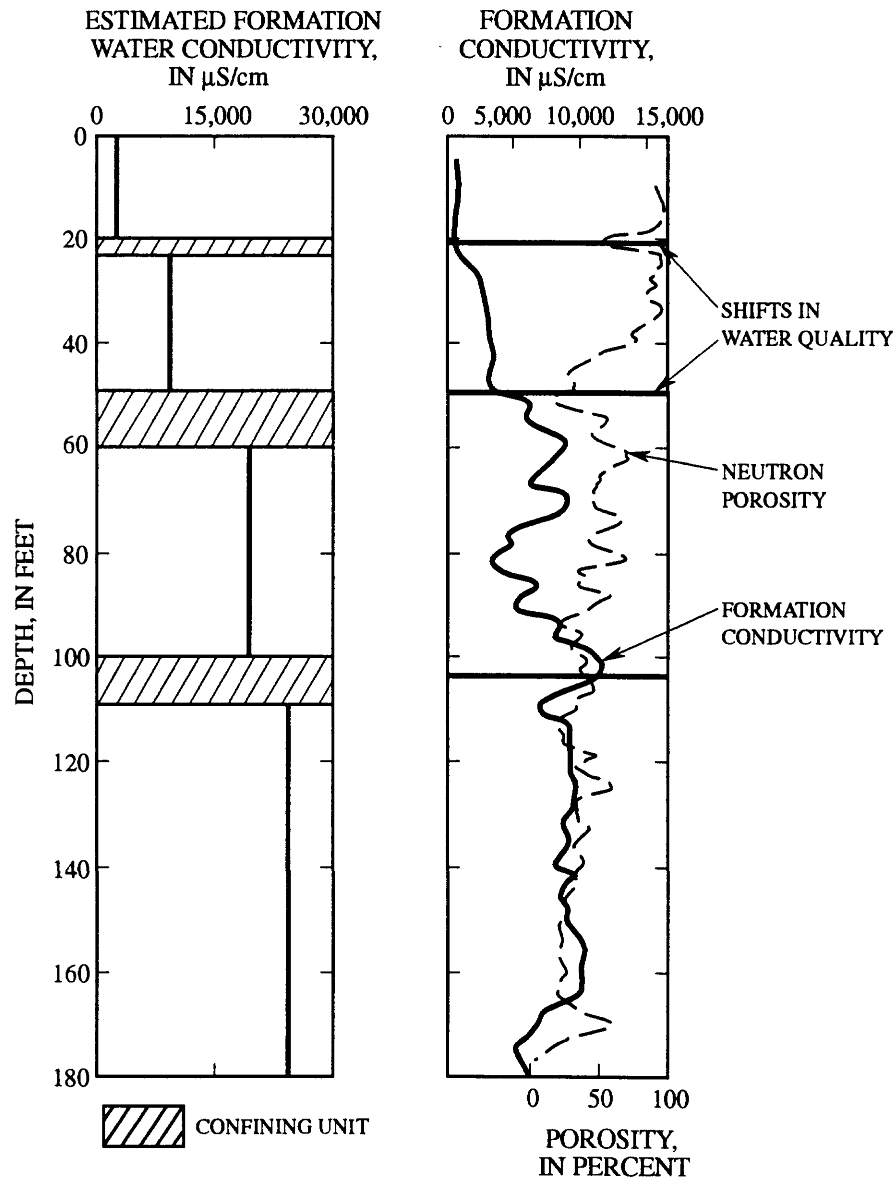

Figure 11C. Pore-water conductivity and the location of confining units separating zones of different water quality inferred from induction logs in the Old Pump Road corehole.

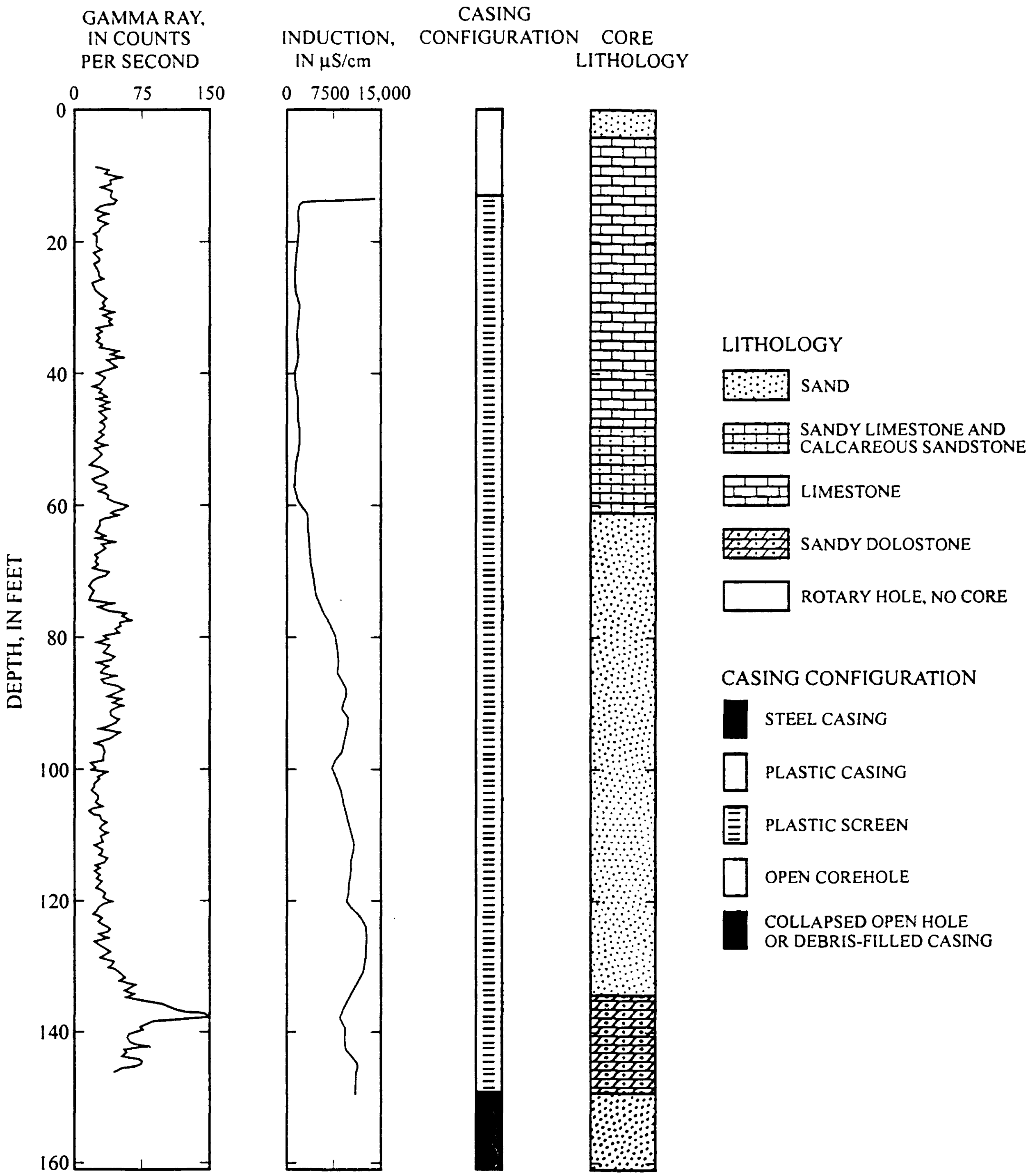

Figure 12. Geophysical logs for the Fakahatchee Strand Ranger Station corehole. A. Logs related to lithology (gamma-ray, and induction) compared to a schematic illustration of corehole conditions during logging (casing configuration) and lithology.

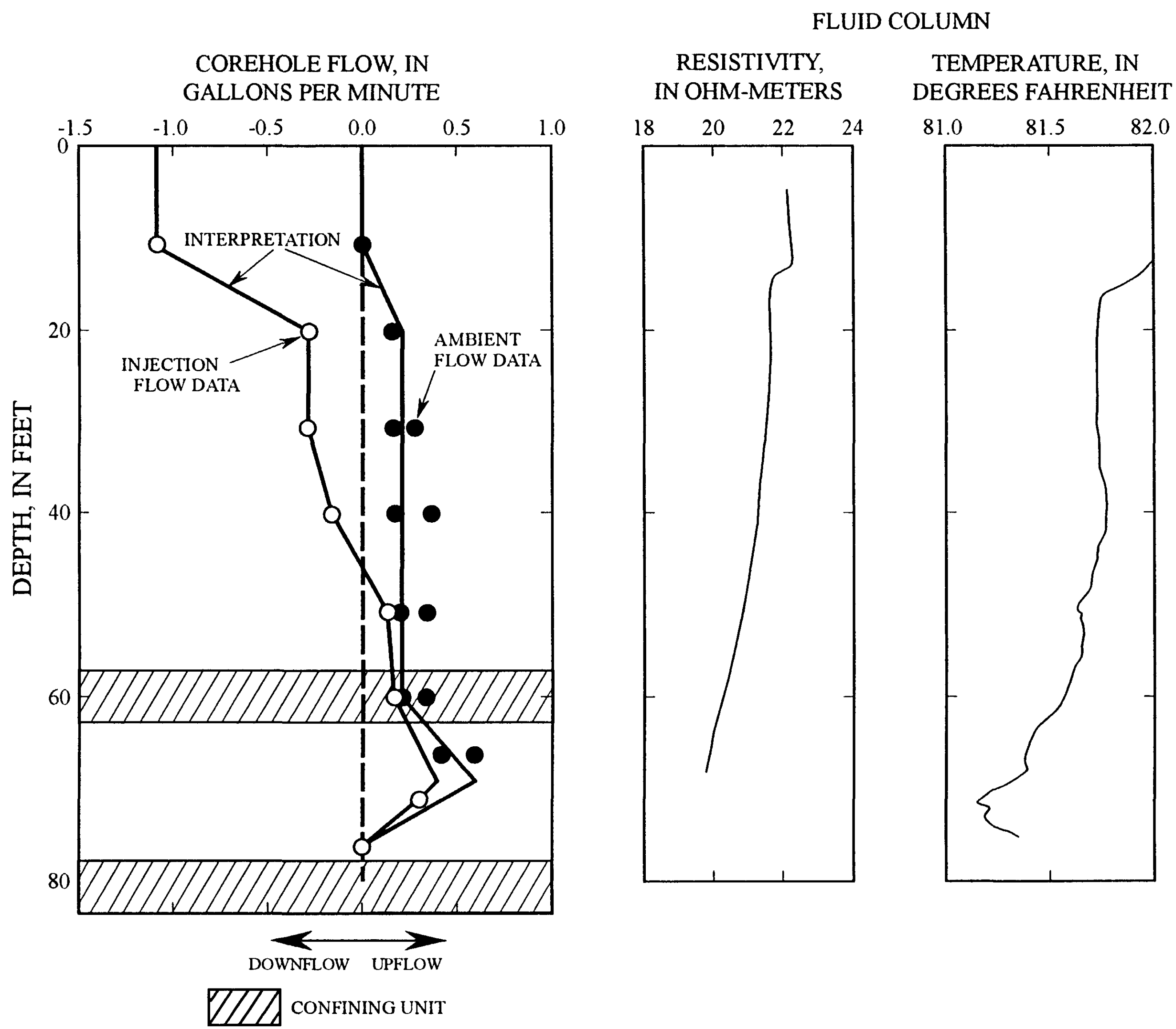

Figure 12B. Heat-pulse flowmeter (HPFM) profiles of flow under ambient and injection conditions for the Fakahatchee Strand-Ranger Station corehole compared to fluid column logs after flushing mud from corehole.

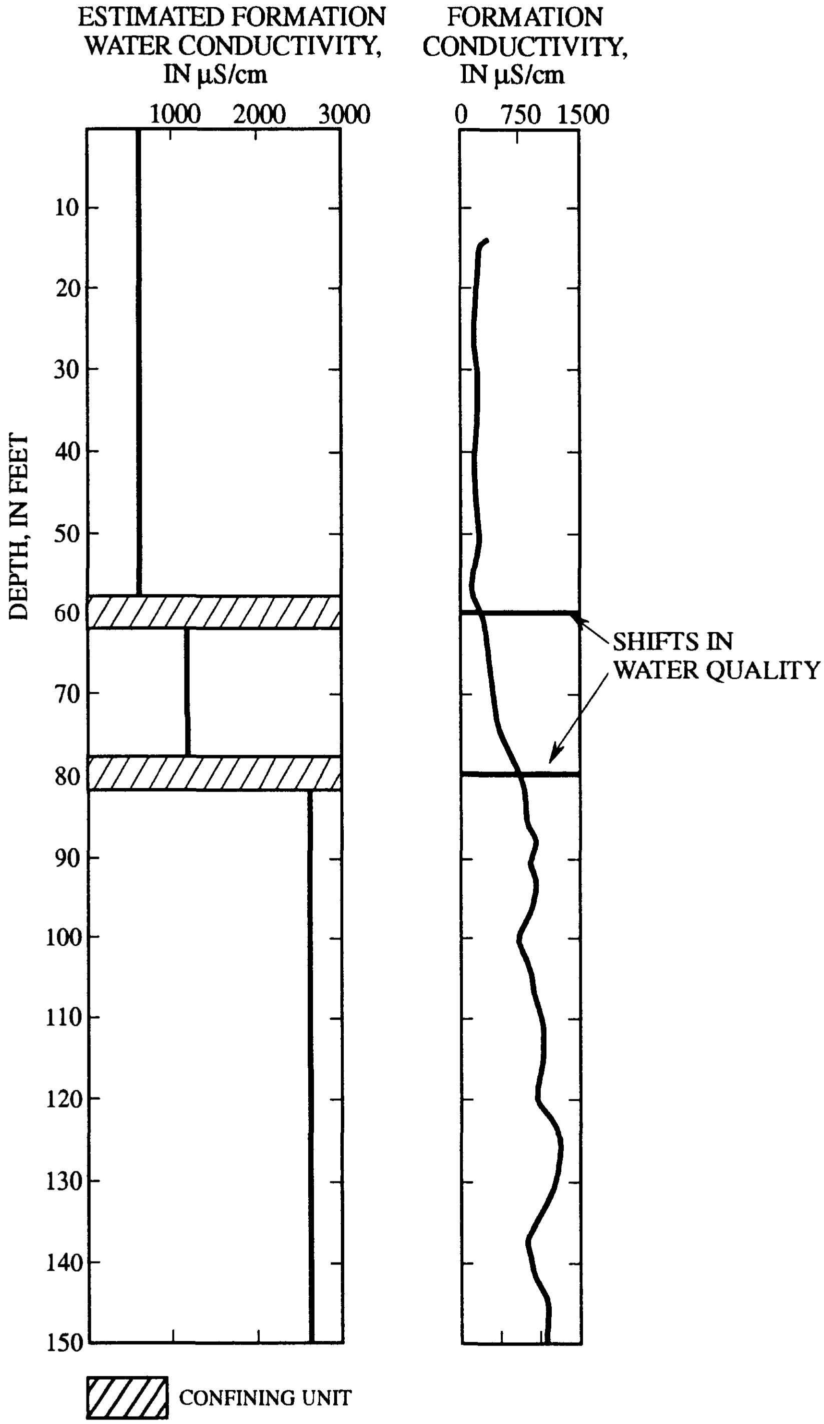

Figure 12C. Pore-water conductivity and the location of confining units separating zones of different water quality inferred from induction logs in the Fakahatchee Strand Ranger Station corehole.

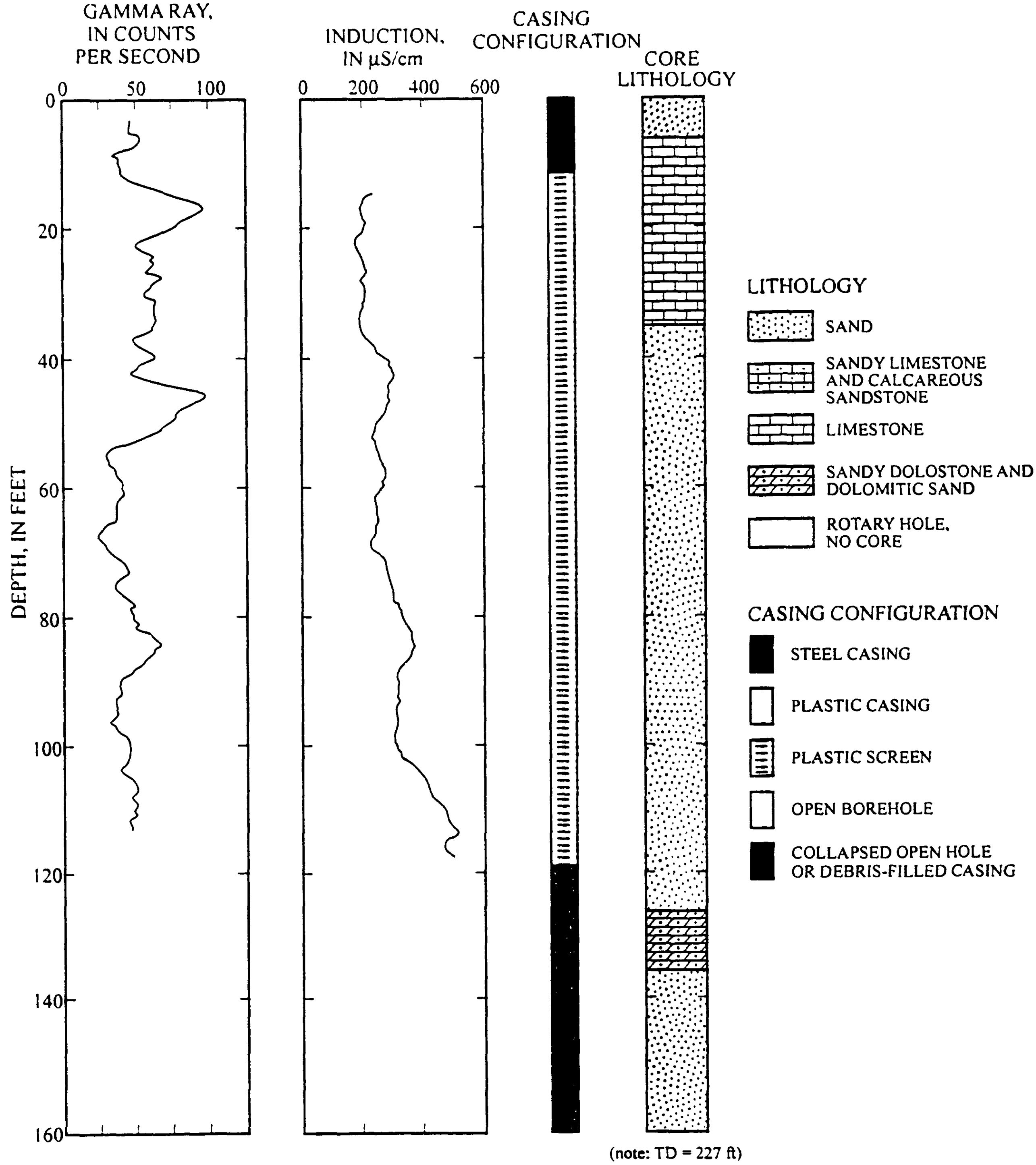

Figure 13. Geophysical data from the Fakahatchee Strand Gate 12 corehole. A. Logs related to lithology (gamma ray and induction) compared to a schematic Illustration of corehole conditions (casing configuration) during logging and lithology.

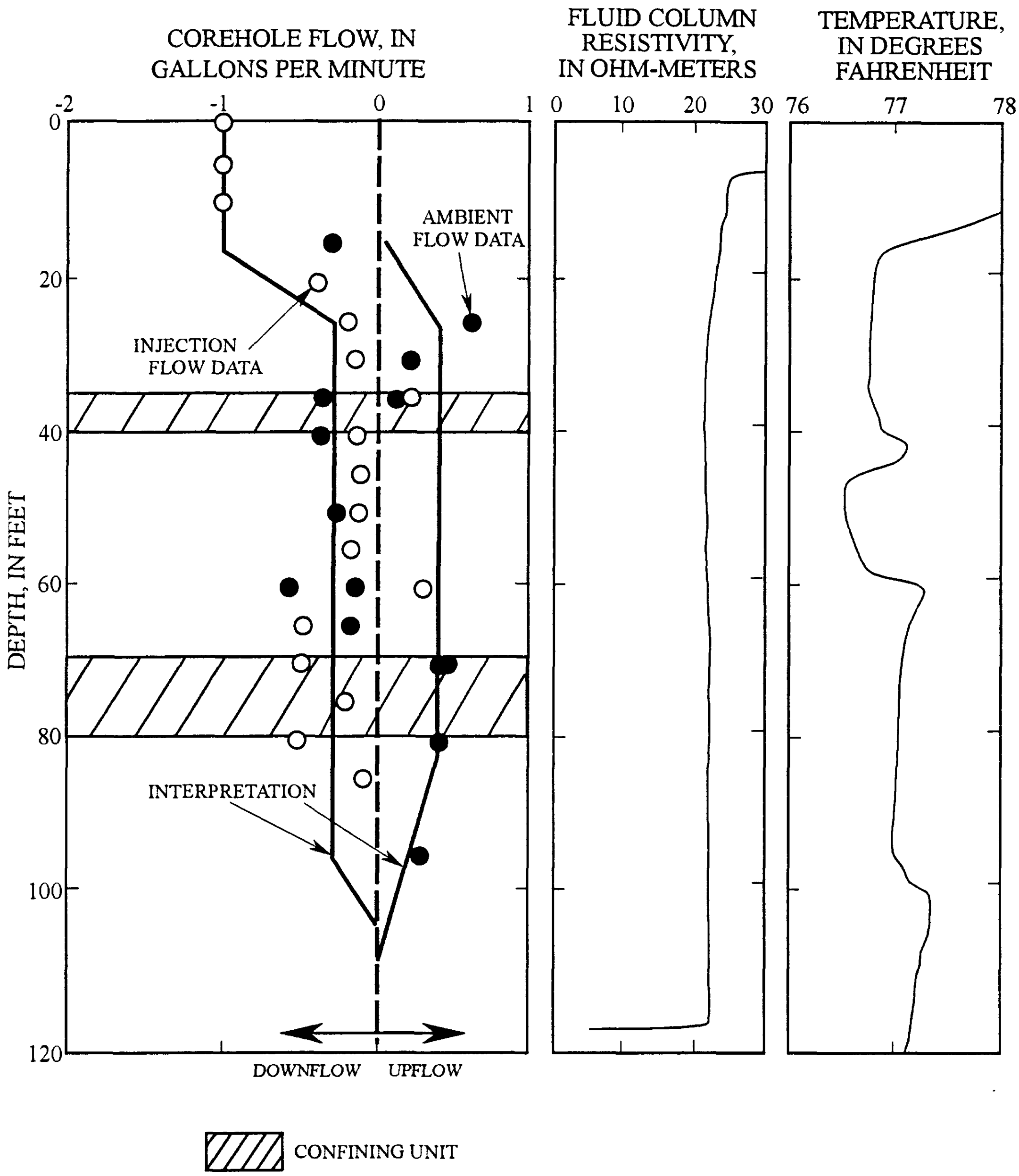

Figure 13B. Heat-pulse flowmeter (HPFM) profiles of flow under ambient and injection conditions for the Fakahatchee Strand Gate 12 corehole compared to fluid column logs after flushing mud from the corehole.

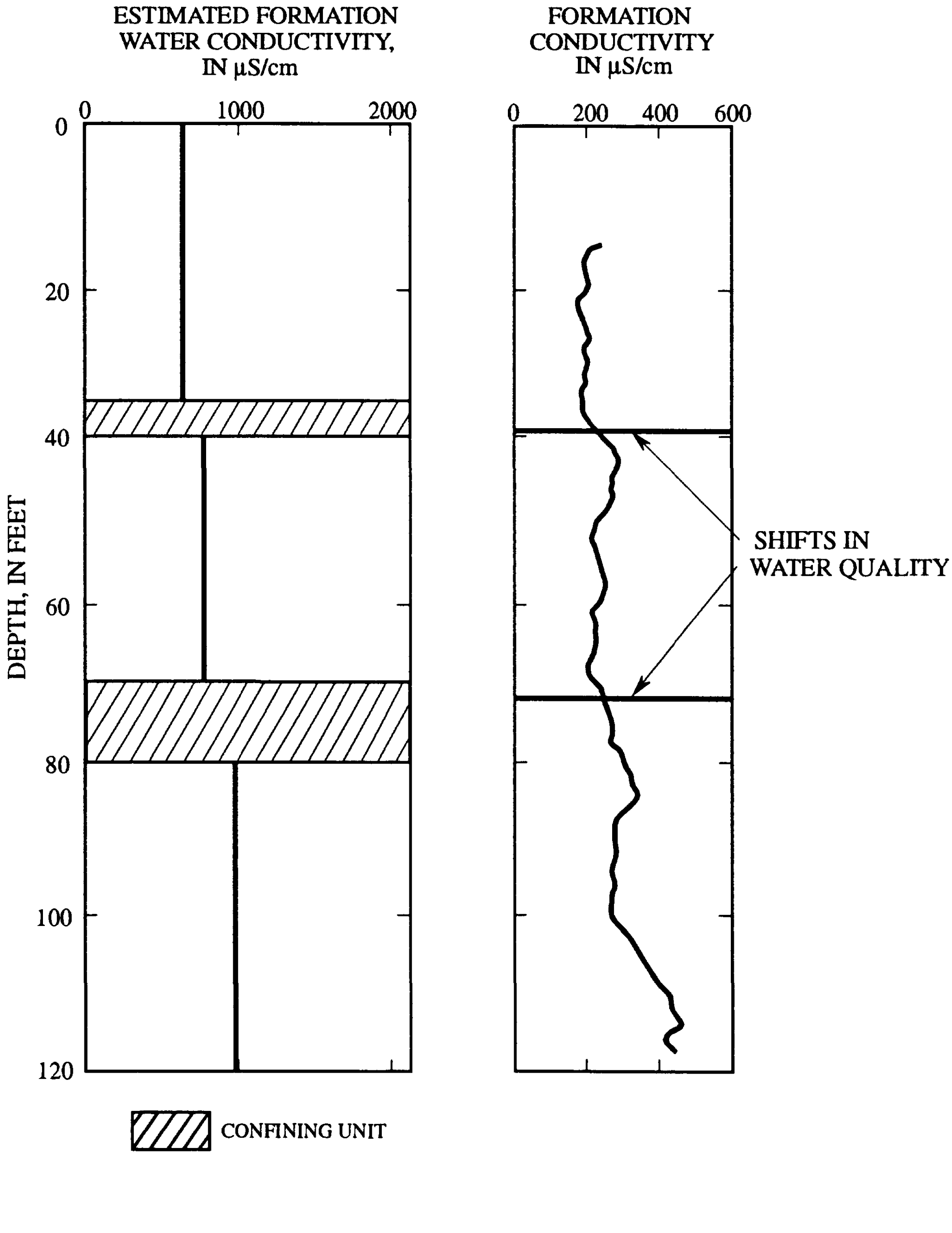

Figure 13C. Pore-water conductivity and the location of confining units separating zones of different water quality inferred from induction logs in the Fakahatchee Strand Gate 12 corehole.

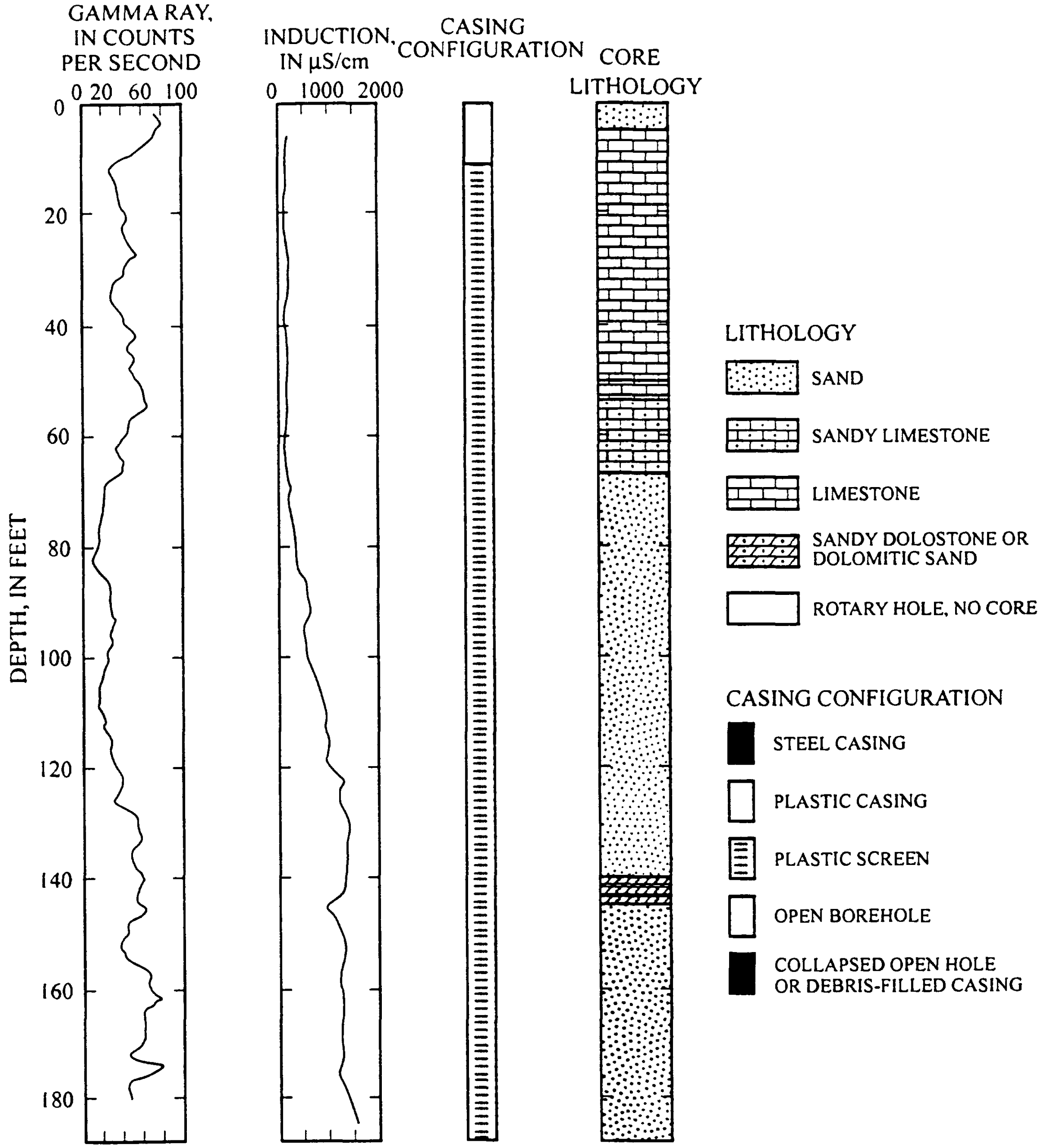

Figure 14. Geophysical data from the Fakahatchee Strand Jones Grade corehole. A. Logs related to lithology (gamma and induction) compared to a schematic illustration of corehole conditions during logging (casing configuration) and lithology.

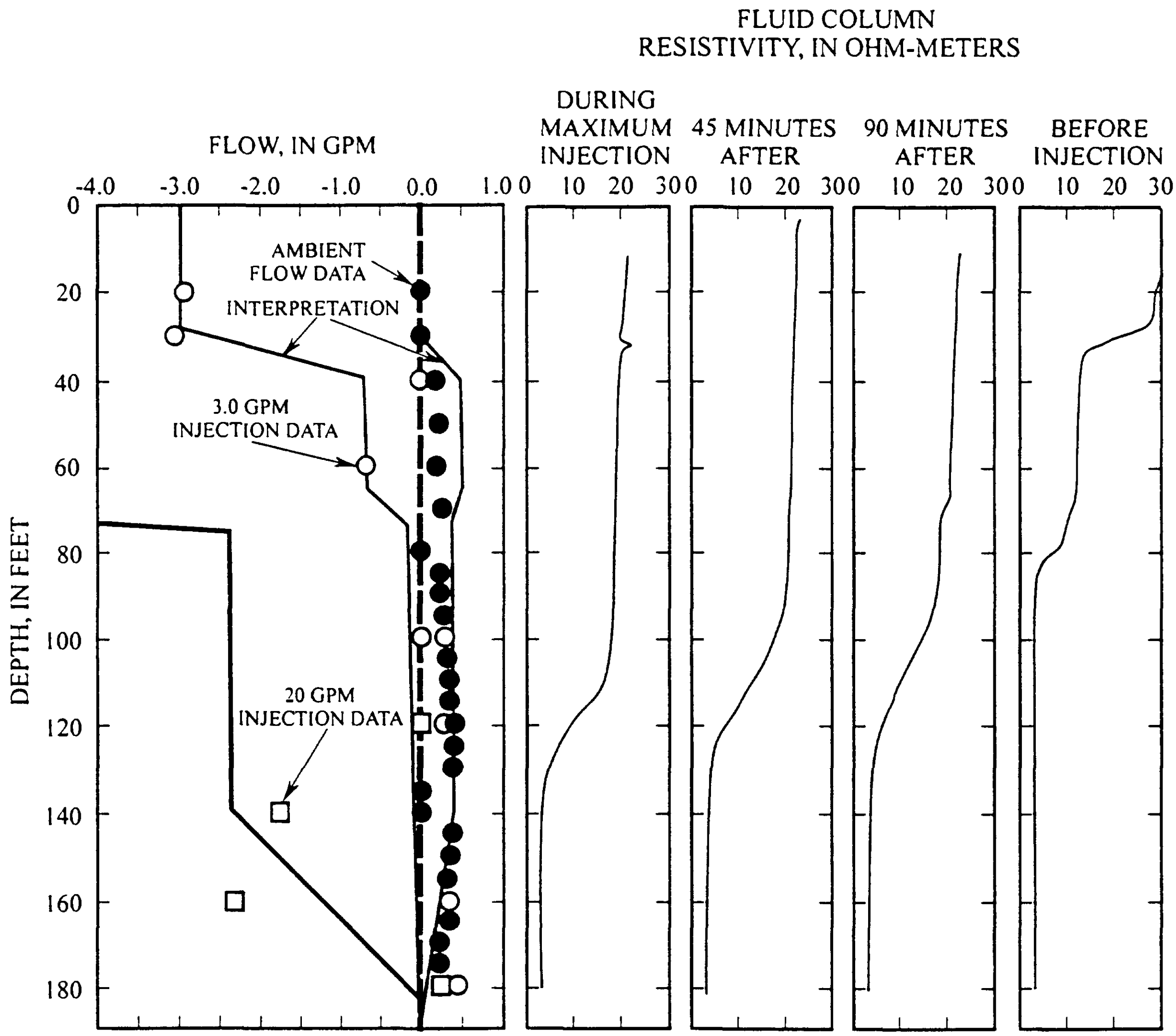

Figure 14B. Heat-pulse flowmeter (HPFM) profiles of flow under ambient and injection conditions for the Fakahatchee Strand Jones Grade corehole compared to fluid column logs before, during, and after injecting water into the corehole.

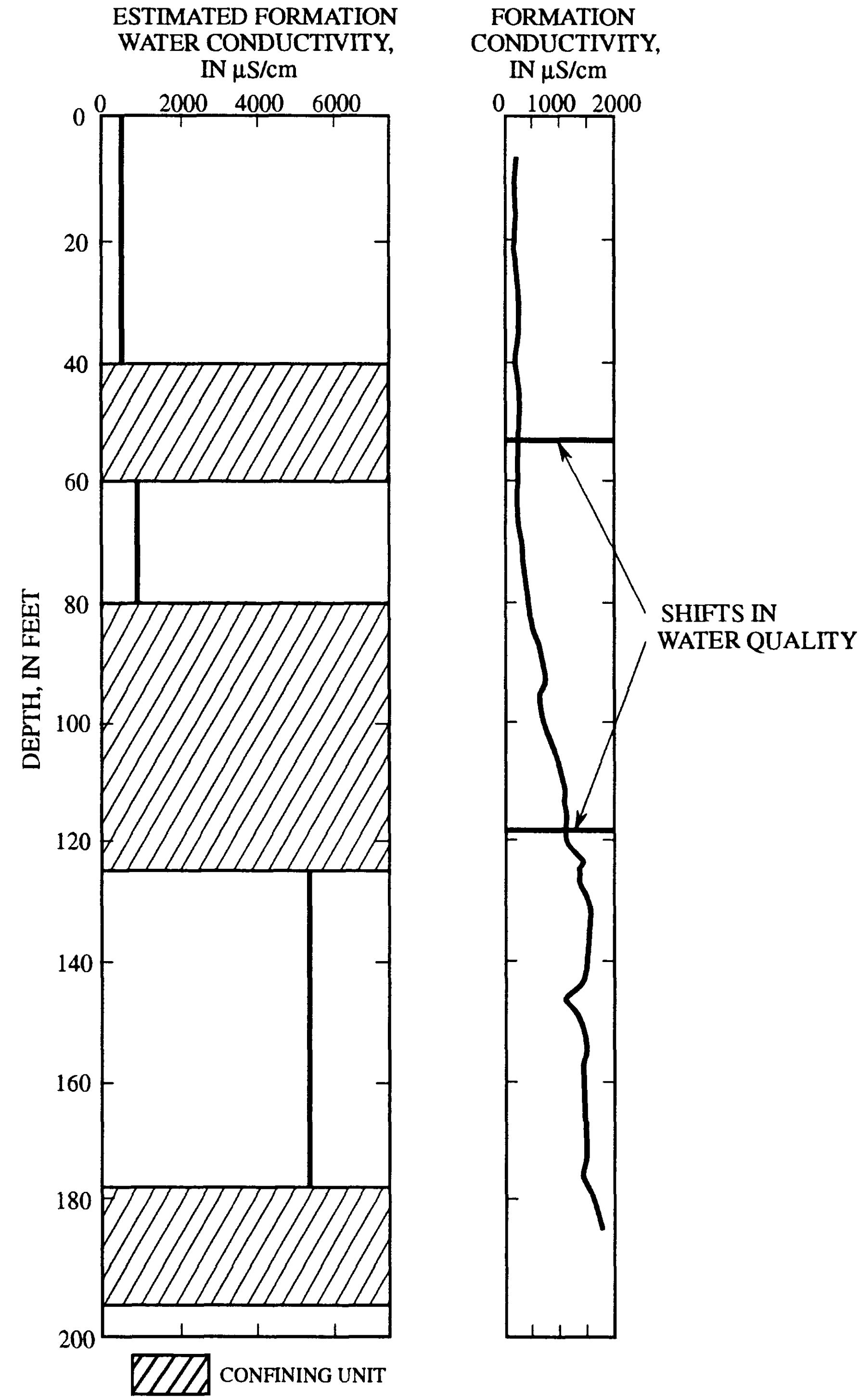

Figure 14C. Pore-water conductivity and the location of confining units separating zones of different water quality inferred from induction logs in the Fakahatchee Strand Jones Grade corehole.

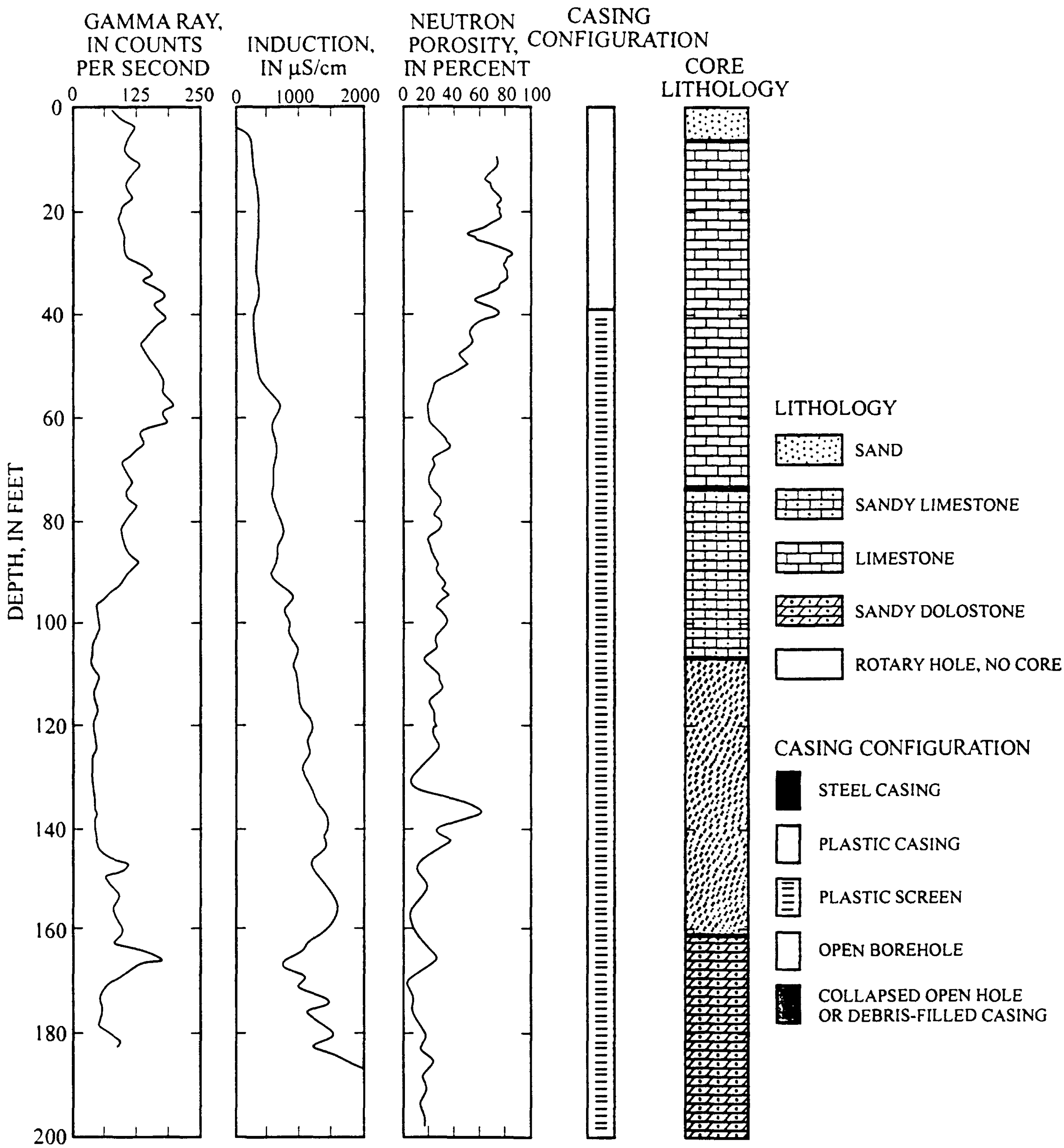

Figure 15. Geophysical data from the Picayune Strand corehole. A. Logs related to lithology (gamma ray, induction, and neutron porosity) compared to a schematic illustration of corehole conditions during loging (casing confinguration) and lithology.

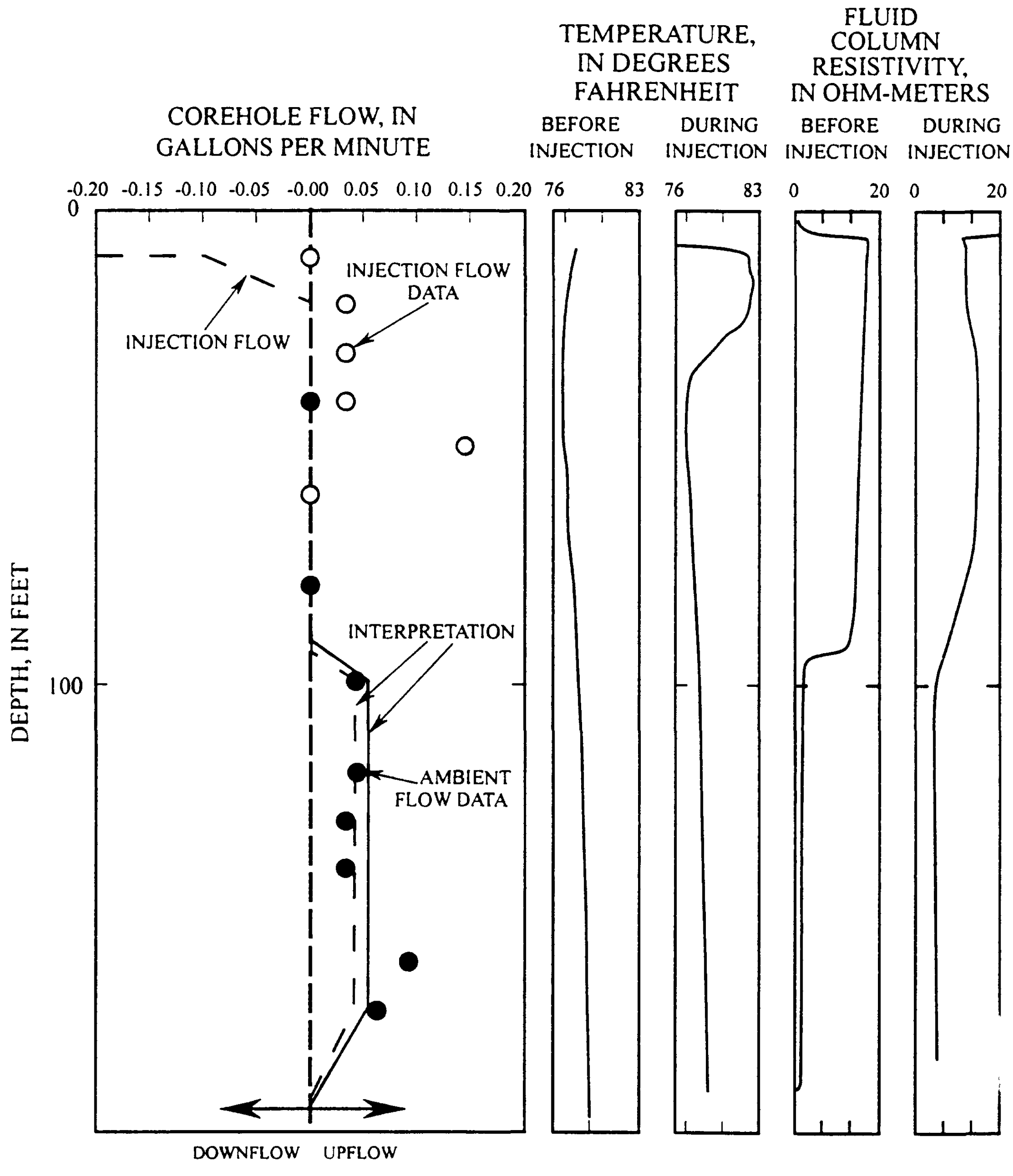

Figure 15B. Heat-pulse flowmeter (HPFM) profiles of flow under ambient and injection conditions for the Picayune Strand corehole compared with fluid column logs before and during injection.

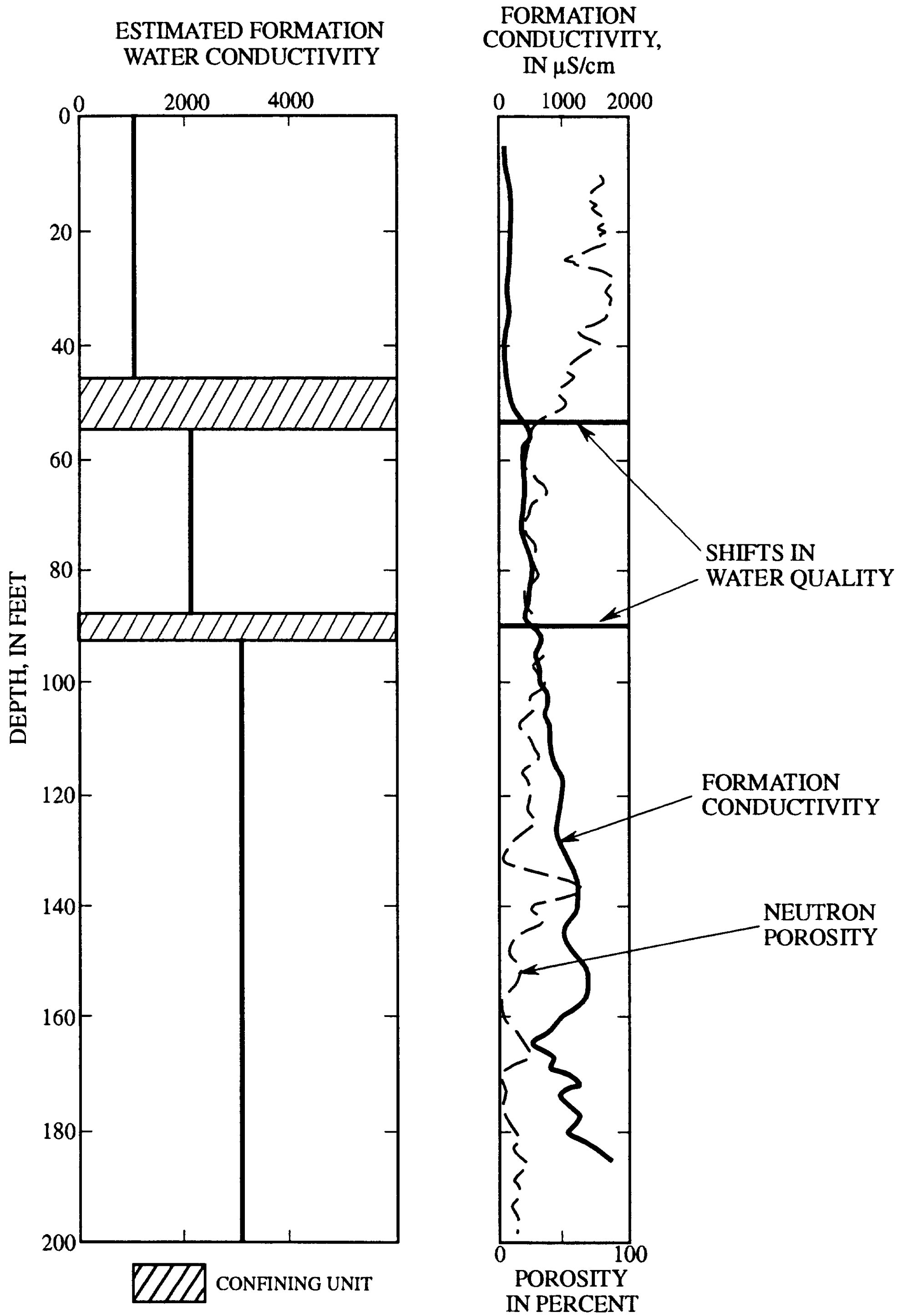

Figure 15C. Pore-water conductivity and the location of confining units separating zones of different water quality inferred from the induction logs in the Picayune Strand corehole.

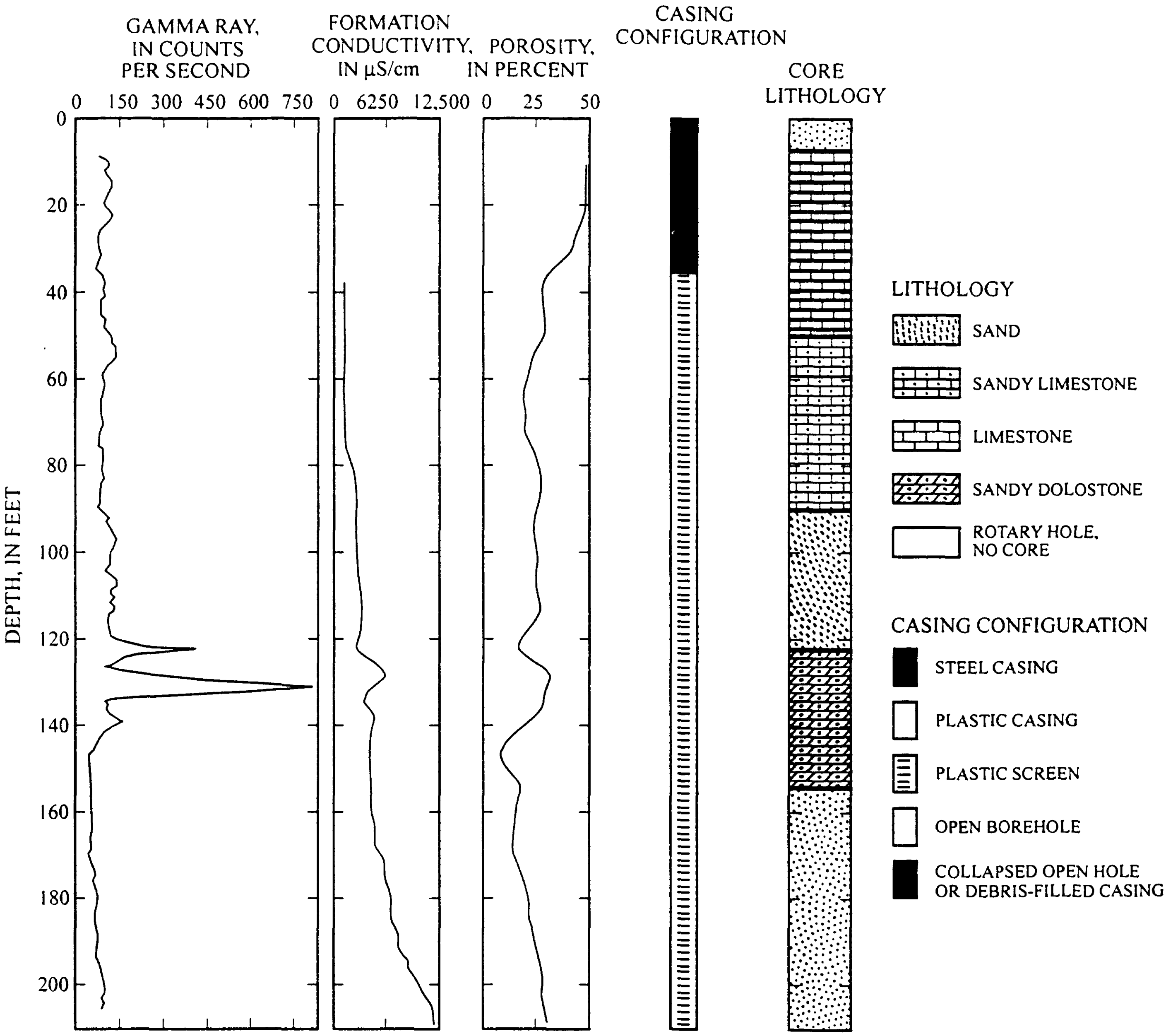

Figure 16. Geophysical data from the Southern States Utilities corehole. A. Logs related to lithology (gamma ray, induction, and neutron porosity) compared to a schematic illustration of corehole conditions during logging (casing configuration) and lithology.

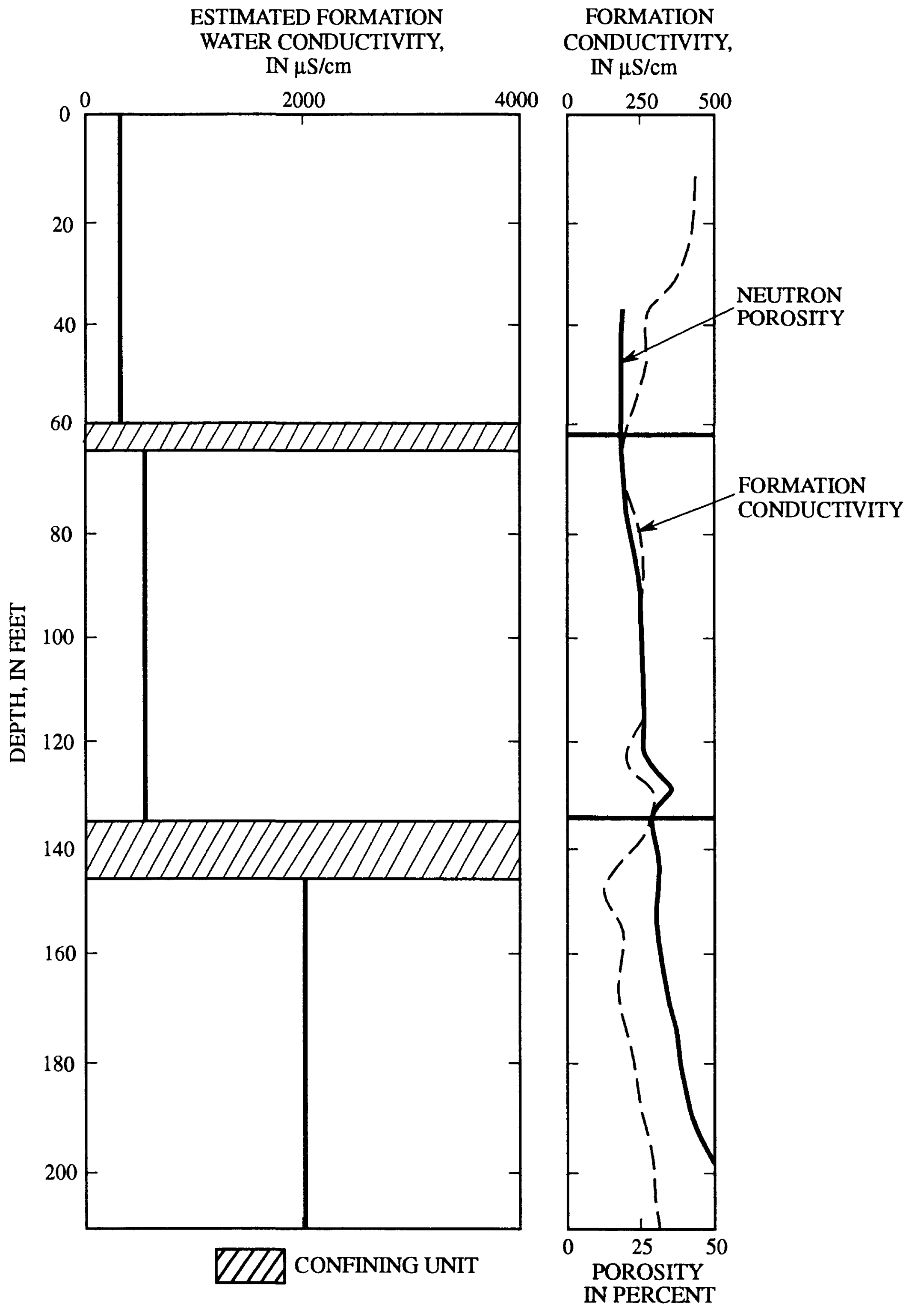

Figure 16B. Pore-water conductivity and the location of confining units separating zones of different water quality inferred from induction logs in the Southern States Utilities corehole.

Flow logs

Flow in coreholes was inferred from the shape of fluid column logs, and measured ectly using the HPFM. For example, upflow was measured in the Collier-Seminole corehole ur ambient conditions after drilling mud was flushed from the corehole (Figure 10B). The c ole fluid column resistivity log before corehole flushing shows a gradual increase in fluid resi ity with depth. However, after flushing, the fluid resistivity shows a uniform value of abou .7 ohm-meters from the bottom of the corehole up to about 50 ft in depth, where there is an abrupt increase in fluid resistivity. This profile indicates that water of about 17,000 µS/cm enters near the bottom of the corehole; the last of this inflow leaves the corehole at the bottom of casing. Therefore, the fluid column logs after flushing are consistent with the measured upflow under ambient conditions. It appears unlikely that the measured flow is an artifact of the inherent upflow buoyancy in the heat pulse because the measurement indicates no flow near the bottom of the corehole and in casing (Paillet et al., 1996). If the upflow were attributed to the buoyancy of the heat pulse, the same flow would have been measured even at the bottom of the corehole and in casing.

Corehole flow was also profiled in the Collier-Seminole corehole during steady injection at about 2.0 gallons per minute. Such injection tests are routinely run to identify permeable intervals where the injected flow exits from the corehole. The two repeat profiles during injection show that the injection head increase in the corehole was not large enough to completely reverse the upflow towards the bottom of the corehole. The outflow in the upper part of the corehole otherwise indicates that the interval just below the bottom of casing is the most permeable interval in the entire corehole.

HPFM logs were run in all but the Southern States Utilities corehole (Figures 10B-15B). Ambient upflow ranging from 0.05 to 0.5 gallons per minute was measured in at least some intervals in all these coreholes. In those situations where the flow was near the limit of resolution of the flowmeter, or where there was a great deal of scatter in the flow measurements, the fluid column logs support the interpretation of upflow and the identification of the zones where water was inferred to be entering or exiting from the corehole. In the Old Pump Road corehole (Figure 11B), most of the open corehole had collapsed by the time the HPFM was run. However, the HPFM indicated ambient upflow from below 40 ft, exiting in the 15-20 foot interval. HPFM measurements during injection indicated outflow in the 15-20 foot interval. In the Fakahatchee Ranger Station corehole (Figure 12B), fluid column logs are consistent with the measured ambient upflow exiting in the 15-20 foot interval. The HPFM measurements during injection likewise show that almost all of the injected flow exited in that same interval. A similar ambient upflow regime was inferred in the Fakahatchee Gate 12 corehole (Figure 13B), but there is a great deal of scatter in the individual HPFM measurements. This scatter is interpreted as the superposition of a secondary circulation on the steady upflow. This interpretation is strongly supported by the temperature log, which shows the sharp variations of fluid column temperature expected when such thermally driven circulations are present.

The ambient and injection flow data for the Jones Grade corehole (Figure 14B) were investigated by running a series of fluid column logs before, during, and after steady injection. The HPFM data indicate steady upflow under ambient conditions. This interpretation is consistent with the "steps" in the fluid column resistivity log run before injection. The fluid column log indicates inflow of water below 140 ft in depth which is augmented by additional inflow of less conductive water at about 80 ft. This flow exits in the 30-40 foot interval. The upflow is given as about 0.40 gallons per minute by the HPFM. HPFM and fluid column logs run during injection both indicate that about 90 percent of the injected flow was exiting the corehole in the 30-40 interval. The changes in fluid column resistivity logs in the period after the injection give an additional estimate of the ambient flow conditions. For example, the fluid resistivity profile shows an upward shift of the lowermost "step" of about 10 ft over the first 45 minutes. This is equivalent to an upward influx of water of about 0.50 gallons per minute, consistent with the HPFM measurements under ambient conditions.

The ambient and injection flow data for the Picayune Strand corehole (Figure 15B) show a similar stepped fluid column resistivity profile that is consistent with an ambient upflow regime in the lower part of the corehole (140-100 ft). Even at injection rates greater than 10 gallons per minute, the HPFM and fluid column logs run during injection indicate that the injection has essentially no effect on the fluid column below 30 ft. For example, the location of the "step" in fluid column resistivity near 90 ft remains unchanged, except for the "smearing" of the step by the passage of the logging tool after the first run. All data show that all of the injected flow was exiting the corehole above 20 ft in depth.

Water quality logs

Geophysical logs indicate formation water conductivity indirectly through the formation induction log, and directly through the fluid column resistivity log. In general, formation conductivity is assumed to be a function of three variables (MacCary, 1980; Jorgensen, 1988, 1991):

$$S_t = f(R_w, K, C) \qquad (2)$$

where S_t is the electrical conductivity of the formation, R_w is the resistivity of pore water, K is the formation permeability, and C is the proportion of electrically conductive minerals present in the formation. Formation conductivity can be used to infer the electrical conductivity of pore water in formations from the relation:

$$F = R_t/R_w \qquad (3)$$

where R_t is the resistivity (inverse of conductivity) of the formation from the induction log, and R_w is the resistivity of the fluid in the pore spaces within the formation. R_w is assumed to come from carefully controlled water sampling. The formation factor, F, is assumed to be an intrinsic property of the formation, depending upon pore geometry and permeability. Under two important assumptions, the formation factor can be related to porosity (Kwader, 1985; Jorgensen, 1988, 1991):

$$F = a/\Phi^m \qquad (4)$$

where a and m are constants, and Φ is formation porosity. The two assumptions are (Biella et al., 1983; Alger, 1964): (1) that there are negligible amounts of conductive minerals (usually clays) present in the formation; and (2) that $R_w < 10.0$ ohm-meters. The first assumption means that electrical conduction through mineral grains can be ignored, and all electrical current can be assumed to pass through the fluid-filled pores. The second assumption means that the pore water must be electrically conductive enough that the interconnected pores can be assumed to form an effective current path. All of the lithology logs discussed above indicate that there are no electrically conductive clays present in the formation. Otherwise, the analysis will be restricted to intervals where R_w is known or expected to be substantially less than the 10.0 ohm-meter limit.

When the formation is assumed to be completely free of electrically conductive minerals, we assume that formation conductivity is expressed as a function of K and R_w. The combined effects of K and R_w on measured formation conductivity can be investigated by assuming that K is closely related to formation porosity (Kwader, 1985). Then we assume that the neutron porosity and formation conductivity logs show similar trends wherever R_w does not change. For example, the overlay of conductivity and porosity logs in Figure 10C shows similar trends with offsets at depths where abrupt changes in R_w causes shifts in the conductivity log. The offsets between formation conductivity and porosity are relatively subtle for the Collier-Seminole corehole, probably because there are relatively small changes in formation water salinity along the portion of the corehole that was available for logging. The offsets between formation conductivity and porosity are much more obvious on the logs for the other three coreholes where both induction and porosity logs were obtained (Old Pump Road, Picayune Strand, and Southern States Utilities coreholes; Figures 11C, 15C, and 16C). Although there may be some concern that the offsets in Figure 10C are so small that they cannot be taken as significant indicators of contacts of aquifer compartments containing water of different salinities, the offsets in Figures 11C, 15C, and 16C clearly indicate that there are abrupt changes in formation water salinity at the depths where such offsets occur. For those coreholes where neutron logs could not be run, shifts in water quality are inferred from inspection of the induction log (Figures 12C, 13C, and 14C).

In most of the corehole induction logs (Figures 10C-16C) we can only determine that there are shifts in water quality. However, we do have a definite value for R_w in the interval below 170 ft in depth in the Collier-Seminole corehole. This value comes from the fluid resistivity log run after flushing the corehole to remove drilling mud. After flushing, the HPFM log showed inflow near the bottom of the corehole and outflow below the bottom of casing. Therefore, the fluid column resistivity gives a value of R_w for the formation below 170 ft in depth. For this interval only, formation factor is given by:

$$F = R_t/R_w = [(10{,}000)/[0.7*S_f] \qquad (5)$$

The various formation conductivity values given for this interval indicate a variation in formation factor over the range 2-14. A crossplot of porosity values from the neutron log and F values from the induction log show the expected relationship between porosity and formation factor, with a = 1.6, and m = 0.274 (Figure A3.1). For comparison, an empirical equation established by petroleum engineers as the best fit to data for clean quartz sandstones from around the world uses values of a = 0.52 and m = 2.15 (the Humble Equation; Lynch, 1962). Therefore, the values of a and m for south Florida carbonate aquifers imply much larger permeability values and much weaker dependence of F on porosity than found for "typical" cemented sandstones. The low value for m and the relatively weak dependence of F on porosity are indicative of permeability controlled by solution openings and little cementation (Aguilera, 1980).

The most important result of this analysis is that typical porosity values of the shallow sandy limestone aquifer of about 30 percent correspond with a formation factor of about or slightly below 3.0. This analysis suggests that a rough estimate of formation water conductivity can be made from the induction log using the relation:

$$R_w = R_t/3.0 \qquad (6)$$

This equation (with its built-in assumption that F = 3.0) is only approximate, in that the formation factor analysis shows that F actually varies between 2.0 and 4.0 for most of the intervals labeled sandy limestone. This amount of variation of F contrasts with the typical variation F over a range from about 20 to more than 100 for cemented quartz sandstone (Hearst and Nelson, 1985). The almost complete lack of electrically conductive clays in the formation, combined with weak dependence of F on porosity and the restriction of F to a relatively narrow range make it possible to use such a simple relationship.

DISCUSSION

Lithology

Although the cores are highly variable over the study area, some sedimentologic patterns can be recognized. Over much of the study area, a thin layer of unconsolidated quartz sand occurs at the surface below the artificial full. In the cores examined, this sand is well developed at the Collier-Seminole and Old Pump Road sites. Typically, below the sand is a dense, well indurated, but moldic sandy limestone, locally referred to as "caprock." The caprock is densely cemented and noticeably heavier than the rest of the lithified core, is commonly mottled with light orange bands, and is typically no thicker than about 5 ft. Caprock is well exposed along canals and around borrow pits in the study area. It was recovered at the Fakahatchee Strand Ranger Station, Gate 12, Jones Grade, Picayune Strand, and Southern States Utilities sites. Caprock formation is generally thought to be a diagenetic process that occurs at the modern water table, and is superimposed on the carbonate sediments; it occurs within the depth of water table seasonal fluctuation in all cores. Its absence at the Collier Seminole and Old Pump Road sites may be explained by the presence of a thick surface quartz sand layer there. However, the dense limestone at Old Pump Road from 17.5 to 18.5 ft might be caprock; recovery and depth control were not very good at that site.

Below the well-indurated limestone at all sites is a variably lithified, white to yellowish gray, moldic molluscan limestone that grades downward into sandy limestone and calcareous sandstone. The thickness of this lithified unit ranges from a maximum of 90 ft at Collier-Seminole State Park, to about 34 ft at Fakahatchee Strand Gate 12. The moldic nature of this rock is due to leaching of aragonitic mollusks. Permeability is generally quite high in moldic limestones if the concentration of molds is such that they intersect providing connected pathways (Fish and Stewart, 1991).

In most cores, below the lithified zone at an abrupt contact is unconsolidated quartz sand, typically with some carbonate mud in the matrix but few shells. This sand unit varies in thickness from about 11.5 ft thick at Collier-Seminole State Park to over 185 ft thick at Fakahatchee Strand Gate 12. In general, the unconsolidated quartz sand is thickest in the eastern part of the study area of the cores drilled this year. At Gate 12 and Jones Grade, the two easternmost sites, the sand lithofacies comprises most of the core down to the base.

Below the unconsolidated sands are a variety of rock types that are typically mottled, dolomitic, and coarse-grained. At the Collier-Seminole State Park, the dolomitized limestone at about 130 ft, is tightly cemented, bored, and phosphatic, suggesting a major sedimentologic boundary, perhaps representing a regional hiatus. That horizon forms the base of the water table aquifer and confines the underlying aquifer unit, and is distinctive in the geophysical logs (Figure 10). Insufficient flow meter data at the Old Pump Road and Fakahatchee Strand Ranger Station sites preclude confirmation of a confining zone in the dolomitic rock below the unconsolidated sand at about 170 ft and 135 ft depths, respectively. At Fakahatchee Strand Gate 12 and Jones Grade sites, there is a dolomitized zone with the unconsolidated sand at 126 and 140 ft depths, respectively, but no indication of aquifer confinment a those depths from the geophysical logs (Figures 13 and 14). At Picayune Strand and Southern States Utilities, west of the Gate 12 and Jones Grade sites, there is a mottled, phosphatic, dolomitized limestone under the unconsolidated sand at about 155 and 127 ft depths respectively, similar in appearance to the dolostone at Collier-Seminole State Park at about 130 ft depth. The lithified dolomitized zone below the unconsolidated sand appears to form a confining zone at the Southern States Utilities site (Figure 16) but not at Picayune Strand (Figure 15).

Geophysical log responses of lithologic units

The geophysical logs expected to correlate with formation lithology (gamma-ray, induction, neutron, and caliper) all indicate that there is no consistent geophysical log response that can be associated with a given lithology. There are a number of abrupt contacts identified in core and inferred from logs. The BHTV is especially effective at indicating sharp bed contacts through the contrasts in corehole wall texture indicated on the logs and the fine-scale spatial resolution given by the BHTV. Some of these changes in corehole wall texture are also indicated by the caliper log, but with much less spatial resolution. The gamma-ray log response is low to moderate for sandy limestone and sandy dolostone, and subject to a good deal of fluctuation. The gamma-ray activity of clean, unconsolidated sand can be uniformly low, but is also variable. The gamma-ray activity of phosphatic sand and siltstone is high to very high. Therefore, there is considerable overlap in the gamma-ray response of each of the lithologies identified in core.

The induction logs obtained in the study area appear to be independent of lithology except through the indirect effects of permeability. The induction logs for all seven coreholes show a close correlation to the spatially smoothed trends in porosity given by the neutron log, with offsets where there are abrupt changes in water quality in the pore spaces. Therefore, neither the induction nor neutron porosity logs provide a direct indication of lithology except for the indirect relationship between porosity and permeability and lithology. At the same time, the apparent lack of electrically conductive clays in the formation in this part of the study area means that clay mineral effects do not influence the interpretation of induction and neutron porosity logs.

The primary application of the "lithology" logs (gamma-ray, induction, neutron, caliper, and BHTV) is to correlate changes in texture or character of logs with lithologic contacts. The depth points and character of these patterns are useful in filling in intervals of lost core, and in determining the exact relative depth of contacts identified on core runs. The combinations of logs and core together provide a means to generate a continuous and complete lithologic column in a way that would not be possible using either geophysics or core alone.

Aquifer compartments and confining units

In the core descriptions and geophysical logs, many of the units encountered by the seven coreholes appear porous and permeable. The core and logs each indicate the presence of one to several thin (less than one to several ft thick), relatively tight intervals, that may serve as confining units. The low vertical permeability and lateral extent of these possible confining units are indicated by the repeated measurement of vertical flow in coreholes after mud has been flushed from the formation.

An indirect effect of the presence of confining units is the generation of compartments of different water quality within the aquifer. The combination of these changes in water quality and the weak dependence of formation factor on porosity acts to produce profiles of formation conductivity that have a stepwise increasing character, (see, for example, Figures 11A and 12A). The confining units generate barriers to vertical mixing of water under the influence of recharge so that there are sharp contrasts in water quality on either side of the confining units. We hypothesize that many of these "steps" in formation conductivity can be attributed to confining units (Table 3).

One possible check on the estimation of pore water conductivity from the induction log is to compare the estimates of R_w obtained from the assumption that $F = 3.0$ with fluid column resistivity logs. This comparison can only be made for intervals where flow logs or other information indicates that water is entering the corehole, so that we know which aquifer compartment serves as the source for the water in the corehole. Under that condition only can we be assured that the water in the corehole has the same electrical conductivity as the water saturating

TABLE 3. Summary of shifts of formation conductivity with depth and their relationship to confining zones, logs, and cores.

BOREHOLE	DEPTH INTERVAL (ft)	INFERRED WATER QUALITY (µS/cm)		FLOW DETECTED?	CONFINING ZONE DETECTED LOGS?	CONFINING ZONE DETECTED CORE?
		ABOVE SHIFT	BELOW SHIFT			
Collier-Seminole	90 - 95	16,500	20,000	yes	no	no
Collier-Seminole	125 - 130	20,000	14,000	yes	yes	yes
Collier-Seminole	170 - 175	14,000	20,000	yes	yes	yes
Old Pump Road	20 - 25	2,100	8,300	yes	yes	no
Old Pump Road	50 - 60	8,300	20,000	ND	yes	no
Old Pump Road	100 - 110	20,000	25,000	ND	yes	no
Fak. Ranger Sta.	58 - 62	600	1,200	yes	yes	yes
Fak. Ranger Sta.	78 - 82	1,200	2,700	yes	yes	no
Fak. Gate 12	35 - 40	600	750	ND	no	yes
Fak. Gate 12	70 - 80	750	1,000	ND	no	no
Jones Grade	40 - 60	500	650	yes	no	no
Jones Grade	80 - 125	650	5,000	yes	no	no
Picayune Str.	45 - 55	1,000	2,000	no	no	no
Picayune Str.	88 - 92	2,000	3,000	yes	yes	no
Southern States	60 - 65	350	500	ND	no	no
Southern States	135 - 145	500	2,000	ND	yes	yes

ND = no data

the interval where water is entering the corehole (Table 4). The comparison of predicted and measured estimates of R_w show that the constant F assumption is a useful but not perfect way to determine formation water quality. This method was used to estimate water quality *in situ* only when no other methods (such as direct water sampling or fluid column R_w) were available. One important result of using a fixed value of F = 3.0 to estimate water quality in situ is that F generally falls in the range of 2.0-3.0 for the most permeable intervals, so that the estimate tends to be conservative (we slightly overestimate pore water salinity).

In two of the coreholes water quality samples were available, either as samples taken during the drilling of another corehole in the immediate vicinity (Fakahatchee Strand Ranger Station; Figure 17A) or as samples taken with all but the bottom of the corehole isolated by drill string (Southern States; Figure 17B). In both figures, the water sample data are plotted as discrete points on the water quality zones inferred from the induction log, and the water conductivity values inferred by assuming F = 3.0. The correspondence is quite good for the Southern States corehole. There is agreement for the Fakahatchee Strand Ranger Station data in that the induction log and water quality data both indicate steps in the water quality profile at the same depths. However, the predictions based on the log and F = 3.0 differ from the water quality data (Missimer and Associates, 1981) below the first step (below 60 ft in depth). This could indicate that the F = 3.0 assumption does not apply to these data. More likely, there has been a change in water quality over the 15 years since the water samples were taken. These changes may have been caused when the Everglades City production well near this location came on line after the 1981 study. Thus, the continued presence of contrasts in water quality at depths of about 60 and 80 ft in the vicinity of the Everglades City water production well confirms the hypothesis that the steps in the induction log formation conductivity profile are caused by lithologic barriers preventing vertical movement of ground water.

Estimating aquifer permeability

All of the results obtained so far indicate that formation conductivity for the near-surface sandy limestone lithology of the study area is a function of formation permeability and pore-water conductivity alone, and independent of lithology. This conclusion is supported by the fact that all formations encountered during drilling appear free of electrically conductive clay minerals, and that the only effect of lithology on formation conductivity occurs indirectly through the effect of rock fabric on permeability. Therefore, we propose that the formation factor definition

$$F = R_t/R_w = S_w/S_t \qquad (7)$$

removes all dependence of F on water conductivity, and we assume that F is primarily a function of formation permeability. Under this assumption, we propose that the interval-averaged F of each aquifer compartment can be correlated with the interval-averaged permeability determined from aquifer tests. In particular, we expect that F decreases as permeability increases (Kwader, 1985):

$$\log(K) = A - B*\log(F) \qquad (8)$$

This relationship cannot be calibrated on a strictly statistical basis without using a large number of F values picked from the log and correlated with a large number of K values determined from laboratory tests on core samples. We need a large number because of the many sources of error in such a correlation. Errors would be introduced from improper depth alignment in sections with poor recovery, disturbance to samples during recovery, and the mismatch between the size of the core sample and the sample volume of the log. We expect that a very large number of data points would be needed to recognize a statistically significant relationship between F and K within the data set.

An alternate approach is to develop a limited number of data points where interval averaging reduces the sampling error, and where aquifer tests are performed in situ so that aquifer

TABLE 4. Predictions of formation-water quality for zones where pore-water quality can be identified as fluid-column resistivity.

BOREHOLE ID	INFLOW DEPTH (feet)	FLUID COLUMN R_w (ohm-m)	FLUID COLUMN S_w (µS/cm)	PREDICTED R_w (ohm-m)	PREDICTED S_w (µS/cm)
Collier Seminole	150	0.9	11,000	0.6	16,000
Old Pump Road	40	2.0	5,000	1.2	8,300
Fak. Ranger Sta.	90	18.0	555	8.3	1,200
Fak. Gate 12	90	20.0	500	10.0	1,000
Jones Grade	170	2.5	4,000	2.0	5,000
Jones Grade well	35	25.0	400	17.0	590
Picayune Str.	150	2.5	4,000	3.0	3,300

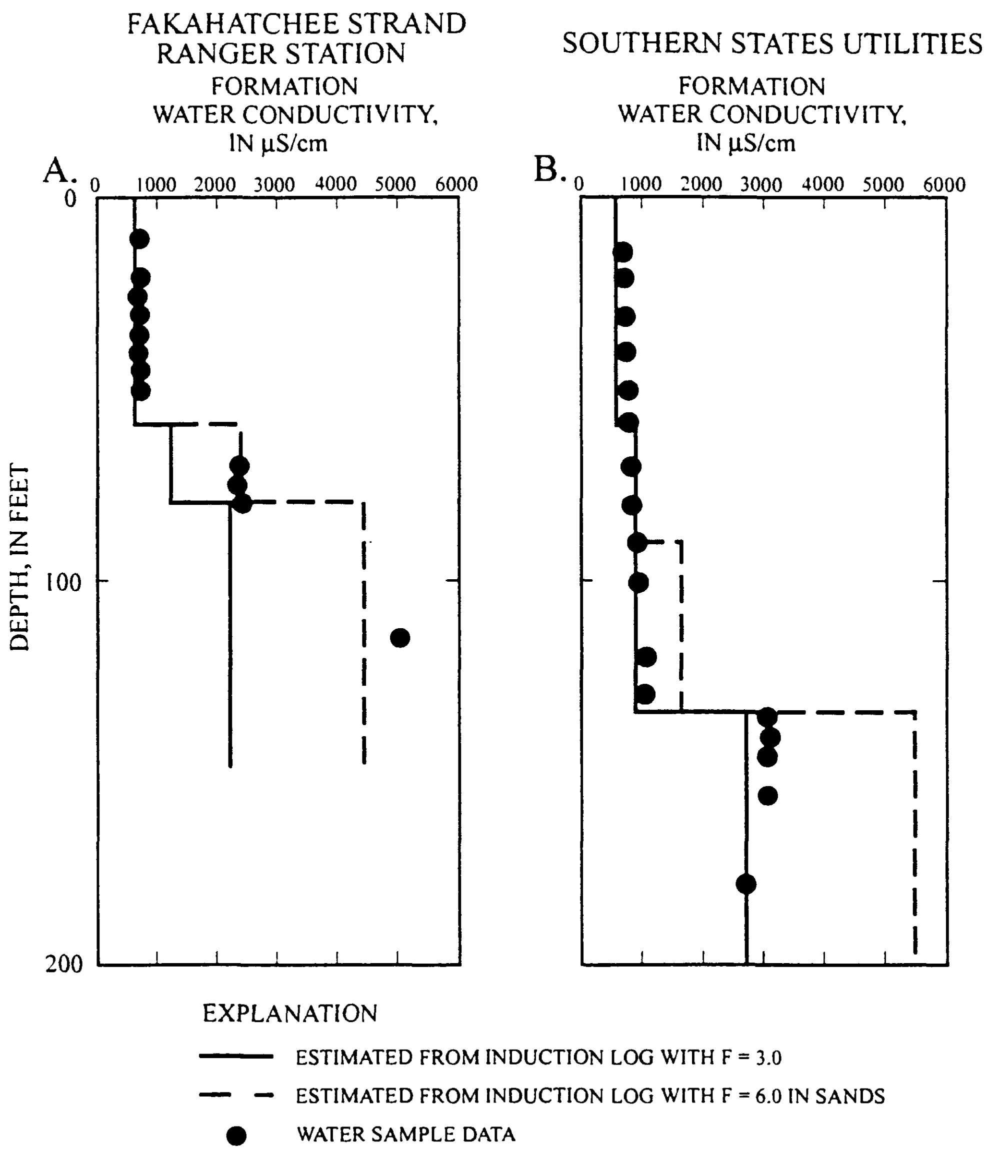

Figure 17. Comparison of water quality inferred from induction logs with water sample data for: A) Fakahatchee Strand Ranger Station corehole (water data from Missimer and Associates, Inc., 1981) and B) Southern States Utilities corehole (water data from K. Rohrer, unpublished data).

sample disturbance during core recovery is not involved. This approach is based on the regression of interval-averaged F versus T/b, where T is the aquifer transmissivity determined from aquifer tests, and b is the thickness of the aquifer. Two such data points are available. One is given for the Everglades City wellfield (Missimer and Associates, 1981; F = 3.0 and K = 3000 ft/day), and the other for an aquifer test a few miles further east where Henderson Creek crosses the Tamiami Trail (Jakob, 1980; F = 4.3 and K = 800 ft/day). These two data points define a line which shows the expected decrease in K with increasing F. However, there is no statistical significance to support this relationship. If two or three such points can be added to Figure 18, and the additional points plot close to the line defined by the first two points, then we can accept this relationship as a useful predictor of formation K when F is given from well logs and water sample data.

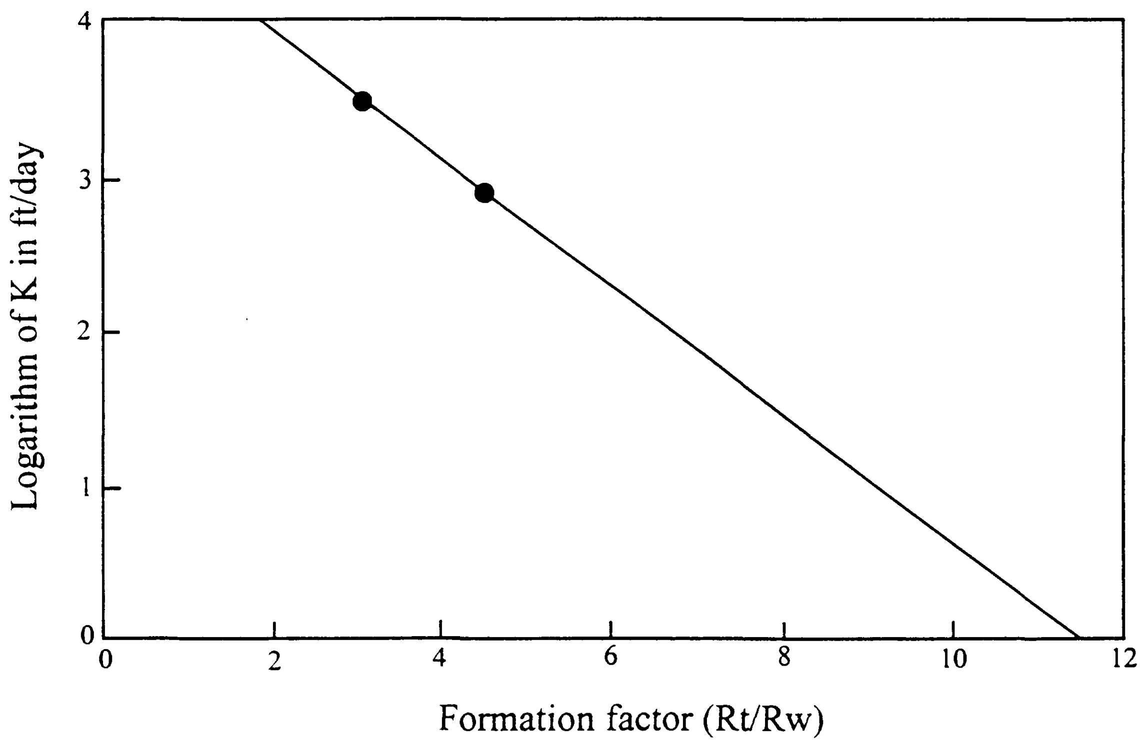

Figure 18. Comparison of interval-averaged formation factor and surficial aquifer permeability (K) for two sites in the study area.

REFERENCES

Abbot, G.C., and Nath, A.K., 1996, Hydrologic restoration of southern Golden Gate Estates conceptual plan, Final Report: Naples, FL, Big Cypress Basin Board, South Florida Water Management District, 206 p.

Aguilera, Roberto, 1980, Naturally Fractured Reservoirs: Tulsa, Okla., Petroleum Publishing, 703 p.

Alger, R.P., 1964, Interpretation of electric logs in fresh water wells in unconsolidated formations: Society of Professional Well Log Analysts Annual Logging Symposium, 4th, Oklahoma City, Oklahoma, 1964, Transactions, p. CC1-CC25.

Allmon, W. D., 1992, Whence southern Florida's Plio-Pleistocene shell beds?, *in* Scott, T.M, and Allmon, W.D., The Plio-Pleistocene stratigraphy and paleontology of southern Florida: Florida Geological Survey Special Publication 36, p. 1-20.

Bennett, M. W., 1992, A three dimensional finite difference ground water flow model of western Collier County, Florida: South Florida Water Management District, Technical Publication 92-04, 358p.

Biella, Giancarlo, Lozej, Alfredo, and Tobacco, Ignazio, 1983, Experimental study of some hydrogeophysical properties of unconsolidated porous media: Ground Water, v. 21, no. 6, p. 751.

Causaras, C.R., 1985, Geology of the surficial aquifer system, Broward County: U.S. Geological Survey Water-Resources Investigations Report 84-4068, 167 p.

Causaras, C.R., 1987, Geology of the surficial aquifer system, Dade County: U.S. Geological Survey Water-Resources Investigations Report 86-4126, 240 p.

Cooke, C.W. and Mossom, S. 1929, Geology of Florida, 20th Annual Report of the FGS, p. 29-227.

Dall, W. H., 1887, Notes on the Geology of Florida: American Journal of Science, v. 34, p. 165-170.

Dall, W.H., 1890 - 1903, Contributions to the Tertiary fauna of Florida, with especial reference to the Miocene Silex beds of Tampa and the Pliocene beds of the Caloosahatchee River: Wagner Free Institute of Science, Transactions, v.3, 1654p., 60 pls., pts.1, 1890; pts. 2, 1892; pts. 3, 1895; pt. 4, 1898; pt. 5, 1900; pt. 6, 1903.

Davis, J.H., 1943, The natural features of southern Florida, especially the vegetation and the Everglades, Florida Geological Survey Bulletin 25, 311 p.

DuBar, Jules, 1958, Neogene stratigraphy of southwestern Florida: Gulf Coast Association of Geological Societies Transactions, v. 8, p. 129-155.

Fish, J.E., and Stewart, M.T., 1991, Hydrogeology of the surficial aquifer system, Dade County, Florida: U.S. Geological Survey Water Resource Investigations Report 90-4108, 50p.

Fish, J.E., 1988, Hydrogeology, aquifer characteristics, and ground-water flow of the surficial aquifer system, Broward County, Florida: U.S. Geological Survey Water-Resources Investigations Report 87-4034, 92p.

Hearst, J.R., and Nelson, P.H., 1985, Logging for Physical Properties: New York, McGraw Hill, 571 p.

Hess, A.E., 1986, Identifying hydraulically conductive fractures with a slow-velocity corehole flowmeter: Canadian Geotechnical Journal, v. 23, no. 1, p. 69-78.

Hunter, M.E., and Wise, S.W., 1980, Possible restriction and redefinition of the Tamiami Formation of South Florida: Points of Discussion, *in* Gleason, P.J., (ed.) Water, Oil, and the geology of Collier, Lee and Hendry Counties: Miami Geological Society Field Trip Guidebook, May 31 - June 1, p. 41-44.

Hunter, M.E., 1968, Molluscan guide fossils in Late Miocene sediments of southern Florida: Gulf Coast Association of Geological Societies, Transactions, v. 18, p. 439-450.

Jakob, P.G., 1980, Some aspects of hydrogeology of coastal Collier County, Florida, *in* P.J. Gleason, ed., Water, Oil, and Geology of Collier, Lee, and Hendry Counties: Miami Geological Society, 1980 Field Experience Guidebook, p. 21-26.

Jakob, P., 1983, Hydrogeology of the Shallow Aquifer System south of Naples area, Collier County, Florida: SFWMD Technical Publication 83-3, 89 p.

Jorgensen, D.G., 1988, Estimating permeability in water-saturated formations: Log Analyst, v. 29, no. 6, p. 401-409.

Jorgensen, D.G., 1991, Estimating geohydrologic properties from corehole geophysical logs: Ground Water Monitoring and Remediation, v. 10, no. 2, p. 123-129.

Keys, W.S., 1986, Analysis of geophysical well logs with a microcomputer: Ground Water, v. 24, no. 6, p. 750-760.

Keys, W.S., 1990, Corehole geophysics applied to ground-water investigations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 2, chap. E2, 150p.

Klein, Howard, Schroeder, M.C., and Lichtler, W.F., 1964, Geology and ground-water resources of Glades and Hendry Counties, Florida: Florida Geological Survey Report of Investigations 37, 101 p.

Klein, Howard, Schneider, J.J., McPherson, B.F., and Buchanan, T.J., 1970, Some hydrologic and biologic aspects of the Big Cypress Swamp drainage agea, southern Florida: U.S. Geological Survey Open-File Report, FL-70003, 94p.

Klein, Howard, 1972, The shallow aquifer of southwest Florida: Florida Bureau of Geology Map Series, No. 53.

Knapp, Michael, Burns, W.S., and Sharp, T.S., 1986, Preliminary assessment of the groundwater resources of western Collier County, Florida, South Florida Water Management District, Technical Publication 86-1, 142 p.

Kwader, Thomas, 1985, Estimating aquifer permeability from formation resistivity factors: Ground Water, v. 23, no. 6, p. 762-766.

Lynch, E.J., 1962, Formation Evaluation: New York, Harper and Row, 422 p.

MacCary, L.M., 1980, Use of geophysical logs to estimate water-quality trends in carbonate aquifers: U.S. Geological Survey Water-Resources Investigations Report 80-57, 23 p.

Mansfield, W.C., 1939, Notes on the upper Tertiary and Pleistocene mollusks of peninsular Florida: Florida Geological Survey Bulletin 18, 75 p.

Matson, C.G., and Clapp, F.G., 1909, A preliminary report on the geology of Florida,with special reference to the stratigraphy: Florida Geological Survey Annual Report 2, p. 25-173.

McCoy, Jack, 1962, Ground-water resources of Collier County, Florida: Florida Geological Survey Report of Investigations No. 31.

McCoy, Jack, 1967, Ground water in the Immokalee area, Collier County, Florida: Florida Geological Survey Report of Investigations No. 31, 82 p.

McCoy, Jack, 1972, Hydrology of Western Collier County, Florida: Bureau of Geology, Report of Investigations No. 63, 32p.

Meeder, John F., 1979, The Pliocene fossil reef of southwest Florida: Field trip guide with log, Miami Geological Society, January 1979, 18 p.

Missimer and Associates, Inc., 1981, Hydrologic investigation for the Everglades City raw water supply: Missimer and Associates, Inc., 53 p.

Missimer, T. M., 1978, The Tamiami Formation-Hawthorn contact in Southwest Florida: Florida Scientist, v. 41-p. 31-35.

Missimer, T. M., 1984, The Geology of South Florida, in Gleason, P.J. (ed.) Environments of South Florida Present and Past II: Coral Gables, Fl, Miami Geological Society Memoir 2, p. 385-404.

Missimer, T.M., 1992, Stratigraphic relationships of sediment facies within the Tamiami Formation of southwest Florida: Proposed intraformational correlations, *in* Scott, T.M, and Allmon, W.D., The Plio-Pleistocene stratigraphy and paleontology of southern Florida: Florida Geological Survey Special Publication 36, p. 63-92.

North American Commission on Stratigraphic Nomenclature, 1983, North American Stratigraphic Code: American Association of Petroleum Geologists Bulletin, v. 67, no. 5, p. 841-875, 11 figs., 2 tables.

Olsson, A.A., 1964, Geology and stratigraphy of southern Florida, *in* Olsson, A.A. and Petit, R.E., Some Neogene mollusca from Florida and the Carolinas: Bulletin of American Paleontology, v. 47, no. 217, p. 509-574.

Paillet, F.L., Crowder, R.E., and Hess, A.E., 1996, High-resolution flowmeter logging applications with the heat-pulse flowmeter: Journal of Environmental and Engineering Geophysics, v. 1, no. 1, p. 1-14.

Paillet, F.L., Hess, A.E., Cheng, C.H., and Hardin, E.L., 1987, Characterization of fracture permeability with high-resolution vertical flow measurements during corehole pumping: Ground Water, v. 25, no. 1, p. 28-40.

Parker, G.G., Ferguson, G.E., and Love, S.K., 1955, Water resources of southeastern Florida, with special reference to the geology and ground water of the Miami area: U.S. Geological Survey Water-Supply Paper 1255, 965 p.

Parker, G.G., 1942, Notes on the geology and groundwater of the Everglades in southern Florida: Proceedings floria Soil Socience Society, v. 4, p. 47-76.

Peacock, Roland, 1983, The post-Eocene stratigraphy of southern Collier County, Florida, South Florida Water Management District Technical Publication 83-5.

Scott, T.M., 1992, Coastal plains stratigraphy: The dichotomy of biostratigraphy and lithostratigraphy-a philosophocal approach to an old problem, *in* Scott, T.M, and Allmon, W.D., The Plio-Pleistocene stratigraphy and paleontology of southern Florida: Florida Geological Survey Special Publication 36, p. 21-25.

Southeastern Geological Society, Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986, Hydrogeological units of Florida, Florida Geological Survey Special Publication 28, 8p.

Sherwood, C.B., and Klein, Howard, 1961, Ground-water resources of north-western Collier County, Florida: Florida Geological Survey Information Circular 29.

Stewart, M.T., Lizanec, Theodore, and Layton, Michael, 1982, Application of DC resistivity surveys to regional hydrogeologic investigations, Collier County, Florida: West Palm Beach, Florida, South Florida Water Management District, 95 p.

APPENDIX 1

FLORIDA GEOLOGICAL SURVEY LITHOLOGS

1.1 Collier-Seminole State Park core
1.2 Old Pump Road core
1.3 Fakahatchee Strand-Ranger Station core
1.4 Fakahatchee Strand-Gate 12 core
1.5 Fakahatchee Strand-Jones Grade core
1.6 Picayune Strand core
1.7 Southern States Utilities core

1.1 COLLIER SEMINOLE STATE PARK CORE

LITHOLOGIC WELL LOG PRINTOUT — SOURCE - FGS

WELL NUMBER: W-17360 — COUNTY - COLLIER

TOTAL DEPTH: 194.0 FT. — LOCATION: T.51S R.27E S.36

SAMPLES - NONE — LAT = 25D 59M 20S

LON = 81D 34M 43S

COMPLETION DATE: N/A — ELEVATION: 5 FT

OTHER TYPES OF LOGS AVAILABLE - CALIPER, INDUCTION, NEUTRON

OWNER/DRILLER:USGS CORE DRILLED BY FGS (JIM TRINDELL).

WORKED BY:GUY H. MEANS

COLLIER/SEMINOLE CORE

PALEONTOLOGICAL DATA NEEDED TO FACILITATE UNDERSTANDING OF

OF LITHOLOGIC UNITS. ALL FORMATIONAL PICKS TENTATIVE PER TOM SCOTT

NOTE THAT OT UNDER ACCESSORY MINERALS REPRESENTS A TRACE.

0.0	- 5.0	**FILL**
5.0	- 20.0	**UNDIFFERENTIATED SAND**
20.0	- 111.0	**OCHOPEE MEMBER LIMESTONE (TAMIAMI FORMATION)**
111.0	- 194.0	**UNNAMED SAND AND CARBONATE**

0 - .3 SAND; GRAYISH BROWN

POROSITY: INTERGRANULAR

GRAIN SIZE: FINE; RANGE: FINE TO COARSE

ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY

POOR INDURATION

CEMENT TYPE(S): CLAY MATRIX

ACCESSORY MINERALS: LIMESTONE-10%, PLANT REMAINS-05%

ORGANICS-03%, HEAVY MINERALS-01%

INDURATED CHUNKS NEAR LIMESTONE CLASTS CONTAIN CALCITE CEMENT.

.3- .8 SAND; GRAYISH ORANGE TO WHITE

POROSITY: INTERGRANULAR

GRAIN SIZE: FINE; RANGE: FINE TO COARSE

ROUNDNESS: SUB-ANGULAR TO ANGULAR; MEDIUM SPHERICITY

MODERATE INDURATION

CEMENT TYPE(S): SPARRY CALCITE CEMENT, CLAY MATRIX

ACCESSORY MINERALS: LIMESTONE-15%, PLANT REMAINS-01%

CALCILUTITE-01%

FOSSILS: MOLLUSKS

4 BY 4 CM. CHUNK OF FOSSILIFEROUS LIMESTONE IN INTERVAL.

FOSSIL PELECYPODS & MOLDS OF OTHER MOLLUSKS. MOLDS COATED IN SPAR. PROBABLY FILL MATERIAL.

.8- 1.1 SAND; MODERATE LIGHT GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX, CLAY MATRIX
ACCESSORY MINERALS: PLANT REMAINS-15%, ORGANICS-30%
CLAY-01%

1.1- 5 SAND; VERY LIGHT GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: ORGANICS-05%, PLANT REMAINS-01%
ORGANIC CONTENT VARIES THROUGHOUT INTERVAL FROM 1% TO 10%.

5 - 6.3 SAND; GRAYISH BROWN RED
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: ORGANICS-20%, CLAY-01%
PLANT REMAINS-01%
TOP OF INTERVAL CONTAINS SEVERAL 2 BY 2 CM. CHUNKS OF
LIMESTONE.

6.3- 7 SAND; GRAYISH BROWN
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-05%, ORGANICS-01%
PLANT REMAINS-01%

7 - 8 SAND; MODERATE BROWN
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, ORGANIC MATRIX
ACCESSORY MINERALS: CLAY-03%, HEAVY MINERALS-01%
PLANT REMAINS-01%, ORGANICS-03%
INTERVAL LESS INDURATED THAN ABOVE INTERVAL.

8 - 9.3 SAND; LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, ORGANIC MATRIX
ACCESSORY MINERALS: CLAY-01%, LIMONITE-05%
PLANT REMAINS-01%, LIMESTONE-01%
COLOR VARIABLE.

9.3- 10 SAND; LIGHT REDDISH BROWN TO MODERATE REDDISH BROWN
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-03%, LIMONITE-05%
PLANT REMAINS-01%
INTERVAL IS MOTTLED BROWN TO DARK BROWN.

10 - 12 SAND; LIGHT GRAYISH RED TO LIGHT REDDISH BROWN
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-03%, LIMONITE-01%
PLANT REMAINS-01%
INTERVAL MOTTLED. TRACES OF HEAVY MINERALS INCLUDING
PHOSPHATE.

12 - 13.5 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-03%
INTERVAL HAS ORANGE RIND.

13.5- 14.5 SAND; LIGHT GREENISH GRAY TO GREENISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX, CALCILUTITE MATRIX
ACCESSORY MINERALS: CLAY-05%, PLANT REMAINS-0T%

14.5- 16.5 SAND; VERY LIGHT GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-05%, HEAVY MINERALS-01%
LIMESTONE-01%
AT APPROX. 14.7 FEET LIMESTONE RUBBLE.

16.5- 17 NO SAMPLES

17 - 19 SAND; GRAYISH BROWN
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-03%, HEAVY MINERALS-01%
LIMESTONE-01%
BETWEEN 18.0 AND 18.6 FEET LIMESTONE RUBBLE. SMALL
LIMESTONE CLASTS OCCUR THROUGHOUT.

19 - 19.4 SAND; VERY LIGHT ORANGE
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-01%

19.4- 20 SAND; MODERATE BROWN
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: FINE TO VERY COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-20%, LIMESTONE-10%
INTERVAL HIGHLY VARIABLE IN COLOR-LIGHTER NEAR LIMESTONE
CLASTS & DARKER AWAY FROM THEM. TRACE OF CALCAREOUS CEMENT
NEAR LIMESTONE CLASTS.

20 - 24 LIMESTONE; WHITE
POROSITY: MOLDIC, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: SKELETAL, CRYSTALS, CALCILUTITE
30% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: MEDIUM TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-15%, PHOSPHATIC SAND-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, CHALKY
FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. SOME MOLDS INFILLED WITH SAND. MOST
ALLOCHEMS ARE DISSOLVED OUT. SPARRY CALCITE LINES SOME
MOLDS.

24 - 28.5 LIMESTONE; WHITE TO YELLOWISH GRAY
POROSITY: MOLDIC, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, CRYSTALS
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: VERY COARSE; RANGE: COARSE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%, SHELL-10%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. MOLDS INFILLED WITH SOME SAND. ALLOCHEMS
MOSTLY DISSOLVED OUT.MOLDS COATED WITH SPARRY CALCITE.

28.5- 30 LIMESTONE; WHITE TO VERY LIGHT GRAY
POROSITY: INTRAGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
40% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: GRAVEL; RANGE: VERY COARSE TO GRAVEL
GOOD INDURATION
ACCESSORY MINERALS: QUARTZ SAND-15%, SHELL-15%
PHOSPHATIC SAND-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. MOLDS CONTAIN SOME INFILLED SAND. ALLOCHEMS
MOSTLY DISSOLVED OUT. OYSTER SHELLS PREFERENTIALLY
PRESERVED.

30 - 32 NO SAMPLES

32 - 47 LIMESTONE; PINKISH GRAY
POROSITY: INTRAGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
40% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: GRAVEL; RANGE: VERY COARSE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%, SHELL-15%
PHOSPHATIC SAND-03%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. SAND CONTENT VARIABLE-NOT EXCEEDING 30%.REDDISH CLAY SLIGHTLY COATS SOME EXTERNAL SURFACES OF INTERVAL. PHOSPHATE CONTENT RANGES FROM 1% TO 3%. MOST ALLOCHEMS DISSOLVED OUT.

47 - 53 LIMESTONE; YELLOWISH GRAY
POROSITY: INTRAGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: GRAVEL; RANGE: VERY COARSE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-15%, PHOSPHATIC SAND-03%
SHELL-20%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
OYSTER SHELLS AND SHELL FRAGMENTS WELL PRESERVED.

53 - 66.5 SANDSTONE; WHITE TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-03%
HEAVY MINERALS-01%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS, LOW RECRYSTALLIZATION
FOSSILS: BRYOZOA, ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
POOR RECOVERY. TURRITELLA COMMON IN INTERVAL. INTERVAL BECOMES WHITER DOWN CORE. INTERVAL RANGES FROM A SANDY LIMESTONE TO A CALCAREOUS SANDSTONE.

66.5- 67.2 SANDSTONE; WHITE TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS
FOSSIL MOLDS GENERALLY SMALLER THAN PREVIOUS INTERVALS.

67.2- 73 SANDSTONE; PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL MOLDS
UPPER 1 FOOT OF THIS INTERVAL CONTAINS LESS MACRO MOLLUSK MOLDS THAN LOWER PART OF THIS INTERVAL. PELECYPOD CONTENT INCREASES DOWN INTERVAL.

73 - 75 SANDSTONE; PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-01%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL MOLDS

75 - 80.5 SANDSTONE; GRAYISH ORANGE PINK
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS
POOR RECOVERY.

80.5- 81 NO SAMPLES

81 - 88 SANDSTONE; LIGHT BROWNISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL MOLDS
INTERVAL BETWEEN 86.5 & 87 FEET LESS INDURATED THAN THE REST OF THE INTERVAL. PELECYPOD MOLDS DOMINATE FOSSIL ASSEMBLEDGE

88 - 102.3 SANDSTONE; DARK GRAYISH RED TO LIGHT RED
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-03%
HEAVY MINERALS-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
FOSSIL MOLDS DECREASE IN SIZE DOWN INTERVAL. POOR RECOVERY.

102.3- 106.2 SANDSTONE; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%, SHELL-20%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY.

106.2- 111 SANDSTONE; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%, SHELL-20%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. SHELLS WELL PRESERVED.

111 - 118.5 NO SAMPLES

118.5- 121 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-03%, SHELL-30%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS
INDURATION INCREASES DOWN INTERVAL. POOR RECOVERY.

121 - 122 NO SAMPLES

122 - 128 SAND; LIGHT BROWNISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC GRAVEL-01%, PHOSPHATIC SAND-03%, SHELL-03%
FOSSILS: MOLLUSKS

128 - 133 DOLOSTONE; LIGHT GRAY TO YELLOWISH GRAY
POROSITY: MOLDIC, LOW PERMEABILITY; 50-90% ALTERED
ANHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, SPAR-05%
QUARTZ SAND-40%
OTHER FEATURES: FOSSILIFEROUS, HIGH RECRYSTALLIZATION
FOSSILS: CORAL, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
MOLDS COATED WITH SPARRY CALCITE. AT 128.0 HARDGROUND WITH
A PHOSPHATIC COATING & BURROW TRACES. COLOR IS VARIABLE.
PHOSPHATIC COATING IS BLACK IN COLOR.

133 - 133.9 LIMESTONE; GRAYISH ORANGE PINK TO GRAYISH BROWN
POROSITY: MOLDIC, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
15% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: MEDIUM TO GRANULE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-40%
OTHER FEATURES: DOLOMITIC, LOW RECRYSTALLIZATION
FOSSILIFEROUS
FOSSILS: CORAL, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
COLOR VARIABLE. INDURATION RANGES FROM MODERATE TO GOOD.

133.9- 134.8 SAND; WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-03%
OTHER FEATURES: DOLOMITIC, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
INTERVAL IS POSSIBLY AN ARTIFACT OF DRILLING.

134.8- 140 SAND; PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
FOSSIL CONTENT MUCH LESS THAT PREVIOUS INTERVALS.

140 - 140.8 DOLOSTONE; WHITE TO LIGHT GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY; 50-90% ALTERED
GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO FINE
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
SEDIMENTARY STRUCTURES: BIOTURBATED
ACCESSORY MINERALS: QUARTZ SAND-30%, PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS
DARKER GRAY AREAS APPEAR MORE INDURATED THAN SURROUNDING LIGHTER COLORED AREAS. LIGHTER COLORED AREAS CONTAIN UP TO 49% SAND WHEREAS DARKER DOLOMITIC AREAS CONTAIN ONLY TRACES OF SAND.

140.8- 143 DOLOSTONE; WHITE TO LIGHT GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY; 50-90% ALTERED; ANHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, QUARTZ SAND-30%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS

143 - 144 DOLOSTONE; WHITE TO LIGHT GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY; 50-90% ALTERED; ANHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%, PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS
FOSSIL MOLDS ARE DARK GRAY AND MATRIX IS LIGHTER COLORED.
SAND CONTENT AND COLOR ARE VARIABLE.

144 - 144.3 DOLOSTONE; MODERATE LIGHT GRAY TO MODERATE GRAY
POROSITY: MOLDIC; 50-90% ALTERED; ANHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, CALCILUTITE-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS
SAND CONTENT RANGES FROM 20% TO OVER 50% IN SOME AREAS.

144.3- 153 SANDSTONE; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
LARGER SAND GRAINS ARE FROSTED. CEMENT IS DOLOSILT.

153 - 155.1 SANDSTONE; MODERATE LIGHT GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS
SAND MODE VARIABLE. LARGER SAND GRAINS APPEAR FROSTED.

155.1- 161 SANDSTONE; WHITE TO LIGHT BLUISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS
GRAYER AREAS ARE MORE INDURATED THAN SURROUNDING INTERVAL.
LARGER SAND GRAINS APPEAR FROSTED.

161 - 165 SANDSTONE; VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL MOLDS
POOR RECOVERY. LARGER SAND GRAINS APPEAR FROSTED.

165 - 166 NO SAMPLES

166 - 166.2 SANDSTONE; PINKISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRANULE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: SHELL-01%
OTHER FEATURES: CHALKY, FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS

166.2- 177 SANDSTONE; GRAYISH ORANGE PINK TO PINKISH GRAY
POROSITY: MOLDIC, INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
MEDIUM SPHERICITY; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
SEDIMENTARY STRUCTURES: GRADED BEDDING, LAMINATED
ACCESSORY MINERALS: PHOSPHATIC SAND-03%, SHELL-05%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
SAND RANGES FROM FINE GRAINED TO GRAVEL SIZE. INTERVAL LAMINATED IN SOME PLACES. GRAVEL SIZE QUARTZ EXHIBITS A DISCOIDAL SHAPE. SOME SHELL FRAGMENTS ALSO APPEAR ROUNDED AND DISCOIDAL. POSSIBLY A TRACE OF DOLOSILT IN THE FINE GRAINED PARTS OF INTERVAL. SHELL CONTENT RANGES FROM A TRACE TO 30%.

177 - 181 SANDSTONE; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRANULE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-03%, SHELL-03%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
SEVERAL PEBBLE SIZE, ROUNDED CHUNKS OF FELDSPAR IN INTERVAL.

181 - 188 SANDSTONE; GRAYISH BROWN TO GRAYISH ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%, MICA-01%
PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS
POOR RECOVERY. BOTTOM 2 - 3 INCHES IS A LAMINATED DOLOMITE - POSSIBLY A HARDGROUND.

188 - 194 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%, MICA-01%
PHOSPHATIC SAND-01%
POOR RECOVERY.

194 TOTAL DEPTH

1.2 OLD PUMP ROAD CORE

LITHOLOGIC WELL LOG PRINTOUT　　　SOURCE - FGS

WELL NUMBER: W-17361　　　COUNTY - COLLIER
TOTAL DEPTH: 196 FT.　　　LOCATION: T.52S R.28E S.04
SAMPLES - NONE　　　LAT = 25D 58M 37S
LON = 81D 30M 19S
COMPLETION DATE: N/A　　　ELEVATION: 5 FT
OTHER TYPES OF LOGS AVAILABLE - CALIPER, INDUCTION, NEUTRON

OWNER/DRILLER:USGS DRILLED BY FGS (JIM TRINDELL)

WORKED BY:GUY H. MEANS
OLD PUMP ROAD CORE
PALEONTOLOGICAL DATA NEEDED TO FACILITATE UNDERSTANDING OF LITHOLOGIC UNITS. ALL FORMATIONAL PICKS TENTATIVE PER TOM SCOTT.
NOTE THAT UNDER ACCESSORY MINERALS OT REPRESENTS A TRACE.

0.0	-	3.0	**FILL**
3.0	-	29.0(?)	**UNDIFFERENTIATED SAND**
29.0	-	111.0	**OCHOPEE MEMBER LIMESTONE (TAMIAMI FORMATION)**
111.0	-	196.0	**UNNAMED SAND AND CARBONATE**

0 - .7 SAND; MODERATE GRAY TO DARK GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: SILT-01%, PLANT REMAINS-05%
ORGANICS-15%, CLAY-01%
OTHER FEATURES: CALCAREOUS
FILL MATERIAL

.7- 2.3 SAND; GRAYISH BROWN TO GRAYISH ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, PLANT REMAINS-0T%
CLAY-01%
FILL MATERIAL. COLOR VARIABLE & INDURATION RANGES FROM MODERATE TO POOR DOWN INTERVAL. A 4 BY 3 CM. CHUNK OF LIMESTONE AT 2.3'.

2.3- 3 SAND; WHITE TO LIGHT GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: ORGANICS-0T%
FILL MATERIAL.

3 - 4 SAND; MODERATE DARK GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-01%, ORGANICS-05%
PLANT REMAINS-0T%
DARK GRAY ORGANIC RICH RIND THROUGHOUT INTERVAL. TRACE OF CARBONATE.

4 - 7 SAND; LIGHT GRAY TO GRAYISH PURPLE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: CLAY-01%, ORGANICS-03%
PLANT REMAINS-01%
POOR RECOVERY. INDURATION RANGES FROM POOR TO UNCONSOLIDATED.

7 - 12 SAND; GRAYISH BROWN TO LIGHT BROWNISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-05%, PLANT REMAINS-0T%
POOR RECOVERY. CALCAREOUS RIND THROUGHOUT INTERVAL MAY BE AN ARTIFACT OF DRILLING.

12 - 15 NO SAMPLES

15 - 17 SAND; WHITE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-0T%, PLANT REMAINS-0T%
POOR RECOVERY. SAND COARSENS DOWNWARD.

17 - 17.5 LIMESTONE; WHITE TO VERY LIGHT GRAY
POROSITY: INTERGRANULAR
GRAIN TYPE: SKELETAL, BIOGENIC
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, CALCILUTITE-15%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS

17.5- 18.5 LIMESTONE; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: VUGULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, CALCILUTITE
40% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, CALCILUTITE-15%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: CORAL
VUGS INFILLED WITH SANDY CALCILUTITE.

18.5- 20 NO SAMPLES

20 - 23 SAND; WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%
POOR RECOVERY.

23 - 25 SAND; WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, CLAY-0T%
POOR RECOVERY. CLAY CONTENT INCREASES DOWNWARD.

25 - 26.6 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, CLAY-0T%
OTHER FEATURES: CALCAREOUS
POOR RECOVERY.

26.6- 27 LIMESTONE; YELLOWISH GRAY TO GRAYISH YELLOW
POROSITY: MOLDIC, INTRAGRANULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS
MOLDS LINED WITH SPARRY CALCITE AND INFILLED WITH SAND.

27 - 27.5 LIMESTONE; WHITE
POROSITY: MOLDIC, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: CRYSTALS, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO COARSE; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, SHELL-05%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS
MOLLUSK SHELLS WELL PRESERVED. SOME MOLDS LINED WITH SPARRY CALCITE.

27.5- 28 CALCILUTITE; WHITE TO PINKISH GRAY
POROSITY: INTERGRANULAR
GRAIN TYPE: SKELETAL; 45% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: MEDIUM TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: SHELL-45%, QUARTZ SAND-01%
OTHER FEATURES: CHALKY, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. THIS INTERVAL PROBABLY AN ARTIFACT OF DRILLING.

28 - 29 NO SAMPLES

29 - 30 LIMESTONE; PINKISH GRAY
POROSITY: MOLDIC, VUGULAR
GRAIN TYPE: CRYSTALS, SKELETAL
40% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
SAND CONTENT VARIABLE.

30 - 31 NO SAMPLES

31 - 36 LIMESTONE; LIGHT GRAY TO PINKISH GRAY
POROSITY: MOLDIC, VUGULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%
OTHER FEATURES: DOLOMITIC, HIGH RECRYSTALLIZATION
FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. SAND CONTENT EXCEEDS 40% IN SOME PARTS OF INTERVAL

36 - 46 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: GRAVEL; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-03%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY.

46 - 56 LIMESTONE; WHITE TO PINKISH GRAY
POROSITY: MOLDIC, INTERGRANULAR
GRAIN TYPE: BIOGENIC, CRYSTALS
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-03%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. INTERVAL VERY RUBBLY.

56 - 62 NO SAMPLES

62 - 68 LIMESTONE; WHITE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: GRAVEL; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-03%, HEAVY MINERALS-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
BRYOZOANS ABUNDANT.

68 - 70.5 NO SAMPLES

70.5- 72.4 LIMESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: VERY COARSE; RANGE: FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%, HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
POOR RECOVERY.

72.4- 73 LIMESTONE; WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%
OTHER FEATURES: CHALKY, FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS
40% TO 50% OF INTERVAL CONSISTS OF FOSSIL FRAGMENTS.
INTERVAL MAY BE AN ARTIFACT OF DRILLING.

73 - 75 LIMESTONE; GRAYISH ORANGE PINK TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY.

75 - 80 NO SAMPLES

80 - 87.5 LIMESTONE; GRAYISH ORANGE PINK TO WHITE
POROSITY: MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY.

87.5- 88 CALCILUTITE; WHITE
POROSITY: INTERGRANULAR
GRAIN TYPE: BIOGENIC, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-30%
OTHER FEATURES: CHALKY, FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS
INTERVAL PROBABLY AN ARTIFACT OF DRILLING. MATRIX CONSISTS
OF A PASTY CALCAREOUS MUD CONTAINING 40% TO 50% ROCK AND
FOSSIL FRAGMENTS. INTERVAL PROBABLY AN ARTIFACT OF DRILLING

88 - 96 SANDSTONE; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: MOLDIC, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
INTERVAL RANGES FROM A SANDY LIMESTONE TO A CALCAREOUS SANDSTONE. POOR RECOVERY.

96 - 100.5 NO SAMPLES

100.5- 101 SANDSTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: MOLDIC, VUGULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
DESCRIPTION BASED ON ONE RECOVERED FRAGMENT.

101 - 107 NO SAMPLES

107 - 107.5 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS

107.5- 111 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%, SHELL-05%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR SAMPLES. INDURATION RANGES FROM POOR TO MODERATE.

111 - 111.3 SAND; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
POOR RECOVERY.

111.3- 115 SAND; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-03%, SHELL-30%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
SIZE AND AMOUNT OF SHELL FRAGMENTS INCREASES DOWN INTERVAL.
POOR RECOVERY.

115 - 121 SAND; GRAYISH ORANGE PINK TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: SHELL-15%, HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SAMPLE BAGGED - PROBABLY WASHED. POOR RECOVERY.

121 - 122 SAND; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-10%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY.

122 - 123 SAND; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-05%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL CONTENT LESS THAN PREVIOUS INTERVALS.

123 - 126 NO SAMPLES

126 - 129 SAND; WHITE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-01%
PHOSPHATIC SAND-03%, SHELL-05%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL FRAGMENT CONTENT DECREASES DOWN INTERVAL. SAND FINES DOWNWARD. POOR RECOVERY.

129 - 136 SAND; WHITE TO VERY LIGHT GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, SHELL-10%
PHOSPHATIC SAND-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL CONTENT RANGES FROM 5% TO 15%. AREAS AF MODERATE INDURATION NEAR 132 FEET AND 134 FEET MAY BE ARTIFACTS OF DRILLING. PHOSPHATIC SAND CONTENT RANGES FROM A TRACE TO 3%.

136 - 137 SAND; GRAYISH ORANGE PINK TO DARK YELLOWISH ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: IRON STAIN-0T%, PHOSPHATIC SAND-0T%
SHELL-05%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS

137 - 141 NO SAMPLES

141 - 146.5 SAND; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-03%, SHELL-05%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL FRAGMENT CONTENT VARIABLE - RANGES FROM 1% TO 5%.
COLOR VARIABLE. POOR RECOVERY.

146.5- 154 NO SAMPLES

154 - 166 SAND; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. INTERVAL HAS AN ORANGISH RIND. AT APPROX.
161.4 FEET A WHITEISH NONCALCAREOUS MATERIAL IS PRESENT.

166 - 171 SAND; WHITE TO LIGHT GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-45%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. INTERVAL RANGES FROM A FOSSILIFEROUS SAND TO
A SHELL BED. INDURATION MAY BE AN ARTIFACT OF DRILLING.

171 - 180 SANDSTONE; GRAYISH ORANGE TO LIGHT BLUISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN SIZE: FINE; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: CALCILUTITE-05%, PHOSPHATIC SAND-0T%
SHELL-05%
OTHER FEATURES: DOLOMITIC, MEDIUM RECRYSTALLIZATION
FOSSILIFEROUS
FOSSILS: CORAL, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. INTERVAL RANGES FROM A DOLOMITIC SANDSTONE TO A SANDY DOLOSTONE. SOME PATCHES OF CALCITE CEMENTED SAND. SOME VUGS AND CORALS ARE HIGHLY RECRYSTALLIZED DOLOMITE. SOME SHELL FRAGMENTS COATED WITH PYRITE. MOLD CONTENT VARIABLE.

180 - 182 DOLOSTONE; PINKISH GRAY TO LIGHT BLUISH GRAY
POROSITY: MOLDIC, LOW PERMEABILITY; 50-90% ALTERED
ANHEDRAL
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-0T%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS
SOME VUGS INFILLED WITH SAND AND CALCAREOUS FRAGMENTS.

182 - 185 SANDSTONE; PINKISH GRAY TO LIGHT BLUISH GRAY
POROSITY: MOLDIC, INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: CALCILUTITE-05%, PHOSPHATIC SAND-0T%
SHELL-05%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
INTERVAL HIGHLY VARIABLE. RANGES FROM A DOLOMITIC SANDSTONE TO A SANDY DOLOSTONE. SOME MOLDS INFILLED WITH SANDY CALCILUTITE. SHELL PRESERVATION INCREASES DOWN INTERVAL. POOR RECOVERY.

185 - 187 LIMESTONE; GRAYISH ORANGE PINK TO GRAYISH ORANGE
POROSITY: MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%, SHELL-05%
OTHER FEATURES: DOLOMITIC, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. ANGULAR CHUNKS IN INTERVAL RANGING FROM SEVERAL MM. TO SEVERAL CM. IN DIAMETER CONSIST OF SANDY DOLOSTONE.

187 - 187.5 CALCILUTITE; GRAYISH ORANGE PINK TO DARK BROWN
POROSITY: INTERGRANULAR
GRAIN TYPE: BIOGENIC
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-20%, SHELL-15%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
THIS INTERVAL PROBABLY AN ARTIFACT OF DRILLING.

187.5- 196 LIMESTONE; GRAYISH ORANGE PINK TO DARK BROWN
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
60% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-20%, SHELL-30%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: CORAL, MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. CORALS ABUNDANT. SOME AREAS MAY BE DOLOMITIC. SHELLS WELL PRESERVED.

196 TOTAL DEPTH

1.3 FAKAHATCHEE STRAND RANGER STATION

LITHOLOGIC WELL LOG PRINTOUT SOURCE - FGS

WELL NUMBER: W-17393 COUNTY - COLLIER

TOTAL DEPTH: 161 FT. LOCATION: T.52S R.29E S.12

SAMPLES - NONE LAT = 25D 57M 06S

LON = 81D 21M 39S

COMPLETION DATE: N/A ELEVATION: 5 FT

OTHER TYPES OF LOGS AVAILABLE - FLUID CONDUCTIVITY, INDUCTION, GAMMA

OWNER/DRILLER:USGS DRILLED BY FGS (JIM TRINDELL)

WORKED BY:GUY H. MEANS

FAKAHATCHEE RANGER STATION CORE

PALEONTOLOGICAL DATA NEEDED TO FACILITATE UNDERSTANDING OF LITHOLOGIC UNITS. ALL FORMATIONAL PICKS TENTATIVE PER TOM SCOTT. NOTE THAT UNDER ACCESSORY MINERALS OT REPRESENTS A TRACE.

0.0	**4.0**	**FILL MATERIAL**
4.0	**61.5**	**OCHOPEE MEMBER LIMESTONE (TAMIAMI FORMATION)**
61.5	**99.0**	**TAMIAMI SAND (INFORMAL) (TAMIAMI FORMATION)**
99.0	**161.0**	**UNNAMED SAND AND CARBONATE**

0 - 1.5 SAND; LIGHT GRAY TO PINKISH GRAY

POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: CALCILUTITE-05%, LIMESTONE-20%
PLANT REMAINS-03%, SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
lIMESTONE CHUNKS INCREASE IN NUMBER DOWN INTERVAL. PROBABLY FILL.

1.5- 3 SAND; GRAYISH ORANGE PINK TO GRAYISH BROWN

POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: PLANT REMAINS-01%, ORGANICS-05%
PROBABLY FILL MATERIAL.

3 - 3.5 SAND; BLACK

POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX
ACCESSORY MINERALS: LIMESTONE-03%, PLANT REMAINS-03%
ORGANICS-05%
PROBABLY FILL MATERIAL.

3.5- 4 SAND; GRAYISH ORANGE PINK TO GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: LIMESTONE-10%, CLAY-0T%
PROBABLY FILL MATERIAL. SAND NEAR LIMESTONE CHUNKS CEMENTED WITH CALCITE. ENOUGH CLAY TO LOOSELY CONSOLIDATE SOME SAND.

4 - 4.5 LIMESTONE; VERY LIGHT ORANGE TO LIGHT GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PLANT REMAINS-0T%
PHOSPHATIC SAND-0T%, ORGANICS-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
INTERVAL VERY RUBBLY. SOME AREAS MOSTLY CEMENTED SAND RANGING TO A SANDY LIMESTONE. POOR RECOVERY. POSSIBLY FILL MATERIAL.

4.5- 6 LIMESTONE; VERY LIGHT ORANGE TO DARK YELLOWISH ORANGE
POROSITY: INTERGRANULAR
GRAIN TYPE: BIOGENIC, CRYSTALS
40% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-40%, IRON STAIN-01%
CRUMBLY WITH SWIRLY APPEARENCE. AREAS OF IRON STAINED CALCILUTITE MIXED INTO AREAS OF WHITE CALCILUTITE. POSSIBLY FILL MATERIAL.

6 - 8.5 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY.

8.5- 9 LIMESTONE; WHITE
POROSITY: INTERGRANULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-10%, PHOSPHATIC SAND-0T%
OTHER FEATURES: CHALKY, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. SHELL FRAGMENTS IN CALCILUTITE MATRIX MAY BE AN ARTIFACT OF DRILLING.

9 - 13.7 LIMESTONE; YELLOWISH GRAY TO WHITE
POROSITY: MOLDIC, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
15% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO VERY COARSE
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-01%, PHOSPHATIC SAND-0T%
HEAVY MINERALS-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, CHALKY
FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY.

13.7- 14 LIMESTONE; WHITE
POROSITY: INTERGRANULAR
GRAIN TYPE: BIOGENIC, CRYSTALS
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO VERY COARSE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-05%
OTHER FEATURES: CHALKY, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. RECRYSTALIZED SHELL FRAGMENTS IN CALCILUTITE PASTE PROBABLY AN ARTIFACT OF DRILLING.

14 - 18.5 LIMESTONE; GRAYISH ORANGE PINK
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELTAL CAST
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO VERY COARSE
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, WORM TRACES, FOSSIL FRAGMENTS
FOSSIL MOLDS
POOR RECOVERY. RUBBLY OVER LOWER PART OF INTERVAL.

18.5- 19 LIMESTONE; WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO VERY COARSE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-03%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS, HIGH RECRYSTALLIZATION
CHALKY
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. RECRYSTALLIZED FOSSIL FRAGMENTS IN
CALCILUTITE PASTE PROBABLY AN ARTIFACT OF DRILLING.

19 - 20.1 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO VERY COARSE
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. VERY RUBBLY.

20.1- 21.5 LIMESTONE; WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO VERY COARSE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-05%, HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: CHALKY, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. RECRYSTALLIZED SHELL FRAGMENTS IN A
CALCILUTITE PASTE PROBABLY AN ARTIFACT OF DRILLING.

21.5- 23.5 LIMESTONE; YELLOWISH GRAY TO WHITE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-01%, PHOSPHATIC SAND-01%
SHELL-05%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, MOLLUSKS, WORM TRACES
FOSSIL FRAGMENTS
SOME CASTS AND MOLDS HAVE A YELLOWISH COATING. MOST SHELLS
DISSOLVED OUT.

23.5- 25.9 LIMESTONE; WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL, SKELTAL CAST
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-0T%
SHELL-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, WORM TRACES, FOSSIL FRAGMENTS
FOSSIL MOLDS

25.9- 29 LIMESTONE; WHITE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-0T%
SHELL-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS

29 - 34.5 LIMESTONE; WHITE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-0T%
SHELL-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
RUBBLE ZONE BETWEEN 29 FEET AND 31 FEET. SAND CONTENT
RANGES FROM 1% TO 5%.

34.5- 37 LIMESTONE; WHITE TO LIGHT BROWNISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL, SKELTAL CAST
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-01%
SHELL-40%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
RUBBLE WITH WELL PRESERVED OYSTER SHELLS. SAND CONTENT
RANGES FROM 5% TO 10%. POOR RECOVERY.

37 - 47 LIMESTONE; WHITE TO LIGHT BROWNISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL, SKELTAL CAST
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-01%
HEAVY MINERALS-0T%, SHELL-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, CRUSTACEA
MOLLUSKS, FOSSIL MOLDS
RUBBLE. POOR RECOVERY. FOSSIL CRAB CLAW AT APPROX. 41 FEET.

47 - 48.5 NO SAMPLES
DRILLERS LOG STATES THAT INTERVAL WAS AN UNCONSOLIDATED
ZONE THUS THERE WAS NO RECOVERY.

48.5- 53 LIMESTONE; WHITE TO LIGHT BROWNISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-0T%
HEAVY MINERALS-0T%, SHELL-01%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, CORAL, ECHINOID, MOLLUSKS, FOSSIL MOLDS
POOR RECOVERY. SAND CONTENT RANGES FROM 40% TO 50%. VERY
DENSE.

53 - 55 LIMESTONE; WHITE TO LIGHT BROWNISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-40%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
MOST SHELLS ARE DISSOLVED OUT.

55 - 57 LIMESTONE; WHITE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-40%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
MOLLUSK MOLDS ARE GENERALLY LARGER IN SIZE THAN PREVIOUS
INTERVALS. LAST 2 - 3 INCHES OF INTERVAL DRILLING ARTIFACT.

57 - 57.3 LIMESTONE; WHITE TO LIGHT GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
75% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-01%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
SAND CONTENT RANGES FROM 40% TO 50%. ROCK IN THIS INTERVAL
IS GENERALLY MORE DENSE THAN ABOVE INTERVALS. MOSTLY
RUBBLE.

57.3- 61.3 LIMESTONE; WHITE TO LIGHT BROWNISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-40%
PHOSPHATIC SAND-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
VERY RUBBLY. SOME SAND GRAINS APPEAR FROSTED. INDURATION
VARIES FROM MODERATE TO GOOD.

61.3- 61.5 LIMESTONE; VERY LIGHT GRAY TO PINKISH GRAY
POROSITY: LOW PERMEABILITY, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
60% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
VERY DENSE. SAND CONTENT RANGES FROM 40% TO 50%.

61.5- 64.5 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: LIMESTONE-03%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FROSTED, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SAND RECOVERED FROM APPROX. 63 FEET POSSIBLY AN ARTIFACT OF
DRILLING. POOR RECOVERY.

64.5- 67 NO SAMPLES

67 - 71 LIMESTONE; LIGHT BROWN TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
95% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%, PHOSPHATIC SAND-0T%
SHELL-55%
OTHER FEATURES: LOW RECRYSTALLIZATION, MUDDY
FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
DESCRIPTION BASED ON SMALL BAGGED SAMPLE. VERY POOR
RECOVERY.

71 - 76 SAND; GRAYISH ORANGE PINK TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: LIMESTONE-05%, PHOSPHATIC SAND-0T%
SHELL-03%
OTHER FEATURES: FOSSILIFEROUS, MEDIUM RECRYSTALLIZATION
FOSSILS: FOSSIL FRAGMENTS
POOR RECOVERY. SOME SHELL MATERIAL COATED WITH PYRITE
CRYSTALS. INTERVAL LIGHTENS IN COLOR DOWNWARDS.

76 - 79 SHELL BED; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-45%, QUARTZ SAND-40%
OTHER FEATURES: FOSSILIFEROUS, MEDIUM RECRYSTALLIZATION
FOSSILS: FOSSIL FRAGMENTS
SHELLS WELL PRESERVED. SHELL CONTENT MAY EXCEED 50% IN SOME
PARTS OF THE INTERVAL. SAND MODE IS FINE.

79 - 87 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. SHELL CONTENT RANGES FROM 1% TO 5%. SHELL
CONCENTRATION NEAR 87 FEET MAY BE AN ARTIFACT OF DRILLING.

87 - 88 NO SAMPLES

88 - 93.5 SAND; VERY LIGHT GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-01%
PHOSPHATIC SAND-01%, SHELL-20%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL CONTENT VARIABLE. CALCAREOUS RIND OVER SOME PARTS OF
INTERVAL. COMPACT PLUG AT 96.5 FEET IS AN ARTIFACT OF
DRILLING.

93.5- 99 SHELL BED; LIGHT GRAYISH BROWN TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-01%
QUARTZ SAND-45%, PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS, BROWN ANHYDRITE CRYSTALS
MEDIUM RECRYSTALLIZATION, VARVED
SAND CONTENT MAY EXCEED 50% IN SOME PARTS OF INTERVAL.
SHELL FRAGMENTS WELL PRESERVED. CALCAREOUS PLUGS AT 96.5
FEET AND 99 FEET PROBABLY AN ARTIFACT OF DRILLING. SHELL
CONTENT APPEARS TO INCREASE WITH DEPTH. SAND MODE IS FINE.
COLOR VARIABLE.

99 - 101 SHELL BED; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
UNCONSOLIDATED
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
PYRITE-0T%
OTHER FEATURES: FOSSILIFEROUS, MEDIUM RECRYSTALLIZATION
UNWASHED SAMPLE, VARVED
VERY POOR RECOVERY. ONE SMALL BAG OF WASHED SHELL MATERIAL.
SOME SHELL FRAGMENTS COATED WITH PYRITE. ONE HALF OF A
SHARK TOOTH.

101 - 106.5 NO SAMPLES

106.5- 111 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY.

111 - 121 SAND; WHITE TO VERY LIGHT GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, SHELL-03%
FELDSPAR-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL FRAGMENTS CONCENTRATED AT THE BASE OF INTERVAL MAY BE
AN ARTIFACT OF DRILLING. POOR RECOVERY.

121 - 123 NO SAMPLES

123 - 126 SMALL BAG WITH WASHED SHELL MATERIAL.CONTENTS INCLUDE
MOLLUSK SHELL FRAGMENTS,PHOSPHATE GRAINS,QUARTZ SAND &
ROUNDED FELDSPAR GRAIN.

126 - 130 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL FRAGMENTS APPEAR MUCH SMALLER THAN IN PREVIOUS
INTERVALS. POOR RECOVERY.

130 - 134 SAND; VERY LIGHT GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
SEDIMENTARY STRUCTURES: BIOTURBATED, STYLOLITIC
BIOTURBATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-05%, FELDSPAR-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. MUDDY PLUG NEAR 134 FEET IS A DRILLING
ARTIFACT.

134 - 134.2 SANDSTONE; WHITE TO VERY LIGHT GRAY
POROSITY: VUGULAR, LOW PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%
DESCRIPTION BASED ON ONE ROCK CLAST. CLAST VARIES FROM A
SANDY LIMESTONE TO A CALCAREOUS SANDSTONE.

134.2- 136.5 SAND; GRAYISH ORANGE PINK TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, SHELL-01%
SILT-SIZE DOLOMITE-01%
OTHER FEATURES: FOSSILIFEROUS, MEDIUM RECRYSTALLIZATION
VARVED
POOR RECOVERY. INTERVAL HIGHLY VARIABLE WITH AREAS OF DOLOSILT & AREAS OF CLEANER SAND. A CHALKY RIND OVER SOME PARTS OF INTERVAL MAY BE AN ARTIFACT OF DRILLING. SAND SIZE VARIABLE .

136.5- 137.2 SAND; GRAYISH ORANGE PINK TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-01%
PHOSPHATIC SAND-0T%, SILT-SIZE DOLOMITE-10%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. INTERVAL INCLUDES A LARGE SANDY LIMESTONE CLAST AS WELL AS LARGE ROUNDED QUARTZ PEBBLES. NEAR 137.25 FEET INTERVAL CONTAINS WHAT MAY BE A LARGE WEATHERED MOLLUSK SHELL.

137.2- 138.7 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-0T%, SILT-SIZE DOLOMITE-10%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, SHARKS TEETH, FOSSIL FRAGMENTS
POOR RECOVERY. INTERVAL CONTAINS PEBBLE SIZE QUARTZ CLASTS AS WELL AS PEBBLE SIZE PHOSPHATE GRAINS. ONE SMALL SHARK TOOTH.

138.7- 149 DOLOSTONE; MODERATE LIGHT GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY; 50-90% ALTERED; ANHEDRAL
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%, PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SAND CONTENT RANGES FROM 20% TO 40%. INDURATION RANGES FROM MODERATE TO GOOD. MODERATELY INDURATED INTERVAL CEMENTED BY DOLOSILT.

149 - 154 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%, SHELL-05%
SILT-SIZE DOLOMITE-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. POSSIBLY A TRACE OF DOLOSILT.

154 - 156.5 NO SAMPLES

156.5- 161 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%, SHELL-10%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
INTERVAL GRADUALLY INCREASES IN SHELL CONTENT FROM 5% TO 40% DOWNWARD. COULD BE AN ARTIFACT OF DRILLING. CALCAREOUS RIND THROUGHOUT INTERVAL.

161 TOTAL DEPTH

1.4 FAKAHATCHEE STRAND GATE 12 CORE

LITHOLOGIC WELL LOG PRINTOUT — SOURCE - FGS

WELL NUMBER: W-17389 — COUNTY - COLLIER

TOTAL DEPTH: 227 FT. — LOCATION: T.51S R.29E S.21

SAMPLES - NONE — LAT = 26D 00M 26S

LON = 81D 24M 44S

COMPLETION DATE: N/A — ELEVATION: 9 FT

OTHER TYPES OF LOGS AVAILABLE - FLUID CONDUCTIVITY, GAMMA, INDUCTION

OWNER/DRILLER:USGS CORE DRILLED BY FGS (JIM TRINDELL)

WORKED BY:GUY H. MEANS

FAKAHATCHEE GATE 12 CORE

PALEONTOLOGICAL DATA NEEDED TO FACILITATE UNDERSTANDING OF LITHOLOGIC UNITS. ALL FORMATIONAL PICKS ARE TENTATIVE PER TOM SCOTT. OT UNDER ACCESSORY MINERALS REPRESENTS A TRACE.

0.0 - 6.0	FILL
6.0 - 40.0	**OCHOPEE MEMBER (?) (TAMIAMI FORMATION)**
40.0 - 90.0	**TAMIAMI SAND (INFORMAL) (TAMIAMI FORMATION)**
90.0 - 227.0	**UNNAMED SAND AND CARBONATE**

0 - 2.3 LIMESTONE; WHITE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, SKELTAL CAST
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRANULE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-01%
PLANT REMAINS-0t%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: CORAL, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
VERY RUBBLY. FILL MATERIAL.

2.3- 4 SAND; PINKISH GRAY TO DARK BROWN
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: LIMESTONE-40%, SILT-05%, ORGANICS-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
POOR RECOVERY. COLOR HIGHLY VARIABLE. LIMESTONE CONTENT VARIABLE. FILL MATERIAL.

4 - 6 SAND; LIGHT BROWN TO LIGHT BROWN
POROSITY: INTERGRANULAR, LOW PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-10%, IRON STAIN-0T%
LIMESTONE-01%
POOR RECOVERY. GRAYISH RIND OVER INTERVAL. LIMESTONE CLASTS
CONCENTRATED NEAR 4 FEET. FILL MATERIAL.

6 - 8.5 LIMESTONE; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, SKELTAL CAST
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-01%, PHOSPHATIC SAND-0T%
PLANT REMAINS-01%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
INTERVAL VERY RUBBLY.

8.5- 10.3 LIMESTONE; WHITE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. DESCRIPTION BASED ON TWO CLASTS.

10.3- 14 LIMESTONE; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-03%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, BARNACLES
MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. RUBBLY. SAND CONTENT RANGES FROM 1% TO 5%.

14 - 19 LIMESTONE; VERY LIGHT GRAY TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-03%
PHOSPHATIC SAND-0T%, PLANT REMAINS-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, BARNACLES
MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. INTERVAL BETWEEN 14 AND 14.3 FEET CONTAINS
LARGE ROOT FRAGMENTS. INTERVAL MOSTLY RUBBLE.

19 - 21 NO SAMPLES

21 - 23 LIMESTONE; GRAYISH ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-10%
PHOSPHATIC SAND-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BENTHIC FORAMINIFERA, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
POOR RECOVERY. CHALKY PASTE BETWEEN 22 AND 23 FEET IS AN
ARTIFACT OF DRILLING.

23 - 31 LIMESTONE; LIGHT GRAY TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-10%
PHOSPHATIC SAND-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. SAND CONTENT VARIABLE BUT DOES NOT EXCEED
10%. CHALKY PASTE BETWEEN 27.3 AND 31 FEET IS AN ARTIFACT
OF DRILLING.

31 - 35.5 LIMESTONE; GRAYISH ORANGE PINK TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%, PHOSPHATIC SAND-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. CHALKY PASTE BETWEEN 32.8 AND 33 FEET IS AN ARTIFACT OF DRILLING.SAND CONTENT INCREASES WITH DEPTH. RECRYSTALLIZATION INCREASES WITH DEPTH.

35.5- 40 LIMESTONE; GRAYISH ORANGE PINK TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-40%
PHOSPHATIC SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. SANDY, CHALKY PASTE BETWEEN 36.25 AND 37 FEET IS AN ARTIFACT OF DRILLING. ROCK IS VERY DENSE. MOSTLY RUBBLE. SAND CONTENT VARIABLE AND MAY REACH 50% IN SOME AREAS.

40 - 41.8 SAND; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, IRON STAIN-0T%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
40 TO 40.3 FEET CONTAINS UP TO 30% SHELL MATERIAL AND EXHIBITS MODERATE INDURATION. POSSIBLY AN ARTIFACT OF DRILLING.

41.8- 70 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, ORGANIC MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%, SHELL-40%
ORGANICS-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL CONTENT VARIABLE THROUGHOUT INTERVAL RANGING FROM 30% TO 50%. SHELLS WELL PRESERVED.

70 - 72 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0t%
PHOSPHATIC SAND-01%, SHELL-25%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
TRACE OF OXIDATION STAIN AT APPROX. 72 FEET.

72 - 76 SHELL BED; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY; UNCONSOLIDATED
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
WASHED SAMPLE. POOR RECOVERY.

76 - 77 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%, SHELL-10%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
INTERVAL INCREASES IN CARBONATE CONTENT DOWNWARD. THIS MAY BE AN ARTIFACT OF DRILLING.

77 - 77.5 NO SAMPLES

77.5- 78.6 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: FELDSPAR-0T%, PHOSPHATIC SAND-0T%
SHELL-20%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SAMPLE STILL MOIST. FELDSPAR GRAINS ARE DARK IN COLOR AND ARE ROUNDED.

78.6- 79.5 SAND; VERY LIGHT ORANGE TO GRAYISH ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, IRON STAIN-0T%
PHOSPHATIC SAND-01%, SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SAMPLE INTERVAL STILL MOIST. ORANGISH RIND OVER INTERVAL.

79.5- 86 NO SAMPLES

86 - 90 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-40%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
SHELLS WELL PRESERVED. PELECYPOD VALVES ABUNDANT. SHELL CONCENTRATION DECREASES DOWNWARD.

90 - 94 NO SAMPLES

94 - 97.2 SAND; GRAYISH ORANGE PINK TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: FELDSPAR-0T%, HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-10%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. SAMPLE STILL MOIST. ORANGISH RIND.

97.2- 101 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
BROWN TO BROWNISH ORANGE RIND OVER INTERVAL. AT 98.3 FEET
CLAYEY TEXTURE MAY BE A RESULT OF DRILLING. INTERVAL
VARIABLE IN COLOR & INDURATION.

101 - 103.5 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SOME PARTS OF THIS INTERVAL EXHIBIT AN ORANGISH COLOR.
MICACEOUS MATERIAL MAY BE SHELL FRAGMENT OR MICA.

103.5- 104.5 NO SAMPLES

104.5- 110 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. POSSIBLY A TRACE OF CLAY AND, OR ORGANICS AT APPROX. 109.5 FEET.

110 - 118 SAND; VERY LIGHT GRAY TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-30%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. INTERVAL BETWEEN 110 & 115 FEET WAS DROPPED AND IS NOT IN STRATIGRAPHIG ORDER. SHELL CONTENT RANGES FROM 10% TO 30%. WHITE CALCAREOUS RIND OVER INTERVAL.

118 - 125 SAND; GRAYISH ORANGE PINK TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-30%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. FOSSIL CONTENT INCREASES SLIGHTLY DOWNWARD. SHELLS WELL PRESERVED. CHALKY PLUG AT 125 FEET IS AN ARTIFACT OF DRILLING.

125 - 125.5 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-03%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS

125.5- 126.3 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-40%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SEVERAL CHUNKS OF GRAYISH, SANDY LIMESTONE IN THIS INTERVAL.

126.3- 130 SILT-SIZE DOLOMITE; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, QUARTZ SAND-45%
PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. INTERVAL RANGES FROM A DOLOMITIC SAND TO A SANDY DOLOSILT. GRAVEL SIZED CLASTS OF WELL INDURATED DOLOSTONE IN THIS INTERVAL.

130 - 131.8 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%, SHELL-30%, SILT-SIZE DOLOMITE-01%
OTHER FEATURES: DOLOMITIC, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SOME INDURATED DOLOMITIC CLASTS IN INTERVAL. SOME CHUNKS OF THIS DOLOMITE ARE ROUNDED.

131.8- 134.7 SAND; VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-0T%
OTHER FEATURES: DOLOMITIC, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
DOLOMITIC CEMENT CONTENT INCREASES DOWN INTERVAL.

134.7- 136.6 SAND; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0t%
PHOSPHATIC SAND-0t%, SHELL-35%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL CONCENTRATION RANGES FROM 20% TO 40%.SHELLS WELL PRESERVED. SHELL CONCENTRATION DECREASES DOWN INTERVAL. COLOR DARKENS DOWN INTERVAL.

136.6- 140 SAND; LIGHT BROWN TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, ORGANIC MATRIX
ACCESSORY MINERALS: SHELL-01%, ORGANICS-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. COLOR MAY BE A RESULT OF CLAY OR ORGANICS.

140 - 146 NO SAMPLES

146 - 151 SAND; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX, CLAY MATRIX
ACCESSORY MINERALS: SHELL-0T%, ORGANICS-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. CEMENT MAY BE CLAY OR ORGANICS OR BOTH.

151 - 151.1 SAND; BLACK
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX
ACCESSORY MINERALS: ORGANICS-01%
DARK BROWNISH CEMENT DOES NOT REACT TO HYDROGEN PEROXIDE - MAY NOT BE ORGANIC.

151.1- 152 SAND; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX

152 - 160 SAND; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
WHITEISH COMPACTED ZONE AROUND 160 FEET IS A DRILLING ARTIFACT.

160 - 174 SAND; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
POOR RECOVERY. WHITEISH RIND. INDURATION DECREASES FROM 173 TO 174 FEET.

174 - 177 NO SAMPLES

177 - 178 SAND; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, LIMESTONE-0T%
INTERVAL CONTAINS SEVERAL CLASTS OF SANDY LIMESTONE.

178 - 180 SAND; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, SHELL-0T%
LIGHT COLORED RIND OVER INTERVAL.

180 - 186.7 SAND; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. SHELL CONTENT INCREASES DOWN INTERVAL.

186.7- 187 SAND; LIGHT BROWN TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: CLAY-01%

187 - 192 SAND; VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-0T%
POOR RECOVERY. SAND COARSENS DOWN INTERVAL.

192 - 192.5 SAND; VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0t%
PHOSPHATIC SAND-0t%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
COLOR DARKENS DOWNWARD.

192.5- 192.9 SAND; VERY LIGHT ORANGE TO VERY LIGHT GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, SHELL-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
LARGER GRAVEL CLASTS ARE DISCOIDAL IN SHAPE.

192.9- 194 SAND; LIGHT GRAYISH RED TO GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
LAST 5 INCHES OF THIS INTERVAL PROBABLY AN ARTIFACT OF DRILLING.

194 - 197.5 SAND; GRAYISH ORANGE PINK TO GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: LIMESTONE-0T%, PHOSPHATIC SAND-0T%
COLOR VARIABLE. LARGER PEBBLES INCREASE IN CONCENTRATION DOWN INTERVAL.

197.5- 200 SAND; GRAYISH BROWN RED TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
SEDIMENTARY STRUCTURES: MOTTLED
LAST 5 INCHES OF THIS INTERVAL PROBABLY AN ARTIFACT OF DRILLING. COLOR HIGHLY VARIABLE. INTERVAL STILL MOIST.

200 - 204 SAND; GRAYISH ORANGE PINK TO LIGHT BROWNISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: FELDSPAR-0T%, MICA-0T%, CLAY-02%
COLOR HIGHLY VARIABLE. GRAVEL CONCENTRATION DECREASES DOWN INTERVAL. LAST 6 INCHES OF INTERVAL PROBABLY AN ARTIFACT OF DRILLING. INTERVAL STILL MOIST.

204 - 206.5 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: FELDSPAR-0T%, PHOSPHATIC SAND-0T%
COLOR VARIABLE. LAST 4 INCHES OF INTERVAL PROBABLY AN ARTIFACT OF DRILLING. INTERVAL STILL MOIST.

206.5- 207 SAND; VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%

207 - 210.5 SAND; GRAYISH ORANGE PINK TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: FELDSPAR-0T%, HEAVY MINERALS-0T%
MICA-0T%, SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
GRAVEL IS DISCOIDAL IN SHAPE. LAST 6 INCHES OF INTERVAL
PROBABLY AN ARTIFACT OF DRILLING. POOR RECOVERY.

210.5- 212.3 SAND; LIGHT GRAYISH BROWN TO DARK YELLOWISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: FELDSPAR-0T%, PHOSPHATIC SAND-0T%
SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS

212.3- 212.5 SAND; LIGHT GRAYISH BROWN TO DARK YELLOWISH BROWN
POROSITY: INTERGRANULAR, LOW PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: ORGANICS-0T%
OTHER FEATURES: CALCAREOUS
INTERVAL CONTAINS SOME BROWNISH CALCAREOUS CLAY.

212.5- 213 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%, SHELL-05%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SAND SIZE INCREASES DOWN INTERVAL.

213 - 218 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: FELDSPAR-0T%, PHOSPHATIC SAND-0T%
SHELL-25%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
SHELL FRAGMENTS ARE ROUNDED.

218 - 218.4 CLAY; LIGHT BROWNISH GRAY TO BROWNISH GRAY
POROSITY: LOW PERMEABILITY; GOOD INDURATION
CEMENT TYPE(S): CLAY MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: MICA-0T%, QUARTZ SAND-20%
INTERVAL VERY RUBBLY WITH ZONES OF PURE CLAY & ZONES OF
VERY SANDY CLAY.

218.4- 227 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: FELDSPAR-0T%, HEAVY MINERALS-0T%
SHELL-30%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. FINE GRAINED SANDY MATRIX WITH GRAVEL SIZE
QUARTZ & SHELL CLASTS.SHELL FRAGMENTS AR ROUNDED.

227 TOTAL DEPTH

1.5 FAKAHATCHEE STRAND JONES GRADE CORE

LITHOLOGIC WELL LOG PRINTOUT SOURCE - FGS

WELL NUMBER: W-17394 COUNTY - COLLIER
TOTAL DEPTH: 200 FT. LOCATION: T.50S R.30E S.06
SAMPLES - NONE LAT = 26D 08M 36S
LON = 81D 21M 04S
COMPLETION DATE: N/A ELEVATION: 13 FT
OTHER TYPES OF LOGS AVAILABLE - GAMMA, INDUCTION, FLUID CONDUCTIVITY

OWNER/DRILLER:USGS CORE DRILLED BY FGS (JIM TRINDELL)

WORKED BY:GUY H. MEANS
JONES GRADE CORE
PALEONTOLOGICAL DATA NEEDED TO FACILITATE UNDERSTANDING OF LITHOLOGIC UNITS. ALL FORMATIONAL PICKS TENTATIVE PER TOM SCOTT. NOTE THAT OT UNDER ACCESSORY MINERALS REPRESENTS A TRACE.

0.0	-	3.0	**FILL**
3.0	-	5.0	**WEATHERED LIMESTONE OR FILL**
5.0	-	46.0	**OCHOPEE MEMBER (?) OR GOLDEN GATE MEMBER (?) (TAMIAMI FORMATION)**
46.0	-	70.9	**OCHOPEE MEMBER LIMESTONE (TAMIAMI LIMESTONE)**
70.9	-	200.0	**UNNAMED SAND AND CARBONATE**

0 - 3 CALCILUTITE; LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC
GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO FINE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-10%, LIMESTONE-0t%
ORGANICS-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS
FILL MATERIAL.

3 - 3.6 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, VUGULAR
GRAIN TYPE: BIOGENIC, CRYSTALS
50% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%
SOME PARTS OF INTERVAL EXHIBIT MEDIUM RECRYSTALLIZATION AND AN ORANGISH COLOR.

3.6- 5 CALCILUTITE; VERY LIGHT ORANGE TO GRAYISH ORANGE
POROSITY: INTERGRANULAR
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-30%
SAND CONTENT VARIABLE.

5 - 10 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
60% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
VERY POOR RECOVERY. INTERVAL HIGHLY VARIABLE. MOSTLY RUBBLE. SAND CONTENT VARIES. SOME AREAS HIGHLY RECRYSTALLIZED.

10 - 12 LIMESTONE; GRAYISH ORANGE PINK TO VERY LIGHT GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, WORM TRACES, FOSSIL FRAGMENTS
FOSSIL MOLDS

12 - 14.3 LIMESTONE; VERY LIGHT ORANGE TO GRAYISH ORANGE
POROSITY: PIN POINT VUGS
GRAIN TYPE: BIOGENIC, SKELETAL
40% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
VERY POOR RECOVERY. MOSTLY RUBBLE. COLOR VARIABLE.

14.3- 16.5 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS
POOR RECOVERY. MOSTLY RUBBLE.

16.5- 18.5 LIMESTONE; GRAYISH ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. RUBBLE.

18.5- 23.1 LIMESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY.

23.1- 25 LIMESTONE; GRAYISH ORANGE PINK TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL MOLDS
INTERVAL MORE DENSE THAN PREVIOUS INTERVALS. MOLDS INFILLED
WITH SAND.

25 - 29 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
75% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-01%, PHOSPHATIC SAND-0T%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
VERY POOR RECOVERY. SAND CONTENT VARIABLE.

29 - 37.5 LIMESTONE; VERY LIGHT ORANGE TO GRAYISH ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
SEDIMENTARY STRUCTURES: STREAKED, STYLOLITIC, BIOTURBATED
ACCESSORY MINERALS: QUARTZ SAND-40%, PHOSPHATIC SAND-01%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
SAND CONTENT INCREASES DOWN INTERVAL. LESS MOLDIC THAN PREVIOUS INTERVAL.

37.5- 38 LIMESTONE; GRAYISH ORANGE PINK TO DARK YELLOWISH ORANGE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%, PHOSPHATIC SAND-01%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
HIGHLY RECRYSTALLIZED.

38 - 43 LIMESTONE; VERY LIGHT ORANGE TO GRAYISH ORANGE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%, PHOSPHATIC SAND-01%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
MOSTLY RUBBLE. VERY POOR RECOVERY.

43 - 46 NO SAMPLES

46 - 50.5 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-01%
HEAVY MINERALS-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
POOR RECOVERY. MOSTLY RUBBLE. SAND CONTENT INCREASES DOWN INTERVAL.

50.5- 51.3 CALCILUTITE; WHITE TO VERY LIGHT GRAY
POROSITY: INTERGRANULAR
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-50%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS
INTERVAL IS AN ARTIFACT OF DRILLING.

51.3- 56 LIMESTONE; YELLOWISH GRAY TO PINKISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-50%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL MOLDS
INTERVAL RANGES FROM A SANDY LIMESTONE TO A CALCAREOUS SANDSTONE. INDURATION RANGES FROM MODERATE TO GOOD.

56 - 56.3 LIMESTONE; VERY LIGHT ORANGE TO GRAYISH ORANGE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
INTERVAL RUBBLY.

56.3- 61 LIMESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, MOLDIC
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-50%, PHOSPHATIC SAND-01%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
INTERVAL RANGES FROM A SANDY LIMESTONE TO A CALCAREOUS SANDSTONE. VERY RUBBLY. SOME CHUNKS EXHIBIT GOOD INDURATION.

61 - 70.9 LIMESTONE; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-01%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
INTERVAL RANGES FROM A SANDY LIMESTONE TO A CALCAREOUS SANDSTONE. VERY RUBBLY. INDURATION RANGES FROM MODERATE TO GOOD. LAST 1 FOOT OF INTERVAL IS PROBABLY AN ARTIFACT OF DRILLING.

70.9- 72 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-01%
POOR RECOVERY. ORANGISH STAIN AT BOTTOM OF INTERVAL - POSSIBLY CLAY.

72 - 74.3 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-01%
INTERVAL CONTAINS GRAVEL SIZE CLASTS OF QUARTZ AND LIMESTONE. INTERVAL STILL MOIST.

74.3- 76 SAND; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-01%
POOR RECOVERY. ORANGISH RIND OVER SOME PARTS OF INTERVAL.

76 - 80 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%
POOR RECOVERY. CARBONATE MATRIX NEAR 80 FEET MAY BE AN
ARTIFACT OF DRILLING.

80 - 89.1 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-0T%
INTERVAL STILL MOIST. INDURATION MAY BE A FACTOR OF
MOISTURE OR CLAY CONTENT. COLOR VARIATION MAY BE INFLUENCED
BY MOISTURE AS WELL.

89.1- 90 SAND; WHITE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: CALCAREOUS
INTERVAL COMPACTION IS AN ARTIFACT OF DRILLING. POOR
RECOVERY. COLOR LIGHTENS DOWN INTERVAL.

90 - 100 NO SAMPLES

100 - 107.6 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-01%
POOR RECOVERY. INTERVAL STILL MOIST.

107.6- 108.7 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, FOSSIL FRAGMENTS

108.7- 110 SAND; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO VERY COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, FOSSIL FRAGMENTS
LAST 5 INCHES OF INTERVAL IS AN ARTIFACT OF DRILLING.
INTERVAL SAND COARSENS DOWNWARD.

110 - 116.8 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
I% POROSITY: POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS
POOR RECOVERY.

116.8- 119 SAND; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO COARSE
MEDIUM SPHERICITY; UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
SAND COARSENS DOWN INTERVAL.

119 - 120 SAND; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
MEDIUM SPHERICITY; UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, FOSSIL FRAGMENTS
SAND COARSENS DOWN INTERVAL. GRAVEL SIZE CLASTS DISCOIDAL IN SHAPE.

120 - 129.5 SAND; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO COARSE
MEDIUM SPHERICITY; UNCONSOLIDATED
ACCESSORY MINERALS: FELDSPAR-0T%, LIMESTONE-0T%
VERY POOR RECOVERY.

129.5- 130 SAND; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%
LAST 3 INCHES OF INTERVAL PROBABLY AN ARTIFACT OF DRILLING.

130 - 139.1 SAND; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: COARSE TO GRAVEL
MEDIUM SPHERICITY; UNCONSOLIDATED
ACCESSORY MINERALS: FELDSPAR-0T%, LIMESTONE-0T%, SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
VERY POOR RECOVERY. DISCOIDAL SHAPED GRAVEL IN INTERVAL. THIS INTERVAL WAS PROBABLY WASHED.

139.1- 140 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%, ORGANICS-0T%
MATRIX MATERIAL INCREASES IN AMOUNT DOWN INTERVAL.

140 - 143.1 SAND; GRAYISH ORANGE PINK TO GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%
POOR RECOVERY. CEMENT APPEARS TO BE DOLOSILT.

143.1- 144.9 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL MOLDS
INDURATION INCREASES DOWN INTERVAL. FAINT MOLLUSK MOLDS THROUGHOUT INTERVAL. SOME AREAS MAY GRADE INTO A SANDY DOLOSTONE.

144.9- 145.2 DOLOSTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, LOW PERMEABILITY, MOLDIC
50-90% ALTERED; ANHEDRAL
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL MOLDS
SAND CONTENT VARIABLE - INTERVAL RANGES FROM A SANDY DOLOSTONE TO A DOLOMITIC SANDSTONE. WHITEISH, CHALKY RIND OVER INTERVAL.

145.2- 145.5 SILT-SIZE DOLOMITE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, LOW PERMEABILITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-0T%

145.5- 150 SAND; LIGHT GRAYISH BROWN TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, ORGANIC MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%
COLOR VARIABLE. GRAVES SIZE CLASTS EMBEDDED IN RIND POSSIBLY FROM ABOVE INTERVALS. BOTTOM 5 INCHES OF INTERVAL CONTAIN SOME DOLOSILT. ARTIFICIAL COMPACTION OF LOWER 5 INCHES OF INTERVAL IS AN ARTIFACT OF DRILLING. POOR RECOVERY.

150 - 159.5 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, FOSSIL FRAGMENTS
POOR RECOVERY. LARGER QUARTZ PEBBLES ARE DISCOIDALLY SHAPED.

159.5- 160 SAND; LIGHT GRAYISH BROWN TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR, LOW PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: LIMESTONE-0T%, PHOSPHATIC SAND-0T%

160 - 166 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO VERY COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, LIMESTONE-0T%
PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, FOSSIL FRAGMENTS
POOR RECOVERY.

166 - 166.3 SAND; LIGHT GRAYISH BROWN TO VERY LIGHT ORANGE
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX, ORGANIC MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-0T%
COMPACTION IS PROBABLY AN ARTIFACT OF DRILLING. A TRACE OF CARBONATE IN INTERVAL.

166.3- 167.5 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: FELDSPAR-0t%, LIMESTONE-0t%
PHOSPHATIC SAND-0t%

167.5- 168.5 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-0t%, LIMESTONE-0t%
PHOSPHATIC SAND-0t%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, FOSSIL FRAGMENTS
GRAVEL SIZE CLASTS WELL ROUNDED.

168.5- 170 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: FELDSPAR-0T%, HEAVY MINERALS-0T%
LIMESTONE-0T%, PHOSPHATIC SAND-0T%

170 - 175.9 SAND; LIGHT OLIVE GRAY TO LIGHT OLIVE GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, ORGANIC MATRIX
ACCESSORY MINERALS: LIMESTONE-0T%, PHOSPHATIC SAND-0T%
COLOR DARKENS DOWN INTERVAL. WHITEISH RIND OVER INTERVAL.
ROUNDED , GRAVEL SIZE QUARTZ CLASTS APPEAR SPORADICALLY
THROUGHOUT INTERVAL.

175.9- 177.6 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: HEAVY MINERALS-0T%
PHOSPHATIC SAND-0T%
COMPACTION IN THIS INTERVAL MAY BE AN ARTIFACT OF DRILLING.
POSSIBLY A TRACE OF ORGANICS IN THIS INTERVAL. DOLOMITIC
CEMENT CONTENT DECREASES DOWN INTERVAL.

177.6- 180 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, MICA-0T%
PHOSPHATIC SAND-0T%, SILT-SIZE DOLOMITE-0T%
LAST 4 INCHES OF INTERVAL COMPACTED BY DRILLING PROCESS.
COLOR LIGHTENS DOWN INTERVAL.

180 - 184.4 SAND; GRAYISH BROWN TO LIGHT BROWNISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, MICA-0T%
PHOSPHATIC SAND-0T%
COLOR VARIABLE.

184.4- 189.7 SAND; GRAYISH BROWN TO LIGHT BROWNISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINF; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, MICA-0T%
PHOSPHATIC SAND-0T%, DOLOMITE-0T%
AT APPROX. 187 FEET, SEVERAL SANDY DOLOSTONE CHUNKS. COLOR VARIABLE. OVERALL CLAY CONTENT HIGHER THAN PREVIOUS INTERVAL.

189.7- 190 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX

190 - 198.3 SAND; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO GRAVEL
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: HEAVY MINERALS-0T%, DOLOMITE-0T%
PHOSPHATIC SAND-0T%, SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY.

198.3- 200 SAND; VERY LIGHT ORANGE TO WHITE
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
MODERATE INDURATION
CEMENT TYPE(S): CLAY MATRIX
LAST 4 INCHES OF INTERVAL COMPACTED BY DRILLING PROCESS.
CLAY CONTENT INCREASES DOWN INTERVAL.

200 TOTAL DEPTH

1.6 PICAYUNE STRAND CORE

```
LITHOLOGIC WELL LOG PRINTOUT                SOURCE - FGS

WELL NUMBER:  W-17450                       COUNTY - COLLIER
TOTAL DEPTH:     201  FT.                   LOCATION: T.50S R.27E S. 1
SAMPLES - NONE                                        LAT = 26D 08M 36S
                                                      LON = 81D 33M 43S
COMPLETION DATE: N/A                        ELEVATION: 13 FT
OTHER TYPES OF LOGS AVAILABLE - FLUID CONDUCTIVITY, GAMMA, INDUCTION

OWNER/DRILLER:USGS DRILLED BY FGS (JIM TRINDELL)

WORKED BY:GUY H. MEANS & TOM SCOTT
PICAYUNE STRAND CORE
PALEONTOLOGICAL DATA NEEDED TO FACILITATE UNDERSTANDING OF LITHOLOGIC
UNITS. ALL FORMATIONAL PICKS TENTATIVE PER TOM SCOTT. NOTE THAT OT
UNDER ACCESSORY MINERALS REPRESENTS A TRACE.
```

0.0	-	5.2	**UNDIFFERENTIATED SAND AND FILL**
5.2	-	13.0	**CALOOSAHATCHEE FAUNAL UNIT (?)**
13.0	-	106.0	**OCHOPEE MEMBER LIMESTONE (TAMIAMI FORMATION)**
106.0	-	201.0	**UNNAMED SAND AND CARBONATE**

```
  0 -    .6 SAND; LIGHT GRAYISH BROWN TO GRAYISH BROWN
            POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
            GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
            ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
            POOR INDURATION
            CEMENT TYPE(S): CLAY MATRIX, ORGANIC MATRIX
            ACCESSORY MINERALS: PLANT REMAINS-01%, CLAY-0T%
            ORGANICS-0T%, PHOSPHATIC SAND-0T%
            ROOTS DIMINISH DOWN INTERVAL.

  .6-   2.3 SAND; LIGHT BROWN TO DARK YELLOWISH ORANGE
            POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
            GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
            ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
            MODERATE INDURATION
            CEMENT TYPE(S): CLAY MATRIX
            ACCESSORY MINERALS: CLAY-03%, PLANT REMAINS-0T%
            IRON STAIN-0T%
            COLOR VARIABLE.

 2.3-   4   SAND; LIGHT GRAYISH BROWN TO GRAYISH BROWN
            POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
            GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
            ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
            MODERATE INDURATION
            CEMENT TYPE(S): CLAY MATRIX, ORGANIC MATRIX
            ACCESSORY MINERALS: CLAY-03%, LIMESTONE-0T%
            PLANT REMAINS-01%, ORGANICS-01%
            OTHER FEATURES: FOSSILIFEROUS
            FOSSILS: FOSSIL FRAGMENTS
            COLOR DARKENS DOWN INTERVAL.
```

4 - 5.2 SAND; GRAYISH ORANGE PINK TO LIGHT GRAYISH BROWN
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: CLAY-0T%, LIMESTONE-05%
PLANT REMAINS-40%, ORGANICS-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
LARGE 1 FOOT LONG ROOT MASS IN INTERVAL. INTERVAL GRADES INTO A CARBONATE RICH SAND.

5.2- 6 LIMESTONE; WHITE TO VERY LIGHT GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRANULE
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%, PLANT REMAINS-01%
ORGANICS-0T%
OTHER FEATURES: WEATHERED, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
INDURATION VARIES FROM MODERATE TO GOOD.

6 - 10 LIMESTONE; GRAYISH ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, VUGULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRANULE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%, PLANT REMAINS-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. RUBBLE THAT DECREASES IN SIZE DOWN INTERVAL.

10 - 13 LIMESTONE; GRAYISH BROWN TO LIGHT OLIVE GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, VUGULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-0T%
OTHER FEATURES: HIGH RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, ECHINOID
POOR RECOVERY. VUGS INFILLED WITH SANDY CARBONATE MATERIAL.

13 - 18 NO SAMPLES
DRILLER'S LOG STATES THAT A SOFT ZONE WAS HIT THUS NO RECOVERY.

18 - 23 LIMESTONE; GRAYISH BROWN TO LIGHT OLIVE GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, VUGULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
VERY POOR RECOVERY. INTERVAL RANGES FROM A LIMESTONE TO A SANDY LIMESTONE.

23 - 25 LIMESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-01%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
DRILLER STATES THAT THIS INTERVAL IS REPRESENTATIVE OF AREAS BETWEEN 13 FEET AND 25 FEET WHERE NO SAMPLE WAS RECOVERED. SHELLS WELL PRESERVED. SAND CONTENT VARIABLE.

25 - 27 LIMESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: VERY FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
PLANT REMAINS-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
INDURATION DECREASES DOWN INTERVAL.

27 - 28.7 CALCILUTITE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, LOW PERMEABILITY
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
SHELL-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
INTERVAL CONTAINS VERY FEW SHELLS OR FRAGMENTS.

28.7- 29.5 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR
GRAIN TYPE: BIOGENIC, SKELETAL
75% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
INDURATION INCREASES DOWN INTERVAL.

29.5- 32.4 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL, CRYSTALS
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-01%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, CORAL, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
RUBBLY.

32.4- 34.4 LIMESTONE; VERY LIGHT ORANGE TO PINKISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-01%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
INDURATION RANGES FROM MODERATE TO GOOD. COLOR DARKENS DOWN INTERVAL.

34.4- 39 LIMESTONE; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
60% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: FINE TO COARSE
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS
LAST 4 INCHES OF INTERVAL COMPACTED BY DRILLING PROCESS.

39 - 45 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0t%, PHOSPHATIC SAND-0t%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: BRYOZOA, ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
INDURATION INCREASES DOWN INTERVAL. VERY RUBBLY.

45 - 49 LIMESTONE; VERY LIGHT ORANGE TO WHITE
POROSITY: INTRAGRANULAR, INTERGRANULAR
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: FINE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
INTERVAL CONSISTS MOSTLY OF PEBBLE SIZE RUBBLE. 46.9 TO 47 FEET COMPACTED BY DRILLING PROCESS. COLOR VARIABLE.

49 - 51.5 LIMESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, SKELETAL
80% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: ECHINOID, MOLLUSKS, FOSSIL FRAGMENTS
FOSSIL MOLDS
VERY RUBBLY.SOME PARTS OF INTERVAL GROUND TO SAND SIZE - POSSIBLY AN ARTIFACT OF DRILLING. INDURATION RANGES FROM MODERATE TO GOOD. COLOR LIGHTENS DOWN INTERVAL.

51.5- 56.5 LIMESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
HEAVY MINERALS-0T%
OTHER FEATURES: LOW RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
LAST 8 INCHES OF INTERVAL GROUND TO PASTE BY DRILLING PROCESS.

56.5- 64 LIMESTONE; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: INTRAGRANULAR, INTERGRANULAR, MOLDIC
GRAIN TYPE: BIOGENIC, CRYSTALS, SKELETAL
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MEDIUM; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION, FOSSILIFEROUS
FOSSILS: BRYOZOA, BENTHIC FORAMINIFERA, MOLLUSKS
FOSSIL FRAGMENTS, FOSSIL MOLDS
60.6 TO 61.0 FEET AND 63.3 TO 64 FEET GROUND TO A PASTE BY DRILLING PROCESS. RUBBLY. POOR RECOVERY.

64 - 73 LIMESTONE; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: MOLDIC, INTERGRANULAR
GRAIN TYPE: BIOGENIC, SKELETAL
95% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: MEDIUM TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-02%, PHOSPHATIC SAND-01%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL MOLDS, MOLLUSKS, FOSSIL FRAGMENTS
BENTHIC FORAMINIFERA
RUBBLY. DRILLING PASTE BETWEEN 72.8 TO 73 FEET. WELL INDURATED PIECES.

73 - 81 LIMESTONE; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: MOLDIC, INTERGRANULAR
GRAIN TYPE: BIOGENIC, SKELETAL
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%, PHOSPHATIC SAND-01%
OTHER FEATURES: MEDIUM RECRYSTALLIZATION
FOSSILS: FOSSIL MOLDS, MOLLUSKS, FOSSIL FRAGMENTS
BENTHIC FORAMINIFERA, ECHINOID
SAND COARSENS DOWN INTERVAL. POOR RECOVERY.

81 - 91 SAND; YELLOWISH GRAY
POROSITY: MOLDIC, INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-02%, LIMESTONE-35%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL MOLDS, MOLLUSKS, BENTHIC FORAMINIFERA
FOSSIL FRAGMENTS
MOLLUSCAN MOLDIC SANDSTONE. THIN ZONES OF VERY SANDY LIMESTONE. WELL PRESERVED CRAB CLAW IN INTERVAL.

91 - 106 SAND; YELLOWISH GRAY
POROSITY: MOLDIC, INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-02%, LIMESTONE-35%
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL MOLDS, FOSSIL FRAGMENTS, MOLLUSKS
BENTHIC FORAMINIFERA
VERY POOR RECOVERY. ONLY HARD ZONES RECOVERED. 1 TO 2 FEET
RECOVERED OF 15 FEET. SOFT SEDIMENT WASHED OUT.

106 - 108 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; UNCONSOLIDATED
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, BENTHIC FORAMINIFERA

108 - 114 SAND; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
FOSSILS: FOSSIL FRAGMENTS, MOLLUSKS, BENTHIC FORAMINIFERA
VERY POOR CONSOLIDATION WITH UNCONSOLIDATED ZONES. LAST ONE
FOOT OF INTERVAL PUSHED BY DRILLER. ARTIFICIALLY COMPACTED.

114 - 119 SAND; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, CALCILUTITE-0T%
FOSSILS: FOSSIL FRAGMENTS, MOLLUSKS, BENTHIC FORAMINIFERA
ABUNDANT MOLLUSK FRAGMENTS - SOME ARE VERY LEACHED.

119 - 121 NO SAMPLES

121 - 126 SAND; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; UNCONSOLIDATED
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
FEW MOLLUSK FRAGMENTS. COMPACTED ZONE LAST .5 FEET.

126 - 140 SAND; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; UNCONSOLIDATED
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
FOSSILS: FOSSIL FRAGMENTS, MOLLUSKS
SCATTERED LEACHED MOLLUSK FRAGMENTS. COMPACTED ZONE AT 135.5 FEET

140 - 145.8 SAND; YELLOWISH GRAY TO LIGHT OLIVE GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: MEDIUM TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; UNCONSOLIDATED
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
COMPACTED ZONES AT 140.8 AND 145.8 FEET.

145.8- 151.5 SAND; YELLOWISH GRAY TO VERY LIGHT GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: MEDIUM TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, CLAY-0T%
CALCILUTITE-0T%
FOSSILS: FOSSIL FRAGMENTS, MOLLUSKS
LEACHED LARGER SHELL FRAGMENTS AND WHOLE SHELL.

151.5- 154 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%
FOSSILS: FOSSIL FRAGMENTS, MOLLUSKS
CONSOLIDATION RANGES FROM POOR TO UNCONSOLIDATED.

154 - 161 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, MICA-01%
SHELL FRAGMENTS APPEAR TO BE CAVINGS. FIRST MICA OCCURANCE.
FEW COMPACTED ZONES.

161 - 163 DOLOSTONE; YELLOWISH GRAY
POROSITY: INTERGRANULAR, MOLDIC; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-40%, PHOSPHATIC SAND-01%
MICA-01%
VERY POOR RECOVERY. GRADES INTO A SAND BELOW.

163 - 165.5 SAND; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CLAY MATRIX
ACCESSORY MINERALS: DOLOMITE-0T%, PHOSPHATIC SAND-01%
CLAY-01%, MICA-01%
BLACKENED (PHOSPHATIC ?) DOLOSTONE PIECES AT BASE.

165.5- 181.2 DOLOSTONE; YELLOWISH GRAY TO LIGHT GRAY
POROSITY: INTERCRYSTALLINE, MOLDIC; 50-90% ALTERED
SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, BENTHIC FORAMINIFERA
BRYOZOA
DOLOMITIZED COQUINA OF MOLLUSK FRAGMENTS. INDURATION
VARIES. VERY FRIABLE ZONES. ZONES OF POOR RECOVERY.

181.2- 185.5 DOLOSTONE; YELLOWISH GRAY
POROSITY: INTERCRYSTALLINE, MOLDIC, LOW PERMEABILITY
50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: CRYPTOCRYSTALLINE; GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
SEDIMENTARY STRUCTURES: MOTTLED
ACCESSORY MINERALS: QUARTZ SAND-01%
BECOMES CLAYEY WITH DEPTH.

185.5- 188.8 DOLOSTONE; LIGHT GREENISH GRAY TO YELLOWISH GRAY
POROSITY: INTERCRYSTALLINE, LOW PERMEABILITY
50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: CRYPTOCRYSTALLINE; MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CLAY MATRIX
ACCESSORY MINERALS: QUARTZ SAND-10%, PHOSPHATIC SAND-01%
CLAY-0T%
VARIABLE CLAY CONTENT, SAND IS VERY FINE AT 186 FEET THEN
INCREASES IN ABUNDANCE AND SIZE.

188.8- 201 DOLOSTONE; VERY LIGHT GRAY TO YELLOWISH GRAY
POROSITY: INTERCRYSTALLINE, LOW PERMEABILITY
50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: CRYPTOCRYSTALLINE; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CLAY MATRIX
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-01%
CLAY-0T%, MICA-01%
SAND VARIES TO DOLOMITE CEMENTED SAND. SAND VARIES IN SIZE
FROM FINE TO COARSE AND GRAVEL.

201 TOTAL DEPTH

1.7 SOUTHERN STATES UTILITIES CORE

LITHOLOGIC WELL LOG PRINTOUT — SOURCE - FGS

WELL NUMBER: W-17454 — COUNTY - COLLIER
TOTAL DEPTH: 210 FT. — LOCATION: T.50S R.26E S.34
SAMPLES - NONE — LAT = 26D 04M 04S
LON = 81D 41M 43S
COMPLETION DATE: N/A — ELEVATION: 7 FT
OTHER TYPES OF LOGS AVAILABLE - NEUTRON

OWNER/DRILLER:USGS CORE DRILLED BY FGS (JIM TRINDELL)

WORKED BY:TOM SCOTT
SOUTHERN STATES UTILITIES CORE
PALEONTOLOGICAL DATA NEEDED TO FACILITATE UNDERSTANDING OF LITHOLOGIC UNITS. ALL FORMATIONAL PICKS TENTATIVE PER TOM SCOTT. NOTE THAT OT UNDER ACCESSORY MINERALS REPRESENTS A TRACE.

0.0 - 7.0	SOIL AND FILL
7.0 - 9.5	CALOOSAHATCHEE FAUNAL UNIT (?)
9.5 - 121.5	OCHOPEE MEMBER LIMESTONE (TAMIAMI FORMATION)
121.5 - 210.0	UNNAMED SAND AND CARBONATE

0 - 7 PUSHED CORE - APPEARS TO BE FILL TO 6 FEET THEN SAND WITH RUBBLE TO 7 FEET.

7 - 8.2 LIMESTONE; YELLOWISH GRAY
POROSITY: MOLDIC, VUGULAR, LOW PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%
FOSSILS: MOLLUSKS, BENTHIC FORAMINIFERA, FOSSIL MOLDS
7 TO 7.3 FEET RUBBLY. SAND VERY FINE. RECRYSTALLIZED GRAINSTONE - PACKSTONE. ABUNDANT CHIONE CANCELLATA.

8.2- 8.7 LIMESTONE; MODERATE DARK GRAY
POROSITY: LOW PERMEABILITY, MOLDIC, VUGULAR
GRAIN TYPE: SKELETAL, BIOGENIC, CALCILUTITE
10% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
SEDIMENTARY STRUCTURES: BIOTURBATED
ACCESSORY MINERALS: QUARTZ SAND-10%
FOSSILS: MOLLUSKS, FOSSIL MOLDS
FRESH WATER LIMESTONE. VERY IRREGULAR BEDDING DUE TO BIOTURBATION .FRESH WATER MOLLUSKS. MATRIX IS ORGANIC RICH.

8.7- 9.5 LIMESTONE; YELLOWISH GRAY
POROSITY: LOW PERMEABILITY, MOLDIC, VUGULAR
GRAIN TYPE: SKELETAL, BIOGENIC
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO GRAVEL
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-10%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, BENTHIC FORAMINIFERA
VOIDS FILLED WITH FRESH WATER LIMESTONE.

9.5- 13 LIMESTONE; YELLOWISH GRAY TO YELLOWISH GRAY
10% POROSITY: MOLDIC, VUGULAR
GRAIN TYPE: SKELETAL, BIOGENIC
GRAIN SIZE: COARSE; RANGE: VERY FINE TO GRAVEL
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-15%, CLAY-02%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, FOSSIL FRAGMENTS
POOR RECOVERY. SOFT WITH HARD LENSES. MOLDS ABUNDANT.
MOLLUSK FRAGMENTS. LOST 10 TO 13 FEET.

13 - 23 LIMESTONE; DARK GRAYISH YELLOW TO YELLOWISH GRAY
POROSITY: LOW PERMEABILITY, MOLDIC
GRAIN TYPE: SKELETAL, BIOGENIC
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-02%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, FOSSIL FRAGMENTS
VERY HARD CAPROCK PIECES RECOVERED BETWEEN 13 AND 23 FEET.
SOFT ZONES LOST EXCEPT BETWEEN 20 AND 21 FEET. SOFT
SLIGHTLY SANDY FOSSILIFEROUS LIMESTONE. FORAMS AND MOLLUSKS
PRESENT.SOME HARD LIMESTONE APPEARS TO BE RECRYSTALLIZED
BURROW FILL.

23 - 34.3 LIMESTONE; YELLOWISH GRAY TO YELLOWISH GRAY
30% POROSITY: INTERGRANULAR
GRAIN TYPE: SKELETAL, BIOGENIC
90% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: FINE TO GRAVEL; POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-03%, PHOSPHATIC SAND-01%
FOSSILS: MOLLUSKS, BENTHIC FORAMINIFERA, FOSSIL MOLDS
FOSSIL FRAGMENTS
HARD ZONES SCATTERED IN SOFT MATRIX. FRAGMENTS OF OYSTERS.
MORE MOLDIC, BETTER INDURATED ZONES AT 27 - 29.3 FEET.
GENERALLY A GRAINSTONE.

34.3- 34.7 NO SAMPLES

34.7- 41 LIMESTONE; YELLOWISH GRAY TO YELLOWISH GRAY
35% POROSITY: MOLDIC, VUGULAR, INTERGRANULAR
GRAIN TYPE: SKELETAL, BIOGENIC
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, BENTHIC FORAMINIFERA
ECHINOID, FOSSIL FRAGMENTS
END OF CORE RUN 37.2 - 38 FEET CALCILUTITE MATRIX IS AN
ARTIFACT OF DRILLING.

41 - 41.7 LIMESTONE; YELLOWISH GRAY
20% POROSITY: MOLDIC, VUGULAR, INTERGRANULAR
GRAIN TYPE: SKELETAL, BIOGENIC
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, BENTHIC FORAMINIFERA
FOSSIL FRAGMENTS
ABUNDANT TURRITELLID MOLDS.

41.7- 50.5 LIMESTONE; YELLOWISH GRAY TO YELLOWISH GRAY
35% POROSITY: MOLDIC, VUGULAR, INTERGRANULAR
GRAIN TYPE: SKELETAL, BIOGENIC
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-05%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL MOLDS, FOSSIL FRAGMENTS, MOLLUSKS
BENTHIC FORAMINIFERA, BRYOZOA
INTERVAL VERY MOLDIC.

50.5- 55.2 LIMESTONE; YELLOWISH GRAY TO LIGHT GRAY
30% POROSITY: MOLDIC, VUGULAR, INTERGRANULAR
GRAIN TYPE: SKELETAL, BIOGENIC
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-25%, PHOSPHATIC SAND-02%
FOSSILS: FOSSIL MOLDS, FOSSIL FRAGMENTS, MOLLUSKS
BENTHIC FORAMINIFERA, BARNACLES
VARIABLE SAND CONTENT RANGING TO 30%. LOTS OF ORIGINAL
SHELL. FEWER MOLDS.

55.2- 80 LIMESTONE; WHITE TO VERY LIGHT GRAY
35% POROSITY: INTERGRANULAR, MOLDIC, VUGULAR
GRAIN TYPE: SKELETAL, BIOGENIC
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-25%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL MOLDS, FOSSIL FRAGMENTS, MOLLUSKS
BENTHIC FORAMINIFERA, BARNACLES
INTERVAL VERY MOLDIC. VARIABLE SAND CONTENT INCREASING
BETWEEN 78 AND 80 FEET, AND GRADES INTO UNDERLYING UNIT.

80 - 82 LIMESTONE; VERY LIGHT GRAY TO YELLOWISH GRAY
35% POROSITY: INTERGRANULAR, MOLDIC, VUGULAR
GRAIN TYPE: SKELETAL, BIOGENIC
MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT, CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-35%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL FRAGMENTS, FOSSIL MOLDS, MOLLUSKS
BENTHIC FORAMINIFERA

82 - 90 LIMESTONE; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN TYPE: SKELETAL, BIOGENIC
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: QUARTZ SAND-45%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL FRAGMENTS, PLANKTONIC FORAMINIFERA
BENTHIC FORAMINIFERA, SPICULES
CALCAREOUS SAND WITH QUARTZ SAND. VERY MICROFOSSILIFEROUS. POOR RECOVERY. QUARTZ SAND IS VERY FINE GRAINED AND GRADES INTO UNDERLYING SAND.

90 - 121.5 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO FINE
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: LIMESTONE-40%, PHOSPHATIC SAND-02%
FOSSILS: FOSSIL FRAGMENTS, BENTHIC FORAMINIFERA
PLANKTONIC FORAMINIFERA, SPICULES
POOR RECOVERY. VERY MICROFOSSILIFEROUS. GRADES TO A CALCAREOUS SAND AS 90 FOOT INTERVAL. FIRST QUARTZ PEBBLE AROUND 97.5 FEET. COARSER GRAINS INCREASE 118 - 120 FEET.

121.5- 123 DOLOSTONE; LIGHT OLIVE GRAY
POROSITY: MOLDIC, VUGULAR; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%, PHOSPHATIC SAND-01%
FOSSILS: MOLLUSKS, FOSSIL FRAGMENTS, FOSSIL MOLDS
IRREGULAR CONTACT, SAND INCREASES WITH DEPTH. SAND IS FINE GRAINED AT 121.5 AND BECOMES COARSER TOWARD 122.5 TO 123 FEET. GRADES INTO UNDERLYING SAND.

123 - 124 SAND; LIGHT OLIVE GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CLAY MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, CLAY-0T%
GRADES INTO A CLAY.

124 - 126 CLAY; DARK GREENISH GRAY TO DARK GREENISH GRAY
POROSITY: LOW PERMEABILITY; POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, DOLOMITE CEMENT
SEDIMENTARY STRUCTURES: MOTTLED, BIOTURBATED
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
THIN LAYERS OF SAND AND SILT, BURROW FILL.

126 - 127 NO SAMPLES

127 - 127.1 DOLOSTONE; VERY LIGHT GRAY TO LIGHT GRAY
POROSITY: MOLDIC; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-30%, PHOSPHATIC SAND-01%
FOSSILS: FOSSIL MOLDS, MOLLUSKS
THIN DOLOSTONE CAPROCK.

127.1- 129 SAND; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: LOW PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CLAY MATRIX
SEDIMENTARY STRUCTURES: MOTTLED
ACCESSORY MINERALS: DOLOMITE-0T%, CLAY-0T%
PHOSPHATIC SAND-02%
DOLOMITE CLAY SAND MIX GRADES TO CLAYEY DOLOSILT. VERY POOR
RECOVERY.

129 - 129.1 SILT-SIZE DOLOMITE; YELLOWISH GRAY
POROSITY: LOW PERMEABILITY; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CLAY MATRIX
ACCESSORY MINERALS: CLAY-0T%
FILLS BURROWS IN UNDERLYING CLAY.

129.1- 129.6 CLAY; DARK GREENISH GRAY
POROSITY: LOW PERMEABILITY; POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: QUARTZ SAND-0T%, PHOSPHATIC SAND-0T%
DOLOMITE-0T%
FOSSILS: DIATOMS
THIN SILT AND SAND LAMINAE AND BURROW FILL.

129.6- 131.8 SAND; YELLOWISH GRAY TO DARK GREENISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE; POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, DOLOMITE CEMENT
SEDIMENTARY STRUCTURES: MOTTLED
ACCESSORY MINERALS: PHOSPHATIC SAND-25%, CLAY-0T%
DOLOMITE-0T%
FOSSILS: FOSSIL FRAGMENTS
PHOSPHATE MAY BE PRIMARY, NOT REWORKED. VARIABLE CLAY
CONTENT.

131.8- 135 DOLOSTONE; YELLOWISH GRAY
POROSITY: MOLDIC, VUGULAR, INTERGRANULAR; 50-90% ALTERED SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-02%
FOSSILS: FOSSIL MOLDS, MOLLUSKS
DOLOMITIZED COQUINA OF MOLLUSK FRAGMENTS AND CASTS. POOR RECOVERY

135 - 137.5 DOLOSTONE; BLACK TO LIGHT GRAY
POROSITY: MOLDIC; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, PHOSPHATE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-35%, PHOSPHATIC SAND-0T%
FOSSILS: FOSSIL MOLDS, MOLLUSKS, FOSSIL FRAGMENTS
PHOSPHATIZED CAPROCK. VERY POOR RECOVERY. SOFT ZONES WASHED OUT.

137.5- 139 DOLOSTONE; GRAYISH BROWN TO YELLOWISH GRAY
POROSITY: MOLDIC, VUGULAR; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; POOR INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-02%
FOSSILS: CORAL, MOLLUSKS, FOSSIL MOLDS
VERY POOR RECOVERY.

139 - 145 DOLOSTONE; YELLOWISH GRAY
POROSITY: MOLDIC, VUGULAR; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-25%, PHOSPHATIC SAND-01%
FOSSILS: MOLLUSKS, FOSSIL MOLDS
COARSER SAND TO GRAVEL SIZED QUARTZ. MOST SAND IS FINE GRAINED. GRAVEL BECOMES MORE ABUNDANT WITH DEPTH.

145 - 154 DOLOSTONE;
POROSITY: MOLDIC, VUGULAR; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: MICROCRYSTALLINE; MODERATE INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: QUARTZ SAND-35%, PHOSPHATIC SAND-01%
FOSSILS: MOLLUSKS, FOSSIL MOLDS
VERY COARSE SAND AND GRAVEL. DISCOID QUARTZ PEBBLES UP TO 2.5 CM. MOLLUSK MOLDIC ZONES.

154 - 160 NO SAMPLES

160 - 161.5 SAND; YELLOWISH GRAY TO YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, CALCILUTITE-05%
FOSSILS: BENTHIC FORAMINIFERA
VERY POORLY INDURATED TO UNCONSOLIDATED.

161.5- 180 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM; POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX, DOLOMITE CEMENT
SEDIMENTARY STRUCTURES: MOTTLED, BIOTURBATED
ACCESSORY MINERALS: CLAY-0T%, PHOSPHATIC SAND-01%
MICA-01%
SOME ZONES OF MORE COARSE QUARTZ SAND. MICA APPEARS AT APPROX. 167.0 FEET. 167 - 180 BOX DROPPED SO IT IS OUT OF SEQUENCE. POOR RECOVERY.

180 - 185 SAND; LIGHT OLIVE GRAY TO GREENISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
SEDIMENTARY STRUCTURES: BIOTURBATED
ACCESSORY MINERALS: PHOSPHATIC SAND-02%, SILT-0T%
MICA-01%
THIN MORE CLAYEY LAMINAE INTERBEDDED WITH THIN UNCONSOLIDATED TO VERY POORLY CONSOLIDATED FINE SAND AND SILT.

185 - 190 SAND; YELLOWISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE; UNCONSOLIDATED
ACCESSORY MINERALS: PHOSPHATIC SAND-02%, CLAY-0T%
SILT-0T%, MICA-01%
SAME AS 185 BUT WITH LESS CLAY. POOR RECOVERY.

190 - 204 SAND; LIGHT OLIVE GRAY TO GREENISH GRAY
POROSITY: INTERGRANULAR, LOW PERMEABILITY
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01%, SILT-0T%
MICA-01%
MORE CLAY LAMINAE WITH DEPTH.

204 - 206 CLAY; LIGHT OLIVE GRAY TO LIGHT OLIVE
POROSITY: LOW PERMEABILITY, INTERGRANULAR; POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
SEDIMENTARY STRUCTURES: BIOTURBATED, MOTTLED
ACCESSORY MINERALS: QUARTZ SAND-0T%, SILT-0T%, MICA-01%
THIN LAMINAE OF VERY FINE SAND AND SILT.

206 - 210 SAND; LIGHT OLIVE GRAY TO GREENISH GRAY
POROSITY: INTERGRANULAR
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
SEDIMENTARY STRUCTURES: BIOTURBATED, MOTTLED
ACCESSORY MINERALS: CLAY-0T%, SILT-0T%, MICA-01%
COMMENT SAME AS ABOVE. RECOVERY LESS THAN PREVIOUS
INTERVAL.

210 TOTAL DEPTH

APPENDIX 2

SUMMARY OF GEOPHYSICAL LOGS AND COREHOLE CONDITIONS DURING LOGGING

2.1 Collier-Seminole State Park
2.2 Old Pump Road
2.3 Fakahatchee Strand-Ranger Station
2.4 Fakahatchee Strand-Gate 12
2.5 Fakahatchee Strand-Jones Grade
2.6 Picayune Strand
2.7 Southern States Utilities

2.1 COLLIER-SEMINOLE STATE PARK

LOG ID NUMBER	LOG TYPE	TOOL AND CONFIGURATION	DATE	INTERVAL LOGGED	COMMENTS
A. Core down to about 195 ft, drill to 207, and pull stem					
la	CALIPER	3-arm	2/20/96	0-207	Steel casing to 53 ft
1b	GAMMA	Multi-func	2/20/96	0-205	Steel casing to 53 ft
lc	INDUCTION		2/20/96	0-205	Steel casing to 53 ft
ld	NEUTRON	Dual detect	2/20/95	0-200	Steel casing to 53 ft
le	TELEVIEWER		2/20/95	50-195	Steel casing to 53 ft
B. Circulate clean pond water in the hole to clean out mud; steady injection at about 1.7 gpm					
1f	HP FLOWMTR	6" diverter	2/20/95	50-170	Steel casing to 53 ft
C. Let hole settle overnight					
1g	HP FLOWMTR	6" diverter	2/21/96	50-150	Steel casing to 53 ft
1h	FLUID COND	Multi-func	2/21/95	50-150	Steel casing to 53 ft

D. Throw multi-func tool in pond, measure fluid R of 1.92 Ohm-m

E. Pull inner and outer surface casing

2.2 OLD PUMP ROAD

LOG ID NUMBER	LOG	TOOL AND CONFIGURATION	DATE	INTERVAL LOGGED	COMMENTS
A. Core down to about 25 feet; hole unstable					
2a	CALIPER	3-arm	3/9/96	0-20	Steel casing to 15 ft
2b	INDUCTION		3/9/96	0-20	Steel casing to 15 ft
B. Core down to 182 feet; stem down to bottom of hole					
2c	GAMMA	Spectral	3/22/96	0-180	Inside drill stem
2d	GAMMA SPECTRA		3/22/96	171,112	Inside drill stem
2e	NEUTRON	Dual detect	3/22/96	0-182	Inside drill stem
C. Core down to 196 feet; remove drill stem from hole					
2f	CALIPER	3-arm	3/23/96	0-192	BOC (steel) at 37 ft
2g	NORMAL	Multi-func	3/23/96	0-160	BOC (steel) at 37 ft
2h	INDUCTION		3/23/96	0-126	BOC (steel) at 37 ft
D. Clean out hole; leave stem on bottom of hole					
2i	GAMMA	Slim	3/23/96	0-196	Inside drill stem
E. Log in 40-ft sections as pull stem up					
2j	INDUCTION		3/24/96	150-190	Bottom of stem at 156 ft
2k	INDUCTION		3/24/96	100-190	Bottom of stem at 116 ft
2l	CALIPER	3-arm	3/24/96	100-190	Bottom of stem at 116 ft
2m	CALIPER	Repeat	3/24/96	100-190	Tool still drifts badly
F. Remove inner 4-inch steel casing, leaving 16.5 ft 8" PVC to 16.5 ft					
2n	INDUCTION		3/24/96	0-100	PVC to 16.5 ft
2o	GAMMA SPECTRA		3/24/96	22	
G. Circulate out mud and pump about 30 minutes to develop					
2p	FLUID COND	Multi-func	3/24/96	0-60	Log down
2q	FLUID COND	Multi-func	3/24/96	0-60	Log up
2r	HP FLOWMTR	6" diverter	3/24/96	0-23	Static and injection at about 1.4 gpm; lower hole collapsing during logging

2.3 FAKAHATCHEE RANGER STATION

LOG ID NUMBER	LOG	TOOL AND CONFIGURATION	DATE	INTERVAL LOGGED	COMMENTS
A. Core down to 160 feet					
3a	GAMMA	Induction	4/19/96	0-160	Run inside drill pipe
B. Drill string removed and hole left mudded up overnight					
3b	INDUCTION		4/19/96	0-150	Steel casing above 50 ft
C. Hole reamed and 75 feet of casing placed in hole					
3c	INDUCTION		4/20/96	0-70	Slotted pvc casing in hole
D. PVC Screen from 12-72 feet developed with circulation					
3e	FLUID COND	Multi-func	4/20/96	0-70	Immediately after development
3f	HP FLOWMTR	6" diverter	4/20/96	0-70	Static and inject at 1.1 gpm

2.4 FAKAHATCHEE STRAND GATE 12

A. Core down to 227 feet

B. Line well with 230 feet (60 ft of 4" above 170 ft of 3") plastic casing inside of 10 feet of steel surface casing; screen open from 0 to 230 feet.

C. Well developed by surging and circulation; separation of casing at 85 feet and filling of deeper part of hole limits logging.

4a	FLUID COND	Multi-func	6/12/96	0-112	logging down
4b	GAMMA	Multi-func	6/12/96	0-112	Immediately after development
4c	INDUCTION		6-12-96	0-112	Steel casing above 10 feet
4d	HP FLOWMTR	6"diverter	6/12/96	0-95	Static and inject at 1.0 gpm

2.5 FAKAHATCHEE STRAND JONES GRADE

LOG ID NUMBER	LOG	TOOL AND CONFIGURATION	DATE	INTERVAL LOGGED	COMMENTS
A. Core down to 196 feet					
B. Line well to total depth with slotted 3" PVC screen; liner is inside a 4" diameter steel surface casing					
C. Develop well by circulation and surging					
5a	GAMMA	Multi-func	7/25/96	0-194	Logging down
5b	INDUCTION		7/25/96	30-194	Steel casing above 30 ft
5c	HP FLOWMTR		7/25/96	30-185	Static and inject at 3.0 and then at full capacity (40 gpm)
5d	FLUID COND	Multi-func	7/25/96	0-194	During 40 gpm injection
5e	FLUID COND	Multi-func	7/25/96	0-194	45 min after injection stopped
5f	FLUID COND	Multi-func	7/25/96	0-194	90 min after injection stopped
D. Pull steel casing leaving PVC liner in hole					
5g	INDUCTION		7/25/96	0-194	Surface casing removed

2.6 PICAYUNE STRAND

A. Core down to 191 feet

B. Install PVC casing and develop by surging

6a	FLUID COND	Multi-func	9/15/96	0-187	Log down
6b	GAMMA	Multi-func	9/15/96	0-187	Log up
6c	INDUCTION		9/15/96	0-185	Surf casing to 39 ft
6d	NEUTRON	Dual detect	9/15/96	0-185	Surf casing to 39 ft
6e	HP FLOWMTR	Bare tool	9/15/96	10-170	Static & inject 2 gpm
6f	FLUID COND	Multi-func	9/15/96	0-185	Injecting at 20 gpm

2.7 SOUTHERN STATES UTILITIES

LOG ID NUMBER	LOG TYPE	TOOL AND CONFIGURATION	DATE	INTERVAL LOGGED	COMMENTS

A. Core down to 210 feet

B. Leave hole mudded - 4" open hole below 30 feet, 4" ID steel casing about 30 feet

7a	NORMAL RESISTIVITY		9/27/96	30-210
7b	SINGLE POINT RESISTANCE		9/27/96	30-210
7c	NEUTRON GAMMA		9/27/96	0-210

APPENDIX 3

Formation factor analysis

FORMATION FACTOR ANALYSIS

The formation factor, F, is defined as the ratio of formation resistivity (R_t, given by induction log data) to the resistivity of pore water (R_w, given by water sample data when water is recovered from a specific interval). In the study described in this report we have obtained induction logs from most boreholes, but have very few water sample data. However, we do have borehole flow logs which can be analyzed to indicate where water is entering the borehole. The fluid column resistivity log can then be used to give the resistivity of water in the borehole. The flow log analysis allows us to identify the interval where that water is entering the borehole. Therefore, we can compute the formation factor for these specific intervals using the combination of induction and fluid column resistivity logs.

We performed such an analysis for the interval from 140 to 180 feet in depth in the Collier-Seminole borehole where flowmeter logs indicate that water was flowing into the borehole over this interval (Figure 10C). The fluid column resistivity log indicates that for this specific interval $R_w = 0.75$ ohm-meters. However, we cannot simply take a point-by-point set of values of induction log divided by fluid column resistivity as estimates of F for comparison with formation porosity in evaluating the parameters a and m in equation 4. The porosity and induction logs have different sample volumes so that each represents a differently weighted sample of formation properties. There may also be small but significant depth offsets between the two logs. For this reason, we restrict the regression of porosity and formation factor to those intervals where the logs are not varying very much to eliminate the effects of sample volume size and small depth errors. We identify eight points in the interval of interest where these conditions are satisfied (Table A3.1); these data are plotted in Figure A3.1. The result shows the expected inverse correlation between the logarithm of F and the logarithm of porosity. A linear fit of the equation 4 to the data points yield estimates of $a = 1.6$ and $m = 0.274$. This value of m is much smaller than typical values for consolidated sandstone reservoirs published by the petroleum industry. This result indicates that F has a relatively weak dependence on porosity, varying over the range from 2.0 to 3.0 for the most permeable aquifer zones characterized by porosity values from 15 to 40%. Such weak dependence of F on porosity allows us to estimate pore water salinity from values of R_t given by the induction logs using an assumed $F = 3.0$. Note that this serves as a conservative estimate of water quality whenever production of saline water from boreholes is a concern, because this value of F represents the upper limit of average values of F in Figure A3.1. Wherever the true value of F is less than 3.0, the assumption that $F = 3.0$ leads to a slight overestimation of R_w.

TABLE A3.1. Formation factor and porosity values from the 140-180 depth interval in the Collier-Seminole corehole.

DEPTH (ft)	NEUTRON POROSITY (percent)	FORMATION CONDUCTIVITY (µS/cm)	FORMATION RESISTIVITY (ohm-m)	FORMATION FACTOR
143	39	668	1.64	2.19
148	10	491	2.04	2.72
152	22	627	1.59	2.12
158	4	450	2.22	2.96
164	20	518	1.93	2.57
166	30	573	1.75	2.33
171	3	205	4.88	6.51
173	10	409	2.45	3.27

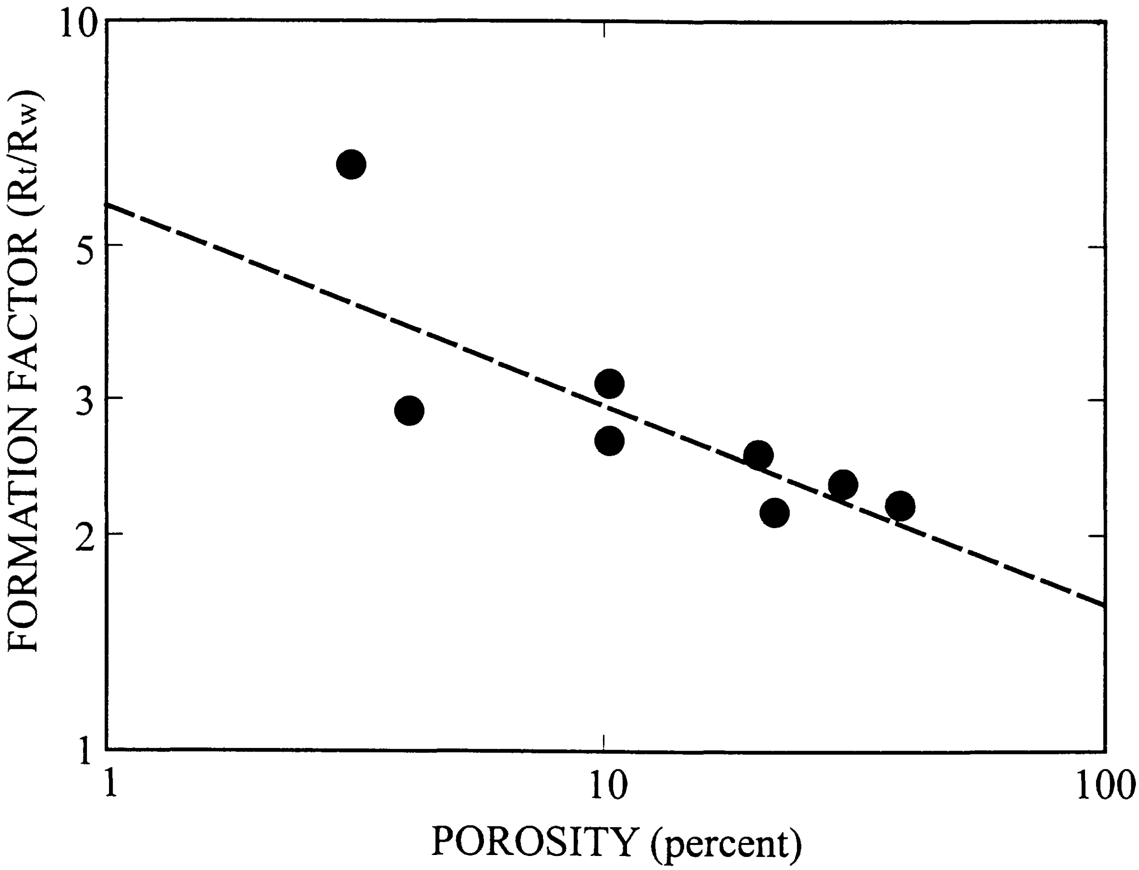

Figure A3.1 Comparison of interval-averaged formation factor and surficial aquifer porosity for two sites in the study area.