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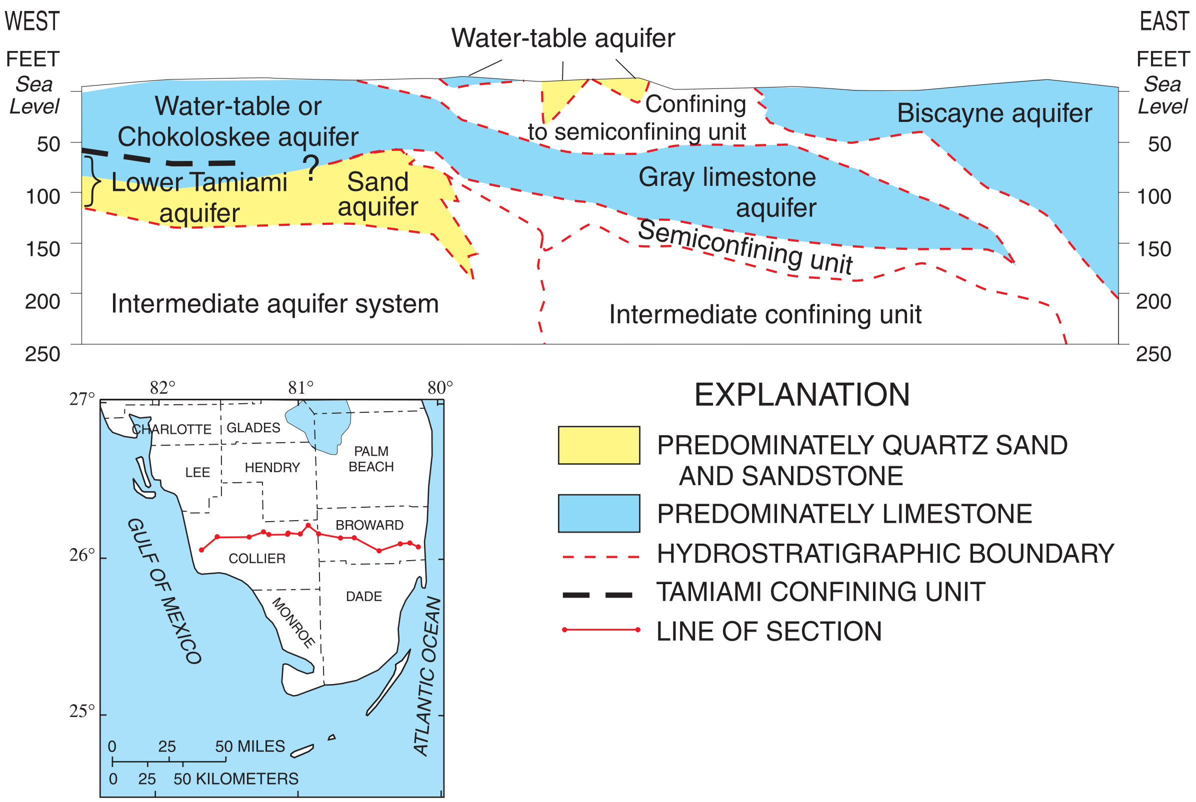
Hydrogeology of the Gray Limestone Aquifer in Southern Florida



U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 99-4213

Prepared in cooperation with the
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Hydrogeology of the Gray Limestone Aquifer in Southern Florida

By RONALD S. REESE and KEVIN J. CUNNINGHAM

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Tallahassee, Florida
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U.S. DEPARTMENT OF THE INTERIOR
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Charles G. Groat, Director

For additional information write to:

District Chief
U.S. Geological Survey
Suite 3015
227 N. Bronough Street
Tallahassee, FL 32301

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Hydrogeology of the Gray Limestone Aquifer in Southern Florida

By Ronald S. Reese *and* Kevin J. Cunningham

Abstract

Results from 35 new test coreholes and aquifer-test, water-level, and water-quality data were combined with existing hydrogeologic data to define the extent, thickness, hydraulic properties, and degree of confinement of the gray limestone aquifer in southern Florida. This aquifer, previously known to be present only in southeastern Florida (Miami-Dade, Broward, and Palm Beach Counties) below, and to the west of, the Biscayne aquifer, extends over most of central-south Florida, including eastern and central Collier County and southern Hendry County; it is the same as the lower Tamiami aquifer to the north, and it becomes the water-table aquifer and the upper limestone part of the lower Tamiami aquifer to the west. The aquifer generally is composed of gray, shelly, lightly to moderately cemented limestone with abundant shell fragments or carbonate sand, abundant skeletal moldic porosity, and minor quartz sand.

The gray limestone aquifer comprises the Ochopee Limestone of the Tamiami Formation, and, in some areas, the uppermost permeable part of an unnamed formation principally composed of quartz sand. Underlying the unnamed formation is the Peace River Formation of the upper Hawthorn Group, the top of which is the base of the surficial aquifer system. Overlying the aquifer and providing confinement in much of the area is the Pinecrest Sand Member of the Tamiami Formation. The thickness of the aquifer is comparatively uniform, generally ranging from 30 to 100 feet. The unnamed formation part of the aquifer is up to 20 feet thick. The Ochopee Limestone accumulated in a carbonate ramp depositional system and contains a heterozoan carbonate-particle association. The principal rock types of the aquifer are pelecypod lime rudstones and floatstones and permeable quartz sands and sandstones. The pore types are mainly intergrain and separate vug (skeletal-moldic) pore spaces. The rock fabric and associated primary and secondary pore spaces combine to form a dual diffuse-carbonate and conduit flow system capable of producing high values of hydraulic conductivity.

Transmissivity values of the aquifer are commonly greater than 50,000 feet squared per day to the west of Miami-Dade and Broward Counties. Hydraulic conductivity ranges from about 200 to 12,000 feet per day and generally increases from east to west; an east-to-west shallowing of the depositional profile of the Ochopee Limestone carbonate ramp contributes to this spatial trend. The aquifer contains two areas of high transmissivity, both of which trend northwest-southeast. One area extends through southern Hendry County. The other area extends through eastern Collier County, with a transmissivity as high as 300,000 feet squared per day; in this area, the aquifer is structurally high, the top of the aquifer is close to land surface, and it is unconfined to semiconfined. The confinement of the aquifer is good to the north and east in parts of southern Hendry, Palm Beach, Collier, Broward, and Miami-Dade Counties. In these areas, the upper confining unit approaches or is greater than 50 feet thick, and vertical leakance is less than 1.0×10^{-3} 1/day.

In most of the study area, the specific conductance in water from the gray limestone aquifer is 1,500 microsiemens per centimeter or less (chloride concentration of about 250 milligrams per liter or less). Areas where specific conductance is greater than 3,000 microsiemens per centimeter are found where there is a low horizontal-head gradient and the upper confining unit is greater than 50 feet thick. An area with specific conductance less than 1,500 microsiemens per centimeter extends from southern Hendry County to the southeast into western Broward County and coincides with an area of high transmissivity. However, much of this area has good confinement. The potentiometric gradient also is to the southeast in much of the area, and this area of low specific conductance is probably caused by a relatively rapid downgradient movement of fresh ground water that has been recharged in Hendry County.

INTRODUCTION

Southern Florida is an area of rapid population growth, and expanding urbanized areas are underlain by the surficial aquifer system. Large ground-water withdrawals from the unconfined Biscayne aquifer of the surficial aquifer system in southeastern Florida could adversely affect sensitive wetlands that lie immediately west of municipal well fields and agricultural lands. These wetland areas include Everglades National Park and several large water-conservation impoundment areas that help to maintain the hydrologic regimes of southern Florida. Because of the competing municipal, agricultural, and natural ecosystem water-supply demands, alternate water supplies need to be identified and developed.

The relations between the wetland ecosystems in central-south Florida and shallow aquifers are poorly understood. A detailed understanding of the hydrogeologic framework of the surficial aquifer system and characterization of the its hydraulic properties could greatly enhance current or planned efforts to simulate the interaction between ground water and surface water. Stratigraphic and hydrogeologic correlation between the eastern and western coastal areas in the surficial aquifer system is needed.

The gray limestone aquifer of the surficial aquifer system could provide an additional water supply. Additionally, definition of the hydrogeologic framework in which it occurs and determination of its extent, depth, and hydraulic properties address the above needs and questions. The U.S. Geological Survey (USGS), in cooperation with the South Florida Water Management District (SFWMD), conducted a hydrogeologic study of the gray limestone aquifer that began in October 1995 and ended in September 1999. This study was completed in collaboration with separate USGS projects, entitled "Hydrogeology of the surficial aquifer system in southwest Florida” and “Hydrogeologic characterization and mapping of two semiconfining units in the surficial aquifer system, southeastern Florida.” The study area includes parts of Miami-Dade, Broward, Palm Beach, Monroe, Collier, and Hendry Counties (fig. 1) and lies within the U.S. Department of the Interior’s South Florida Ecosystem (Place-Based) Program study area (McPherson and others, 1995).

The gray limestone aquifer was first identified in western Broward County (Fish, 1988); subsequent drilling traced the gray limestone aquifer into western Miami-Dade County (Fish and Stewart, 1991). The aquifer was described as “composed of gray (in places, greenish-gray or tan) limestone of the lower part and locally the middle part of the Tamiami Formation” and “usually is shelly with abundant shell fragments or carbonate sand and minor quartz sand, and it is lightly to moderately cemented” (Fish, 1988). In Broward and Miami-Dade Counties, the gray limestone aquifer underlies and extends west of the Biscayne aquifer (fig. 2). It was unknown at that time if the aquifer extended westward into Monroe, Collier, and Hendry Counties, or if it was equivalent to the lower Tamiami aquifer in Hendry County (Smith and Adams, 1988) and western Collier County (Knapp and others, 1986). A shallow aquifer, referred to as the shallow aquifer of southwestern Florida, was mapped in Collier County (Klein, 1972; Klein and others, 1975); however, a map and cross section showing the extent of this aquifer indicated that it is not present in a central area near the border between Collier County and Broward and Miami-Dade Counties. In this area, only local discontinuous water-bearing material of low yield was mapped.

Most of the data for the gray limestone aquifer were collected as part of studies with a broader focus, such as those by Fish (1988) and Fish and Stewart (1991), and most hydrogeologic studies of the surficial aquifer system have been restricted to coastal areas, such as the one by Knapp and others (1986). One notable exception was a local study in central Miami-Dade County of the gray limestone aquifer, in which it was referred to as the Everglades aquifer (Labowski and others, U.S. Geological Survey, written commun., 1988).

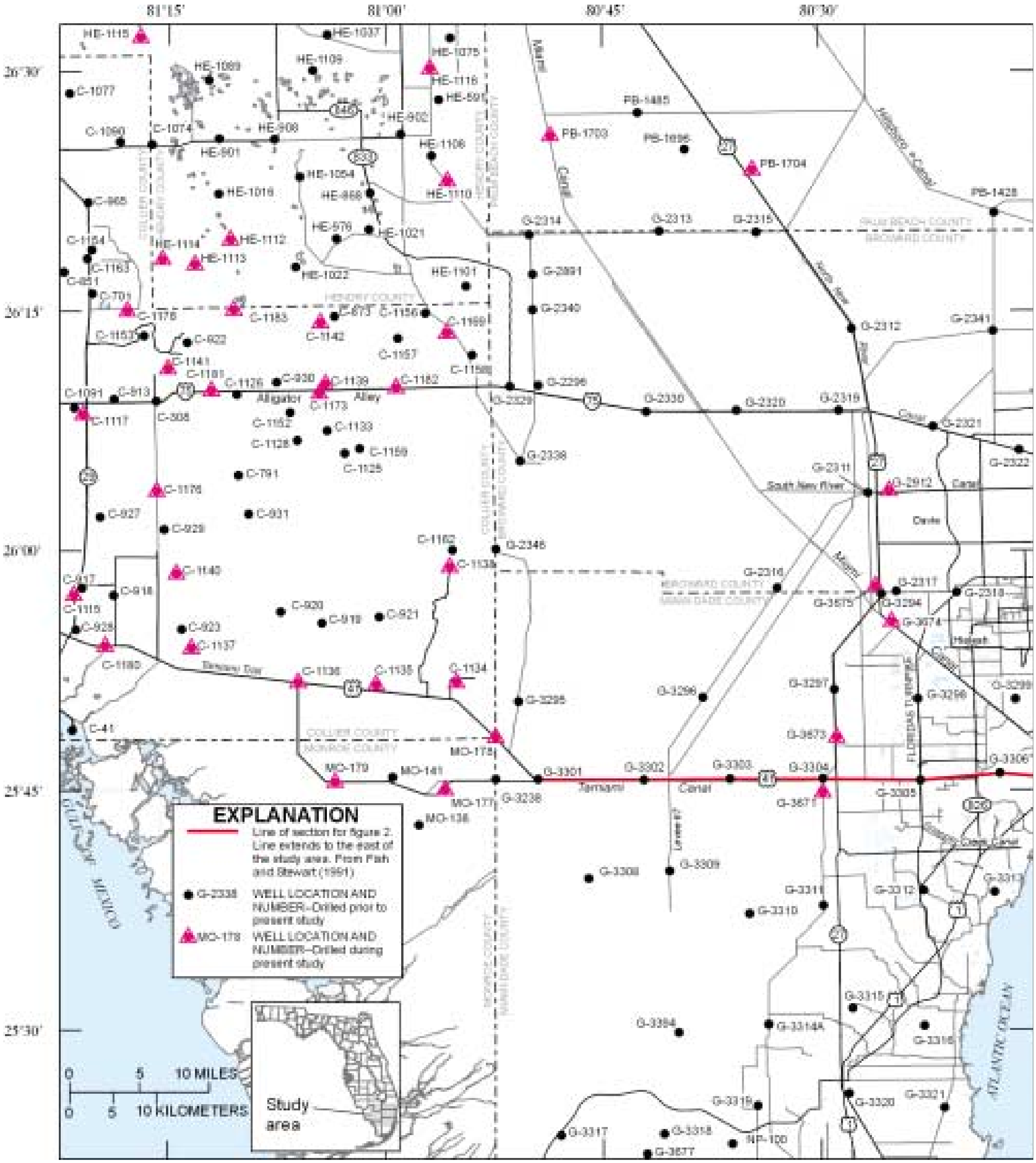


Figure 1. Location of study area and test wells used in the study. Some test well sites have more than one well. Refer to tables 1 and 2 for lists of test wells, site names, and additional wells at each site.

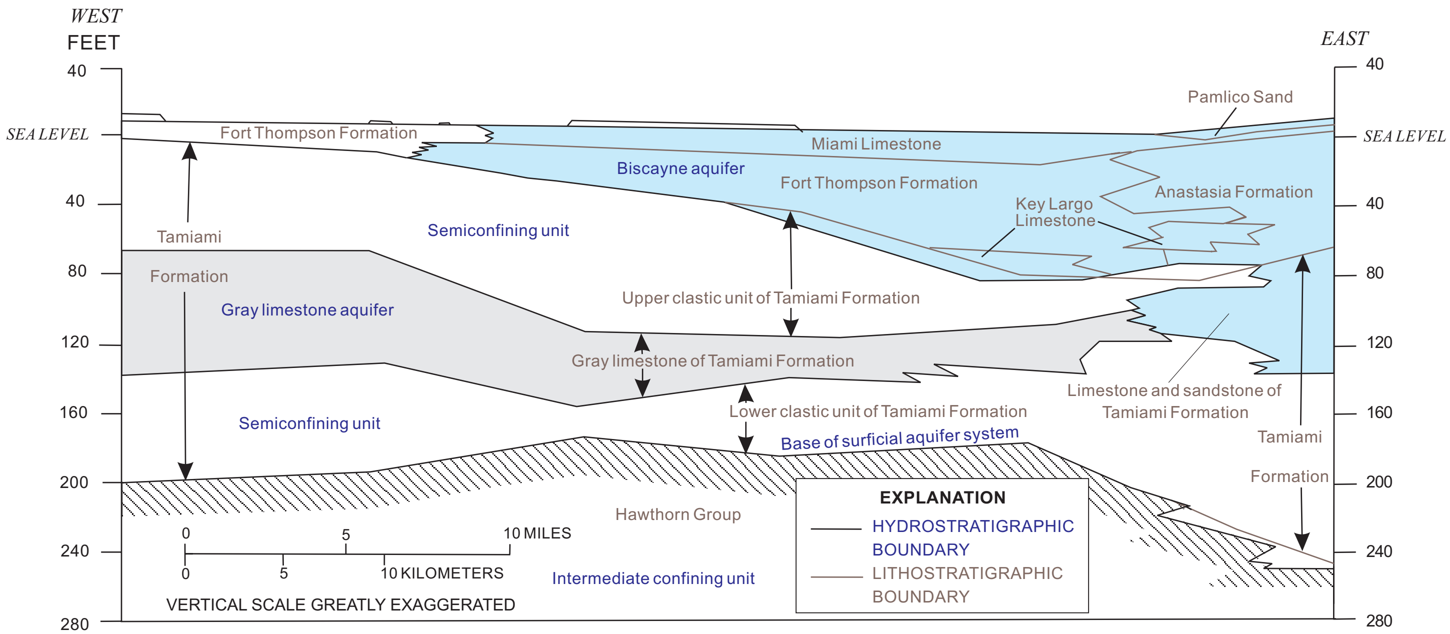


Figure 2. Hydrogeologic section in central Miami-Dade County along Tamiami Trail (modified from Fish and Stewart, 1991, fig. 6b(. Line of section shown in figure 1.

Purpose and Scope

The purpose of this report is to evaluate the hydrogeologic framework, hydraulic properties, and ground-water flow of the gray limestone aquifer in southern Florida. The report also emphasizes the geologic framework (stratigraphy and structure) and the hydrogeologic framework (aquifers and confining and semiconfining units) above and below the gray limestone aquifer. Specifically, this report: (1) delineates the configuration, thickness, and extent of the gray limestone aquifer; (2) estimates the hydraulic properties of the gray limestone aquifer (transmissivity, hydraulic conductivity, and leakance or degree of confinement) and relates these characteristics to the geologic framework; and (3) maps the distribution of water level and water quality in the aquifer.

The lithology, limiting extent, and thickness of lithostratigraphic units are determined by examination of core, well cutting samples, archived lithologic descriptions, and borehole-geophysical logs for selected wells. Four hydrogeologic sections have been constructed to show lithostratigraphic and hydrogeologic units and their structure in southern Florida, and maps have been constructed to show the configuration of the top, base, and thickness of the gray limestone aquifer. The geometry, thickness, and physical extent of the hydrogeologic units are delineated on the basis of lithologic and borehole geophysical data, well-to-well correlation, core sample analysis, evaluation of flowmeter log data, and aquifer test results. Estimates of the hydraulic properties of the gray limestone aquifer including transmissivity, hydraulic conductivity, and leakance are made by analysis of aquifer test data. Other hydraulic properties (porosity and hydraulic conductivity) of the aquifer and its bounding low permeability units are visually estimated from core samples and measured from core sample analysis. The distributions of water level and water quality in the gray limestone aquifer have been mapped to gain an understanding of ground-water flow patterns.

Relevant literature and well information contained within the files of the USGS have been compiled. Data from deep petroleum exploration and production wells supplemented the water-well data, and samples from cuttings collected from some of these wells are described. Previously collected hydraulic data pertaining to the gray limestone aquifer or to an equivalent or related aquifer have been synthesized.

Description of Study Area

The study area includes inland parts of Miami-Dade, Broward, Palm Beach, Monroe, and Collier Counties, and the southeastern part of Hendry County (fig. 1). The eastern boundary of the study area, which is in eastern Miami-Dade, Broward, and Palm Beach Counties, was chosen to include the eastern limit of the gray limestone aquifer as defined by Fish (1988) and Fish and Stewart (1991). Based on previous studies, the other boundaries were chosen such that the enclosed area could include the full extent of the gray limestone aquifer. The western part of the study area extends to central Collier County, to just west of State Highway 29. This highway nearly coincides with an axis of a thick unnamed quartz sand deposit that underlies the Tamiami Formation (Cunningham and others, 1998). The northern boundary of the study area is in central Hendry County and is just south of a surface-water divide (Parker and others, 1955, pl. 12).

Land-surface elevation in the study area ranges from sea level in coastal areas to slightly greater than 30 feet (ft) above sea level in central Hendry County and northwestern Collier County (Smith and Adams, 1988, fig. 3). Most of the study area falls into three physiographic units that include the Sandy Flatlands, Big Cypress Swamp, and the Everglades (fig. 3). The western edge of the Everglades unit adjoins the other two units, and approximately coincides with the L-2 and L-3 Canals in eastern Hendry County and the L-28 Canal in Broward and Miami-Dade Counties. The Sandy Flatlands unit in southern and central Hendry County occupies the highest part of the study area and borders the other two units typically at an elevation ranging from 15 to 20 ft above sea level (Smith and Adams, 1988, fig. 3).

The two major east to west highways that traverse the study area are Tamiami Trail (U.S. Highway 41) and Alligator Alley (Interstate 75). From west to east, major north- or northwest-trending canals include the L-28 Interceptor, L-2, L-3, L-28 (North and South), Miami, North New River, and Hillsboro Canals (fig. 3). The Tamiami Canal lies along the north side of Tamiami Trail. Water-conservation areas are present in southeastern Palm Beach County, western Broward County, and northwestern Miami-Dade County and occupy much of the Everglades unit area (fig. 3). Water flows, or is back-pumped, into these water-conservation areas and is stored to: (1) maintain ground-water levels, (2) provide recharge to municipal well fields, and (3) maintain surface-water flows to Everglades National Park.

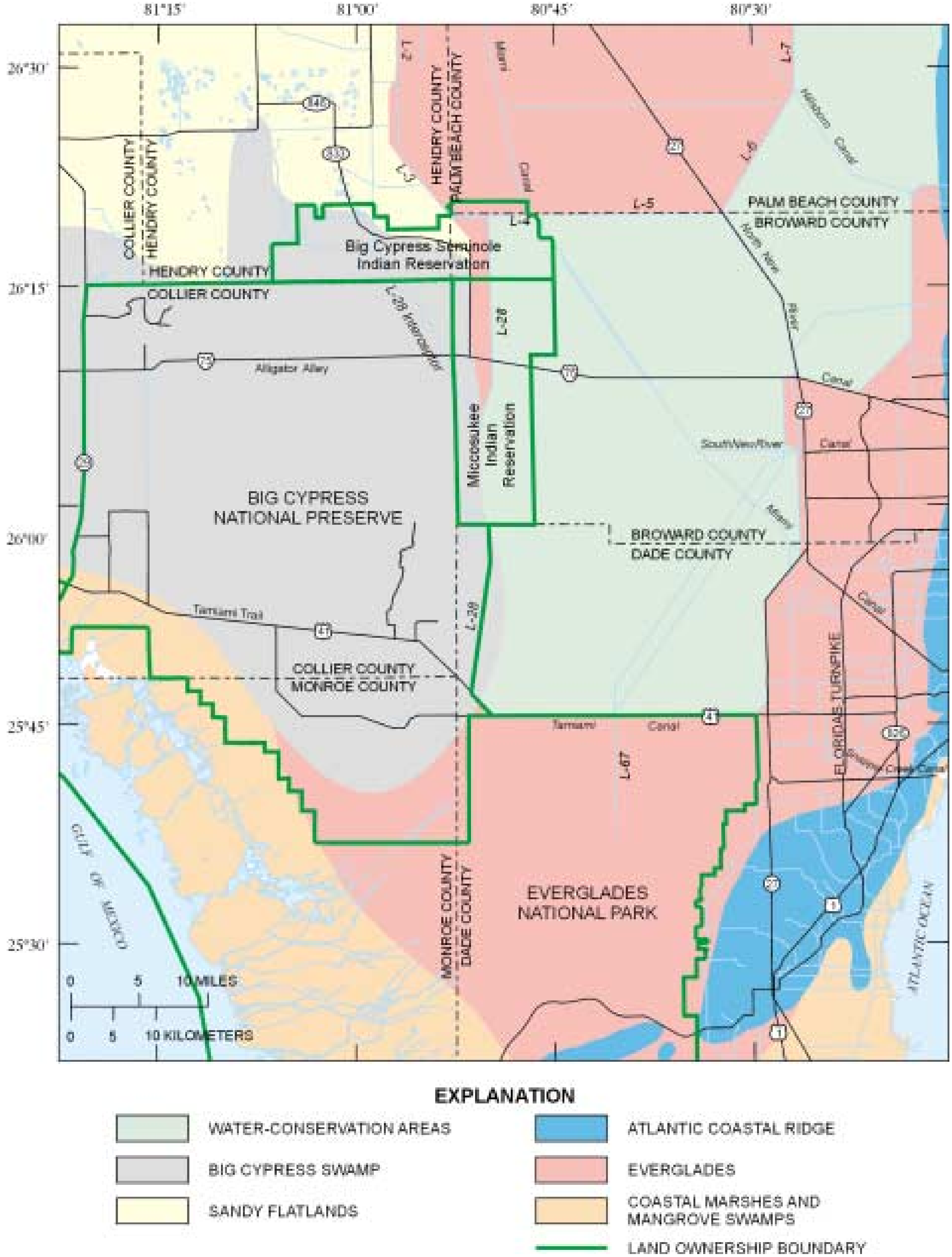


Figure 3. Physiographic units, water-conservation areas, and Indian Reservation Lands in the study area. Modified from Parker and others (1955, pl.12).

Important public land areas in the study area include Big Cypress National Preserve and Everglades National Park (fig. 3). Two other important land ownership areas are the Miccosukee Indian Reservation in western Broward County, and the Big Cypress Seminole Indian Reservation in southeastern Hendry County and extreme northwestern Broward County.

Previous Studies

Several "classic" early studies contributed to the geology and hydrogeology of the surficial aquifer system in southern Florida, such as Parker and others (1955), DuBar (1958), McCoy (1962), and Klein and others (1964). The base of the surficial aquifer system in Big Cypress Preserve and Everglades National Park was mapped by Jarosewich and Wagner (1985). Since the late 1980's, the SFWMD has completed two reconnaissance hydrogeologic studies (Knapp and others, 1986; Smith and Adams, 1988) and has constructed two ground-water flow models (Smith, 1990; Bennett, 1992) of the surficial aquifer system and the upper part of the intermediate aquifer system in the extreme western and northwestern parts of the study area (western Collier County and Hendry County). Reports by Causaras (1985; 1987), Fish (1988), and Fish and Stewart (1991) combine to define a hydrogeologic framework of the surficial aquifer system in Broward and Miami-Dade County, respectively. For Palm Beach County, Miller (1987) prepared lithostratigraphic sections that include the formations composing the surficial aquifer system; however, the extent of these formations was not delineated. Weedman and others (1997) and Edwards and others (1998) presented multidisciplinary geologic studies of the surficial aquifer system in western Collier County. Prior to the current study, the subsurface hydrogeology of the surficial aquifer system in eastern Collier County remained virtually unstudied; however in a concurrent study, Weedman and others (1999) describe the lithostratigraphy and geophysics of the surficial aquifer system in eastern Collier County and the most northeastern part of peninsular Monroe County.

Acknowledgments

Contributions and technical assistance were made by numerous individuals and governmental agencies. Especially important was a constructive, collaborative effort with Suzanne Weedman (USGS). Fred Paillet (USGS) collected and interpreted borehole geophysical log data on most of the test coreholes. Don Weeks, hydrologist with the Big Cypress National Preserve, assisted with site selection and obtaining permission to drill wells and conduct aquifer tests. Christine Bates, Pat Kinney, and Ron Clark (also with the Big Cypress National Preserve) were very helpful. Jim Trindell of the Florida Geological Survey (FGS) drilled 13 test coreholes and 3 monitoring wells and installed monitoring wells in all of the test coreholes. Jim proved to be reliable and knowledgeable in this effort. The FGS core drilling program was supervised by Tom Scott. Four production wells and 22 monitoring wells were drilled by Tony Lubrano (SFWMD), who also provided valuable advice about equipment procurement and setup for aquifer tests. Peter Dauenhauer and David Demonstranti (SFWMD) provided borehole geophysical logs for several test holes. Aquifer-test and water-level data were provided by Gail Murray (Murray Consultants, Inc., 1989) for the Big Cypress Seminole and Miccosukee Indian Reservations. Frank Rupert (FGS) provided assistance with some paleontologic identifications.

A number of people in the USGS office in Miami, Fla., contributed to this project. Steven Memberg and David Schmerge provided valuable assistance both in the office and the field. Bob Mooney also played an important role, providing logistical support, site selection, land-owner negotiations, and permitting. During the first half of the project, Scott Prinos assisted in the field and described cores. Other personnel who assisted in the field were Richard Verdi, Rich Krulikas, Loretta Leist, Anne Vlad, and Tony Brown.

METHODS OF INVESTIGATION

Intensive field and laboratory work was performed during this study. This work principally included well drilling, coring, and construction; borehole geophysical logging; core description and analysis in the laboratory; aquifer testing; and data collection from completed wells. The data collection from completed wells included some additional borehole geophysical logging, water-level measurements, and water-quality sampling and analysis.

Well Drilling, Coring, and Inventory of Wells

Test wells drilled at 35 sites during this study (fig. 1 and table 1) form the foundation of the physical framework described herein. Three test wells are located in northeastern Monroe County, 19 in eastern

Table 1. List of wells drilled during the study

[Well C-995 was the only well drilled prior to this study. All test wells were continuously cored, except for wells C-1173 and HE-1110, which were drilled by the dual-tube, reverse-air method. Borehole geophysical logging suite for test well: Basic represents induction resistivity, natural gamma ray, spontaneous potential, and single-point resistance logs; complete represents all logs listed for basic as well as neutron porosity, fluid resistivity, fluid temperature, and heat-pulse flowmeter logs. USGS, U.S. Geological Survey]

Test well (USGS local well number shown in fig. 1)	Site name	Borehole geophysical logging suite for test well	Additional wells at site (USGS local well number not shown in fig. 1)
C-1115	Fakahatchee Ranger Station	Complete	C-995
C-1117	Fakahatchee Jones Grade	Complete	
C-1134	Dade-Collier Airport	Complete	C-1148, C-1149
C-1135	FAA Radar	Complete	C-1143, C-1144 to C-1147, C-1172
C-1136	Monroe Station	Complete	C-1150
C-1137	Doerr's Lake	Complete	
C-1138	Raccoon Point	Complete	
C-1139	Noble's Road	Complete	C-1184, C-1185
C-1140	Bass	Complete	
C-1141	Bear Island Campground	Complete	C-1165, C-1166, C-1167
C-1142	Noble's Farm	Basic	
C-1169	Big Cypress Sanctuary	Complete	C-1170, C-1171
C-1173	Sabine Road	Basic	C-1174
C-1176	Turner River Road	Complete	C-1177
C-1178	Sunniland II	Complete	C-1179
C-1180	Big Cypress Headquarters	Complete	
C-1181	Cypress Lane	Complete	
C-1182	Alligator Alley East	Basic	
C-1183	Baker's Grade	Basic	
G-2912	South New River Canal, B-5	Basic	
G-3671	West Bird Drive Basin, B-1	Basic	
G-3673	Levee 31, B-2B	Basic	
G-3674	Miami Canal, B-3	Basic	
G-3675	Snake Creek Canal, B-4	Basic	
HE-1110	L-3 Canal	Basic	HE-1111
HE-1112	Windmill Road	Basic	
HE-1113	Prison I	Basic	
HE-1114	Prison II	Basic	
HE-1115	Mustang Grade	Basic	
HE-1116	L-2 Canal	Basic	HE-1117
MO-177	Golightly	Complete	MO-184
MO-178	Trail Center	Complete	MO-180 to MO-183, MO-185 to MO-188
MO-179	West Loop Road	Complete	
PB-1703	G-200 Pump Station	Basic	
PB-1704	Sod Farm	Basic	

Collier County, 6 in Hendry County, 2 in southwestern Palm Beach County, 1 in Broward County, and 4 in Miami-Dade County. A total of 33 test wells were continuously cored, and 2 were drilled by the dual-tube reverse-air rotary method. Most of the test wells were drilled to a depth of about 200 ft below land surface. Fourteen of the test wells were drilled as part of this study, 16 were drilled under the direction of separate studies (Weedman and others, 1997; Edwards and others, 1998; and Weedman and others, 1999), and 5 were drilled as part of a concurrent study on the effectiveness of local semiconfining units contained within the Biscayne aquifer in Miami-Dade and Broward Counties (K.J. Cunningham, U.S. Geological Survey, written commun., 1998). In addition to the 35 test wells, 30 wells were drilled (as part of this study) at the test well sites as monitoring or production wells. These wells are given in table 1, where they are listed under additional wells at a site. Large areas in the Big Cypress Swamp and the Everglades, such as between Alligator Alley and Tamiami Trail in eastern Collier County, could not be evaluated because of inaccessibility. An exception was well C-1138 at the Raccoon Point site located at the terminus of a road that extends 11 mi (miles) north of Tamiami Trail (fig. 1).

Continuous core drilling was preferred to the conventional rotary method in which cutting samples are obtained. The availability of core samples enhanced the opportunity to estimate porosity and permeability of rock and sediment, determine probable environments of deposition, and obtain better control on the depth to specific geologic and hydrogeologic units. Coreholes were drilled by using a Mobile B-61 drill rig (USGS) and a Failing 1500 drill rig (FGS). Both drill rigs utilized wireline coring methods. The two semi-continuous test coreholes were drilled by the SFWMD using the dual-tube, reverse-air method. Monitoring wells also were drilled by the dual-tube method. In the dual-tube method, drilling mud is not used, and uncontaminated rock and formation water samples are collected every 5 ft as drilling progresses. One advantage to this drilling technique is that it provides a qualitative measure of the formation “productivity” as the well is being drilled because water flowing into the borehole from productive intervals is forced up the inside of the drill pipe by compressed air injected near the bottom of the drill string.

Data from 163 wells drilled prior to this study also were used, with most of these wells used to assist in mapping hydrogeologic boundaries. The locations of historical test wells are shown in figure 1, but additional wells used in this study located at the same site as a test well are not shown, rather they are listed in table 2. Identification, location, and construction data for all wells used in this report are presented in appendix I. This information and other details are stored in the USGS Ground-Water Site Inventory (GWSI) database.

Borehole Geophysical Logging

For most test wells drilled during this study, borehole geophysical logs were run including induction resistivity, natural gamma ray, spontaneous potential, and single-point resistance. Induction resistivity was determined by using an electromagnetic induction tool that measures formation conductivity. In most cases, borehole geophysical tools were run in holes containing drilling mud and with polyvinyl chloride (PVC) or steel surface casing set to a depth ranging from 10 to 40 ft. In some instances tools were not run until after the well was completed with PVC casing; under these conditions only induction resistivity and gamma-ray measurements are useful. Borehole geophysical measurements were useful in determining the depth interval to screen in a well, defining geologic and hydrogeologic boundaries, determining relative changes in formation water quality, and correlating stratigraphy from well to well.

A more complete suite of borehole geophysical logs was run for 18 of the test coreholes (table 1). The additional logs included neutron porosity, fluid resistivity, fluid temperature, and heat-pulse flowmeter logs. Tools were run in a 3-in. (inch) diameter continuously slotted PVC screen, temporarily installed in the test hole after coring. A flushing and development process removed most drilling mud and caused unconsolidated formation to collapse and fill the annulus around the screen. However, based on flowmeter log results, collapse of the formation around the screen in some wells was not complete. For the wells in which a more complete suite of logs was run, a discussion of procedures used, description of logging tools used by type, and plots of log traces collected for each well are provided in Weedman and others (1997; 1999).

Table 2. List of historical wells used in the study with more than one well used at a site

[Other historical test wells used for the study and shown on figure 1 are given in appendix I. SFWMD, South Florida Water Management District sites]

Test well (USGS local well number - shown in fig. 1)	Site name or other well identifier	Additional wells at site (USGS local well number - not shown in fig. 1)
C-965	C-2042 (SFWMD)	C-966
C-1074	C-2066 (SFWMD)	C-131
C-1077	C-2064 (SFWMD)	C-1075, C-1076
C-1163	U of M Sunniland I	C-1164
G-2296	S-140 Pumping Station, BOF-1	G-2907, G-2908
G-3294	Opa-Locka West Airport, DAT-003	G-3294C
G-3295	Levee 28, DAT-004	G-3295A, G-3295C
G-3296	Levee 67, DAT-005	G-3296A, G-3296C
G-3301	Forty-Mile Bend, DAT-010	G-3301C
G-3302	Tamiami West, DAT-011	G-3302A, G-3302C
G-3303	Tamiami Central, DAT-012	G-3303A, G-3303C
G-3304	Tamiami East, DAT-013	G-3304C
G-3305	Florida International University, DAT-014	G-3305C
G-3308	Shark Valley Tower, DAT-017	G-3308C
G-3309	Levee 67 Extension, DAT-026	G-3309A, G-3309C
G-3310	Chekika Hammock State Park, DAT-018	G-3310A, G-3310C
G-3311	Levee 31N, DAT-019	G-3311A, G-3311D
G-3314A	Homestead Airport, DAT-023	G-3314C
G-3317	Sisal Pond, DAT-027	G-3317C, G-3317D
G-3318	Park Research Center, DAT-028	G-3318A, G-3318C
G-3394	Context Road West, DAT-022	G-3394B
HE-1016	Barron Collier, HY 314	HE-1042
HE-1022	Seminole Tribe site 1, HY 311	HE-1062, HE-1063
HE-1037	ALICO site C, HY 207	HE-1036

For comparative purposes, the heat-pulse flowmeter was run in boreholes under ambient, and either injection or pumped conditions. Flowmeter data pairs for each well were analyzed to determine the transmissivity of water-producing zones as a fraction of the transmissivity of the entire borehole. Flowmeter profiles showing the relative transmissivity of 10-ft zones in eight test holes in the study area were then plotted (Weedman and others, 1999).

Borehole geophysical tools also were run in monitoring and production wells at sites where multiwell aquifer tests were conducted. The suite of borehole logs collected in some of the monitoring and production wells at these sites included gamma ray, induction resistivity, and heat-pulse flowmeter; in addition to these logs types, fluid column resistivity and temperature logs were collected in the production wells.

Core Description and Core Sample Analysis

Core samples were macroscopically described in the laboratory by using a 10-power hand lens to determine vertical patterns of microfacies, sedimentary structures, lithostratigraphic boundaries, and depositional sequence boundaries, and to assess the regional-scale rock unit variability. The rock colors of dry samples were recorded by comparison to a rock-color chart with Munsell color chips (Geological Society of America, 1991). Hydraulic conductivity of cores were visually estimated using a classification scheme based on local lithologies and physical properties of sediments developed by Fish (1988, table 8) and also used by Fish and Stewart (1991). This scheme distinguishes five categories of hydraulic conductivity within the surficial aquifer system in Broward and Miami-Dade Counties and allows comparison of the hydraulic conductivities to lithology, grain size, clay content, and solution features:

Category	Hydraulic conductivity range (feet per day)
Very high	Greater than 1,000
High	100 to 1,000
Moderate	10 to 100
Low	0.1 to 10
Very low to practically impermeable	Less than 0.1

Core sample descriptions are provided in appendix II for all but seven test wells listed in table 1. Descriptions for core samples from two of these wells (C-1115 and C-1117) are given by Weedman and others (1997); and descriptions for core samples from the remaining five wells (G-2912, G-3671, G-3673, G-3674, and G-3675) will be provided in a later USGS publication. Additionally, as part of this study, cuttings from samples collected from 10 historical test wells were described (C-1133, C-1152, C-1154, C-1156, C-1157, C-1158, C-1162, HE-1089, MO-138, and PB-1696). These descriptions are not included in appendix II, but are available in USGS files.

Forty thin sections of core samples were examined by using standard transmitted-light petrography to characterize and interpret rock and hydraulic properties (appendix III). Porosity, horizontal permeability to air, and grain density of 32 limestone and sandstone core-plug samples were quantified by analysis at Core Laboratories, Inc. All continuous cores collected or used in this study are archived at the FGS in Tallahassee, Fla.

Aquifer Testing

Aquifer tests were performed at 6 sites; a total of 10 tests were conducted, including 4 multiwell tests and 6 single-well tests. The multiwell-test production wells were constructed with 6- or 8-in. PVC casing and screen. The screen was the continuous-slotted type with a slot size of 20 or 40 and was gravel packed. Monitoring wells constructed with 2-in. PVC casing and sand-packed screen (continuous-slotted type, with slot size of 20) were used for the single-well tests.

Average single-well test pumping rates ranged from 17 to 98 gal/min (gallons per minute), depending on the depth, length of screened interval, and the transmissivity of the aquifer. The duration of pumping was about 1 to 3 hours, followed by a recovery period of 1 to 2 hours. The pumping rate was continuously monitored using an in-line vortex flowmeter.

A 4- or 6-in. suction-lift pump with a check valve was used in the production wells for the multiwell tests. Discharge was measured by using a 6-in. orifice pipe located at the end of the discharge hose by continuously recording pressure in the orifice pipe with a pressure transducer. As a check, discharge rates were monitored by using an in-line-impeller flowmeter. Average discharge rates during these tests varied from about 170 to 300 gal/min. Although 24-hour pumping periods were planned, the duration of pumping ranged from 5 to

24 hours because of problems with keeping the pump running. The number of monitoring wells for each test ranged from two to seven, and the production well and all of the monitoring wells were instrumented with pressure transducers.

Background water levels in monitoring wells were measured for a period of several days to greater than a month prior to the multiwell aquifer tests. For a selected day, the background water level for the same period of day as the pumping period was subtracted from the water-level data collected during the test. A number of difficulties occurred during the multiwell tests including lower-than-expected pumping rates, limited drawdown in monitoring wells, a rapid decline in baseline water levels, and mechanical problems associated with the pump.

Water-Level Data Collection

Water-level data were collected to help define the hydraulic properties of the aquifer, provide background data prior to aquifer tests, and construct a synoptic water-level map. Down-hole pressure transducer/data logger units were used to collect continuous water-level measurements, with a data-collection interval of 5 or 10 minutes. For synoptic data collection, the same transducer units were used, but at most wells either a steel tape or an electric water-level tape was used. Steel tape and electric water-level tape measurements were found to agree with each other within 0.01 ft. Water levels for most of the wells in Hendry County were measured by the SFWMD. To supplement data collected by the USGS and SFWMD, some measurements were selected from chart recordings made by the Seminole Big Cypress Indian Reservation.

A synoptic map was prepared using water-level data collected in 69 wells located at 47 separate sites. Water levels of both the water-table aquifer and the underlying gray limestone aquifer were collected at sites with dual completions. Additionally, at some sites concurrent canal surface-water levels were recorded. Altitude datum at each site was determined by using conventional leveling or differential global positioning surveying (GPS), and all altitudes were referenced to the North American Vertical Datum of 1988. The GPS-determined datums were required at 21 sites due to their remoteness and lack of nearby benchmarks. In the more remote areas, GPS-determined datums required a network consisting of benchmarks, temporary benchmarks, and unknowns, whereby unknowns were determined from more than one baseline and the error was distributed. First-order or second-order benchmarks were used, and the accuracy of datum determination using GPS was estimated to range from 0.1 to 0.16 ft.

Water-Quality Data Collection

Monitoring and production wells were routinely sampled shortly after they were completed, and 24 wells were sampled during an 8-day period in late August to early September 1998. Field analysis procedures followed are given by Wilde and Radtke (1998). Specific conductance and chloride concentration were measured during the routine sampling. If drilling mud was used to drill a well, this mud and fine sediment were cleaned out of the well by using a long suction hose connected to a suction-lift pump; the hose was repeatedly lowered to the bottom of the well during pumping. Specific conductance was measured in the field and laboratory, and chloride concentration was determined in the laboratory.

Major ion and low-level nutrient analyses were performed on the water samples collected from the 24 wells sampled during the 8-day period. Color, dissolved-solids concentration, field pH, specific conductance, and total alkalinity also were determined. Low-level nutrient analyses included total sample analysis of all phosphorous and nitrogen species. These 24 wells included 18 wells completed in the gray limestone aquifer and 6 wells completed in a deeper aquifer. After purging wells with a suction-lift pump, samples were collected by using a peristaltic pump that pumped through silicon tubing placed down the well. All data have been archived in the USGS water-quality data storage and retrieval database (QWDATA).

GEOLOGIC FRAMEWORK OF SOUTHERN FLORIDA

Limestones, sandstone, quartz and carbonate sand, and clay compose most of the shallow rock and sediment that are the focus of this study in southern Florida. The emphasis of the stratigraphic study herein is on the rock and sediment contained within the gray limestone aquifer, and those above and below the gray limestone aquifer that include confining or semiconfining units. Discussion of the structure is based mostly on two maps that were constructed to show the altitude of the top and base of the gray limestone aquifer.

Stratigraphy

Lithostratigraphic units of primary interest in this study are those contained within the gray limestone aquifer and those affecting the upper and lower boundary conditions of the aquifer (fig. 4). They include the Peace River Formation of the upper Hawthorn Group, an unnamed formation, the Tamiami Formation (Ochopee Limestone and Pinecrest Sand Members), and rock and sediment of Quaternary age. Rock and sediment of Quaternary age include the Key Largo Limestone, Anastasia Formation, Fort Thompson Formation, Miami Limestone, Pamlico Sand, and Lake Flirt Marl. These Quaternary units occur locally in the study area (Parker and Cooke, 1944; DuBar, 1958; McCoy, 1962; Klein and others, 1964; and Causaras, 1985; 1987); however, they were not observed or differentiated in most new test coreholes nor reported in archived well data available for Hendry, Palm Beach, Collier and Monroe Counties. Causaras (1985; 1987) shows the distribution or the absence of these units in a series of sections that extend across Broward and Miami-Dade Counties.

The lithology, limiting extent, and thickness of lithostratigraphic units were determined by examination of core, well cutting samples, archived lithologic descriptions, and borehole geophysical logs for selected wells. The 35 test wells drilled during this study were deemed to be most useful (fig. 1 and table 1). Lithostratigraphic units mapped in Broward and Miami-Dade Counties are based largely on lithologic description and sections presented by Causaras (1985; 1987). Other geologic information was obtained from files of the USGS. Lithologic core descriptions prepared in this study are presented in appendix II, and thin-section rock-sample descriptions are provided in appendix III.

Peace River Formation

In southern Florida, the Hawthorn Group includes the Arcadia Formation that is principally composed of carbonate rocks and the Peace River Formation that is principally composed of siliciclastics. At the type area in DeSoto County, Fla., the Peace River Formation, which is sandwiched between the Tamiami and Arcadia Formations, consists of interbedded quartz sand, clay, and carbonate rocks with siliciclastic sediment composing two-thirds or more of the formation (Scott, 1988). The quartz sand contains a highly variable concentration of phosphate grains that ranges from a trace to 40 percent. The Peace River Formation ranges in age from late Miocene to early Pliocene (Missimer, 1997).

This study limited its scope within the Hawthorn Group to evaluating the lithologic and stratigraphic character of the upper part of the Peace River Formation. In ascending order, three lithofacies were identified in the upper part of the Peace River Formation: (1) diatomaceous mudstone, (2) terrigenous mudstone, and (3) clay-rich quartz sand. These lithofacies are characterized in table 3, and examples are shown in the thin sections in figure 5. The diatomaceous mudstone facies is underlain by quartz sand of the Peace River Formation, and in most of the study area, the clay-rich quartz sand facies of the Peace River Formation is overlain by less clay-rich quartz sand and sandstone of the unnamed formation and locally by the Ochopee Limestone. Continuous core samples show that, where present, the diatomaceous mudstone facies ranges from 0.1 to 18 ft in thickness; the terrigenous mudstone facies ranges from 2 to 28 ft in thickness; and the clay-rich quartz sand facies ranges from 0.5 to 75 ft in thickness. The Peace River Formation is distinguished from the unnamed formation by typically finer grain size and more silt and clay. Weedman and others (1999) used similar criteria. In the far western part of the study area, rock and sediment of the Peace River Formation grade laterally into sand of the unnamed formation.

Study of foraminifera from test wells C-1169, C-1182, and PB-1703 (fig. 1) by L.A. Guertin (Mary Washington College, oral commun., 1999) suggests that the Peace River Formation was deposited in a marine shelf depositional environment. Scott (1988) suggested open-marine conditions during deposition of the Peace River Formation in southeastern Florida. The present-day slope of the siliciclastic shelf profile within the study area is less than 1.0 degree in a paleobasinward direction, which was to the east or southeast. The upward transition from mudstones to quartz sand records an upward coarsening of grain size, an upward decrease in pelagic sedimentation, and an upward increase in siliciclastic sediment supply. These relationships represent a seaward shift in the vertical stacking of lithofacies related to a decrease in relative sea level.

Series	Lithostratigraphic units	Approximate thickness (feet)	Lithology	Hydrogeologic unit	Approximate thickness (feet)
HOLOCENE	LAKE FLIRT MARL, UNDIFFERENTIATED SOIL AND SAND (UNDIFFERENTIATED)	0 - 5	Marl, peat, organic soil, quartz sand	SURFICIAL AQUIFER SYSTEM: WATER TABLE AQUIFER / BISCAYNE AQUIFER	0 - 120
PLEISTOCENE	PAMLICO SAND (UNDIFFERENTIATED)	0 - 50	Quartz sand		
	MIAMI LIMESTONE (UNDIFFERENTIATED)	0 - 30	Oolitic limestone		
	FORT THOMPSON FORMATION (UNDIFFERENTIATED)	0 - 100	Marine limestone and minor gastropod-rich freshwater limestone		
	ANASTASIA FORMATION (UNDIFFERENTIATED)	0 - 140	Coquina, quartz sand and sandy limestone		
	KEY LARGO LIMESTONE (UNDIFFERENTIATED)	0 - 20	Coralline reef rock		
PLIOCENE	TAMIAMI FORMATION: PINECREST SAND MEMBER	0 - 90	Quartz sand, pelecypod-rich quartz sandstone, terrigenous mudstone	UPPER SEMICONFINING TO CONFINING UNIT	0 - 130
	TAMIAMI FORMATION: OCHOPEE LIMESTONE MEMBER	0 - 130	Pelecypod lime rudstone and floatstone, pelecypod-rich quartz sand, moldic quartz sandstone	GRAY LIMESTONE AQUIFER	0 - 130
MIOCENE	UNNAMED FORMATION	0 - 300	Moldic pelecypod-rich quartz sand or sandstone	LOWER SEMICONFINING UNIT	0 - 20
			Quartz sand, sandstone, and pelecypod-rich quartz sand, local abundant phosphate grains	SAND AQUIFER(S)	0 - 100
	UPPER HAWTHORN GROUP: PEACE RIVER FORMATION	0 - 300	Clay-rich quartz sand, terrigenous mudstone, diatomaceous mudstone, local abundant phosphate grains	INTERMEDIATE CONFINING UNIT OR INTERMEDIATE AQUIFER SYSTEM	300±

Figure 4. Lithostratigraphic units recognized in the study area, their generalized geology, and relationship with hydrogeologic units. Modified from Olsson (1964), Hunter (1968), Miller (1990), Missimer (1992), and Weedman and others (1999).

Table 3. Lithofacies characteristics of the Peace River Formation

[Visual estimation was made for porosity; hydraulic conductivity was visually estimated by using a classification scheme from Fish (1988, table 8). Colors in the lithologic description refer to Munsell rock-color chart (Geological Society of America, 1991)]

Characteristic	Lithologic description
	Clay-Rich Quartz Sand Facies
Depositional textures	Terrigenous clay-rich sand
Color	Mainly yellowish-gray 5Y 7/2 and 5Y 8/1, and light-gray-olive 5Y 6/1
Carbonate grains	Local thin-shelled pelecypods, oysters, *Turritella* and benthic foraminifers
Accessory grains	Common phosphate grains (trace to 40 percent); minor heavy minerals; trace mica
Grain size	Mainly very fine quartz grains; minor silt-size quartz grains and terrigenous mud; local micrite, fine sand-size to small pebble-size quartz grains and very fine sand-size to pebble-size phosphate grains
Porosity	Mainly intergrain; local moldic; ranges from 5 to 20 percent
Hydraulic conductivity	Mainly very low (less than 0.1 foot per day) to low (0.1 to 10 feet per day); ranges from very low (less than 0.1 foot per day) to moderate (10 to 100 feet per day)
	Terrigenous Mudstone Facies
Depositional textures	Terrigenous mudstone
Color	Mainly light-olive-gray 5Y 5/2, yellowish-gray 5Y 7/2, and olive-gray 5Y 4/1, 5Y 3/2
Carbonate grains	Local benthic foraminifers and pelecypod fragments
Accessory grains	Common quartz grains; local diatoms, phosphate grains, mica, fish scales, shark's teeth
Grain size	Mainly terrigenous clay; minor silt-size quartz; local very fine sand- to granule-size quartz grains and very fine sand- to pebble-size phosphate grains
Porosity	Minor microporosity
Hydraulic conductivity	Very low (less than 0.1 foot per day)
	Diatomaceous Mudstone Facies
Depositional textures	Diatomaceous mudstone
Color	Mainly yellowish-gray 5Y 7/2 and light-olive-gray 5Y 5/2
Carbonate grains	Local benthic foraminifers
Accessory grains	Common quartz grains and local phosphate grains
Grain size	Mainly clay-size terrigenous clay and fine sand-size diatoms; minor silt-size quartz; local very fine sand-size quartz and phosphate grains, and fish scales
Porosity	Minor microporosity
Hydraulic conductivity	Very low (less than 0.1 foot per day)

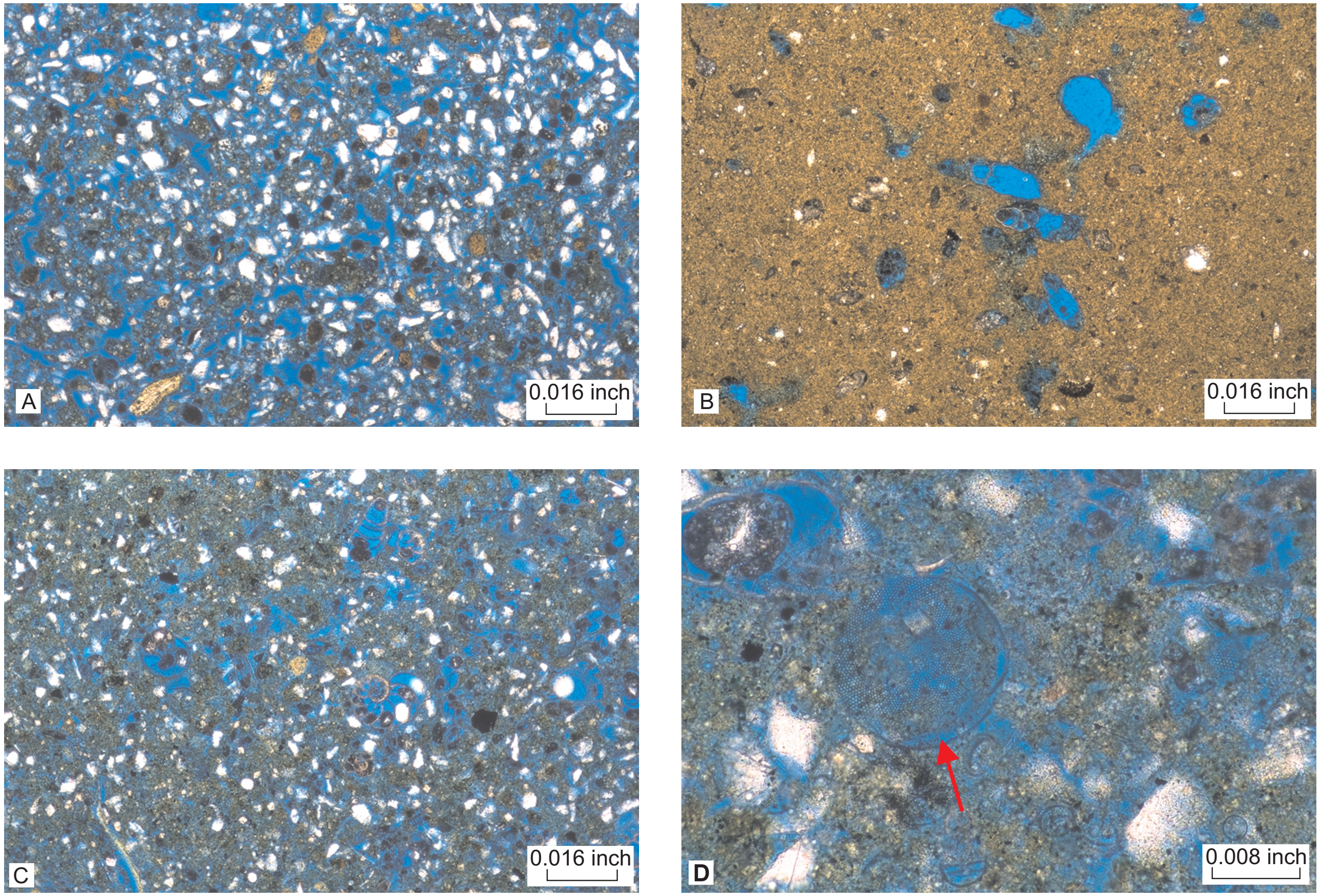


Figure 5. Thin-section photomicrographs showing lithofacies identified for the Peace River Formation. Samples collected from well C-1182. Photographs represent (A) sample HXP-22, terrigenous clay-rich quartz sand. Sample preparation has greatly increased original intergrain porosity; (B) sample HXP-23, benthic foram terrigenous mudstone; (C) sample HXP-24, diatomaceous terrigenous mudstone; and (d) enlarged view of sample shown in photo C (arrow points to a diatom). Plane-polarized light; blue epoxy highlights porosity. Appendix III presents complete description of rock samples.

Unnamed Formation

The boundary separating the base of the Tamiami Formation and the top of the Peace River Formation is poorly defined in much of southern Florida. Quartz sand and sandstone occur beneath the mixed carbonate and siliciclastic rock of the Tamiami Formation and above the clay-rich quartz sand of the Peace River Formation. This sand and sandstone has not as yet been assigned to a formally defined formation. Weedman and others (1997), Edwards and others (1998), and Weedman and others (1999) included these unnamed sediments as part of an informal “unnamed formation,” anticipating clarification of its status following further study. The unnamed formation was defined by Weedman and others (1999, p. 15) as "variably phosphatic and fossiliferous combinations of quartz gravel, sand, and silt, clay, and carbonate rocks and sediment." For the present study (this report), the unnamed formation is defined as relatively clay-free, quartz sand and sandstone underlying the lowest part of the Ochopee Limestone. At the base of the unnamed formation, relatively clean quartz sand overlies clay-rich siliciclastics of the Peace River Formation. Thus, definition of the unnamed formation includes the siliciclastic interval previously included in the lower part of the Tamiami Formation (Causaras, 1985; 1987) and the Miocene coarse clastics (Knapp and others, 1986; Smith and Adams,1988). The unnamed formation is probably equivalent, in part, to the Long Key Formation (Cunningham and others, 1998) of the Florida Keys south of the study area. The unnamed formation was not recognized by Missimer (1997), and the unit defined as the unnamed formation herein is included in the Peace River Formation by Missimer.

Two lithofacies can be differentiated within the unnamed formation, occurring as quartz sand and pelecypod-rich quartz sand or sandstone. These lithofacies are characterized in table 4, and examples are shown in thin sections in figure 6. The pelecypod-rich facies locally contains abundant *Turritella* gastropod molds and occurs locally beneath the base of the Ochopee Limestone; it is invariably underlain by the quartz sand facies. The unnamed formation was probably deposited in a marine siliciclastic-shelf depositional environment. Indicators of depositional environments include: (1) local presence of marine fossils, (2) absent or minor clay content suggesting deposition above fair-weather wave base, and (3) probably partial equivalency to Peace River beds containing foraminifera that indicate a marine shelf depositional environment (L.A. Guertin, Mary Washington College, oral commun., 1999). The

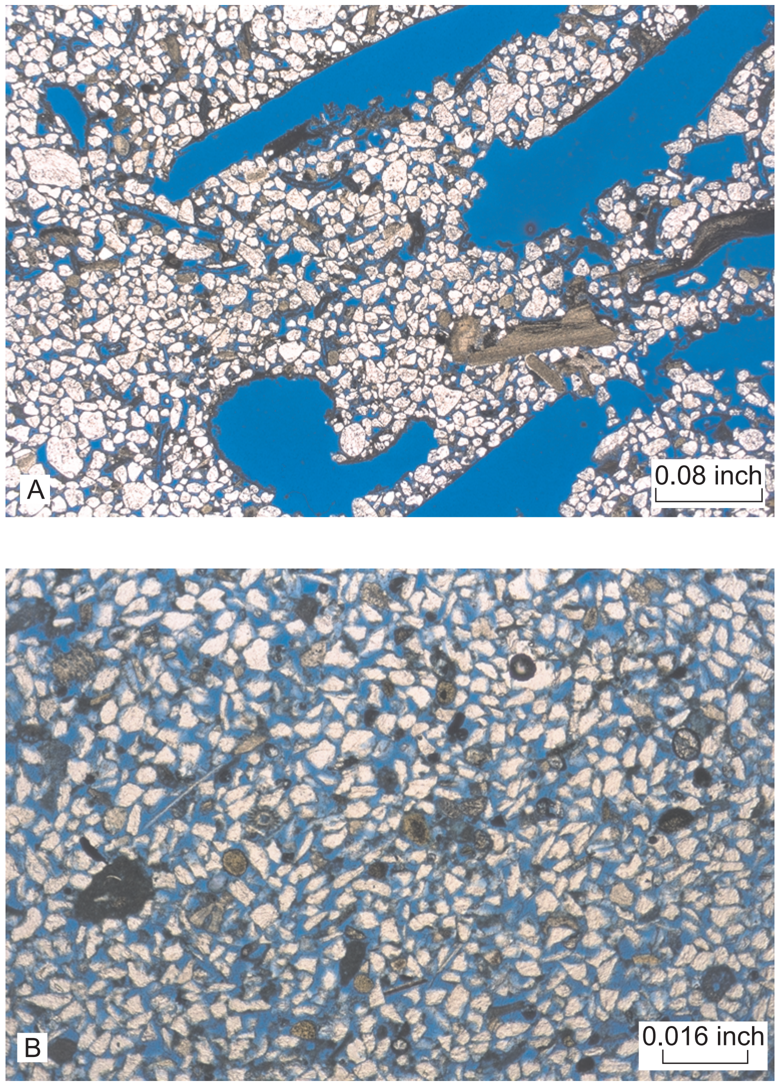


Figure 6. Thin-section photomicrographs showing lithofacies identified for the unnamed formation. Photographs represent (A) sample HHW-2 from well C-1141, pelecypod-rich quartz sand or sandstone showing moldic and integrain porosity; and (B) sample HXP-21 from well C-1182, quartz sand showing integrain porosity. Plain-polarized light; blue epoxy highlights porosity. Original integrain porosity probably increased during sample preparation. Appendix III presents complete description of rock samples.

Table 4. Lithofacies characteristics of the unnamed formation

[Visual estimation was made for porosity; hydraulic conductivity was visually estimated by using a classification scheme from Fish (1988, table 8). Colors in the lithologic description refer to Munsell rock-color chart (Geological Society of America, 1991)]

Characteristic	Lithologic description
Pelecypod-Rich Quartz Sand or Sandstone Facies	
Depositional textures	Quartz sand matrix with pelecypod rudstone framework, or quartz sand supporting skeletal floatstone
Color	Mainly yellowish-gray 5Y 8/1 and 5Y 7/2; locally light-gray N7 to white N9, light-olive-gray 5Y 5/2, light-olive-gray 5Y 6/1, and very pale orange 10YR 8/2
Carbonate grains	Pelecypods (including *Pecten* and oysters), undifferentiated skeletal grains, gastropods (including *Turritella*), bryozoans, serpulids, and echinoids
Accessory grains	Trace to 40 percent phosphate and heavy mineral grains; local minor terrigenous clay and lime mudstone; local trace mica
Grain size	Mainly very fine to fine quartz sand; ranges from silt to very coarse quartz sand; carbonate grains range from silt to cobble size; local terrigenous clay
Porosity	Intergrain and moldic; ranges from 5 to 25 percent; local abundant pelecypod molds contribute to high porosity
Hydraulic conductivity	Mainly low (0.1 to 10 feet per day) to moderate (10 to 100 feet per day); ranges from very low (less than 0.1 foot per day) to high (100 to 1,000 feet per day); local abundant pelecypod molds contribute to high hydraulic conductivity
Quartz Sand Facies	
Depositional textures	Quartz sand with less than 10 percent skeletal grain
Color	Mainly yellowish-gray 5Y 8/1 and yellowish-gray 5Y 7/2; locally medium-dark-gray N4 to very light gray N8, light-olive-gray 5Y 5/2, grayish-yellow-green 5GY 7/2, pale-olive 10Y 6/2, very pale orange 10YR 8/2, and pale-yellowish-brown 10YR 6/2
Carbonate grains	Pelecypods (local *Pecten* and *Chione*), benthic foraminifers, echinoids, and undifferentiated skeletal grains
Accessory grains	Trace to 30 percent phosphate and heavy mineral grains; local minor terrigenous clay; local trace mica; trace to 1 percent plagioclase; trace microcline
Grain size	Mainly very fine to medium quartz sand; ranges from silt to granule size; carbonate grains range from silt to pebble size; terrigenous clay
Porosity	Intergrain; ranges from 5 to 20 percent
Hydraulic conductivity	Mainly low (0.1 to 10 feet per day) to moderate (10 to 100 feet per day); ranges from very low (less than 0.1 foot per day) to moderate (10 to 100 feet per day)

upward transition of the two lithofacies represents an upward decrease in supply of quartz sand relative to local supply of carbonate grains. The eastward gradation from relatively clean quartz sand of the unnamed formation to clay-rich sands and mudstone of the Peace River Formation in the far western part of the study area indicates an eastward deepening of the marine siliciclastic shelf.

The unnamed formation occurs throughout most of the study area, bounded at its top by the Ochopee Limestone and at its base by the Peace River Formation or the Arcadia Formation. The contact between the unnamed formation and the Ochopee Limestone, as indicated by core samples and borehole geophysical logs, appears to be sharp in some areas; in other areas, it is gradational with some interfingering of limestone and quartz sand or sandstone over a short interval. In southwestern Florida, Missimer (1999) recognized an unconformity representing a 0.2 million year hiatus between the top of the Peace River Formation and overlying Tamiami Formation. This unconformity may be equivalent to the contact between the unnamed formation and Ochopee Limestone. On the basis of continuous core data collected during this study, the unnamed formation is locally absent, but increases to as much as 306 ft in thickness at well C-1163 in northwestern Collier County (fig. 1), where the unnamed formation lies directly on the Arcadia Formation.

Tamiami Formation

The "Tamiami limestone" was named informally by Mansfield (1939) to describe sandy limestone that crops out along the northern side of Tamiami Trail in Collier County. He reported the Tamiami as a "light-gray to white, hard, sandy limestone containing abundant identifiable mollusk molds and well preserved pectens, oysters, barnacles, and echinoids." The Tamiami Formation was redefined by Parker (1951, p. 823) to include all upper Miocene deposits in southern Florida. Description and definition of the Tamiami Formation have varied over the past 50 years (Parker and others, 1955; McCoy, 1962; Klein and others, 1964; Hunter, 1968; Missimer, 1978; Peck and others, 1979; Hunter and Wise, 1980; and Missimer, 1992), and the precise upper and lower boundaries remain problematic (Missimer, 1992).

Hunter (1968) formally proposed three members, all equivalent in age, to the upper Tamiami Formation: (1) Ochopee Limestone Member, (2) Pinecrest Sand Member, and (3) Buckingham Limestone Member. Hunter further divided the lower Tamiami Formation into two members: Murdock Station Member and Bayshore Clay Member. Hunter and Wise (1980) proposed that the Tamiami Formation be restricted to include the Ochopee and Buckingham Limestones and equivalent facies, such as the Pinecrest Sand. They further suggested that subjacent units be included as part of the Peace River Formation, which is in agreement with additional definition of the Peace River Formation by Scott (1988). For the present study, only the Ochopee Limestone and Pinecrest Sand Members could be identified, and in most of the study area the unnamed formation has been mapped underlying the Ochopee Limestone. Further refinement of core data collected during this study could show that other members of the Tamiami Formation are present.

Missimer (1992) estimated the age of the Tamiami Formation to be Pliocene (4.2 to 2.8 million years ago), using paleontologic data and interpretation of an established global sea-level curve. Edwards and others (1998) assigned the Ochopee Limestone of western Collier County to an early Pliocene age, but possibly ranging from late Miocene to late Pliocene. Age designations of Edwards and others (1998) were based on strontium-isotope chemostratigraphy and biostratigraphy (dinocysts and molluscan assemblages). Weedman and others (1999) suggested an early Pliocene age for the Tamiami Formation in eastern Collier and northern Monroe Counties; however, some age dating provided in that study are consistent with late Pliocene age.

Ochopee Limestone Member

The Ochopee Limestone includes a regionally extensive limestone facies of the Tamiami Formation that can be mapped beneath most of Collier County and parts of Lee, Hendry, Miami-Dade, Monroe, and Broward Counties (Hunter, 1968). Missimer (1992) characterized the Ochopee Limestone Member as containing very fine to fine sand-size quartz grains (5 to 80 percent), commonly with an increase in the quartz sand to limestone ratio with depth. In western Broward and western Miami-Dade Counties, Causaras (1985; 1987) recognized a gray limestone unit within the lower part of the Tamiami Formation, within which Fish (1988) and Fish and Stewart (1991) later defined the gray limestone aquifer.

The Ochopee Limestone was delineated by Weedman and others (1997), Edwards and others (1998), and Weedman and others (1999) for the Collier County part of the study area. Well-to-well correlation shown herein indicates that the Ochopee Limestone is equivalent to limestone of the lower Tamiami Formation in western Collier County (Knapp and others, 1986), Hendry County (Smith and Adams, 1988), and Broward and Miami-Dade Counties (Causaras 1985; 1987). The Ochopee Limestone may be equivalent, in part, to the Long Key and Stock Island Formations that occur in the Florida Keys (Cunningham and others, 1998).

Two lithofacies characterize the Ochopee Limestone Member: (1) pelecypod lime rudstone or floatstone, and (2) pelecypod-rich quartz sand or sandstone. The lithofacies are characterized in table 5, and examples of thin sections are shown in figure 7. The pelecypod lime rudstone or floatstone facies is the most common lithofacies, whereas the pelecypod-rich quartz sand or sandstone facies occurs only locally as thin to thick beds (fig. 1, wells C-1141, C-1178, HE-1110, and PB-1703). Skeletal carbonate grains of the pelecypod lime rudstone or floatstone lithofacies include pelecypods (local oysters, *Pecten*, *Chione*, and *Ostrea*), undifferentiated skeletal fragments, bryozoans, gastropods (local *Turritella* and *Vermicularia*), benthic foraminifera, echinoids, serpulids, barnacles, planktic foraminifera, ostracods, encrusting foraminifera, and ahermatypic corals. In the pelecypod-rich quartz sand or sandstone lithofacies, quartz sand is typically very fine to fine grained, but locally may range from silt to very coarse sand.

The Ochopee Limestone was deposited in a carbonate ramp depositional system (Burchette and Wright, 1992; Cunningham and Reese, 1998). Criteria to support this interpretation include: (1) a low depositional gradient of less than 1 degree, (2) widespread continuity of facies patterns, and (3) an almost complete absence of internal exposure surfaces. In the study area, most mixed-siliciclastic-carbonate rocks of the Ochopee Limestone were deposited in a mid-ramp depositional environment as defined by Burchette and Wright (1992), and the direction of dip of the ramp was generally to the east or southeast. Evidence for this depositional environment is indicated by the common occurrence of coarse-grained lime rudstone that has a well washed, grain-dominated matrix (Lucia, 1995) and lime mud-rich floatstone. The mixture of these grain-dominated and mud-dominated carbonates and lack of shallow-water indicators suggest deposition below fair-weather wave base (FWWB) but above storm wave base (SWB). This zone between FWWB and SWB defines the mid-ramp depositional environment (Burchette and Wright, 1992). The occurrence of regional-scale facies patterns in the Ochopee Limestone ramp suggest predictable hydraulic properties.

The benthic-carbonate grains of the Ochopee Limestone represent a heterozoan particle association, which James (1997) defined as a group of carbonate particles produced by light-independent benthic organisms that may or may not contain red calcareous algae. Red algae were not observed in the Ochopee Limestone within the study area. Their absence combined with a predominately heterozoan particle association and lack of shallow-marine particles, such as ooids, is consistent with relatively deep, noneuphotic, temperate bottom-water conditions. An almost complete absence of exposure surfaces within the Ochopee suggests deposition at water depths sufficient to minimize changes in water-bottom conditions during low-amplitude changes in relative sea level.

At one test well in west-central Collier County (fig. 1, well C-1178), the Ochopee Limestone is bounded at its top by a subaerial exposure “zone” that extends to a depth of 30 ft below the upper bounding surface of the Ochopee. Root molds lined with calcrete are common within this thick zone. The exposure zone contains a record of at least two emersions due to relative falls in sea level, possibly caused by very local tectonic flexure of the Ochopee seafloor.

The age dating by Weedman and others (1999) and the vertical facies analysis described above suggest that the Ochopee Limestone may have been deposited during transgressive to high-stand conditions (as defined by Haq and others, 1988) of the early Pliocene. During this time, the Florida Platform was flooded, siliciclastic supply had diminished, and water depth and climate created bottom conditions favorable to light-independent animals.

The Ochopee Limestone is comparatively uniform in thickness in southern Florida, generally ranging between 30 and 100 ft. The unit is thickest in a widespread area that extends across southwestern Palm Beach, northwestern Broward, and southern Hendry Counties where it attains 130 ft in thickness. South of the Tamiami Trail in Miami-Dade County, the Ochopee Limestone pinches out to the southeast where it merges with siliciclastics of the overlying Pinecrest Sand and underlying unnamed formation. The southeastern limit of the “Ochopee” ramp is about coincident with the southern boundary of the study area. The eastern limit is approximately coincident with the eastern boundary of the gray limestone aquifer that underlies eastern Miami-Dade and Broward Counties.

Table 5. Lithofacies characteristics of the Ochopee Limestone Member of the Tamiami Formation

[Visual estimation was made for porosity; hydraulic conductivity was visually estimated by using a classification scheme from Fish (1988, table 8). Colors in the lithologic description refer to Munsell rock-color chart (Geological Society of America, 1991)]

Characteristic	Lithologic description
Pelecypod Lime Rudstone or Floatstone Facies	
Depositional textures	Pelecypod lime rudstone or floatstone with quartz sand-rich lime packstone or grainstone matrix
Color	Mainly medium-light-gray N6 to very light gray N8 and yellowish-gray 5Y 8/1; locally yellowish-gray 5Y 7/2, black to medium-gray N5, white N9, and very pale orange 10YR 8/2
Carbonate grains	Pelecypods (local oysters, *Pecten*, *Chione*, and *Ostrea*), undifferentiated skeletal fragments, bryozoans, gastropods (local *Turritella* and *Vermicularia*), benthic foraminifers, echinoids, serpulids, barnacles, planktic foraminifers, ostracods, encrusting foraminifers, corals (ahermatypic)
Accessory grains	Common quartz sand and phosphate grains
Grain size	Carbonate grains range from silt to cobble size; quartz sand mainly very fine to fine, ranges from silt to very coarse
Porosity	Mainly intergrain and moldic; local intrafossil and boring; ranges from 5 to 25 percent
Hydraulic conductivity	Mainly moderate (10 to 100 feet per day); ranges from low (0.1 to 10 feet per day) to high (100 to 1,000 feet per day)
Pelecypod-Rich Quartz Sand or Sandstone Facies	
Depositional textures	Pelecypod-rich quartz sand and quartz-rich sandstone
Color	Mainly yellowish-gray 5Y 8/1 and light-gray N7 to very light gray N6; locally medium-dark-gray N4 to medium-light-gray N6, very pale orange 10YR 8/2, light-olive-gray 5Y 6/1, yellowish-gray 5Y 7/2, and pale-yellowish-brown 10YR 6/2
Carbonate grains	Pelecypods (local oysters), undifferentiated skeletal fragments, gastropods, echinoids, barnacles, serpulids, intraclasts, bryozoans, and encrusting foraminifers
Accessory grains	Absent to 5 percent phosphate and heavy mineral grains; local minor terrigenous clay or lime mudstone matrix
Grain size	Mainly very fine to fine quartz sand; ranges from silt to coarse quartz sand; carbonate grains range from silt to cobble size
Porosity	Mainly intergrain with local moldic and intragrain; ranges from 10 to 20 percent
Hydraulic conductivity	Mainly low (0.1 to 10 feet per day) to moderate (10 to 100 feet per day); ranges from low (0.1 to 10 feet per day) to moderate (10 to 100 feet per day)

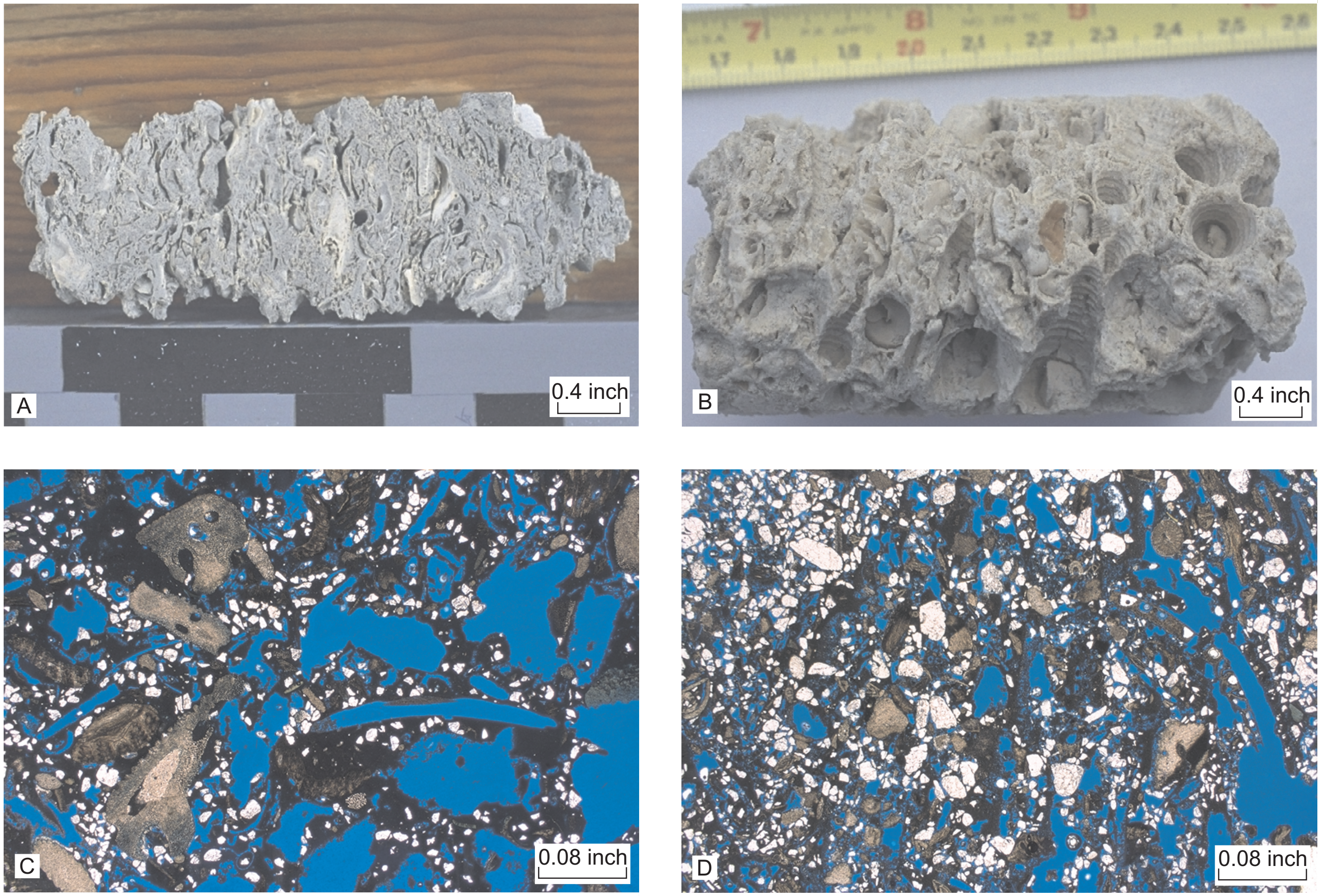


Figure 7. Core photographs and thin-section photomicrographs of the pelecypod lime rudstone facies of the Ochopee Limestone Member of the Tamiami Formation. Photographs represent (A) sample from well C-1142 from a depth of 73.5 feet below land surface, core slab with moldic porosity in a pelecypod lime rudstone; (B) sample from well HE-1113 from a depth of 49 feet below land surface, whole core with moldic porosity of a *Turritella* rudstone; (C) sample HHW-20 from well C-1181, pelecypod-rich quartz sandstone with lime mud matrix; and (D) sample HHW-4 from well C-1142, pelecypod quartz sand-rich lime packstone. Plane-polarized light; blue epoxy highlights porosity. Appendix III presents complete thin-section descriptions of photos C and D.

Pinecrest Sand Member

The name Pinecrest Sand Member is derived from the "Pinecrest beds" informally described by Olsson (1964) for a faunal assemblage found along Tamiami Trail near the boundary between Collier and Miami-Dade Counties. Missimer (1992) defined the Pinecrest Sand as a sand and shell unit. In southwestern Florida, he recognized it as occurring discontinuously and only in small areas, commonly less than 1 mi^2 (square mile) in size. Weedman and others (1999) recognized the Pinecrest Member overlying the Ochopee Limestone in northeasternmost Monroe County.

Three lithofacies have been differentiated within the Pinecrest Sand Member: (1) a quartz sand facies, (2) a pelecypod lime rudstone and floatstone facies, and (3) a terrigenous mudstone facies. These lithofacies are characterized in table 6, and examples of thin sections are shown in figure 8. The quartz sand facies is characteristic of most of the Pinecrest Sand. The terrigenous mudstone facies occurs mainly in the north-central part of the study area where it typically occurs as one or two beds within the lower part of the Pinecrest Sand. The pelecypod lime rudstone is found only very locally as discrete beds within or near the top of the Pinecrest Sand. Foraminiferal analyses by L.A. Guertin (Mary Washington College, oral commun., 1999) of test well PB-1703 (fig. 1) in Palm Beach County indicate deposition of the Pinecrest Sand Member in a marine siliclastic shelf.

The Pinecrest Sand ranges from 20 to 60 ft in thickness in most of the study area. The Pinecrest is thickest (125 ft) in central and south-central Miami-Dade County. Other areas where the Pinecrest Sand is thick were mapped in southern Hendry, northeastern Collier, west-central Broward, and south-central Palm Beach Counties. The Pinecrest Sand pinches out in the western part of the study area: Monroe, Collier and Hendry Counties. In southern Miami-Dade County, the Pinecrest Sand merges with siliciclastics of the Long Key Formation (Cunningham and others, 1998) in the Florida Keys.

Post-Pliocene Formations

The Fort Thompson Formation (as defined by Causaras, 1987) was penetrated in test wells C-1135 and MO-178 in southeastern Collier County and northeastern Monroe County (fig. 1). Limestone units in these wells were identified as Fort Thompson Formation based on: (1) presence of calcrete (Perkins, 1977), (2) marine pelecypod limestone lithology (Causaras, 1987), and (3) occurrence of Miami Limestone above the Fort Thompson Formation in well MO-178. These units are composed of pelecypod lime floatstone with a quartz sandstone matrix or a skeletal, quartz sand-rich, lime packstone matrix. The rock contains 10 to 70 percent quartz grains. Porosity ranges from 15 to 20 percent; however, estimated hydraulic conductivity is low. In well MO-178, the top of the Fort Thompson Formation is bounded by a 0.75-ft thick quartz-sand-rich calcrete and the formation is 5.75 ft thick. The top of this calcrete layer could be equivalent to the upper surface of the Q3 unit of Perkins (1977).

Beds possibly equivalent to the Fort Thompson Formation were penetrated in test well PB-1704 in southeastern Palm Beach County (fig. 1) from a depth of 5.5 to 49.5 ft below land surface. These beds combine to form at least seven high-frequency, vertically stacked, marine-to-lacustrine, sedimentary cycles that range from 2 to 14 ft in thickness. The base of each cycle is composed of marine inner shelf, restricted bay or lagoon, or marine tidal flat deposits. Each cycle is capped with subaerially exposed lacustrine lime mudstone or marl, which typically contains root molds and desiccation cracks, and rarely calcrete. Low-spired *Helisoma* gastropods are common in the lacustrine deposits, which are characteristic of the Fort Thompson Formation (Perkins, 1977; Causaras, 1987).

The Miami Limestone, as defined by Hoffmeister and others (1967), was penetrated in well MO-178 (fig. 1). Here, the 0.75-ft thick Miami Limestone is exposed at land surface. The Miami Limestone is a pelecypod lime floatstone with a pelmoldic grainstone and packstone matrix. Pelecypods and molds of peloids are abundant; gastropods and the cheilostome bryozoan *Schizoporella* are uncommon. This unit is considered to be part of the bryozoan facies described by Hoffmeister and others (1967), and this occurrence lies within the western mapped limit of the Miami Limestone in northernmost Monroe County.

The Lake Flirt Marl, as defined by Sellards (1919), was penetrated only in well C-1141 in east-central Collier County and well PB-1704 in southwestern Palm Beach County (fig. 1). The thickness of the unit in the two wells ranges from 2 to 3 ft. The Lake Flirt Marl is composed of silty marl or quartz sand with a marl matrix. DuBar (1958) and Klein and others (1964) described similar deposits in southwestern Florida that they assign to the Lake Flirt Marl. Porosity is predominately intergranular microporosity with local root-mold and desiccation-crack porosity. Visual estimates indicate very low hydraulic conductivity. The localized areal distribution of the unit and the occurrence of root molds and desiccation cracks are consistent with accumulation within freshwater lakes.

Table 6. Lithofacies characteristics of the Pinecrest Sand Member of the Tamiami Formation

[Visual estimation was made for porosity; hydraulic conductivity was visually estimated by using a classification scheme from Fish (1988, table 8). Colors in the lithologic description refer to Munsell rock-color chart (Geological Society of America, 1991)]

Characteristic	Lithologic description
Quartz Sand Facies	
Depositional textures	Quartz sand with locally abundant fossils
Color	Mainly yellowish-gray 5Y 8/1 and yellowish-gray 5Y 7/2; locally medium-gray N5 to very light gray N8, very pale orange 10YR 8/2, light-olive-gray 5Y 6/1, light-olive-gray 5Y 5/2, grayish-yellow 5Y 8/4, grayish-orange 10YR 7/4, and dark-yellowish-orange 10 YR 6/6
Carbonate grains	Pelecypods (local oysters), undifferentiated skeletal fragments, echinoids, serpulids, bryozoans, and benthic and planktic foraminifers
Accessory grains	Trace to 3 percent phosphate and heavy mineral grains; local trace mica; local minor terrigenous clay
Grain size	Mainly very fine to fine quartz sand; ranges from silt to very coarse quartz sand; carbonate grains range from silt to pebble size
Porosity	Mainly intergrain and local intragrain, ranges from 5 to 25 percent
Hydraulic conductivity	Mainly low (0.1 to 10 feet per day); ranges from very low (less than 0.1 foot per day) to moderate (10 to 100 feet per day)
Pelecypod Lime Rudstone and Floatstone Facies	
Depositional textures	Pelecypod lime rudstone or floatstone with quartz sand-rich lime packstone and grainstone matrix
Color	yellowish-gray 5Y 8/1, medium-gray N5 to light-gray N7, very pale orange 10YR 8/2, pale-yellowish-brown 10YR 6/2
Carbonate grains	Pelecypods, undifferentiated skeletal fragments, gastropods, oysters, serpulids, bryozoans, cerithiids, and echinoids
Accessory grains	Trace to 3 percent phosphate and heavy mineral grains
Grain size	Carbonate grains up to pebble size; quartz sand mainly very fine to fine and ranges from silt to coarse size
Porosity	Mainly intergrain and moldic; local intragrain and shelter; ranges from 5 to 15 percent
Hydraulic conductivity	Mainly low (0.1 to 10 feet per day); ranges from very low (less than 0.1 foot per day) to moderate (10 to 100 feet per day)
Terrigenous Mudstone Facies	
Depositional textures	Silty terrigenous mudstone to quartz sand-rich terrigenous mudstone; locally grades into terrigenous clay-rich lime mudstone
Color	Light-olive-gray 5Y 5/2, light-olive-gray 5Y 6/1 and yellowish-gray 5Y 8/1; locally pale-olive 10Y 6/2, light-olive-gray 5Y 6/1, dusky-yellow-green 5GY 5/2, and yellowish-gray 5Y 7/2
Carbonate grains	Pelecypods (local oysters), benthic and planktic foraminifers, undifferentiated skeletal fragments, and fish scales
Accessory grains	Locally common quartz grains; trace to 1 percent phosphate grains; trace to 3 percent heavy mineral grains; local trace mica; trace plagioclase and microcline
Grain size	Mainly terrigenous clay; quartz grains range from silt to fine sand size; local medium to coarse quartz sand
Porosity	Intergrain; less than or equal to 5 percent
Hydraulic conductivity	Very low (less than 0.1 foot per day)

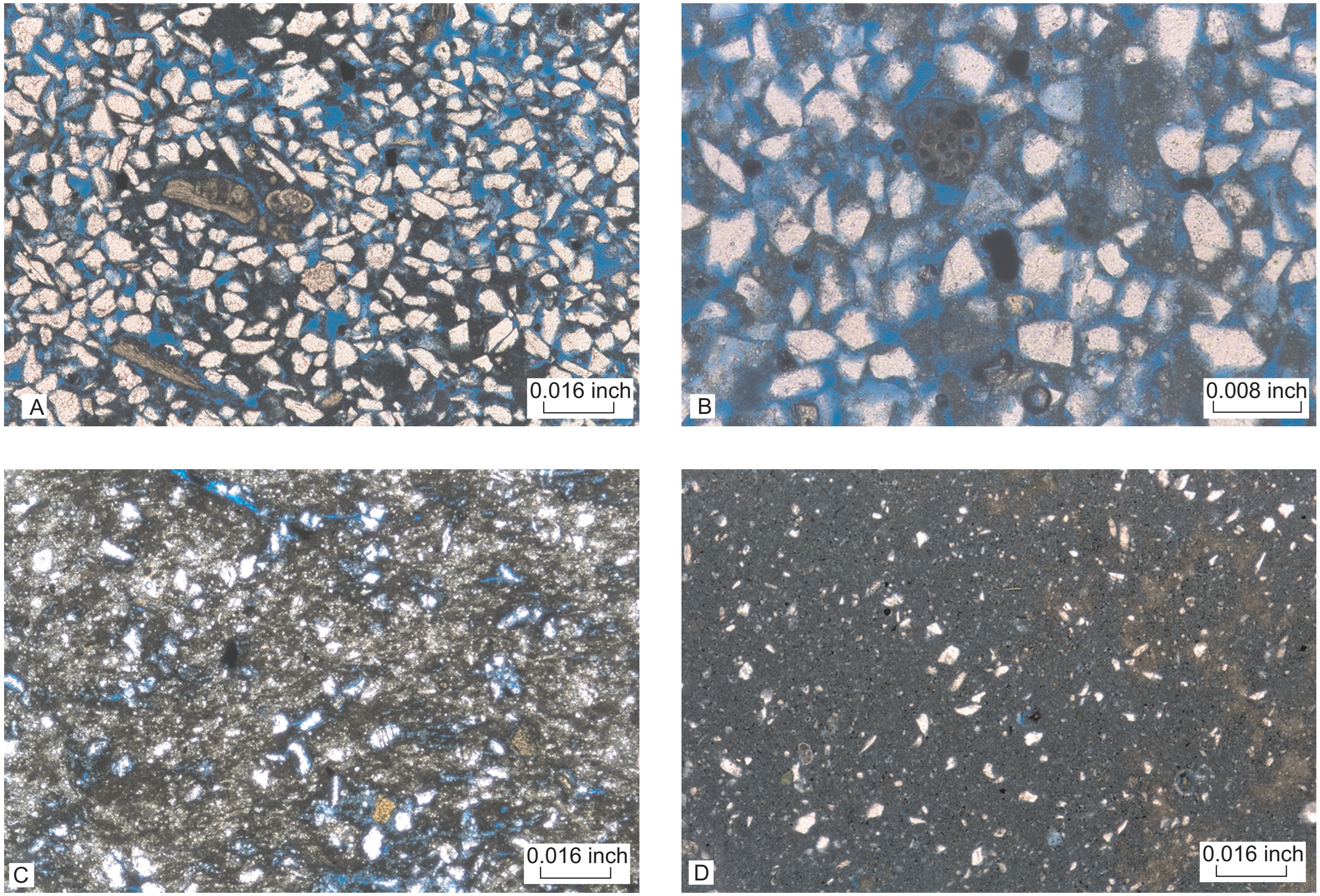


Figure 8. Thin-section photomicrographs showing lithofacies identified for the pinecrest Sand Member of the Tamiami Formation. Photographs represent (A) sample HXP-1 from well C-1183, fine quartz sand; (B) sample HXP-18 from well C-1182, very fine to fine quartz sand; (C) sample HXP-19 from well C-1182, terrigenous mudstone; and (D) sample HXP-2 from well C-1183, lime mudstone. Non-effective moldic porosity is shown. Original intergrain porosity slightly increased during sample preparation for A, B, and C. Plain-polarized light; blue epoxy highlights porosity. Appendix III presents complete description of rock samples.

Structure

Four hydrogeologic sections show lithostratigraphic units and structure in the study area. Their traces are shown in figure 9. Hydrogeologic sections A-A′ and A′-A″ extend northwest to southeast from southern Hendry County to southern Miami-Dade County (figs. 10 and 11). Hydrogeologic sections B-B′ and C-C′ extend west to east along Alligator Alley and Tamiami Trail, respectively (figs. 12 and 13).

The configuration of the top and base of the gray limestone aquifer (figs. 14 and 15) approximately conforms to the upper and lower boundaries of the Ochopee Limestone (figs. 10-13), respectively. Accordingly, the top and base of the aquifer are used herein to discuss the structural setting of the study area. The criteria used for determining the boundaries of the aquifer are presented later in the report. The depths below land surface of these boundaries in selected wells are given in table 7.

In the northern part of the study area in Hendry, Palm Beach, Collier and Broward Counties, comparison of the base of the gray limestone aquifer (fig. 15) and the top of the Arcadia Formation (Cunningham and others, 1998, fig. 17b) indicates similar structural configuration of both marker horizons. Two southeastward plunging synclines mapped at the top of the Arcadia Formation are approximately mirrored by the base of the gray limestone aquifer as shown in fig. 15. One structurally low area at the base of the aquifer lies in west-central Collier County (fig. 15, wells C-913 and C-1178), and the other extends through the intersection of Hendry, Palm Beach, and Broward Counties (fig. 15). Similarly, in the southern part of the study area, a southeast-to-southward plunging syncline at the Arcadia level (Cunningham and others, 1998, fig. 17b) coincides with an area where the altitude of the base of the gray limestone aquifer is low passing through well G-3677 (fig. 15).

In the northern part of the study area in Hendry, Palm Beach, Collier, and Broward Counties, areas of thick gray limestone aquifer (fig. 16) correspond to low areas mapped on the top of the Arcadia (Cunningham and others, 1998, fig. 17b). Additionally, in southeastern Hendry and eastern Collier Counties, a relatively thin area of the gray limestone aquifer trending northwest and passing through well HE-1113 (fig. 16) exists above a plunging anticline mapped at the top of the Arcadia. Correspondence in structural altitudes were not observed between the top of the Arcadia and the top of the gray limestone aquifer.

The coincidence between aquifer thickness, structural configuration at the base of the aquifer, and the structural attitude at the top of the Arcadia Formation suggests that Miocene paleotopography at the Arcadia level influenced deposition of the Ochopee Limestone. Comparison of maps shown herein and in Cunningham and others (1998) suggests accumulation of the Ochopee Limestone was thickest in paleotopographic low areas and thinnest in paleotopographic high areas. This hypothesis suggests that paleotopography played a role in controlling the thickness of the gray limestone aquifer. Alternatively, structural movements in parts of the study area may have occurred concurrent to Pliocene deposition of the Ochopee Limestone, permitting greater accumulation of carbonate sediment. This second hypothesis suggests structural movement may have locally influenced the thickness of the gray limestone aquifer in parts of the study area.

A northwest-southeast trending fault is suggested in eastern Collier County based on well-control data for the base of the gray limestone aquifer (fig. 15). Displacement could be as large as 60 ft. An offset of about 30 ft is indicated between two test wells along Alligator Alley, the Noble’s Road test well (C-1139) and the Sabine Road test well (fig. 15, C-1173), which is about 2,500 ft south of C-1139, and this offset is shown on hydrogeologic sections A-A′ and B-B′ (figs. 10 and 12). Two monitoring wells (C-1184 and C-1185) were installed in the gray limestone aquifer at the Noble’s Road site near well C-1139 (table 1). Well C-1185 is only about 60 ft west of C-1139, and well C-1184 is about 700 ft west of C-1139. On the basis of correlation between C-1184 and C-1185 using lithologic data and gamma-ray logs, it is postulated the fault is present between them and was active during deposition of the Ochopee Limestone and possibly the Pinecrest Sand (fig. 17). Both units are thicker in well C-1185 on the downthrown side of the fault. The thickening of these units between the wells could have resulted from differential erosional paleotopography of a subjacent unit prior to their deposition; however, the continuity in thickness of the lower semiconfining unit (unnamed formation) below the Ochopee Limestone (figs. 10 and 17) does not indicate erosion. If this fault is present, it is probably deep seated. It may not actually extend up as high as the Tamiami Formation, and the apparent displacement at the gray limestone aquifer level could be the result of differential rates of deposition caused by concurrent, deep-seated movement along the fault.

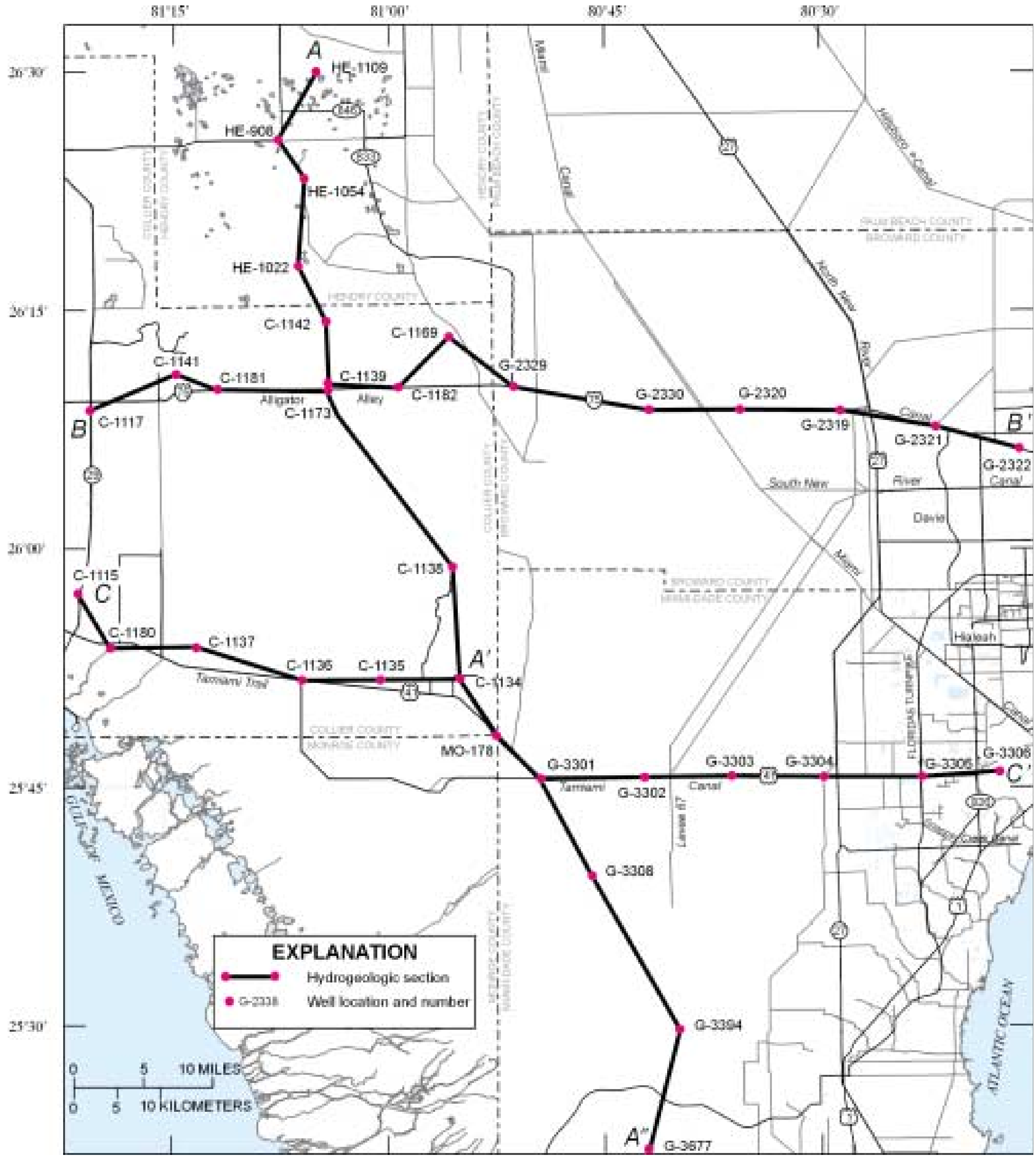
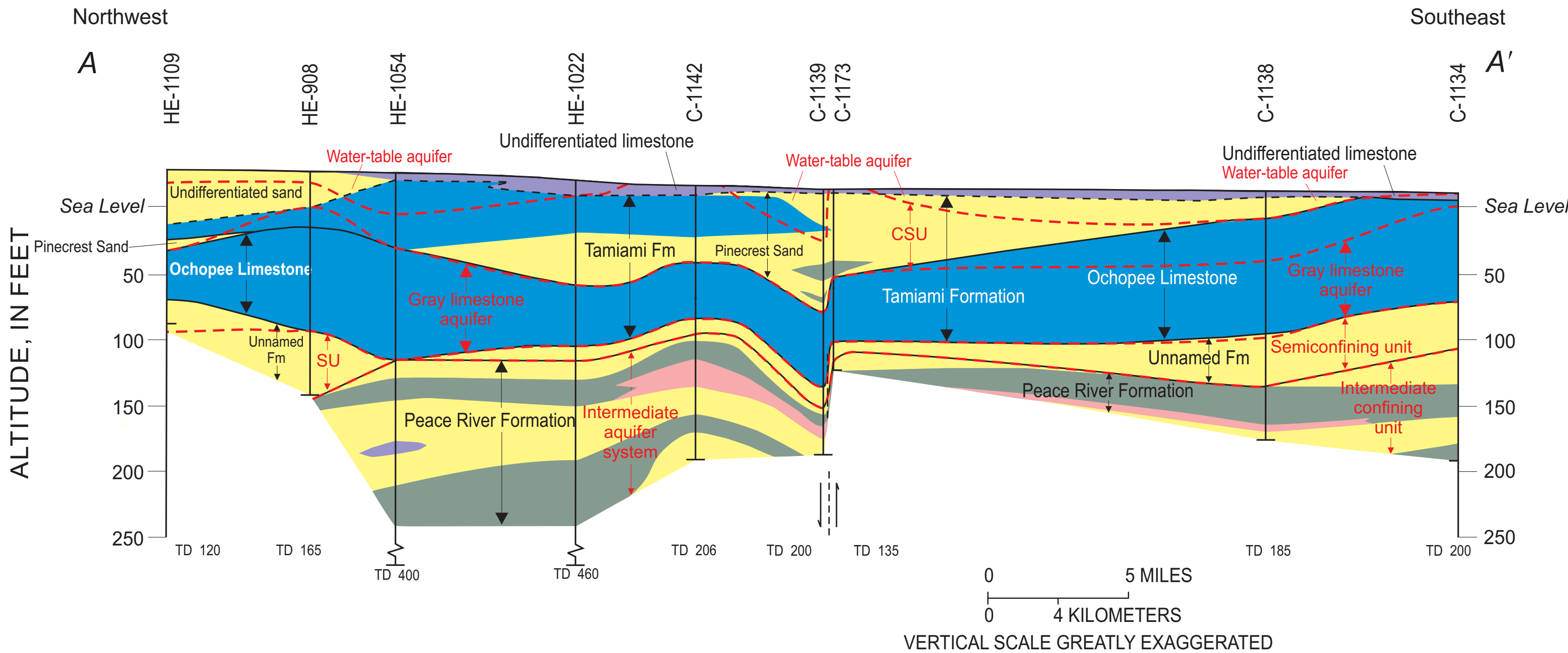


Figure 9. Traces of hydrogeologic section *A-A′*, *A′-A″*, *B-B′* and *C-C′* in the study area.



EXPLANATION

UNDIFFERENTIATED LIMESTONE

PELECYPOD RUDSTONE AND FLOATSTONE; MINOR PELECYPOD-RICH QUARTZ SAND OR SANDSTONE

QUARTZ SAND OR SANDSTONE

TERRIGENOUS MUDSTONE

DIATOMACEOUS MUDSTONE

HYDROSTRATIGRAPHIC BOUNDARY

LITHOSTRATIGRAPHIC BOUNDARY--Dashed where approximately located

POSTULATED FAULT--Direction of movement shown

CSU CONFINING TO SEMICONFINING UNIT

SU SEMICONFINING UNIT

Fm FORMATION

TD TOTAL WELL DEPTH, IN FEET BELOW LAND SURFACE

Figure 10. Hydrogeologic section A-A′. Location of section line shown in figure 9.

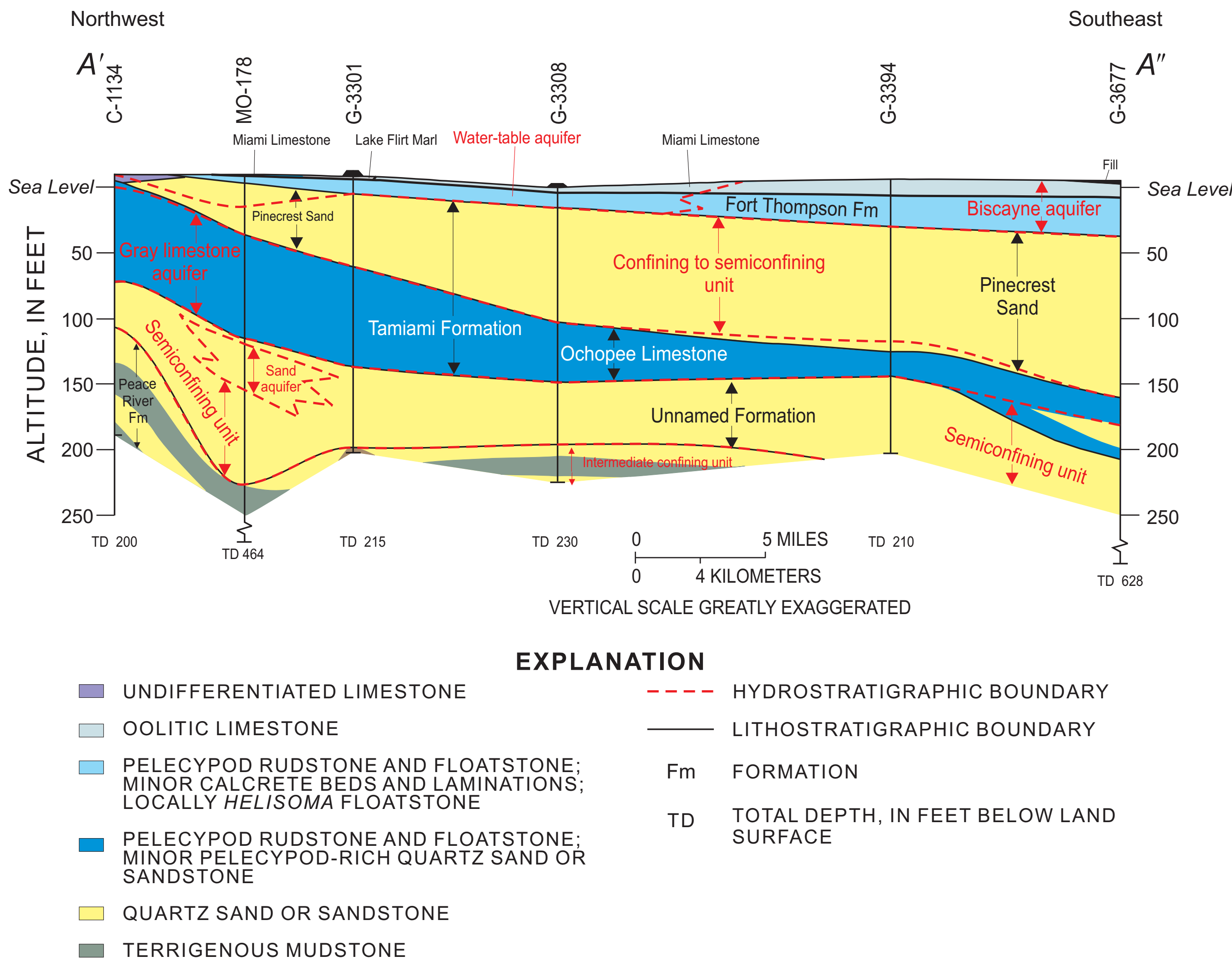


Figure 11. Hydrogeologic section A-A′. Location of section line shown in figure 9.

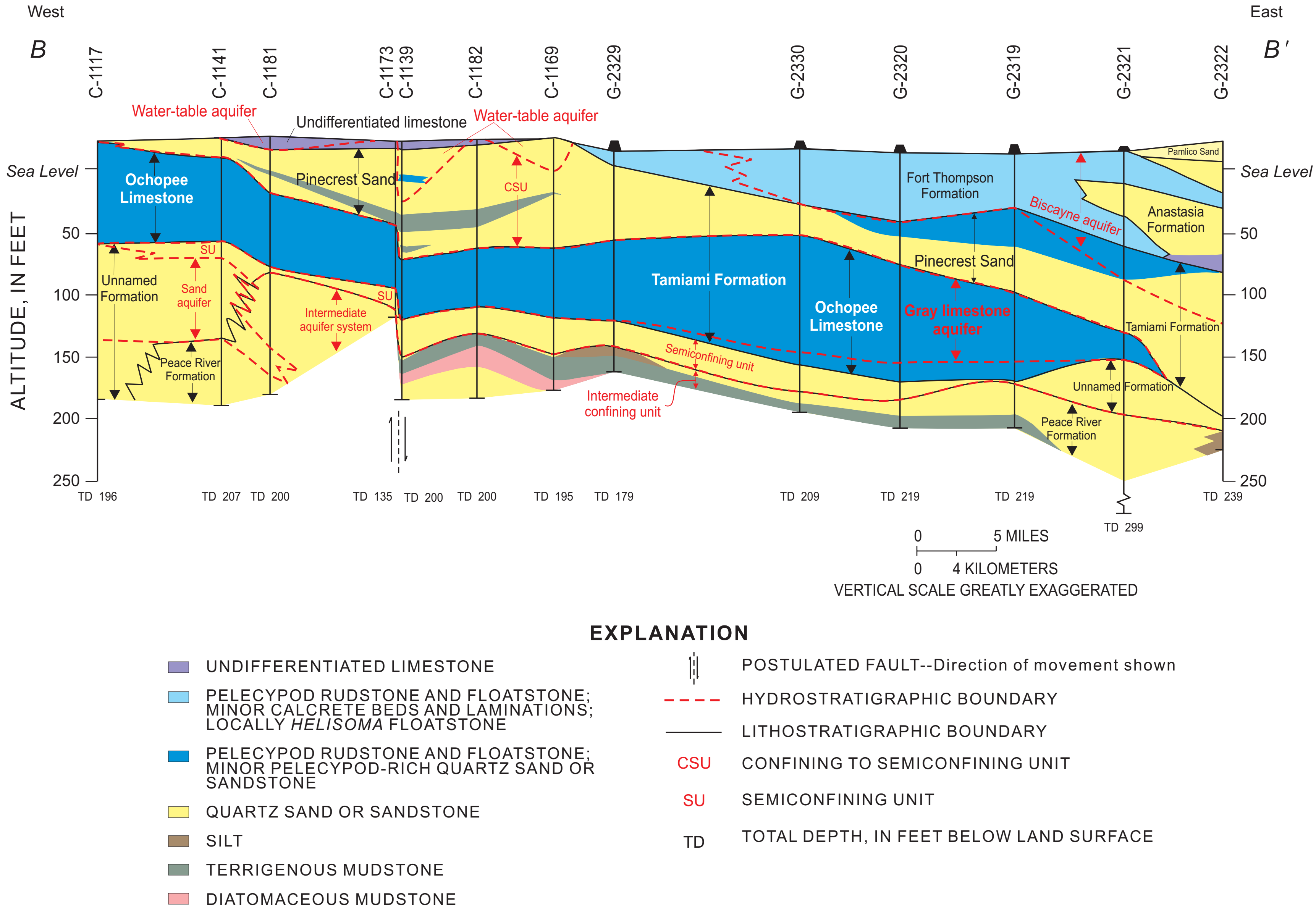


Figure 12. Hydrogeologic section *B-B′*. Location of section line shown in figure 9.

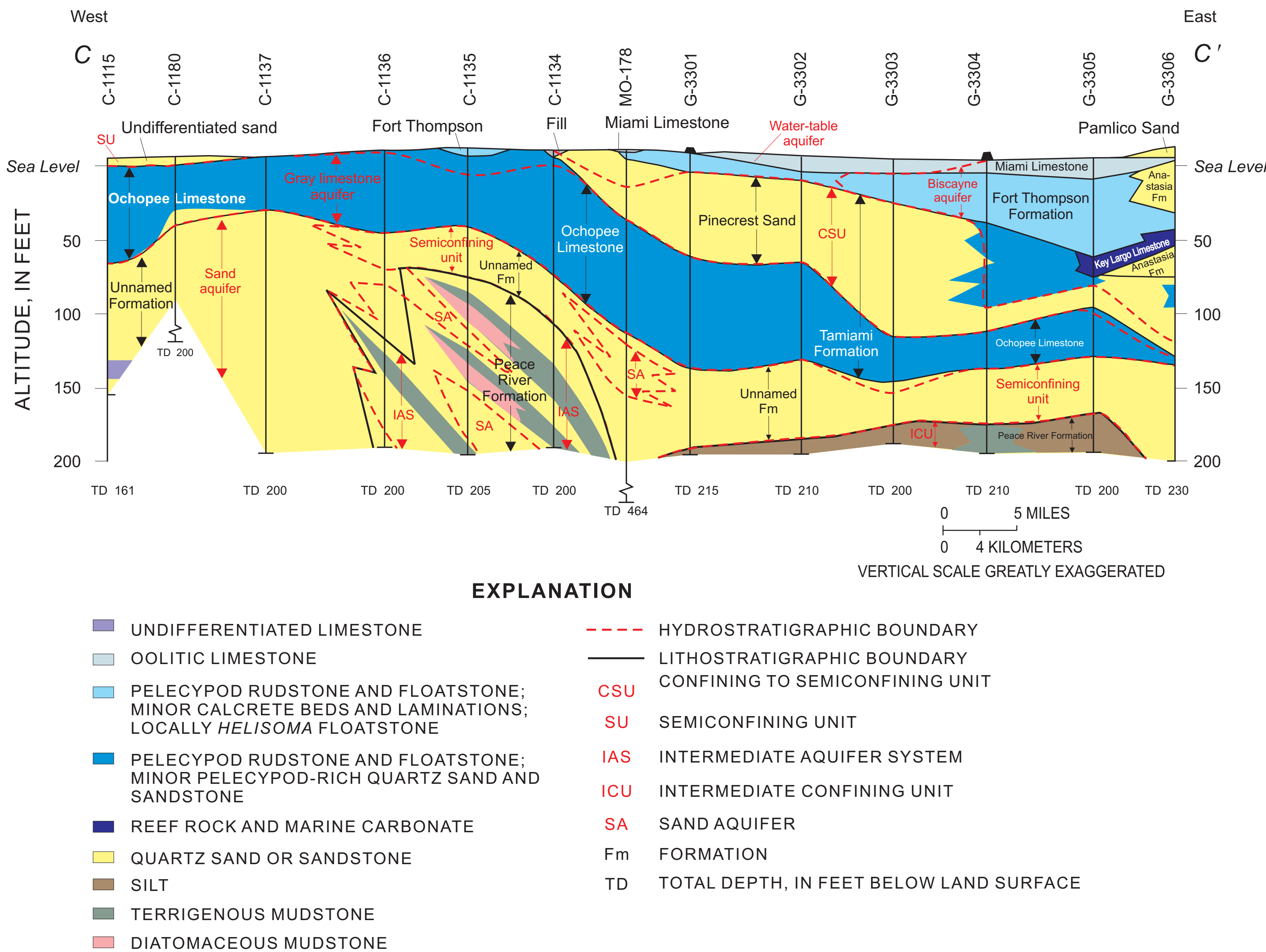


Figure 13. Hydrogeologic section *C-C′*. Location of section line shown in figure 9. Lithologies of test coreholes C-1134, C-1136, and MO-178 are based in part on descriptions from Weedman and others (1999).

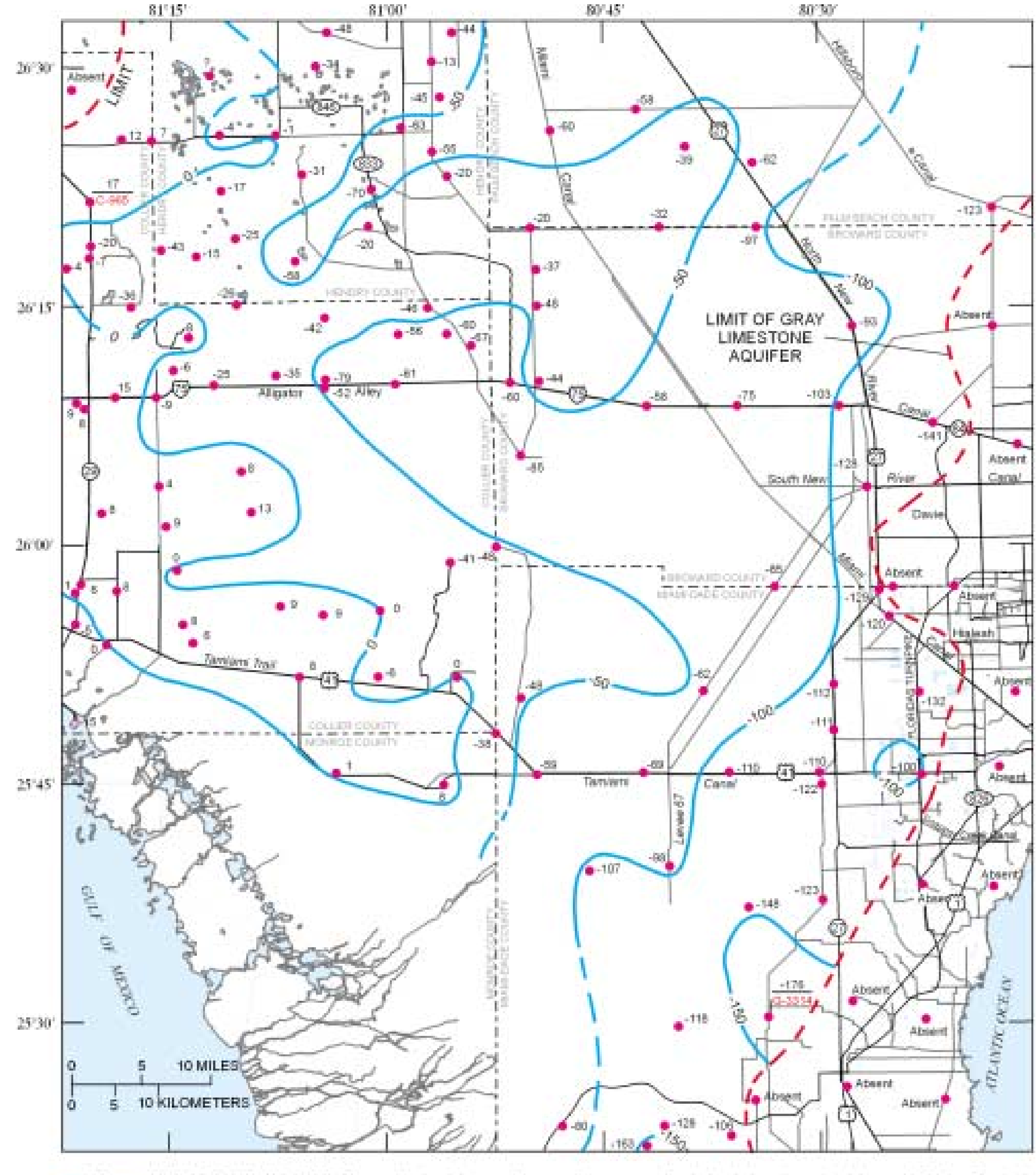
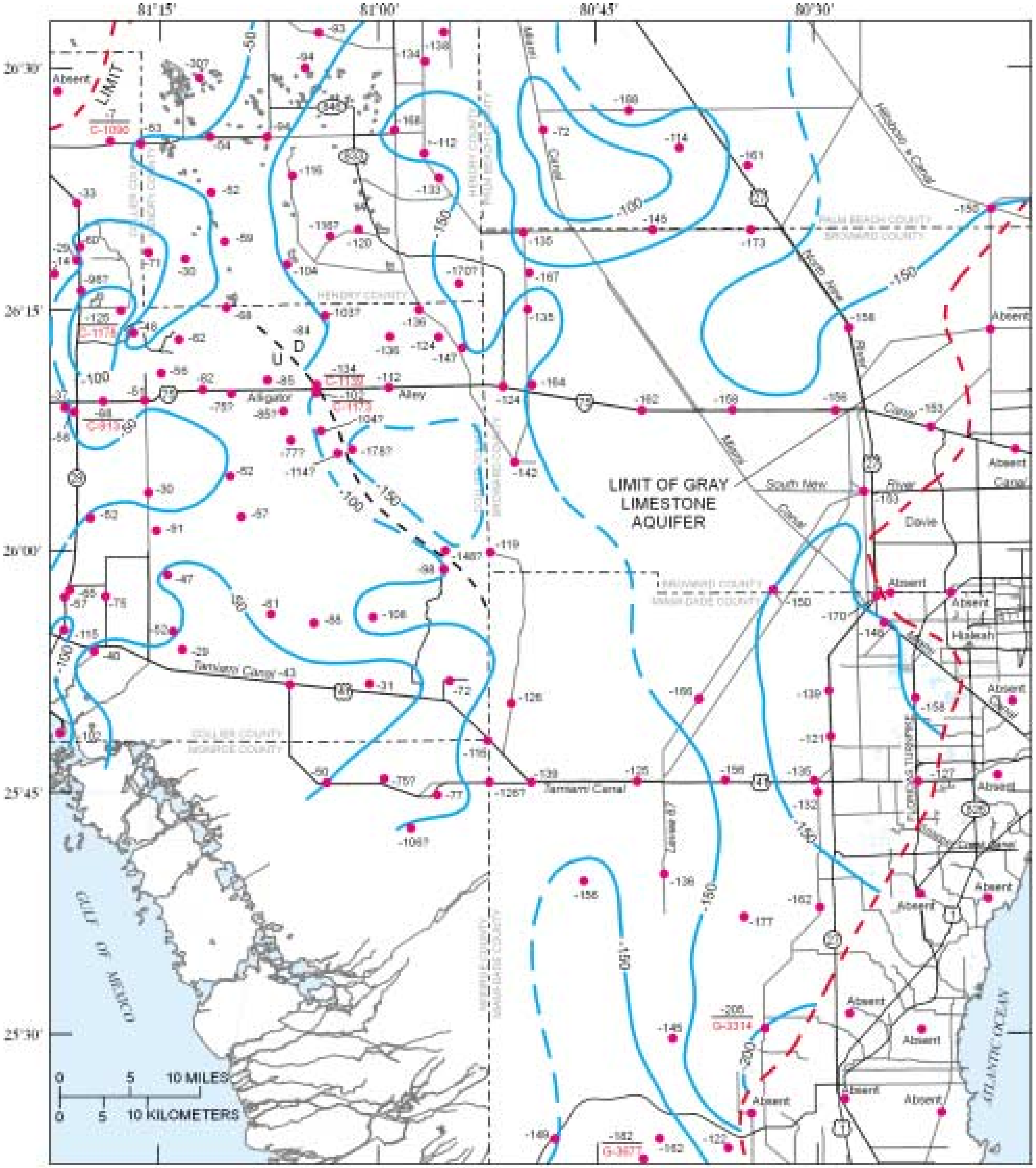


Figure 14. Altitude of the top of the gray limestone aquifer.



— -50 — LINE OF EQUAL ALTITUDE--Shows altitude of the base of the gray limestone aquifer, in feet below (-) sea level. Interval is 50 feet. Dashed where approximately located

U D POSTULATED FAULT--D is downthrown side and U is upthrown side

• -162 WELL LOCATION AND ALTITUDE--Number is altitude of the base of the gray limestone aquifer, in feet below (-) sea level. Question mark (?) indicates altitude is uncertain. Greater than (>) indicates depth is greater than value shown. Some well numbers are identified because they are mentioned in text. See figure 1 for all local well numbers.

Figure 15. Altitude of the base of the gray limestone aquifer.

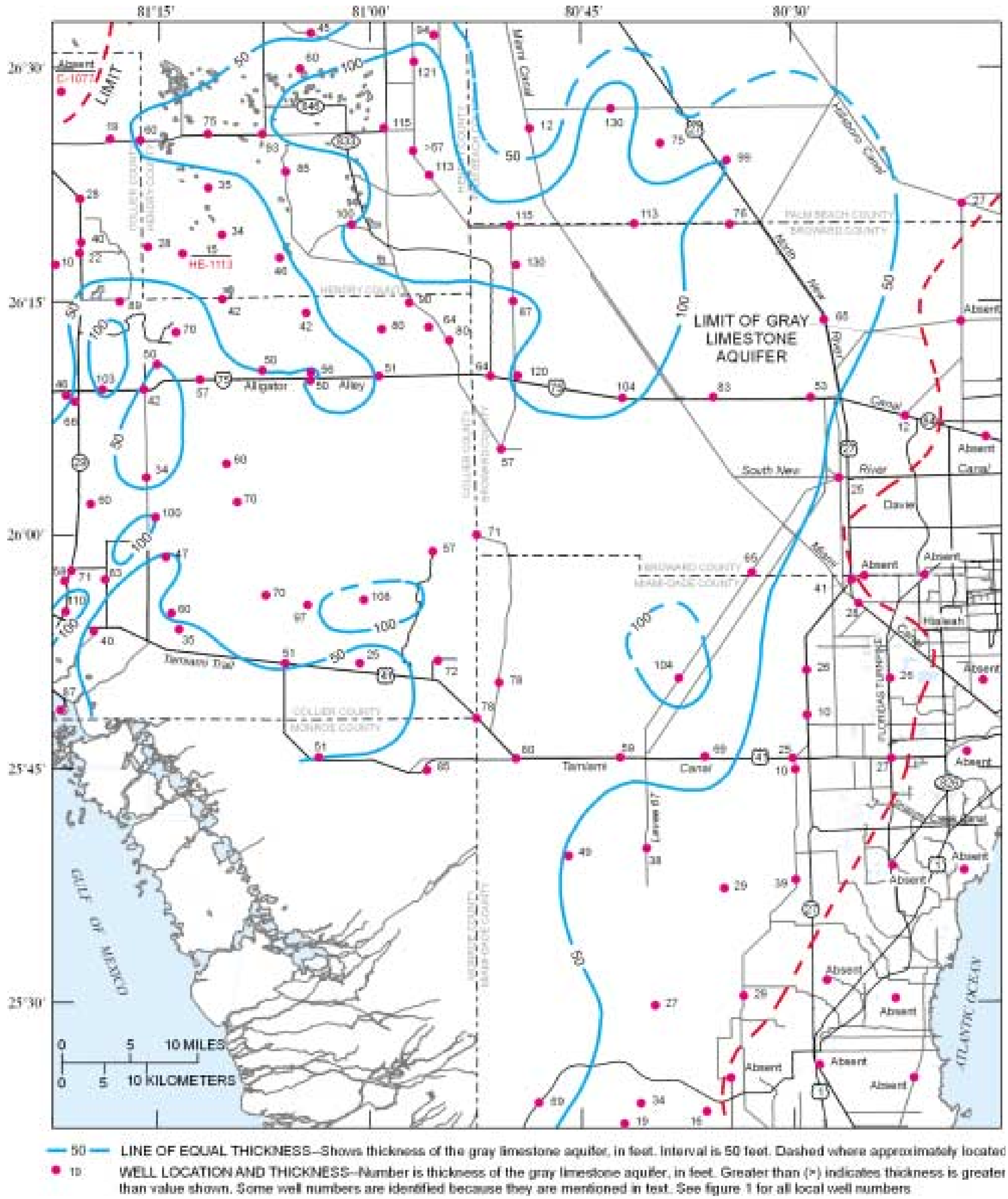


Figure 16. Thickness of the gray limestone aquifer.

Table 7. Tops of hydrogeologic units in selected wells as determined for this study

[Well locations shown in figure 1. All units shown in feet. Depths are from measuring point, which is at land surface or above. Type of data: 1, cuttings; 2, continuous core; 3, geophysical logs; and 4, reverse-air core. FGS, Florida Geological Survey; USGS, U.S. Geological Survey; DNP, did not penetrate; ?, questionable or uncertain depth, often because cuttings samples are of poor quality or are collected at large intervals; >greater than]

Local well identifier	Altitude of measuring point	Depth to top of upper confining or semi-confining unit	Depth to top of gray limestone aquifer	Depth to base of gray limestone aquifer	Type of data	Source of data
C-41	-5	?	20	107	1	USGS files
C-308	15	0	24	66	1	McCoy (1962)
C-701	34	?	?	130?	1	USGS files
C-791	38	?	30	90	1	USGS files
C-851	18	3	22	32	2	USGS files
C-873	37	?	?	140?	3	USGS files
C-913	15	Absent	0	103	1	Peacock (1983)
C-917	6	Absent	0	71	1	Peacock (1983)
C-918	8	Absent	0	83	1	Peacock (1983)
C-919	9	Absent	0	97	1	Peacock (1983)
C-920	9	Absent	0	70	1	Peacock (1983)
C-921	10	0	10	118	1	Peacock (1983)
C-922	8	Absent	0	70	1	Peacock (1983)
C-923	8	Absent	0	60	1	Peacock (1983)
C-927	8	Absent	0	60	1	Peacock (1983)
C-928	5?	0	10	120	1	Peacock (1983)
C-929	9	Absent	0	100	1	Peacock (1983)
C-930	15	10	50	100	1	Peacock (1983)
C-931	13	Absent	0	70	1	Peacock (1983)
C-965	21.96	0	5	55	1	Knapp and others (1986)
C-1074	26.71	0	20	80	1	Knapp and others (1986)
C-1077	30.64	Absent	Absent	Absent	1	Knapp and others (1986)
C-1090	25	4	13	32	2	FGS description
C-1091	13	Absent	4	50	2	FGS description
C-1115	5	Absent	4	62	2	Weedman and others (1997)
C-1117	13	Absent	5	71	2	Weedman and others (1997)
C-1125	36	?	?	150?	1	FGS-Fort Myers description
C-1126	40	?	?	115?	1	FGS-Fort Myers description
C-1128	38	?	?	115?	1	FGS-Fort Myers description
C-1133	38	?	?	142?	1	Current study
C-1134	10	0	10	82	2	Current study
C-1135	12	0	18	43	2	Current study
C-1136	10	Absent	2	53	2	Current study
C-1137	6	Absent	0	35	2	Current study
C-1138	11.4	20	52	109	2	Current study
C-1139	13	40	92	148	2	Current study
C-1140	8	2	9	55	2	Current study
C-1141	15	0	21	71	2	Current study
C-1142	16	0	58	100	2	Current study
C-1152	15	?	?	100?	1	Current study
C-1153	42	?	?	90	1	FGS-Fort Myers description
C-1154	20	0	40	80	1	Current study
C-1156	14	25	60	150	1	Current study
C-1157	14	50	70	150	1	Current study
C-1158	13	0	80	160	1	Current study
C-1159	12	?	?	190?	1	FGS description
C-1162	12	?	?	160?	1	Current study
C-1163	20	13	27	49	2	Cunningham and McNeil (1997)

Table 7. Tops of hydrogeologic units in selected wells as determined for this study (Continued)

[Well locations shown in figure 1. All units shown in feet. Depths are from measuring point, which is at land surface or above. Type of data: 1, cuttings; 2, continuous core; 3, geophysical logs; and 4, reverse-air core. FGS, Florida Geological Survey; USGS, U.S. Geological Survey; DNP, did not penetrate; ?, questionable or uncertain depth, often because cuttings samples are of poor quality or are collected at large intervals; >greater than]

Local well identifier	Altitude of measuring point	Depth to top of upper confining or semi-confining unit	Depth to top of gray limestone aquifer	Depth to base of gray limestone aquifer	Type of data	Source of data
C-1169	15	17	75	139	2	Current study
C-1173	13	0	65	115	2	Current study
C-1176	12	0	8	42	2	Current study
C-1178	19.2	3	55	144	2	Current study
C-1180	~5	0	6	45	2	Current study
C-1181	17	10	42	99	2	Current study
C-1182	13	0	74	125	2	Current study
C-1183	15	6	41	83	2	Current study
G-2296	15.5	?	60	180	1	USGS files
G-2311	~10	75	138	163	4	Fish (1988)
G-2312	~12	74	105	170	4	Fish (1988)
G-2313	~10	28	42	155	4	Fish (1988)
G-2314	~20	30	40	155	4	Fish (1988)
G-2315	~19	41	116	192	4	Fish (1988)
G-2316	~8	58	93	158	4	Fish (1988)
G-2317	~5	85	Absent	Absent	4	Fish (1988)
G-2318	~5	57	Absent	Absent	4	Fish (1988)
G-2319	~10	50	113	166	4	Fish (1988)
G-2320	~10	53	85	168	4	Fish (1988)
G-2321	~8	103	149	161	4	Fish (1988)
G-2322	~14	149	Absent	Absent	4	Fish (1988)
G-2329	~13	7	73	137	4	Fish (1988)
G-2330	~5	43	63	167	4	Fish (1988)
G-2338	~12	47	97	154	4	Fish (1988)
G-2340	~12	17	60	147	4	Fish (1988)
G-2341	~12	122	Absent	Absent	4	Fish (1988)
G-2346	~9	18	57	128	4	Fish (1988)
G-2891	13	30	50	180	1	FGS description
G-2912	~10	72	DNP	DNP	2	Current study
G-3238	14	?	?	140?	1	USGS files
G-3294	~9	117	138	179	4	Fish and Stewart (1991)
G-3295	~9	19	57	135	4	Fish and Stewart (1991)
G-3296	~8	43	70	174	4	Fish and Stewart (1991)
G-3297	~9	87	121	147	4	Fish and Stewart (1991)
G-3298	~8	99	140	166	4	Fish and Stewart (1991)
G-3299	~6	165	Absent	Absent	4	Fish and Stewart (1991)
G-3301	13	19	72	152	4	Fish and Stewart (1991)
G-3302	~6	14	79	138	4	Fish and Stewart (1991)
G-3303	~4	29	91	160	4	Fish and Stewart (1991)
G-3304	~9	102	119	144	4	Fish and Stewart (1991)
G-3305	~5	78	105	132	4	Fish and Stewart (1991)
G-3306	~12	127	Absent	Absent	4	Fish and Stewart (1991)
G-3308	~4	19	111	160	4	Fish and Stewart (1991)
G-3309	~2	16	100	138	4	Fish and Stewart (1991)
G-3310	~5	43	153	182	4	Fish and Stewart (1991)
G-3311	~12	51	135	174	4	Fish and Stewart (1991)
G-3312	~15	113	Absent	Absent	4	Fish and Stewart (1991)
G-3313	~15	123	Absent	Absent	4	Fish and Stewart (1991)
G-3314A	~5	56	181	210	4	Fish and Stewart (1991)

Table 7. Tops of hydrogeologic units in selected wells as determined for this study (Continued)

[Well locations shown in figure 1. All units shown in feet. Depths are from measuring point, which is at land surface or above. Type of data: 1, cuttings; 2, continuous core; 3, geophysical logs; and 4, reverse-air core. FGS, Florida Geological Survey; USGS, U.S. Geological Survey; DNP, did not penetrate; ?, questionable or uncertain depth, often because cuttings samples are of poor quality or are collected at large intervals; >greater than]

Local well identifier	Altitude of measuring point	Depth to top of upper confining or semi-confining unit	Depth to top of gray limestone aquifer	Depth to base of gray limestone aquifer	Type of data	Source of data
G-3315	~15	97	175	180	4	Fish and Stewart (1991)
G-3316	~12	95	Absent	Absent	4	Fish and Stewart (1991)
G-3317	~4	27	84	153	4	Fish and Stewart (1991)
G-3318	~4	43	132	166	4	Fish and Stewart (1991)
G-3319	~3	33	166	170	4	Fish and Stewart (1991)
G-3320	~9	87	Absent	Absent	4	Fish and Stewart (1991)
G-3321	~6	111	Absent	Absent	4	Fish and Stewart (1991)
G-3394	~6	36	124	151	4	Fish and Stewart (1991)
G-3671	~6	105	128	138	2	Current study
G-3673	~15	96	126	136	2	Current study
G-3674	~5	90	125	153	2	Current study
G-3675	~5	75	DNP	DNP	2	Current study
G-3677	~4	43	167	186	2	McNeill and others (1996)
HE-591	15	20	60	DNP	1	Smith and Adams (1988)
HE-868	25	30	95	DNP	1	Smith and Adams (1988)
HE-901	26	10	30	80	1	Smith and Adams (1988)
HE-902	22	30	85	190	1	Smith and Adams (1988)
HE-908	24	6	25	118	1	Smith and Adams (1988)
HE-976	38	?	?	154?	3	USGS files
HE-1016	23	10	40	75	1	Smith and Adams (1988)
HE-1021	20	5	40	140	1	Smith and Adams (1988)
HE-1022	20	12	78	124	1	Smith and Adams (1988)
HE-1037	27	35	75	120	1	Smith and Adams (1988)
HE-1054	24	30	55	140	1	Smith and Adams (1988)
HE-1075	18	3	62	156	1	Smith and Adams (1988)
HE-1089	30	?	?	60?	1	Current study
HE-1101	30	?	?	200?	3	USGS files
HE-1108	20	25	75	>132	1	Smith and Adams (1988)
HE-1109	26	9	60	120	1	Smith and Adams (1988)
HE-1110	15	0	35	148	4	Current study
HE-1112	21	Absent	46	80	2	Current study
HE-1113	20	12	35	50	2	Current study
HE-1114	20	16	63	91	2	Current study
HE-1115	32	4	100?	123	2	Current study
HE-1116	18	11	31	152	2	Current study
MO-138	14	Absent?	?	120?	1	Current study
MO-141	25	?	?	100?	3	USGS files
MO-177	8	Absent	0	78	2	Current study
MO-178	10	25	48	126	2	Current study
MO-179	6	Absent	5	56	2	Current study
NP-100	4.5	58	110	126	1	USGS files
PB-1428	12	119	135	162	4	Fish and others (1988)
PB-1485	10	?	68	198	1	Miller (1987)
PB-1696	11	0	50	125	1	Current study
PB-1703	20	19	80	92	2	Current study
PB-1704	11	3	73	173	2	Current study

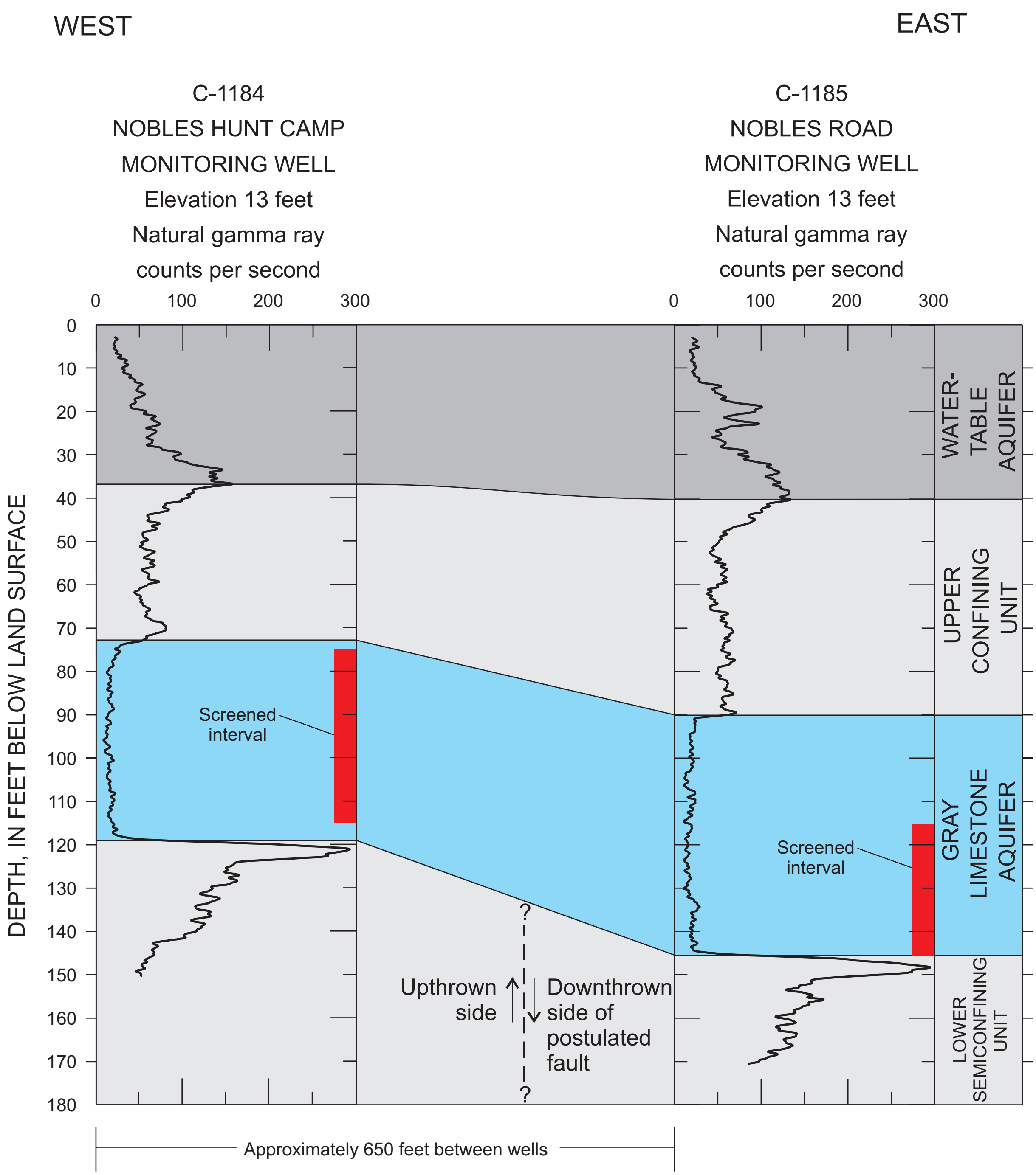


Figure 17. Hydrogeologic section showing correlation between wells C-1184 and C-1185 in eastern Collier County using gamma-ray logs. Well C-1185 is located 60 feet west of test corehole C-1139 at the Noble's Road site (see figure 1).

Evidence for a similar southeast fault trend has been observed in eastern Lee and northwestern Collier Counties, as indicated by possible displacement of a lower Arcadia Formation marker unit (Reese, 1999, fig. 6). The axis of a narrow structural depression mapped in this previous study can be projected to the southeast to approximately align with the postulated fault in northeastern Collier County (fig. 15).

The gray limestone aquifer and its confining unit were mapped in the portion of the study area in central and eastern Collier County and southern Hendry County (Shoemaker, 1998). The purpose of Shoemaker's study was to better define these units using surface geophysics in areas inaccessible to drilling or where well control was sparse. A total of 65 time-domain electromagnetic (TDEM) and 33 direct-current (DC) resistivity soundings were completed in the vicinity of, or along, transects between test wells drilled during this study as well as previous studies. These soundings provided information on the thickness and depth to geoelectric layers within the study area, and a comparison of geoelectric and hydrogeologic units at eight well locations suggested major contrasts in electrical resistivity are coincident with contacts between hydrogeologic units. Based on this comparison, it was assumed that geoelectric layers correspond to hydrogeologic units, and the hydrogeologic units were mapped using the TDEM and DC data in addition to data collected from 12 test wells.

Some of the surface-geophysical data were collected close to the projected position of the postulated fault in northeastern Collier County (fig. 15), and evidence for displacement of the base of the gray limestone aquifer across the fault was not found. However, in general, significant variability in estimates of the depth to the base of the gray limestone aquifer was found to be present over short distances. Potential sources of this variability include a complex hydrogeologic framework, poor correspondence between geoelectric and hydrogeologic units, poor resolution of the depth to the base of the gray limestone aquifer by surface-geophysical soundings, or cultural noise that was undetected (Shoemaker, 1998).

HYDROGEOLOGIC FRAMEWORK OF SOUTHERN FLORIDA

Southern Florida is underlain by aquifer systems that include the regionally extensive surficial and Floridan aquifer systems (Miller, 1986). In southwestern Florida, the intermediate aquifer system separates these two regional aquifer systems and contains aquifers that are sandwiched between thick confining units (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986). To the east, these aquifers of the intermediate aquifer system either pinch out or grade out by facies change, and only the intermediate confining unit is present in southeastern Florida. The intermediate confining unit is equivalent to the upper confining unit of the Floridan aquifer system (Miller, 1986). The relations between the hydrologic nomenclatural scheme proposed herein and those in other studies is presented in figure 18.

Surficial Aquifer System

The surficial aquifer system includes all rocks and sediments from land surface to the top of the intermediate confining unit or intermediate aquifer system. Its lower limit "coincides with the top of laterally extensive and vertically persistent beds of much lower permeability" (Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986). The surficial aquifer system in southern Florida consists mostly of beds of limestone, unconsolidated quartz sand, terrigenous mudstone, shell, and quartz sandstone. Limestone beds constitute the major component of two aquifers: the Biscayne aquifer and gray limestone aquifer. These aquifers can grade into one another and into a third aquifer, the water-table aquifer, which occurs to the west and north of the Biscayne aquifer (fig. 18).

The water-table aquifer extends from land surface to the top of confining beds that are part of the upper Tamiami Formation, or the aquifer merges with the top of the gray limestone aquifer. In much of the study area, the water-table aquifer comprises near-surface undifferentiated quartz sand and limestone or quartz sand and limestone of the Pinecrest Sand that merge laterally to the east with the Biscayne aquifer. In most of Monroe County and south-central and western Collier County, the gray limestone aquifer is the water-table aquifer; in this area the water-table aquifer has also been referred to as the Chokoloskee aquifer (Jarosewich and Wagner, 1985).

The Biscayne aquifer was named and defined by Parker (1951, p. 820) and is the only formally named aquifer contained within the surficial aquifer system. The Biscayne is the principal aquifer and a sole-source aquifer (Federal Register Notice, 1979) in southeastern Florida. It is the most productive aquifer of the surficial aquifer system and one of the most permeable water-bearing units in the world (Parker and others, 1955).

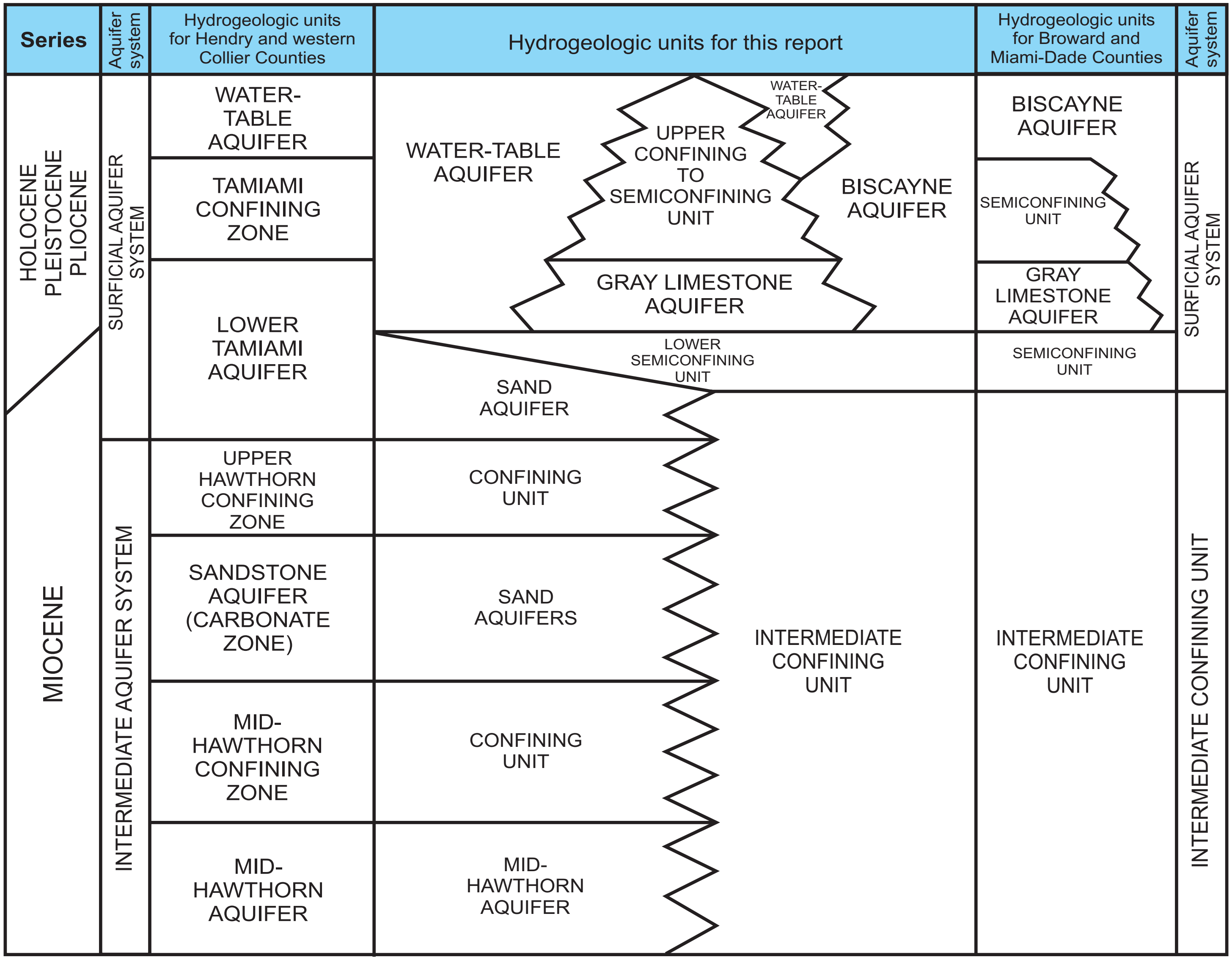


Figure 18. Hydrogeologic nomenclature used in previous studies and in this report. Nomenclatures are shown in a generally west-to-east order. Hendry County nomenclature by Smith and Adams (1988), western Collier County nomenclature by Knapp and others (1986), Miami-Dade County nomenclature by Fish and Stewart (1991), and Broward County nomenclature by Fish (1988).

Fish (1988, p. 20) defined the Biscayne aquifer as:

> "That part of the surficial aquifer system in southeastern Florida comprised (from land surface downward) of the Pamlico Sand, Miami Oolite (Limestone), Anastasia Formation, Key Largo Limestone, and Fort Thompson Formation all of Pleistocene age, and contiguous highly permeable beds of the Tamiami Formation of Pliocene age, where at least 10 ft of the section is highly permeable (a horizontal hydraulic conductivity of about 1,000 ft/d or more)."

For Miami-Dade (Fish and Stewart, 1991) and Broward (Fish, 1988) Counties, the permeability requisite of this definition provides an approach for estimating the boundary of the Biscayne aquifer.

Intermediate Aquifer System and Intermediate Confining Unit

In this report, the intermediate aquifer system is defined as those aquifers that lie below the top of the Peace River Formation. This definition is consistent with Fish's (1988) and Fish and Stewart's (1991) inclusion of limestones of the Tamiami Formation in the surficial aquifer system in Broward and Miami-Dade Counties. However, this definition differs from Miller's (1990) delineation of the intermediate aquifer system in southwestern Florida, which includes sand, limestone, and shell beds of the Tamiami Formation.

Water-yielding rocks of the intermediate aquifer system are known to be widely present only in the northwestern part of the study area in Hendry and western Collier Counties (Smith and Adams, 1988). Locally, quartz sand aquifers occur within the Peace River Formation in the study area; for example, in well C-1135 (fig. 13). However, the lateral extent of these aquifers in the study area is poorly understood.

HYDROGEOLOGY OF THE GRAY LIMESTONE AQUIFER

The gray limestone aquifer includes the Ochopee Limestone Member of the Tamiami Formation and, in some areas, a small portion of the underlying unnamed formation (fig. 4). Although the gray limestone aquifer is well confined in some areas, it is placed in the surficial aquifer system in this study, as it has been in previous studies (Fish, 1988; Fish and Stewart, 1991). Discussion of the gray limestone aquifer in this section includes its definitions, delineation of the thickness and extent of the aquifer and its confining units, description of its pore system geometry based on core study, determination of the hydraulic properties and porosity of the aquifer, and delineation of the distribution of these hydraulic properties and the degree of confinement of the aquifer. Measurements of water level and water quality in the gray limestone aquifer are used to gain an understanding of the ground-water flow system of the aquifer.

The gray limestone aquifer was defined by Fish (1988) as follows:

> "That part of the limestone beds (usually gray) and contiguous, very coarse, clastic beds of the lower to middle part of the Tamiami Formation that are highly permeable (having a hydraulic conductivity of about 100 ft/d or greater) and at least 10 ft thick."

In this report, the gray limestone aquifer was mapped according to hydraulic conductivity criteria that slightly differ from that of Fish (1988). Limestone and sandstone of the Ochopee were included in the gray limestone aquifer if hydraulic conductivities were moderate to very high (about 10 ft/d or greater). Quartz sand and sandstone of the unnamed formation contiguous to limestone beds at the base of the Ochopee were included in the gray limestone aquifer if hydraulic conductivity was high to very high (about 100 ft/d or greater) or included moldic porosity. In this study, hydraulic conductivity assessment is based on core samples, core analyses, aquifer tests, and flowmeter log results. The data assembled by Fish (1988) and Fish and Stewart (1991) for Broward and Miami-Dade Counties, respectively, were reevaluated, resulting in only minor changes.

The gray limestone aquifer is the same as the lower Tamiami aquifer in southern Hendry County (fig. 18). This equivalency is shown by hydrogeologic sections A-A′ and B-B′ (figs. 10 and 12). To the west and south in Collier and Monroe Counties, the aquifer becomes the water-table or Chokoloskee aquifer and is probably hydraulically continuous with the upper predominantly limestone part of the lower Tamiami aquifer of Knapp and others (1986) (figs. 12, 13, 18 and 19).

Characteristic borehole geophysical log responses in the gray limestone aquifer in an area where it is semiconfined to confined are shown in well C-1183 in eastern Collier County (figs. 1 and 20). Borehole log responses shown are induction resistivity, natural gamma ray, spontaneous potential, and single-point resistance. The gray limestone aquifer, as in most of the study area, is best defined by the natural gamma-ray curve; it has a gamma-ray activity that is much lower than that in the upper and lower confining units.

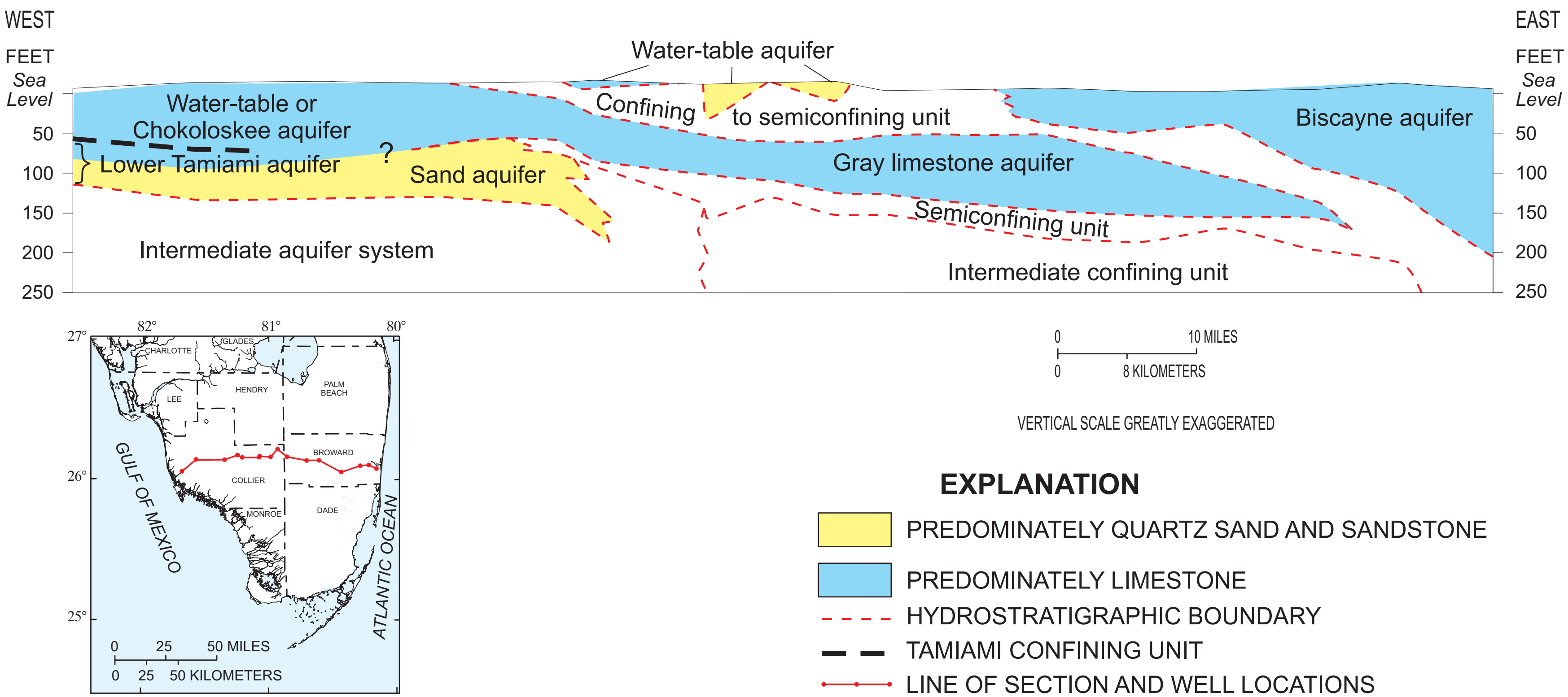


Figure 19. Relations among aquifers and confining units in a coast-to-coast section across the southern peninsula of Florida along Alligator Alley. Section line drawn, from west to east, through the Southern States Utilities and Picayune Strand test wells (Weedman and others, 1997), wells C-1117, C-1141, C-1181, C-1173, C-1139, C-1182, C-1169, G-2329, G-2330, G-2320, G-2319, G-2321, G-2322 (all listed in appendix II), and G-2345 and G-2347 (both listed in Fish, 1988).

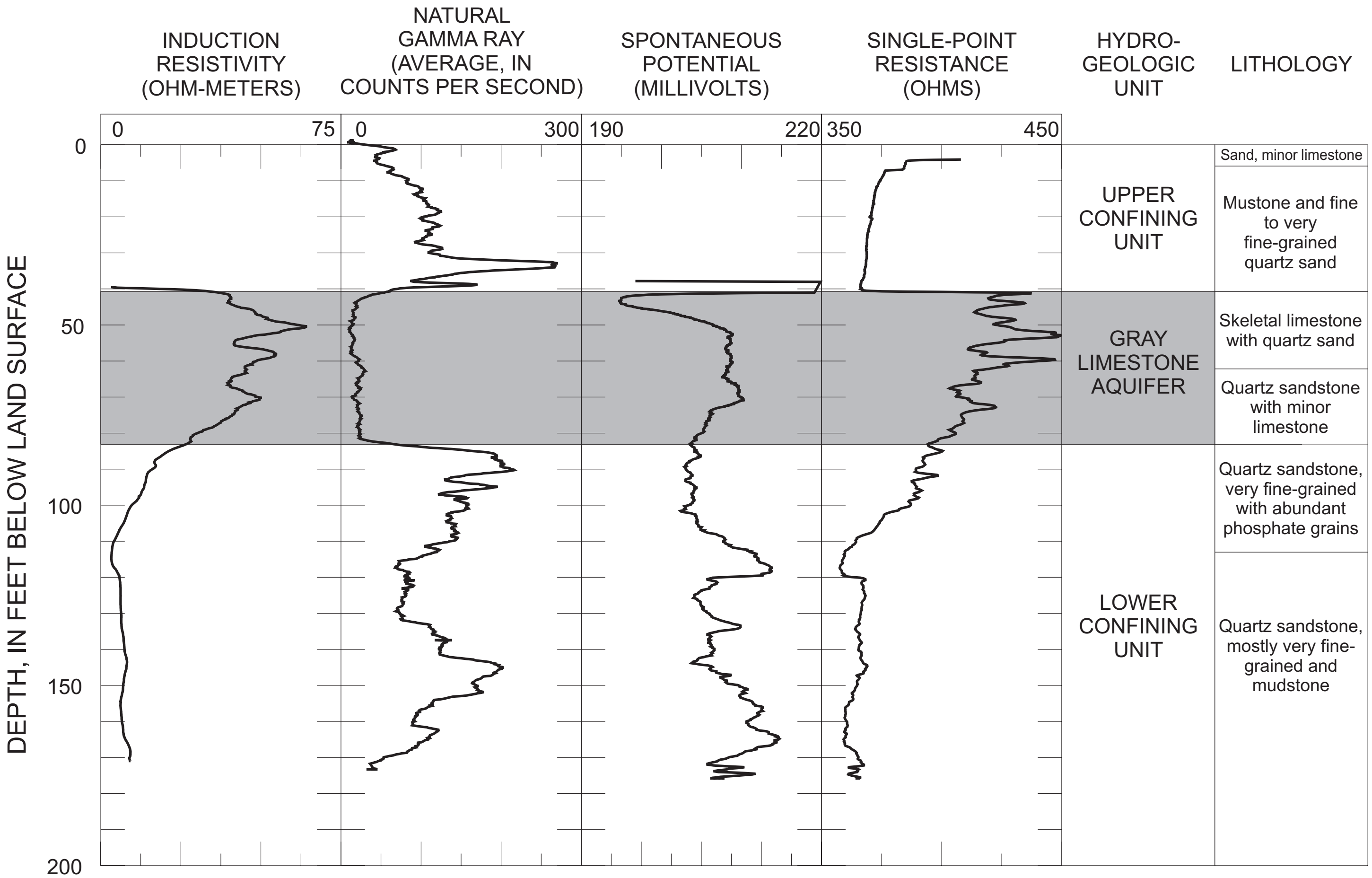


Figure 20. Geophysical logs, hydrogeologic units, and lithology of test well C-1183 at Baker's Grade site in eastern Collier County. Steel casing extended to 41 feet below land surface during geophysical logging.

Configuration, Thickness and Extent of the Aquifer and Its Confining Units

The geometry, thickness, and physical extent of hydrogeologic units were delineated on the basis of lithologic and borehole geophysical data, well-to-well correlation, core sample analysis, an evaluation of available flowmeter log data, and aquifer test results. The configuration, extent, and thickness of various water-bearing and confining units may not necessarily correspond to geologic units that underlie this area. Rather, a comparison of the relative change in permeability between adjoining rock units and their lithofacies played an integral part in helping to define and delineate major aquifers and confining units. Hydrogeologic and lithostratigraphic units are shown on the hydrogeologic sections (figs. 10-13).

The top and base of the gray limestone aquifer are similar in that both surfaces are shallowest in Collier and Hendry Counties and slope to the southeast and east (figs. 14 and 15). The altitude of the top of the gray limestone aquifer generally ranges between sea level and 100 ft below sea level in the study area. However, it is as much as 17 ft above sea level in northwestern Collier County (fig. 14, well C-965) and as low as 176 ft below sea level in south-central Miami-Dade County (fig. 14, well G-3314). The altitude of the base of the aquifer generally ranges from 50 to 160 ft below sea level, but the basal surface can be comparatively irregular in some areas. This is apparent in northwestern to central Collier County where the base of the aquifer is as shallow as 7 ft below sea level in well C-1090 and extends to a depth of 125 ft below sea level in well C-1178 (fig. 15). The base of the aquifer lies at a maximum depth of 205 ft below sea level in southeastern Miami-Dade County (fig. 15, well G-3314). An irregularly shaped anticline on the top of the gray limestone aquifer extends across southwestern Palm Beach, northwestern Broward, and southern Hendry Counties with an altitude as high as 20 ft below sea level. On the base of the aquifer, a syncline is present in some of the same area occupied by this anticline.

The thickness of the gray limestone aquifer generally ranges from 30 to 100 ft (fig. 16). The thickness of the unnamed formation included within the aquifer at its base ranges from 1 to 20 ft in seven test wells where it is present (appendix II). The aquifer is thickest in southwestern Palm Beach, northwestern Broward, and southern Hendry Counties where it ranges from 100 to as much as 130 ft thick. Local areas of similar thickness are found in western and southeastern Collier County and northern Miami-Dade County. Many of the areas where the aquifer is thick correspond to where the altitude of the base of the aquifer is low, such as in southern Hendry County, northwestern Broward County, and parts of western Collier County (figs. 15 and 16).

The northern and western extents of the gray limestone aquifer were not defined in this study. Although the aquifer is interpreted to be absent in well C-1077 in northwestern Collier County (fig. 16), the lower Tamiami aquifer is mapped as being present in most of western and northeastern Hendry County (Smith and Adams, 1988, fig. 21), which are outside of the study area. However, the limestones of the Tamiami Formation, which are included in the lower Tamiami aquifer, thin to the north, and sand and sandstone layers make up most of the thickness of the formation in central Hendry County (Smith and Adams, 1988, p. 10).

The easternmost extent of the gray limestone aquifer corresponds closely to the limits previously delineated by Fish (1988) and Fish and Stewart (1991). In northeastern Broward County, the eastern edge of the aquifer occurs at the transition from highly permeable limestone or contiguous shell sand to a significantly less permeable facies composed of sandy, clayey limestone and quartz sand and sandstone. In northeastern Miami-Dade County, the eastern limit of the aquifer is mapped where the aquifer merges with the Biscayne aquifer and the intervening semiconfining unit wedges out. South of the Tamiami Trail, the eastern boundary occurs at a transition to less-permeable siliciclastic sediments.

The gray limestone aquifer is overlain and underlain by upper and lower confining to semiconfining units in most of the study area. These units are usually composed of siliciclastics of low to very low hydraulic conductivity (sand, clayey sand, mudstone, and clay), but they can also be principally limestone of low hydraulic conductivity (figs. 10-13). As described earlier in this report, rock lithofacies and their interpreted hydraulic properties served as important factors in delineation of water-bearing and less-permeable hydrogeologic units.

The term “confining unit” is often used in a general sense in this report. The presence of confining units bounding the gray limestone aquifer does not necessarily imply confining conditions, rather that the aquifer is bounded by lithologic units that are less permeable than the aquifer as determined by visual estimation, core analysis, or aquifer testing. Terms used herein to further qualify the degree of confinement provided by a confining unit are “semiconfining unit” and “good confining unit.” The term “semiconfining” indicates a range in confinement from poor to moderate. As described later in this report, the gray limestone aquifer can be bounded above by what is described as a semiconfining unit, yet characteristics of the response of the aquifer to an aquifer test can indicate unconfined conditions. The terms “good confinement” or “well confined” are based on leakance as determined from aquifer testing, and they are defined using this property later in the report. Leakance is related to the thickness and vertical hydraulic conductivity of a confining unit.

Contour maps that delineate the top and thickness of the confining unit bounding the top of the gray limestone aquifer are shown in figures 21 and 22. The altitude of the top of the confining unit ranges from 10 ft above sea level to 50 ft below sea level in much of the study area, and this surface slopes downward to the east and to the southeast (fig. 21). The areas of lowest altitude of the top of the confining unit are in eastern Palm Beach and Broward Counties and in eastern and south-central Dade County where the altitude ranges from 50 to 108 ft below sea level. These areas adjoin and are close to the eastern limit of the gray limestone aquifer.

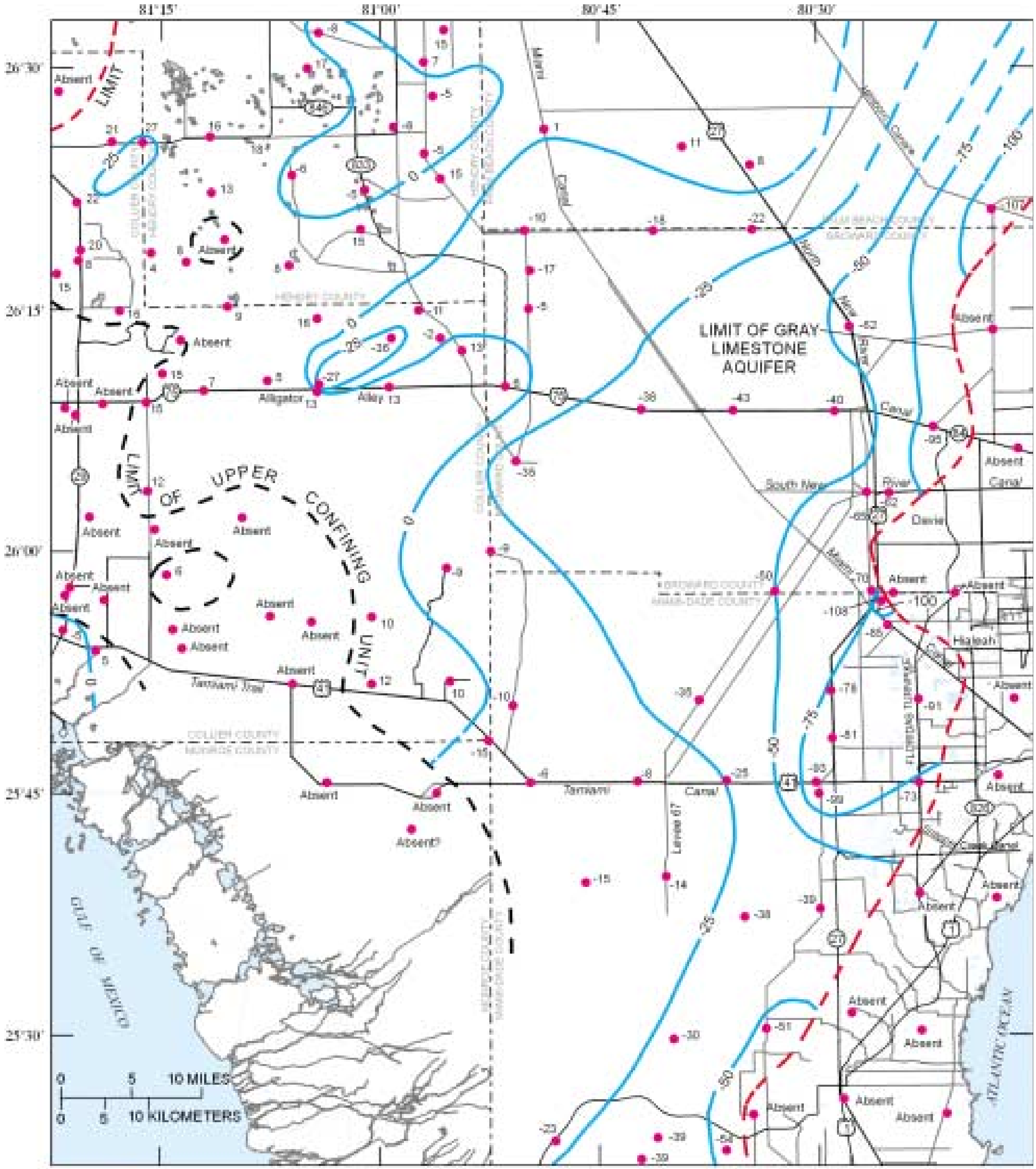
The upper confining unit ranges from 20 to 60 ft in thickness in most of the study area, but is absent to the west and southwest in much of Collier County and most of Monroe County (fig. 22). The confining unit is thickest in south-central and southwestern Miami-Dade County, where the unit is as much as 125 ft thick in well G-3314 (fig. 22). This area corresponds, in part, to areas of low structural altitude of the top of the gray limestone aquifer (fig. 14). The unit thickens to 50 ft or more in an area that extends southeastward from southern Hendry County through northeastern Collier County and into western Broward County. This area also generally corresponds to an area of low altitude of the top of the gray limestone aquifer. The confining unit also thickens to 50 ft or more in southern Palm Beach County and north-central and central Broward County. Local thickening occurs in west-central Collier County in well C-1178 (fig. 22) and corresponds to an area where the gray limestone aquifer also thickens. The upper confining unit is thin in an area that includes small contiguous parts of southwestern Palm Beach, northeastern Broward, and southern Hendry Counties, and in this area the underlying gray limestone aquifer is both thick and its upper surface is elevated. In southeastern Hendry County, the upper confining unit is locally absent (fig. 22, well HE-1112); quartz sand deposits equivalent to the upper confining unit here have moderate hydraulic conductivity.

A semiconfining unit is present below the gray limestone aquifer in most of the study area (figs. 10-13). However, except for parts of Collier County in the western part of the study area, the base of this semiconfining unit marks the base of the surficial aquifer system; it is underlain by silt and mudstone confining beds of very low hydraulic conductivity contained in the intermediate aquifer system or the intermediate confining unit.

Controls on Porosity and Permeability

Porosity in the gray limestone aquifer is primarily intergrain and moldic (skeletal moldic), using the pore type terminology of Lucia (1995). Solution-enlarged pore spaces and minor intraparticle, root-mold, and boring porosity are distributed locally. Moldic porosity can be classified as “separate vug” or “touching vug” porosity and is related to grain packing. The rudstones of the gray limestone aquifer contain touching vug, separate vug, and intergrain porosity (fig. 7), whereas the floatstones are characterized by separate vug and intergrain porosity. In the rudstones with a matrix that contains intergrain porosity, moldic pore space is linked by both touching vugs and the intergrain pore space. In the floatstones with a matrix that contains an intergrain porosity, the moldic pore space is connected only by the intergrain pore space. Rocks containing pore spaces connected only by intergrain pores have relatively low values of hydraulic conductivity, whereas rocks containing touching vug pore space have relatively high values of hydraulic conductivity. Intergrain, moldic, and solution-enlarged pore spaces all contribute to the overall hydraulic conductivity of the rocks of the gray limestone aquifer.

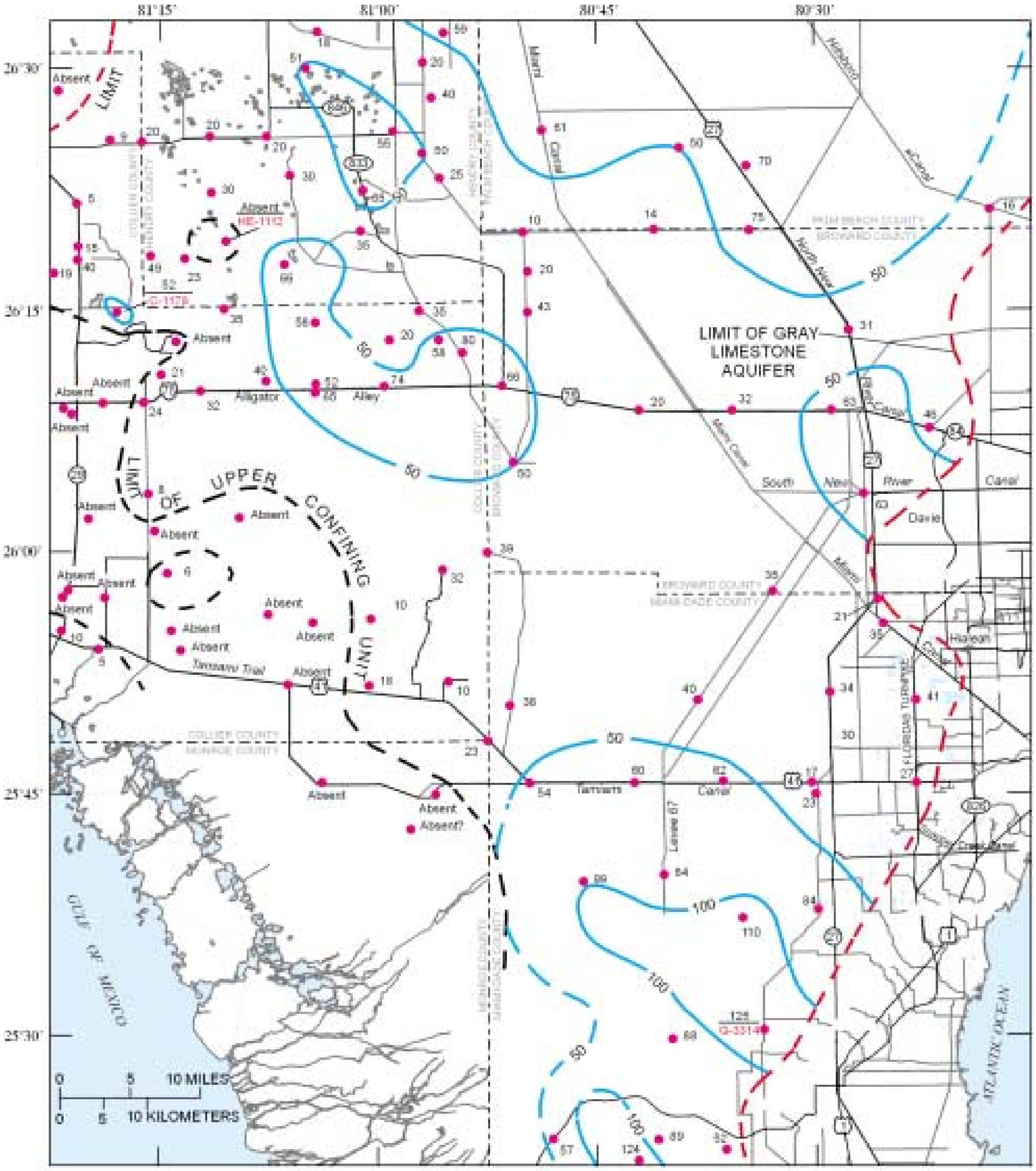
Diffuse-carbonate and conduit flow are important ground-water flow mechanisms in the gray limestone aquifer. In diffuse-carbonate flow, the movement of water is partitioned within and flows through small-scale moldic and intergrain pore space contained in the rock. The pathways of ground-water movement in a conduit fluid-flow system are principally along bedding planes, fractures, joints, faults, and any other type of touching vugs expanded by chemical dissolution.



— 25 — LINE OF EQUAL ALTITUDE--Shows altitude of the top of the upper confining unit, in feet above or below (-) sea level. Interval is 25 feet. Dashed where approximately located

• -39 WELL LOCATION AND ALTITUDE--Number is altitude of the top of the upper confining unit, in feet above or below (-) sea level. See figure 1 for all local well numbers

Figure 21. Altitude of the top of the upper confining unit of the gray limestone aquifer.



— 50 — LINE OF EQUAL THICKNESS--Shows thickness of the upper confining unit, in feet. Interval is 50 feet. Dashed where approximately located

• 52 WELL LOCATION AND THICKNESS-Number is thickness of the upper confining unit, in feet. Some well numbers are identified because they are mentioned in text. See figure 1 for all local well numbers

Figure 22. Thickness of the upper confining unit of the gray limestone aquifer.

Hydraulic Properties and Porosity Estimates

Estimates of the hydraulic properties of the gray limestone aquifer, including transmissivity, hydraulic conductivity, and the leakance were made by analysis of aquifer-test data. Additionally, qualitative estimates of porosity and hydraulic conductivity for the aquifer and bounding units were made visually by using a classification scheme developed by Fish (1988, table 8) during core sample description (appendix II). Quantitative estimates of these same parameters within the aquifer were made through laboratory analysis of core-plug samples. The "Core description and core sample analysis" section describes these methods in detail.

Historical Hydraulic Test Data

A total of 37 aquifer tests from published reports or made available from the files of private consultants were reviewed, including multiwell, single-well, specific-capacity, and step-drawdown tests (table 8). In three tests, the reported estimates were based on more than one of these methodologies. The least accurate of these methods used to determine transmissivity is the specific capacity test (Fish, 1988, p. 23); only five tests are based solely on this method. Two aquifer tests were performed within separate intervals of the gray limestone aquifer at the same site (table 8, map nos. 20 and 20A). Information in table 8 includes map number, site name, operator of the test, and source of information. The locations of all aquifer test sites are shown in figure 23.

On the basis of historical test data, the transmissivity of the gray limestone aquifer ranges from 5,800 to 160,000 ft^2/d, with storativity (storage coefficient) ranging from 1.0×10^{-5} to 6.0×10^{-4} (table 8). Where the aquifer is confined or semiconfined, reported values for leakance varied widely, ranging from about 8.6×10^{-7} to 2.3×10^{-2} 1/d. The test at sites with map numbers 33 to 36 (table 8) are interpreted to indicate unconfined conditions; these sites are located in western Collier County (fig. 23), and the aquifer in this area has been referred to as the water-table aquifer (Knapp and others, 1986). The average hydraulic conductivity of the gray limestone aquifer determined by aquifer test, as reported by others, ranged from 148 to 2,900 ft/d (table 8).

Aquifer Tests Conducted During this Study

Ten aquifer tests were conducted at six sites as part of this study (table 9). Four tests were multiwell tests and six were single-well tests. Five of the test sites are located in eastern Collier County and one is located in northern Monroe County. The multiwell tests were performed at the Bear Island Campground, Big Cypress Sanctuary, FAA Radar, and Trail Center sites (table 9, map nos. 38-40 and 42). The former two sites are located just to the north of Alligator Alley, and the latter two are located along Tamiami Trail (fig. 23). Single-well tests were performed at the Noble's Farm, Bear Island Campground, Big Cypress Sanctuary, Alligator Alley East, and FAA Radar sites (table 9, map nos. 37, 38A, 39A, 40A, 40B, and 41).

All of the tests conducted in this study were of the gray limestone aquifer except two, which were single-well tests of sand aquifers within the Peace River Formation at the FAA Radar site. Hydraulic properties also were determined for the sand aquifer of the unnamed formation at the Bear Island Campground site using the multiwell test data collected during the test of the overlying gray limestone aquifer. This information was derived from numerical analysis of monitoring well drawdown data, which included data from well C-1141 completed in the sand aquifer (table 9, map no. 38B).

Analysis of aquifer test and heat-pulse flowmeter data and review of long-term water-level data suggest that the gray limestone aquifer is unconfined at the Bear Island Campground and FAA Radar sites, semiconfined at the Trail Center site, and confined at the Big Cypress Sanctuary site. Flow zones were determined at all four of these multiwell test sites using flowmeter data, and these zones together with other borehole geophysical logs and hydrogeologic units are shown in figure 24.

Analysis of the gray limestone aquifer test data at the FAA Radar site was made by using the Neuman (1972) unconfined solution (table 9). The site plan and time-drawdown plots for aquifer tests conducted at this site are shown in figure 25. The time-drawdown plots are from a monitoring well in the gray limestone aquifer (well C-1145) during the multiwell test and from the lower sand aquifer monitoring well (C-1143) during a single-well test (table 9). Data collected from single-well aquifer tests of the two sand aquifers of the intermediate aquifer system at this site (fig. 24) were evaluated using the Theis recovery solution (Theis, 1935). During the multiwell test of the gray limestone aquifer, no drawdown was observed in the monitoring wells completed in these well-confined sand aquifers, despite a 24-hour pumping period with an average pumping rate of 297 gal/min.

Table 8. Historical aquifer-test results for the gray limestone aquifer or equivalent aquifer

[Map numbers are shown in figure 23. Type of test: 1, multiwell test with solutions by Theis (1935), Cooper and Jacob (1946), Hantush and Jacob (1955) and other investigators; 2, single-well test with Theis (1935) recovery solution; 3, specific capacity test; and 4, step-drawdown test. Operator of test: SFWMD, South Florida Water Management District; USGS, U.S. Geological Survey; Missimer, Missimer and Associates; LB & G, Leggette, Brashears, and Graham. Units: ft, feet; ft^2/d, feet squared per day; ft/d, feet per day, 1/d, one over day. Other annotations: ?, top of depth interval open in production well is unknown; NR, not reported; and NA, not applicable given aquifer behavior or type of test; *, USGS local number]

Map No.	Site name or land owner	Operator of test	Production well		Type of test	Trans-missivity (ft^2/d)	Storativity[1]	Leakance (1/d)	Average hydraulic conduc-tivity (ft/d)	Source of information
			Well number	Depth interval open (ft)						
1	Alico (site C)	SFWMD	HE-1035*	70 - 120	1	33,000	1.9×10^{-5}	8.6×10^{-7}	730	Smith and Adams (1988)
2	Collier Corporation	USGS	HE-286*	? - 40	1	125,000	4.2×10^{-4}	[2]2.5×10^{-3}	NR	Klein and others (1964)
3	Barron Collier	SFWMD	HE-1041*	40 - 80	1	61,000	1.2×10^{-4}	1.4×10^{-3}	1,700	Smith and Adams (1988)
4	U.S. Sugar Corporation, Rogers Ranch	Missimer	H-M-310	65 - 105	1	78,000	1.5×10^{-4}	5.5×10^{-3}	NR	Smith and Adams (1988)
5	Carl Gallagher	SFWMD	HE-1054*	70 - 100	1	88,000	2.1×10^{-4}	1.4×10^{-2}	2,900	Smith and Adams (1988)
6	Robert McDaniels	Hydro Designs	PW	60 - 118	1	62,000	2.1×10^{-4}	2.3×10^{-3}	NR	Smith and Adams (1988)
7	S & M Farms	USGS	HE-303*	? - 120	1	31,000	6.0×10^{-4}	[2]2.3×10^{-3}	NR	Klein and others (1964)
8	U.S. Sugar Corporation, South Division Ranch	Missimer	H-M-235	65 - 125	1	14,000	5.0×10^{-4}	1.5×10^{-4}	NR	Smith and Adams (1988)
9	U.S. Sugar Corporation, South Division Ranch	Missimer	H-M-301	76 - 124	1	44,000	2.6×10^{-4}	1.3×10^{-5}	NR	Smith and Adams (1988)
10	U.S. Sugar Corporation, South Division Ranch	Missimer	H-M-328	75 - 133	1	66,000	2.6×10^{-4}	3.3×10^{-4}	NR	Smith and Adams (1988)
11	Seminole Tribe	Murray-Milleson	PW	63 - 120	1	72,000	4.2×10^{-4}	2.5×10^{-4}	NR	Smith and Adams (1988)
12	Seminole Tribe (site 2)	SFWMD	HE-1021*	50 - 135	1	56,000	2.2 x 10-4	2.4×10^{-3}	560	Smith and Adams (1988)
13	Seminole Tribe (site 1)	SFWMD	HE-1061*	78 - 123	1	50,000	1.3×10^{-4}	1.3×10^{-4}	1,100	Smith and Adams (1988)
14	Hendry County Correctional Institute	LB & G	12	97 - 125	1	24,000	5.6×10^{-5}	NR	600	Smith and Adams (1988)
15	Collier Enterprises	Murray-Milleson	TPW	65 - 105	1	100,000	1.2×10^{-4}	3.5×10^{-3}	NR	Smith and Adams (1988)
16	Miccosukee Tribe (north site)	Murray-Milleson	TPW	55 - 135	1	44,000	3.0×10^{-4}	1.0×10^{-4}	NR	Murray-Milleson (1989)
17	Miccosukee Tribe (NW site)	Murray-Milleson	TPW	90 - 165	1	64,000	4.0×10^{-5}	4.0×10^{-5}	NR	Murray-Milleson (1989)
18	Miccosukee Tribe (south site)	Murray-Milleson	TPW	85 - 160	1	78,000	4.0×10^{-5}	3.0×10^{-5}	NR	Murray-Milleson (1989)
19	Twenty-Six Mile Bend	USGS	G-2312J*	110 - 140	1,3	22,000	6.0×10^{-5}	NR	650	Fish (1988)
20	North Everglades Central	USGS	G-2313B*	46 - 81	3	9,000	NA	NA	280	Fish (1988)

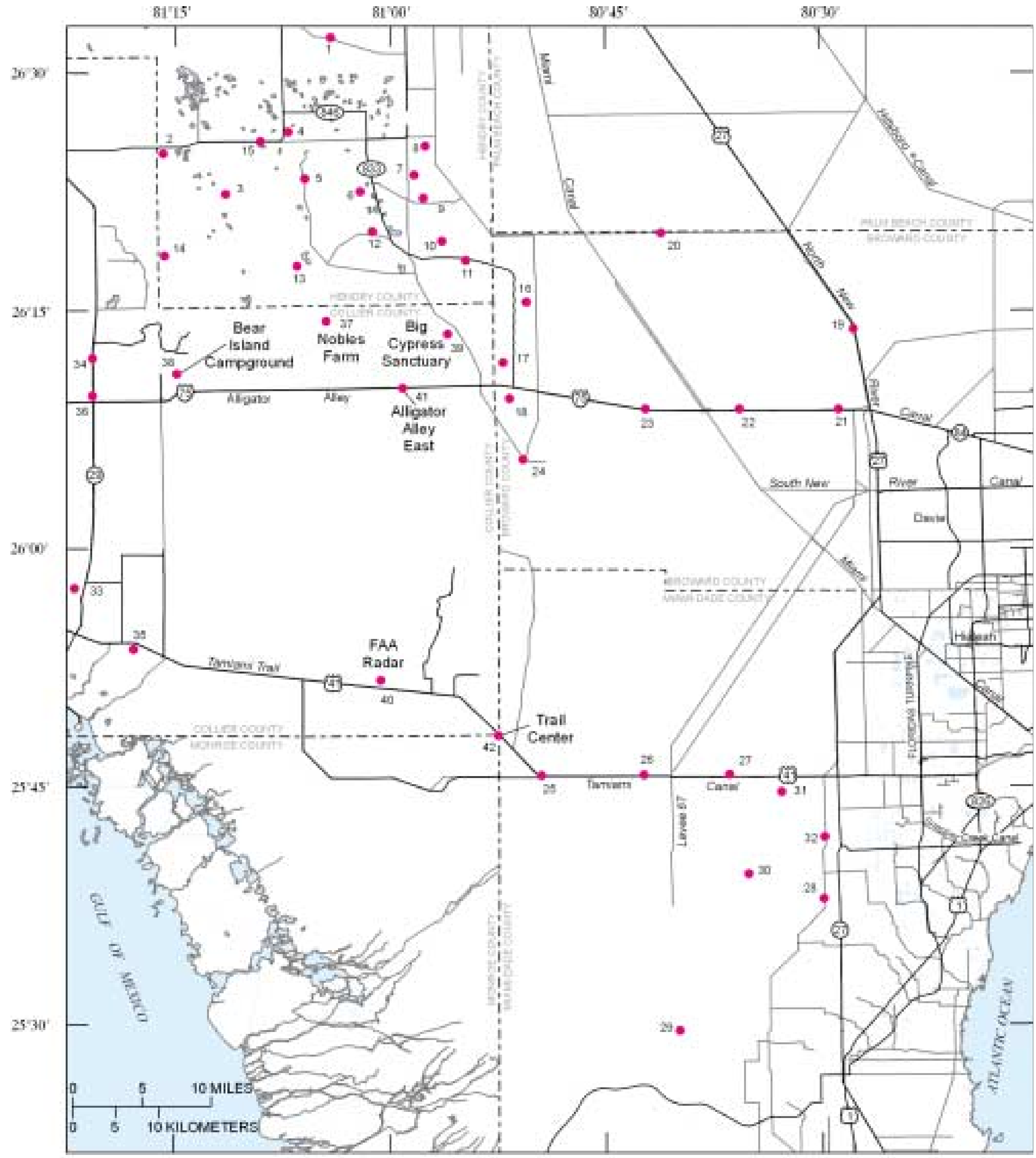
Table 8. Historical aquifer-test results for the gray limestone aquifer or equivalent aquifer (Continued)

[Map numbers are shown in figure 23. Type of test: 1, multiwell test with solutions by Theis (1935), Cooper and Jacob (1946), Hantush and Jacob (1955) and other investigators; 2, single-well test with Theis (1935) recovery solution; 3, specific capacity test; and 4, step-drawdown test. Operator of test: SFWMD, South Florida Water Management District; USGS, U.S. Geological Survey; Missimer, Missimer and Associates; LB & G, Leggette, Brashears, and Graham. Units: ft, feet; ft^2/d, feet squared per day; ft/d, feet per day, 1/d, one over day. Other annotations: ?, top of depth interval open in production well is unknown; NR, not reported; and NA, not applicable given aquifer behavior or type of test; *, USGS local number]

Map No.	Site name or land owner	Operator of test	Production well		Type of test	Transmissivity (ft^2/d)	Storativity[1]	Leakance (1/d)	Average hydraulic conductivity (ft/d)	Source of information
			Well number	Depth interval open (ft)						
20A	North Everglades Central	USGS	G-2313C*	106 - 146	4	26,000	NA	Very leaky	650	Fish (1988)
21	Alligator Alley East	USGS	G-2319X*	118 - 140	2	22,000	NA	NA	590	Fish (1988)
22	Alligator Alley Central	USGS	G-2320J*	93 - 167	4	67,000	NA	NA	910	Fish (1988)
23	Alligator Alley West	USGS	G-2330Z*	81 - 167	1,2,4	88,000	7.0×10^{-5}	NR	930	Fish (1988)
24	Southwest Everglades	USGS	G-2338C*	102.5 - 156	1	50,000	1.0×10^{-5}	Confined	890	Fish (1988)
25	Forty-Mile Bend	USGS	G-3301E*	101 - 149	1	39,000	NR	NR	780	Fish and Stewart (1991)
26	Tamiami West	USGS	G-3302E*	81 - 138	1	25,000	NR	NR	420	Fish and Stewart (1991)
27	Tamiami Central	USGS	G-3303E*	121 - 150	1	13,000	NR	NR	430	Fish and Stewart (1991)
28	Levee 31N	USGS	G-3311H*	145 - 173	3	5,800	NA	NA	210	Fish and Stewart (1991)
29	Context Road West	USGS	G-3394B*	110 - 145	1,3	14,000	NR	NR	400	Fish and Stewart (1991)
30	WWF-3	USGS	WWF-3	160 - 198	1	16,000	2.8×10^{-5}	Confined	424	Labowski and others (1988)
31	WWF-6	USGS	WWF-6	140 - 170	1	15,000	6.9×10^{-5}	Confined	523	Labowski and others (1988)
32	WWF-9	USGS	WWF-9	85 - 150	1	9,600	6.0×10^{-4}	2.3×10^{-2}	148	Labowski and others (1988)
33	Copeland	Missimer	CO-304	15 - 25	1	160,000	1.2×10^{-1} (specific yield)	NA	NR	Missimer and Associates (1981)
34	Site C-28	SFWMD	Unknown	10 - 39	3	120,000	NA	NA	NR	Knapp and others (1986)
35	Site C-30	SFWMD	Unknown	12 - 40	3	96,000	NA	NA	NR	Knapp and others (1986)
36	Site C-34	SFWMD	Unknown	0 - 53	3	130,000	NA	NA	NR	Knapp and others (1986)

[1]Aquifer at site nos. 33 to 36 is interpreted to be unconfined; aquifer at remaining sites interpreted to be confined or semiconfined.

[2]Value for leakance was determined from reanalysis of drawdown data (reported value found to be in error).



42 MAP NUMBER--Map number of aquifer test site. See tables 8 and 9 for map number, site name, and additional information. Site names are shown for sites where aquifer tests were conducted in this study

Figure 23. Location of aquifer test sites.

Table 9. Aquifer-test results from tests conducted during the course of the study

[Map numbers are shown in figure 23. Type of test: 1, multiwell test with solutions by Theis (1935), Cooper and Jacob (1946), or Hantush and Jacob (1955); 2, multiwell test with solution by Neuman (1972); 3, single well test with Theis (1935) recovery solution; and 4, multiwell test with numerical analysis using drawdown data in gray limestone and sand aquifers during same test. Units: ft, feet; ft^2/d, feet squared per day; ft/d, feet per day; 1/d, one over day. NA, not applicable given aquifer behavior or type of test]

Map No.	Site name	Production well		Type of test	Transmissivity (ft^2/d)	Storativity[1]	Leakance (1/d)	Estimated hydraulic conductivity (ft/d)[2]
		USGS local well number	Depth interval open (ft)					
Gray Limestone Aquifer								
37	Nobles Farm	C-1142	60 - 100	3	80,000	S/S′ = 0.44	NA	2,000
38	Bear Island Campground	C-1167	22 - 57	4	[3]200,000	2.0×10^{-4}	NA	4,000
38A	Bear Island Campground	C-1166	23 - 43	3	200,000	S/S′ = 0.19	NA	4,000
39	Big Cypress Sanctuary	C-1171	75 - 135	1	70,000	6.0×10^{-4}	NA[4]	1,100
39A	Big Cypress Sanctuary	C-1170	80 - 120	3	70,000	S/S′ = 1.5	NA	1,100
40	FAA Radar	C-1172	9 - 49	2	300,000	4.0×10^{-3}	[5]0.2	12,000
41	Alligator Alley East	C-1182	75 - 125	3	100,000	S/S′ = 1.1	NA	2,000
42	Trail Center	MO-188	89 - 114	1	90,000	4.0×10^{-4}	7.0×10^{-3}	1,200
Sand Aquifer								
38B	Bear Island Campground	C-1141[6]	88 - 108	4	840	8.0×10^{-5}	NA	20
40A	FAA Radar	C-1143	180 - 200	3	1,500	S/S′ = 1.0	NA	75
40B	FAA Radar	C-1144	120 - 130	3	180	S/S′ = 1.1	NA	14

[1]Gray limestone aquifer at site nos. 38 and 40 interpreted to be unconfined; gray limestone aquifer at remaining sites and all sand aquifers tested interpreted to be confined or semiconfined. S/S′ is ratio of storativity during drawdown to that of recovery.

[2]Estimated using full thickness of aquifer (see table 7 and Appendix II).

[3]Best fit to data was obtained assuming the aquifer is semiconfined, but long-term water-level data indicate aquifer is unconfined. A similar value for transmissivity was obtained by the Cooper-Jacob analysis of early time data.

[4]Test not run long enough to determine leakance.

[5]Specific yield.

[6]Used as monitoring well during test of gray limestone aquifer (map no. 38 above).

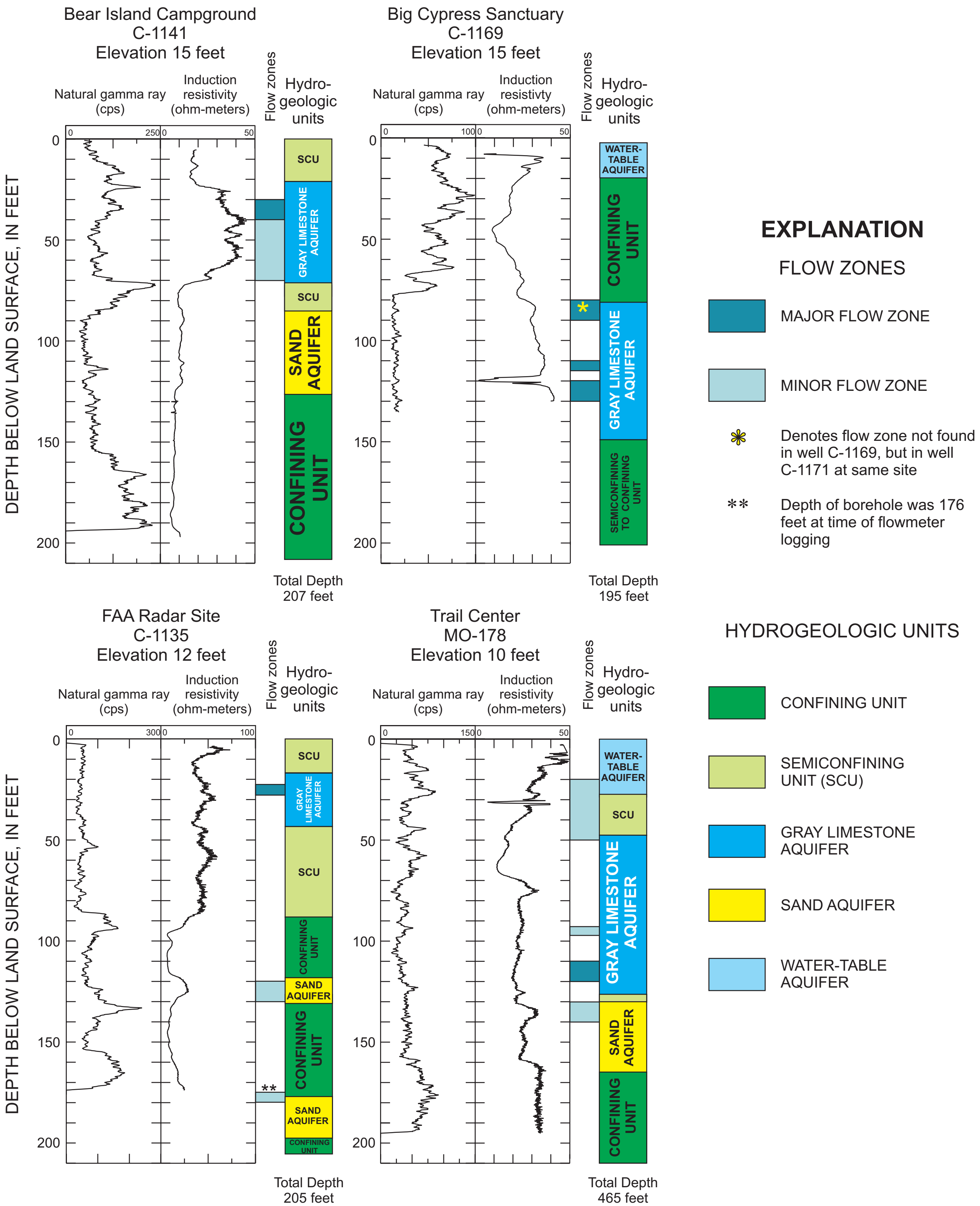


Figure 24. Borehole geophysical logs, flow zones, and principal hydrogeologic units for test wells at four sites where multiwell aquifer tests were conducted. The cps unit represents counts per second.

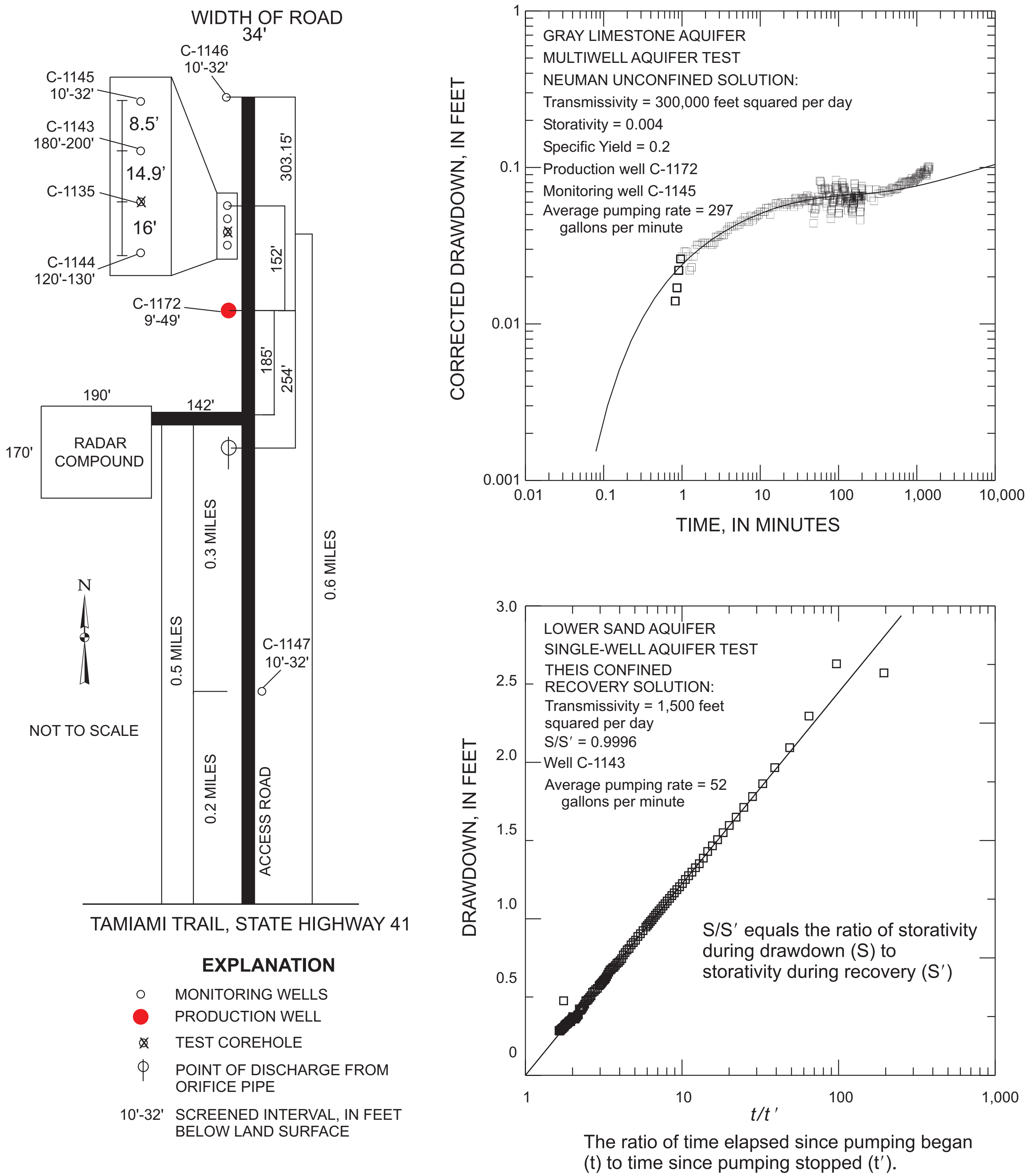


Figure 25. Site plan and time-drawdown plots for two aquifer tests conducted at the FAA Radar site. All wells are completed in the gray limestone aquifer, except for wells C-1143 and C-1144 which are completed in sand aquifers.

The average transmissivity value reported for the multiwell test of the gray limestone aquifer at the Trail Center site was 90,000 ft^2/d based on a composite analysis of monitoring wells MO-180, MO-182, and MO-185, all of which were screened in the lower part of the aquifer at about the same depths as the production well (fig. 26 and table 9). The production well (MO-178) was screened from 89 to 114 ft below land surface. Poorly permeable limestone containing a carbonate mud-rich matrix occurs at depths between 80 and 96 ft below land surface and separates the aquifer into upper and lower parts; and this unit provides some confinement within the aquifer based on water-quality data. Nevertheless, drawdown data from MO-187, screened from 70 to 80 ft below land surface in the upper part of the aquifer, gave a transmissivity of approximately 80,000 ft^2/d, which is similar to the value obtained from the wells in the lower part of the aquifer.

Core Analysis Data

A total of 32 limestone and sandstone core-plugs were horizontally cut from core samples: 30 of the samples were from the gray limestone aquifer, and 2 were from just below the base of the aquifer. Porosity measured from these plugs ranged from 9.5 to 45.1 percent, and horizontal permeability to air ranged from 189 to greater than 20,000 mD (millidarcies) (table 10). Equivalent hydraulic conductivity was calculated from the permeability values and ranged from 0.5 to greater than 55 ft/d (table 10). Permeability could not be determined for five (16 percent) core plugs because permeability exceeded the upper limit of the laboratory instrumentation (20,000 mD) or because of a poor seat with the portion of the instrument holding the plug. Plots of porosity as a function of the logarithm of permeability and as a function of hydraulic conductivity (fig. 27) suggest no linear relationships.

Core-plug derived measurements of hydraulic conductivity are one to two orders of magnitude less than aquifer-test-derived hydraulic conductivity estimates. For example, at the Trail Center site, the hydraulic conductivity determined for the gray limestone aquifer by aquifer testing was 1,200 ft/d (table 9, map no. 42). However, horizontal hydraulic conductivity determined from analysis of three core plugs taken from the aquifer at the site averaged only 23 ft/d (table 10, wells MO-185 and MO-187). This discrepancy is due to a large scale difference in the volume of the aquifer measured. However, the core measurements can be considered to indicate a range for the minimum hydraulic conductivity within the gray limestone aquifer because core plugs do not include large-scale pore spaces.

Distribution of Transmissivity, Hydraulic Conductivity, and Degree of Confinement

Flow-zone thicknesses determined by using flowmeter logs in combination with analysis of aquifer test data indicate that flow is concentrated through thin, high hydraulic conductivity zones within the gray limestone aquifer, forming a flow system that is partially conduit in nature (fig. 24). Flow zones are usually only 5 to 10 ft thick and are separated by intervals of low to moderate hydraulic conductivity that can function as semiconfining units within the aquifer. Only one flow zone in the gray limestone aquifer was found at the FAA Radar site, and its depth is from 23 to 28 ft below land surface. A hydraulic conductivity value for the aquifer at this site of 12,000 ft/d was calculated based on the thickness (25 ft) of the aquifer and the estimated transmissivity (table 7, well C-1135 and table 9, map no. 40). If the thickness of only the flow zone is used, the hydraulic conductivity would be much larger. At the FAA Radar site, some vuggy porosity was observed in core samples collected from this flow zone. Additionally, core recovery in well C-1135 (at the FAA Radar site) for the interval 20 to 30 ft below land surface was only 7 percent, compared to an average of 66 percent for the Ochopee Limestone intervals in all of the continuous cores for which descriptions are given in appendix II. The poor recovery in this 10-ft interval in well C-1135 could have resulted from large solution openings in the rock affecting its structural integrity during coring. The high hydraulic conductivity of the thin flow zone at the FAA Radar site is attributed to solution openings, rather than the moldic and intergranular porosity common in the aquifer.

Flow zones tend to be developed in the lower part of the gray limestone aquifer where the aquifer is confined or semiconfined; for example, at the Big Cypress Sanctuary and Trail Center sites (fig. 24) and at the Noble's Road site (fig. 1 and table 1, well C-1139). The upper part of the aquifer in these areas is commonly poorly consolidated possibly due to poor cementation.

Aquifer tests conducted during this study suggest a much higher upper limit for transmissivity than previously reported for the gray limestone aquifer;

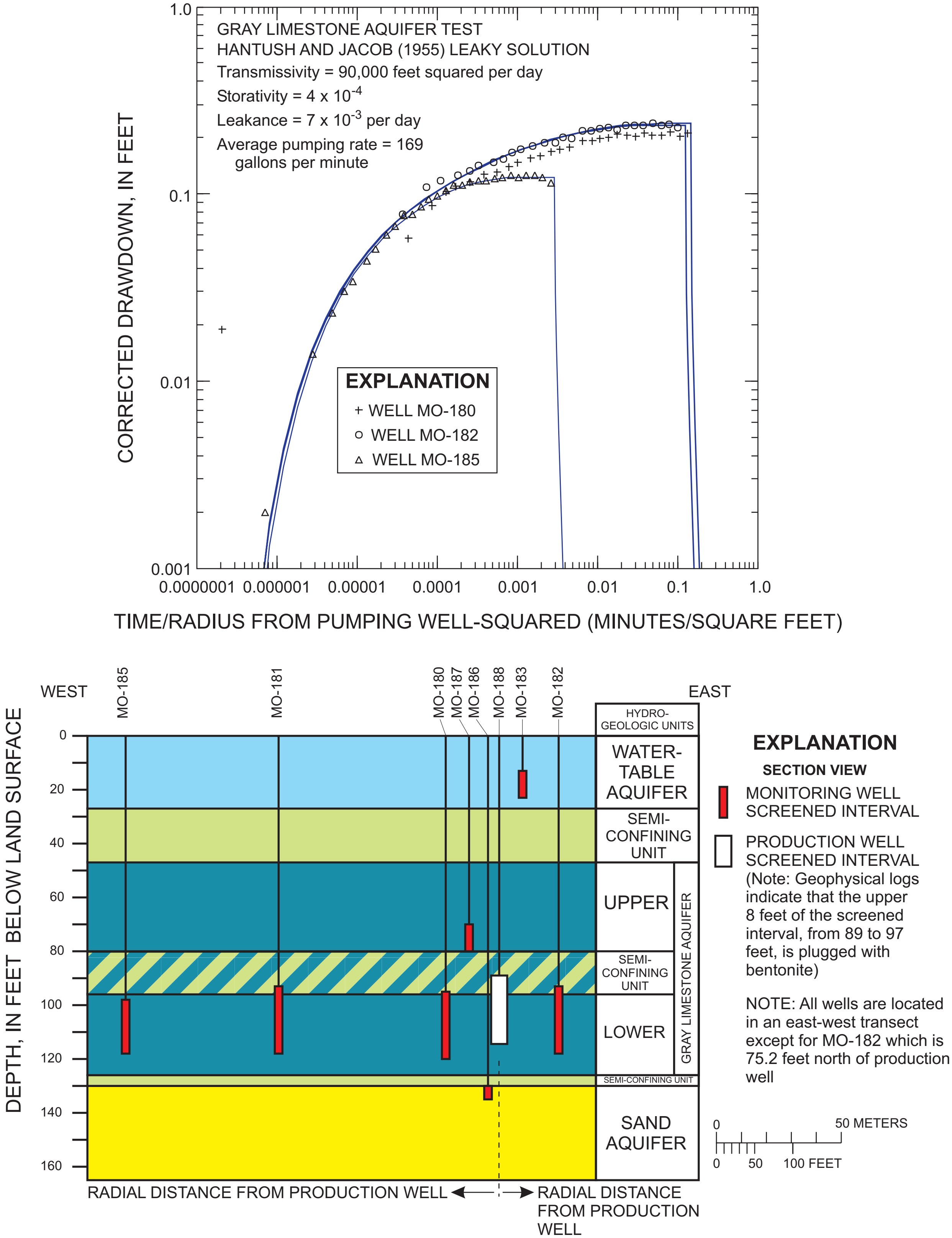


Figure 26. Time (over radius squared) drawdown plot and section showing screened intervals in wells for aquifer test of gray limestone aquifer at the Trail Center site.

Table 10. Core analysis data for limestone and quartz sandstone from the gray limestone aquifer

[Each analysis is of a 1- to 1.5-inch diameter plug taken from the depth or depth interval given, and the direction of permeability measurement was horizontal. The upper limit of instrument for measaurement of permeability(greater than 20,000 millidarcies or 55 feet per day where noted) was exceeded because of very high permeability or poor seat of sample with instrument. Annotations: ft, feet; mD, millidarcies; ft/d, feet per day; g/cm^3, grams per cubic centimeter; >, greater than the value]

USGS local well number	Site name or other well identifier	Depth (ft)	Porosity (percent)	Permeability to air[1] (mD)	Hydraulic conductivity[2] (ft/d)	Grain density (g/cm^3)
C-1141	Bear Island-D	67.5	39.4	8,985	25	2.64
C-1143	RD (FAA Radar)	20 - 25	11.5	350	1.0	2.69
		25 - 30	21.4	>20,000	>55	2.70
		30 - 35	9.5	5,888	16	2.70
		50 - 58[3]	27.2	2,767	7.6	2.64
C-1166	Bear Island-2	28 - 43	37.3	12,277	35	2.70
C-1169	BSC-1	109.6	43.3	>20,000	>55	2.69
		130	35.8	1,593	4.4	2.72
		138.2	26.0	253	.7	2.73
C-1183	Baker's Grade	44	41.7	>20,000	>55	2.75
		51	32.2	2,873	7.9	2.76
		56.3	31.9	366	1.0	2.72
		66	40.9	16,172	44	2.68
		76	35.2	10,203	28	2.67
G-3301	DAC-10C	104	38.7	10,802	30	2.70
		112	Unsuitable[4]	6,249	17	2.69
		118.5	Unsuitable[4]	10,211	28	2.68
G-3671	B-1, L-30	128.0	20.7	512	1.4	2.76
G-3673	B-2B, L-31	127.5	35.0	15,241	42	2.77
G-3674	B-3 Miami Canal	134.9	22.6	1,914	5.2	2.68
		140.2	24.2	1,316	3.6	2.68
HE-1110	L-3 Deep	55 - 60	29.8	>20,000	>55	2.68
		140 - 145	33.9	743	2.0	2.68
MO-184	Golightly	72 - 82	30.2	2,265	6.2	2.72
MO-185	TC-5	70 - 80	38.7	13,107	36	2.69
		80 - 90	45.1	7,520	21	2.69
MO-186	TC-6	130 - 135[3]	16.7	189	.5	2.69
MO-187	TC-7	58 - 73	35.6	4,192	12	2.75
		73 - 80	35.8	>20,000	>55	2.70
PB-1704	Sod Farm	84.9	24.8	Unsuitable[5]	Unsuitable[5]	2.75
		89.7	39.9	16,702	46	2.72
		171.3	41.9	1,648	4.5	2.66

[1]Not corrected for Klinkenberg effect.
[2]Calculated from measured air permeability value using factor of 1 mD equal to 0.00274 ft/d.
[3]Sample taken from just below the base of the gray limestone aquifer.
[4]Sample unsuitable for porosity measurement.
[5]Sample unsuitable for permeability measurement.

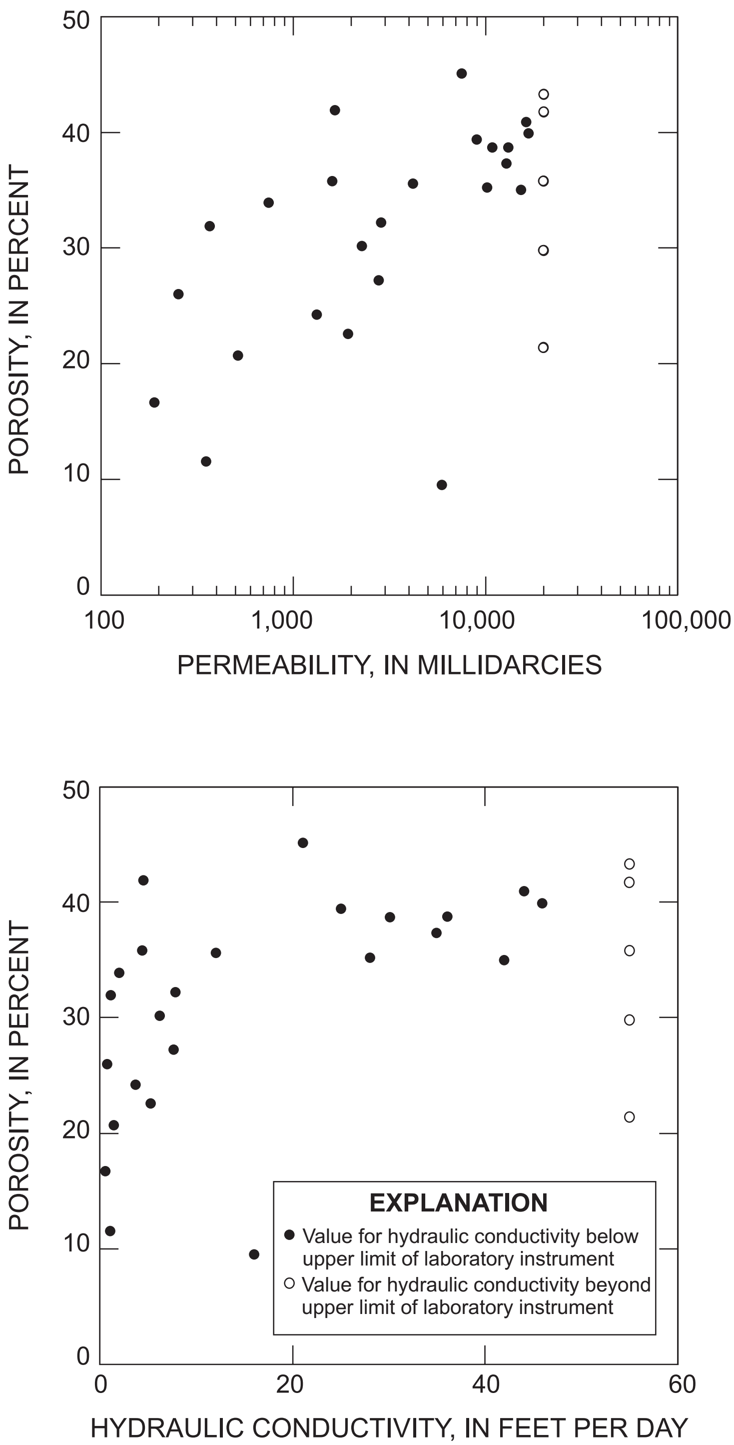


Figure 27. Relations between permeability and porosity and between hydraulic conductivity and porosity of limestone and sandstone from the gray limestone aquifer as determined by core analysis. Direction of permeability measurement is horizontal. Upper limit of the laboratory instrumentation is 20,000 millidarcies (55 feet per day). Data from table 10.

transmissivity is as high as 300,000 ft^2/d (table 9, map no. 40). A transmissivity distribution map of the gray limestone aquifer was constructed (fig. 28) by using transmissivity values determined from aquifer tests (tables 8 and 9) and transmissivity values estimated at test corehole sites where no aquifer tests were performed. These latter transmissivity estimates represent a “synthetic” value. They are based on aquifer thickness, written core descriptions, flowmeter log data, depth to the top of the aquifer, and the location of the site with respect to the regional depositional setting.

The transmissivity distribution map shows two large areas with transmissivity greater than 50,000 ft^2/d, both of which extend in a southeast direction (fig. 28). One area extends through southern Hendry County into west-central Broward County and has a transmissivity as high as 125,000 ft^2/d; the second area extends from west-central Collier through eastern Collier County to northern Monroe County with a transmissivity as high as 300,000 ft^2/d. The orientation of these areas of higher transmissivity could be related to a depositional trend for the Ochopee Limestone. Areas where transmissivity is less than 50,000 ft^2/d occur in southern Palm Beach County, northern and east-central Broward County, most of Miami-Dade County, and parts of Hendry County (fig. 28).

Alternatively, in the area of higher transmissivity extending through eastern Collier County, high values could be related to the structural position of the aquifer. In this area, the top of the aquifer is close to land surface and the upper confining unit is usually thin (less than 20 or 30 ft thick) or absent (fig. 22). At the Bear Island Campground and FAA Radar sites in this area, where the upper semiconfining unit is 21 ft thick or less, aquifer tests and long-term water-level data indicated the gray limestone aquifer is unconfined (fig. 28, map nos. 38 and 40). High hydraulic conductivity in the aquifer in this area could be, in part, related to greater rates of recharge of meteoric waters to the aquifer than in areas where the aquifer is buried more deeply and is better confined. Greater recharge rates could enhance carbonate dissolution in the aquifer.

A review of the hydraulic conductivity estimates (tables 8 and 9) and their location (fig. 23) indicate a general increase from east to west in hydraulic conductivity. A transect of aquifer tests along Alligator Alley illustrate this increase; hydraulic conductivity increases from 590 ft/d in central Broward County (fig. 23, map no. 21) to about 1,000 ft/d near the

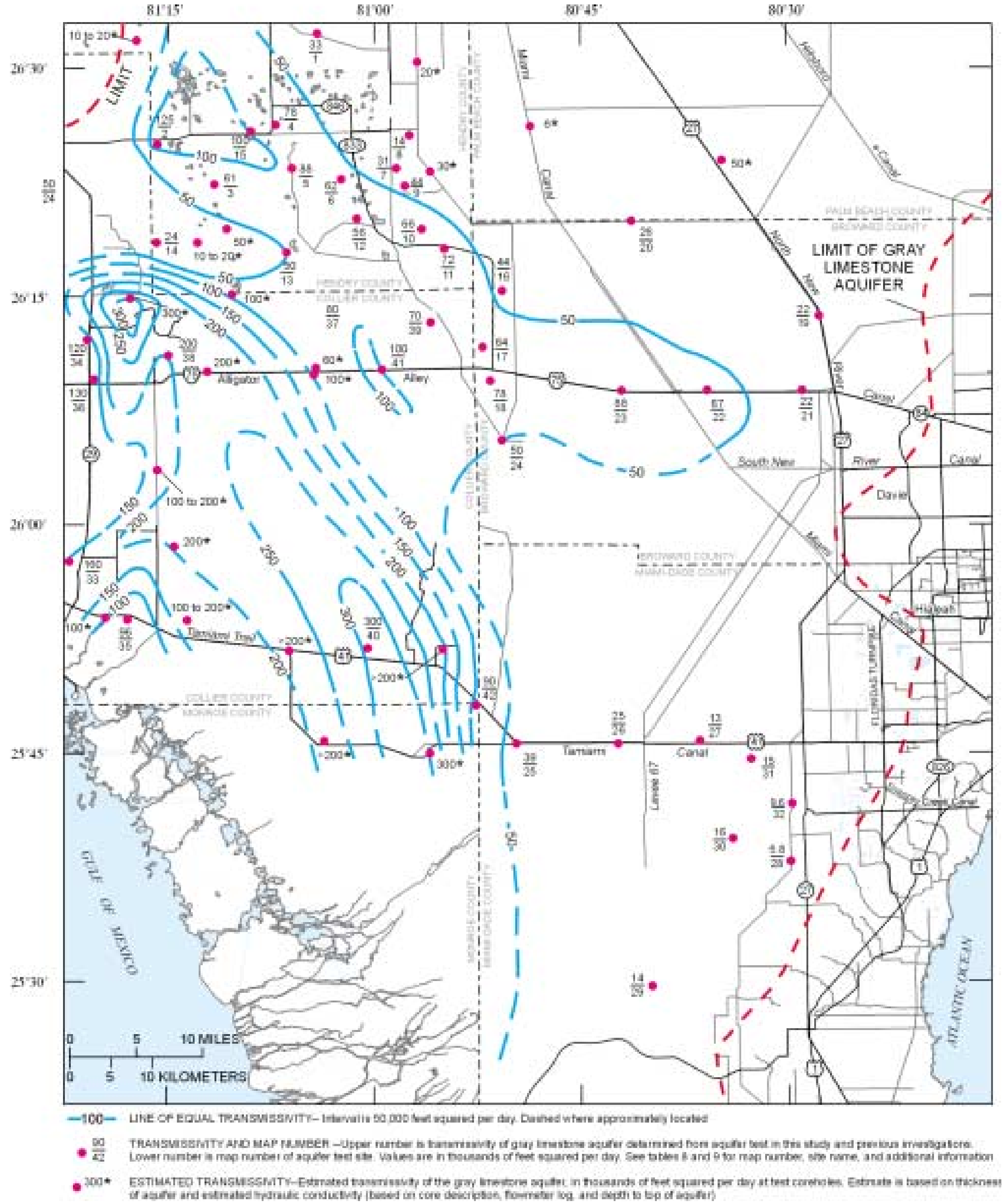


Figure 28. Distribution of transmissivity of the gray limestone aquifer in the study area.

Broward-Collier County line (map nos. 23, 24, and 39), to 2,000 ft/d at the Alligator Alley East site (map no. 41), and to 4,000 ft/d at the Bear Island Campground site in central Collier County (map no. 38). The lowest hydraulic conductivity estimates range from 148 to 523 ft/d, and these conductivities occur in Miami-Dade County near the eastern limit of the gray limestone aquifer (map nos. 28-32) and along the Broward-Palm Beach County line (map no. 20). An east-to-west shallowing of the depositional profile of the Ochopee Limestone carbonate ramp contributes to this spatial trend in hydraulic conductivity.

Leakance, which is the vertical hydraulic conductivity of the confining unit divided by its thickness, can be used to provide an indication of the degree of confinement of the aquifer. For purposes of this discussion, an aquifer is considered to be well confined, or have “good confinement,” if leakance was less than 1.0×10^{-3} 1/d. Sites where leakance was determined by aquifer testing to be less than 1.0×10^{-3} 1/d or the behavior of the aquifer was described as confined or well confined (tables 8 and 9) are shown in figure 29. These sites are located in southern Hendry County, western Broward County, and central Miami-Dade County and are in areas where the thickness of the confining unit approaches or is more than 50 ft. However, confining bed thickness did not necessarily prove to be a determinant of confinement. For example, the reported leakance at a site in central Hendry County (fig. 29 and table 8, map no. 1) was 8.6×10^{-7} 1/d, but the thickness of the upper confining unit is only 18 ft. Applying the 50-ft thickness criteria, areas where the aquifer should also be well confined include northeastern Collier County, south-central and southwestern Palm Beach County, and west-central and southern Miami-Dade County (fig. 29). A leakance value of 1.0×10^{-3} 1/d multiplied by a confining unit thickness of 50 ft gives an average vertical hydraulic conductivity of 0.05 ft/d. Review of leakance data and confining unit thickness (table 8 and fig. 29) indicates that the average vertical hydraulic conductivity is often less than this value in areas where the aquifer is well confined. A hydraulic conductivity of 0.05 ft/d is in the “very low” category as defined by Fish (1988), and lithologies in this category include clay, silt, and lime mud (Fish, 1988, table 8).

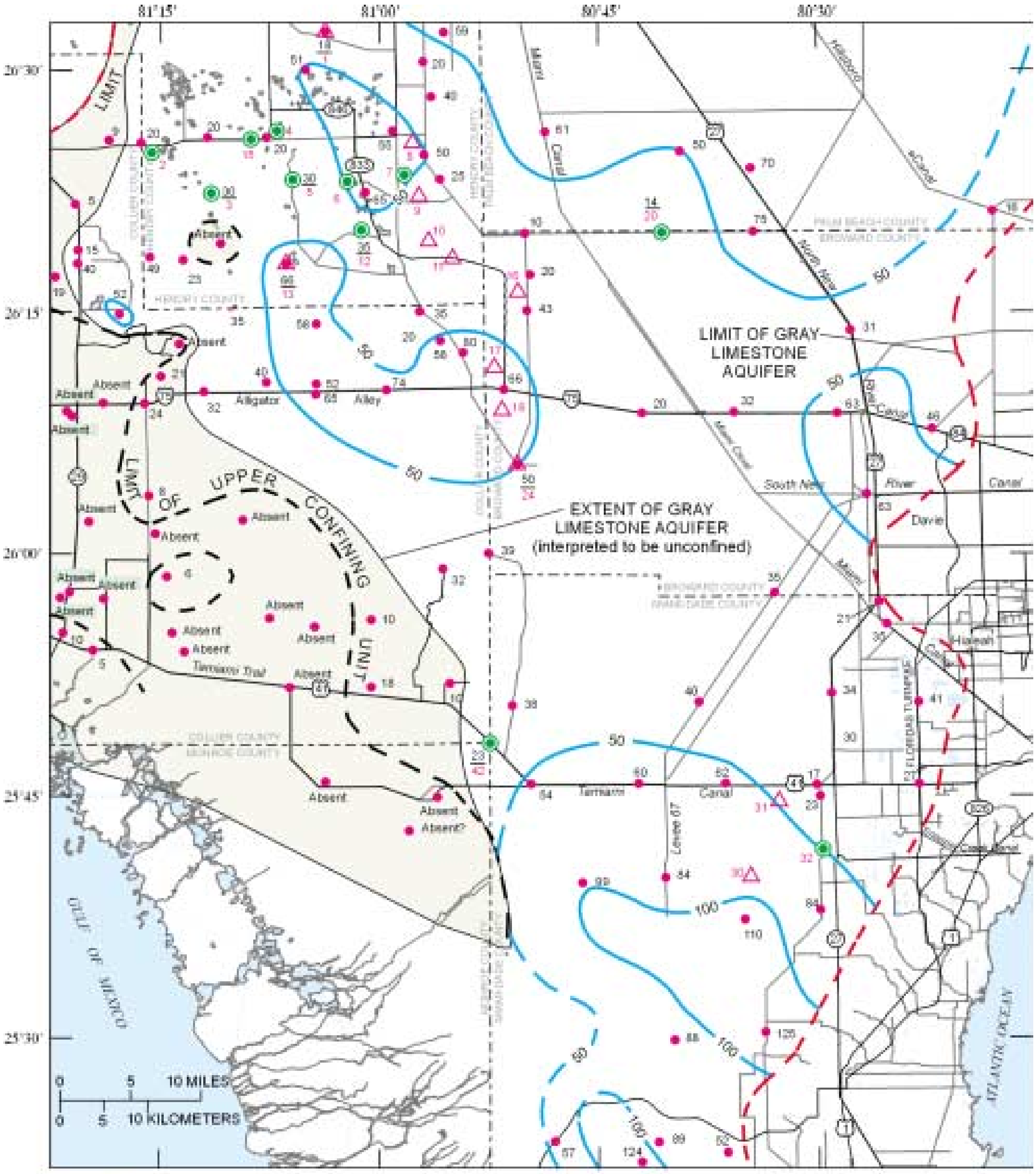
In some areas, the unnamed formation below the gray limestone aquifer contains a sand aquifer (figs. 12 and 13), and some degree of confinement separating the two aquifers exists. This is true in parts of Collier County, for example at the Bear Island Campground site (fig. 1, well C-1141), Trail Center site (fig. 1, well MO-178), and Doerr's Lake site (fig. 1, well C-1137). Some confinement between these aquifers is suggested on the basis of lithology, analysis of core samples, analysis of aquifer test and flowmeter data, and changes in water quality and hydraulic head.

At the Bear Island Campground site, the semiconfining unit between the gray limestone and the underlying sand aquifer is about 14 ft thick and consists of very fine sand (fig. 24). Disparate conditions exist between the two aquifers, as indicated by water-quality and water-level data collected on August 28, 1998. Chloride concentration was 61 mg/L (milligrams per liter), in water from the gray limestone aquifer and 840 mg/L in water from the sand aquifer. The water level in the gray limestone aquifer was about 0.6 ft below that in the sand aquifer. Numerical analysis of multiwell aquifer test data at this site (table 9) indicated that this semiconfining unit has a vertical hydraulic conductivity of 0.3 ft/d.

At some sites, the only confinement between the two aquifers could be a thin layer or layers of dense limestone or sandstone that are less than 1 ft thick. At the Trail Center site in northern Monroe County (fig. 1, well MO-178), the base of the gray limestone aquifer was penetrated at a depth of 126 ft below land surface. Core plug analysis of a sample of dense limestone recovered between the depths of 130 to 135 ft below land surface in well MO-186 (an offset monitoring well at the site) produced a horizontal hydraulic conductivity of about 0.5 ft/d; vertical hydraulic conductivity could be considerably less. Additional support for some confinement at the base of the aquifer at this site was provided by flowmeter log data collected in the test corehole; these data indicated there is a vertical barrier to flow between the depths of 110 to 130 ft below land surface.

Water Levels and Hydraulic Gradient

Continuous ground-water levels were measured in the gray limestone aquifer in September 1998 from five wells at five sites (fig. 30). Four of the wells were at the sites where multiwell aquifer tests were conducted (fig. 23, map nos. 38-40 and 42), and the other well was at the Noble’s Farm site (fig. 23, map no. 37). A tidal effect is apparent in wells at the Big Cypress Sanctuary (fig. 23, map no. 39) and Trail Center site (fig. 23, map no. 42) where the gray limestone aquifer is confined to semiconfined. The tidal signal is expressed by two small daily peaks. The pronounced drops (0.1 ft or more) often occurring each day during the afternoon at the Bear Island Campground site (fig. 23, map no. 38) could be caused by evapotranspiration.



50 LINE OF EQUAL THICKNESS--Shows thickness of the upper confining unit, in feet. Interval is 50 feet. Dashed where approximately located

52 WELL LOCATION AND THICKNESS-- Number is thickness of the upper confining unit, in feet. See figure 1 for local well number

18/1 or 23/42 WELL LOCATION, THICKNESS, AND MAP NUMBER OF AQUIFER TEST SITE--Upper number is thickness of upper confining unit, in feet. Lower number is map number of aquifer test site. Identifies aquifer test sites where leakance for the gray limestone aquifer was determined to be less than $1.0X10^{-3}$ 1/day or aquifer was well confined (triangle), and sites where leakance was determined to be greater than $1.0X10^{-3}$ 1/day (circle). See figure 1 for well numbers and tables 8 and 9 for information on aquifer tests using map number

30 or 32 AQUIFER TEST SITE--Number is map number of aquifer test site. Identifies aquifer test sites where leakance for the gray limestone aquifer was determined to be less than $1.0X10^{-3}$ 1/day or aquifer was well confined (triangle), and sites where leakance was determined to be greater than $1.0X10^{-3}$ 1/day (circle). See tables 8 and 9 for information on aquifer tests using map number

Figure 29. Thickness of upper confining unit and leakance of the gray limestone aquifer.

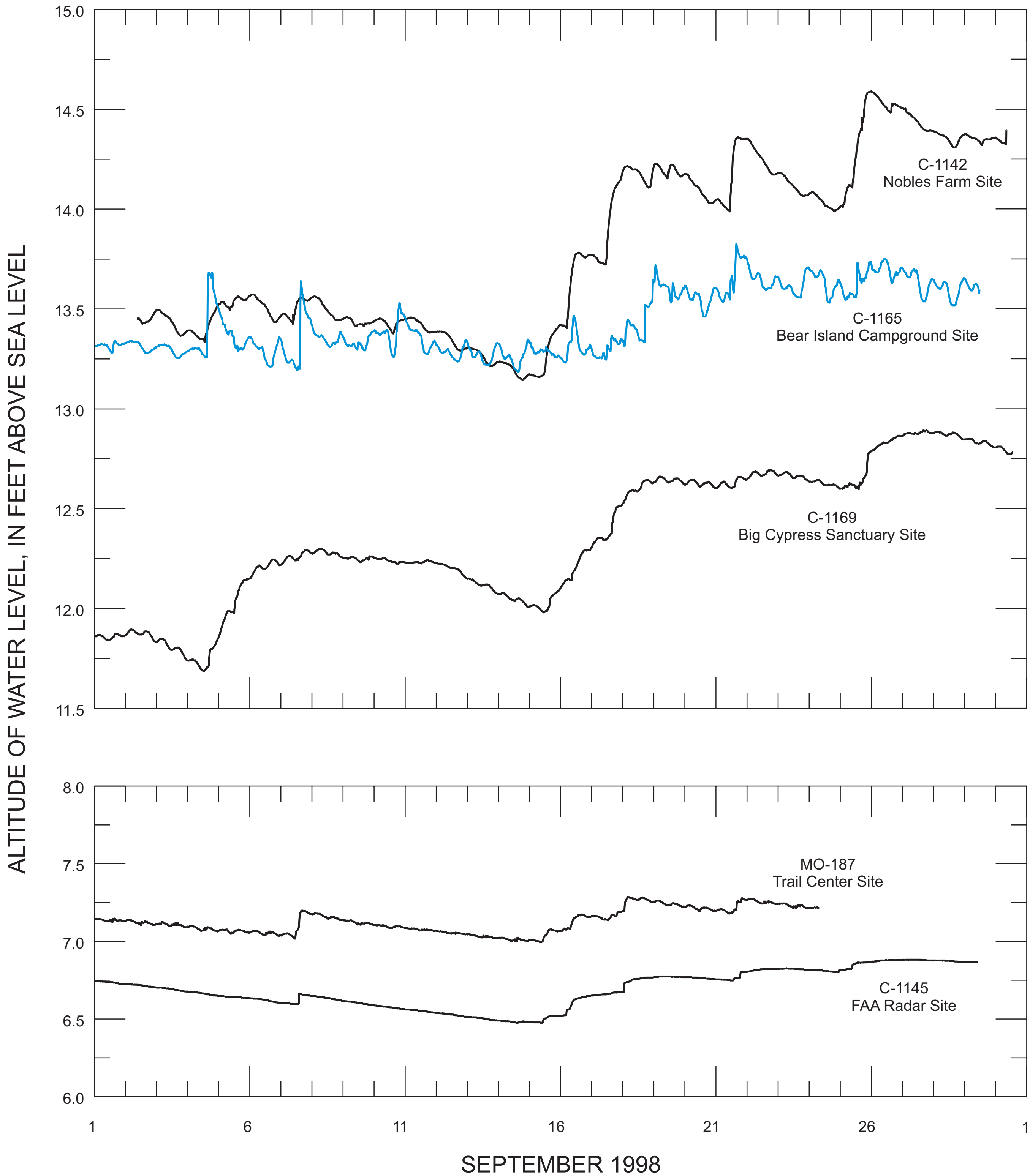


Figure 30. Hydrographs of five wells screened in the gray limestone aquifer in September 1998. Chart begins at 12:00 a.m., September 1. Well locations are shown in figure 1.

Water-level measurements of wells completed in the gray limestone aquifer were used to construct a synoptic potentiometric map showing hydrologic conditions for September 29, 1998 (fig. 31), which is close to the peak of the wet season (June through October). All but 4 of the 53 wells used to construct this map were measured on September 29, 1998. Two were measured on October 3, 1998, and two were estimated on the basis of the average late September 1986-95 levels. Discrete water-level data collected for the synoptic map are provided in table 11. For the purpose of comparison with the level in the gray limestone aquifer, water levels (at some sites) also were measured at the same time in the water-table aquifer and nearby surface-water stations on canals (table 11).

Water levels in the gray limestone aquifer ranged from as much as 26 ft above sea level in the far northwestern part of the study area in central Hendry County to less than 4 ft above sea level in coastal areas in Collier, Monroe, and Miami-Dade Counties (fig. 31). The direction of ground-water flow is to the south or southwest in part of southern Hendry County, most of Collier County, Monroe County, and western Miami-Dade County. Farther east in central Miami-Dade County, most of Broward County, and parts of eastern Collier and Hendry Counties, flow is to the east or southeast. Potentiometric surface contours form a large southeast plunging nose that extends from southern Hendry County to the east and southeast into Broward and Miami-Dade Counties and a small part of Palm Beach County.

The major recharge area for the aquifer is in central and southern Hendry County, some of which is north of the study area. In the major recharge area the potentiometric surface and land-surface elevation are high, and most recharge occurs where the upper confining unit is thin or absent (fig. 29). Comparison of water levels measured in the overlying water-table aquifer to the level measured in the gray limestone aquifer at the same site gives an indication whether there is potential for recharge (level in water-table aquifer is higher than level in the gray limestone aquifer) or discharge (level in water-table aquifer is lower than level in the gray limestone aquifer) to occur. In Hendry and northwestern Collier Counties, potential recharge was indicated at all five sites where both levels were measured on September 29, 1998. At these sites, the water level in the gray limestone aquifer ranged from 0.40 to 1.30 ft lower than the level in the water-table aquifer (table 11).

Areas of potential discharge were indicated to occur in eastern Collier, Broward, and Miami-Dade Counties on September 29, 1998. In this area, water levels in both the water table and gray limestone aquifers were measured at 12 sites, with discharge indicated at 9 of these sites. The water level at the nine sites in the gray limestone aquifer ranged from 0.09 to 2.15 ft higher than the water level in the water-table aquifer (table 11). Of the remaining three sites, two were located at the boundary of areas of impounded surface water where the level in the water table aquifer would be expected to be artificially elevated.

The area with the highest potentiometric gradient in the study area is in eastern Hendry County just to the west of the L-2 and L-3 Canals (figs. 3 and 31). The gradient here is as steep as 3 ft/mi (feet per mile). This area coincides with a physiographic unit boundary between the Sandy Flatlands and the Everglades (fig. 3). It also generally coincides with a decrease in transmissivity of the gray limestone aquifer from west to east (fig. 28). The area with the lowest gradient occurs in the water-conservation areas of western Broward and northwestern Miami-Dade Counties (fig. 3) where the gradient is as low as 0.1 ft/mi. The hydraulic head of impounded surface water in the water-conservation areas could affect water levels with the gray limestone aquifer. This effect is suggested by the increase in gradient to as much as 0.3 ft/mi south of the water-conservation areas in Miami-Dade County (fig 31; south of Tamiami Canal).

Water-level data measured in the gray limestone aquifer were reviewed to determine if the postulated fault in northeastern Collier County (fig. 15) had any effect. No change in hydraulic head is apparent across the mapped position of the fault as shown by potentiometric-surface contours (fig. 31). However, some local water-level data were collected at the Noble's Road site (fig. 1, well C-1139) through which the postulated fault is mapped and some anomalous differences in water levels were found. Water-level data were collected from wells C-1184 and C-1185 at the Noble's Road site; the water level was simultaneously measured in well C-1173, which is about 2,500 ft south of the Noble's Road site (table 11). These data, collected on March 25, 1999, indicated that the water level measured in well C-1185 on the downthrown side of the fault (fig. 17) was almost 1 ft higher than the water levels measured in wells C-1184 and C-1173, both on the upthrown side of the fault. Additionally, the local water-level gradient direction indicated by these three wells is to the west, whereas the regional gradient is to the south-southeast (fig. 31).

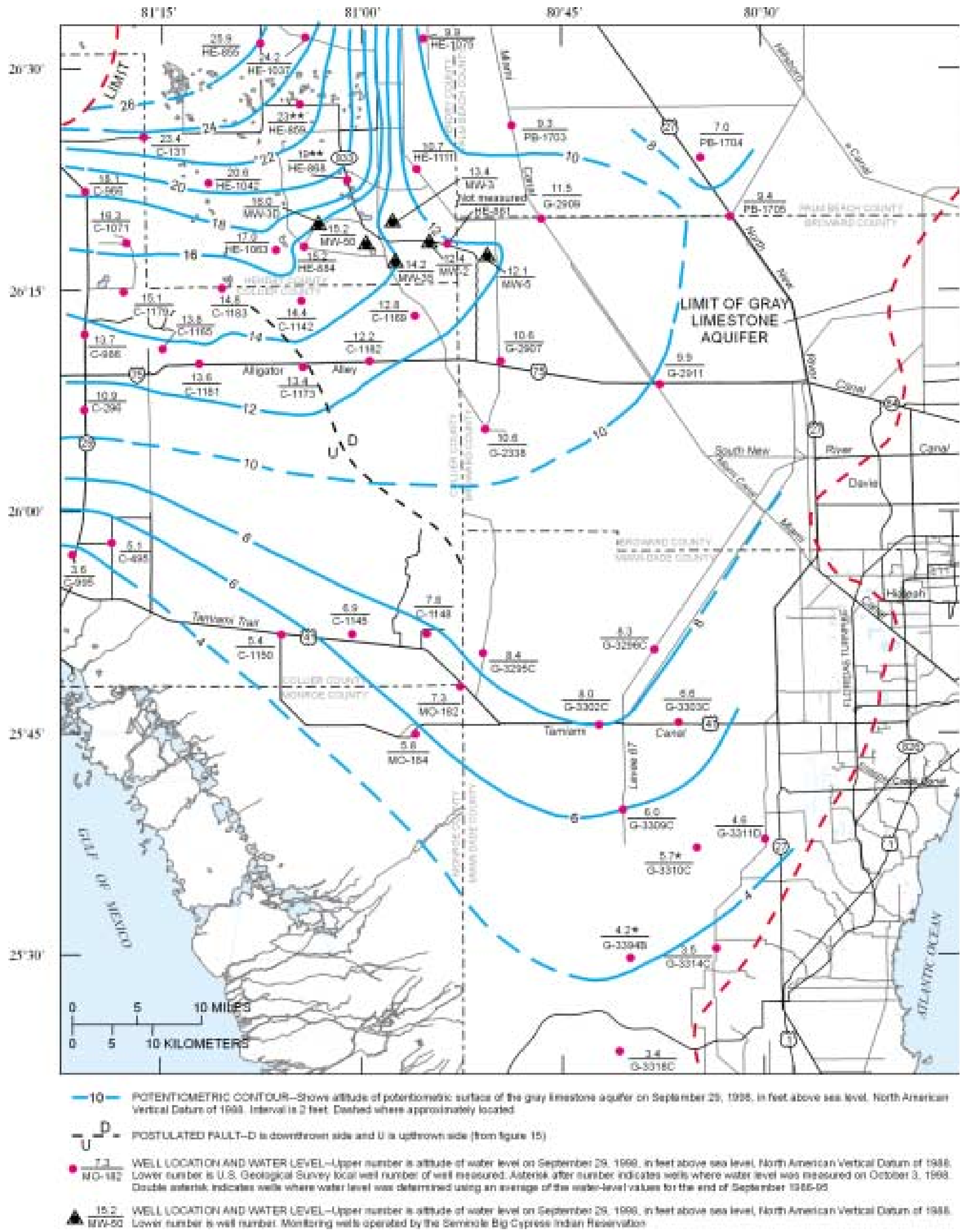


Figure 31. Configuration of the potentiometric surface of the gray limestone aquifer on September 29,1998. Water-level data used are given in table 11.

Table 11. Ground- and surface-water-level data collected during this study

[Well locations shown in figure 31 or figure 1 directly, or indirectly with reference to tables 1 and 2. NAVD of 88, North American Vertical Datum of 1988. Surface-water-level measurements at a site were made at about the same time as the ground-water-level measurements. Aquifer designations: GL, gray limestone or lower Tamiami; SS, sandstone; WT, water table. Other abbreviations: USGS, U.S. Geological Survey; ND, not determined; NM, not measured]

Site No.	Local number	Altitude of measurement point NAVD of 88 (feet)	Date of collection	Time of collection (hour and minutes)	Depth to water (feet)	Altitude of water level NAVD of 88 (feet)	Differential of gray limestone aquifer level above (+) or below (-) water-table aquifer level	Aquifer open in well	Depth of open interval (feet)
1	C-131	28.34	09-29-98	12:35	4.94	23.40		GL	22-54
	C-1074	28.63	09-29-98	12:30	4.23	24.40		SS	100-130
2	C-296	16.81	09-29-98	11:00	5.94	10.87		GL	8-45
3	C-495	8.69	09-29-98	9:45	3.60	5.09		GL	8-70
4	C-966	26.64	09-29-98	12:00	8.10	18.14		GL	30-40
5	C-986	19.05	09-29-98	11:30	5.33	13.72		GL	28-40
6	C-995	5.83	09-29-98	10:15	2.19	3.64		GL	28-37
7	C-1071	21.65	09-29-98	11:45	5.32	16.33		GL	20-35
8	C-1076	32.77	09-29-98	14:00	5.07	27.70		Unknown	65-85
	C-1075	32.10	09-29-98	14:10	3.04	29.06		WT	8-28
9	C-1142	19.09	09-29-98	8:58	4.73	14.36		GL	60-100
10	C-1145	12.09	09-29-98	10:21	5.18	6.91		GL	10-32
11	C-1148	12.09	09-29-98	9:45	4.28	7.81	0.01	GL	40-70
	C-1149	12.09	09-29-98	9:38	4.29	7.80		WT	9-29
12	C-1150	6.50	09-29-98	10:37	1.11	5.39		GL	25-45
13	C-1165	15.28	09-29-98	11:43	1.52	13.76		GL	24-58
14	C-1169	16.90	09-29-98	8:5	4.07	12.83		GL	77-137
15	C-1173	14.48	09-29-98	11:00	1.09	13.39	.77	GL	65-115
	C-1174	14.54	09-29-98	10:59	1.93	12.61		WT	15-25
	C-1173	14.48	03-25-99	9:25	3.05	11.43	.63	GL	65-115
	C-1174	14.54	03-25-99	9:27	3.75	10.79		WT	15-25
16	C-1179	15.98	09-29-98	9:11	0.88	15.10		GL	58-83
17	C-1181	15.26	09-29-98	8:42	1.68	13.58		GL	61-91
18	C-1182	14.25	09-29-98	11:14	2.02	12.23		GL	75-125
19	C-1183	17.30	09-29-98	9:56	2.47	14.83		GL	41-71
20	C-1184	16.40	03-25-99	9:44	4.98	11.42		GL	75-115
	C-1185	16.32	03-25-99	9:48	3.99	12.33		GL	115-145
21	G-2338	19.30	09-29-98	11:45	8.71	10.59		GL	151-161
22	G-2907	17.14	09-29-98	12:15	6.56	10.58	-0.02	GL	91-101
	G-2908	17.19	09-29-98	12:16	6.59	10.60		WT	4-14
	S-140 pumping station, tail water side					10.60		Surface water	
23	G-2909	16.20	09-29-98	10:36	4.67	11.53	.19	GL	90-100
	G-2910	16.51	09-29-98	10:33	5.17	11.34		WT	10-20
	S-8 pumping station					[1]11.00		Surface water	
	Wells are on head water side of S-8 but close to tail water side								
24	G-2911	17.16	09-29-98	12:38	7.24	9.92		GL	100-115

Table 11. Ground- and surface-water-level data collected during this study (Continued)

[Well locations shown in figure 31 or figure 1 directly, or indirectly with reference to tables 1 and 2. NAVD of 88, North American Vertical Datum of 1988. Surface-water-level measurements at a site were made at about the same time as the ground-water-level measurements. Aquifer designations: GL, gray limestone or lower Tamiami; SS, sandstone; WT, water table. Other abbreviations: USGS, U.S. Geological Survey; ND, not determined; NM, not measured]

Site No.	Local number	Altitude of measurement point NAVD of 88 (feet)	Date of collection	Time of collection (hour and minutes)	Depth to water (feet)	Altitude of water level NAVD of 88 (feet)	Differential of gray limestone aquifer level above (+) or below (-) water-table aquifer level	Aquifer open in well	Depth of open interval (feet)
25	G-3295C	8.64	09-29-98	9:04	0.29	8.35	.21	GL	127-130
	G-3295A	8.53	09-29-98	9:00	.39	8.14		WT	17-20
26	G-3296C	11.49	09-29-98	11:26	3.16	8.33	.09	GL	144-144
	G-3296A	10.33	09-29-98	11:28	2.09	8.24		WT	20-20
27	G-3302C	10.81	09-29-98	8:30	2.80	8.01	-.24	GL	120-123
	G-3302A	10.54	09-29-98	8:27	2.29	8.25		WT	14-14
	S-333, west side of structure					8.60			
28	G-3303C	9.31	09-29-98	10:56	2.75	6.56	.18	GL	127-130
	G-3303A	9.51	09-29-98	10:51	3.13	6.38		WT	20-20
	S-333, east side of structure					6.00		Surface water	
29	G-3309C	6.41	09-29-98	10:07	.37	6.04	-.63	GL	127-130
	G-3309A	6.99	09-29-98	10:05	.32	6.67		WT	20-20
	L-67 Extension (canal on west side of levee)					6.52		Surface water	
30	G-3310C	5.73	10-03-98	9:36	.02	5.71	-.04	GL	130-133
	G-3310A	5.86	09-29-98	12:07	.12	5.74		WT	19-19
31	G-3311D	6.69	09-29-98	13:07	2.07	4.62	.50	GL	157-160
	G-3311A	6.87	09-29-98	13:04	2.75	4.12		WT	20-23
32	G-3314C	5.11	09-29-98	10:47	1.64	3.47	.21	GL	187-190
	G-3314A	5.08	09-29-98	10:45	1.81	3.27		WT	27-30
33	G-3317C	ND	09-29-98	9:53	.71	Unknown		GL	147-150
	G-3317D	ND	09-29-98	9:49	.57	Unknown		WT	8-28
34	G-3318C	5.22	09-29-98	8:54	1.79	3.43	-0.19	GL	158-161
	G-3318A	5.47	09-29-98	8:51	1.85	3.62		WT	23-23
35	G-3394B	4.27	10-03-98	13:15	0.06	4.21		GL	110-145
36[2]	HE-855	28.80	09-29-98	9:51	2.88	25.92	-.51	GL	70-90
	HE-856	28.32	09-29-98	9:50	1.89	26.43		WT	6-11
37	HE-859	27.75	See footnote 3			22.70		GL	58-59
38[2]	HE-861	16.54	NM					GL	37-70
	HE-862	15.71	09-29-98	11:33	4.58	11.13		WT	7-10
39	HE-868	20.71	See footnote 3			19.60		GL	84-97
40[2]	HE-884	19.48	09-29-98	11:51	4.24	15.24		GL	62-67
41[2]	HE-1037	26.21	09-29-98	9:20	1.98	24.23	-.48	GL	70-120
	HE-1036	25.34	09-29-98	9:19	.63	24.71		WT	5-10
42[2]	HE-1042	21.77	09-29-98	10:29	1.17	20.60		GL	40-80
43[2]	HE-1063	17.04	09-29-98	11:57	.08	16.96	.00	GL	78-123
	HE-1062	16.96	09-29-98	11:56	.00	16.96		WT	5-10
44[2]	HE-1075	14.76	09-29-98	12:45	4.88	9.88		GL	135-155

Table 11. Ground- and surface-water-level data collected during this study (Continued)

[Well locations shown in figure 31 or figure 1 directly, or indirectly with reference to tables 1 and 2. NAVD of 88, North American Vertical Datum of 1988. Surface-water-level measurements at a site were made at about the same time as the ground-water-level measurements. Aquifer designations: GL, gray limestone or lower Tamiami; SS, sandstone; WT, water table. Other abbreviations: USGS, U.S. Geological Survey; ND, not determined; NM, not measured]

Site No.	Local number	Altitude of measurement point NAVD of 88 (feet)	Date of collection	Time of collection (hour and minutes)	Depth to water (feet)	Altitude of water level NAVD of 88 (feet)	Differential of gray limestone aquifer level above (+) or below (-) water-table aquifer level	Aquifer open in well	Depth of open interval (feet)
45	HE-1111	14.51	09-29-98	11:48	3.85	10.66		GL	38-118
	HE-1110	ND	09-29-98	11:42	3.05			GL	[4]146-156
	L-3 canal					14.30		Surface water	
46	MO-182	11.21	09-29-98	9:05	3.90	7.31	.12	GL	93-118
	MO-183	8.75	09-29-98	9:10	1.56	7.19		WT	13-23
	MO-187	10.95	09-29-98	9:13	3.64	7.31		GL	70-80
47	MO-184	8.93	09-29-98	14:24	3.15	5.78		GL	30-80
48	PB-1703	16.84	09-29-98	9:43	7.55	9.29		GL	75-85
	G-200 pumping station					8.90[1]		Surface water	
49	PB-1704	10.96	09-29-98	8:42	3.95	7.01		GL	82-112
50	PB-1705	15.25	09-29-98	8:06	5.86	9.39	-.13	GL	86-96
	PB-1706	15.25	09-29-98	8:12	5.73	9.52		WT	6-16
	S-7 pumping station, head water side					9.8-10.1		Surface water	
[5]51	OBS1N	[6]12.85	09-30-99	14:30	1.44	11.4	2.2	GL	65-140
	WTIN	[6]12.5	09-30-98	14:57	3.24	9.3		WT	5-8
[7]52	MW-2		09-29-98	8:00		12.40	-0.40	GL	63-120
	MW-4		09-29-98	10:00		12.80		WT	10-20
[7]53	MW-3		09-29-98	12:00		13.40		GL	78-100
[7]54	MW-3D		09-29-98	10:00		16.00	-1.30	GL	70-100
	MW-3S		09-29-98	6:00		17.30		WT	20-30
[7]55	MW-5		09-29-98	9:00		12.10		GL	70-100
[7]56	MW-35		09-29-98	9:00		14.20		GL	63-102
[7]57	MW-50		09-29-98	10:00		15.20		GL	63.5-105
[7]58	DW-W		09-29-98	10:00		17.00		GL	78-120.6

[1]Average of head water and tail water.
[2]Water-level data collected by South Florida Water Management District.
[3]Altitude of water level is average of end of September values from historical data for the 1986-95 period.
[4]Depth of bentonite seal above screen in well not known.
[5]Site 51 is on the Miccosukee Indian Reservation at the north aquifer test site (Murray-Milleson, 1989). Site locations is shown in figure 23 (map no. 16).
[6]Estimated using topographic map and measurement of top of casing height above ground surface, accurate to only 1 or 2 feet.
[7]Sites 52 to 58 are on the Seminole Big Cypress Indian Reservation. The water-level altitudes were read from continuous chart records. Site locations are shown in figure 31, except for site 58 which is at site 43.

Water Quality

Field-measured specific conductance data were collected to help delineate the water-quality variations within the gray limestone aquifer and to gain an understanding of the ground-water flow patterns. A plot of the relation between field-derived specific conductance and chloride concentration for water samples collected from 60 wells completed in the gray limestone aquifer was constructed by using data given in table 12 (fig. 32). A least-squares linear relation with a coefficient of determination of 0.88 was obtained; using this relation, a specific conductance of about 1,500 µS/cm (microsiemens per centimeter) approximately equals a chloride concentration of 250 mg/L. Water that is dominated by chloride ions has been shown to have a specific conductance/chloride concentration ratio of about 3:1 (Schiner and others, 1988), whereas water from the gray limestone aquifer has a ratio of 4:1 or higher (fig. 32). The higher ratio for gray limestone aquifer water is due to increased mineralization of the water, probably because of long residence time of the water in the aquifer. Water from the gray limestone aquifer contains calcium, sodium, bicarbonate, potassium, magnesium, and sulfate ions at a milliequivalent ratio to chloride higher than that found in seawater (Howie, 1987, fig. 6, Stiff diagrams). The samples with higher chloride concentration–greater than 200 or 250 mg/L–indicate the presence of connate water.

Table 12. Selected water-quality data from the gray limestone and sand aquifers

[Well locations shown in figure 33 or figure 1 directly, or indirectly with reference to tables 1 and 2. mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; --, not available or not measured; ?, depth of casing unknown]

USGS local well number	Sampling date	Chloride concentration (mg/L)	Specific conductance field (µS/cm)	Specific conductance lab (µS/cm)	Depth of open interval in completed well (feet below land surface)		Depth of drilling sample (feet below land surface)	Depth of gray limestone aquifer (feet below land surface)	
					Top	Bottom		Top	Bottom
Gray Limestone Aquifer									
C-131[1]	10-27-86	80	878	--	22	54		20	80
C-296	10-19-92	160	1,740	--	8	45		[2]5	[2]55
C-495	10-19-92	16	370	--	8	70		[2]5	[2]90
C-966	10-21-92	18	530	--	30	40		[2]5	[2]55
C-986	10-19-92	46	620	--	28	40		[2]10	[2]115
C-1071	10-21-92	40	582	--	20	35		[2]10	[2]90
C-1142[3]	09-02-98	150	1,900	1,760	60	100		58	100
C-1145[3]	08-27-98	12	526	456	10	32		18	53
C-1148[3]	08-28-98	20	697	678	40	70		25	82
C-1150[3]	08-28-98	16	574	554	25	45		2	53
C-1165[3]	08-28-98	61	931	967	24	58		21	71
C-1169[3]	08-31-98	120	1,170	1,130	77	137		75	139
C-1173[3]	09-02-98	150	1,900	1,750	65	115		65	115
C-1179[3]	09-02-98	67	1,060	994	53	83		55	144
C-1181[3]	08-31-98	170	1,100	1,090	61	91		42	99
C-1182[3]	08-31-98	240	1,550	1,510	75	125		74	122
C-1183[3]	09-01-98	120	1,150	1,110	41	71		41	83
C-1184	01-18-99	200	1,323	1,670	75	115		73	118
C-1185	01-06-99	195	1,437	1,520	115	145		91	146
C-1185	01-18-99	--	1,485	--	115	145		91	146
G-2311[4]	05-27-81	870	3,560	--			149	138	163
G-2312[4]	05-28-81	165	1,230	--			159	105	170

Table 12. Selected water-quality data from the gray limestone and sand aquifers (Continued)

[Well locations shown in figure 33 or figure 1 directly, or indirectly with reference to tables 1 and 2. mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; --, not available or not measured; ?, depth of casing unknown]

USGS local well number	Sampling date	Chloride concentration (mg/L)	Specific conductance field (µS/cm)	Specific conductance lab (µS/cm)	Depth of open interval in completed well (feet below land surface)		Depth of drilling sample (feet below land surface)	Depth of gray limestone aquifer (feet below land surface)	
					Top	Bottom		Top	Bottom
G-2313[4]	06-01-81	360	2,100	--			119	42	155
G-2314[4]	06-02-81	200	1,700	--			129	40	155
G-2315[4]	06-04-81	1,250	4,330	--			159	116	192
G-2316[4]	06-05-81	118	1,095	--			149	93	158
G-2319[4]	06-12-81	550	2,750	--			149	113	166
G-2320[4]	06-16-81	345	2,000	--			129	85	168
G-2321[4]	06-18-81	125	1,100	--			159	149	161
G-2329[4]	07-10-81	145	1,240	--			129	73	137
G-2330[4]	07-14-81	327	2,050	--			129	63	167
G-2338[4]	07-15-81	200	1,600	--			149	97	154
G-2340[4]	07-16-81	230	1,575	--			119	60	147
G-2346[4]	08-05-81	245	1,650	--			120	57	128
G-2907[3]	09-03-98	160	1,320	1,270	90.6	101		[2]60	[2]180
G-2909[1]	08-25-94	803	3,510	3,410	90	100		[2]40	[2]135
G-2911[1]	10-04-96	260	[5]1,560	--	100	115		[2]85	[2]175
G-3294C	06-08-84	300	1,360	1,470	147	150		138	179
G-3295C	09-09-98	45	908	876	127	130		57	135
G-3296C	09-09-98	60	1,003	943		[6]144		70	174
G-3297[4]	09-14-83	205	1,210	--			140	121	147
G-3298[4]	09-21-83	46	620	--			170	140	166
G-3301[4]	05-25-83	40	640	--			150	72	152
G-3301C	06-01-64	35	797	--	?	130		72	152
G-3302C	09-09-98	63	920	776	120	123		79	138
G-3303C	09-09-98	150	982	959	127	130		91	160
G-3304C	04-06-84	42	646	--	127	130		119	144
G-3305C	07-16-84	51	686	--	117	120		105	132
G-3308C	06-06-84	39	585	--	127	130		111	160
G-3309C	09-09-98	35	855	850	127	130		100	138
G-3310C	09-09-98	15	370	373	130	133		153	182
G-3311D	09-09-98	19	485	477	157	160		135	174
G-3314C	09-09-98	16	391	386	187	190		181	210
G-3317C	11-14-84	2,000	4,020	--	147	150		84	153
G-3318C	09-09-98	830	2,980	2,780	158	161		132	166
HE-855	10-20-92	82	760	--	70	90		[2]40	[2]90
HE-859	10-20-92	58	791	--	70	90		[2]45	[2]130
HE-861	10-20-92	48	562	--	37	70		[2]45	[2]185
HE-868[1]	10-31-86	135	1,043	--	84	97		95	[2]140
HE-1021[1]	10-06-86	158	1,253	--	Unknown (lower Tamiami aquifer)			40	140

Table 12. Selected water-quality data from the gray limestone and sand aquifers (Continued)

[Well locations shown in figure 33 or figure 1 directly, or indirectly with reference to tables 1 and 2. mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; --, not available or not measured; ?, depth of casing unknown]

USGS local well number	Sampling date	Chloride concentration (mg/L)	Specific conductance field (µS/cm)	Specific conductance lab (µS/cm)	Depth of open interval in completed well (feet below land surface)		Depth of drilling sample (feet below land surface)	Depth of gray limestone aquifer (feet below land surface)	
					Top	Bottom		Top	Bottom
HE-1037	10-20-92	94	980	--	70	120		75	120
HE-1042	10-21-92	125	1,270	--	40	80		40	75
HE-1054	10-29-87	98	1,100	--	30	100		55	140
HE-1063	10-20-92	164	1,276	--	78	123		78	124
HE-1075	10-19-92	580	2,990	--	135	155		62	156
HE-1111[3]	08-29-98	54	620	605	38	118		35	148
HE-1112	01-05-99	40	808	813	50	80		46	80
HE-1113	12-30-98	26	742	785	35	50		35	50
HE-1114	12-30-98	32	694	732	67	82		65	85
HE-1115	03-10-99	215	1,445	1,660	105	120		105	125
HE-1116	03-26-99	200	1,320	1,530	140	150		47	152
HE-1117	03-26-99	80	831	960	50	80		47	152
MO-180	06-18-97	160	1,222	--	95	120		48	126
MO-184[3]	08-28-98	19	605	541	30	80		0	85
MO-187	01-13-98	55	840	841	70	80		48	126
MO-188	03-02-98	--	1,800	--	89	114		48	126
MO-188[3]	08-27-98	200	1,290	1,260	89	114		48	126
PB-840	12-19-74	1,100	4,300	--	84	260		[2]60	[2]160
PB-1428[4]	07-01-81	1,700	6,250	--			159	135	162
PB-1703[3]	08-29-98	66	795	780	75	85		80	92
PB-1704[3]	08-29-98	270	2,680	2,800	82	112		73	172
PB-1705[3]	09-03-98	150	1,280	1,220	86	96		[2]110	[2]170
Sand Aquifer or Deeper									
C-1141[3]	08-28-98	840	3,520	3,540	88	108		Sand aquifer	
C-1143[3]	08-28-98	57	1,020	1,010	180	200		Sand aquifer	
C-1144[3]	08-27-98	41	777	757	120	130		Sand aquifer	
C-1164[3]	09-02-98	95	979	915	48	253		Sand aquifer	
C-1177[3]	08-28-98	219	987	1,990	143	168		Sand aquifer	
MO-178[3]	08-27-98	30	825	745	412	452		Arcadia Formation	

[1]Non-U.S. Geological Survey sample.

[2]Contact estimated from contour map to the nearest 5 feet.

[3]Analysis also included color, dissolved-solids concentration, pH, total alkalinity, all major ions, and low-level nutrient analysis (all phosphorous and nitrogen species). This additional data is archived in the USGS water-quality data storage and retrieval database (QWDATA).

[4]Sampled collected while drilling with reverse-air rotary method.

[5]Specific conductance calculated from chloride concentration value using relationship shown in figure 32.

[6]Cased to total depth.

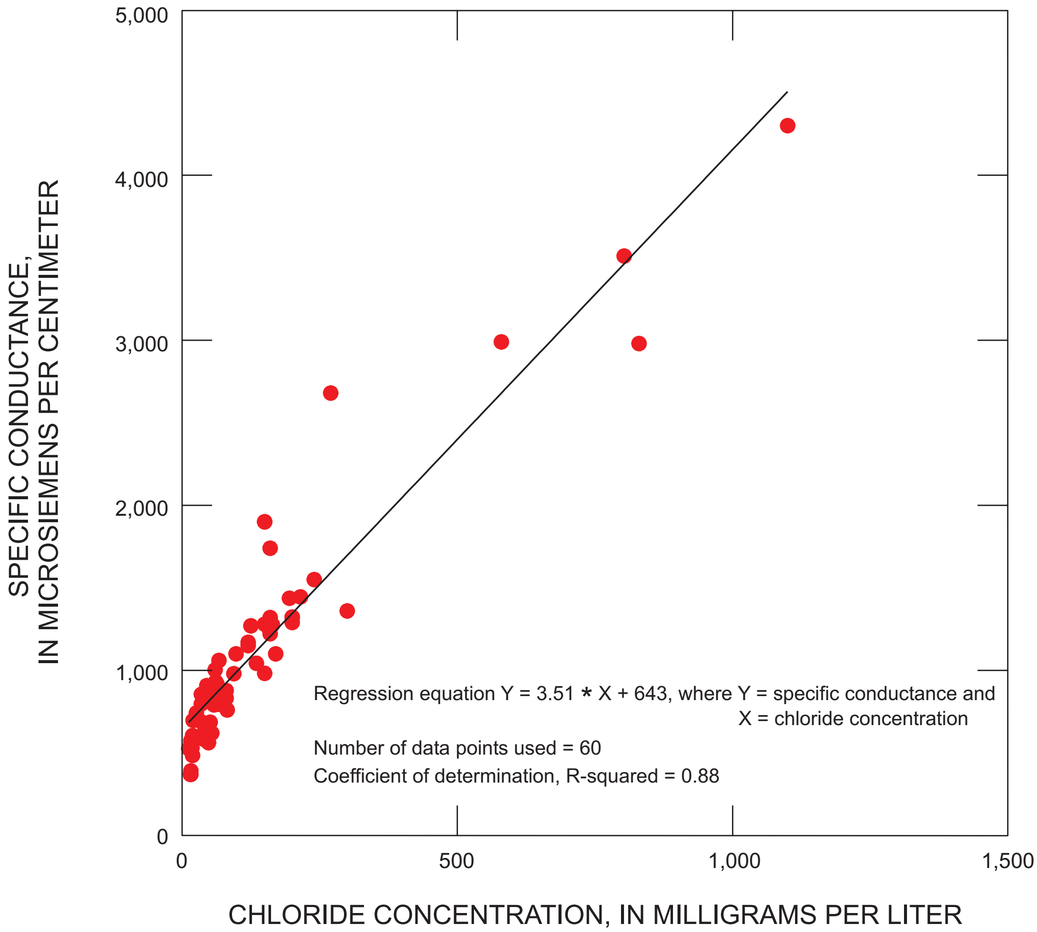


Figure 32. Relation between chloride concentration and field specific conductance for water samples collected from wells completed in the gray limestone aquifer.

In a study of the chemical characteristics of water in the surficial aquifer system in Broward County, samples were collected at 10-ft intervals while drilling with the dual-tube reverse-air method; results indicated that specific conductance in the gray limestone aquifer usually increases with depth (Howie, 1987). Based on these data, the increase in specific conductance with depth in the aquifer was sometimes abrupt, such as in wells G-2313 and G-2314 located along the Broward/Palm Beach County line in northwestern Broward County. For example, in well G-2313, specific conductance increased from 640 to 5,800 µS/cm with depth in the aquifer, which extends from 42 to 155 ft below land surface. The increase was not gradual but occurred abruptly at the depths of about 110 and 130 ft where specific conductance nearly doubled.

The sudden increases in specific conductance with depth that occur in the gray limestone aquifer probably are related to the presence of semiconfining layers contained within the aquifer. These units probably retard downward seepage of recharged meteoric water and the dilution of connate water in the lower part of the aquifer. For example, at the Trail Center site (fig. 1, well MO-178) where the aquifer is interpreted to occur at depths of between 48 and 126 below land surface (fig. 24), poorly permeable limestone containing a carbonate mud-rich matrix occurs at depths of between 80 and 96 ft below land surface and serves to divide the aquifer into upper and lower permeable intervals. Wells MO-187 and MO-188 at this site have screened intervals at depths from 70 to 80 ft and 89 to 114 ft below land surface, respectively, which are effectively above and below this poorly permeable layer (fig. 26). Samples collected from these wells showed that specific conductance from the shallow well was less than half that in the deep well (table 12).

Water from wells MO-187 and MO-188 had specific conductances of 840 and 1,800 µS/cm, respectively.

Although these semiconfining units within the aquifer serve to stratify water, they do not necessarily cause differences in head within the aquifer during natural or stressed hydrologic conditions. At the Trail Center site, water levels in wells MO-187 (70 to 80 ft below land surface) and MO-182 (93 to 118 ft below land surface) were identical on September 29, 1998. Analysis of drawdown data from the gray limestone aquifer test at the Trail Center site gave approximately the same transmissivity estimates for monitoring wells completed in the upper and lower permeable intervals, even though the production well (89 to 114 ft below land surface) was open only in the lower interval (fig. 26).

The distribution of specific conductance within the gray limestone aquifer principally during the wet season (June through October) was mapped (fig. 33) by using field-measured specific conductance data reported from 73 wells (table 12). A total of 63 of the samples used were collected during the wet season, of which 25 were from August 27 to September 9, 1998; however, dry-season specific conductance values were used for 10 wells due to a lack of available wet-season data. Data from 17 wells were collected while drilling with the dual-tube, reverse-air method (fig. 33); monitoring wells were not completed in the gray limestone aquifer at these sites. For these 17 wells, an attempt was made to choose a sample taken at a depth that was representative of the whole aquifer. Because of the compartmentalization of the aquifer as discussed above, this was difficult in some cases.

Several wells completed in the gray limestone aquifer were sampled both during the dry season and wet season, and, in most cases, the change in water quality was not great. For example, well C-1165 at the Bear Island Campground site (fig. 33) was sampled during both periods, and specific conductance decreased from 1,020 µs/cm on January 28, 1998, to 931 µs/cm on August 28, 1998.

Specific conductance of water from the gray limestone aquifer in the study area varies widely, but is generally less than 1,500 µS/cm in most areas (fig. 33). High specific conductance (from 3,000 to 6,300 µS/cm) occurs in Palm Beach County; parts of central and northern Broward County; and southwestern Miami-Dade County. Low specific conductance (less than 500 µS/cm) is found in south-central and eastern Miami-Dade County and a small area within western Collier County. Some of the local variations may be the result of samples collected at different depths within the aquifer in nearby wells. For example, in Palm Beach County, well PB-1704 was screened over a 30-ft interval within the upper part of a 100-ft thick aquifer, whereas the entire aquifer is open in well PB-840 located about 5 mi to the northwest of well PB-1704. The specific conductance values are 2,700 and 4,300 µS/cm for wells PB-1704 and PB-840, respectively (fig. 33). A semiconfining layer of low to very low hydraulic conductivity was penetrated in well PB-1704 at a depth of 110 ft below land surface within the aquifer (appendix II), which is about the depth of the bottom of the screened interval.

Areas of high specific conductance in the gray limestone aquifer are probably caused by confining units, both above and within the aquifer, or a low potentiometric surface gradient in the aquifer that causes ground-water movement from distant recharge areas to be slow. The areas of high specific conductance in Palm Beach County and parts of northern Broward County could result from both of these factors. The easterly directed head gradient in these areas is very low (fig. 31). The area of high specific conductance in central to south-central Broward County, defined by samples from wells G-2319 and G-2311 (fig. 33), also coincides with an area where the upper confining unit thickness exceeds 50 ft (fig. 29). An area of higher specific conductance (greater than 1,500 µS/cm) that extends from southern Hendry County to the southeast through eastern Collier County and into southwestern Broward County could also be attributed to confinement above the aquifer. The upper confining unit is greater than 50 ft thick in much of this area.

The areas of high specific conductance in Palm Beach County and parts of northern Broward County (fig. 33) could be the result of seawater invasion during the Pleistocene, followed by incomplete flushing of the aquifer (Parker and others, 1955, p. 821). An area of high chloride concentration (more than 500 mg/L) was mapped in roughly the same area as these areas of high specific conductance for a depth interval from 51 to 100 feet (Parker and others, 1955; fig. 221C).

An area of low specific conductance (less than 1,500 µS/cm) extends from southern Hendry County through well HE-861 to the southeast into western Broward County (fig. 33). Much of this area has good confinement on the basis of the thickness of the upper confining unit and on leakance values estimated from aquifer tests (fig. 29). This area of low specific conductance probably is caused by the movement of fresh ground water to the southeast that has its source as

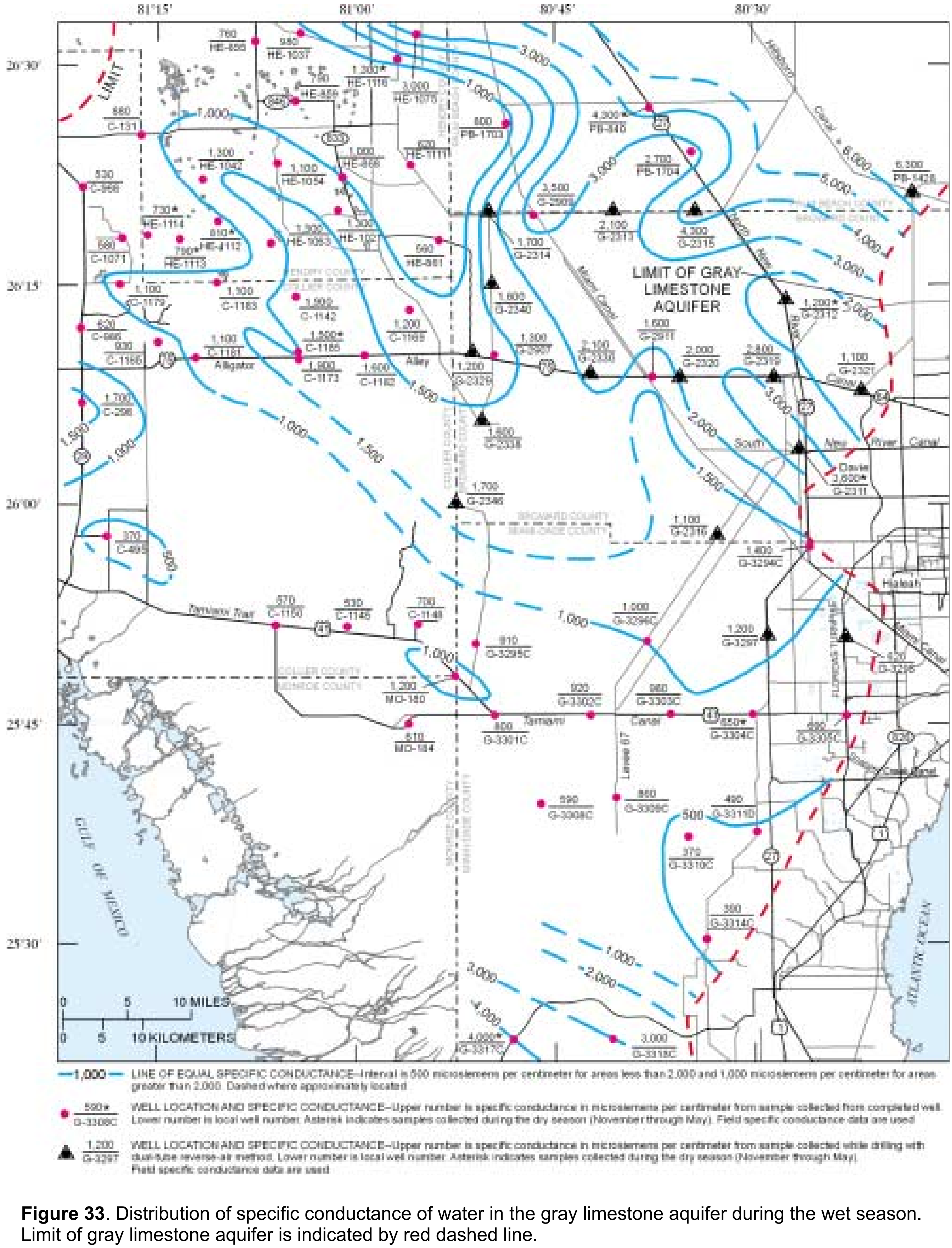


Figure 33. Distribution of specific conductance of water in the gray limestone aquifer during the wet season. Limit of gray limestone aquifer is indicated by red dashed line.

recharged meteoric water in Hendry County. Ground-water flow, as indicated by the potentiometric surface (fig. 31), is directed to the southeast in much of this area of low specific conductance. Additionally, an area of high transmissivity (greater than 50,000 ft^2/d) has been mapped in this area, and it also extends to the southeast (fig. 28). Hydraulic conductivity is likely to be higher in a direction parallel to this area of high transmissivity, and ground-water flow would tend to be directed along this area as it moves downgradient.

SUMMARY AND CONCLUSIONS

The gray limestone aquifer of the surficial aquifer system is a potential supplemental source for public-water supply in central-south Florida. Prior to this study, the relations between the wetlands and shallow aquifers were not well defined, and additional hydrologic data were needed to improve characterization of the hydraulic properties of the aquifers of the surficial aquifer system. Stratigraphic and hydrogeologic correlation between the east and west coastal areas in the surficial aquifer system was needed.

To address these needs, 35 test wells were drilled, of which 33 were continuously cored. All collected cores samples were described, selected intervals were analyzed for porosity and permeability, and thin sections of selected samples were examined. Extensive borehole geophysical logging was done in many of the test wells. Wells were installed at most test corehole sites, and aquifer testing of the gray limestone aquifer was conducted at six sites that included four multiwell tests and six single-well tests. Water-quality data were collected from all wells installed, and synoptic water levels of the gray limestone and water-table aquifers were determined in 69 wells at 47 sites.

The lithologic units of primary interest to this study include the Peace River Formation of the Hawthorn Group, the unnamed formation, Tamiami Formation (Ochopee Limestone and Pinecrest Sand Member), and younger rock and sediment of Pleistocene age. The unnamed formation consists of relatively clay-free quartz sands and sandstones overlying clay-rich siliciclastics of the Peace River Formation and underlying the lowest limestones of the Ochopee Limestone.

The Ochopee Limestone consists of mixed siliciclastic-carbonate rocks that contain a heterozoan carbonate-particle association. The heterozoan carbonate particles accumulated in a carbonate ramp depositional system. The extensive carbonate ramp sequence that forms the Ochopee Limestone could have been deposited during transgressive to high-stand conditions in the early Pliocene; the bounding marine siliciclastic shelf deposits (unnamed formation and Pinecrest Sand) were deposited during low-stand conditions. Subtle regional-scale facies patterns that characterize ramp depositional systems suggest that gross hydraulic properties of the gray limestone aquifer are predictable.

The gray limestone aquifer of the surficial aquifer system includes moderately to highly permeable limestones, sandstones, and sand of the Ochopee Limestone. Additionally, quartz sands and sandstones of the uppermost part of the unnamed formation were included as part of the gray limestone aquifer if hydraulic conductivity was high to very high, or if they contained moldic porosity. The Ochopee Limestone part of the aquifer is primarily composed of pelecypod lime rudstones and floatstones with common skeletal-moldic pore spaces. The aquifer overlies less-permeable quartz sand and sandstone of the unnamed formation and Peace River Formation. In most areas, the aquifer is overlain by a confining to semiconfining unit, and this unit usually consists of poorly permeable clayey quartz sands and terrigenous mudstones of the Pinecrest Sand.

In general, the gray limestone aquifer thickens where the base of the aquifer is structurally low and, based on a previous study, where the top of a deeper formation also is low. This coincidence suggests that the thickest deposition of the gray limestone aquifer occurred in paleotopographic low areas, or that structural movements during deposition influenced the thickness of the gray limestone aquifer. A northwest-southeast trending fault is postulated to be present in eastern Collier County based on structure at the base of the gray limestone aquifer. Vertical offset at the base of the aquifer caused by this fault could be as great as 60 ft. Local thickening of correlative units across the fault to its downthrown side, found to occur at one of the test corehole sites, is consistent with movement along this inferred fault during deposition of the Ochopee Limestone and possibly the Pinecrest Sand.

The gray limestone aquifer extends over most of the study area except in a small area in northwestern Collier County. The gray limestone aquifer is the same as the lower Tamiami aquifer in southern Hendry County; to the west and south in Collier and Monroe Counties, it becomes the water-table aquifer and the upper part of the lower Tamiami aquifer. The thickness of the gray limestone aquifer ranges from 30 to 100 ft over most of the study area. The eastern limit of the gray limestone aquifer occurs where permeable facies that constitute the aquifer grade eastward into less permeable facies, or where the aquifer merges with the Biscayne aquifer and the intervening semiconfining unit wedges out. South of Tamiami Trail in Miami-Dade County, the eastern limit of the aquifer corresponds to the limits of the Ochopee Limestone carbonate ramp where these rocks are transitional with less-permeable siliciclastics of the Pinecrest Sand and the unnamed formation.

The rock-pore types within the gray limestone aquifer are mainly intergranular and separate vug (skeletal-moldic) pore spaces. Solution-enlarged pore spaces and minor intragrain, root-mold and boring porosity are distributed locally. Aquifer tests and semi-quantitative and quantitative core analyses of gray limestone aquifer core samples indicate that the rock-fabric and associated primary and secondary pore spaces combine to form a dual diffuse-carbonate and conduit flow system capable of yielding large quantities of water.

The transmissivity of the gray limestone aquifer is reported to be as much as 90,000 ft^2/d based on historical aquifer test data for Miami-Dade and Broward Counties. Transmissivity of the equivalent lower Tamiami aquifer in Hendry County is as much as 125,000 ft^2/d. Tests conducted during this study suggest that transmissivity and hydraulic conductivity in the gray limestone aquifer are at least as high as 300,000 ft^2/d and 12,000 ft/d, respectively. Two areas of high transmissivity (greater than 50,000 ft^2/d), both of which trend northwest-southeast, were mapped. One extends through southern Hendry County and into west-central Broward County, and the other extends from central Collier County to northern Monroe County. The very high transmissivity (as much as 300,000 ft^2/d) in the area extending through eastern Collier County could be associated with the structural position of the aquifer in this area. In this area, the aquifer lies near the land surface and is unconfined to semi-confined; greater rates of meteoric recharge in this area as compared to areas where the aquifer is better confined could have enhanced dissolution in the aquifer.

Based on aquifer tests, hydraulic conductivity within the aquifer is reported to range from about 200 to 12,000 ft/d, but this property for individual flow zones probably is much larger. Flow-zone thicknesses within the gray limestone aquifer were determined from heat pulse flowmeter data; most of the flow within the aquifer occurs within relatively thin zones that are highly permeable. These flow zones are usually only 5 to 10 ft thick and are separated by intervals of low to moderate hydraulic conductivity that can act as semiconfining units. The hydraulic conductivity within the gray limestone aquifer generally increases from east to west across the study area, and this pattern is related to a shallowing of the depositional profile of the Ochopee Limestone carbonate ramp in the same direction.

The gray limestone aquifer is semiconfined or confined in most areas but is unconfined to the south and west in Collier and Monroe Counties. The thickness of the upper confining unit ranges from 20 to 60 ft in most of the area where the unit is present. The leakance of the upper confining unit is as low as about 1.0×10^{-6} 1/d based on aquifer tests. Sites with a leakance of less than 1.0×10^{-3} 1/d, a value considered to indicate good confinement, are located in areas where the thickness of the upper confining unit approaches or is more than 50 ft. Areas where the upper confining unit is 50 ft thick or greater are in southwestern Palm Beach County and parts of southern Hendry, eastern Collier, Broward, and Miami-Dade Counties.

A semiconfining unit is present below the gray limestone aquifer in most of the study area and is usually contained within the unnamed formation. This semiconfining unit is usually underlain by confining beds at the top of the Peace River Formation that mark the base of the surficial aquifer system. In some areas, the unnamed formation contains a sand aquifer, and some confinement separates this aquifer from the gray limestone aquifer based on lithology, core sample analysis, analysis of aquifer-test and flowmeter data, and changes in water quality and hydraulic head. However, some previous investigators have combined the gray limestone aquifer and the sand aquifer of the unnamed formation into one aquifer, referred to as the lower Tamiami aquifer.

Water levels in the gray limestone aquifer on September 29, 1998, ranged from as much as 26 ft above sea level (North American Vertical Datum of 1988) in central Hendry County to less than 4 ft above sea level in coastal areas. The direction of ground-water flow is to the south or southwest in part of southern Hendry County, most of Collier County, Monroe County, and western Miami-Dade County; in most of the rest of the study area, flow is to the east or southeast. Based on differences in water levels between the gray limestone aquifer and the overlying water-table aquifer, recharge is indicated for the gray limestone aquifer in central and southern Hendry County, and discharge is indicated in eastern Collier County, Broward County, and Miami-Dade County.

During the wet season (June through October), the specific conductance of water from the gray limestone aquifer ranged from less than 500 to greater than 6,000 μS/cm in the study area. However, in most areas, specific conductance was 1,500 μS/cm or less, a value that approximately equates to a dissolved chloride concentration of 250 mg/L. Areas of higher specific conductance (greater than 3,000 μS/cm) probably are caused either by confining units, both above and within the aquifer, which retard downward seepage of recharged meteoric water into the aquifer, or by a low potentiometric-surface gradient, or by both of these factors. Specific conductance tends to be high in areas where the upper confining unit is 50 ft thick or greater.

An area with a specific conductance of less than 1,500 μS/cm extends from southern Hendry County toward the southeast into western Broward County. However, much of this area is indicated to have good confinement, based on the thickness of the upper confining unit and hydraulic properties estimated from aquifer tests. An area of high transmissivity (greater than 50,000 ft^2/d) was mapped in this area and trends in the same direction. The hydraulic head gradient also is to the southeast in this area. Relatively rapid downgradient movement of ground water that has been recharged in Hendry County probably causes this area of low specific conductance.

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APPENDIXES

Appendix I. Inventory of wells used in this report

[Well locations are shown in figure 1 directly or indirectly with reference to tables 1 and 2, or in figures 31 or 33. USGS, U.S. Geological Survey. Altitude of measuring point usually is land surface, but can be higher. All depths are below measuring point. Permit or other identifier: Permit, State permit number for oil test or production well; W, well number assigned by Florida Geological Survey; MW, monitoring well; PW, production well; WS, water-supply well; TW, test well. Dashes indicate no data or not applicable]

USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
C-41	548-121-3	T53S R29E	254839	812147	254839081214702	5	497	--	4.0	--	--	08-49
C-131	F	NWSE S01 T47S R30E	262520	811619	262521081161901	26.7	54	22	6.0	--	--	01-01-52
C-296	F	SESESE S18 T50S R30E	260645	812042	260640081204301	14.1	45	8	4.0	8	45	--
C-308	609-115-1	S01 T50S R30E	260919	811559	260919081155901	15	700	587	2.5	--	--	1959
C-495	F	NENENE S09 T52S R30E	255750	811840	255748081181801	6.6	70	8	6.0	8	70	01-01-71
C-701	Permit 42, W-820	S29 T48S R30E	261606	812024	261606081202401	42	11,626	11,597	7.0	--	--	09-26-43
C-791	Permit 885	S36 T50S R31E	260437	811008	260437081100801	--	--	--	--	--	--	--
C-851	W-10252	S24 T48S R29E	261716	812227	261716081222701	18	2,056	--	--	--	--	--
C-873	Permit 1000	S06 T49S R33E	261436	810340	261436081034001	--	--	3,998	9.6	--	--	--
C-913	W-14919	--	260916	811853	260916081185301	--	1,205	--	--	--	--	--
C-917	W-14934	--	255730	812111	255730081211101	--	785	--	--	--	--	--
C-918	W-10180	--	255708	811845	255708081184501	--	1,282	--	--	--	--	--
C-919	W-10183	--	255530	810425	255530081042501	--	1,151	--	--	--	--	--
C-920	W-10184	--	255604	810722	255555081024501	--	1,171	--	--	--	--	--
C-921	W-10187	--	255550	810025	255550081002501	--	1,140	--	--	--	--	--
C-922	W-10188	--	261300	811345	261300081134501	--	1,112	--	--	--	--	--
C-923	W-10190	--	255500	811405	255500081140501	--	1,302	--	--	--	--	--
C-927	W-8899	--	260200	811945	260200081194501	--	1,032	--	--	--	--	--
C-928	W-8951	--	255500	812130	255500081213001	--	1,247	--	--	--	--	--
C-929	W-9413	--	260110	811515	260110081151501	--	1,491	--	--	--	--	--
C-930	W-9905	--	261035	810740	261035081074001	--	1,265	--	--	--	--	--
C-931	W-10014	--	260205	810925	260205081092501	--	1,198	--	--	--	--	--
C-965	--	NESW S29 T47S R30E	262138	812041	262136081204202	22.0	460	438	2.0	438	460	--
C-966	--	NESW S29 T47S R30E	262138	812041	262136081204201	22.0	40	30	6.0	30	40	--
C-986	--	SESE S18 T49S R30E	261203	812048	261200081204901	16.4	40	28	6.0	28	40	--
C-995	--	SESE S12 T52S R29E	255705	812134	255703081213801	7	37	28	2.0	28	37	--
C-1071	2068 S	NWSENE S14 T48S R30E	261814	811737	261823081171901	19.3	35	20	4.0	20	35	10-01-85
C-1074	2066 I	NESENE S01 T47S R30E	262520	811619	262519081162102	26.7	130	100	4.0	100	130	10-01-85
C-1075	2064 S	NESWSE S18 T46S R30E	262831	812157	262822081213201	30.6	28	8	4.0	8	28	10-01-85
C-1076	2064 I	NESWSE S18 T46S R30E	262831	813158	262822081213202	30.6	85	65	4.0	65	85	10-01-85

Appendix I. Inventory of wells used in this report (Continued)

[Well locations are shown in figure 1 directly or indirectly with reference to tables 1 and 2, or in figures 31 or 33. USGS, U.S. Geological Survey. Altitude of measuring point usually is land surface, but can be higher. All depths are below measuring point. Permit or other identifier: Permit, State permit number for oil test or production well; W, well number assigned by Florida Geological Survey; MW, monitoring well; PW, production well; WS, water-supply well; TW, test well. Dashes indicate no data or not applicable]

USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
C-1077	2064 D	NESWSE S18 T46S R30E	262831	812158	262822081213203	30.6	210	170	4.0	170	210	10-01-85
C-1090	W-16434, Immokalee Core	NENE S3 T47S R30E	262528	811828	262528081182801	25	715	--	--	--	--	1989
C-1091	W-16505, Fakahatchee St. Core	SWNW S06 T50S R30E	260852	812128	260852081212801	13	702	271	--	--	--	02-05-99
C-1115	W-17393, FS Ranger St. Core	S12 T52S R29E	255706	812139	255706081213901	5	160	--	--	--	--	04-21-96
C-1117	W-17394, FS Jones Grade Core	S6 T50S R30E	260834	812100	260834081210001	13	196	--	--	--	--	07-26-96
C-1125	Permit 1063	NESW S20 T50S R33E	260603	810246	260603081025601	14.1	11,759	3,813	9.6	--	--	07-01-82
C-1126	Permit 1065	WNWS06 T50S R32E	260947	811002	260947081100202	15.7	11,802	3,696	9.6	--	--	02-22-83
C-1128	Permit 1094	SWSW S14 T50S R32E	260652	810601	260652081060101	13.2	11,505	11,505	7.0	--	--	10-30-83
C-1129	Permit 1095	NESW S6 T50S R33E	260841	810403	260841081040301	15.2	11,790	3,945	9.6	--	--	03-06-83
C-1133	Permit 1216	NWNW S18 T50S R33E	260723	810400	260723081040001	12.9	11,755	3,995	9.6	--	--	05-23-88
C-1134	W-17970, Dade-Collier Airport Core	SWSW S10 T53S R34E	255152	805504	255152080550401	10	200	--	--	--	--	02-16-97
C-1135	W-17971, FAA Radar Core	NWNE S15 T53S R33E	255146	810038	255146081003801	12	205	160	2.0	--	--	02-07-97
C-1136	W-17972, Monroe Station Core	NWNW S14 T53S R32E	255145	810601	255145081060101	10	200	--	--	--	--	02-16-97
C-1137	W-17974, Doerr's Lake Core	NESW S33 T52S R31E	255351	811328	255351081132801	6	200	--	--	--	--	03-10-97
C-1138	W-17975, Raccoon Point Core	SESE S33 T51S R34E	255856	805533	255856080553301	11.4	185	--	--	--	--	03-09-97
C-1139	W-17976, Noble's Road Core	NESW S31 T49S R33E	261019	810409	261019081040902	13	200	--	--	--	--	04-05-97
C-1140	W-17977, Bass Core	NENW S5 T52S R31E	255832	811431	255832081143101	8	200	--	--	--	--	03-25-97

Appendix I. Inventory of wells used in this report (Continued)

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USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
C-1141	W-17746. Bear Island Core & BI-D	SESW S29 T49S R31E	261058	811452	261058081145201	15	207	207	2.0	88	108	06-14-97
C-1142	W-17748, Noble's Farm Core	NWNW S07 T49S R33E	261417	810424	261417081042401	16	206	60	2.0	60	100	06-12-97
C-1143	Radar Deep MW	NWNE S15 T53S R33E	255146	810038	255146081003802	--	207	207	2.0	180	200	05-14-97
C-1144	Radar Medium MW	NWNE S15 T53S R33E	255146	810038	255146081003803	--	148	148	2.0	120	130	06-03-97
C-1145	Radar Shallow 1 MW	NWNE S15 T53S R33E	255146	810038	255146081003804	--	40	40	2.0	10	32	05-19-97
C-1146	Radar Shallow 2 MW	NWNE S15 T53S R33E	255148	810038	255148081003801	--	35	35	2.0	10	32	06-19-97
C-1147	Radar Shallow 3 MW	SWNE S15 T53S R33E	255127	810038	255127081003801	--	35	35	2.0	10	32	06-19-97
C-1148	Airport 1 MW	SWSW S10 T53S R34E	255152	805504	255152080550402	--	73	73	2.0	40	70	07-09-97
C-1149	Airport 2 MW	SWSW S10 T53S R34E	255152	805504	255152080550403	--	32	31	2.0	9	29	07-15-97
C-1150	Monroe Station MW	NWNW S14 T53S R32E	255145	810601	255145080060102	--	52	47	2.0	25	45	07-15-97
C-1152	Permit 1059	SE S03 T50S R32E	260840	810630	260840081070001	15	11,795	11,483	7.0	--	--	05-31-82
C-1153	Permit 1115, W-15455	NW S12 T49S R30E	261330	811650	261330081165001	17.4	11,949	11,949	7.0	--	--	11-12-84
C-1154	W-8988	SWSE S08 T48S R30E	261850	812030	261855081203001	20	730	--	--	--	--	--
C-1156	W-10018	S5 T49S R34E	261500	805720	261455080571501	14	1,000	--	--	--	--	04-74
C-1157	W-10029	S13 T49S R33E	261315	805910	261315080591001	14	1,140	--	--	--	--	04-74
C-1158	W-10034	S23 T49S R34E	261230	805415	261230080541501	13	1,010	--	--	--	--	04-74
C-1159	W-16923	S21 T50S R33E	260615	810145	260614081014701	12	3,480	--	--	--	--	--
C-1162	Raccoon Pt. PAD 4 WS 2	NESE S28 T51S R34E	260000	805530	255950080553501	12	350	--	--	--	--	--
C-1163	W-17534, Sunniland I Core	SESW S17 T48S R30E	261801	812044	261801081204401	20	815	--	--	--	--	03-97
C-1164	Sunniland 1 MW	SESW S17 T48S R30E	261801	812044	261801081204402	20	274	--	--	48	253	03-97
C-1165	Bear Island 1 MW	SESW S29 T49S R31E	261058	811452	261058081145202	15	58	58	2.0	24	58	01-07-98
C-1166	Bear Island 2 MW	SESW S29 T49S R31E	261100	811452	261100081145201	15	43	43	2.0	23	43	01-07-98
C-1167	Bear Island PW	SESW S29 T49S R31E	261057	811452	260907081145201	15	59	57	6.0	22	57	01-29-98

Appendix I. Inventory of wells used in this report (Continued)

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USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
C-1169	W-17614, Big Cypress Sanctuary Core	SENE S16 T49S R34E	261317	805552	261320080555301	15	195	137	2.0	77	137	12-20-97
C-1170	BCS-2 MW	SENE S16 T49S R34E	261317	805554	261320080555101	15	120	120	2.0	80	120	01-11-98
C-1171	BCS-P PW	SENE S16 T49S R34E	261317	805551	261320080555102	15	139	136	6.0	76	136	02-05-98
C-1172	Radar PW	NWNE S15 T53S R33E	255145	810038	255145081003801	12	52	50	8.0	9	49	03-04-98
C-1173	Sabine Road Deep MW	NWNW S06 T50S R33E	260953	810417	260953081041701	13	135	135	2.0	65	115	04-02-98
C-1174	Sabine Road Shallow MW	NWNW S06 T50S R33E	260953	810417	260953081041702	13	25	25	2.0	15	25	04-02-98
C-1176	Turner River Road Core	SWNW S06 T51S R31E	260338	811549	260338081154701	12	365	--	--	--	--	01-18-98
C-1177	Turner River Road MW	SWNW S06 T51S R31E	260338	811549	260338081154702	12	168	168	2.0	143	168	03-11-98
C-1178	Sunniland II Core	SWNW S02 T49S R30E	261453	811744	261453081174401	19.2	200	--	--	--	--	02-05-98
C-1179	Sunniland II MW	SWNW S02 T49S R30E	261453	811744	261453081174402	19.2	83	83	2.0	53	83	03-25-98
C-1180	BC HQ Core	SENW S33 T52S R30E	255345	811924	255345081192401	5	200	--	--	--	--	02-18-98
C-1181	Cypress Lane Core	SW S35 T49S R31E	261002	811203	261002081120301	17	200	91	2.0	61	91	03-12-98
C-1182	W-17749, Alligator Alley East Core	NWNW S01 T50S R33E	261011	805921	261011080592101	13	200	125	2.0	75	125	05-30-98
C-1183	W-17750, Baker's Grade Core	NENE S01 T49S R31E	261504	811023	261504081102301	15	179	71	2.0	41	71	07-04-98
C-1184	Noble's Hunt Camp MW	NWSW S31 T49S R33E	261018	810415	261018081041501	--	152	115	2.0	75	115	12-04-98
C-1185	Noble's Road MW	NESW S31 T49S R33E	261019	810410	261019081041001	--	172	145	2.0	115	145	12-19-98
G-2296	BOF-1	S03 T50S T35E	261016	804926	261016080492601	15.5	2,811	2,447	2.4	811	816	01-07-80
G-2311	BRT-22	SESESE S28 T50S R39E	260335	802637	260335080263701	10	209	195	2.0	185	195	05-27-81
G-2312	BRT-19	SENENE S32 T48S R39E	261347	802737	261347080273701	15	229	217	2.0	207	217	05-28-81
G-2313	BRT-14	--	261958	804106	261958080410601	12	219	188	2.0	178	188	06-01-81

Appendix I. Inventory of wells used in this report (Continued)

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USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
G-2314	BRT-13	--	261952	805002	261952080500201	20	199	176	2.0	166	176	06-03-81
G-2315	BRT-15	--	261958	803421	261958080342101	19.5	249	235	2.0	225	235	06-04-81
G-2316	BRT-2	--	255732	803256	255732080325601	12	209	191	2.0	181	191	06-08-81
G-2317	BRT-3	SWSWSE S35 T51S R39E	255722	802455	255722080245501	5	139	70	2.0	60	70	06-09-81
G-2318	BRT-4	SWSWSW S34 T51S R40E	255724	802036	255724080203601	5	204	198	2.0	188	198	06-10-81
G-2319	BRT-10	NWNENE S31 T49S R39E	260843	802839	260843080283901	10	219	206	2.0	196	206	06-15-81
G-2320	BRT-9	--	260846	803542	260846080354201	11	219	206	2.0	196	206	06-17-81
G-2321	BRT-11	SWNENE S05 T50S R40E	260742	802200	260742080220001	8	299	262	2.0	252	262	06-22-81
G-2322	BRT-12	NWNENE S17 T50S R41E	260617	801612	260617080161201	13	239	191	2.0	181	191	06-23-81
G-2329	BRT-7	--	261014	805122	261014080512201	14	179	147	2.0	137	147	07-13-81
G-2330	BRT-8	--	260844	804159	260844080415901	12	209	187	2.0	177	187	07-14-81
G-2338	BRT-21	--	260532	805036	260532080503601	16	179	161	2.0	151	161	07-15-81
G-2340	BRT-20	--	261458	804947	261458080494701	14	199	162	2.0	152	162	07-17-81
G-2341	BRT-23	T48S R40E	261343	801758	261343080175801	12	209	136	2.0	126	136	07-21-81
G-2346	BRT-1	--	255958	805222	255958080522201	12	170	127	2.0	117	127	08-06-81
G-2891	W-10075	NW S27 T48S R35E	261715	804940	261717080524801	13	970	--	--	--	--	--
G-2907	WCAS-140D, W-17016	S33 T49S R35E	261016	804933	261016080493301	14	101	101	2.0	91	101	03-01-93
G-2908	WCAS-140S	S33 T49S R35E	261016	804933	261016080493302	14	14	14	2.0	4	14	03-01-93
G-2909	WCAS-8D, W-17015, S-8 pumping station	S06 T48S R36E	261952	804631	261952080463101	16	100	100	2.0	90	100	--
G-2910	WCAS-8S, S-8 pumping station	S06 T48S R36E	261952	804631	261952080463102	16	20	20	2.0	10	20	--
G-2911	I-75 MM35 West WS 1	NW S34 T49S R37E	260842	803736	260842080373601	--	115	100	4.0	100	115	07-20-98
G-2912	South New River, B-5 Core	NWNW S03 T52S R39E	260341	802528	260341080252801	10	90	90	3.0	--	--	08-20-98
G-3238	W-147	S19 T54S R35E	264537	805222	254537080522201	14	4,570	2,000	6.0	--	--	05-32
G-3294	DAT-003TW	--	255707	802548	255707080254801	9	220	197	1.5	197	200	07-22-83
G-3294C	DAT-003C	--	255707	802548	255707080254804	--	150	147	1.5	147	150	07-22-83

Appendix I. Inventory of wells used in this report (Continued)

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USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
G-3295	DAT-004D	--	255028	805049	255028080504901	12	230	217	1.5	217	220	06-01-83
G-3295A	DAT-004A	--	255028	805049	255028080504902	--	20	17	2.0	17	20	06-01-83
G-3295C	DAT-004C	--	255028	805049	255028080504904	--	130	127	1.5	127	130	06-01-83
G-3296	DAT-005TW	--	255048	803805	255043080380501	5	210	188	1.5	188	191	05-17-83
G-3296A	DAT-005A	--	255048	803805	255043080380502	--	23	20	2.0	20	--	05-17-83
G-3296C	DAT-005C	--	255043	803805	255043080380504	--	144	144	1.5	--	--	05-17-83
G-3297	DAT-006TW	--	255116	802903	255116080290301	11	180	164	1.5	164	167	09-14-83
G-3298	DAT-007TW	--	255043	802310	255043080231001	9	200	163	1.5	163	166	09-21-83
G-3299	DAT-008TW	--	255042	801630	255042080163001	5	310	287	1.5	287	290	09-12-83
G-3301	DAT-010TW	--	254537	804936	254537080493601	11.5	215	170	1.5	170	173	05-26-83
G-3301C	DAT-010C	--	254537	804936	254537080493604	--	130	--	--	--	--	05-27-83
G-3302	DAT-011TW	--	254542	804217	254542080421701	9.5	210	164	1.5	164	167	09-06-83
G-3302A	DAT-011A	--	254542	804217	254542080421702	--	16	14	2.0	14	--	09-07-83
G-3302C	DAT-011C	--	254542	804217	254542080421704	--	123	120	1.5	120	123	09-06-83
G-3303	DAT-012TW	--	254545	803617	254545080361701	11	200	179	1.5	179	182	05-12-83
G-3303A	DAT-012A	--	254545	803617	254545080361702	--	23	20	2.0	20	23	05-12-83
G-3303C	DAT-012C	--	254545	803617	254545080361704	--	130	126	1.5	127	130	05-12-83
G-3304	DAT-013TW	--	254539	803006	254539080300601	11	210	183	1.5	183	186	09-07-83
G-3304C	DAT-013C	--	254539	803006	254539080300604	--	130	127	1.5	127	130	09-08-83
G-3305	DAT-014TW	--	254536	802303	254536080230301	6	200	174	1.5	174	177	09-20-83
G-3305C	DAT-014C	--	254536	802303	254536080230304	--	120	117	1.5	117	120	09-20-83
G-3306	DAT-015TW	--	254600	801737	254600080173701	10	230	212	1.5	212	215	10-21-83
G-3308	DAT-017TW	--	253927	804559	253927080455901	6	230	167	1.5	167	170	05-25-83
G-3308C	DAT-017C	--	253927	804559	253927080455904	--	130	127	1.5	127	130	05-25-83
G-3309	DAT-026TW	--	253954	804025	253954080402501	9	175	--	1.5	--	--	--
G-3309A	DAT-026A	--	253954	804025	253954080402502	--	23	20	2.0	20	23	05-20-83
G-3309C	DAT-026C	--	253954	804025	253954080402504	--	130	127	1.5	127	130	05-20-83

Appendix I. Inventory of wells used in this report (Continued)

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USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
G-3310	DAT-018TW	--	253714	803459	253714080345901	10	250	244	1.5	244	247	06-07-83
G-3310A	DAT-018A	--	253714	803459	253714080345902	--	19	19	2.0	--	--	--
G-3310C	DAT-018C	--	253714	803459	253714080345904	--	133	130	1.5	130	133	06-07-83
G-3311	DAT-019TW	--	253746	802950	253746080295001	13	240	214	1.5	214	217	09-16-83
G-3311A	DAT-019A	--	253746	802950	253746080295002	--	23	20	2.0	20	23	09-16-83
G-3311D	DAT-019D	--	253746	802950	253746080295005	--	160	--	1.5	157	160	09-16-83
G-3312	DAT-020TW	--	253842	802258	253842080225801	14	200	167	1.5	164	167	09-26-83
G-3313	DAT-021TW	--	253831	801802	253831080180201	16	230	210	1.5	210	213	10-07-83
G-3314A	DAT-023TW	--	253018	803335	253018080333501	8	260	30	2.0	27	30	06-10-83
G-3314C	DAT-023C	--	253018	803335	253018080333503	--	190	190	1.5	187	190	06-10-83
G-3315	DAT-024TW	--	253119	802748	253119080274801	13	210	187	1.5	187	190	10-04-83
G-3316	DAT-025TW	--	253010	802250	253010080225001	11	210	177	1.5	177	180	10-03-83
G-3317	DAT-027TW	--	252326	804757	252326080475701	6	213	210	1.5	210	213	06-15-83
G-3317C	DAT-027C	--	252326	804757	252326080475704	--	150	147	1.5	147	150	06-15-83
G-3317D	DAT-027D	--	252326	804757	252326080475705	--	28	8	6.0	8	28	02-12-85
G-3318	DAT-028TW	--	252329	804049	252256080363501	5	260	220	1.5	220	223	06-20-83
G-3318A	DAT-028A	--	252329	804049	252256080363502	--	26	23	2.0	23	--	06-20-83
G-3318C	DAT-028C	--	252329	804049	252256080363504	--	161	158	1.5	158	161	06-20-83
G-3319	DAT-029TW	--	252507	803427	252507080342701	14	300	237	1.5	237	240	06-23-83
G-3320	Naval Station	--	252555	802810	252555080281001	8	86	--	--	--	--	--
G-3321	L-31E	--	252506	802128	252506080212801	6	200	--	--	--	--	--
G-3394	DAT-022TW	--	252945	803952	252945080395204	6	210	127	1.5	127	130	02-21-85
G-3394B	DAT-022B	--	252945	803952	252945080395202	--	145	110	6.0	110	145	02-22-85
G-3671	W. Bird Drive Basin, B-1 Core	SESE S11 T54S R38E	254456	802953	254456080295301	6	150	--	--	0	150	08-07-98
G-3673	L-31, B-2B Core	SENE S25 T53S R38E	254822	802902	254822080290202	15	160	18	3.0	18	160	08-10-98
G-3674	Miami Canal, B-3 Core	NWNW S14 T52S R39E	255529	802511	255529080251101	5	160	--	--	0	160	08-16-98
G-3675	Snake Creek, B-4 Core	SESE S27 T50S R39E	255723	802613	255723080261301	5	90	--	--	0	90	08-21-98

Appendix I. Inventory of wells used in this report (Continued)

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USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
G-3677	W-17273, UM ENP 1 Core	SW S36 T58S R36E	252210	804200	252210080420001	--	628	--	--	--	--	07-18-95
HE-591	HY-312	S21 T46S R34E	262810	805620	252810080562001	15	100	80	--	--	--	--
HE-855	--	--	263142	810735	263035081073501	27.6	90	70	--	70	90	--
HE-856	--	--	263142	810735	263035081073502	27.6	11	6	--	6	11	--
HE-859	--	SWSESE S24 T46S R32E	262737	810436	262735081044602	26.3	59	58	--	58	59	--
HE-861	--	NWNENW S24 T48S R34E	261809	805335	261735080534001	14.4	70	37	--	37	70	--
HE-862	--	NWNENW S24 T48S R34E	261809	805335	261735080534002	14.4	11	7	--	7	10	--
HE-868	--	SESWSE S22 T47S R33E	262222	810100	262118081002901	20.7	97	84	--	84	97	--
HE-884	--	SESESE S18 T48S R33E	261803	810418	261801081042501	20	67	62	--	62	67	--
HE-901	HY-307	S35 T46S R31E	262545	811135	262545081113601	26	300	--	--	--	--	--
HE-902	HY-306	SE S36 T46S R33E	262610	805900	262612080581901	22	280	--	--	--	--	--
HE-908	HY-309	S33 T46S R32E	262545	810740	262543081074101	24	165	120	--	--	--	--
HE-976	Permit 418, W-10747	S08 T48S R33E	261932	810320	261932081032001	38.5	12,490	3,995	9.6	3,995	12,490	05-03-70
HE-1016	HY-314	NW S26 T47S R31E	262215	811130	262215081113001	23	400	--	--	--	--	04-29-87
HE-1021	HY 310	SE S03 T48S R33E	262000	810120	262042081011801	20	482	--	--	--	--	--
HE-1022	HY-311	NW S23 T48S R32E	261745	810620	261746081061801	20	460	--	--	--	--	08-27-86
HE-1036	H-207-1S	SENESW S30 T45S R33E	263213	810408	263213081040801	--	10	5	2.0	5	10	07-15-87
HE-1037	H-207-1D	SENESW S30 T45S R33E	263213	810408	263213081040802	26.3	120	70	2.0	70	120	07-15-87
HE-1042	H-314-1D	NENENE S26 T47S R31E	262216	811132	262214081113001	22.8	80	40	2.0	40	80	04-29-87
HE-1054	H-308-PD	SWSWSE S14 T47S R32E	262319	810555	262319081055502	--	400	30	6.0	30	100	06-17-86
HE-1062	H-311-1S	SENWNW S23 T48S R32E	261746	810618	261746081061803	--	10	5	2.0	5	10	08-27-86
HE-1063	H-311-1D	SENWNW S23 T48S R32E	261746	810618	261746081061804	18.3	123	78	2.0	78	123	08-27-86

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USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
HE-1075	--	SESESW S27 T45S R34E	263211	805531	263207080553101	16.6	202	135	2.0	135	155	06-10-87
HE-1089	Permit 1242	SW S11 T46S R31E	262930	811220	262925081122001	30	1,510	--	--	--	--	--
HE-1101	Permit 903	NESW S26 T48S R34E	261638	805428	261638080542801	13.9	11,633	3,817	9.6	--	--	12-13-77
HE-1108	HY-301, HM-265	NW S08 T47S R34E	262440	805650	262440080565001	20	132	--	--	--	--	--
HE-1109	HY-315, HM-291	NW S12 T46S R32E	263000	810500	263000081050001	26	120	--	--	--	--	1987
HE-1110	L-3 Deep MW	NESW S22 T47S R34E	262309	805548	262310080554701	15	160	156	2.0	146	156	04-14-98
HE-1111	L-3 Shallow MW	NESW S22 T47S R34E	262309	805548	262310080554702	15	118	118	2.0	38	118	04-14-98
HE-1112	W-17764, Windmill Road Core	SENE S12 T48S R31E	261915	811035	261915081103501	21	151	80	2.0	50	80	10-03-98
HE-1113	W-17782, Prison 1 Core	SESE S16 T48S R31E	261805	811317	261805081131701	20	151	50	2.0	35	50	10-27-98
HE-1114	W-17785, Prison 2 Core	NW S18 T48S R31E	261827	811543	261827081154301	--	181	82	2.0	67	82	11-21-98
HE-1115	W-17810, Mustang Grade Core	NWNW S36 T45S R30E	263153	811709	263153081170901	32	221	120	2.0	105	120	01-23-99
HE-1116	W-17868, L-2 Core	NWSW S04 T46S R34E	263023	805652	263023080565201	--	201	150	2.0	140	150	03-11-99
HE-1117	L-2 Shallow MW	NWSW S04 T46S R34E	263023	805652	263023080565202	--	80	80	2.0	50	80	03-12-99
MO-138	S396, W-445	S06 T55S R34E	254247	805748	254247080574801	14	9,965	3,089	11.9	3,089	10,006	05-27-39
MO-141	Permit 564	S11 T54S R33E	254548	805932	254548080593201	25	12,662	--	--	--	--	--
MO-177	W-17968, Golightly Core	T54S R34E	254456	805558	254456080555801	8	200	--	--	--	--	02-14-97
MO-178	W-17969, Trail Center Core	NE S01 T54S R34E	254815	805231	254815080523101	10	465	457	2.0	412	452	04-04-97
MO-179	W-17973, West Loop Road Core	T54S R33E	254540	810334	254540081033401	6	250	--	--	--	--	03-11-97
MO-180	Trail Center 1 MW	--	254814	805235	254814080523501	10	120	120	2.0	95	120	05-29-97
MO-181	Trail Center 2 MW	--	254814	805237	254814080523701	10	118	18	2.0	93	118	06-24-97
MO-182	Trail Center 3 MW	--	254815	805234	254815080523401	10	118	118	2.0	93	118	06-24-97
MO-183	Trail Center 4 MW	--	254814	805234	254814080523401	10	25	25	2.0	13	23	07-09-97
MO-184	Golightly MW 1	--	254459	805556	254459080555601	--	82	82	2.0	30	80	07-08-97
MO-185	Trail Center 5 MW	--	254814	805239	254814080523901	10	118	118	2.0	98	118	01-05-98
MO-186	Trail Center 6 MW	--	254814	805234	254814080523402	10	135	135	2.0	130	135	01-06-98

Appendix I. Inventory of wells used in this report (Continued)

[Well locations are shown in figure 1 directly or indirectly with reference to tables 1 and 2, or in figures 31 or 33. USGS, U.S. Geological Survey. Altitude of measuring point usually is land surface, but can be higher. All depths are below measuring point. Permit or other identifier: Permit, State permit number for oil test or production well; W, well number assigned by Florida Geological Survey; MW, monitoring well; PW, production well; WS, water-supply well; TW, test well. Dashes indicate no data or not applicable]

USGS local well number	Permit or other identifier	Location			USGS site identification number	Altitude of measuring point (feet)	Depth drilled (feet)	Bottom of casing (feet)	Diameter of casing (inches)	Depth of completed interval (feet)		End date of construction
		Land net (Section, Township Range)	Latitude	Longitude						Top	Bottom	
MO-187	Trail Center 7 MW	--	254814	805235	254814080523403	10	80	80	2.0	70	80	01-06-98
MO-188	Trail Center PW	--	254814	805234	254814080523404	10	120	114	2.0	89	114	01-22-98
NP-100	W-7363	S14 T58S R37E	252255	803611	252255080361101	4.5	1,333	620	2.0	620	1,333	09-23-64
PB-840	--	--	262713	803750	262713080375001	11	260	84	2.0	--	--	11-07-74
PB-1428	BRT-16	--	262109	801751	262109080175101	12.5	219	188	2.0	176	188	07-02-81
PB-1485	--	S26 T46S R36E	262722	804245	262722080424501	--	225	215	1.5	215	220	08-22-83
PB-1696	W-7500	NWNW S28 T46S R37E	262505	803916	262505080391601	11	1,705	--	--	--	--	1965
PB-1701	W-10102	NW S10 T46S R36E	263000	804400	263000080440001	12	935	--	--	--	--	--
PB-1703	W-17554, G-200 Core Pumping Station	SESW S35 T46S R35E	262606	804838	262606080483801	20	221	85	1.3	75	85	03-15-98
PB-1704	W-17747, Sod Farm Core	SENE S31 T46S R38E	262359	803434	262359080343401	11	201	112	2.0	82	112	04-30-98
PB-1705	WCAS-7D, S-7 Pumping Station	S22 T47S R38E	262006	803214	262006080321401	10	96	96	2.0	86	96	01-28-94
PB-1706	WCAS-7S, S-7 Pumping Station	--	262006	803214	262006080321402	10	16	16	2.0	6	16	01-28-94

Appendix II
Lithologic Descriptions of Selected Cores as Determined for this Study

[Items in the descriptions are arranged in the following order: Rock type with modifiers, color, grain size, sorting, roundness, accessory grains, porosity, hydraulic conductivity, environment, and comments. However, not all of these items are included in every description]

USGS local well No.	Core name
C-1134	Dade-Collier Airport Core
C-1135	FAA Radar Core
C-1136	Monroe Station Core
C-1137	Doerr’s Lake Core
C-1138	Raccoon Point Core
C-1139	Nobles Road Core
C-1140	Bass Core
C-1141	Bear Island Campground Core
C-1142	Noble’s Farm Core
C-1163	Sunniland No. 1 Core
C-1169	Big Cypress Sanctuary Core (Miller Property)
C-1173	Sabine Road Core
C-1176	Turner River Road Core
C-1178	Sunniland No. 2 Core
C-1180	Big Cypress Headquarter’s Core
C-1181	Cypress Lane Core
C-1182	Alligator Alley East Core
C-1183	Baker’s Grade Core
HE-1110	L-3 Canal Core
HE-1112	Windmill Road Core
HE-1113	Prison No. 1 Core
HE-1114	Prison No. 2 Core
HE-1115	Mustang Grade Core
HE-1116	L2 Core
MO-177	Golightly Core
MO-178	Trail Center Core
MO-179	West Loop Road Core
PB-1703	G-200 Core Pumping Station
PB-1704	Sod Farm Core

Dade-Collier Airport Core

Florida Geological Survey well number	W-17970
Well number	C-1134
Total depth	200 feet
Cored from	0 to 200 feet
County	Collier
Location	SW, SW, sec. 10, T53S, R34E
Latitude	25°51′ 52″
Longitude	80°55′04″
Elevation	10 feet
Completion date	February 16, 1997
Other types of available logs	Gamma ray, induction, fluid velocity, fluid conductivity
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Ronald S. Reese (description by Weedman and others, 1999, used in part in figure 13)
Fill	0 to 5 feet
Tamiami Limestone, Ochopee Limestone Member	5 to 82 feet
Unnamed sand	82 to 117 feet
Peace River Formation	117 to 200 feet
Upper confining unit	0 to 10 feet
Gray limestone aquifer	10 to 82 feet
Lower confining unit	82 to 200 feet

Depth (feet below land surface)	Lithologic description of well C-1134
0.0 - 2.5	Quartz sand-rich limestone; white N9 to grayish orange 10YR 7/4; fine to medium quartz sand; large mollusk shells; low hydraulic conductivity; dense
2.5 - 5.0	No recovery
5.0 - 5.8	Quartz sand-rich limestone; white N9 to grayish-orange 10YR 7/4 and grayish-yellow-green 5GY 7/2; fine quartz sand; low hydraulic conductivity; dense to locally broken; common micrite
5.8 - 10.0	No recovery
10.0 - 12.0	Limestone; white N9 to grayish-yellow-green 5GY 7/2 to dusky-yellow-green 5GY 5/2; mainly clay size; moldic and vuggy porosity; low to high hydraulic conductivity; very finely crystalline
12.0 - 15.0	No recovery
15.0 - 15.5	Lime mudstone to wackestone; white N9 to grayish-yellow-green 5GY 7/2 to dusky-yellow-green 5GY 5/2; mainly clay size; moderate to high hydraulic conductivity; very fine crystalline
15.5 - 20.0	No recovery
20.0 - 21.5	Carbonate sand; yellowish gray 5Y 8/1; mainly fine to granule; minor fine quartz sand; low hydraulic conductivity; minor lime mud matrix
21.5 - 25.0	No recovery
25.0 - 29.0	Carbonate sand; yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; mainly fine to granule; minor fine to medium quartz sand; abundant shell casts; minor moldic porosity; low to moderate hydraulic conductivity; abundant lime mud matrix
29.0 - 30.0	No recovery
30.0 - 35.0	Carbonate sand; light-gray N7 to light-olive-gray 5Y 6/1; mainly fine to granule; minor fine to medium quartz sand; abundant shells; low hydraulic conductivity; abundant lime mud matrix
35.0 - 37.5	Carbonate sand; light-gray N7 to light-olive-gray 5Y 6/1; mainly fine to granule; trace quartz sand; low to moderate hydraulic conductivity; minor lime mud matrix
37.5 - 40.0	No recovery
40.0 - 44.2	Carbonate sand; medium-gray N5; mainly fine to granule; shell fragments; moderate to high hydraulic conductivity
44.2 - 45.0	No recovery
45.0 - 48.2	Carbonate sand; light-gray N7 to light-olive-gray 5Y 6/1; mainly fine to granule; shell fragments; low to moderate hydraulic conductivity; minor lime mud matrix
48.2 - 50.0	No recovery
50.0 - 54.5	Carbonate sand; light-gray N7 to light-olive-gray 5Y 6/1; mainly fine to pebble; shell fragments; moderate hydraulic conductivity; minor lime mud matrix
54.5 - 55.0	No recovery
55.0 - 59.8	Carbonate sand; light-gray N7 to light-olive-gray 5Y 6/1; mainly fine to pebble; large shell fragments; low hydraulic conductivity; abundant lime mud matrix
59.8 - 60.0	No recovery
60.0 - 65.0	Carbonate sand; light-gray N7 to medium-gray N5; mainly fine to pebble; large shell fragments; minor moldic porosity; low to moderate hydraulic conductivity; minor lime mud matrix
65.0 - 70.0	Carbonate sand; light-gray N7 to medium-gray N5; mainly fine to granule; large shell fragments; minor moldic porosity; moderate hydraulic conductivity; minor lime mud matrix; friable
70.0 - 72.0	Carbonate sand; light-gray N7 to medium-gray N5; mainly very fine to pebble; large shell fragments; minor moldic porosity; low to moderate hydraulic conductivity; minor lime mud matrix; friable
72.0 - 75.0	Limestone; light-gray N7 to dark-gray N3; fine to coarse quartz sand; abundant large mollusks; minor moldic porosity; low hydraulic conductivity
75.0 - 79.0	Limestone; yellowish-gray 5Y 7/2; fine quartz sand; abundant shell fragments, mainly gastropods; minor moldic porosity; moderate hydraulic conductivity; firm and locally broken
79.0 - 80.0	No recovery
80.0 - 82.0	Limestone; yellowish-gray 5Y 7/2; fine quartz sand; abundant shell fragments, mainly gastropods; minor moldic porosity; moderate hydraulic conductivity; firm and locally broken
82.0 - 85.0	Quartz sand; yellowish-gray 5Y 7/2; mainly very fine to fine; trace to 3 percent phosphorite grains; minor shell fragments; low hydraulic conductivity; gradational contact between limestone above and quartz sand in this interval; calcareous
85.0 - 89.0	Quartz sand; yellowish-gray 5Y 7/2; mainly fine; trace to 3 percent phosphorite grains; minor shell fragments; low hydraulic conductivity; calcareous

Depth (feet below land surface)	Lithologic description of well C-1134
89.0 - 90.0	Limestone; yellowish-gray 5Y 7/2; fine quartz sand; abundant shell fragments, mainly gastropods; minor moldic porosity; low to moderate hydraulic conductivity
90.0 - 92.0	Quartz sand; yellowish-gray 5Y 7/2; mainly fine; minor shell fragments; minor moldic porosity; low to moderate hydraulic conductivity; calcareous
92.0 - 94.5	Quartz sand; yellowish-gray 5Y 7/2; mainly fine; trace to 3 percent phosphorite grains; minor shell fragments; minor moldic porosity; low hydraulic conductivity; minor clay matrix
94.5 - 95.0	No recovery
95.0 - 99.5	Quartz sand; yellowish-gray 5Y 7/2; mainly fine; ranges from fine to coarse; trace to 3 percent phosphorite grains; minor moldic porosity; low hydraulic conductivity
99.5 - 100.0	No recovery
100.0 - 104.0	Quartz sand; yellowish-gray 5Y 8/1; very fine to fine; trace to 3 percent phosphorite grains; low hydraulic conductivity
104.0 - 105.0	No recovery
105.0 - 109.8	Quartz sand; yellowish-gray 5Y 8/1; mainly fine; range fine to granule; trace to 3 percent phosphorite grains; low hydraulic conductivity
109.8 - 110.0	No recovery
110.0 - 112.5	Quartz sand; yellowish-gray 5Y 8/1 to light-gray N7; mainly fine to granule; trace to 10 percent fine- to granule-size phosphorite grains; low hydraulic conductivity
112.5 - 115.0	Quartz sand; yellowish-gray 5Y 8/1 to light-gray N7; mainly fine to medium; trace to 3 percent phosphorite grains; low hydraulic conductivity; mottled appearance due to clay matrix
115.0 - 117.0	Quartz sand; yellowish-gray 5Y 8/1 to medium-gray N5; mainly fine; trace to 3 percent phosphorite grains; low hydraulic conductivity; mottled appearance due to clay matrix
117.0 - 119.5	Quartz sand; light-gray N7 to medium-gray N5; mainly clay, very fine and granule; ranges from clay to granule; 3 to 10 percent phosphorite; very low to low hydraulic conductivity; mottled appearance due to clay matrix
119.5 - 120.0	No recovery
120.0 - 123.0	Quartz sand; light-gray N7 to medium-gray N5 to dusky-yellow-green 5GY 5/2; mainly clay and very fine; ranges from clay to fine; minor white shells and 3 to 10 percent phosphorite grains; very low hydraulic conductivity; clay matrix
123.0 - 125.0	Quartz sand; light-gray N7 to medium-gray N5 to dusky-yellow-green 5GY 5/2; mainly clay and coarse to granule; ranges from clay to granule; minor white shells and 3 to 10 percent phosphorite grains; very low hydraulic conductivity; clay matrix
125.0 - 127.0	Quartz sand; dusky-yellow-green 5GY 5/2 to grayish-olive-green 5GY 5/2; mainly clay, very fine and coarse; ranges from clay to coarse; 3 to 10 percent phosphorite grains; very low hydraulic conductivity; clay matrix
127.0 - 129.0	Quartz sand; dusky-yellow-green 5GY 5/2 to grayish-olive-green 5GY 3/2; mainly clay and fine; ranges from clay to fine; trace to 3 percent phosphorite grains; very low hydraulic conductivity; clay matrix
129.0 - 130.0	No recovery
130.0 - 132.0	Quartz sand and clay; grayish-olive-green 5GY 3/2; mainly clay to fine; trace to 3 percent phosphorite grains; very low hydraulic conductivity; clay matrix
132.0 - 175.0	Quartz sand-rich, silty clay; dark-olive
175.0 - 200.0	Quartz sand-rich, silty clay; medium- to dark-olive-green

FAA Radar Core

Florida Geological Survey well number	W-17971
Well number	C-1135
Total depth	205 feet
Cored from	0 to 205 feet
County	Collier
Location	NW, NE, sec. 15, T53S, R33E
Latitude	25°51′46″
Longitude	81°00′38″
Elevation	12 feet
Completion date	February 7, 1997
Other types of available logs	Gamma ray, induction, fluid velocity, fluid conductivity, neutron
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Kevin J. Cunningham (0 to 87.5 feet) and Scott T. Prinos (87.5 to 205 feet). Lithologies between 87.5 and 205 feet in figure 13 based on notes by Kevin J. Cunningham
Soil and fill	0 to 5 feet
Tamiami Formation, Ochopee Limestone Member	5 to 43.25 feet
Unnamed formation	43.25 to 87.5 feet
Peace River Formation	87.5 to 205 feet
Upper confining unit	0 to 18 feet
Gray limestone aquifer	18 to 43.25 feet
Lower confining unit	43.25 to 118 feet
Sand aquifer	118 to 131 feet
Confining unit	131 to 178 feet
Sand aquifer	178 to 198 feet
Confining unit	198 to 205 feet

Depth (feet below land surface)	Lithologic description of well C-1135
0.0 - 0.1	Dirt and plant material
0.1 - 0.9	Rubble of pelecypod lime floatstone with skeletal, quartz-sand rich lime packstone matrix; dark-yellowish-orange 10YR 6/6, grayish-orange 10YR 7/4, very pale orange 10YR 8/2, pale-yellowish-orange 10YR 8/6, pale-yellowish brown 10YR 6/2, light-brown 5YR 5/6, light-brown 5YR 6/4; mainly clay-size lime mudstone, very fine to fine sand-size quartz sand and granule- to pebble-size fossils; minor medium to very coarse sand-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; pelecypods, skeletal fragments, oysters; 10 to 40 percent quartz sand; 15 to 20 percent moldic and intergrain porosity; low hydraulic conductivity; unit contains calcrete in part, hard when wet, well cemented
0.9 - 5.0	No recovery
5.0 - 6.0	Rubble of pelecypod lime floatstone with skeletal lime packstone and lime-mud rich sandstone matrix; very pale orange 10YR 8/2, dark-yellowish-orange 10YR 6/6; mainly clay-size lime mudstone, very fine to fine sand-size quartz sand and granule- to pebble-size fossils; minor medium to very coarse sand-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; pelecypods, skeletal fragments, oysters; 10 to 60 percent quartz sand; 20 percent moldic and intergrain porosity; low hydraulic conductivity; hard when wet, well cemented; minor laminated calcrete
6.0 - 8.0	No recovery
8.0 - 8.1	Rubble of limestone
8.1 - 10.0	No recovery
10.0 - 11.0	Rubble of pelecypod lime rudstone with skeletal, quartz-sand rich, mud-dominated lime wackestone and packstone matrix; yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine to fine sand-size quartz sand and granule- to pebble-size fossils; minor medium to very coarse sand-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods; 10 to 20 percent quartz sand; 15 percent moldic and intergrain porosity; low hydraulic conductivity; hard when wet, well cemented
11.0 - 15.0	No recovery
15.0 - 17.1	Rubble of pelecypod lime rudstone with skeletal, quartz sand-rich, mud-dominated, lime packstone matrix; yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine to fine quartz sand and granule to pebble-size fossils; minor medium to very coarse sand-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, *Vermicularia*; 10 to 45 percent quartz sand; 20 percent moldic porosity; low hydraulic conductivity; friable to hard when wet, poorly to well cemented
17.1 - 18.0	No recovery
18.0 - 19.4	Rubble of pelecypod lime floatstone with skeletal, grain-dominated lime packstone and grainstone matrix; very pale orange 10YR 8/2; mainly medium sand- to pebble-size fossils; minor clay-size lime mudstone and very fine to fine sand-size fossils; pelecypods, skeletal fragments, gastropods, serpulids, bryozoans, benthic foraminifers; 25 percent intergrain porosity; moderate hydraulic conductivity; mainly friable to minor hard when wet, mainly poorly to minor well cemented
19.4 - 20.0	No recovery
20.0 - 20.3	Rubble of pelecypod lime floatstone with skeletal, grain-dominated lime packstone and grainstone matrix; white N9; mainly medium sand to pebble-size fossils; minor clay-size lime mudstone and very fine to fine sand-size fossils; pelecypods, skeletal fragments, gastropods, serpulids, bryozoans, benthic foraminifers; 25 percent intergrain porosity; moderate hydraulic conductivity; friable to hard when wet, poorly to well cemented
20.3 - 25.0	No recovery
25.0 - 25.4	Rubble of pelecypod lime rudstone with skeletal lime grainstone matrix; very pale orange 10YR 8/2, yellowish-gray 5Y 8/1; mainly fine sand to pebble-size fossils; minor very fine sand-size fossils; pelecypods, skeletal fragments, serpulids, bryozoans; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; well cemented with isopachous calcite equant spar
25.4 - 30.0	No recovery
30.0 - 30.6	Rubble of pelecypod lime rudstone with skeletal lime grainstone matrix; very pale orange 10YR 8/2; mainly fine sand to pebble-size fossils; minor very fine sand-size fossils; pelecypods, skeletal fragments, serpulids, bryozoans, sand dollars; 20 percent moldic porosity; moderate hydraulic conductivity; well cemented with isopachous calcite equant spar and pore-fill equant spar
30.6 - 32.5	No recovery
32.5 - 32.6	Rubble of pelecypod lime rudstone with skeletal lime grainstone matrix; very pale orange 10YR 8/2; mainly fine sand to pebble-size fossils; minor very fine sand-size fossils; pelecypods, skeletal fragments, serpulids, bryozoans, sand dollars; 20 percent moldic porosity; moderate hydraulic conductivity; well cemented with isopachous calcite equant spar and pore-fill equant spar
32.6 - 35.0	No recovery
35.0 - 36.5	Rubble of pelecypod lime rudstone with skeletal lime grainstone and grain-dominated lime packstone matrix; very pale orange 10YR 8/2, yellowish-gray 5Y 8/1; mainly very fine sand to pebble-size fossils; minor clay-size lime mudstone; pelecypods, skeletal fragments, bryozoans, *Vermicularia*, sand dollars, barnacles, serpulids; 25 percent moldic and intergrain porosity; high hydraulic conductivity; poorly to moderately cemented

Depth (feet below land surface)	Lithologic description of well C-1135
36.5 - 37.5	No recovery
37.5 - 38.2	Rubble of pelecypod lime rudstone with skeletal lime grainstone and grain-dominated lime packstone matrix; very pale orange 10YR 8/2, yellowish-gray 5Y 8/1; mainly fine sand to pebble-size fossils; minor clay-size lime mudstone; pelecypods, skeletal fragments, bryozoans, *Vermicularia*, sand dollars, barnacles, serpulids; 25 percent moldic and intergrain porosity; high hydraulic conductivity; poorly cemented
38.2 - 42.5	No recovery
42.5 - 43.25	Rubble of pelecypod lime rudstone with skeletal mud-dominated and grain-dominated lime packstone matrix; very pale orange 10YR 8/2, yellowish-gray 5Y 8/1; mainly fine sand to pebble-size fossils and clay-size lime mudstone; minor very fine sand-size fossils; pelecypods, skeletal fragments, bryozoans, *Vermicularia*, sand dollars, barnacles, serpulids; 20 to 25 percent moldic and intergrain porosity; moderate hydraulic conductivity; poorly cemented
43.25 - 43.5	No recovery
43.5 - 44.1	Quartz sand; yellowish-gray 5Y 8/1; mainly very fine to fine sand-size quartz sand, clay-size lime mudstone and terrigenous mud; minor medium sand-size quartz sand, very fine sand to pebble-size fossils, very fine to fine sand-size phosphorite and heavy mineral grains; well sorted; subangular quartz sand; 30 percent pelecypods; 5 percent black phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; poorly cemented; friable; soft when wet
44.1 - 48.5	No recovery
48.5 - 50.8	Quartz sand; white N9, yellowish-gray 5Y 8/1; mainly very fine to fine sand-size quartz sand, clay-size lime mudstone and terrigenous mud; minor medium sand-size quartz sand, very fine to fine sand-size phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; 10 percent skeletal grains; 5 to 10 percent black phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; poorly cemented; friable; soft when wet
50.8 - 51.0	No recovery
51.0 - 52.8	Quartz sand; yellowish-gray 5Y 8/1; mainly very fine to fine sand-size quartz sand; minor medium sand-size quartz sand, very fine to fine sand-size phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; 10 to 20 percent skeletal grains; 10 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; low hydraulic conductivity; poorly cemented; friable; soft when wet
52.8 - 53.0	Quartz sandstone with pelecypod rudstone framework; light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to fine sand-size quartz sand and pebble-size fossils; minor medium to coarse sand-size quartz sand, very fine sand-size to granule-size fossils, clay-size terrigenous clay and lime mudstone matrix, very fine to medium sand-size phosphorite grains and very fine to fine sand-size heavy mineral grains; moderately to well sorted; subangular to subrounded quartz sand; pelecypods (moldic); less than 5 percent black phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly to well cemented; friable to well consolidated; soft to hard when wet
53.0 - 54.0	No recovery
54.0 - 58.3	Quartz sandstone with pelecypod rudstone framework; yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; mainly very fine to fine sand-size quartz sand and pebble-size fossils; minor medium to coarse sand-size quartz sand, very fine sand-size to granule-size fossils, clay-size terrigenous clay and lime mudstone matrix, very fine to medium sand-size phosphorite grains and very fine to fine sand-size heavy mineral grains; moderately to well sorted; subangular to subrounded quartz sand; pelecypods (moldic); less than 5 percent black phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly to well cemented; friable to well consolidated; soft to hard when wet
58.3 - 59.0	No recovery
59.0 - 61.5	Quartz sandstone with pelecypod floatstone framework; yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; mainly very fine to fine sand-size quartz sand and pebble-size fossils; minor medium to coarse sand-size quartz sand, very fine sand-size to granule-size fossils, clay-size terrigenous clay and lime mudstone matrix, very fine to fine sand-size phosphorite and heavy mineral grains; moderately to well sorted; subangular to subrounded quartz sand; pelecypods (moldic); less than 5 percent black phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly to moderately cemented; friable to moderately consolidated; soft to moderately hard when wet
61.5 - 62.8	Quartz sand; yellowish-gray 5Y 8/1; mainly fine to medium sand-size quartz sand; minor very fine and coarse sand-size quartz sand, very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted; subangular to subrounded quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet
62.8 - 64.3	No recovery
64.3 - 68.8	Quartz sand; yellowish-gray 5Y 8/1; mainly fine to medium sand-size quartz sand; minor very fine and coarse sand-size quartz sand, very fine to coarse sand-size phosphorite and very fine to fine sand-size heavy mineral grains; moderately sorted; subrounded quartz sand; 10 percent skeletal grains; 5 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet
68.8 - 69.5	No recovery
69.5 - 70.8	Quartz sand; yellowish-gray 5Y 8/1; mainly fine to medium quartz sand; minor very fine and coarse quartz sand, very fine to coarse sand-size phosphorite and very fine to fine sand-size heavy mineral grains; moderately sorted; subrounded quartz sand; 5 percent skeletal grains; 5 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet

Depth (feet below land surface)	Lithologic description of well C-1135
70.8 - 71.0	No recovery
71.0 - 75.1	Quartz sand; yellowish-gray 5Y 8/1; mainly fine to medium quartz sand; minor very fine and coarse quartz sand, very fine to coarse sand-size phosphorite and very fine to fine sand-size heavy mineral grains; moderately sorted; subrounded quartz sand; 5 percent skeletal grains; 5 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet; abrupt contact at 75.1 feet
75.1 - 79.5	Quartz sand; yellowish-gray 5Y 8/1; mainly fine to coarse quartz sand; minor very fine and very coarse to small pebble-size quartz sand, very fine sand to pebble-size fossils, very fine to very coarse sand-size phosphorite and very fine to fine sand-size heavy mineral grains; moderately sorted; subangular to rounded quartz sand; 10 to 20 percent skeletal grains, pelecypods, sand dollars; 5 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet; abrupt contact at 75.1 feet
79.5 - 84.7	Quartz sand; yellowish-gray 5Y 8/1; mainly fine to coarse quartz sand; minor very fine and very coarse to granule-size quartz sand, very fine sand to small pebble-size fossils, very fine to very coarse sand-size phosphorite and very fine to fine sand-size heavy mineral grains; moderately sorted; subangular to subrounded quartz sand; less than 5 percent skeletal grains; 5 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet
84.7 - 85.0	No recovery
85.0 - 87.0	Quartz sand; yellowish-gray 5Y 8/1; mainly fine to coarse quartz sand; minor very fine and very coarse to small pebble-size quartz sand, very fine sand to small pebble-size fossils, very fine sand to granule-size phosphorite grains and very fine to fine sand-size heavy mineral grains; moderately sorted; subangular to subrounded quartz sand; 20 percent skeletal grains; 5 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet; abrupt contact at 87 feet
87.0 - 87.5	Quartz sand; yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted; subangular to subrounded quartz sand; 15 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet; abrupt contact at 87 feet
87.5 - 88.0	No recovery
88.0 - 90.0	Calcareous clay; grayish-green 5G 5/2; mainly clay to medium; trace to 3 percent phosphorite grains; 5 percent intergrain porosity; very low to low hydraulic conductivity; interval contains lenses of quartz sand
90.0 - 94.0	Quartz sand-rich, silty, calcareous clay; grayish-green 5G 5/2; mainly clay to fine; granule-size quartz grains floating in clay matrix; trace to 3 percent phosphorite grains; 5 percent porosity; very low to low hydraulic conductivity
94.0 - 95.0	Quartz sand-rich, silty, calcareous clay; grayish-green 5G 5/2; mainly clay to fine; granule-size quartz grains floating in clay matrix; skeletal fragments; trace to 3 percent phosphorite grains; 5 percent porosity; very low to low hydraulic conductivity
95.0 - 100.0	Silty, calcareous clay; grayish-olive 10Y 4/2 to light-olive-gray 5Y 5/2; mainly clay to very fine; trace to 3 percent phosphorite grains; very low to low hydraulic conductivity; lenses of fine-grained quartz sand
100.0 - 114.5	Silty, calcareous clay; mottled light-olive-gray 5Y 5/2; mainly clay to silt; very low to low; lenses of fine-grained quartz sand
114.5 - 115.0	No recovery
115.0 - 118.5	Clay-rich quartz sand fining upward to silty, calcareous clay; light-olive-gray 5Y 5/2 and moderate-olive-brown 5Y 4/4; mainly clay to coarse at base grading upward to mainly clay to silt at top; trace to 3 percent phosphorite grains; very low to low hydraulic conductivity
118.5 - 120.0	Clay-rich quartz sand; moderate-olive-brown 5Y 4/4; mainly clay to coarse; trace to 3 percent phosphorite grains; low hydraulic conductivity
120.0 - 123.5	Clay-rich quartz sand; moderate-olive-brown 5Y 4/4; mainly clay to fine and coarse; trace to 3 percent phosphorite grains; 5 percent intergranular; low hydraulic conductivity
123.5 - 125.0	No recovery
125.0 - 128.5	Clay-rich quartz sand; moderate-olive-brown 5Y 4/4; mainly clay to fine and coarse; 3 to 10 percent phosphorite grains; 5 percent intergranular; low hydraulic conductivity; minor pebble-size phosphorite grains
128.5 - 130.0	Quartz sand-rich clay grading upward to clay-rich quartz sand; light-olive-gray 5Y 5/2; mainly clay to very fine at base; mainly clay to fine and coarse at top; trace to 3 percent phosphorite grains; 5 percent intergranular; very low to low hydraulic conductivity
130.0 - 135.0	Clay coarsening upward to quartz sand; clay, olive-gray 5Y 4/1; sand, light-olive-gray 5Y 5/2; mainly clay to silt at base coarsening upward to mainly clay and coarse to pebble at top; quartz sand is mainly coarse to very coarse and phosphorite grains are commonly granule to pebble size; trace to 3 percent phosphorite grains at base increasing upward from 3 to 15 percent nonporous at base to 5 to 10 percent intergranular porosity at top; very low hydraulic conductivity at base; low to moderate hydraulic conductivity at top
135.0 - 136.0	Quartz sand-rich calcareous clay; mottled light-olive-gray 5Y 5/2 to olive 5Y 4/1; mainly clay to silt; trace to 3 percent phosphorite grains; nonporous; very low hydraulic conductivity
136.0 - 140.0	Silty, calcareous clay and quartz sand-rich clay with quartz sand lenses; dusky-yellow-green 5GY 5/2; clay is mainly clay to silt; sand-rich clay is mainly clay to very fine; quartz sand lenses are mainly clay to very fine and coarse to granule; trace to 10 percent phosphorite grains; less than 5 percent intergranular porosity; very low to low hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1135
140.0 - 144.0	Quartz sand-rich clay with quartz sand lenses; dusky-yellow-green 5GY 5/2; sand-rich clay is mainly clay to very fine; quartz sand lenses are mainly clay to very fine and coarse; less than 5 percent intergranular porosity; very low to low hydraulic conductivity
144.0 - 145.0	Quartz sand-rich clay; dusky-yellow-green 5GY 5/2; clay to medium; less than 5 percent intergranular porosity; very low hydraulic conductivity
145.0 - 150.0	Silty, calcareous clay with minor quartz sand-rich clay at base; dusky-yellow-green 5GY 5/2; mainly clay to silt and locally clay to fine; less than 5 percent intergranular porosity; very low hydraulic conductivity
150.0 - 151.5	Silty, calcareous clay; dusky-yellow-green 5GY 5/2; mainly clay to silt; less than 5 percent intergranular porosity; very low hydraulic conductivity
151.5 - 155.0	Calcareous clay coarsening upward to silty, calcareous clay; dusky-yellow-green 5GY 5/2, grayish-yellow-green 5GY 5/2; mainly clay coarsening upward to mainly clay and silt; less than 5 percent intergranular porosity; very low hydraulic conductivity
155.0 - 159.0	Silty, quartz sand-rich, calcareous clay; dusky-yellow-green 5GY 5/2; clay to medium; less than 5 percent intergranular porosity; very low hydraulic conductivity; quartz sand lens at 156.3 feet composed of medium to coarse quartz sand
159.0 - 160.0	Silty, quartz sand-rich, calcareous clay; dusky-yellow-green 5GY 5/2; clay to medium; less than 5 percent intergranular porosity; very low hydraulic conductivity
160.0 - 165.0	Silty, quartz sand-rich, calcareous clay; dusky-yellow-green 5GY 5/2; clay to medium; less than 5 percent intergranular porosity; very low hydraulic conductivity; quartz sand-rich lens at 164 to 164.5 feet
165.0 - 167.0	Silty, quartz sand-rich, calcareous clay; dusky-yellow-green 5GY 5/2; clay to medium; less than 5 percent intergranular porosity; very low hydraulic conductivity
167.0 - 170.0	Very quartz sand-rich, calcareous clay; dusky-yellow-green 5GY 5/2; clay to medium; less than 5 percent intergranular porosity; very low hydraulic conductivity
170.0 - 175.0	Very quartz sand-rich, silty, calcareous mudstone; grayish-olive-green 5GY 3/2, grayish-yellow-green 5GY 7/2; mainly clay to medium; locally mainly clay to pebble; trace to 3 percent phosphorite grains; less than 5 percent intergranular porosity; very low to low hydraulic conductivity
175.0 - 180.0	Very quartz sand-rich, silty, calcareous clay; grayish-yellow-green 5GY 7/2; mainly clay to granule; trace to 3 percent phosphorite grains; less than 5 percent intergranular porosity; very low to low hydraulic conductivity
180.0 - 183.0	Very quartz sand-rich, silty, calcareous clay; mottled grayish-yellow-green 5GY 7/2; mainly clay to granule; trace to 3 percent phosphorite grains; fossil fragments; less than 5 percent intergranular porosity; low hydraulic conductivity
183.0 - 185.0	Very quartz sand-rich, silty, calcareous clay; very light gray N8 to greenish-gray 5GY 6/1; mainly clay to granule; minor pebble-size quartz grains; trace to 3 percent phosphorite grains; less than 5 percent intergranular porosity; low to moderate hydraulic conductivity
185.0 - 187.5	Very quartz sand-rich, silty, calcareous clay; very light gray N8 to greenish-gray 5GY 6/1; mainly clay to granule; minor pebble-size quartz grains; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity
187.5 - 190.0	No recovery
190.0 - 193.5	Quartz sand with silt and clay matrix; very light gray N8 to greenish-gray 5GY 6/1; poorly sorted; mainly clay to coarse; trace to 3 percent phosphorite grains; less than 5 percent intergranular porosity; low to moderate hydraulic conductivity
193.5 - 195.0	Quartz sand with silt matrix; very light gray N8 to greenish-gray 5GY 6/1; poorly sorted; mainly silt to coarse; less than 5 percent intergranular porosity; moderate to high hydraulic conductivity
195.0 - 200.0	Quartz sand-rich, calcareous clay to quartz sand with silt matrix; light olive gray 5Y 5/2 to dusky yellow green 5GY 5/2; poorly sorted; mainly clay to coarse; trace to 3 percent phosphorite grains; less than5 percent intergranular porosity; hydraulic conductivity increasing upward from very low and low to moderate and high
200.0 - 201.5	Slightly quartz sand-rich, silty, calcareous clay; dusky-yellow-green 5GY 5/2; clay to very fine; very low hydraulic conductivity
201.5 - 205.0	Silty, calcareous clay; olive-gray 5Y 3/2; clay to silt; very low hydraulic conductivity

Monroe Station Core

Florida Geological Survey well number	**W-17972**
Well number	**C-1136**
Total depth	**202 feet**
Cored from	**0 to 202 feet**
County	**Collier**
Location	**NW, NW, sec. 14, T53S, R32E**
Latitude	**25°51′45″**
Longitude	**81°06′01″**
Elevation	**10 feet**
Completion date	**February 16, 1997**
Other types of available logs	**Gamma ray, induction, fluid velocity, fluid conductivity**
Owner	**U.S. Geological Survey**
Driller	**U.S. Geological Survey**
Core described by	**Scott T. Prinos (description by Weedman and others, 1999, used in part in figure 13)**
Soil and fill	**0 to 2 feet**
Tamiami Formation, Ochopee Limestone Member	**2 to 55 feet**
Unnamed formation	**55 to 128 feet (Weedman and others, 1999)**
Peace River Formation	**128 to 202 feet (Weedman and others, 1999)**
Gray limestone aquifer	**2 to 53 feet**
Lower confining unit	**53 to 78 feet**
Sand aquifer	**78 to 98 feet**
Confining unit	**98 to 187 feet**
Sand aquifer	**187 to 202 feet**

Depth (feet below land surface)	Lithologic description of well C-1136
0.0 - 0.5	Soil and limestone gravel; olive-black (5Y 2/1) and white (N9); limestone micritic and well cemented; extensive recrystallization to calcite spar; clay and granule to pebble; very high hydraulic conductivity
0.5 - 2.0	No recovery
2.0 - 2.7	Hard crystalline and soft micritic limestone and pebble-size limestone fragments; bluish-white (5B 9/1) to grayish-orange (10YR 7/4); pebble size; mollusks; loose pieces of wood; very high hydraulic conductivity
2.7 - 6.0	No recovery
6.0 - 6.8	Molluscan limestone; white (N9) to yellowish-gray (5Y 8/1); hard micritic limestone and limestone fragments; 15 percent moldic porosity (molds of mollusks) at base; clay and fine to medium in upper fraction and granule to pebble in lower fraction; very high hydraulic conductivity, high hydraulic conductivity at base; light-olive-gray (5Y 6/1) sand and soil at top
6.8 - 9.0	No recovery
9.0 - 10.0	Limestone gravel and sand with lime mud matrix; very pale orange (10YR 8/2); clay and coarse to pebble; 15 to 20 percent porosity; low to moderate hydraulic conductivity
10.0 - 12.0	No recovery
12.0 - 12.5	Limestone gravel with lime mud matrix; very pale orange (10YR 8/2); clay and coarse to pebble; 15 to 20 percent porosity; low to moderate hydraulic conductivity
12.5 - 14.5	Limestone gravel with lime mud matrix; gradational to relatively more cemented and fossiliferous at base; very pale orange (10YR 8/2); clay and coarse to pebble; 15 to 20 percent porosity; moderate hydraulic conductivity
14.5 - 15.0	No recovery
15.0 - 16.5	Limestone gravel with lime mud matrix; large pebble-size micritic limestone fragments with lime mud matrix; fragments generally decrease in size downward and lime mud content increases downward; white (N9) to very pale orange (10YR 8/2); clay and coarse to pebble; 15 to 20 percent porosity; high to moderate hydraulic conductivity, decreases downward
16.5 - 20.0	No recovery
20.0 - 21.5	Limestone gravel with lime mud matrix; fossil fragments and pieces of micritic limestone (partially recrystallized to sparry calcite) with varying amounts of lime mud matrix (40 to 50 percent); white (N9) to very pale orange (10YR 8/2); clay and coarse to pebble; 15 to 20 percent porosity; very high to high hydraulic conductivity, increases downward
21.5 - 22.5	No recovery
22.5 - 24.0	Limestone gravel with lime mud matrix (about 60 percent) and about 40 percent fossils and limestone fragments; very pale orange (10YR 8/2); clay and coarse to pebble; *Pecten*, *Chione*, *Turritella* and *Ostrea*; 15 percent porosity; moderate to low hydraulic conductivity, decreases downward
24.0 - 25.0	No recovery
25.0 - 27.5	Limestone gravel with lime mud matrix (about 60 percent) and about 40 percent fossils and limestone fragments; very pale orange (10YR 8/2); clay and coarse to pebble; minor pebble-size grains; possible echinoid fragments; 10 percent porosity; low hydraulic conductivity; slightly cemented locally
27.5 - 30.0	No recovery
30.0 - 31.5	Limestone gravel with lime mud matrix; partially cemented, soft lime mud and micritic limestone; limestone more fragmented at base; fossiliferous; white (N9); clay and coarse to pebble; 5 to 10 percent porosity; low to moderate hydraulic conductivity
31.5 - 32.8	Fossiliferous limestone; well-cemented micritic limestone; extensively recrystallized to sparry calcite locally; white (N9) to light-gray (N7); very abundant *Turritella*, and abundant *Ostrea*, *Pecten* and *Chione*; 20 to 26 percent porosity; very high to high hydraulic conductivity
32.8 - 35.0	No recovery
35.0 - 36.0	Fossiliferous limestone; well-cemented micritic limestone; extensively recrystallized to sparry calcite locally; very light gray (N8) to light-greenish-gray (5GY 8/1); clay and pebble to cobble; very abundant *Turritella*, and abundant *Ostrea*, *Pecten* and *Chione*; 20 to 26 percent porosity; high hydraulic conductivity
36.0 - 40.0	No recovery
40.0 - 41.0	Limestone gravel with a lime mud matrix; fragments of limestone with varying amounts of carbonate mud matrix, white (N9) to very pale orange (10YR 8/2); clay and granule to pebble; trace fine mollusks, bryozoans, clams and *Chione*; trace fine, subangular quartz sand; 5 to 10 percent porosity; moderate to high hydraulic conductivity
41.0 - 45.0	No recovery
45.0 - 47.5	Limestone gravel with lime mud matrix; lime mud decreases downward; white (N9) to very pale orange (10YR 8/2); clay, fine and granule to pebble; pecten and fossil fragments; fine, subangular quartz sand; gradational from 5 to 10 percent at top to 20 to 25 percent porosity at base; moderate to very high hydraulic conductivity, increases downward

Depth (feet below land surface)	Lithologic description of well C-1136
47.5 - 48.5	Sandy lime mudstone; 20 to 30 percent coarse sand to pebble-size limestone fragments, white (N9) at top to very pale orange (10YR 8/2) at base; 20 percent fine, subangular to subrounded quartz sand; 3 to 10 percent phosphorite grains; 5 to 10 percent porosity; low to moderate hydraulic conductivity
48.5 - 50.0	No recovery
50.0 - 50.2	Sandy lime mudstone; 20 to 30 percent coarse sand and rounded granule to small pebble-size fragments of limestone; increasingly fossiliferous downward, white (N9); clay, very fine and coarse to pebble; 15 to 20 percent and 20 to 25 percent porosity, grades downward; low to moderate and high to very high hydraulic conductivity, grades downward
50.2 - 52.5	Limestone gravel with lime mud matrix; clean, granule to small pebble-size limestone gravel at top, grading downward to lime mudstone with 5 to 10 percent limestone fragments at base; granule to pebble at top grading downward to clay and fine to granule at base; high to very high hydraulic conductivity at top grading downward to low hydraulic conductivity at base
52.5 - 60.0	No recovery
60.0 - 64.0	Clay-rich quartz sand, yellowish-gray (5Y 8/1); subangular quartz sand; mainly very fine to fine quartz sand; clay to granule; microscopic bryozoans(?); about 3 percent black grains possibly phosphorite; low hydraulic conductivity
64.0 - 65.0	No recovery
65.0 - 68.0	Clay-rich quartz sand, white (N9); subangular to subrounded; mainly fine to medium quartz grains, but up to coarse; clay to pebble; 85 to 90 percent quartz grains; 10 to 15 percent calcite grains; less than 1 percent black grains; possible bryozoan; low hydraulic conductivity
68.0 - 69.5	Clay-rich quartz sand, yellowish-gray (5Y 7/2); mainly fine to medium quartz grains; clay to granule; 3 to 10 percent phosphorite grains; minor medium to granule-size shell fragments; low hydraulic conductivity
69.5 - 70.0	No recovery
70.0 - 74.0	Clay-rich quartz sand, yellowish-gray (5Y 7/2); subangular quartz grains; mainly fine to medium quartz grains, but up to coarse to very coarse, well-rounded quartz grains; clay to granule; about 1 percent black grains, possibly phosphorite; 1 percent very coarse to granule-size limestone and sandstone fragments; low hydraulic conductivity
74.0 - 75.0	No recovery
75.0 - 77.5	Clay-rich quartz sand, yellowish-gray (5Y 7/2); subangular quartz grains; mainly fine to medium quartz grains, but up to coarse to very coarse, well-rounded quartz grains; clay to pebble; about 1 percent black grains, possibly phosphorite; 5 percent limestone granules at top of interval; low hydraulic conductivity
77.5 - 80.0	Clay-rich quartz sand, yellowish-gray (5Y 7/2); fine to very coarse quartz grains; clay to pebble; *Pecten* and *Chione*, medium to pebble size; 3 to 10 percent phosphorite grains; granule-size sandstone and limestone grains; low hydraulic conductivity
80.0 - 83.0	Fossiliferous, clay-rich quartz sand, grades downward from yellowish-gray (5Y 7/2) to yellowish-gray (5Y 8/1); moderately sorted; mainly very fine to coarse quartz grains, but ranges from very fine to granule-size quartz grains; clay to granule; 30 to 40 percent limestone, sandstone and fossil grains (very coarse to granule); 1 percent phosphorite grains; 5 percent interparticle porosity; gradational low to moderate hydraulic conductivity to low hydraulic conductivity downward
83.0 - 85.0	No recovery
85.0 - 87.5	Fossiliferous, clay-rich quartz sand, yellowish-gray (5Y 7/2); moderately sorted; very fine to granule quartz grains; clay to granule; 30 to 40 percent limestone, sandstone and fossil grains (very coarse to granule); 1 percent phosphorite grains; 5 percent interparticle porosity; gradational low to moderate hydraulic conductivity to moderate hydraulic conductivity downward
87.5 - 90.0	Clay-rich quartz sand, yellowish-gray (5Y 7/2); moderately sorted; subangular to subrounded; mainly medium to coarse quartz grains, but up to very coarse quartz grains; clay to granule; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; grades downward from low hydraulic conductivity to very low to low hydraulic conductivity; more clay-rich from 88.5 to 89.0 feet
90.0 - 95.0	Clay-rich quartz sand, grayish-yellow-green (5GY 7/2); moderately sorted; subangular to subrounded; mainly medium to coarse quartz grains, but up to very coarse quartz grains; clay to granule; 5 percent interparticle porosity; low hydraulic conductivity
95.0 - 96.0	Clay-rich quartz sand, grayish-yellow-green (5GY 7/2); moderately sorted; mainly fine to medium quartz grains, but up to coarse quartz grains; clay to coarse; 1 to 2 percent heavy minerals, carbonate grains and phosphorite grains; low hydraulic conductivity
96.0 - 99.5	Clay-rich quartz sand, grayish-yellow-green (5GY 7/2); moderately sorted; mainly fine to medium quartz grains, but up to coarse quartz grains; clay to coarse; 1 to 2 percent heavy minerals, carbonate grains and phosphorite grains; very low to low hydraulic conductivity; relatively more clay-rich than for 95 to 96 feet
99.5 - 100.0	No recovery
100.0 - 101.8	Clay-rich quartz sand, yellowish-gray (5Y 8/1); poorly sorted; quartz grains, very fine to granule size; clay to granule; small pebble size bone fragments; trace to 3 percent phosphorite grains; low hydraulic conductivity
101.8 - 104.0	Clay-rich quartz sand, mottled greenish-gray (5GY 6/1); very poorly sorted; quartz grains, very fine to granule size; clay to granule; small pebble-size bone fragments; trace to 3 percent phosphorite grains; very low to low hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1136
104.0 - 105.0	No recovery
105.0 - 107.0	Very clay-rich quartz sand with lenses of clean fine to medium quartz sand; sand in clay is very fine to fine, subangular quartz, pale-olive 10Y 6/2 to grayish-olive 10Y 4/2; very poorly sorted; mainly very fine to fine quartz grains; quartz grains, very fine to granule size; clay to granule; 5 percent phosphorite and heavy minerals; mollusks and possibly *Chione ulocyma*; very low to low hydraulic conductivity
107.0 - 110.0	No recovery
110.0 - 113.5	Very clay-rich quartz sand to very quartz sand-rich clay with minor lenses of cleaner quartz sand, grayish-olive 10Y 4/2; clay to granule; 50 to 10 percent phosphorite; fossil fragments; one mollusk, possibly *Chione ulocyma*; very low hydraulic conductivity
113.5 - 115.0	No recovery
115.0 - 119.0	Very clay-rich quartz sand to very quartz sand-rich clay with minor lenses of cleaner quartz sand, grayish-olive 10Y 4/2; very poorly sorted; mainly very fine to fine quartz grains; clay to granule; 5 to 10 percent phosphorite; fossil fragments; very low hydraulic conductivity
119.0 - 120.0	No recovery
120.0 - 123.5	Very clay-rich quartz sand to very quartz sand-rich clay with minor lenses of cleaner quartz sand, grayish-olive 10Y 4/2; very poorly sorted; mainly very fine to fine quartz grains; clay to granule; 5 to 10 percent phosphorite; fossil fragments; very low hydraulic conductivity
123.5 - 125.0	Very clay-rich quartz sand to very quartz sand-rich clay with minor lenses of cleaner quartz sand, grayish-olive 10Y 4/2; very poorly sorted; mainly very fine to fine quartz grains, but up to small pebble size; all grains, clay to granule; 3 percent phosphorite; fossil fragments; very low hydraulic conductivity
125.0 - 129.0	Very clay-rich quartz sand and quartz sand-rich clay in part; quartz sand-rich clay laminations from 127.5 to 128.2 feet.; clay content increases downward from 128.2 to 129.0 feet, grayish-olive 10Y 4/2; poorly sorted; interval coarsens upward with mainly mud and silt-size grains at base and mud to granule size grains at top; ranges from mud and silt-size grains at base to between mud and granule-size grains at top; phosphorite increases downward from 3 to 10 percent at top to trace and between 3 percent at base; very low hydraulic conductivity
129.0 - 130.0	No recovery
130.0 - 134.0	Silty, calcareous clay with several thin lenses of quartz sand, grayish-olive 10Y 4/2; interval fines upward with mainly mud and silt-size grains at base and mud-size grains at top; ranges from mud- to fine-size grains at base to mud-size grains at top; trace to 3 percent phosphorite grains; very low hydraulic conductivity, becomes increasingly harder downward
134.0 - 135.0	Silty, calcareous clay with thin lenses of quartz sand, grayish-olive 10Y 4/2; mainly mud and silt-size grains; ranges from mud to fine-size grains; trace to 3 percent phosphorite grains; very low hydraulic conductivity; variable hardness
135.0 - 140.0	Silty, calcareous clay with thin lenses of quartz sand, grayish-olive 10Y 4/2; interval coarsens upward with mainly mud and silt-size grains; ranges from mud to silt-size grains at base and middle to mud to fine sand-size grains at top; trace to 3 percent phosphorite grains; very low hydraulic conductivity; variable hardness
140.0 - 141.5	Silty, calcareous clay with thin lenses of quartz sand, grayish-olive 10Y 4/2; interval coarsens upward with mainly mud and silt-size grains; ranges from mud to silt-size grains at base to mud to fine sand-size grains at top; trace to 3 percent phosphorite grains; very low hydraulic conductivity; variable hardness
141.5 - 145.0	Silty clay, grayish-olive 10Y 4/2 mottled with olive-gray 5Y 3/2; mainly clay to silt; ranges from clay to fine; trace to 3 percent phosphorite grains; very low hydraulic conductivity; hard from 141.5 to 143.5 feet and plastic from 143.5 to 145.0 feet
145.0 - 149.0	Silty clay, grayish-olive 10Y 4/2 mottled with olive-gray 5Y 3/2; mainly clay to very fine; clay to fine; trace to 3 percent phosphorite grains; very low hydraulic conductivity; more quartz sand-rich than 141.5 to 145.0 feet
149.0 - 150.0	Very quartz sand-rich silty clay, light-olive-gray 5Y 6/1; mainly clay to fine; ranges from clay to coarse; 3 to 10 percent phosphorite grains; very low hydraulic conductivity; numerous burrows
150.0 - 157.0	Very quartz sand-rich clay to very clay-rich quartz sand, grayish-olive 10Y 4/2; mainly clay to fine; ranges from clay to coarse; 3 to 10 percent phosphorite grains; very low to low hydraulic conductivity; quartz sand is mainly very fine to fine, angular to subangular grains with about 10 to 15 percent medium subangular grains and 5 percent very coarse grains
157.0 - 160.0	Very quartz sand-rich clay to very clay-rich quartz sand; grayish olive 10Y 4/2; mainly clay to fine; ranges from clay to small pebble; 3 to 10 percent phosphorite grains; very low to low hydraulic conductivity; coarse fraction of quartz sand composed of granule and small pebble-size, well-rounded grains
160.0 - 165.0	Very quartz sand-rich clay to very clay-rich quartz sand, grayish-olive 10Y 4/2; mainly clay to fine; ranges from clay to coarse; 3 to 10 percent phosphorite grains; very low to low hydraulic conductivity
165.0 - 170.0	Very quartz sand-rich clay to very clay-rich quartz sand, grayish-olive 10Y 4/2; mainly clay to fine; ranges from clay to granule; 3 to 10 percent phosphorite grains; very low to low hydraulic conductivity; relatively more well rounded, very coarse quartz sand than interval above; pebble-size concretion
170.0 - 172.5	Quartz sand-rich, silty clay, grayish-olive 10Y 4/2; mainly clay to fine; ranges from clay to coarse; 3 to 10 percent phosphorite grains; stringers of very fine to fine quartz sand; very low to low hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1136
172.5 - 175.0	Quartz sand-rich, silty clay; grayish-olive 10Y 4/2; mainly clay to fine; ranges from clay to coarse; 3 to 10 percent phosphorite grains; very low to low hydraulic conductivity; about 20 percent coarse, well-rounded quartz and phosphorite sand
175.0 - 178.0	Quartz sand-rich, silty clay, grayish-olive 10Y 4/2, pale-olive 10Y 6/2; coarsens upward from mainly clay and silt to clay to fine; coarsens upward from clay and silt to coarse; trace to 10 percent phosphorite grains; very low hydraulic conductivity; concretions and granule-size quartz at 177 feet
178.0 - 180.0	Very clay-rich quartz sand, light-olive-gray 5Y 5/2; mainly clay to granule; ranges from clay to pebble; 5 to 10 percent well rounded quartz and phosphorite grains; low hydraulic conductivity
180.0 - 180.8	No recovery
180.8 - 183.0	Quartz sand-rich, silty clay, light-olive-gray 5Y 5/2 mottled with white N9; mainly clay to pebble; fossil fragments and quartz granules; 3 to 10 percent phosphorite grains; low hydraulic conductivity
183.0 - 188.0	Clay-rich, silty quartz sand grading downward to a clean, medium-grained, quartz sand, light-olive-gray 5Y 5/2 to very light gray N8; grading downward from clay and pebble to fine to medium; fossil fragments and well-rounded small quartz pebbles grading downward to clean, medium-grained, quartz sand; 3 to 10 percent phosphorite grains; low to medium hydraulic conductivity, grading downward
188.0 - 191.5	Clean, medium-grained sand, very light gray N8; mainly fine to medium; ranges from clay to granule; abundant fossil fragments from 188.3 to 191 feet; trace to 3 percent phosphorite grains; 5 percent porosity; medium hydraulic conductivity; several thin (2-millimeter thick) laminations of clay; quartz sand becomes coarser locally
191.5 - 193.0	No recovery
193.0 - 196.5	Very coarse, fossiliferous, clay-rich, quartz sand, very light gray N8 mottled with dusky-yellow-green 5GY 5/2; mainly medium to granule; ranges from clay to pebble; 3 to10 percent phosphorite grains; 5 percent intergranular porosity; moderate to high hydraulic conductivity; well-rounded quartz granules and pebbles grading downward to a coarse to medium-grained, clean, quartz sand
196.5 - 197.5	No recovery
197.5 - 200.0	Very coarse, fossiliferous, quartz sand grading downward to a clean, fine-grained quartz sand, light gray N7; mainly very fine to very coarse; ranges from silt to very coarse; 3 to 10 percent phosphorite grains; 5 percent intergranular porosity; moderate to high hydraulic conductivity
200.0 - 202.0	Chalky limestone, light-gray N7; massive; very porous; moderate hydraulic conductivity; well cemented

Doerr’s Lake Core

Florida Geological Survey well number	**W-17974**
Well number	**C-1137**
Total depth	**200 feet**
Cored from	**0 to 200 feet**
County	**Collier**
Location	**NE, SW, sec. 33, T52S, R31E**
Latitude	**25°53′51″**
Longitude	**81°13′28″**
Elevation	**6 feet**
Completion date	**March 10, 1997**
Other types of available logs	**Gamma ray, induction, neutron, fluid velocity, fluid conductivity**
Owner	**U.S. Geological Survey**
Driller	**Florida Geological Survey**
Core described by	**Kevin J. Cunningham**
Undifferentiated quartz sand	**0 to 0.5 foot**
Tamiami Formation, Ochopee Limestone Member	**0.5 to 35 feet**
Unnamed formation	**35 to 198 feet**
Gray limestone aquifer	**0 to 35 feet**
Lower confining unit	**35 to 189 feet**

Depth (feet below land surface)	Lithologic description of well C-1137
0.0 - 0.5	Quartz sand, mottled colors of grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6 and very pale orange 10YR 8/2, mainly fine to medium grain size; ranges from very fine to medium; broken fossil fragments; 20 percent interparticle porosity; high hydraulic conductivity
0.5 - 1.4	Mollusk lime rudstone with quartz sand-rich matrix, mottled colors of grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6 and very pale orange 10YR 8/2; mud to cobble; 20 percent moldic and vuggy porosity; high hydraulic conductivity
1.4 - 5.0	No recovery
5.0 - 6.0	Mollusk lime rudstone with lime packstone matrix, mottled colors of grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6 and very pale orange 10YR 8/2; mud to cobble; 20 percent moldic and vuggy porosity; high hydraulic conductivity
6.0 - 6.9	Mollusk lime rudstone with lime packstone matrix; white (N9) to very light gray (N8) and yellowish-gray (5Y 7/2); mud to cobble; 20 percent moldic and vuggy porosity; high hydraulic conductivity
6.9 - 10.0	No recovery
10.0 - 11.0	Rubble of mollusk lime rudstone with lime packstone matrix; white (N9) to very light gray (N8) and yellowish-gray (5Y 7/2), mainly mud to pebble; ranges from mud to cobble; 15 percent moldic and vuggy porosity; moderate hydraulic conductivity
11.0 - 14.0	No recovery
14.0 - 15.0	Rubble of mollusk lime rudstone with lime packstone matrix; white (N9) to very light gray (N8) and yellowish-gray (5Y 7/2); mainly mud to pebble; ranges from mud to cobble; 20 percent moldic porosity; high hydraulic conductivity
15.0 - 17.0	Mollusk lime mudstone with marl matrix, white (N9) and minor very light gray (N8); mainly mud to pebble; ranges from mud to cobble; 10 percent moldic porosity; low hydraulic conductivity
17.0 - 20.0	No recovery
20.0 - 23.5	Mollusk lime mudstone with marl matrix, white (N9) and minor very light gray (N8); mainly mud to pebble; ranges from mud to cobble; mollusks, gastropods and oysters; 10 percent moldic porosity; low hydraulic conductivity
23.5 - 24.0	No recovery
24.0 - 28.2	Mollusk lime mudstone with marl matrix, white (N9) and minor very light gray (N8); mainly mud to pebble; ranges from mud to cobble; mollusks, gastropods and oysters; 10 percent moldic porosity; low hydraulic conductivity
28.2 - 29.4	No recovery
29.4 - 33.5	Mollusk lime rudstone with quartz sand-rich skeletal wackestone matrix, white (N9) to very light gray (N8); mainly mud to pebble; ranges from mud to cobble; mollusks and gastropods; trace to 3 percent phosphorite grains; 15 percent moldic and vuggy porosity; moderate hydraulic conductivity; rubbly texture
33.5 - 34.5	No recovery
34.5 - 35.0	Mollusk lime rudstone with quartz sand-rich skeletal wackestone matrix, white (N9) to very light gray (N8); mainly mud to pebble; ranges from mud to cobble; mollusks and gastropods; trace to 3 percent phosphorite grains; 15 percent moldic and vuggy porosity; moderate hydraulic conductivity; rubbly texture
35.0 - 40.0	No recovery
40.0 - 43.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from clay and very fine to medium; trace mollusks; 3 to 10 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
43.0 - 45.0	No recovery
45.0 - 51.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from clay and very fine to medium; trace mollusks; 3 to 10 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
51.0 - 52.2	Friable quartz sand with lime mud matrix, yellowish-gray (5Y 8/1); mainly clay and very fine to fine grain size; ranges from clay and very fine to granule; minor mollusks; 3 to 10 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
52.2 - 55.0	No recovery
55.0 - 57.7	Friable quartz sand with lime mud matrix, yellowish-gray (5Y 8/1); mainly clay and fine to medium grain size; ranges from clay and fine to pebble; mollusks; 3 to 10 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1137
57.7 - 58.7	Friable quartz sand, pale-yellowish-brown (10YR 6/2); mainly fine to medium grain size; ranges from clay and fine to pebble; mollusks; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
58.7 - 60.0	No recovery
60.0 - 62.0	Friable quartz sand, pale-yellowish-brown (10YR 6/2); mainly fine to medium grain size; ranges from clay and fine to pebble; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
62.0 - 63.5	Friable quartz sand, medium-dark-gray (N4); mainly fine to medium grain size; ranges from clay and fine to pebble; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
63.5 - 65.0	No recovery
65.0 - 66.5	Friable quartz sand; medium-dark-gray (N4), mainly fine to medium grain size; ranges from clay and fine to pebble; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
66.5 - 70.0	No recovery
70.0 - 73.0	Friable quartz sand, yellowish-gray (5Y 7/2) to light-olive-gray (5Y 5/2); mainly fine to medium; clay and fine to granule; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
73.0 - 75.0	Friable quartz sand, yellowish-gray (5Y 7/2) to light-olive-gray (5Y 5/2); mainly fine to medium grain size; ranges from clay and fine to pebble; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
75.0 - 80.0	Friable quartz sand, light-olive-gray (5Y 5/2); mainly fine to medium grain size; ranges from clay and fine to pebble; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
80.0 - 81.5	No recovery
81.5 - 84.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from clay and fine to granule; trace to 3 percent; phosphorite grains; minor mica; 15 percent interparticle porosity; moderate hydraulic conductivity
84.5 - 85.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly clay to medium grain size; ranges from clay to coarse; trace to 3 percent phosphorite grains; minor mica; 10 percent interparticle porosity; low hydraulic conductivity; abrupt contact at 84.5 feet
85.0 - 90.0	No recovery
90.0 - 91.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from clay to coarse; trace to 3 percent phosphorite grains; minor mica; 15 percent interparticle porosity; moderate hydraulic conductivity
91.0 - 94.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from clay to medium; trace to 3 percent phosphorite grains; minor mica; 15 percent interparticle porosity; moderate hydraulic conductivity
94.5 - 95.0	No recovery
95.0 - 98.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from clay to pebble; mollusks; trace to 3 percent phosphorite grains; minor mica; 15 percent interparticle porosity; moderate hydraulic conductivity
98.5 - 100.0	No recovery
100.0 - 101.6	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to medium grain size; ranges from silt to pebble; mollusks; trace to 3 percent phosphorite grains; minor mica; 20 percent interparticle porosity; moderate hydraulic conductivity
101.6 - 106.0	Friable quartz sand, yellowish-gray (5Y 7/2); mainly fine to medium grain size; ranges from silt to pebble; mollusks; trace to 3 percent phosphorite grains; minor mica; 15 percent interparticle porosity; moderate hydraulic conductivity
106.0 - 108.0	Friable quartz sand, yellowish-gray (5Y 7/2); mainly fine to medium grain size; ranges from silt to pebble; trace to 3 percent phosphorite grains; minor mica; 20 percent interparticle porosity; moderate hydraulic conductivity
108.0 - 110.0	Friable quartz sand, yellowish-gray (5Y 7/2); mainly fine to coarse grain size; ranges from silt to pebble; trace to 3 percent phosphorite grains; minor mica; 20 percent interparticle porosity; moderate hydraulic conductivity
110.0 - 113.0	Friable quartz sand, yellowish-gray (5Y 7/2); mainly fine to coarse grain size; ranges from silt to cobble; mollusks; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
113.0 - 114.0	Friable quartz sand, yellowish-gray (5Y 7/2); mainly fine to coarse grain size; ranges from silt to pebble; mollusks; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
114.0 - 115.0	No recovery
115.0 - 117.0	Friable quartz sand, yellowish-gray (5Y 7/2); mainly very fine to medium grain size; ranges from silt to pebble; mollusks; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
117.0 - 119.0	Friable quartz sand, yellowish-gray (5Y 7/2); mainly very fine to medium grain size; ranges from silt to cobble; mollusks; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1137
119.0 - 120.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from silt to pebble; mollusks; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
120.0 - 121.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from silt to granule; mollusks; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
121.0 - 125.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
125.0 - 127.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to medium grain size; ranges from silt to pebble; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
127.0 - 128.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; minor clay clasts or clay drapes, olive-gray (5Y 4/1)
128.0 - 130.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly very fine to fine grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
130.0 - 134.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
134.5 - 135.0	No recovery
135.0 - 139.3	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; minor clay clasts or clay drapes at 135.7 to 136.8 feet, olive-gray (5Y 4/1)
139.3 - 140.0	No recovery
140.0 - 144.3	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; minor clay clasts at 140.2 to 140.8 feet, olive-gray (5Y 4/1)
144.3 - 145.0	No recovery
145.0 - 145.7	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to pebble; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
145.7 - 147.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; minor clay clasts or clay drapes or both, olive-gray (5Y 4/1)
147.5 - 149.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
149.0 - 150.0	No recovery
150.0 - 150.8	Friable quartz sand, yellowish-gray (5Y 8/1); mainly medium to coarse grain size; ranges from silt to pebble; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
150.8 - 152.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
152.0 - 154.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly medium to coarse grain size; ranges from silt to pebble; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
154.0 - 154.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
154.5 - 155.0	No recovery
155.0 - 159.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; minor pebble- to cobble-size clay clasts, olive-gray (5Y 4/1); 20 percent interparticle porosity; moderate hydraulic conductivity
159.0 - 160.0	No recovery
160.0 - 165.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
165.0 - 166.5	No recovery
166.5 - 170.8	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1137
170.8 - 174.0	Friable quartz sand, yellowish gray (5Y 8/1); mainly fine to medium; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; cobble-size clay clasts and clay laminae with soft sediment deformation,olive-gray (5Y 4/1)
174.0 - 175.0	No recovery
175.0 - 178.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; clay clasts at 175.4 feet, olive- gray (5Y 4/1)
178.5 - 180.0	No recovery
180.0 - 182.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; clay laminae from 181.7 to 182 feet, olive-gray (5Y 4/1)
182.0 - 185.0	No recovery
185.0 - 186.5	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
186.5 - 190.0	No recovery
190.0 - 190.8	Clay drape, olive-gray (5Y 4/1); no porosity; very low hydraulic conductivity; laminae of silt to very fine quartz sand at base
190.8 - 195.0	No recovery
195.0 - 198.0	Friable quartz sand, yellowish-gray (5Y 8/1); mainly fine to medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
198.0 - 200.0	No recovery

Raccoon Point Core

Florida Geological Survey well number	**W-17975**
Well number	**C-1138**
Total depth	**185 feet**
Cored from	**0 to 185 feet**
County	**Collier**
Location	**SE, SE, sec. 33, T51S, R34E**
Latitude	**25°58′56″**
Longitude	**80°55′33″**
Elevation	**11.4 feet**
Completion date	**March 9, 1997**
Other types of available logs	**Gamma ray, induction, neutron, fluid velocity**
Owner	**U.S. Geological Survey**
Driller	**U.S. Geological Survey**
Core described by	**Kevin J. Cunningham**
Possible fill	**0 to 2.5 feet**
Tamiami Formation, undifferentiated limestone and quartz sand	**2.5 to 20 feet**
Tamiami Formation, Ochopee Limestone Member	**20 to 107 feet**
Unnamed formation	**107 to 147.5 feet**
Peace River Formation	**147.5 to 185 feet**
Water-table aquifer	**0 to 20 feet**
Upper confining unit	**20 to 52 feet**
Gray limestone aquifer	**52 to 109 feet**
Lower confining unit	**109 to 185 feet**

Depth (feet below land surface)	Lithologic description of well C-1138
0.0 - 2.5	No recovery
2.5 - 3.5	Quartz sand-rich, mollusk lime floatstone with quartz sand-rich packstone matrix, yellowish-gray 5Y 8/1 and dark-yellowish-orange 10YR 6/6; mainly clay and very fine to medium grain size; ranges from clay to pebble; 5 percent moldic and vuggy porosity; low hydraulic conductivity
3.5 - 4.5	Quartz sand-rich, mollusk lime floatstone with quartz sand-rich packstone matrix, yellowish-gray 5Y 8/1 and dark-yellowish-orange 10YR 6/6; mainly clay and very fine to medium grain size; ranges from clay to pebble; 15 percent moldic and vuggy porosity; high hydraulic conductivity
4.5 - 5.5	Calcareous quartz sandstone, yellowish-gray 5Y 8/1 and 5Y 7/2; mainly clay and fine to medium grain size; ranges from clay to pebble; 10 percent interparticle porosity; low hydraulic conductivity
5.5 - 6.0	Calcareous quartz sandstone, yellowish-gray 5Y 8/1 and 5Y 7/2; mainly fine to pebble grain size; ranges from clay to pebble; 10 percent moldic and vuggy porosity; low hydraulic conductivity
6.0 - 7.0	Mollusk lime rudstone with quartz sand-rich lime packstone matrix, yellowish-gray 5Y 8/1 and 5Y 7/2; mainly fine to pebble grain size; ranges from clay to pebble; 15 percent moldic and vuggy porosity; moderate hydraulic conductivity
7.0 - 9.0	No recovery
9.0 - 9.5	Fossiliferous quartz sandstone, yellowish-gray 5Y 8/1 and 5Y 7/2; mainly fine to medium grain size; ranges from clay to pebble; 15 percent interparticle porosity; moderate hydraulic conductivity
9.5 - 10.0	Mollusk lime rudstone with quartz sand-rich lime packstone matrix, yellowish-gray 5Y 8/1 and 5Y 7/2; mainly clay and fine to pebble grain size; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
10.0 - 20.0	No recovery
20.0 - 22.0	Fossil fragment-rich marl, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; mollusks; 5 percent interparticle porosity; low hydraulic conductivity
22.0 - 22.5	No recovery
22.5 - 23.5	Fossil fragment-rich marl, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; mollusks; 5 percent interparticle porosity; low hydraulic conductivity
23.5 - 25.0	No recovery
25.0 - 27.0	Fossil fragment-rich marl, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; mollusks, oysters; 5 percent interparticle porosity; low hydraulic conductivity
27.0 - 30.0	No recovery
30.0 - 31.5	Fossil fragment-rich marl, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; mollusks, oysters; 5 percent interparticle porosity; low hydraulic conductivity
31.5 - 35.0	No recovery
35.0 - 36.0	Fossil fragment-rich marl, yellowish-gray 5Y 7/2; mainly clay to pebble grain size; ranges from clay to cobble; mollusks, oysters; 5 percent interparticle porosity; low hydraulic conductivity
36.0 - 40.0	No recovery
40.0 - 42.0	Fossiliferous, quartz sand-rich marl, yellowish-gray 5Y 7/2; mainly clay and very fine to fine grain size; ranges from clay to pebble; 5 percent interparticle porosity; low hydraulic conductivity
42.0 - 47.0	Quartz sand-rich marl, yellowish-gray 5Y 7/2; mainly clay and very fine to fine grain size; ranges from clay to pebble; oysters; 5 percent interparticle porosity; low hydraulic conductivity
47.0 - 50.0	No recovery
50.0 - 52.0	Fossiliferous marl, yellowish-gray 5Y 8/1 with medium-dark-gray N4 intraclasts; mainly clay to pebble grain size; ranges from clay to cobble; intraclasts in upper half; 5 percent interparticle porosity; low hydraulic conductivity
52.0 - 54.3	Mollusk lime rudstone with marl matrix, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
54.3 - 55.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1138
55.0 - 58.5	Mollusk lime rudstone with marl matrix, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1; mainly from clay to pebble grain size; ranges from clay to cobble; fossil fragments, bivalves; interparticle and moldic porosity; low hydraulic conductivity
58.5 - 65.0	No recovery
65.0 - 67.5	Mollusk lime rudstone with marl matrix, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1; mainly from clay to pebble grain size; ranges from clay to cobble; echinoids, bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
67.5 - 70.0	No recovery
70.0 - 74.0	Mollusk lime rudstone with marl matrix, mottled medium-light gray N6, gray N7, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; echinoids, bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
74.0 - 75.0	No recovery
75.0 - 79.0	Mollusk lime rudstone with marl matrix, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; echinoids, bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
79.0 - 80.0	No recovery
80.0 - 89.0	Mollusk lime rudstone with marl matrix, mottled medium-light gray N6, gray N7, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; echinoids, bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
89.0 - 90.0	No recovery
90.0 - 94.2	Mollusk lime rudstone with marl matrix, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; echinoids, bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
94.2 - 95.0	No recovery
95.0 - 96.0	Mollusk lime rudstone with marl matrix, mottled medium-light-gray N6, gray N7, yellowish gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; minor quartz sand; echinoids, bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
96.0 - 98.5	Mollusk lime rudstone with marl matrix, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; mainly clay to pebble grain size; ranges from clay to cobble; minor quartz sand; echinoids, bryozoans, oysters; interparticle and moldic porosity; low hydraulic conductivity
98.5 - 100.0	No recovery
100.0 - 104.0	Mollusk lime rudstone with quartz sand-rich matrix, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; mainly clay to granule grain size; ranges from clay to pebble; fossil fragments, bivalves, oysters; 5 percent interparticle and moldic porosity; low hydraulic conductivity
104.0 - 105.0	No recovery
105.0 - 106.0	Mollusk lime rudstone with quartz sand-rich matrix; mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; mainly clay to granule grain size; ranges from clay to pebble; fossil fragments, bivalves, oyster; 5 percent interparticle and moldic porosity; low hydraulic conductivity
106.0 - 107.0	Mollusk lime floatstone, mottled medium-light-gray N6, gray N7, yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; mainly clay to granule grain size; ranges from clay to pebble; 10 percent moldic porosity; moderate hydraulic conductivity
107.0 - 109.0	Friable quartz sand, yellowish-gray 5Y 8/1; mainly fine to medium grain size; ranges from fine to medium; trace fossil fragments; trace to 3 percent phosphorite; 10 percent interparticle and moldic porosity; moderate hydraulic conductivity
109.0 - 110.0	No recovery
110.0 - 113.0	Quartz sand, yellowish-gray 5Y 8/1; fine to medium grain size; minor fossil fragments; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
113.0 - 114.5	Mollusk lime rudstone with quartz sand-rich marl matrix; mainly clay and fine to medium grain size; ranges from clay to pebble; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1138
114.5 - 115.0	No recovery
115.0 - 116.0	Quartz sand, yellowish-gray 5Y 8/1; mainly clay and fine to medium grain size; ranges from clay to pebble; fossil fragments; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
116.0 - 117.5	Quartz sand; yellowish-gray 5Y 8/1; mainly clay and fine to medium grain size; fossil fragments; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity
117.5 - 118.3	Quartz sand; yellowish-gray 5Y 8/1; mainly clay to pebble grain size; fossil fragments; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
118.3 - 120.0	No recovery
120.0 - 124.0	Mollusk lime floatstone with quartz sand-rich marl matrix, yellowish-gray 5Y 8/1; mainly clay to pebble grain size; ranges from clay to cobble; mollusks, fossil fragments; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity
124.0 - 124.4	Quartz sand, yellowish-gray 5Y 8/1; fine to medium grain size; trace to 3 percent phosphorite; 15 percent interparticle porosity; moderate hydraulic conductivity
124.4 - 125.0	No recovery
125.0 - 127.5	Friable quartz sand, yellowish-gray 5Y 8/1; mainly fine to medium grain size; ranges from clay to medium; fossil fragments; trace to 3 percent phosphorite; 15 percent interparticle porosity; moderate hydraulic conductivity; calcareous
127.5 - 128.5	No recovery
128.5 - 129.0	Friable quartz sand, yellowish-gray 5Y 8/1; mainly very fine to granule grain size; ranges from clay to granule; fossil fragments; trace to 3 percent phosphorite; 15 percent interparticle porosity; moderate hydraulic conductivity; calcareous
129.0 - 133.0	Friable quartz sand, yellowish-gray 5Y 8/1; mainly very fine to medium grain size; ranges from clay to medium; fossil fragments; trace to 3 percent phosphorite; 15 percent interparticle porosity; moderate hydraulic conductivity; calcareous
133.0 - 134.5	Friable quartz sand, yellowish-gray 5Y 8/1; mainly very fine to medium grain size; ranges from clay to medium; fossil fragments; trace to 3 percent phosphorite; 15 percent interparticle porosity; high hydraulic conductivity; calcareous
134.5 - 135.0	No recovery
135.0 - 135.5	Friable quartz sand, yellowish-gray 5Y 8/1; mainly very fine to medium grain size; ranges from clay to medium; fossil fragments; trace to 3 percent phosphorite; 15 percent interparticle porosity; high hydraulic conductivity; calcareous
135.5 - 136.0	No recovery
136.0 - 137.0	Quartz sand, pale-olive 10Y 6/2, light-olive-gray 5Y 6/1; mainly very fine grain size; ranges from clay to fine; trace mollusk fragments, fossil fragments; greater than 10 percent phosphorite; 15 percent interparticle porosity; moderate hydraulic conductivity
137.0 - 144.0	Quartz sand, pale-olive 10Y 6/2, light-olive-gray 5Y 6/1; mainly very fine grain size; ranges from clay to fine; trace mollusk fragments; greater than 10 percent phosphorite; 15 percent interparticle porosity; low hydraulic conductivity; low-inclination planar laminations at base
144.0 - 144.5	No recovery
144.5 - 146.0	Quartz sand, pale-olive 10Y 6/2, light-olive-gray 5Y 6/1; mainly very fine grain size; ranges from clay to fine; trace mollusk fragments; greater than 10 percent phosphorite; 15 percent interparticle porosity; low hydraulic conductivity
146.0 - 147.0	No recovery
147.0 - 147.5	Quartz sand, pale-olive 10Y 6/2, light-olive-gray 5Y 6/1; mainly very fine grain size; ranges from clay to fine; trace mollusk fragments; greater than 10 percent phosphorite; 15 percent interparticle porosity; low hydraulic conductivity
147.5 - 148.0	Quartz sand, pale-olive 10Y 6/2, light-olive-gray 5Y 6/1,olive-gray 5Y 4/1; mainly clay; ranges from clay to very fine; 5 percent interparticle porosity; very low hydraulic conductivity
148.0 - 149.0	Mudstone interbedded with quartz sand laminations, olive-gray 5Y 4/1; mainly clay and very fine sand grain size; ranges from clay to very fine; 5 percent interparticle porosity; very low hydraulic conductivity
149.0 - 154.5	Mudstone,olive-gray 5Y 4/1; mainly clay grain size; ranges from clay to very fine; accebenthic foraminifers, mollusk fragments; 5 percent interparticle porosity; very low hydraulic conductivity
154.5 - 155.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1138
155.0 - 157.0	Mudstone, olive-gray 5Y 4/1; mainly clay grain size; ranges from clay to very fine; benthic forams; 5 percent interparticle porosity; very low hydraulic conductivity
157.0 - 159.0	Mudstone, light-olive-gray 5Y 5/2; mainly clay grain size; ranges from clay to very fine; benthic forams, diatoms; 5 percent interparticle porosity; very low hydraulic conductivity
159.0 - 162.5	Mudstone, pale-olive 10Y 6/2; mainly clay grain size; ranges from clay to very fine; benthic forams, diatoms; 5 percent interparticle porosity; very low hydraulic conductivity
162.5 - 164.0	Mudstone; yellowish-gray 5Y 7/2; mainly clay grain size; ranges from clay to very fine; benthic forams, diatoms; 5 percent interparticle porosity; very low hydraulic conductivity
164.0 - 165.0	No recovery
165.0 - 170.0	Diatomaceous mudstone, yellowish-gray 5Y 7/2; mainly clay grain size; ranges from clay to very fine; diatoms; 5 percent interparticle porosity; very low hydraulic conductivity
170.0 - 171.0	Quartz sand-rich mudstone, yellowish-gray 5Y 7/2; mainly clay grain size; ranges from clay to very fine; minor mollusks, fossil fragments, diatoms; greater than 10 percent phosphorite; 5 percent interparticle porosity; low hydraulic conductivity
171.0 - 174.0	Quartz sand-rich mudstone; yellowish-gray 5Y 7/2; mainly clay grain size; ranges from clay to very fine; minor mollusks, fossil fragments, diatoms; trace to 3 percent phosphorite; 5 percent interparticle porosity; low hydraulic conductivity
174.0 - 175.0	Quartz sand-rich mudstone, yellowish-gray 5Y 7/2; mainly clay grain size; ranges from clay to very fine; minor mollusks, fossil fragments, diatoms; trace to 3 percent phosphorite; 5 percent interparticle porosity; very low hydraulic conductivity
175.0 - 179.0	Quartz sand with clay matrix, yellowish-gray 5Y 7/2; mainly very fine grain size; ranges from clay to coarse; 3 to 10 percent phosphorite; 10 percent interparticle porosity; low hydraulic conductivity
179.0 - 179.5	Diatomaceous mudstone, yellowish-gray 5Y 7/2; mainly clay grain size; ranges from clay to very fine; diatoms; trace to 3 percent phosphorite; 5 percent interparticle porosity; very low hydraulic conductivity
179.5 - 181.5	Clay-rich quartz sand, pale-olive 10Y 6/2; mainly very fine grain size; ranges from clay to cobble; mollusks; trace to 3 percent phosphorite; 5 percent interparticle porosity; low hydraulic conductivity
181.5 - 185.0	Clay-rich quartz sand, pale-olive 10Y 6/2; mainly very fine grain size; ranges from clay to pebble; mollusks; trace to 3 percent phosphorite; 5 percent interparticle porosity; low hydraulic conductivity

Noble's Road Core

Florida Geological Survey well number	W-17976
Well number	C-1139
Total depth	200 feet
Cored from	0 to 200 feet
County	Collier
Location	NE, SW, sec. 31, T49S, R33E
Latitude	26°10′19″
Longitude	81°04′09″
Elevation	13 feet
Completion date	April 5, 1997
Other types of available logs	Gamma ray, induction, flowmeter, neutron, fluid resistivity
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Kevin J. Cunningham
Fill	0 to 1 foot
Peat	1 to 1.4 feet
Undifferentiated limestone and quartz sand	1.4 to 6 feet
Tamiami Formation, Pinecrest Member	6 to 92 feet
Tamiami Formation, Ochopee Limestone Member	92 to 148 feet
Unnamed sand	148 to 165 feet
Peace River Formation	165 to 200 feet
Water-table aquifer	0 to 40 feet
Upper confining unit	40 to 92 feet
Gray limestone aquifer	92 to 148 feet
Lower confining unit	148 to 200 feet

Depth (feet below land surface)	Lithologic description of well C-1139
0.0 - 1.0	Mechanically broken skeletal fragment-rich quartz sand, very pale orange 10YR 8/2, grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6; mainly fine to medium grain size; ranges from very fine to granule; 15 percent interparticle porosity; moderate hydraulic conductivity; soft
1.0 - 1.4	Peat, brownish-black 5YR 2/1; clay to pebble grain size, 15 percent interparticle porosity; moderate hydraulic conductivity; soft
1.4 - 1.8	Laminated calcrete, very pale orange 10YR 8/2, grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6, moderate-yellowish-orange 10YR 5/5; mainly clay to very fine grain size; ranges from clay to coarse; 5 percent vuggy porosity; low hydraulic conductivity; hard
1.8 - 2.1	Quartz sand, pale-yellowish-brown 10YR 6/2; mainly fine to medium grain size; ranges from clay to medium; 10 percent interparticle porosity; low hydraulic conductivity; soft
2.1 - 3.4	Gastropod and mollusk lime packstone; very pale orange 10YR 8/2, grayish-orange 10YR 7/4, pale-yellowish-orange 10YR 8/6; mainly clay-size lime mud; ranges from clay to pebble; 10 percent moldic porosity; low hydraulic conductivity; hard
3.4 - 4.5	No recovery
4.5 - 6.0	Gastropod lime packstone, very pale orange 10YR 8/2, grayish-orange 10YR 7/4, pale-yellowish-orange 10YR 8/6; mainly clay-size lime mud; ranges from clay to pebble; 10 percent moldic, vuggy and root mold porosity; low hydraulic conductivity; hard; root molds
6.0 - 10.0	No recovery
10.0 - 10.8	Mollusk-rich quartz sand, very pale orange 10YR 8/2; mainly fine to medium quartz sand; ranges from very fine to pebble; mollusks; 15 percent interparticle porosity; moderate hydraulic conductivity; soft
10.8 - 13.0	No recovery
13.0 - 14.0	Mollusk-rich quartz sand, very pale orange 10YR 8/2; mainly very fine quartz sand; ranges from clay to pebble; mollusks; 10 percent interparticle porosity; low hydraulic conductivity; minor clay matrix; soft when wet
14.0 - 15.0	No recovery
15.0 - 18.0	Mollusk-rich quartz sand, very pale orange 10YR 8/2; mainly fine quartz sand; ranges from clay to pebble; mollusks, skeletal fragments; 5 percent interparticle, moldic and minor intraparticle porosity; low hydraulic conductivity; minor clay matrix; soft when wet
18.0 - 20.0	No recovery
20.0 - 21.0	Mollusk-rich quartz sand, very pale orange 10YR 8/2; mainly fine quartz sand and pebble-size fossils; grains range from clay to cobble; mollusks, skeletal fragments; minor gastropods, oysters and serpulids; 5 percent interparticle, moldic and minor intraparticle porosity; low hydraulic conductivity; minor clay matrix; soft when wet
21.0 - 25.0	No recovery
25.0 - 26.2	Mollusk-rich quartz sand, very pale orange 10YR 8/2; mainly fine quartz sand and pebble-size fossils; grains range from clay to cobble; mollusks, skeletal fragments; minor gastropods, oysters and serpulids; 5 percent interparticle, moldic and minor intraparticle porosity; low hydraulic conductivity; minor clay matrix; soft when wet
26.2 - 27.6	Mollusk lime rudstone with quartz sand-rich lime packstone matrix, very pale orange 10YR 8/2; mainly fine quartz sand and pebble-size fossils; grains range from very fine to pebble; mollusks; 5 percent interparticle, moldic and minor intraparticle porosity; low hydraulic conductivity; minor clay matrix; soft when wet
27.6 - 29.0	No recovery
29.0 - 29.5	Mollusk lime rudstone with quartz sand-rich lime packstone matrix, very pale orange 10YR 8/2; mainly clay-size lime mudstone and very fine quartz sand-size fossils; grains range from very fine to pebble; mollusks; 5 percent interparticle, moldic and minor intraparticle porosity; low hydraulic conductivity; minor clay matrix; soft when wet
29.5 - 31.0	Mollusk lime rudstone with quartz sand-rich lime packstone matrix, very pale orange 10YR 8/2; mainly clay-size lime mudstone and very fine quartz sand-size fossils; grains range from very fine to pebble; mollusks; 5 percent interparticle, moldic and minor intraparticle porosity; very low hydraulic conductivity; minor clay matrix; soft when wet

Depth (feet below land surface)	Lithologic description of well C-1139
31.0 - 32.6	Mollusk-rich quartz sand, yellowish-gray 5Y 8/1; mainly clay-size terrigenous mud and very fine quartz sand; grains range from clay to pebble; mollusks, skeletal fragments; minor gastropods, oysters and serpulids; 5 percent interparticle porosity; very low hydraulic conductivity; minor clay matrix; soft when wet
32.6 - 34.0	No recovery
34.0 - 34.8	Mollusk-rich quartz sand, yellowish-gray 5Y 8/1; mainly clay-size terrigenous mud and very fine to fine quartz sand; grains range from clay to pebble; mollusks, skeletal fragments; minor gastropods, oysters and serpulids; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; minor clay matrix; soft when wet
34.8 - 35.0	No recovery
35.0 - 37.0	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 6/1; mainly very fine to fine quartz sand; grains range from clay to cobble; minor mollusks fragments and trace serpulids and gastropods; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity
37.0 - 40.0	No recovery
40.0 - 44.0	Quartz sand, mottled light-olive-gray 5Y 6/1 and light-olive-gray 5Y 5/2; mainly very fine to fine quartz sand; grains range from clay to pebble; minor mollusk fragments; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; minor terrigenous mud matrix
44.0 - 45.0	No recovery
45.0 - 48.0	Quartz sand, mottled light-olive-gray 5Y 6/1 and light-olive-gray 5Y 5/2; mainly very fine quartz sand; grains range from clay to pebble; minor mollusk fragments; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; minor terrigenous mud matrix
48.0 - 50.0	No recovery
50.0 - 53.0	Quartz sand, mottled light-olive-gray 5Y 6/1 and light-olive-gray 5Y 5/2; mainly very fine quartz sand; grains range from clay to fine; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; minor terrigenous mud matrix
53.0 - 55.0	No recovery
55.0 - 57.0	Quartz sand, mottled light-olive-gray 5Y 6/1 and light-olive-gray 5Y 5/2; mainly very fine quartz sand; grains range from clay to fine; trace to 3 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; minor terrigenous mud matrix
57.0 - 57.5	Quartz sand-rich mudstone, yellowish-gray 5Y 7/2; mainly clay-size terrigenous mud and very fine quartz sand; grains range from clay to fine; 5 percent interparticle porosity; very low hydraulic conductivity; minor terrigenous mud matrix
57.5 - 60.0	No recovery
60.0 - 64.5	Quartz sand-rich mudstone, yellowish-gray 5Y 7/2; mainly clay-size terrigenous mud and very fine quartz sand; grains range from clay to fine; 5 percent interparticle porosity; very low hydraulic conductivity; minor terrigenous mud matrix
64.5 - 65.0	No recovery
65.0 - 69.5	Quartz sand-rich mudstone; yellowish-gray 5Y 7/2; mainly clay size terrigenous mud and very fine quartz sand; grains range from clay to very fine; 5 percent interparticle porosity; very low hydraulic conductivity; minor terrigenous mud matrix
69.5 - 70.0	No recovery
70.0 - 73.0	Terrigenous mud-rich quartz sand, yellowish-gray 5Y 7/2 and minor light-olive-gray 5Y 5/2; mainly very fine quartz; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity
73.0 - 75.0	Terrigenous mud-rich quartz sand, yellowish-gray 5Y 7/2; mainly clay-size terrigenous clay and very fine quartz; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity
75.0 - 81.0	Terrigenous mud-rich quartz sand; light-olive-gray 5Y 5/2; mainly very fine quartz; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity
81.0 - 86.0	Terrigenous mudstone, light-olive-gray 5Y 6/1; mainly terrigenous clay; grains range from clay to silt size; trace interparticle porosity; very low hydraulic conductivity; maximum flooding surface at 81 feet

Depth (feet below land surface)	Lithologic description of well C-1139
86.0 - 87.0	Terrigenous mud-rich quartz sand, light-olive-gray 5Y 5/2; mainly terrigenous clay and very fine quartz sand; grains range from clay to very fine; minor mollusks and skeletal fragments; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity
87.0 - 88.0	Terrigenous mud-rich quartz sand, light-olive-gray 5Y 5/2; mainly terrigenous clay and very fine to medium quartz sand; grains range from clay to medium; minor mollusks and skeletal fragments; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity
88.0 - 90.0	Terrigenous mud-rich quartz sand, yellowish-gray 5Y 7/2; mainly terrigenous clay and very fine to medium quartz sand; grains range from clay to medium; minor mollusks and skeletal fragments; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity
90.0 - 92.0	Terrigenous mud-rich quartz sand, yellowish-gray 5Y 7/2; mainly terrigenous clay and very fine to medium quartz sand; grains range from clay to pebble; minor mollusks, skeletal fragments and oysters; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity
92.0 - 94.0	Mollusk lime rudstone with matrix of skeletal lime packstone with marl matrix, medium-gray N5 to light-gray N7; mainly clay-size marl and very fine to medium fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters and bryozoans; trace to 3 percent phosphorite grains; 5 percent interparticle and minor intraparticle, moldic and bored porosity; low hydraulic conductivity; soft lime packstone matrix; rubbly recovery
94.0 - 95.0	Mollusk lime rudstone with matrix of skeletal lime packstone with marl matrix, medium-light-gray N6 to light-gray N7; mainly clay-size marl and very fine to medium fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters and bryozoans; trace to 3 percent phosphorite grains; 5 percent interparticle and minor intraparticle, moldic and bored porosity; low hydraulic conductivity; soft lime packstone matrix; rubbly recovery
95.0 - 99.5	Mollusk lime rudstone with matrix of skeletal lime packstone with marl matrix, medium-light-gray N6 to light-gray N7; mainly clay-size marl and very fine to medium fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters and bryozoans; trace to 3 percent phosphorite grains; 5 percent interparticle and minor intraparticle, moldic and bored porosity; low to moderate hydraulic conductivity; cobble-size oysters at 97 feet; soft lime packstone matrix; rubbly recovery
99.5 - 100.0	No recovery
100.0 - 102.0	Mollusk lime rudstone with matrix of skeletal lime packstone with marl matrix, medium-light-gray N6 to light-gray N7; mainly clay-size marl and very fine to medium fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters and bryozoans; trace to 3 percent phosphorite grains; 5 percent interparticle and minor intraparticle, moldic and bored porosity; low to moderate hydraulic conductivity; soft lime packstone matrix; rubbly recovery
102.0 - 104.2	Mollusk lime rudstone with matrix of skeletal lime packstone with marl matrix, medium-light-gray N6 to light-gray N7; mainly clay-size marl and very fine to medium fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters and bryozoans; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low hydraulic conductivity; soft lime packstone matrix; rubbly recovery
104.2 - 105.0	No recovery
105.0 - 112.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, medium-light-gray N6 to light-gray N7; mainly clay-size marl and very fine to medium fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low to moderate hydraulic conductivity; cobble-size mollusks at 107 and 111 feet; soft lime wackestone and packstone matrix; rubbly recovery
112.0 - 114.8	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix; medium-light-gray N6 to light-gray N7; mainly clay-size marl and very fine to medium fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low hydraulic conductivity; soft lime wackestone and packstone matrix; rubbly recovery
114.8 - 115.0	No recovery
115.0 - 119.5	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to granule-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low hydraulic conductivity; soft lime wackestone and packstone matrix; rubbly recovery

Depth (feet below land surface)	Lithologic description of well C-1139
119.5 - 120.0	No recovery
120.0 - 122.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low hydraulic conductivity; soft lime wackestone and packstone matrix; rubbly recovery
122.0 - 124.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low to moderate hydraulic conductivity; cobble-size mollusk at 123 feet.; soft lime wackestone and packstone matrix; rubbly recovery
124.0 - 125.0	No recovery
125.0 - 129.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low hydraulic conductivity; soft lime wackestone and packstone matrix; rubbly recovery
129.0 - 130.0	No recovery
130.0 - 139.5	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low to moderate hydraulic conductivity; cobble-size mollusk at 132 feet; soft lime wackestone and packstone matrix; rubbly recovery
139.5 - 140.0	No recovery
140.0 - 142.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low to moderate hydraulic conductivity; soft lime wackestone and packstone matrix; rubbly recovery
142.0 - 144.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low hydraulic conductivity; soft lime wackestone and packstone matrix; rubbly recovery
144.0 - 145.0	No recovery
145.0 - 147.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low to moderate hydraulic conductivity; low to moderate cobble-size mollusk at 146 feet; soft lime wackestone and packstone matrix; rubbly recovery
147.0 - 148.0	Mollusk lime rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, very light gray N8 to yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to pebble-size fossils; grains range from clay to pebble; mollusks, skeletal fragments, oysters, bryozoans, gastropods and echinoids; trace to 3 percent phosphorite grains; 5 percent moldic and interparticle porosity; minor intraparticle and bored porosity; low hydraulic conductivity; soft lime wackestone and packstone matrix; rubbly recovery
148.0 - 154.5	Quartz sand; yellowish-gray 5Y 7/2, mainly very fine quartz sand; grains range from clay to pebble; minor broken mollusks; greater than 10 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; cobble-size mollusk at 150 feet; minor terrigenous mud matrix; soft
154.5 - 155.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1139
155.0 - 164.0	Quartz sand, pale-olive 10Y 6/2; mainly very fine quartz sand; grains range from clay to pebble; minor broken mollusks; greater than 10 percent phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; cobble-size mollusk at 157 feet; minor terrigenous mud matrix; soft
164.0 - 165.0	Quartz sand, pale-olive 10Y 6/2; mainly very fine quartz sand; grains range from clay to coarse; minor broken mollusks; 3 to 10 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity; minor terrigenous mud matrix; soft
165.0 - 165.1	Quartz sand; pale-olive 10Y 6/2; mainly clay-size terrigenous mud and very fine quartz sand; grains range from clay to pebble; trace broken mollusks; 3 to 10 percent phosphorite grains (up to pebble size); 5 percent interparticle porosity; very low hydraulic conductivity; minor terrigenous mud matrix; soft; phosphorite pebbles may indicate unconformity
165.1 - 170.0	Quartz sand, pale-olive 10Y 6/2, mainly clay-size terrigenous mud and very fine quartz sand; grains range from clay to coarse; trace broken mollusks; 3 to 10 percent phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity; abundant terrigenous mud matrix; soft
170.0 - 172.0	Terrigenous mudstone with minor laminae of quartz sand, pale-olive 10Y 6/2; mainly clay-size terrigenous mud; grains range from clay to very fine; trace to 3 percent phosphorite grains; trace interparticle porosity; very low hydraulic conductivity; abundant terrigenous mud matrix; soft when wet
172.0 - 174.6	Terrigenous mudstone with minor laminae of quartz sand, olive-gray 5Y 4/1; mainly clay-size terrigenous mud; grains range from clay to very fine; trace to 3 percent phosphorite grains; trace interparticle porosity; very low hydraulic conductivity; abundant terrigenous mud matrix; soft when wet
174.6 - 175.0	No recovery
175.0 - 178.0	Terrigenous mudstone, olive-gray 5Y 4/1; mainly clay-size terrigenous mud; grains range from clay to very fine benthic forams between 177.5 and 178 feet; minor quartz sand; trace interparticle porosity; very low hydraulic conductivity; soft when wet; maximum flooding surface at 175 feet
178.0 - 187.5	Diatomaceous mudstone, olive-gray 5Y 4/1; mainly clay-size terrigenous mud; grains range from clay to very fine; benthic forams between 178 and 180 feet.; diatoms between 179 and 187 feet; minor quartz sand; trace interparticle porosity; very low hydraulic conductivity; soft when wet; gradational contact with quartz sand below
187.5 - 188.5	Quartz sand, olive-gray 10YR 6/2, mainly clay-size terrigenous mud and very fine quartz sand; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity; abundant terrigenous mud matrix; abundant bioturbation; soft
188.5 - 193.5	Quartz sand, olive-gray 10YR 6/2; mainly very fine quartz sand; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity; abundant terrigenous mud matrix; abundant bioturbation; soft
193.5 - 194.5	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity; abundant terrigenous mud matrix; abundant bioturbation; soft
194.5 - 195.0	No recovery
195.0 - 197.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity; abundant terrigenous mud matrix; abundant bioturbation; soft
197.0 - 200.0	Quartz sand, pale-olive 10Y 6/2; mainly very fine quartz sand; grains range from clay to very fine; trace to 3 percent phosphorite grains; 5 percent interparticle porosity; low hydraulic conductivity; abundant terrigenous mud matrix; abundant bioturbation; soft

Bass Core

Florida Geological Survey well number	**W-17977**
Well number	**C-1140**
Total depth	**200 feet**
Cored from	**0 to 200 feet**
County	**Collier**
Location	**NE, NW, sec. 5, T52S, R31E**
Latitude	**25°58′32″**
Longitude	**81°14′31″**
Elevation	**8 feet**
Completion date	**March 25, 1997**
Other types of available logs	**Gamma ray, induction, neutron, fluid velocity, fluid conductivity**
Owner	**U.S. Geological Survey**
Driller	**U.S. Geological Survey**
Core described by	**Kevin J. Cunningham, with modifications by Ronald S. Reese**
Undifferentiated sand, terrigenous mudstone and limestone	**0 to 8.5 feet**
Tamiami formation, Ochopee Limestone Member	**8.5 to 61 feet**
Unnamed Formation	**61 to 200 feet**
Water-table aquifer	**0 to 2.5 feet**
Upper confining unit	**2.5 to 8.5 feet**
Gray limestone aquifer	**8.5 to 55 feet**
Lower confining unit	**55 to 200 feet**

Depth (feet below land surface)	Lithologic description of well C-1140
0.0 - 2.5	Quartz sand with minor limestone clasts, pale-yellowish-brown 10YR 6/2; mainly fine grain size; ranges from clay to coarse; 20 percent interparticle porosity; moderate hydraulic conductivity
2.5 - 2.9	Mudstone, dark-yellowish-brown 10YR 4/2l; mainly clay grain size; ranges from clay to coarse; 5 percent interparticle; very low hydraulic conductivity
2.9 - 3.5	Quartz sand with limestone clasts, dark-yellowish-brown 10YR 4/2; mainly fine grain size; ranges from clay to coarse; 15 percent interparticle; low hydraulic conductivity
3.5 - 7.0	No recovery
7.0 - 8.5	Quartz sand, dark-yellowish-brown 10YR 4/2; mainly fine grain size; ranges from clay to coarse; 15 percent interparticle; low hydraulic conductivity
8.5 - 9.0	Mechanically broken mollusk lime rudstone, very pale orange 10YR 8/2; clay to coarse grain size; 10 percent vuggy(?) porosity; moderate hydraulic conductivity
9.0 - 10.0	No recovery
10.0 - 10.5	Mechanically broken molluscan limestone, white N9; clay to coarse grain size; 10 percent vuggy(?); low to high hydraulic conductivity
10.5 - 15.0	Skeletal fragment molllusk lime floatstone with well-washed skeletal lime packstone matrix, white N9 to very pale orange 10YR 8/2; clay to pebble grain size;10 percent interparticle and moldic porosity; moderate hydraulic conductivity
15.0 - 20.0	No recovery
20.0 - 23.5	Skeletal fragment mollusk lime floatstone with well-washed skeletal lime packstone matrix, white N9 to very pale orange 10YR 8/2; clay to pebble grain size; range from clay to pebble; 10 percent interparticle and moldic porosity; moderate hydraulic conductivity
23.5 - 25.0	No recovery
25.0 - 28.0	Skeletal fragment mollusk lime floatstone with well-washed skeletal lime packstone matrix, white N9 to very pale orange 10YR 8/2; clay to pebble grain size; barnacle and bryozoans; 10 percent interparticle and moldic porosity; moderate hydraulic conductivity
28.0 - 31.9	Skeletal fragment mollusk lime floatstone with well-washed skeletal lime packstone matrix, white N9 to very pale orange 10YR 8/2; clay to pebble grain size; barnacle and bryozoans; trace to 3 percent phosphorite grains; 10 percent interparticle and moldic porosity; moderate hydraulic conductivity
31.9 - 35.0	No recovery
35.0 - 37.5	Skeletal fragment mollusk lime floatstone with well-washed skeletal lime packstone matrix; white N9 to very pale orange 10YR 8/2; clay to pebble grain size; barnacle and bryozoans; trace to 3 percent phosphorite grains; 10 percent interparticle and moldic porosity; moderate hydraulic conductivity
37.5 - 39.0	Mollusk lime floatstone with well-washed skeletal lime packstone matrix with minor medium quartz sand, medium-gray N6 to light-gray N7; mainly clay to pebble grain size; trace to 3 percent phosphorite grains; 10 percent porosity; moderate hydraulic conductivity
39.0 - 40.0	No recovery
40.0 - 43.5	Mollusk lime floatstone with well-washed skeletal lime packstone matrix with minor medium quartz sand, medium-gray medium N6 to light-gray N7; mainly clay to pebble; trace to 3 percent phosphorite grains; 10 percent porosity; moderate hydraulic conductivity
43.5 - 50.0	No recovery
50.0 - 53.0	Mollusk lime floatstone with well-washed skeletal lime packstone matrix with minor medium quartz sand, very light gray N8 and yellowish-gray 5Y 8/1; mainly clay to pebble grain size; trace to 3 percent phosphorite grains; 10 percent porosity; low to moderate hydraulic conductivity; clay rich
53.0 - 55.0	Mollusk lime floatstone with well-washed skeletal lime packstone matrix with minor medium quartz sand, very light gray N8 and yellowish-gray 5Y 8/1; mainly clay to pebble; trace to 3 percent phosphorite grains; 10 percent porosity; moderate hydraulic conductivity; clay rich
55.0 - 58.0	Mollusk lime floatstone with skeletal lime packstone matrix with minor to abundant medium quartz sand; very light gray N8 and yellowish-gray 5Y 8/1; mainly clay to pebble grain size; trace to 3 percent phosphorite grains; 10 percent interparticle and moldic porosity; low to moderate hydraulic conductivity
58.0 - 60.0	No recovery
60.0 - 61.0	Mollusk lime floatstone with skeletal lime packstone matrix with minor to abundant medium quartz sand, very light gray N8 and yellowish-gray 5Y 8/1; mainly clay to pebble; trace to 3 percent phosphorite grains; 10 percent interparticle and moldic porosity; moderate hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1140
61.0 - 64.0	Quartz sand, very pale orange 10YR 8/2; mainly medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity; pebble-size discoid quartz between 63 and 68.8 feet
64.0 - 65.0	No recovery
65.0 - 69.0	Quartz sand, very pale orange 10YR 8/2; mainly medium grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity
69.0 - 70.0	No recovery
70.0 - 74.0	Quartz sand, very pale orange 10YR 8/2; mainly medium grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity
74.0 - 75.0	No recovery
75.0 - 78.0	Quartz sand, very pale orange 10YR 8/2; mainly medium grain size; ranges from silt to coarse; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity; abrupt contact at 77.8 feet
78.0 - 80.0	No recovery
80.0 - 81.0	Quartz sand, very pale orange 10YR 8/2; mainly coarse to granule; ranges from silt to pebble; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity; abrupt contact at 81 feet
81.0 - 82.0	Quartz sand, very pale orange 10YR 8/2; mainly medium to coarse grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity
82.0 - 83.0	Quartz sand, very light gray N8; mainly medium to coarse grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity
83.0 - 85.0	No recovery
85.0 - 88.0	Quartz sand, pale-yellowish-brown 10YR 6/2; mainly medium to coarse grain size; ranges from silt to granule; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity
88.0 - 89.5	Quartz sand, very light gray N8 to white N9; mainly medium to coarse grain size; ranges from silt to granule; 3 to 10 percent phosphorite grains; 15 percent interparticle porosity; moderate to high hydraulic conductivity
89.5 - 90.0	No recovery
90.0 - 95.0	Quartz sand, very light gray N8; mainly medium to granule grain size; ranges from silt to pebble; 3 to 10 percent phosphorite grains; trace muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
95.0 - 97.0	Quartz sand, yellowish-gray 5Y 8/1; mainly medium grain size; ranges from silt to granule; 3 to 10 percent phosphorite grains; trace muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
97.0 - 100.0	No recovery
100.0 - 103.0	Quartz sand, yellowish-gray 5Y 8/1; mainly fine grain size; ranges from silt to fine; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
103.0 - 104.0	Quartz sand, yellowish-gray 5Y 8/1; mainly coarse to pebble grain size; ranges from silt to pebble; 3 to 10 phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity; abrupt contact at 104 feet
104.0 - 106.7	Quartz sand, yellowish-gray 5Y 8/1; mainly fine to medium grain size; ranges from silt to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
106.7 - 107.2	Quartz sand, yellowish-gray 5Y 8/1; mainly fine to medium and granule to pebble grain size; ranges from silt to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity; abrupt contact at 107.2 feet
107.2 - 109.5	Quartz sand, yellowish-gray 5Y 8/1; mainly medium grain size; ranges from silt to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
109.5 - 110.0	No recovery
110.0 - 111.0	Quartz sand,yellowish-gray 5Y 8/1; mainly fine to pebble grain size; ranges from silt to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity; three very thin beds containing pebble-size quartz sand fining upward to fine quartz sand; abrupt contact at 111 feet
111.0 - 114.0	Quartz sand, yellowish-gray 5Y 8/1; mainly coarse to granule grain size; ranges from silt to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
114.0 - 115.0	No recovery
115.0 - 119.0	Quartz sand, yellowish-gray 5Y 8/1; mainly coarse to granule grain size; ranges from silt to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
119.0 - 123.5	No recovery
123.5 - 126.8	Quartz sand, yellowish-gray 5Y 8/1; mainly fine grain size; ranges from very fine to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1140
126.8 - 128.5	No recovery
128.5 - 133.5	Quartz sand, yellowish-gray 5Y 8/1; mainly fine grain size; ranges from very fine to pebble at top and very fine to granule at top; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate to high hydraulic conductivity
133.5 - 135.0	No recovery
135.0 - 147.0	Quartz sand, yellowish-gray 5Y 7/2; mainly fine; ranges from very fine to coarse; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate hydraulic conductivity abrupt contact at 147 feet.; three very thin beds containing very fine to pebble-size quartz sand
147.0 - 148.5	Quartz sand, yellowish-gray 5Y 7/2; mainly fine grain size; ranges from very fine to coarse; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate hydraulic conductivity
148.5 - 149.5	Quartz sand, yellowish-gray 5Y 7/2; mainly fine and granule to pebble grain size; ranges from very fine to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate hydraulic conductivity
149.5 - 150.0	No recovery
150.0 - 153.5	Quartz sand, yellowish-gray 5Y 7/2; mainly fine grain size; ranges from very fine to pebble; 3 to 10 percent phosphorite grains; minor muscovite; 15 percent interparticle porosity; moderate hydraulic conductivity
153.5 - 159.0	Quartz sand; yellowish-gray 5Y 7/2; mainly fine and cobble grain size; ranges from very fine to cobble; 3 to 10 percent phosphorite grains; minor mollusks from 157 to 159 feet; 15 percent interparticle porosity; moderate hydraulic conductivity; up to cobble-size clay-rich sand clasts
159.0 - 160.0	No recovery
160.0 - 160.5	Quartz sand, yellowish-gray 5Y 7/2; mainly fine and cobble grain size; ranges from very fine to cobble; 3 to 10 percent phosphorite grains; minor mollusks; 15 percent interparticle porosity; moderate hydraulic conductivity; up to cobble-size clay-rich sand clasts; abrupt contact at 160.5 feet
160.5 - 164.0	Quartz sand, yellowish-gray 5Y 8/1; mainly medium grain size; ranges from very fine to pebble; 3 to 10 percent phosphorite grains; minor mollusks; 20 percent interparticle porosity; moderate to high hydraulic conductivity
164.0 - 164.5	Quartz sand, yellowish-gray 5Y 8/1; mainly medium to pebble grain size; ranges from fine to pebble; 3 to 10 percent phosphorite grains; minor mollusks; 20 percent interparticle porosity; moderate to high hydraulic conductivity; abrupt contact at 164.5 feet
164.5 - 167.5	Quartz sand, yellowish-gray 5Y 7/2 to light-olive-gray 5Y 5/2; fine to cobble grain size; 3 to 10 percent phosphorite grains; minor mollusks; 10 percent interparticle porosity; low hydraulic conductivity; abundant cobble-size sand-rich mudstone clasts
167.5 - 169.0	Quartz sand, yellowish-gray 5Y 8/1; mainly fine to cobble grain size; 3 to 10 percent phosphorite grains; abundant mollusks; 15 percent interparticle porosity; low hydraulic conductivity; abundant cobble-size sand-rich mudstone clasts
169.0 - 172.0	Quartz sand, yellowish-gray 5Y 7/2; mainly fine to cobble grain size; 3 to 10 percent phosphorite grains; abundant mollusks; 15 percent interparticle porosity; low hydraulic conductivity
172.0 - 174.5	Quartz sand; yellowish-gray 5Y 7/2; mainly fine to cobble grain size; 3 to 10 percent phosphorite grains; 15 percent interparticle porosity; low hydraulic conductivity; bioturbated
174.5 - 175.0	No recovery
175.0 - 194.5	Quartz sandstone, yellowish-gray 5Y 7/2; mainly very fine to fine grain size; ranges from clay to fine; 3 to 10 percent phosphorite grains; 15 percent interparticle porosity; low hydraulic conductivity; highly bioturbated; soft; very minor clay matrix
194.5 - 195.0	No recovery
195.0 - 196.0	Quartz sandstone, yellowish-gray 5Y 7/2; mainly very fine to fine grain size; ranges from clay to fine; 3 to 10 percent phosphorite grains; 15 percent interparticle porosity; low hydraulic conductivity; highly bioturbated; soft; very minor clay matrix
196.0 - 200.0	Quartz sandstone, yellowish-gray 5Y 7/2; mainly very fine grain size; ranges from clay to fine; 3 to 10 percent phosphorite grains; 15 percent interparticle porosity; low hydraulic conductivity; highly bioturbated; soft; very minor clay matrix

Bear Island Campground Core

Florida Geological Survey well number	W-17746
Well number	C-1141
Total depth	207 feet
Cored from	0 to 207 feet
County	Collier
Location	SE, SW, sec. 29, T49S, R31E
Latitude	26°10′58″
Longitude	81°14′52″
Elevation	15 feet
Completion date	June 14, 1997
Other types of available logs	Caliper, spontaneous potential, short normal resistivity, long normal resistivity, single point resistivity, gamma ray, neutron, conductivity
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham (0-79 feet) and Ronald S. Reese and Scott T. Prinos (79-207 feet)
Soil and quartz sand	0 to 2 feet
Lake Flirt Marl	2 to 4 feet
Tamiami Formation, Pinecrest Sand Member	4 to 20.5 feet
Tamiami Formation, Ochopee Limestone Member	20.5 to 71 feet
Unnamed formation	71 to 150 feet
Peace River Formation	150 to 207 feet
Upper confining unit	0 to 20.5 feet
Gray limestone aquifer	20.5 to 71 feet
Lower confining unit	71 to 85 feet
Unnamed sand aquifer	85 to 125 feet
Confining unit	125 to 207 feet

Depth (feet below land surface)	Lithologic description of well C-1141
0.0 - 1.0	Quartz sand-rich soil with grass, dark-yellowish-brown 10YR 4/2; mainly very fine to fine quartz sand; minor terrigenous clay; well sorted quartz sand; angular to subangular quartz sand; abundant organics and plant roots; 15 percent intergrain porosity; low hydraulic conductivity; minor clay matrix; soft when wet; friable
1.0 - 2.0	Quartz sand, dark-yellowish-brown 10YR 4/2; mainly very fine to fine quartz sand; minor terrigenous clay; well sorted quartz sand; angular to subangular quartz sand; plant roots; 10 percent intergrain porosity; low hydraulic conductivity; minor terrigenous clay matrix; soft when wet; friable
2.0 - 4.0	Quartz sand with marl matrix, very light-gray N8; yellowish-gray 5Y 8/1; mainly clay-size marl and very fine to fine quartz sand; well sorted; angular to subangular; minor pelecypods; less than 5 percent porosity; very low hydraulic conductivity; soft when wet
4.0 - 4.5	Rubble of quartz sand-rich skeletal lime wackestone, moderate-yellowish-brown 10YR 5/4, dark-yellowish-brown 10YR 6/6, grayish-orange 10YR 7/4, pale-yellowish-orange 10YR 8/6; mainly clay-size lime mudstone and very fine and fine quartz sand; minor medium sand- to pebble-size fossils; well sorted; angular to subangular; skeletal fragments; greater than 5 percent vuggy porosity; low hydraulic conductivity; very hard when wet
4.5 - 6.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor terrigenous clay and medium sand to pebble-size fossils; very well sorted; angular to subangular; 10 percent skeletal fragments and pelecypods; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet
6.0 - 6.5	No recovery
6.5 - 10.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor terrigenous clay and medium sand to pebble-size fossils; very well sorted; angular to subangular; 10 percent skeletal fragments and pelecypods; trace black N1 phosphorite grains and heavy minerals; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet
10.5 - 11.0	No recovery
11.0 - 11.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor terrigenous clay and medium sand to pebble-size fossils; very well sorted; angular to subangular; 10 percent skeletal fragments and pelecypods; trace black N1 phosphorite grains and heavy minerals; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet
11.5 - 15.0	No recovery
15.0 - 15.5	Marl, yellowish-gray 5Y 8/1; mainly clay-size marl; minor pebble-size fossils; 15 percent pelecypods and barnacles; trace black N1 phosphorite grains and heavy minerals; 5 percent intergrain porosity; very low hydraulic conductivity; soft when wet
15.5 - 20.0	No recovery
20.0 - 20.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor terrigenous clay and medium sand to pebble-size fossils; very well sorted; angular to subangular; 30 percent skeletal fragments, pelecypods, barnacles and oysters; trace black N1 phosphorite grains and heavy minerals; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet
20.5 - 21.0	Pelecypod lime floatstone with skeletal, *Vermicularia* grain-dominated lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly very fine to coarse fossils; minor clay-size lime mudstone, silt and granule to pebble-size fossils, and very fine quartz sand and phosphorite grains; very well sorted; angular to subangular; skeletal fragments, *Vermicularia*, pelecypods; 5 percent quartz sand; trace black N1 phosphorite grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
21.0 - 25.0	No recovery
25.0 - 26.0	Pelecypod lime floatstone with skeletal, bryozoan, grain-dominated, lime grainstone matrix, yellowish-gray 5Y 8/1, very light gray N8; mainly very fine to coarse fossils; minor granule to pebble-size fossils and very fine quartz sand and phosphorite grains; very well sorted; skeletal fragments, branching bryozoans, pelecypods, barnacles, and *Pecten*; trace quartz sand; trace black N1 phosphorite and heavy mineral grains; 25 percent intergrain, moldic, and bored porosity; high hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
26.0 - 30.0	No recovery
30.0 - 31.0	Pelecypod lime floatstone with skeletal lime grainstone and grain-dominated lime packstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to coarse fossils; minor clay-size lime mudstone, granule to pebble-size fossils and very fine quartz sand and phosphorite grains; very well sorted; angular to subangular; skeletal fragments, pelecypods, branching bryozoans, barnacles, trace quartz sand; trace black N1 phosphorite and heavy mineral grains; 25 percent intergrain, moldic, and bored porosity; high hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
31.0 - 33.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1141
33.0 - 34.0	Skeletal lime grainstone and grain-dominated lime packstone matrix, light-gray N7 to very light N8, yellowish-gray 5Y 8/1 mainly very fine to coarse fossils; minor clay-size lime mudstone, granule to pebble-size fossils and very fine to coarse quartz sand and phosphorite grains; very well sorted; angular to subangular; skeletal fragments, pelecypods, branching bryozoans, sand dollars, barnacles, 5 percent quartz sand; trace black N1 phosphorite and heavy mineral grains; 25 percent intergrain, moldic, and bored porosity; high hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
34.0 - 36.0	No recovery
36.0 - 37.0	Skeletal lime grainstone and grain-dominated lime packstone matrix, medium-light-gray N6 to very light gray N8 to yellowish-gray 5Y 8/1; mainly very fine to coarse fossils; minor clay-size lime mudstone, granule to pebble-size fossils and very fine to coarse quartz sand and phosphorite grains; moderately sorted; angular to subrounded; skeletal fragments, pelecypods, branching bryozoans, sand dollars, barnacles, gastropods; 5 percent quartz sand; trace black N1 phosphorite and heavy mineral grains; 25 percent intergrain, moldic, and bored porosity; high hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
37.0 - 38.5	No recovery
38.5 - 39.8	Pelecypod lime floatstone with skeletal lime grainstone and skeletal, grain-dominated, lime packstone matrix, medium-light gray N6 to very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to coarse fossils; minor clay-size lime mudstone, granule to pebble-size fossils, very fine to coarse quartz sand, very fine to fine sand-size phosphorite, and very fine sand-size heavy mineral grains; moderately sorted; angular to subrounded; skeletal fragments, pelecypods, encrusting bryozoans, serpulids, 10 percent quartz sand; 1 percent black N1 phosphorite grains; trace heavy mineral grains; 25 percent intergrain, moldic, and bored porosity; high hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
39.8 - 41.0	No recovery
41.0 - 42.5	Pelecypod lime floatstone with quartz sand-rich, skeletal, grain-dominated and mud-dominated lime packstone matrix, medium-gray N5 to very light gray N8, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone and very fine to coarse fossils; minor granule to pebble-size fossils, very fine to coarse quartz sand, very fine to very coarse sand-size phosphorite, and very fine sand-size heavy mineral grains; moderately sorted; angular to subrounded; skeletal fragments, pelecypods, encrusting bryozoans, 40 percent quartz sand; 1 to 3 percent black N1 phosphorite grains; trace heavy mineral grains; 25 percent intergrain, moldic, and bored porosity; high hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
42.5 - 44.0	No recovery
44.0 - 44.8	Pelecypod-rich quartz sandstone, medium-dark-gray N4 to medium-gray N5; mainly clay-size lime mudstone, very fine to fine quartz sand and granule to pebble-size fossils; minor medium to coarse sand-size fossils; very fine to very coarse sand size phosphorite, and very fine sand-size heavy mineral grains; well sorted; angular to subangular; 40 percent skeletal fragments, pelecypods, sand dollars, and barnacles; 59 percent quartz sand; 1 to 3 percent black N1 phosphorite grains; trace heavy mineral grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; middle carbonate ramp; moderate to hard when wet; moderate to well cemented
44.8 - 50.0	No recovery
50.0 - 51.0	Pelecypod lime floatstone with quartz sand-rich, skeletal lime grainstone matrix, medium-dark-gray N4 to medium-gray N5 between 50.0 and 50.1 feet, light-gray N7 to very light gray N8 and yellowish-gray 5Y 8/1 between 50.1 and 51.0 feet; mainly very fine to fine quartz sand and granule to pebble-size fossils; minor medium to coarse sand-size fossils, very fine to fine sand-size phosphorite, and very fine sand-size heavy mineral grains; well sorted; angular to subrounded; skeletal fragments, pelecypods, and barnacles; 45 percent quartz sand; 1 percent black N1 phosphorite grains; trace heavy mineral grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; middle carbonate ramp; hard when wet; well cemented
51.0 - 52.0	No recovery
52.0 - 55.2	Pelecypod lime floatstone with quartz sand-rich, skeletal lime grainstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and granule to pebble-size fossils; minor medium to coarse sand-size fossils, very fine to fine sand-size phosphorite, and very fine sand-size heavy mineral grains; well sorted; angular to subrounded; skeletal fragments, pelecypods, barnacles, *Vermicularia*, encrusting bryozoans, gastropods and serpulids; 45 percent quartz sand; 1 percent black N1 phosphorite grains; trace heavy mineral grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; middle carbonate ramp; hard when wet; well cemented

Depth (feet below land surface)	Lithologic description of well C-1141
55.2 - 58.0	Pelecypod-rich quartz sandstone, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and granule to pebble-size fossils; minor clay-size lime mudstone matrix, medium to very coarse quartz sand, medium to coarse sand-size fossils, very fine to fine sand-size phosphorite; trace medium to very coarse sand- size phosphorite grains and very fine sand-size heavy mineral grains; well sorted; angular to subrounded; skeletal fragments, pelecypods, barnacles, *Vermicularia*, and bryozoans; 45 percent quartz sand; 1 percent black N1 phosphorite grains; trace heavy mineral grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; middle mixed siliciclastic-carbonate ramp; hard when wet; well cemented
58.0 - 59.0	No recovery
59.0 - 60.0	Pelecypod-rich quartz sandstone, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and granule to pebble-size fossils; minor clay-size lime mudstone matrix, medium to very coarse quartz sand, medium to coarse sand-size fossils, very fine to fine sand-size phosphorite; trace medium to very coarse sand-size phosphorite grains and very fine sand-size heavy mineral grains; well sorted; angular to subrounded; pelecypods, skeletal fragments, barnacles, and bryozoans; 45 percent quartz sand; 1 percent black N1 phosphorite grains; trace heavy mineral grains, 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; middle mixed siliciclastic-carbonate ramp; hard when wet; well cemented
60.0 - 61.0	No recovery
61.0 - 61.5	Pelecypod-rich quartz sandstone, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and granule to pebble-size fossils; minor medium to very coarse quartz sand, medium to coarse sand-size fossils; very fine to medium sand-size phosphorite; trace coarse to very coarse sand-size phosphorite grains and very fine sand-size heavy minerals; well sorted; angular to subrounded; 30 percent pelecypods, encrusting bryozoans, serpulids, and barnacles; 45 percent quartz sand; 5 percent black N1 phosphorite grains; trace heavy mineral grains; 20 percent intergrain, moldic, and bored porosity; moderate hydraulic conductivity; middle mixed siliciclastic-carbonate ramp; hard when wet; well cemented
61.5 - 64.0	No recovery
64.0 - 64.2	Rubble of large oyster with lithology from 61 to 61.5 feet
64.2 - 65.8	No recovery
65.8 - 65.9	Rubble of large oyster with lithology from 61 to 61.5 feet
65.9 - 67.0	No recovery
67.0 - 68.0	Quartz sandstone interbedded with pelecypod moldic-rich quartz sandstone, very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor clay-size lime mudstone to no lime mudstone, medium sand to small pebble-size quartz sand, medium sand- to pebble-size fossils, very fine to medium sand-size phosphorite; trace coarse to very coarse sand-size phosphorite grains and very fine sand-size heavy mineral grains; well sorted; angular to subrounded; up to 40 percent pelecypod molds; 5 percent black N1 phosphorite grains; trace heavy mineral grains; 20 percent intergrain, moldic, and bored porosity; moderate hydraulic conductivity; middle mixed siliciclastic-carbonate ramp; moderately hard to hard when wet; moderately to well cemented; minor small pebble-size discoid quartz grains
68.0 - 68.7	No recovery
68.7 - 70.1	Pelecypod moldic-rich quartz sandstone, very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium sand to small pebble-size quartz sand, very coarse sand to large pebble-size fossils, very fine to fine sand-size phosphorite; trace medium sand to small pebble-size phosphorite grains and very fine sand-size heavy mineral grains; moderately sorted; angular to rounded, abundant pelecypods, gastropods, and serpulids; 3 percent black N1 phosphorite grains; trace heavy minerals; 20 percent intergrain, moldic, and bored porosity; moderately hydraulic conductivity; middle mixed siliciclastic-carbonate ramp; moderately hard to hard when wet; moderate to well cemented
70.1 - 70.8	No recovery
70.8 - 71.0	Pelecypod moldic-rich quartz sandstone, very light gray N8, yellowish-gray 5Y 8/1; mainly very fine sand to small pebble-size quartz sand and lime mudstone matrix; minor medium sand to large pebble-size fossils, very fine sand-size phosphorite, trace fine sand to small pebble-size phosphorite grains and very fine sand-size heavy mineral grains; moderately sorted; angular to rounded; 30 percent pelecypod molds; 10 percent black N1 phosphorite grains; trace heavy mineral grains; 15 percent intergrain and moldic porosity; moderate hydraulic conductivity; middle mixed siliciclastic-carbonate ramp; moderately hard to hard when wet; moderate to well cemented
71.0 - 79.0	No recovery
79.0 - 79.1	Quartz sand, light-gray N7 to medium-light-gray N6; mainly very fine grain size; ranges from very fine to granule; trace to 3 percent phosphorite grains; low hydraulic conductivity
79.1 - 81.0	No recovery
81.0 - 81.3	Quartz sand, medium-gray N5 to greenish-gray 5GY 6/1; mainly very fine grain size; ranges from clay to pebble; poorly sorted; trace to 3 percent phosphorite grains; low hydraulic conductivity
81.3 - 83.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1141
83.0 - 84.3	Quartz sand, medium-gray N5 to greenish-gray 5GY 6/1; mainly very fine grain size; ranges from clay to pebble; poorly sorted; trace to 3 percent phosphorite grains; low hydraulic conductivity
84.3 - 85.0	Quartz sand; medium-gray N5 to greenish-gray 5GY 6/1; mainly fine and coarse grain size; ranges from very fine to granule; trace to 3 percent phosphorite grains; moderate hydraulic conductivity
85.0 - 85.5	No recovery
85.5 - 87.0	Quartz sand, light-greenish-gray 5GY 8/1; bimodal, mainly fine and coarse grain size; ranges from very fine to granule; trace to 3 percent phosphorite grains; moderate hydraulic conductivity
87.0 - 88.0	No recovery
88.0 - 90.0	Quartz sand, light-gray N7; bimodal, mainly fine and coarse to granule grain size; ranges from fine to granule; trace to 3 percent phosphorite grains; moderate hydraulic conductivity
90.0 - 90.7	Quartz sand, light-gray N7; bimodal, mainly very fine to fine and coarse to granule; ranges from fine to granule; trace to 3 percent phosphorite grains; moderate hydraulic conductivity
90.7 - 93.0	No recovery
93.0 - 94.0	Quartz sand, brownish-gray 5YR 4/1; mainly coarse to granule grain size; trace to 3 percent phosphorite grains; moderate to high hydraulic conductivity
94.0 - 95.0	Quartz sand, brownish-gray 5YR 4/1; mainly fine grain size; ranges from very fine to fine; trace to 3 percent phosphorite grains; low hydraulic conductivity
95.0 - 96.0	Quartz sand, brownish-gray 5YR 4/1; mainly coarse to granule grain size; ranges from medium to granule; trace to 3 percent phosphorite grains; high hydraulic conductivity
96.0 - 97.3	Quartz sand, brownish-gray 5YR 4/1; mainly coarse to granule; ranges from fine to granule; trace to 3 percent phosphorite grains; moderate to high hydraulic conductivity
97.3 - 98.0	No recovery
98.0 - 99.8	Quartz sand, brownish-gray 5YR 4/1; ranges from fine to granule; trace to 3 percent phosphorite grains; moderate hydraulic conductivity
99.8 - 101.0	No recovery
101.0 - 102.0	Quartz sand, brownish-gray 5YR 4/1; very fine to granule grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity
102.0 - 103.5	Quartz sand, brownish-gray 5YR 4/1; silt to coarse grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity
103.5 - 104.0	No recovery
104.0 - 104.5	Quartz sand, brownish-gray 5YR 4/1; mainly very fine to pebble grain size; ranges from clay to pebble; trace to 3 percent phosphorite grains; moderate to high hydraulic conductivity
104.5 - 105.7	Quartz sand, brownish-gray 5YR 4/1; mainly very fine to pebble grain size; ranges from clay to pebble; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity
105.7 - 107.0	No recovery
107.0 - 109.0	Quartz sand, brownish-gray 5YR 4/1; mainly very fine grain size; ranges from very fine to coarse; trace to 3 percent phosphorite grains; low hydraulic conductivity
109.0 - 110.0	No recovery
110.0 - 111.0	Quartz sand, brownish-gray 5YR 4/1; bimodal, mainly very fine and granule; ranges from very fine to pebble; trace to 3 percent phosphorite grains; moderate hydraulic conductivity
111.0 - 113.0	Quartz sand, brownish-gray 5YR 4/1; bimodal, mainly very fine and coarse; ranges from very fine to coarse; common shell fragments; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity
113.0 - 114.5	Quartz sand, medium-gray N6; mainly very fine grain size; ranges from very fine to coarse; common shell fragments; 3 to 10 percent phosphorite grains; low hydraulic conductivity
114.5 - 115.0	No recovery
115.0 - 116.6	Quartz sand, medium-gray N6; mainly very fine grain size; ranges from very fine to coarse; common shell fragments; trace to 10 percent phosphorite grains; low to moderate hydraulic conductivity
116.6 - 118.0	No recovery
118.0 - 119.0	Quartz sand, medium-gray N6; mainly fine to coarse grain size; common shell fragments; 3 to 10 percent phosphorite grains; low to moderate hydraulic conductivity

Depth (feet below land surface)	Lithologic description of well C-1141
119.0 - 120.0	Quartz sand, medium-gray N6; ranges from very fine to coarse; common shell fragments; trace to 3 percent phosphorite grains; low hydraulic conductivity
120.0 - 124.0	No recovery
124.0 - 126.9	Quartz sand, medium-gray N6; mainly very fine grain size; ranges from clay to fine; trace to 3 percent phosphorite grains; low hydraulic conductivity; minor clay matrix
126.9 - 127.0	No recovery
127.0 - 129.0	Quartz sand, medium-gray N6; ranges from clay to fine; trace to 3 percent phosphorite grains; low hydraulic conductivity; minor clay matrix
129.0 - 129.5	No recovery
129.5 - 130.0	Quartz sand and calcareous clay, medium-gray N6; clay to fine grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity; clay matrix
130.0 - 131.5	Quartz sand, light-grayish-tan; mainly fine grain size; ranges from clay to fine; trace to 3 percent phosphorite grains; low hydraulic conductivity; calcareous clay matrix
131.5 - 132.0	No recovery
132.0 - 134.0	Quartz sand, grayish-tan; mainly fine grain size; ranges from clay to fine; low hydraulic conductivity; calcareous clay matrix
134.0 - 135.0	Quartz sand, light-grayish-tan; mainly very fine grain size; ranges from clay to very fine; very low to low hydraulic conductivity; calcareous clay matrix
135.0 - 137.0	No recovery
137.0 - 142.0	Quartz sand-rich calcareous clay, light-grayish-tan; mainly clay and very fine grain size; ranges from clay to very fine; very low to low hydraulic conductivity
142.0 - 150.0	Quartz sand, mottled dark-green; mainly fine grain size; ranges from clay to fine; low hydraulic conductivity; abundant clay matrix
150.0 - 151.0	Quartz sand, mottled dark-green; mainly clay to fine grain size; very low hydraulic conductivity; abundant clay matrix
151.0 - 160.0	Clay-rich quartz sand, mottled green; mainly clay and fine grain size; ranges from clay to coarse; trace to 3 percent phosphorite grains; very low hydraulic conductivity; abundant clay matrix
160.0 - 181.0	Clay-rich quartz sand, mottled green; mainly clay and fine grain size; ranges from clay to coarse; very low hydraulic conductivity; abundant clay matrix
181.0 - 194.0	Clay-rich quartz sand to quartz sand-rich clay; mottled green; mainly clay and fine grain size; ranges from clay to coarse; very low hydraulic conductivity; abundant clay matrix
194.0 - 199.0	Clay-rich quartz sand to quartz sand-rich clay, mottled green and light-greenish-tan; mainly clay and medium grain size; ranges from clay to coarse; shell fragments between 194.5 and 195.5 feet; very low to low hydraulic conductivity; abundant clay matrix
199.0 - 200.0	Clay-rich quartz sand, very light tannish-green; mainly clay and fine grain size; ranges from clay to fine; very low hydraulic conductivity; abundant clay matrix
200.0 - 207.0	No recovery

Noble's Farm Core

Florida Geological Survey well number	**W-17748**
Well number	**C-1142**
Total depth	**206 feet**
Cored from	**0 to 206 feet**
County	**Collier**
Location	**NW, NW, sec. 7, T49S, R33E**
Latitude	**26°14′17″**
Longitude	**81°04′24″**
Elevation	**16 feet**
Completion date	**June 12, 1997**
Other types of logs available	**Gamma ray, neutron, caliper, spontaneous potential, single point resistivity, short normal resistivity, long normal resistivity, conductivity**
Owner	**U.S. Geological Survey**
Driller	**Florida Geological Survey**
Core described by	**Scott T. Prinos (0 to 55.5 feet and 117 to 206 feet) and Kevin J. Cunningham (55.5 to 117 feet)**
Undifferentiated limestone	**0 to 3 feet**
Tamiami formation	**3 to 42 feet**
Tamiami Formation, Pinecrest Sand Member	**42 to 58.1 feet**
Tamiami Formation, Ochopee Limestone Member	**58.1 to 100 feet**
Unnamed Formation	**100 to 111 feet**
Peace River Formation	**111 to 206 feet**
Upper confining unit	**0 to 58.1 feet**
Gray limestone aquifer	**58.1 to 100 feet**
Lower confining unit	**100 to 206 feet**

Depth (feet below land surface)	Lithologic description of well C-1142
0.0 - 0.8	Soil and black limestone gravel, black N1 at top and red below; mainly clay-size mud and pebble size; ranges from mud to pebble size; 15 percent porosity; high hydraulic conductivity
0.8 - 2.0	Hard limestone caprock, gray and tan; mainly clay-size mud and pebble size; ranges from mud to pebble size; 5 to 10 percent porosity; low hydraulic conductivity
2.0 - 3.0	Rounded limestone pebbles, white N9 to brownish-red; mainly clay-size mud and pebble size; 25 percent interparticle porosity; very high hydraulic conductivity
3.0 - 3.5	Limestone gravel in a mud matrix, white N9 to brownish-red; mainly clay-size mud and granule to pebble; 5 percent interparticle porosity
3.5 - 4.0	No recovery
4.0 - 5.0	Limestone gravel, white N9; mainly granule to pebble size; 20 to 25 percent interparticle porosity
5.0 - 6.5	Carbonate mud with subangular limestone gravel, white N9; mainly clay-size mud and granule to pebble; 5 percent interparticle porosity; low hydraulic conductivity
6.5 - 7.0	No recovery
7.0 - 8.3	Limestone gravel with mud matrix, white N9 to very light gray N8, mainly clay-size mud and pebble size; 5 percent interparticle porosity; low hydraulic conductivity
8.3 - 9.5	Mixture of quartz sand and limestone gravel, white to very light gray N8; mainly fine quartz sand with minor clay-size mud and pebble-size limestone; 5 percent interparticle porosity; low hydraulic conductivity
9.5 - 12.0	No recovery
12.0 - 15.0	Quartz sand-rich carbonate mud, grayish-tan; mainly clay-size mud and medium sand-size quartz with minor pebble-size fossils; fossil fragments; 5 percent interparticle porosity; moderate to low hydraulic conductivity
15.0 - 18.0	Mixture of carbonate sand and quartz sand-rich carbonate mud, white N9 to light-grayish-tan; mainly clay-size mud and medium sand-size quartz and carbonate grains with minor pebble-size fossils; fossil fragments; 70 percent carbonate and 30 percent quartz sand-size grains; 5 percent interparticle porosity; moderate to low hydraulic conductivity; poorly cemented
18.0 - 20.0	Fossiliferous mixture of carbonate sand and quartz sand-rich carbonate mud, tannish-white; mainly clay-size mud and medium sand-size quartz and carbonate grains with minor granule and pebble-size fossils; fossil fragments; 10 percent interparticle porosity; moderate hydraulic conductivity
20.0 - 25.0	Mollusk-rich terrigenous clay, light-greenish-gray 5Y 8/1; mainly clay-size; minor medium sand to pebble-size fossils; thick-shelled mollusks (*Ostrea*?); 5 percent porosity; low hydraulic conductivity; appears conformable with lithology above
25.0 - 25.6	Mollusk fragments; mainly pebble-size mollusk fragments; 30 percent porosity; very high hydraulic conductivity
25.6- 34.0	Mollusk-rich terrigenous clay; light-greenish-gray 5Y 8/1; mainly clay-size mud with minor medium sand to pebble-size fossils; thick-shelled mollusks; 5 percent porosity; low hydraulic conductivity
34.0 - 34.3	Caved lithology
34.3 - 37.5	Mixture of limestone, fossils and quartz sand in a mud matrix, light-gray N7 to light-tan; mainly clay-size mud and granule- to pebble-size limestone and fossils; all grains range from clay to pebble size; fossils and quartz sand; 5 percent porosity; low hydraulic conductivity
37.5 - 38.0	No recovery
38.0 - 42.0	Mixture of limestone, fossils and quartz sand in a mud matrix, light-gray N7 to yellowish-gray 5Y 8/1; mainly clay-size mud and coarse sand and pebble-size fossils; ranges from clay to pebble-size grains; oysters, pelecypods, and barnacles; 5 percent porosity; low to moderate hydraulic conductivity; coarsens upward
42.0 - 46.5	Quartz sand; light-gray N7 to yellowish-gray 5Y 8/1, mainly clay-size mud and medium quartz sand; ranges from clay to pebble-size grains; skeletal fragments including *Chione*; 5 percent porosity; low to moderate hydraulic conductivity
46.5 - 51.0	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly clay-size mud and medium quartz sand; ranges from clay to pebble-size grains; skeletal fragments including oysters; trace to 3 percent phosphorite grains; 5 percent porosity; low to moderate hydraulic conductivity
51.0 - 55.0	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly clay-size mud and medium quartz sand; ranges from clay to pebble-size grains; skeletal fragments including oysters and *Pecten*; trace to 3 percent phosphorite grains; 5 percent porosity; low to moderate hydraulic conductivity
55.0 - 55.5	No recovery
55.5 - 58.1	Quartz sandstone, yellowish-gray 5Y 7/2; mainly terrigenous clay and fine quartz sand; minor silt to very fine quartz sand, medium to coarse quartz sand, medium sand to large pebble-size fossils and very fine sand to small pebble-size phosphorite grains; moderately sorted; subangular to subrounded; 5 percent skeletal grains; 3 percent black N1 phosphorite and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; abundant terrigenous clay matrix; soft when wet; skeletal fragments, large quartz grains and large phosphorite grains floating in relatively fine quartz sand matrix

Depth (feet below land surface)	Lithologic description of well C-1142
58.1 - 58.8	Pelecypod lime floatstone with skeletal, grain-dominated, lime packstone and grainstone matrix, medium-dark-gray N4 to medium-light-gray N6; mainly coarse sand- to granule- and pebble-size fossils; minor clay-size lime mudstone, very fine quartz sand with subordinate and fine to coarse sand-size quartz, fine to medium sand and granule-size fossils, and very fine to coarse sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; skeletal grains, pelecypods, gastropods, sand-dollars, bryozoans (including *Cyclostomata*), and serpulids; 10 to 20 percent quartz sand; 1 percent black N1 phosphorite grains; 30 percent intergrain, skeletal, moldic, and intragrain porosity; high hydraulic conductivity; mid-ramp; moderately hard when wet; moderately cemented; upper bounding surface at 58.1 feet, probably hard ground with irregular relief (very thin) with overhanging microtopography
58.8 - 60.8	Pelecypod lime floatstone with skeletal grain-dominated lime packstone and grainstone matrix, medium-gray N5 to medium-light-gray N6; mainly coarse sand to granule and pebble-size fossils; minor clay-size lime mudstone, very fine quartz sand with subordinate silt and fine to coarse sand-size quartz, fine to medium and- and granule-size fossils, and very fine to coarse sand-size phosphorite grains; well sorted; subangular to subrounded; skeletal grains, pelecypods, gastropods, sand dollars, bryozoans (including *Cyclostomata*), and serpulids; 10 to 20 percent quartz sand; 1 percent black N1 phosphorite grains; 30 percent intergrain, skeletal, moldic, and intragrain porosity; high hydraulic conductivity; mid-ramp; moderately hard when wet; moderately cemented
60.8 - 63.5	Pelecypod lime floatstone with skeletal grain-dominated lime packstone and grainstone matrix, yellowish-gray 5Y 7/2; light-gray N7 to very light gray N8; mainly coarse sand to granule and pebble-size fossils; minor clay-size lime mudstone, very fine quartz sand with subordinate silt and fine to coarse sand-size quartz, fine to medium sand and granule-size fossils, and very fine to coarse sand-size phosphorite grains; well sorted; subangular to subrounded; skeletal grains, pelecypods, gastropods, sand dollars, bryozoans, and serpulids; 10 to 20 percent quartz sand; 1 percent black N1 phosphorite grains; 30 percent intergrain, skeletal, moldic, and intragrain porosity; high hydraulic conductivity; mid-ramp; moderately hard when wet; moderately cemented
63.5 - 65.0	No recovery
65.0 - 67.0	Pelecypod lime rudstone with quartz sand-rich skeletal mud-dominated lime packstone and grainstone matrix, very pale orange 10YR 8/2; light-gray N7 to very light gray N8; mainly fine sand to pebble-size fossils and very fine to fine quartz sand; minor clay-size lime mudstone and very fine to medium sand-size phosphorite grains; well sorted; subangular to subrounded; skeletal grains, pelecypods, bryozoans, gastropods, barnacles, and serpulids; 10 to 40 percent quartz sand; 1 to 3 percent black N1 phosphorite grains; 30 percent intergrain, skeletal, moldic, and intragrain porosity; high hydraulic conductivity; mid-ramp; friable to moderately hard when wet; poorly to moderately cemented; color lightens upward from 67 to 68.1 feet
67.0 - 69.0	Pelecypod lime rudstone with quartz sand-rich, skeletal, mud-dominated, lime packstone and grainstone matrix, yellowish-gray 5Y 8/1; light-gray N7 to very light gray N8; mainly fine sand- to pebble-size fossils and very fine to fine quartz sand; minor clay-size lime mudstone and very fine to medium sand-size phosphorite grains; well sorted; subangular to subrounded; skeletal grains, pelecypods, bryozoans, gastropods, barnacles, and serpulids; 10 to 40 percent quartz sand; 1 to 3 percent black N1 phosphorite grains; 30 percent intergrain, skeletal, moldic, and intragrain porosity; high hydraulic conductivity; mid-ramp; friable to moderately hard when wet; poorly to moderately cemented
69.0 - 73.0	Pelecypod lime rudstone with quartz sand-rich, skeletal, mud-dominated, lime packstone and grainstone matrix, very pale orange 10YR 8/2; very light gray N8; mainly fine sand to pebble-size fossils and very fine to fine quartz sand; minor clay-size lime mudstone and very fine to medium sand-size phosphorite grains; well sorted; subangular to subrounded; skeletal grains, pelecypods, bryozoans, gastropods, barnacles, and serpulids; 10 to 40 percent quartz sand; 1 to 3 percent black N1 phosphorite grains; 30 percent intergrain, skeletal moldic and intragrain porosity; high hydraulic conductivity; mid-ramp; friable to moderately hard when wet; poorly to moderately cemented
73.0 - 77.0	Pelecypod lime rudstone with quartz sand-rich, skeletal, grain-dominated and mud-dominated, lime packstone and skeletal quartz sandstone matrix, yellowish-gray 5Y 8/1; very light gray N8; mainly clay-size lime mudstone, fine sand to pebble-size fossils, and very fine to medium quartz sand; minor coarse quartz sand and very fine to medium sand-size phosphorite grains; moderately sorted; angular to subrounded; skeletal grains, pelecypods, bryozoans, echinoids, sand dollars, and serpulids; 20 to 60 percent quartz sand; 1 percent black N1 phosphorite grains; 25 percent skeletal, moldic, intergrain and intragrain porosity; high hydraulic conductivity; mid-ramp; lime mudstone matrix in quartz sandstone; friable to hard when wet; poorly to well cemented
77.0 - 78.0	Pelecypod lime rudstone with quartz sand-rich, skeletal, grain-dominated and mud-dominated, lime packstone and skeletal quartz sandstone matrix, yellowish-gray 5Y 8/1; very pale orange 10YR 8/2; mainly clay-size lime mudstone, fine sand to pebble-size fossils, and very fine to medium quartz sand; minor coarse quartz sand and very fine to medium sand-size phosphorite grains; moderately sorted quartz sand; angular to subrounded; skeletal grains, pelecypods, bryozoans, echinoids, sand dollars, and serpulids; 20 to 60 percent quartz sand; 1 percent black N1 phosphorite grains; 25 percent skeletal moldic; intergrain, and intragrain porosity; high hydraulic conductivity; mid-ramp; lime mudstone matrix in quartz sandstone; friable to hard when wet; poorly to well cemented
78.0 - 81.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1142
81.0 - 82.0	Pelecypod lime rudstone with quartz-rich lime mudstone, yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; mainly clay-size lime mudstone, fine sand to pebble-size fossils and fine to coarse quartz sand; minor coarse quartz sand and very fine to coarse sand-size phosphorite grains; moderately sorted; subangular to subrounded; skeletal grains, pelecypods, gastropods and *Vermicularia*; 20 to 70 percent quartz sand; 1 percent black N1 phosphorite grains; 20 percent skeletal moldic and intergrain porosity; moderate hydraulic conductivity; mid-ramp; hard when wet; well cemented; color lightens upward from 82 to 87 feet
82.0 - 84.0	No recovery
84.0 - 87.7	Pelecypod lime rudstone with quartz-rich lime wackestone and quartz sandstone, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly clay-size lime mudstone, very fine sand to pebble-size fossils and very fine to fine quartz sand; minor medium to coarse quartz sand and very fine to coarse sand-size phosphorite grains; moderately sorted; subangular to subrounded; skeletal grains, pelecypods, bryozoans, and serpulids; 20 to 70 percent quartz sand; 1 percent black N1 phosphorite grains; 20 percent skeletal, moldic porosity; moderate hydraulic conductivity; mid-ramp; hard when wet; well cemented
87.7 - 92.0	No recovery
92.0 - 95.7	Pelecypod-rich quartz sandstone, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly clay-size lime mudstone, very fine to coarse quartz sand; minor very coarse quartz sand and very fine to medium sand-size phosphorite grains; moderately sorted; subangular to subrounded; 40 percent skeletal grains, pelecypods, bryozoans, serpulids, gastropods, and sand dollars; 1 percent black N1 phosphorite grains; 20 percent skeletal, moldic, and intergrain porosity; moderate hydraulic conductivity; mid-ramp; lime mudstone matrix; hard when wet; well cemented
95.7 - 97.0	No recovery
97.0 - 98.5	Pelecypod-rich quartz sandstone, yellowish-gray 5Y 8/1, mainly medium to coarse quartz sand; minor very fine to very coarse quartz sand and very fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded; 40 percent skeletal grains, pelecypods, and bryozoans; 1 percent black N1 phosphorite grains; 20 percent skeletal, moldic, and intergrain porosity; moderate hydraulic conductivity; mid-ramp; lime mudstone matrix; hard when wet; well cemented; color lightens upward from 82 to 98.5 feet
98.5 - 101.0	No recovery
101.0 - 102.5	Pelecypod-rich quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor terrigenous clay, medium quartz sand and very fine to fine sand-size phosphorite and heavy minerals grains; moderately sorted; subangular to subrounded; skeletal grains and pelecypods; 5 percent black N1 phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; minor terrigenous clay matrix; moderately hard when wet
102.5 - 111.0	No recovery
111.0 - 113.7	Pelecypod-rich quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine quartz sand and terrigenous clay; minor very fine sand-size phosphorite, granule to pebble-size fossils and heavy minerals grains and subordinate fine to coarse sand-size phosphorite grains; very well sorted; angular to subrounded; 20 percent thin-shelled pelecypods; 20 percent black N1 phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; terrigenous clay matrix; soft when wet; poorly cemented; coarse phosphorite grains floating in quartz sand matrix
113.7 - 114.0	No recovery
114.0 - 117.0	Pelecypod-rich quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine quartz sand and terrigenous clay; minor very fine phosphorite, granule to pebble-size fossils and heavy mineral grains and subordinate fine to coarse sand size phosphorite grains; very well sorted; angular to subrounded; 20 percent thin-shelled pelecypods; 20 percent black N1 phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; terrigenous clay matrix; soft when wet; poorly cemented; coarse phosphorite grains floating in quartz sand matrix
117.0 - 120.5	Quartz sand-rich, silty clay, yellowish-gray 5Y 8/1; mainly terrigenous clay and fine quartz sand; ranges from clay to fine sand-size graoms; minor pelecypod fragments; greater than 10 percent black N1 phosphorite and heavy mineral grains; very low to low hydraulic conductivity
120.5 - 121.0	No recovery
121.0 - 125.5	Very sandy silty clay, green; mainly terrigenous clay and fine quartz sand; ranges from clay to fine sand-size grains; minor pelecypod fragments; 3 percent black N1 phosphorite and heavy mineral grains; very low to low hydraulic conductivity
125.5 - 126.0	No recovery
126.0 - 134.0	Slightly sandy clay, green; mainly terrigenous clay; ranges from clay to fine sand-size grains; trace to 3 percent black N1 phosphorite and heavy mineral grains; very low hydraulic conductivity
134.0 - 140.5	Slightly silty clay, green; mainly terrigenous clay; range from clay to silt sand-size grains; foraminifers and diatoms; very low hydraulic conductivity
140.5 - 141.0	No recovery
141.0 - 146.8	Clay, olive-green at top grading downward to light-green; mainly terrigenous clay; ranges from clay to very fine sand-size grains; ; very low hydraulic conductivity; silt content increases downward, clay grades downward to a very fine grained quartz sand with silt and clay matrix

Depth (feet below land surface)	Lithologic description of well C-1142
146.8 - 151.0	No recovery
151.0 - 156.0	Quartz sand, light-green; mainly very fine quartz sand; ranges from clay to very fine sand-size grains; very low to low hydraulic conductivity; silt and clay matrix
156.0 - 172.0	Quartz sand, light-green; mainly very fine quartz sand; ranges from clay to very fine sand-size grains; minor small skeletal fragments; very low to low hydraulic conductivity; silt and clay matrix
172.0 - 174.5	Sandy, silty clay, dark-gray-green; mainly terrigenous clay; range from clay to very fine sand-size grains; trace to 3 percent phosphorite grains; very low hydraulic conductivity
174.5 - 180.0	Sandy, silty clay, dark-gray-green; mainly terrigenous clay; ranged from clay to very fine sand-size grains; trace to 3 percent phosphorite grains; minor skeletal fragments; very low hydraulic conductivity
180.0 - 181.0	No recovery
181.0 - 185.0	Very sandy clay, dark-gray-green; mainly terrigenous clay; ranges from clay to very fine sand-size grains; trace to 3 percent phosphorite grains; very low to low hydraulic conductivity
185.0 - 188.0	Clay-rich quartz sand, mottled dark-gray-green; mainly terrigenous clay and medium quartz sand; ranges from clay to coarse sand-size grains; trace to 3 percent phosphorite grains; very low to low hydraulic conductivity
188.0 - 195.0	Clay-rich, silty quartz sand, mottled dark-gray-green; mainly fine to coarse quartz sand; ranges from clay to coarse sand- size grains; trace to 3 percent phosphorite grains; very low to low hydraulic conductivity
195.0 - 201.0	Clay-rich, silty quartz sand, mottled dark-gray-green grading to blackish-green; mainly fine to coarse quartz sand; ranges from clay to coarse sand-size grains; trace to 3 percent phosphorite grains; very low to low hydraulic conductivity; grades downward from quartz to silty clay with very fine quartz sand and thin quartz sand lenses
201.0 - 206.0	No recovery

Sunniland No. 1 Core

Florida Geological Survey well number	W-17534
GWSI number	C-1163
Total depth	815 feet
Cored from	0 to 815 feet
County	Collier
Location	SE, SW, sec. 17, T48S, R30E
Latitude	26°18′01″
Longitude	81°20′44″
Elevation	20 feet
Completion date	March 1997
Other types of available logs	Caliper, gamma ray, sonic, resistivity, density
Owner	University of Miami
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham (for a description of 207.2 to 813 feet, see Cunningham and McNeill, 1997).
Undifferentiated limestone and quartz sand	0 to 12.5 feet
Tamiami Formation, Pinecrest Sand Member	12.5 to 27 feet
Tamiami Formation, Ochopee Limestone Member	27 to 49 feet
Top of unnamed formation	49 feet
Water-table aquifer	0 to 12.5 feet
Upper confining unit	12.5 to 27 feet
Gray limestone aquifer	27 to 49 feet
Top of lower confining unit	49 feet

Depth (feet below land surface)	Lithologic description of well C-1163
0.0 - 4.0	Quartz sand, pale-yellowish-brown 10YR 6/2 and dark-yellowish-orange 10YR 6/6; mainly very fine to fine grain size; ranges from clay to fine; well sorted; subrounded to rounded; interparticle porosity; clay matrix; moderate to high hydraulic conductivity; very poor induration; loose unconsolidated sand
4.0 - 8.5	Lime rudstone with packstone matrix, grayish-orange 10YR 7/4; mainly very coarse to very large pebble size, ranges from clay to very large pebble size; bivalves and broken fossil fragments; 60 percent allochemical constituents; lime mudstone matrix; moldic, vuggy, and intraparticle porosity; moderate to high hydraulic conductivity; moderate to well induration; mostly mechanically broken rubble; poor recovery
8.5 - 10.5	No recovery
10.5 - 12.5	Lime rudstone with packstone matrix, grayish-orange 10YR 7/4; mainly very coarse to very large pebble size, ranges from clay to small pebble size; bivalves, broken fossil fragments; 60 percent allochemical constituents; lime mudstone matrix; moldic, vuggy. and intraparticle porosity; moderate to high hydraulic conductivity; moderate to well induration; mostly mechanically broken rubble; poor recovery
12.5 - 19.0	Quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine grain size; ranges from mud to very fine; well sorted; subangular to subrounded; bivalves, broken fossil fragments; 2 percent black grains; lime mud matrix; interparticle porosity; very low hydraulic conductivity; moderate induration; bioturbated
19.0 - 27.0	Quartz sand-rich lime mudstone, yellowish-gray 5Y 8/1; mainly silt to very fine grain size, ranges from clay to very fine; trace bivalves; trace allochemical constituents; 20 percent quartz sand; lime mudstone matrix; interparticle porosity; very low hydraulic conductivity; moderate induration; mottled texture due to bioturbation
27.0 - 30.0	Lime floatstone with mudstone matrix, very pale orange 10YR 8/2; bimodal, clay to large pebble size; broken fossil fragments, bivalves; 50 percent allochemical constituents; clay; mudstone matrix; moldic porosity; moderate hydraulic conductivity; poor induration; very rubbly recovery
30.0 - 35.5	Lime rudstone with lime packstone matrix, very light gray N8 and very pale orange 10YR 8/2; bimodal, mainly coarse sand and large pebble size, ranges from clay to very large pebble size; bivalves, broken fossil fragments, bryozoans; 60 percent allochemical constituents; trace heavy minerals; lime mud matrix; moldic porosity; moderate hydraulic conductivity well indurated; bioturbated; rock mainly rubble; poor recovery
35.5 - 41.0	Lime rudstone with lime packstone matrix; bimodal, mainly coarse sand and large pebble size, ranges from clay to very large pebble size; bivalves, broken fossil fragments; 60 percent allochemical constituents; trace heavy minerals; lime mud matrix; moldic porosity; moderate hydraulic conductivity; well indurated; bioturbated
41.0 - 47.0	Lime rudstone with quartz sandstone matrix, very light gray N8 and very pale orange 10YR 8/2; bimodal, mainly fine sand and large pebble size, ranges from clay to very large pebble size; bivalves; 60 percent allochemical constituents; 30 percent quartz sand; 2 percent phosphorite grains; lime mud matrix; moldic porosity; moderate hydraulic conductivity; moderate to well induration; very poor recovery
47.0 - 49.0	Lime rudstone with sandstone matrix, very light gray N8 and very pale orange 10YR 8/2; bimodal, mainly fine sand and large pebble size, ranges from clay to very large pebble size; gastropods, bivalves; 60 percent allochemical constituents; 30 percent quartz sand; 2 percent phosphorite grains; lime mud matrix; moldic porosity; moderate hydraulic conductivity; moderate to well induration
49.0 - 69.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine grain size, ranges from very fine to coarse; well sorted; subangular to rounded; trace bivalves; trace mica; less than 5 percent phosphorite grains; trace clay matrix; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery
69.0 - 77.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to coarse grain size; moderately to well sorted; subangular to rounded; less than 2 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery
77.0 - 81.0	No recovery
81.0 - 86.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to coarse grain size; moderately to well sorted; subangular to rounded; less than 2 percent phosphorite; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery
86.0 - 91.8	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine grain size, ranges from very fine to coarse; well sorted; subangular to rounded; less than 5 percent mica and less than 1 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration
91.8 - 102.6	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine grain size, ranges from very fine to fine; well sorted; subangular to rounded; trace mica; less than 5 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery

Depth (feet below land surface)	Lithologic description of well C-1163
102.6 - 103.6	No recovery
103.6 - 107.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine grain size, ranges from very fine to fine; well sorted; subangular to rounded; trace mica; less than 5 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery
107.5 - 109.0	No recovery
109.0 - 114.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine grain size, ranges from very fine to fine; well sorted; subangular to rounded; trace mica; less than 5 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery
114.5 - 115.0	No recovery
115.0 - 128.0	Quartz sand; yellowish-gray 5Y 8/1; mainly very fine grain size, ranges from very fine to very coarse; well sorted; subangular to rounded; trace mica; less than 2 percent phosphorite grains; trace clay; interparticle porosity; moderate hydraulic conductivity; poor induration; bioturbated
128.0 - 140.0	Quartz sandstone, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 5/2; mainly very fine grain size, ranges from very fine to very coarse; well sorted; subangular to rounded; trace bivalves; 1 percent mica; trace phosphorite grains; clay matrix; interparticle porosity; moderate hydraulic conductivity; moderate induration; minor layers containing very coarse sand grains floating in very fine sand
140.0 - 140.5	Lime floatstone with sandstone matrix, yellowish-gray 5Y 8/1; bimodal, very fine quartz sand to very large pebble-size fossils; well sorted; subangular to rounded; trace bivalves; trace phosphorite grains; calcite; interparticle porosity; moderate hydraulic conductivity; well indurated; recovery mainly rubble
140.5 - 154.5	Quartz sandstone, medium-light-gray N6 to very light gray N8; mainly very fine to quartz, ranges from very find sand to large pebble size; poor to moderate sorting; subangular to rounded; 10 to 20 percent bivalves; 2 percent phosphorite; clay matrix; interparticle porosity; moderate hydraulic conductivity; poor to moderate induration
154.5 - 158.0	Quartz sand, very light gray N8; fine to medium grain size, ranges from fine sand to small pebble size; moderate sorting; subangular to rounded; 5 percent bivalves; 2 percent phosphorite; interparticle porosity; moderate hydraulic conductivity; poor induration; massive and structureless
158.0 - 160.0	No recovery
160.0 - 162.5	Quartz sand, very light gray N8; mainly fine to medium grain size, ranges from fine to small pebble size; moderate sorting; subangular to rounded; broken bivalves and broken fossil fragments; 1 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery
162.5 - 167.0	No recovery
167.0 - 170.0	Quartz sand, yellowish-gray 5Y 8/1; mainly medium grain size, ranges from fine to very coarse; moderate sorting; subangular to rounded; trace bivalve fragments; less than 3 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; very poor recovery
170.0 - 173.0	No recovery
173.0 - 191.0	Quartz sand, yellowish-gray 5Y 8/1; mainly medium grain size, ranges from fine to very coarse; moderate sorting; subangular to rounded; trace bivalve fragments; less than 3 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; very poor recovery
191.0 - 196.5	Quartz sand, very light gray N8; mainly medium to coarse grain size, ranges from fine to very coarse; moderate sorting; subangular to rounded; trace bivalve fragments; less than 3 percent phosphorite; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery
196.5 - 206.0	No recovery
206.0 - 207.2	Quartz sand, very light gray N8; mainly medium to coarse grain size, ranges from fine to very coarse; moderate sorting; subangular to rounded; trace bivalve fragments; less than 3 percent phosphorite grains; interparticle porosity; moderate hydraulic conductivity; poor induration; poor recovery

Big Cypress Sanctuary Core (Miller Property)

Florida Geological Survey well number	**W-17614**
GWSI number	**C-1169**
Total depth	**195 feet**
Cored from	**0 to 195 feet**
County	**Collier**
Location	**SE, NE, sec. 16, T49S, R34E**
Latitude	**26°13′17″**
Longitude	**80°55′52″**
Elevation	**15 feet**
Completion date	**December 20, 1997**
Other types of available logs	**Gamma ray, induction resistivity**
Owner	**U.S. Geological Survey**
Driller	**Florida Geological Survey**
Core described by	**Kevin J. Cunningham**
Undifferentiated quartz sand	**0 to 5 feet**
Tamiami Formation	**5 to 139 feet**
Pinecrest Sand Member	**5 to 75 feet**
Ochopee Limestone Member	**75 to 139 feet**
Unnamed formation	**139 to 164.5 feet**
Peace River Formation	**164.5 to 195 feet**
Water-table aquifer	**0 to 17 feet**
Upper confining unit	**17 to 75 feet**
Gray limestone aquifer	**75 to 139 feet**
Lower confining unit	**139 to 195 feet**

Depth (feet below land surface)	Lithologic description of well C-1169
0.0 - 1.0	Quartz sand, dark-gray N3; mainly very fine to medium quartz sand with minor coarse quartz sand; ranges from clay to coarse; moderately sorted; abundant modern roots; minor organic particles; 15 percent interparticle porosity; moderate hydraulic conductivity; clay matrix
1.0 - 1.5	Quartz sand, medium-dark-gray N4 to dark-gray N5; mainly fine to medium quartz sand with minor very fine and coarse quartz sand; ranges from clay to granule; poorly sorted; 10 percent interparticle porosity; low hydraulic conductivity; soft when wet; root molds with laminated calcrete linings; minor marl matrix
1.5 - 2.5	Quartz sand, yellowish-gray 5Y 8/1, white N9, dark-yellowish-orange 10YR 6/6; mainly fine to medium quartz sand with minor very fine and coarse quartz sand; ranges from clay to granule; poorly sorted; 10 percent interparticle porosity; low hydraulic conductivity; soft when wet; root molds with laminated calcrete linings; minor marl matrix
2.5 - 5.0	Equal mix of quartz sand, marl, and skeletal fragments, yellowish-gray 5Y 8/1; mainly clay to granule; ranges from clay to granule; poorly sorted; 10 percent interparticle porosity; low hydraulic conductivity; soft when wet
5.0 - 7.0	Quartz sand, yellowish-gray 5Y 8/1; mainly clay and silt to very fine quartz sand and minor fine quartz sand; ranges from clay to fine; 10 percent interparticle porosity; low hydraulic conductivity; abundant marl matrix; soft when wet
7.0 - 9.5	Quartz sand, yellowish-gray 5Y 8/1; mainly clay; ranges very fine to fine quartz sand and pebble-size mollusks; 40 percent mollusk fragments; 10 percent interparticle porosity; low hydraulic conductivity; white N9 mollusks; soft when wet
9.5 - 10.0	No recovery
10.0 - 12.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand with minor medium quartz sand; ranges from clay to pebble; 10 percent mollusks; 10 percent interparticle porosity; low hydraulic conductivity; minor marl matrix; soft when wet
12.0 - 12.5	No recovery
12.5 - 34.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand with trace of pebble-size skeletal and mollusk fragments; ranges from clay to pebble; well sorted; less than 3 percent very fine to fine black grains; trace mica; trace skeletal and mollusk fragments; 10 percent interparticle porosity; low hydraulic conductivity; minor silt and marl matrix
34.0 - 37.5	No recovery
37.5 - 39.5	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand and pebble-size mollusk fragments; ranges from clay to pebble; 10 percent whole mollusks and mollusk fragments; less than 3 percent very fine black grains; trace mica; 10 percent interparticle porosity; low hydraulic conductivity; white mollusks N9; minor silt and marl matrix; soft when wet
39.5 - 40.0	No recovery
40.0 - 42.0	Quartz sand, light-olive-gray 5Y 6/1 to yellowish-gray 5Y 7/2; mainly very fine quartz sand and pebble-size mollusk fragments; ranges from clay to pebble; 10 percent whole mollusks and mollusk fragments; less than 3 percent very fine black grains; trace mica; 10 percent interparticle porosity; low hydraulic conductivity; white mollusks N9; minor silt and marl matrix; soft when wet
42.0 - 43.0	Quartz sand-rich mudstone, light-olive-gray 5Y 6/1 to yellowish-gray 5Y 7/2; mainly clay and silt-size quartz sand with minor very fine quartz sand and pebble-size mollusks; ranges from clay to pebble; 10 percent mollusks; 5 percent interparticle porosity; very low hydraulic conductivity
43.0 - 49.0	Quartz sand, light-olive-gray 5Y 6/1 to yellowish-gray 5Y 7/2; mainly clay and silt and very fine quartz sand; ranges from clay to pebble; well sorted quartz sand; poorly sorted mix of clay, sand and mollusks; less than 3 percent very fine black grains; 5 percent interparticle porosity; low hydraulic conductivity; white N9, thin-shelled mollusks; abundant clay matrix; soft when wet
49.0 - 52.0	Quartz sand, light-olive-gray 5Y 6/1 to yellowish-gray 5Y 7/2; mainly clay and silt and very fine quartz sand; ranges from clay to pebble; well sorted quartz sand; poorly sorted mix of clay, sand, and mollusks; less than 3 percent very fine black grains; 5 percent interparticle porosity; low hydraulic conductivity; white N9, thin-shelled mollusks; abundant clay matrix; soft when wet
52.0 - 56.5	No recovery
56.5 - 61.0	Quartz sand, yellowish-gray 5Y 8/1; mainly clay, silt to medium quartz sand and medium to pebble-size mollusks; ranges from clay to pebble; 10 percent mollusk fragments; less than 3 percent very fine to fine undifferentiated black grains and medium phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity; white N9 and medium-light-gray N7 to light-gray N6 mollusks; abundant marl matrix; massive bedding; friable
61.0 - 65.0	Quartz sand, light-olive-gray 5Y 6/1 to yellowish-gray 5Y 8/1; mainly fine to coarse quartz sand with minor medium to pebble-size mollusks; ranges from clay to pebble; 3 to 5 percent very fine to fine undifferentiated black grains and medium to coarse phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; white N9 and medium-light-gray N7 to light-gray N6 mollusks; minor marl matrix; massive bedding; friable
65.0 - 66.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1169
66.0 - 68.0	Quartz sand, light-olive-gray 5Y 6/1; mainly very fine quartz sand and pebble-size mollusks; ranges from clay to pebble; fine to pebble-size mollusks; 3 to 5 percent very fine to fine black grains; 10 percent interparticle porosity; low hydraulic conductivity; minor clay matrix; massive bedding; friable
68.0 - 71.0	No recovery
71.0 - 74.2	Quartz sand, light-olive-gray 5Y 6/1; mainly very fine quartz sand and pebble-size mollusks; ranges from clay to pebble; fine to pebble-size mollusks; 3 to 5 percent very fine to fine black grains; 10 percent interparticle porosity; low hydraulic conductivity; minor clay matrix; massive bedding; friable
74.2 - 75.0	Equal mix of quartz sand (very fine to fine), marl, and mollusk fragments, yellowish-gray 5Y 8/1; clay to pebble; *Vermicularia*; 3 to 5 percent very fine to fine black grains; 5 percent interparticle porosity; very low hydraulic conductivity
75.0 - 78.5	Mollusk lime rudstone and floatstone with matrix of skeletal fragment packstone with marl matrix, yellowish-gray 5Y 8/1 to light-gray N7; mainly clay and medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, echinoids, gastropods; 10 percent very fine quartz sand; less than 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; low hydraulic conductivity; medium-light-gray N6 and light-gray N7 mollusks; poorly cemented; friable
78.5 - 83.0	Mollusk lime rudstone and floatstone with matrix of skeletal fragment lime packstone and well-washed packstone with marl matrix, yellowish-gray 5Y 8/1 to light-gray N7; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, echinoids, gastropods; 10 percent very fine quartz sand; less than 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; medium hydraulic conductivity; poorly cemented; very friable to moderately friable
83.0 - 84.0	No recovery
84.0 - 100.0	Mollusk lime rudstone and floatstone with well-washed skeletal lime packstone matrix, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, echinoids, *Vermicularia*; less than 3 percent very fine black grains;15 percent interparticle and moldic porosity; moderate hydraulic conductivity; medium-light-gray N6 to light-gray N7 mollusks and skeletal fragments; poorly to moderately cemented; friable to locally hard; minor local marl matrix
100.0 - 109.5	Mollusk lime rudstone and floatstone with well-washed skeletal lime packstone and grainstone matrix, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, *Vermicularia*, bryozoans, echinoids; 10 percent very fine quartz sand; less than 3 percent very fine black grains; 15 percent interparticle and moldic; moderate hydraulic conductivity; poorly cemented but locally moderately cemented; friable but locally moderately friable
109.5 - 111.5	Mollusk lime rudstone and floatstone with well-washed skeletal lime packstone and grainstone matrix, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, *Vermicularia*, bryozoans, echinoids; 10 percent very fine to medium quartz sand; less than 3 percent very fine black grains; 15 percent interparticle and moldic; moderate hydraulic conductivity; poorly cemented but locally moderately cemented; friable but locally moderately friable
111.5 - 113.5	Well-washed skeletal lime packstone with quartz sand-rich matrix, yellowish-gray 5Y 8/1; mainly very fine to medium fossils; ranges from clay to coarse; skeletal fragments, bryozoans; 20 percent very fine to medium quartz sand; less than 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
113.5 - 115.0	Mollusk lime floatstone with well-washed skeletal lime packstone, yellowish-gray 5Y 8/1; mainly medium to pebble fossils; ranges from clay to pebble; skeletal grains, mollusks, bryozoans; less than 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
115.0 - 115.5	No recovery
115.5 - 123.5	Skeletal lime floatstone with well-washed skeletal lime packstone matrix, yellowish-gray 5Y 8/1; mainly fine to granule fossils; ranges from clay to pebble; skeletal fragments, mollusks, echinoids, bryozoans, gastropods; 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
123.5 - 129.5	Mollusk lime rudstone with well-washed skeletal lime packstone matrix, yellowish-gray 5Y 8/1; mainly very fine to pebble fossils; ranges from clay to pebble; skeletal fragments, mollusks, echinoids, bryozoans, gastropods, serpulids; 10 percent very fine to medium quartz sand; 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; moderately cemented; moderately friable
129.5 - 138.5	Mollusk lime rudstone with skeletal lime packstone and well-washed lime packstone matrix, yellowish-gray 5Y 8/1 to light-gray N7; mainly clay size and silt to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, gastropods, bryozoans, echinoids; 10 to 30 percent very fine to coarse quartz sand, mainly very fine to fine quartz sand; 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; well cemented; hard
138.5 - 140.5	No recovery

Depth (feet below land surface)	Lithologic description of well C-1169
140.5 - 141.0	Mollusk-rich quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand with minor medium quartz sand; ranges from very fine to pebble; mollusks and minor gastropods and bryozoans; 5 percent very fine to fine black grains; 10 percent interparticle porosity; low hydraulic conductivity; well cemented; hard
141.0 - 146.5	No recovery
146.5 - 149.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to very fine; 5 to 10 percent very black grains (probably mainly phosphorite); 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; silt and clay matrix; friable
149.0 - 149.5	No recovery
149.5 - 150.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to very fine; 5 to 10 percent very black grains (probably mainly phosphorite); 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; silt and clay matrix; friable
150.0 - 154.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to very fine; 10 percent very fine black grains (mainly phosphorite); trace skeletal fragments; 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; silt and clay matrix
154.0 - 154.5	No recovery
154.5 - 156.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to very fine; 10 percent very fine black grains (mainly phosphorite); trace skeletal fragments; 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; silt and clay matrix
156.5 - 160.5	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; ranges from clay to very fine; 10 percent very fine black grains (mainly phosphorite); trace small pebble-size phosphorite grains; less than 3 percent small to medium pebble-size mollusk fragments; 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; silt and clay matrix
160.5 - 164.5	Quartz sand, light-olive-gray 5Y 6/1; mainly very fine quartz sand; ranges from clay to very fine; 15 percent very fine black grains (mainly phosphorite); less than 5 percent medium sand to small pebble-size mollusks; 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; friable; minor silt and clay matrix
164.5 - 166.5	Interlaminated quartz sand and mudstone, pale-olive 10Y 6/2; mainly very fine quartz sand; ranges from clay to very fine; 15 percent very fine black grains (mainly phosphorite); 10 percent benthic foraminifers; 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; friable
166.5 - 167.5	No recovery
167.5 - 168.8	Interlaminated quartz sand and mudstone, pale-olive 10Y 6/2; mainly very fine quartz sand; ranges from clay to very fine; 15 percent very fine black grains (mainly phosphorite); 10 percent benthic foraminifers; 10 percent interparticle porosity; low hydraulic conductivity; poorly cemented; friable
168.8 - 177.5	Silty mudstone, pale-olive 10Y 6/2; mainly clay; ranges from clay to silt; 10 percent benthic foraminifers; less than 5 percent interparticle; very low hydraulic conductivity; soft when wet
177.5 - 182.5	Silty mudstone, pale-olive 10Y 6/2; mainly clay; ranges from clay to silt; 10 to 20 percent benthic foraminifers and diatoms; less than 5 percent interparticle porosity; very low hydraulic conductivity; soft when wet
182.5 - 187.5	No recovery
187.5 - 195.0	Silty mudstone, yellowish-gray 5Y 7/2; mainly clay; ranges from clay to silt; 10 to 20 percent benthic foraminifers and 10 to 20 percent diatoms; less than 5 percent interparticle; very low hydraulic conductivity; soft when wet

Sabine Road Core

Florida Geological Survey well number	Not applicable
GWSI number	C-1173
Total depth	135 feet
Cored from	0 to 135 feet
County	Collier
Location	NW, NW, sec. 6, T50S, R33E
Latitude	26°09′53″
Longitude	81°04′17″
Elevation	13 feet
Completion date	April 2, 1998
Other types of available logs	Gamma ray, induction, single-point resistivity
Owner	U.S. Geological Survey
Driller	South Florida Water Management District
Core described by	Kevin J. Cunningham
Undifferentiated limestone	0 to 5 feet
Tamiami Formation	5 to 114 feet
Pinecrest Sand Member	5 to 65 feet
Ochopee Limestone Member	65 to 114 feet
Unnamed formation	114 to 125 feet
Peace River Formation	125 to 135 feet
Upper confining unit	0 to 65 feet
Gray limestone aquifer	65 to 115 feet
Lower confining unit	115 to 135 feet

Depth (feet below land surface)	Lithologic description of well C-1173
0.0 - 5.0	Mixture of limestone and sand; 70 percent mollusk lime floatstone with quartz sand-rich lime wackestone and packstone matrix, very pale orange 10YR 8/2, grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6, moderate-yellowish-brown 10YR 5/4; mainly clay-size lime mudstone, very fine to fine quartz sand and pebble-size mollusks; quartz sand ranges from very fine to fine; all grains range from clay to pebble size; well sorted quartz sand; mollusks, skeletal fragments; 10 to 40 percent quartz sand; vuggy and moldic porosity; low hydraulic conductivity; hard when wet and 30 percent quartz sand with terrigenous mud matrix, light-gray N7; mainly clay-size terrigenous mud and very fine to fine quartz sand; quartz sand ranges from very fine to fine; grains range from clay to fine sand size; moderately sorted quartz sand; interparticle porosity; very low hydraulic conductivity; friable, soft when wet; abundant terrigenous mud matrix
5.0 - 10.0	Quartz sand, very pale orange 10YR 8/2, grayish-yellow 5Y 8/4; mainly clay-size marl and very fine grained quartz sand; quartz sand is very fine; fossils range from fine to pebble size; grains range from clay to pebble size; very well sorted quartz sand; minor skeletal fragments and mollusks; 5 percent interparticle porosity; very low hydraulic conductivity; inner delta front(?); friable; soft when wet; abundant marl matrix
10.0 - 15.0	Quartz sand, very pale orange 10YR 8/2, grayish-yellowish 5Y 8/4; mainly very fine quartz sand; grains range from clay to very fine; very well sorted quartz sand; trace very fine black grains; 15 percent interparticle porosity; low hydraulic conductivity; inner delta front(?); friable; soft when wet; minor marl matrix
15.0 - 20.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; grains range from clay to very fine; very well sorted quartz sand; trace very fine black grains; 15 percent interparticle porosity; low hydraulic conductivity; inner delta front(?) or beach(?); friable; soft when wet; minor marl matrix
20.0 - 25.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; grains range from clay to very fine; very well sorted quartz sand; trace very fine black grains; 15 percent interparticle porosity; low hydraulic conductivity inner delta front(?); friable; soft when wet; minor marl matrix
25.0 - 35.0	Quartz sand, yellowish-gray 5Y 8/1, grayish-yellow 5Y 8/4; mainly very fine quartz sand; grains range from clay to very fine; very well sorted quartz sand; trace very fine black grains; 15 percent interparticle porosity; low hydraulic conductivity; inner delta front(?); friable; soft when wet; minor marl matrix
35.0 - 40.0	Quartz sand, light-gray N7; mainly very fine quartz sand; grains range from clay to very fine; very well sorted quartz sand; trace very fine black grains; 15 percent interparticle porosity; low hydraulic conductivity; inner delta front(?); friable; soft when wet; minor marl matrix
40.0 - 50.0	Quartz sand, light-olive-gray 5Y 6/1; mainly clay-size terrigenous mud and silt to very fine quartz sand; quartz sand ranges from silt to very fine sand; grains range from clay to very fine sand; very well sorted quartz sand; trace very fine black grains; 5 percent interparticle porosity; very low hydraulic conductivity; outer delta front(?); friable; soft when wet
50.0 - 55.0	Quartz sand, light-olive-gray 5Y 6/1; mainly clay-size terrigenous mud and silt to very fine quartz sand; quartz sand ranges from silt to very fine sand; fossils range from coarse to pebble size; grains range from clay to very fine sand; very well sorted quartz sand; minor mollusk fragments; trace very fine black grains; 5 percent interparticle porosity; very low hydraulic conductivity; outer delta front(?); friable; soft when wet
55.0 - 65.0	Silty mudstone; dusky-yellow-green 5GY 5/2; mainly terrigenous clay; minor silt-size quartz and fine sand-size foraminifera; grains range from clay to fine; 5 percent interparticle porosity; very low hydraulic conductivity; prodelta(?); soft when wet; maximum flooding surface at 55 feet
65.0 - 70.0	Mollusk lime rudstone with quartz sand-rich skeletal lime packstone and well-washed packstone matrix, medium-gray N5 to light-gray N7; quartz sand is very fine; grains range from clay to pebble size; very well sorted quartz sand; skeletal fragments, mollusks, encrusting bryozoans, sand dollars; 20 percent quartz sand; trace very fine to fine black phosphorite; 20 percent moldic and interparticle porosity; moderate hydraulic conductivity; ramp; poorly to moderately cemented; friable to moderately friable
70.0 - 75.0	Mollusk lime rudstone with quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal grainstone matrix, medium-gray N5 to light-gray N7; mainly very fine to pebble-size fossils; quartz sand is very fine; grains range from clay to cobble size; very well sorted quartz sand; skeletal fragments, mollusks, encrusting bryozoans, sand dollars, *Vermicularia*, oysters; 10 percent quartz sand; trace very fine to fine black phosphorite; 25 percent moldic and interparticle porosity; high hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard; trace *Vermicularia* bondstone
75.0 - 80.0	Mollusk lime rudstone with skeletal well-washed lime packstone and skeletal grainstone matrix, medium-gray N5 to light-gray N7; mainly very fine to pebble-size fossils; quartz sand is very fine; grains range from clay to cobble size; very well sorted quartz sand; skeletal fragments, mollusks, encrusting bryozoans, serpulids; 5 percent quartz sand; trace very fine to fine black phosphorite; 25 percent moldic and interparticle porosity; high hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard
80.0 - 85.0	Mollusk lime rudstone with skeletal well-washed lime packstone and skeletal grainstone matrix, light-gray N7 to yellowish-gray 5Y 8/1; mainly very fine to pebble-size fossils; quartz sand ranges from very fine to medium; grains range from clay to cobble size; moderately sorted quartz sand; skeletal fragments, mollusks, encrusting bryozoans, serpulids, trace small hermatypic coral; 5 percent quartz sand; trace very fine to fine black phosphorite; 20 percent moldic and interparticle porosity; high hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard

Depth (feet below land surface)	Lithologic description of well C-1173
85.0 - 90.0	Mollusk lime rudstone with quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal grainstone matrix, light-gray N7; mainly very fine to pebble-size fossils; quartz sand mainly ranges from very fine to medium with minor coarse; grains range from clay to cobble size; moderately sorted quartz sand; skeletal fragments, mollusks, encrusting bryozoans, barnacles, serpulids, gastropods, oysters; 20 percent quartz sand; trace very fine to medium black phosphorite; 20 percent moldic and interparticle porosity; high hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard
90.0 - 95.0	Mollusk lime rudstone with quartz sand-rich skeletal lime packstone, quartz sand-rich skeletal well-washed lime packstone, and quartz sand-rich skeletal grainstone matrix, light-gray N7, very light gray N8, yellowish-gray 5Y 8/1; mainly very fine to pebble-size fossils; quartz sand mainly ranges from very fine to medium; grains range from clay to cobble size; well sorted quartz sand; skeletal fragments, mollusks, encrusting and free-standing bryozoans, oysters, serpulids; 30 percent quartz sand; trace very fine to medium black phosphorite; 20 percent moldic and interparticle porosity; high hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard
95.0 - 100.0	Mollusk lime rudstone with quartz sand-rich skeletal lime packstone and quartz sand-rich skeletal well-washed lime packstone matrix, light-gray N7, very light gray N8, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine to fine quartz sand, and medium to pebble-size fossils; quartz sand ranges from very fine to medium; grains range from clay to cobble size; well sorted quartz sand; skeletal fragments, mollusks, encrusting bryozoans; 40 percent quartz sand; trace very fine to medium black phosphorite; 20 percent moldic and interparticle porosity; moderate hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard
100.0 - 105.0	Mollusk lime rudstone with quartz sand-rich skeletal lime packstone and quartz sand-rich skeletal well-washed lime packstone matrix, very light gray N8, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, fine quartz sand, and medium to pebble-size fossils; quartz sand ranges from very fine to very coarse; grains range from clay to cobble size; moderately sorted quartz sand; skeletal fragments, mollusks, serpulids, barnacles, encrusting bryozoans; 40 percent quartz sand; trace very fine to fine black phosphorite; 20 percent moldic and interparticle porosity; moderate hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard
105.0 - 110.0	Mollusk lime rudstone with quartz sand-rich skeletal lime packstone and quartz sand-rich skeletal well-washed lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7, very light gray N8; mainly clay-size lime mudstone, very fine to fine quartz sand, and medium to pebble-size fossils; quartz sand ranges from very fine to very coarse; grains range from clay to cobble size; moderately sorted quartz sand; skeletal fragments, mollusks, serpulids, *Vermicularia*, gastropods; 45 percent quartz sand; trace very fine to fine black phosphorite; 20 percent moldic and interparticle porosity; moderate hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard
110.0 - 114.0	Mollusk lime rudstone with quartz sand-rich skeletal lime packstone matrix, yellowish-gray 5Y 8/1, very light gray N8; mainly clay-size lime mudstone, very fine quartz sand, and medium to pebble-size fossils; quartz sand ranges from very fine to granule size; all grains range from clay to cobble size; moderately sorted quartz sand; skeletal fragments, mollusks, gastropods, *Vermicularia*, serpulids; 45 percent quartz sand; 5 percent very fine to fine black phosphorite; 20 percent moldic and interparticle porosity; moderate hydraulic conductivity; ramp; moderately to well cemented; moderately friable to hard
114.0 - 115.0	Mollusk-rich quartz sandstone, light-olive-gray 5Y 6/1; mainly very fine quartz sand and pebble-size mollusks; grains range from clay to pebble size; well sorted quartz sand; mollusks, gastropods; 5 to 10 percent very fine to fine black phosphorite; 15 percent moldic and interparticle porosity; moderate hydraulic conductivity; moderately to well cemented; moderately friable to hard; minor lime mudstone matrix
115.0 - 120.0	Phosphate-rich, mollusk-rich quartz sand, light-olive-gray 5Y 6/1; mainly very fine quartz sand; minor fine to pebble size fossils; all grains range from very fine to pebble size; well sorted quartz sand; 20 percent mollusks and minor pectens; 20 percent very fine black phosphorite; 15 percent interparticle porosity; low hydraulic conductivity; friable; soft when wet
120.0 - 125.0	Phosphate-rich, mollusk-rich quartz sand, light-olive-gray 5Y 6/1; mainly very fine quartz sand; minor fine to pebble size fossils; grains range from very fine to pebble size; well sorted quartz sand; 15 percent mollusks and minor pectens and oysters; 30 percent very fine black phosphorite; 15 percent interparticle porosity; low hydraulic conductivity; friable; soft when wet
125.0 - 130.0	Phosphate-rich, mollusk-rich quartz sand, light-olive-gray 5Y 6/1; mainly very fine quartz sand; minor fine to pebble size fossils; grains range from clay to pebble size; well sorted quartz sand; 10 percent mollusks; 30 percent very fine black phosphorite; 10 percent interparticle porosity; low hydraulic conductivity; friable; soft when wet; minor clay matrix
130.0 - 135.0	Interbedded phosphate-rich, clay-rich quartz sand and quartz sand-rich mudstone, light-olive-gray 5Y 6/1; mainly clay-size terrigenous clay and very fine quartz sand; quartz sand ranges from silt to very fine; phosphorite grains are mainly very fine with minor coarse to small pebble size; grains range from clay to pebble size; well sorted quartz sand; 30 percent black phosphorite; 5 percent interparticle porosity; very low hydraulic conductivity; soft when wet; minor clay matrix

Turner River Road Core

Florida Geological Survey well number	Not applicable
GWSI number	C-1176
Total depth	365 feet
Cored from	0 to 365 feet
County	Collier
Location	SW, NW, sec. 6, T51S, R31E
Latitude	26°03′38″
Longitude	81°15′49″
Elevation	12 feet
Completion date	January 18, 1998
Other types of available logs	Gamma ray, spontaneous potential, fluid resistivity, long-normal resistivity, short-normal resistivity, resistivity, temperature, conductivity, neutron
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Kevin J. Cunningham (description for 50 to 365 feet is on file with the Geologic Division of the U.S. Geological Survey)
Undifferentiated limestone (Fort Thompson Formation?)	0 to 7.6 feet
Tamiami Formation	7.6 to 42.25 feet
Ochopee Limestone Member	7.6 to 42.25 feet
Top of unnamed formation	42.25 feet
Upper confining unit	0 to 7.6 feet
Gray limestone aquifer	7.6 to 42.25 feet
Top of lower confining unit	42.25 feet

Depth (feet below land surface)	Lithologic description of well C-1176
0.0 - 0.5	No recovery
0.5 - 0.6	Skeletal lime packstone, very pale orange 10YR 8/2 to grayish-orange 10YR 7/4; mainly clay size; ranges from clay to pebble; 10 percent interparticle and microporosity; very low hydraulic conductivity
0.6 - 2.0	Mollusk lime floatstone with marl matrix, very pale orange 10YR 8/2 and minor grayish-orange 10YR 7/4; mainly clay size; ranges from clay to pebble; trace very fine to medium quartz sand; 10 percent interparticle and microporosity; very low hydraulic conductivity; calcified marl contains root molds lined with laminated calcrete at 1.8 feet; interval is an exposure zone
2.0 - 5.0	No recovery
5.0 - 7.5	Mollusk lime wackestone with quartz-rich marl matrix, very pale orange 10YR 8/2; mainly clay to very fine; ranges from clay to pebble; 20 percent very fine quartz sand; 10 percent interparticle and microporosity; very low hydraulic conductivity; burrowed
7.5 - 7.6	Mollusk lime floatstone with mollusk, skeletal lime packstone matrix, very pale orange 10YR 8/2; clay to pebble; 5 percent interparticle and microporosity; low hydraulic conductivity
7.6 - 8.0	Rubble of mollusk lime rudstone with marl matrix, very pale orange 10YR 8/2; mainly clay-size marl and granule to pebble size fossils; ranges from clay to pebble; interparticle and microporosity; moderate hydraulic conductivity
8.0 - 8.3	No recovery
8.3 - 10.0	Interbedded mollusk lime floatstone with matrix of mollusk packstone and mollusk lime floatstone with very well-washed skeletal packstone with marl matrix, yellowish-gray 5Y 8/1; mainly clay-size marl and medium to pebble-size fossils; ranges from clay to pebble; mollusks, skeletal fragments; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; mechanically induced rubble
10.0 - 13.0	No recovery
13.0 - 15.0	Mollusk lime floatstone with matrix of very well washed skeletal packstone with marl matrix, yellowish-gray 5Y 8/1; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, echinoids; 20 percent interparticle and moldic; high hydraulic conductivity; poorly cemented; friable; mechanically induced rubble
15.0 - 20.0	No recovery
20.0 - 22.0	Mollusk lime floatstone with matrix of very well washed skeletal packstone with marl matrix, yellowish-gray 5Y 8/1; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, hermatypic corals, oysters; 20 percent interparticle and moldic; high hydraulic conductivity; poorly cemented; friable; mechanically induced rubble
22.0 - 25.0	No recovery
25.0 - 26.25	Mollusk lime floatstone with matrix of well washed skeletal packstone with marl matrix, yellowish-gray 5Y 8/1; mainly medium to pebble; ranges from clay to pebble; skeletal fragments, mollusks, gastropods, bryozoans, oysters, *Vermicularia*; 20 percent interparticle and moldic porosity; high hydraulic conductivity; poorly cemented; friable; mechanically induced rubble
26.25 - 30.0	No recovery
30.0 - 30.5	Mollusk lime floatstone with matrix of well-washed skeletal packstone with marl matrix, yellowish-gray 5Y 8/1 to light-gray N7; mainly medium to pebble; ranges from clay to pebble; skeletal fragments, mollusks, gastropods, oysters; 20 percent interparticle and moldic porosity; high hydraulic conductivity; poorly cemented; friable; mechanically induced rubble
30.5 - 35.0	No recovery
35.0 - 36.5	Mollusk lime floatstone with matrix of well-washed skeletal packstone with marl matrix, very pale orange 10YR 8/2; mainly medium to pebble; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans; 20 percent interparticle and moldic porosity; high hydraulic conductivity; poorly cemented; friable; mechanically induced rubble
36.5 - 37.0	No recovery
37.0 - 37.5	Mollusk lime rudstone with quartz sand-rich skeletal lime grainstone matrix, very pale orange 10YR 8/2; mainly very fine to pebble; ranges from very fine to pebble; skeletal fragments, mollusks, serpulids; trace very fine phosphorite grains; 15 percent interparticle and moldic porosity; high hydraulic conductivity; well cemented
37.5 - 42.0	No recovery
42.0 - 42.25	Cuttings of lithology AA 37 37.5
42.25 - 45.0	No recovery
45.0 - 45.1	Quartz sand, moderate-orange-pink 5YR 8/4; mainly very fine; ranges from clay to very fine; well sorted quartz grains; 3 to 10 percent very fine black grains (mainly phosphorite); 15 percent interparticle porosity; low hydraulic conductivity; friable
45.1 - 49.0	Quartz sand; light-gray N7; mainly very fin e grain size; ranges from clay to very fine; well sorted quartz grains; 3 to 10 percent very fine black grains (mainly phosphorite); 15 percent interparticle porosity; low hydraulic conductivity; soft (quartz sand poured into box); friable
49.0 - 50.0	Quartz sand, light-gray N7; mainly very fine; ranges from clay to very fine; well sorted quartz grains; minor *Pecten*; 3 to 10 percent very fine black grains (mainly phosphorite); 15 percent interparticle porosity; low hydraulic conductivity; soft (quartz sand poured into box); friable

Sunniland No. 2 Core

Florida Geological Survey well number	Not applicable
GWSI number	C-1178
Total depth	200 feet
Cored from	0 to 200 feet
County	Collier
Location	SW, NW, sec. 2, T49S, R30E
Latitude	26°14′53″
Longitude	81°17′44″
Elevation	19.2 feet
Completion date	February 5, 1998
Other types of available logs	Gamma ray, spontaneous potential, fluid resistivity, long-normal resistivity, short-normal resistivity, induction, temperature, conductivity, neutron
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Kevin J. Cunningham (description for 150 to 200 feet is on file with the Geologic Division of the U.S. Geological Survey)
Undifferentiated limestone and quartz sand	0 to 2.75 feet
Lake Okeelanta(?) beds	2.75 to 55 feet
Tamiami Formation	55 to 145 feet
Ochopee Limestone Member	55 to 145 feet
Top of unnamed sand	145 feet
Water-table aquifer	0 to 2.75 feet
Upper confining unit	2.75 to 55 feet
Upper gray limestone aquifer	55 to 92.5 feet
Middle confining unit of gray limestone aquifer	92.5 to 119 feet
Lower gray limestone aquifer	119 to 144 feet
Top of lower confining unit	144 feet

Depth (feet below land surface)	Lithologic description of well C-1178
0.0 - 1.0	Mollusk lime floatstone and rudstone with skeletal lime packstone and grainstone matrix, yellowish-gray 5Y 8/1, minor grayish-orange 10YR 7/4; clay to pebble; mollusks and skeletal fragments; 20 percent moldic and interparticle porosity; moderate hydraulic conductivity; broken-up limestone
1.0 - 2.0	No recovery
2.0 - 2.75	Quartz sand, very pale orange 10YR 8/2; mainly very fine to fine quartz sand; minor medium to coarse quartz sand and fine sand to pebble-size fossils; quartz sand ranges from silt to coarse; grains range from very fine to pebble; skeletal fragments, mollusks, probably caved limestone lithoclasts; 20 percent interparticle porosity; moderate hydraulic conductivity; unconsolidated, loose quartz sand
2.75 - 3.5	Peat; sample removed for analysis
3.5 - 5.0	No recovery
5.0 - 5.4	Peat; sample removed for analysis; delta plain(?) environment
5.4 - 5.8	Quartz sandstone with lime mud matrix, very pale orange 10YR 8/2; mainly very fine to fine quartz sand and clay-size lime mud; quartz sand ranges from silt to fine; grains range from clay to pebble size; 5 percent moldic and root-mold porosity; low hydraulic conductivity; interval contains root molds lined with laminated calcrete; interval is an exposure zone (cycle cap or sequence boundary)
5.8 - 6.5	No recovery
6.5 - 8.0	Quartz sandstone with lime mud matrix, very pale orange 10YR 8/2; mainly very fine to fine quartz sand and clay-size lime mud; quartz sand ranges from silt to fine; grains range from clay to pebble size; gastropods, mollusks; 5 percent moldic and root-mold porosity; low hydraulic conductivity; interval contains root molds lined with laminated calcrete; same exposure zone as 5.4 to 5.8 feet
8.0 - 9.75	Quartz sand, very pale orange 10YR 8/2; mainly very fine to fine quartz sand and clay-size lime mud; quartz sand ranges from silt to fine; grains range from clay to pebble size; mollusks, skeletal fragments; 10 percent interparticle porosity; low hydraulic conductivity; soft; minor clay matrix
9.75 - 10.0	No recovery
10.0 - 11.0	Quartz sand, very pale orange 10YR 8/2; mainly very fine to fine quartz sand, pebble-size mollusks and clay-size terrigenous clay; quartz sand ranges from silt to fine; grains range from clay to pebble; abundant mollusks (uncommonly articulated), minor gastropods; 10 percent interparticle porosity; low hydraulic conductivity; soft; minor clay matrix; mollusks and gastropods floating in quartz sand matrix
11.0 - 13.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand, pebble-size mollusks and clay-size terrigenous clay; quartz sand ranges from silt to fine; grains range from clay to pebble; abundant mollusks (uncommonly articulated), minor gastropods; 10 percent interparticle porosity; low hydraulic conductivity; soft; minor clay matrix; mollusks and gastropods floating in quartz sand matrix
13.0 - 14.0	Quartz sand, grayish-orange 10YR 7/4, pale-yellowish-brown 10YR 6/2; mainly very fine to fine quartz sand and clay-size terrigenous clay; quartz sand ranges from silt to fine; grains range from clay to fine; 5 percent interparticle porosity; low hydraulic conductivity; calcrete matrix in upper half; calcareous clay matrix in lower half; lower half is soft; root molds lined with laminated calcrete throughout interval; interval is an exposure zone (cycle cap or sequence boundary)
14.0 - 15.0	No recovery
15.0 - 16.0	Quartz sand, very pale orange 10YR 8/2, grayish-orange 10YR 7/4; mainly very fine to fine quartz sand and terrigenous clay; quartz sand ranges from silt to fine; grains range from clay to fine; uncommon mollusk fragments; 10 percent interparticle porosity; low hydraulic conductivity; local clay matrix and calcrete matrix; root molds with laminated calcrete linings; same exposure zone as 13.0 to 14.0 feet
16.0 - 17.0	Quartz sand, yellowish-gray 5Y 8/1; mainly from very fine to fine quartz sand; quartz sand ranges from silt to fine; grains range from clay to pebble; mollusks, gastropods; 10 percent interparticle porosity; low hydraulic conductivity; minor clay matrix; soft
17.0 - 18.0	No recovery
18.0 - 20.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; quartz sand ranges from silt to medium; grains range from clay to pebble; mollusks, gastropods; 10 percent interparticle porosity; low hydraulic conductivity; minor clay matrix; clay content decreases upward; soft
20.0 - 22.3	Quartz sand, light-olive-gray 5Y 6/1; mainly very fine to fine quartz sand and terrigenous clay; quartz sand ranges from silt to medium; grains range from clay to pebble; mollusks, gastropods; 5 percent interparticle porosity; low hydraulic conductivity; clay matrix; clay content decreases upward; soft
22.3 - 23.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1178
23.0 - 23.5	Quartz sand, light-olive-gray 5Y 6/1; mainly very fine to fine quartz sand and terrigenous clay; quartz sand ranges from silt to medium; grains range from clay to pebble; mollusks, gastropods; 5 percent interparticle porosity; very low hydraulic conductivity; clay matrix; soft
23.5 - 24.0	Sample removed for analysis; probably exposure zone
24.0 - 24.3	Quartz sand, light-olive-gray 5Y 6/1; mainly very fine to fine quartz sand and terrigenous clay; quartz sand ranges from silt to medium; grains range from clay to pebble; mollusks, gastropods; 5 percent interparticle porosity; very low hydraulic conductivity; clay matrix; soft
24.3 - 26.0	Gastropod-rich terrigenous mudstone, light-olive-gray 5Y 6/1; mainly terrigenous clay; minor silt-size quartz; grains range from clay to pebble; abundant gastropods, minor mollusks; 5 percent microporosity; very low hydraulic conductivity; calcareous; silty; locally gastropods form a framework; soft; root molds; probable exposure zone
26.0 - 26.2	Sample removed for analysis; probably same lithology as interval between 24.3 and 26.0 feet
26.2 - 27.0	Gastropod-rich terrigenous mudstone, light-olive-gray 5Y 6/1; mainly terrigenous clay; minor silt-size quartz; grains range from clay to pebble; abundant gastropods, minor mollusks; 5 percent microporosity; very low hydraulic conductivity; calcareous; silty; soft; root molds; probable exposure zone as interval from 24.3 to 26.0 feet with different exposure zone cap at 26.8 feet and different exposure zone from 26.8 to 27.0 feet
27.0 - 28.0	No recovery
28.0 - 28.9	Gastropod-rich terrigenous mudstone, yellowish-gray 5Y 8/1 at top, light-olive-gray 5Y 6/1 in middle, pale-yellowish-brown 10YR 6/2 at base; mainly terrigenous clay; minor silt-size quartz; grains range from clay to pebble; abundant gastropods; 5 percent microporosity; very low hydraulic conductivity; calcareous; silty; soft; root molds; probable exposure zone as interval from 26.2 to 27.0 feet
28.9 - 29.7	Gastropod-rich terrigenous mudstone, yellowish-gray 5Y 8/1 at top, light-olive-gray 5Y 6/1 in middle, pale-yellowish-brown 10YR 6/2 at base; mainly terrigenous clay; minor silt-size quartz; grains range from clay to pebble; abundant gastropods; 5 percent microporosity; very low hydraulic conductivity; calcareous; silty; soft; root molds; unconformity and exposure zone cap at 28.9 feet
29.7 - 29.8	Peat; grayish black N2; top of an unconformity and exposure zone; exposure zone with cap at 29.7 feet in interval from 29.7 to 29.8 feet
29.8 - 32.0	Gastropod-rich terrigenous mudstone, very pale orange 10YR 8/2 at top to pale-yellowish-brown 10YR 6/2 at base; mainly terrigenous clay and coarse to pebble-size fossils; minor silt-size quartz; grains range from clay to pebble; abundant gastropods; 5 percent microporosity; very low hydraulic conductivity; calcareous; silty; soft; root molds; local gastropod supported framework;
32.0 - 33.0	No recovery
33.0 - 34.8	Gastropod-rich terrigenous mudstone, pale-yellowish-brown 10YR 6/2 at top to dark-yellowish-brown 10YR 4/2 at base; mainly terrigenous clay and coarse to granule-size fossils; minor silt-size quartz; grains range from clay to granule; abundant gastropods; 5 percent microporosity; very low hydraulic conductivity; calcareous; silty; soft
34.8 - 35.0	No recovery
35.0 - 35.5	Peat; sample removed for analysis; top of exposure zone at 35 feet
35.5 - 39.0	Gastropod-rich terrigenous mudstone very pale orange 10YR 8/2 at top to yellowish-gray 5Y 8/1 at base; mainly terrigenous clay and coarse to granule-size fossils; minor silt-size quartz; grains range from clay to granule; abundant gastropods; 5 percent microporosity; very low hydraulic conductivity; calcareous; silty; soft; root molds
39.0 - 40.0	No recovery
40.0 - 48.2	Peat; sample removed for analysis; top of exposure zone at 40 feet
48.2 - 50.0	No recovery
50.0 - 51.0	Peat; sample removed for analysis
51.0 - 52.3	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; quartz skeletal fragments range from fine to pebble; grains range from very fine to pebble; skeletal fragments; 15 percent interparticle porosity; moderate hydraulic conductivity
52.3 - 54.0	Mollusk-rich quartz sand; light-gray N7 to yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and granule to pebble-size mollusks; quartz sand ranges from very fine to fine; grains range from very fine to pebble; well sorted quartz sand; abundant mollusks (minor articulated mollusks), minor gastropods; 15 percent interparticle porosity; moderate hydraulic conductivity; unconsolidated, friable quartz sand; mollusks form a grain-supported framework
54.0 - 55.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1178
55.0 - 56.5	Mollusk lime floatstone and rudstone with quartz sand-rich lime mudstone matrix, dark-gray N3 to medium-gray N5; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; 45 percent quartz sand; 20 percent moldic and root-mold porosity; high hydraulic conductivity; hard; mainly white N9 mollusk; root molds lined with calcite cement; top of exposure zone at 55 feet
56.5 - 56.7	No recovery
56.7 - 57.8	Gastropod and mollusk lime floatstone with quartz sand-rich lime mudstone matrix, grayish-black N2 to medium-dark-gray N4; pale yellowish-brown 10YR 6/2; mainly clay-size lime mud, very fine quartz sand and pebble-size fossils; quartz sand ranges from silt to very fine; fossils range from silt to pebble; grains range from clay to pebble; 45 percent quartz sand; 15 percent moldic, root-mold, and small vug porosity; high hydraulic conductivity; hard; lime floatstone is mechanically broken; root molds; same exposure zone as 55.0 to 56.5 feet
57.8 - 59.5	Mollusk-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and granule to pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from silt to pebble; well sorted quartz sand; 75 percent quartz sand; abundant mollusks, minor gastropods; 15 percent interparticle; moderate hydraulic conductivity; hard; mollusks form a grain-supported framework
59.5 - 60.0	No recovery
60.0 - 61.0	Quartz sand, light-olive-gray 5Y 6/1; very fine to medium quartz sand and granule to pebble-size intraclasts; quartz sand ranges from silt to medium; grains range from silt to pebble; well sorted quartz sand; intraclasts; 15 percent interparticle porosity; moderate hydraulic conductivity; hard; intraclasts are pale-yellowish-brown 10YR 6/2 reworked fragments from the 61.0 to 61.8-foot interval below (interval indicates flooding of exposure surface at 61 feet)
61.0 - 61.8	Mollusk lime rudstone with quartz sand-rich lime mudstone matrix, grayish-black N2 to medium-dark-gray N4, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud and very fine to fine quartz sand; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; well sorted quartz sand; 45 percent quartz sand; 15 percent moldic, root-mold, and small vug porosity; high hydraulic conductivity; mechanically broken lime rudstone; minor fractures; root molds; exposure zone at 61 feet
61.8 - 62.2	Quartz sand, yellowish-gray 5Y 8/1, mainly clay-size lime mud and very fine to fine quartz sand; quartz sand ranges from silt to fine; intraclasts range from medium to pebble; grains range from clay to pebble; intraclasts of mollusk lime rudstone as in interval 61.0 to 61.8 feet; 15 percent interparticle microporosity; low hydraulic conductivity; hard; quartz sand and intraclasts appear to be caved from intervals above
62.2 - 65.0	Mollusk lime floatstone with quartz sand-rich lime mudstone matrix, mottled grayish-black N2 to medium-dark-gray N4 and very pale orange 10YR 6/2 to pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud and very fine to fine quartz sand; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; 45 percent quartz sand; 20 percent micro-vug, root-mold, and moldic porosity; high hydraulic conductivity; hard; lime floatstone mechanically broken throughout interval; micro-vugs form a tripolitic-like texture; root molds lined with laminated calcrete; continuation of exposure zone above
65.0 - 68.5	Mollusk lime floatstone with quartz sand-rich lime mudstone matrix, mottled medium-dark-gray N4 to medium-light-gray N6 and very pale orange 10YR 6/2 to pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; quartz sand; abundant mollusks, minor gastropods; 20 percent micro-vug and root-mold porosity; high hydraulic conductivity; hard; lime floatstone mechanically broken throughout interval; micro-vugs form a tripolitic-like texture; root molds lined with laminated calcrete; continuation of exposure zone above
68.5 - 70.2	Mollusk lime rudstone with quartz sand-rich lime mudstone matrix, mottled medium-light-gray N6 to light-gray N7 and very pale orange 10YR 6/2 to pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; quartz sand; abundant mollusks, minor gastropods, echinoids; 20 percent micro-vug and root-mold porosity; high hydraulic conductivity; hard; lime rudstone mechanically broken throughout interval; micro-vugs form a tripolitic-like texture
70.2 - 73.5	No recovery
73.5 - 74.5	Mollusk lime floatstone with lime wackestone matrix and quartz sand-rich lime mudstone matrix; mottled medium-light-gray N6 to light-gray N7 and very pale orange 10YR 6/2 to pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; 45 percent quartz sand; abundant mollusks, minor gastropods, echinoids, miliolids, coral; 15 percent micro-vug and root-mold porosity; high hydraulic conductivity; hard; lime floatstone mechanically broken throughout interval; root molds; micro-vugs form a tripolitic-like texture
74.5 - 78.5	No recovery

Depth (feet below land surface)	Lithologic description of well C-1178
78.5 - 79.0	Skeletal lime floatstone with quartz sand-rich lime wackestone matrix and quartz sand-rich lime mudstone matrix, mottled medium-light-gray N6 to light-gray N7 and very pale orange 10YR 6/2 to pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; 45 percent quartz sand; abundant skeletal fragments and mollusks; 15 percent micro-vug and root-mold porosity; high hydraulic conductivity; hard; lime floatstone mechanically broken throughout interval; root molds; micro-vugs form a tripolitic-like texture
79.0 - 81.0	No recovery
81.0 - 81.5	Oyster lime rudstone with quartz sand-rich lime wackestone matrix, medium-light-gray N6 to light-gray N7; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; 45 percent quartz sand; abundant oysters; minor bryozoans and serpulids; 15 percent micro-vug, bored and intraparticle porosity; moderate hydraulic conductivity; hard; lime rudstone mechanically broken throughout interval
81.5 - 83.5	No recovery
83.5 - 84.5	Mollusk lime rudstone and floatstone with quartz sand-rich lime mudstone matrix, mottled medium-gray N5 to light-gray N7 and very pale orange 10YR 8/2 to pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; 45 percent quartz sand; abundant mollusks; minor bryozoans; 15 percent micro-vug and intraparticle porosity; high hydraulic conductivity; hard; possible root molds; lime rudstone and floatstone mechanically broken throughout interval; micro-vugs form a tripolitic-like texture
84.5 - 86.0	No recovery
86.0 - 86.5	Mollusk lime rudstone with quartz sand-rich lime wackestone matrix, mottled medium-gray N5 to light-gray N7 and very pale orange 10YR 8/2 to pale-yellowish-brown 10YR 6/2; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; 5 to 45 percent quartz sand; abundant mollusks and skeletal fragments; 15 percent micro- and macro-vug and intraparticle porosity; high hydraulic conductivity; hard; possible root molds; lime rudstone mechanically broken throughout interval
86.5 - 90.0	No recovery
90.0 - 91.5	Oyster lime rudstone with quartz sand-rich skeletal lime packstone matrix, dark-gray N3 to light-gray N7; mainly clay-size lime mud, very fine to fine quartz sand and pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; abundant oysters, minor mollusks; 5 to 45 percent quartz sand; 20 percent moldic and micro- to macro-scale vuggy porosity; high hydraulic conductivity; hard; lime rudstone mechanically broken throughout interval
91.5 - 92.5	No recovery
92.5 - 94.5	Mollusk-rich, marly quartz sand, yellowish-gray 5Y 8/1; mainly clay-size marl, very fine to fine quartz sand and granule to pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; abundant mollusks, minor gastropods; 65 percent quartz sand; 10 percent interparticle and moldic porosity; low hydraulic conductivity; soft when wet; fossils floating in quartz sand matrix
94.5 - 95.0	No recovery
95.0 - 98.0	Mollusk-rich, marly quartz sand, yellowish-gray 5Y 8/1; mainly clay-size marl, very fine to fine quartz sand and granule to pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; abundant mollusks, minor gastropods; 65 percent quartz sand; 10 percent interparticle and moldic porosity; low hydraulic conductivity; soft when wet; fossils floating in quartz sand matrix
98.0 - 98.5	No recovery
98.5 - 99.0	Mollusk-rich, marly quartz sand; yellowish-gray 5Y 7/2; mainly clay-size marl, very fine to fine quartz sand and granule to pebble-size fossils; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; abundant mollusks, minor gastropods; 65 percent quartz sand; 10 percent interparticle and moldic porosity; low hydraulic conductivity; soft when wet; burrowed; fossils floating in quartz sand matrix
99.0 - 99.5	Quartz sand-rich, skeletal fragment, lime wackestone, yellowish-gray 5Y 7/2; mainly clay-size marl and very fine to fine quartz sand; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; abundant skeletal fragments and mollusks; 10 to 60 percent quartz sand; 5 percent interparticle microporosity; very low hydraulic conductivity; hard when wet
99.5 - 103.5	No recovery
103.5 - 103.8	Quartz sand-rich, skeletal fragment, mollusk lime wackestone, yellowish-gray 5Y 7/2; mainly clay-size marl and very fine to fine quartz sand; quartz sand ranges from silt to fine; fossils range from silt to pebble; grains range from clay to pebble; abundant skeletal fragments and mollusks; 10 to 60 percent quartz sand; 5 percent interparticle microporosity; very low hydraulic conductivity; hard when wet

Depth (feet below land surface)	Lithologic description of well C-1178
103.8 - 108.5	No recovery
108.5 - 113.1	Skeletal fragment lime floatstone and rudstone with matrix of skeletal lime wackestone and packstone with marl matrix, yellowish-gray 5Y 8/1; mainly clay-size marl and medium to granule fossils; quartz sand ranges from very fine to fine; grains range from clay to pebble; abundant skeletal fragments, mollusks; trace quartz sand; 10 percent interparticle and moldic porosity; low hydraulic conductivity; soft when wet
113.1 - 115.0	No recovery
115.0 - 119.0	Skeletal fragment lime floatstone and rudstone with matrix of skeletal lime wackestone and packstone with marl matrix; yellowish-gray 5Y 8/1; mainly clay-size marl and medium to granule fossils; grains range from clay to pebble; abundant skeletal fragments, mollusks; minor gastropods, bryozoans, *Vermicularia*; 10 percent interparticle and moldic porosity; low hydraulic conductivity; friable; zone of maximum flooding(?)
119.0 - 125.0	Skeletal fragment lime floatstone with matrix of skeletal well-washed lime packstone with marl matrix, medium-light-gray N6 to light-gray N7; mainly medium to pebble fossils; grains range from clay to pebble; abundant skeletal fragments, mollusks; minor *Vermicularia,* bryozoans, gastropods, oysters, echinoids; 20 percent interparticle and intraparticle porosity; moderate hydraulic conductivity; poorly cemented; friable; cool-water carbonate(?)
125.0 - 130.2	Skeletal fragment lime floatstone with matrix of skeletal well-washed lime packstone with marl matrix, medium-light-gray N6 to light-gray N7; mainly medium to pebble fossils; grains range from clay to pebble; abundant skeletal fragments, mollusks; minor bryozoans, oysters, echinoids; 20 percent interparticle and intraparticle porosity; high hydraulic conductivity; poorly cemented; friable; cool-water carbonate(?)
130.2 - 135.0	Skeletal fragment lime floatstone and rudstone with matrix of skeletal well-washed lime packstone with marl matrix; yellowish-gray 5Y 8/1; mainly medium to pebble fossils; grains range from clay to pebble; abundant skeletal fragments, mollusks; minor bryozoans, gastropods, echinoids; 20 percent interparticle and intraparticle porosity; high hydraulic conductivity; poorly cemented; friable; cool-water carbonate(?)
135.0 - 140.0	Skeletal fragment lime floatstone and rudstone with matrix of skeletal well-washed lime packstone with marl matrix; yellowish-gray 5Y 8/1; mainly medium to pebble fossils; grains range from clay to pebble; abundant skeletal fragments, mollusks; minor bryozoans, gastropods; trace hermatypic coral; 20 percent interparticle and intraparticle porosity; moderate hydraulic conductivity; poorly cemented; friable; cool-water carbonate(?)
140.0 - 142.0	Skeletal fragment lime floatstone and rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone with marl matrix, yellowish-gray 5Y 8/1; mainly medium to pebble fossils; quartz sand ranges from silt to fine; grains range from clay to pebble; abundant skeletal fragments, mollusks; minor bryozoans, *Vermicularia*; 10 to 20 percent quartz sand; 20 percent interparticle porosity; moderate hydraulic conductivity; poorly cemented; friable; cool-water carbonate(?)
142.0 - 144.0	Skeletal fragment lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone with marl matrix, light-gray N7; mainly clay-size marl, medium to pebble fossils and very fine to medium quartz sand; quartz ranges from silt to medium; grains range from clay to pebble; abundant skeletal fragments, mollusks; 10 to 40 percent quartz sand; 15 percent interparticle porosity; moderate hydraulic conductivity; poorly cemented; friable; cool-water carbonate(?)
144.0 - 145.0	Skeletal fragment lime rudstone and floatstone with matrix of quartz sand-rich skeletal lime packstone with marl matrix, light-gray N7; mainly clay-size marl, medium to pebble fossils and very fine to medium quartz sand; quartz sand ranges from silt to medium; grains range from clay to pebble; abundant skeletal fragments, mollusks; 40 to 70 percent quartz sand; trace to 3 percent phosphorite grains 15 percent interparticle porosity; low hydraulic conductivity; poorly cemented; friable; cool-water carbonate(?)
145.0 - 146.0	Quartz sand, very light gray; mainly very fine to fine quartz sand; minor medium to pebble fossil fragments; quartz sand ranges from very fine to medium; grains range from very fine to pebble; minor mollusks; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity; friable
146.0 - 149.5	Quartz sand, very light gray; mainly very fine to fine quartz sand; quartz sand ranges from very fine to medium; grains range from very fine to pebble; trace to 3 percent phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity; friable
149.5 - 150.0	No recovery

Big Cypress Headquarter's Core

Florida Geological Survey well number	**Not applicable**
GWSI number	**C-1180**
Total depth	**200 feet**
Cored from	**0 to 200 feet**
County	**Collier**
Location	**SE, NW, sec. 33, T52S, R30E**
Latitude	**25°53′45″**
Longitude	**81°19′24″**
Elevation	**~5 feet**
Completion date	**February 18, 1998**
Other types of available logs	**Gamma, spontaneous potential, temperature, long-normal resistivity, short-normal resistivity, fluid resistivity**
Owner	**U.S. Geological Survey**
Driller	**U.S. Geological Survey**
Core described by	**Kevin J. Cunningham (description for 95 to 200 feet is on file with the Geologic Division of the U.S. Geological Survey)**
Undifferentiated quartz sand	**0 to 5.5 feet**
Tamiami Formation	**5.5 to 45 feet**
Ochopee Limestone Member	**5.5 to 45 feet**
Unnamed sand	**45 to 130 feet**
Peace River Formation	**130 to 200 feet**
Water-table aquifer	**0 to 5.5 feet**
Gray limestone aquifer	**5.5 to 45 feet**
Sand aquifer	**53 to 130 feet**

Depth (feet below land surface)	Lithologic description of well C-1180
0.0 - 1.0	Quartz sand, medium-gray N5; mainly very fine to coarse; ranges from clay to coarse; moderately sorted; mechanically broken fragments of mollusk lime rudstone with skeletal lime packstone and grainstone matrix, very pale orange 10YR 8/2; 15 percent interparticle porosity; low hydraulic conductivity; friable; clay matrix
1.0 - 4.5	No recovery
4.5 - 5.0	Quartz sand, very pale orange 10YR 8/2 to pale yellowish-brown 10YR 6/2; fine to coarse; well sorted; minor skeletal grains; 20 percent interparticle porosity; moderate hydraulic conductivity; friable
5.0 - 5.5	No recovery
5.5 - 6.0	Mollusk lime rudstone with quartz sand-rich lime skeletal grainstone matrix, yellowish-gray 5Y 8/1 to white N9; mainly fine to pebble; ranges from very fine to pebble; 10 to 20 percent very fine to fine quartz sand; mollusks, skeletal fragments; 15 percent moldic and interparticle porosity; moderate hydraulic conductivity; well cemented; hard
6.0 - 8.5	No recovery
8.5 - 9.5	Cuttings of friable, very fine to coarse, well sorted, quartz sand mixed with limestone cuttings, very pale orange 10YR 8/2 to grayish-orange 10YR 7/4 to pale-yellowish-brown 10YR 6/2
9.5 - 10.0	No recovery
10.0 - 10.25	Mollusk lime rudstone with quartz sand-rich lime skeletal grainstone matrix, yellowish-gray 5Y 8/1 to white N9; mainly fine to pebble; ranges from very fine to pebble; 10 to 20 percent very fine to fine quartz sand; skeletal fragments, mollusks; 15 percent moldic and interparticle; moderate hydraulic conductivity; well cemented; hard
10.25 - 15.0	No recovery
15.0 - 17.5	Mollusk lime rudstone with well-washed skeletal lime packstone matrix, yellowish-gray 5Y 8/1 to white N9; mainly medium to pebble; ranges from clay to pebble; skeletal fragments, mollusks, echinoids, oysters; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; matrix soft when wet; mechanically broken
17.5 - 19.0	No recovery
19.0 - 20.25	Mollusk lime rudstone with well-washed skeletal lime packstone matrix, yellowish-gray 5Y 8/1 to white N9; mainly medium to pebble; ranges from clay to pebble; skeletal fragments, mollusks, echinoids, oysters; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; matrix soft when wet; mechanically broken
20.25 - 22.0	Mollusk lime rudstone with skeletal lime grainstone matrix, yellowish-gray 5Y 8/1 to white N9; medium to pebble; ranges from very fine to pebble; skeletal fragments, mollusks, echinoids, *Vermicularia*, bryozoans; 15 percent moldic and interparticle; moderate hydraulic conductivity; well cemented with isopachous equant calcite; hard; upper 6 feet is mechanically broken
22.0 - 25.0	No recovery
25.0 - 29.5	Mollusk lime rudstone and floatstone with well-washed skeletal packstone matrix, yellowish-gray 5Y 8/1 to white N9; mainly medium to pebble; ranges from clay to pebble; 5 to 10 percent very fine to fine quartz sand; skeletal fragments, mollusks, echinoids, bryozoans, *Vermicularia*; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; matrix soft when wet
29.5 - 30.0	No recovery
30.0 - 31.75	Mollusk lime rudstone and floatstone with well-washed skeletal packstone matrix, yellowish-gray 5Y 8/1 to white N9; mainly medium to pebble; ranges from clay to pebble; 5 to 10 percent very fine to fine quartz sand; skeletal fragments, mollusks, echinoids, bryozoans, *Vermicularia*, barnacles; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; matrix soft when wet; mechanically broken
31.75 - 32.25	Mollusk lime rudstone and floatstone with quartz sand matrix, very light gray N8; mainly very fine to pebble size; well sorted quartz sand; 45 percent very fine to fine quartz sand; mollusks and skeletal fragments; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented, friable
32.25 - 33.0	No recovery
33.0 - 33.75	Mollusk-rich quartz sandstone and loose quartz sand; very light gray N8 to white N9; mainly very fine to fine quartz sand and minor medium quartz sand; grains range from very fine to pebble; well sorted quartz sand; 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; well cemented; mollusks fragments floating in quartz sand; mechanically broken sandstone
33.75 - 35.0	No recovery
35.0 - 36.3	Mollusk-rich quartz sandstone and loose quartz sand, medium-light-gray N6 to white N9; mainly very fine to fine quartz sand and minor medium to coarse quartz sand; grains range from very fine to pebble; well sorted quartz sand; 3 percent very fine to fine black grains; mollusks, echinoids; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; well cemented; mollusk fragments floating in quartz sand; mechanically broken sandstone
36.3 - 37.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1180
37.0 - 38.5	Quartz sandstone with framework composed of whole mollusk shells and fragments, yellow-gray 5Y 8/1 and very light gray N8 to white N9; mainly very fine to fine quartz sand with minor medium to coarse quartz sand; grains range from very fine to pebble; well sorted quartz grains; mollusks, trace gastropods; 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; well cemented; hard
38.5 - 40.0	No recovery
40.0 - 42.0	Mollusk fragment-rich quartz sandstone, yellowish-gray 5Y 8/1 and very light gray N8 to white N9; mainly very fine to fine quartz sand with minor medium to very coarse quartz; grains range from very fine to pebble; moderately sorted quartz grains; mollusks, gastropods, coral, bryozoans, serpulids, echinoids; 3 percent very fine to fine black grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; well to moderately cemented; hard; mechanically broken
42.0 - 50.0	No recovery
50.0 - 51.5	Quartz sand, light-olive-gray 5Y 5/2; mainly fine to medium quartz sand with minor very fine quartz sand; well sorted; trace mollusks; less than 3 percent very fine black grains; 20 percent interparticle porosity; low hydraulic conductivity; trace clay matrix; burrowed
51.5 - 52.0	Quartz sand, yellowish-gray 5Y 7/2; mainly fine to medium quartz sand with minor coarse quartz sand; grains range from fine to pebble; moderately sorted quartz grains; 40 percent thick-shelled mollusk fragments; less than 3 percent very fine to fine black grains; 20 percent interparticle porosity; low hydraulic conductivity
52.0 - 53.0	No recovery
53.0 - 54.0	Quartz sand, yellowish-gray 5Y 7/2; mainly fine to medium quartz sand with minor coarse to very coarse quartz sand; grains range from fine to pebble; moderately to well sorted quartz sand; 30 percent mollusk fragments and minor gastropods; 3 percent very fine to fine black grains; 20 percent interparticle porosity; moderate hydraulic conductivity; mainly very pale orange 10YR 8/2 thin to thick mollusk shells and minor medium-light-gray N6 to light-gray N7 mollusk shells
54.0 - 55.0	No recovery
55.0 - 59.0	Quartz sand, yellowish-gray 5Y 7/2 to very pale orange 10YR 8/2; mainly fine quartz sand with minor medium quartz sand; medium to small pebble mollusk fragments; grains range from fine to pebble; well sorted quartz sand; mollusks and minor gastropods; 3 percent fine black grains; 20 percent interparticle porosity; moderate hydraulic conductivity; thin to moderately thick, very pale orange 10YR 8/2 mollusk shells; friable
59.0 - 60.0	No recovery
60.0 - 65.0	Quartz sand, yellowish-gray 5Y 8/1 to very pale orange 10YR 8/2; mainly fine to medium quartz grains with coarse quartz grains; grains range from fine to pebble; well sorted; 20 percent mollusks and minor gastropods; 3 percent fine black grains; 20 percent interparticle porosity; moderate hydraulic conductivity; thin to moderately thick, very pale orange 10YR 8/2 and medium-light-gray N6 to light-gray N7shells
65.0 - 66.0	No recovery
66.0 - 69.2	Quartz sand, yellowish-gray 5Y 8/1 to very pale orange 10YR 8/2; mainly fine to medium quartz grains with minor coarse quartz; grains range from fine to pebble; well sorted quartz grains; poorly sorted mix of quartz sand and shells; 40 percent mollusk shells and minor gastropods and echinoids; less than 3 percent very fine to fine black grains; 20 percent interparticle porosity; low hydraulic conductivity; thin to thick, very pale orange 10YR 8/2 and medium-light-gray N6 to light-gray N7 shells
69.2 - 70.0	No recovery
70.0 - 72.0	Quartz sand, yellowish-gray 5Y 8/1 to very pale orange 10YR 8/2; mainly fine to medium quartz grains with minor coarse quartz; grains range from clay to pebble; well sorted quartz grains; poorly sorted mix of quartz sand and shells; 40 percent mollusk shells and minor gastropods and echinoids; less than 3 percent very fine to fine black grains; 20 percent interparticle porosity; low hydraulic conductivity; thin to thick, very pale orange 10YR 8/2 and medium-light-gray N6 to light-gray N7 shells; minor lime mud matrix
72.0 - 72.5	No recovery
72.5 - 78.5	Quartz sand, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; mainly fine to medium quartz grains with minor coarse quartz sand; grains range from clay to pebble; well sorted quartz grains; poorly sorted mix of quartz sand and shells; 45 percent mollusks; 3 percent very fine to fine undifferentiated black grains and medium to coarse black phosphorite grains; 15 percent interparticle porosity; low hydraulic conductivity; mainly thick, very pale orange 10YR 8/2 mollusks; minor clay matrix
78.5 - 80.0	No recovery
80.0 - 82.75	Quartz sand, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; mainly fine to medium quartz grains with minor very fine and coarse to small pebble; grains range from very fine to pebble; well sorted quartz grains; poorly sorted mix of quartz sand and shells; mollusks; 3 percent very fine to fine undifferentiated black grains and medium to small pebble-size phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity; thin to thick, very pale orange 10YR 8/2 mollusk shells

Depth (feet below land surface)	Lithologic description of well C-1180
82.75 - 85.5	Quartz sand, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; mainly fine to medium quartz grains with minor very fine and coarse to small pebble; grains range from very fine to pebble; well sorted quartz grains; poorly sorted mix of quartz sand and shells; 10 percent mollusks; 3 percent very fine to fine undifferentiated black grains and medium to small pebble-size phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; thin to thick, very pale orange 10YR 8/2 mollusk shells
85.5 - 94.0	Quartz sand, yellowish-gray 5Y 8/1 to very light gray N8; mainly fine to medium quartz grains with minor very fine and coarse; grains range from very fine to coarse; well sorted quartz grains; poorly sorted mix of quartz sand and shells; 3 percent very fine to fine undifferentiated black grains and medium to coarse phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity
94.0 - 95.0	No recovery

Cypress Lane Core

Florida Geological Survey well number	Not applicable
GWSI number	C-1181
Total depth	200 feet
Cored from	0 to 200 feet
County	Collier
Location	SW, sec. 35, T49S, R31E
Latitude	26°10′02″
Longitude	81°12′03″
Elevation	17 feet
Completion date	March 12, 1998
Other types of available logs	Gamma ray, induction, neutron
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Kevin J. Cunningham (description for 100 to 200 feet is on file with the Geologic Division of the U.S. Geological Survey).
Undifferentiated limestone and quartz sand	0 to 10 feet
Tamiami Formation	10 to 99 feet
Pinecrest Sand Member	10 to 41.5 feet
Ochopee Limestone Member	41.5 to 99 feet
Top of unnamed sand	99 feet
Water-table aquifer	0 to 10 feet
Upper confining unit	10 to 41.5 feet
Gray limestone aquifer	41.5 to 99 feet
Lower confining unit	99 to 163 feet
Sand aquifer	163 to 182 feet
Confining unit	182 to 200 feet

Depth (feet below land surface)	Lithologic description of well C-1181
0.0 - 0.25	Quartz sand-rich lime mudstone, grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6; mainly clay-size lime mud and very fine to fine quartz sand; ranges from clay to pebble; 20 percent very fine to fine quartz sand; 5 percent interparticle porosity; very low hydraulic conductivity; glaebules(?) with circumgranular cracking
0.25 - 0.75	Mollusk lime floatstone and rudstone with skeletal fragment lime grainstone matrix; mainly medium to pebble-size fossils; ranges from clay to pebble; mollusks, skeletal fragments, echinoids; 20 percent interparticle porosity; moderate hydraulic conductivity
0.75 - 9.25	No recovery
9.25 - 10.0	Mechanically mixed fragments of mollusk lime rudstone with quartz sand-rich skeletal lime matrix and loose quartz sand, very pale orange 10YR 8/2, grayish-orange 10YR 7/4; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; ranges from very fine to fine; 20 percent very fine to fine quartz sand; skeletal fragments, mollusks, echinoids; 20 percent interparticle and intraparticle porosity; moderate hydraulic conductivity
10.0 - 13.0	Quartz sand; yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to very fine; 3 percent very fine black grains (heavy minerals?); minor silt and clay; trace skeletal fragments; 15 percent interparticle porosity; low hydraulic conductivity; minor silt and clay matrix; soft when wet; minor ripple cross laminations
13.0 - 18.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to very fine; 3 percent very fine black grains (probably heavy minerals); skeletal grains; 15 percent interparticle porosity; low hydraulic conductivity; minor silt and clay matrix; soft when wet; minor ripple cross laminations
18.0 - 20.0	No recovery
20.0 - 23.25	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to pebble; mollusks, oysters, bryozoans; 3 percent very fine black grains (probably heavy minerals); 15 percent interparticle porosity; low hydraulic conductivity; minor silt and clay matrix; soft when wet; fossil fragments floating in quartz sand matrix
23.25 - 29.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from clay to very fine; trace skeletal fragments; trace mica; 3 percent very fine black grains (probably heavy minerals); 15 percent interparticle porosity; low hydraulic conductivity; silt and clay matrix; soft when wet
29.0 - 30.0	Quartz sand, yellowish-gray 5Y 8/l; mainly very fine quartz sand; ranges from clay to pebble; abundant skeletal fragments, minor mollusks and oysters; 3 percent very fine black grains (probably heavy minerals); 15 percent porosity; low hydraulic conductivity; silt and clay matrix; soft when wet; fossils floating in quartz sand matrix
30.0 - 34.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; ranges from clay to pebble; abundant skeletal fragments, minor mollusks and oysters; 3 percent very fine black grains (probably heavy minerals); 10 percent porosity; low hydraulic conductivity; abundant silt and clay matrix; soft when wet; fossils floating in quartz sand matrix
34.0 - 35.0	No recovery
35.0 - 37.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; ranges from clay to pebble; abundant skeletal fragments, minor mollusks; 3 percent very fine black grains (probably heavy minerals); 5 percent interparticle porosity; low hydraulic conductivity; abundant silt and clay matrix; soft when wet; fossils floating in quartz sand matrix
37.0 - 39.0	Terrigenous mudstone, pale-olive 10Y 6/2; mainly terrigenous clay and silt-size quartz grains; ranges from clay to granule; benthic forams, mollusks, skeletal fragments; silt and very fine quartz sand; 5 percent interparticle porosity; very low hydraulic conductivity; minor ripple cross laminations; fossils floating in mudstone
39.0 - 40.1	Terrigenous mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay and silt-size quartz grains; ranges from clay to granule; benthic forams, mollusks, skeletal fragments; silt and very fine quartz sand; 5 percent interparticle porosity; very low hydraulic conductivity; minor ripple cross laminations; fossils floating in mudstone
40.1 - 41.5	Phosphorite grains and quartz sand in terrigenous clay matrix, light-olive-gray 5Y 6/1; mainly fine sand to small pebble-size phosphorite grains, silt to medium quartz sand and terrigenous clay; ranges from clay to pebble; 10 percent interparticle porosity; very low hydraulic conductivity
41.5 - 42.0	Mollusk lime rudstone with skeletal lime packstone matrix, yellowish-gray 5Y 7/2 to black N1 to medium-light-gray N6; mainly medium to pebble-size fossils; ranges from clay to pebble; mollusks, skeletal fragments, bryozoans; 15 percent interparticle, intraparticle and moldic porosity; medium hydraulic conductivity; probably surface of maximum starvation; black-colored rock is phosphorite or chert, but possibly blackened calcrete
42.0 - 49.0	Skeletal fragment lime rudstone with well-washed skeletal lime packstone matrix, yellow-gray 5Y 8/1; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, echinoids; 15 percent interparticle, intraparticle and moldic; medium hydraulic conductivity; poorly cemented; friable; soft when wet
49.0 - 50.0	No recovery
50.0 - 51.5	Skeletal fragment lime mudstone with matrix of skeletal fragment lime packstone with terrigenous mudstone matrix; medium-light-gray N6 to light-gray N7, light-olive-gray 5Y 6/1 clay matrix; mainly clay to pebble size; ranges from clay to pebble size; skeletal fragments, mollusks; 15 percent interparticle and moldic porosity; low hydraulic conductivity; poorly cemented; friable; soft when wet; locally well cemented and hard
51.5 - 55.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1181
55.0 - 57.5	Skeletal lime rudstone with well-washed lime packstone matrix, medium-light-gray N6 to very light gray N8 to yellowish-gray 5Y 8/1; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks; 10 percent very fine to fine quartz sand; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity ; poorly cemented; friable; soft when wet
57.5 - 60.0	No recovery
60.0 - 63.0	Skeletal lime rudstone with quartz sand-rich skeletal lime packstone matrix, medium light-gray N6 to very light gray N8; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, echinoids; 20 percent very fine to medium quartz sand; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly to well cemented; locally friable; soft to hard when wet
63.0 - 65.0	No recovery
65.0 - 65.25	Skeletal lime rudstone with quartz sand-rich skeletal lime packstone matrix, medium-light-gray N6 to very light gray N8; mainly medium to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, bryozoans, echinoids; 20 percent very fine to medium quartz sand; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly to well cemented; locally friable; soft to hard when wet
65.25 - 72.2	Mollusk lime rudstone with quartz sand matrix, very light gray N8 to white N9; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; ranges from very fine to pebble; mollusks, skeletal fragments; 60 percent very fine to fine quartz sand; 15 percent interparticle porosity; moderate hydraulic conductivity; poorly cemented; friable; soft to moderately hard when wet
72.2 - 77.0	Mollusk lime floatstone with quartz sand-rich skeletal fragment well-washed lime packstone matrix, medium-gray N5 to white N9; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; ranges from clay to pebble; skeletal fragments, mollusks, echinoids; 40 percent very fine to fine quartz sand; 15 percent interparticle porosity; moderate hydraulic conductivity; poorly cemented, friable; soft to moderately hard when wet
77.0 - 79.5	Mollusk lime rudstone and floatstone with quartz sand-rich skeletal lime packstone, light-gray N7 to very light gray N8; mainly clay to pebble; mollusks, skeletal fragments; 20 to 40 percent very fine to fine quartz sand; 10 percent moldic and interparticle porosity; low hydraulic conductivity; poorly to moderately cemented; locally friable
79.5 - 80.0	No recovery
80.0 - 82.0	Mollusk lime rudstone and floatstone with quartz sand-rich skeletal lime packstone, very light gray N8; mainly clay to pebble; mollusks, skeletal fragments; 20 to 40 percent very fine to fine quartz sand; 10 percent moldic and interparticle porosity; low hydraulic conductivity; poorly to moderately cemented; locally friable
82.0 - 87.7	Mollusk lime rudstone and floatstone with quartz sand-rich well-washed skeletal lime packstone matrix, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; ranges from clay to pebble; mollusks, skeletal fragments; 20 to 40 percent very fine to fine quartz sand; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; soft to moderately hard when wet
87.7 - 89.0	Mollusk lime rudstone and floatstone with quartz sand-rich well-washed skeletal lime packstone matrix, very light gray N8; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; ranges from clay to pebble; mollusks, skeletal fragments; 20 to 40 percent very fine to fine quartz sand; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; soft to moderately hard when wet
89.0 - 90.0	No recovery
90.0 - 98.5	Mollusk lime rudstone with matrix of quartz sand-rich skeletal lime packstone and well-washed quartz sand-rich skeletal lime packstone, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and medium sand to pebble-size quartz fossils; minor medium to very coarse quartz sand; ranges from clay to pebble; mollusks, skeletal fragments, gastropods; 20 to 45 percent very fine to fine quartz sand; trace medium to small pebble-size black phosphorite grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; soft to moderately hard when wet
98.5 - 99.0	Mollusk lime rudstone with matrix of quartz sand-rich skeletal lime packstone and well-washed quartz sand-rich skeletal lime packstone, light-gray N7; mainly very fine to fine quartz sand and medium sand to pebble-size quartz fossils; minor medium to very coarse quartz sand; ranges from clay to pebble; mollusks, skeletal fragments, gastropods; 20 to 45 percent very fine to fine quartz sand; trace medium to small pebble-size black phosphorite grains; 15 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable; soft to moderately hard when wet
99.0 - 99.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; ranges from silt to coarse; minor mollusks; 3 to 10 percent very fine black phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet; marine sands; appears conformable with overlying limestone
99.0 - 100.0	Quartz sand, light-olive-gray 5Y 6/1; mainly very fine quartz sand; ranges from silt to coarse; minor mollusks; 3 to 10 percent very fine black phosphorite grains; 15 percent interparticle porosity; moderate hydraulic conductivity; poorly cemented; friable; soft when wet; marine sands

Alligator Alley East Core

Florida Geological Survey well number	**W-17749**
GWSI number	**C-1182**
Total depth	**200 feet**
Cored from	**0 to 200 feet**
County	**Collier**
Location	**NW, NW, sec. 1, T50S, R33E**
Latitude	**26°10′11″**
Longitude	**80°59′21″**
Elevation	**13 feet**
Completion date	**May 30, 1998**
Other types of logs available	**Gamma ray, induction, single-point resistivity, spontaneous potential**
Owner	**U.S. Geological Survey**
Driller	**Florida Geological Survey**
Core described by	**Kevin J. Cunningham**
Undifferentiated limestone	**0 to 3.7 feet**
Tamiami Formation	**3.7 to 128 feet (128 feet picked from gamma-ray log)**
Pinecrest Sand Member	**3.7 to 74 feet**
Ochopee Limestone Member	**74 to 125 feet**
Unnamed formation	**125 to 145.5 feet**
Top of Peace River Formation	**145.5 to 199.8 feet**
Upper confining unit	**0 to 74 feet**
Gray limestone aquifer	**74 to 125 feet**
Top of lower confining unit	**125 feet**

Depth (feet below land surface)	Lithologic description of well C-1182
0.0 - 3.7	Quartz sand-rich, pelecypod lime wackestone, very pale orange 10YR 8/2, grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6, moderate-yellowish-brown 10YR 5/4; mainly clay-size lime mudstone and very fine to fine quartz sand, minor silt-size quartz and medium sand to pebble-size fossils; 10 percent quartz sand; 5 percent moldic porosity; low hydraulic conductivity; shallow marine; drilled with rotary cone bit from 0 to 3.7 feet; results from observation cuttings between 0 and 3.7 feet
3.7 - 4.8	Quartz sand, very pale orange 10YR 8/2, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and sand to pebble-size fossil fragments; minor medium sand to pebble-size fossils, silt and medium to coarse quartz sand and very fine sand size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular very fine to fine sand-size quartz; subangular to subrounded, medium to coarse sand-size quartz; 35 percent broken pelecypods and caved rock fragments; trace black N1 phosphorite and heavy mineral grains; 10 percent interparticle porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; minor lime mud matrix; soft when wet; friable; abundant caved rock fragments; massive with no apparent bedding
4.8 - 5.8	Quartz sand, mottled very pale orange 10YR 8/2, grayish-orange 10YR 7/4; dark-yellowish-orange 10YR 6/6; mainly very fine to fine quartz sand; minor terrigenous clay, silt-size quartz sand, medium sand to pebble-size fossils and very fine phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; 20 percent skeletal and pelecypods fragments; trace black N1 phosphorite and heavy mineral grains; 15 percent intergranular porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; trace terrigenous clay matrix; soft when wet; friable; massive with no apparent bedding
5.8 - 8.0	No recovery
8.0 - 11.3	Quartz sand, mottled very pale orange 10YR 8/2, grayish-orange 10YR 7/4; dark-yellowish-orange 10YR 6/6; mainly very fine quartz sand; minor terrigenous clay, silt and fine quartz sand, medium sand and pebble-size fossils and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; 5 percent broken pelecypod fragments (possible cave from above) and rock fragments (cave from above); trace black N1 phosphorite grains and heavy mineral grains; trace mica; 15 percent interparticle porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; trace terrigenous clay matrix; soft when wet; friable; massive with no apparent bedding
11.3 - 13.0	No recovery
13.0 - 17.0	Quartz sand, yellowish-gray 5Y 8/1; minor mottling with grayish-orange 10YR 7/4; mainly very fine quartz sand; minor terrigenous clay, silt, and fine quartz sand, medium sand- and granule-size fossils and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; trace skeletal fragments; trace mica; 1 percent black N1 phosphorite and heavy mineral grains; 15 percent interparticle porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; trace terrigenous clay matrix; soft when wet; friable; massive with no apparent bedding
17.0 - 18.0	No recovery
18.0 - 20.0	Quartz sand, yellowish-gray 5Y 8/1; minor mottling with grayish-orange 10YR 7/4; mainly very fine quartz sand; minor terrigenous clay, silt, and fine quartz sand; medium sand and granule-size fossils and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; trace skeletal fragments; trace mica; 1 percent black N1 phosphorite and heavy mineral grains; 15 percent interparticle porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; trace terrigenous clay matrix; soft when wet; friable; massive with no apparent bedding
20.0 - 23.0	No recovery
23.0 - 25.0	Quartz sand, yellowish-gray 5Y 8/1, minor mottling with grayish-orange 10YR 7/4; mainly very fine quartz sand and terrigenous clay; minor silt and fine quartz sand, medium sand and granule-size fossils and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; trace skeletal and pelecypods fragments; trace mica; 1 percent black N1 phosphorite and heavy mineral grains; 5 percent interparticle porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; minor terrigenous clay matrix; soft when wet; friable; burrowed; massive with no apparent bedding
25.0 - 28.0	No recovery
28.0 - 42.0	Quartz sand, yellowish-gray 5Y 8/1; minor mottling with moderate-orange-pink 5YR 8/4 and moderate-yellow 5Y 7/6; mainly very fine quartz sand; minor terrigenous clay, minor silt and fine quartz sand, medium sand and granule-size fossils and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; trace skeletal and pelecypods fragments; trace mica; 1 percent black N1 phosphorite and heavy mineral grains; 10 percent interparticle porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; minor terrigenous clay matrix; soft when wet; friable; burrowed; massive with no apparent bedding
42.0 - 47.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; minor terrigenous clay, minor silt-size quartz sand, medium sand and granule-size fossils and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; trace skeletal and pelecypods fragments; trace mica; 1 percent black N1 phosphorite and heavy mineral grains; 10 percent interparticle porosity; low hydraulic conductivity; shallow-marine siliciclastic shelf; minor terrigenous clay matrix; soft when wet; friable; burrowed; massive with no apparent bedding
47.0 - 51.5	No recovery

Depth (feet below land surface)	Lithologic description of well C-1182
51.5 - 52.5	Terrigenous clay-rich quartz sand, yellowish-gray 5Y 7/2; mainly terrigenous clay and very fine quartz sand; minor silt-size quartz sand and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; trace skeletal fragments; trace black N1 phosphorite and heavy mineral grains; 5 percent interparticle porosity; very low hydraulic conductivity; shallow marine below wave base; abundant terrigenous clay matrix; soft when wet; cohesive when wet
52.5 - 53.8	Terrigenous mudstone, yellowish-gray 5Y 7/2, light-olive-gray 5Y 6/1; mainly terrigenous clay; minor silt to very fine quartz sand and very fine to fine sand-size black phosphorite grains; very well sorted quartz sand; angular to subangular quartz sand; trace fish scales; 3 percent black N1 phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm-wave base(?), prodelta(?); thin laminations; soft when wet; top of unit is maximum flooding surface
53.8 - 54.5	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 6/1; mainly very fine quartz sand; minor terrigenous clay, silt, and very fine and medium to coarse quartz sand and very fine sand-size phosphorite grains; well sorted quartz sand; angular to subangular quartz sand; 3 percent black N1phosphorite grains; trace mica; 10 percent interparticle porosity; low hydraulic conductivity; marine above storm-wave base; soft when wet
54.5 - 57.0	Terrigenous mudstone, light-olive-gray 5Y 6/1; mainly terrigenous clay; minor silt and very fine quartz sand; very fine sand-size phosphorite grains; very well sorted quartz sand; angular to subangular quartz sand; trace black N1 phosphorite grains; fish scales; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm wave base(?), prodelta(?); very fine laminations; soft when wet
57.0 - 62.0	Terrigenous mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay; minor silt-size quartz sand; very fine sand-size phosphorite grains; trace fish scales, mica and black N1 phosphorite grains; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm wave base(?), prodelta(?); soft when wet
62.0 - 63.0	Quartz sandstone, light-olive-gray 5Y 5/2; mainly terrigenous clay and silt to very fine quartz sand; minor pebble-size skeletal fragments and phosphorite grains that are mainly very fine sand size with minor fine to medium sand size; mainly very fine sand-size phosphorite grains with minor fine to medium sand-size grains; trace black N1 phosphorite grains, mica and skeletal fragments; 5 percent interparticle porosity; very low hydraulic conductivity; marine above storm wave base(?), prodelta(?); soft when wet; abundant terrigenous clay matrix
63.0 - 65.0	Terrigenous mudstone, light-olive-gray 5Y 6/1; mainly terrigenous clay; minor silt to very fine sand-size quartz sand, and mainly very fine sand-size phosphorite grains with minor fine to medium sand-size grains; moderately sorted quartz sand; angular to subangular; 20 percent quartz sand; trace black N1 phosphorite grains, mica and fish scales; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm wave base(?), prodelta(?); soft when wet
65.0 - 66.0	Terrigenous mudstone, light-olive-gray 5Y 6/1; mainly terrigenous clay; minor quartz sand that is mainly very fine to fine quartz sand and silt- and medium to very coarse quartz sand, and mainly very fine sand-size phosphorite grains with minor fine to medium sand-size grains; moderately sorted quartz sand; angular to subangular silt to fine sand-size quartz sand and subangular to subrounded medium to very coarse quartz sand; 20 to 40 percent quartz sand; trace black N1 phosphorite grains, mica and pelecypods; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm wave base(?), prodelta(?); soft when wet; quartz sand floating mudstone matrix
66.0 - 67.0	Terrigenous mudstone, yellowish-gray 5Y 7/2; mainly terrigenous clay; minor quartz sand that is mainly very fine to fine quartz sand and silt and medium to very coarse quartz sand, and mainly very fine sand-size phosphorite grains with minor fine to medium sand-size grains; moderately sorted quartz sand; angular to subangular silt- to fine sand-size quartz sand and subangular to subrounded medium to very coarse quartz sand; 20 to 40 percent quartz sand; trace black N1 phosphorite grains, mica and pelecypods; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm wave base(?), prodelta(?); soft when wet; quartz sand floating mudstone matrix
67.0 - 68.0	Terrigenous mudstone, yellowish-gray 5Y 7/2; mainly terrigenous clay; mainly very fine to fine quartz sand, silt and medium to coarse quartz sand, and very fine sand-size phosphorite grains; moderately sorted quartz sand; angular to subangular silt to fine quartz sand and subangular to subrounded medium to very coarse quartz sand; 20 to 40 percent quartz sand; trace black N1 phosphorite grains, mica and pelecypods; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm wave base(?), soft when wet; quartz sand floating mudstone matrix
68.0 - 70.0	Terrigenous mudstone, yellowish-gray 5Y 8/1; mainly terrigenous clay; minor quartz sand that is mainly very fine to fine silt and medium to coarse, and very fine sand-size phosphorite grains; moderately sorted quartz sand; angular to subangular silt to fine quartz sand and subangular to subrounded medium to very coarse quartz sand; 20 to 40 percent quartz sand; trace black N1 phosphorite grains, mica and pelecypods; 5 percent interparticle porosity; very low hydraulic conductivity; marine below storm wave base(?); soft when wet; quartz sand floating mudstone matrix
70.0 - 73.0	Quartz sandstone, yellowish-gray 5Y 8/1; mainly medium to coarse quartz sand and terrigenous clay; minor silt to fine quartz sand and very fine to coarse sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 10 to 30 percent pelecypod fragments and disarticulated valves; trace black N1 phosphorite grains and mica; 10 percent interparticle porosity; low hydraulic conductivity; marine below storm wave base(?); soft when wet; some quartz sand floating mudstone matrix or grain supported with abundant mud matrix

Depth (feet below land surface)	Lithologic description of well C-1182
73.0 - 74.0	Quartz sandstone, yellowish-gray 5Y 7/2; mainly medium to coarse quartz sand and terrigenous clay; minor silt to fine quartz sand and very fine to coarse sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 10 to 30 percent pelecypod fragments and disarticulated valves; trace black N1 phosphorite grains and mica; 10 percent interparticle porosity; low hydraulic conductivity; marine below storm wave base(?); soft when wet; some quartz sand floating mudstone matrix or grain supported with abundant mud matrix
74.0 - 76.5	Pelecypod lime rudstone with skeletal lime grainstone and mud-dominated lime packstone matrix, light-gray N7, yellowish-gray 5Y 8/1; mainly medium sand and pebble-size fossils; minor clay-size lime mudstone and silt to medium sand-size fossils; skeletal fragments, pelecypods, encrusting and branching bryozoans and barnacles; 25 percent interparticle, intraparticle, moldic, and bored porosity; moderate hydraulic conductivity; ramp; soft to moderately hard when wet; friable to moderately friable; blackened upper bounding surface with 0.5-inch microtopography, either maximum starvation surface or blackened exposure surface
76.5 - 79.0	No recovery
79.0 - 83.0	Pelecypod lime rudstone and floatstone with skeletal lime grain-dominated lime packstone and skeletal lime grainstone matrix; light-gray N7; mainly medium sand and pebble-size fossils; minor clay-size lime mudstone and silt to fine sand-size fossils; skeletal fragments, pelecypods, encrusting and branching bryozoans, sand dollars, serpulids and gastropods; 30 percent interparticle, moldic, intraparticle and bored porosity; high hydraulic conductivity; ramp; moderately hard to hard when wet
83.0 - 83.7	No recovery
83.7 - 88.0	Pelecypod lime rudstone and floatstone with skeletal grain-dominated lime packstone and grainstone matrix, light-gray N7, yellowish-gray 5Y 8/1; mainly medium sand and pebble-size fossils; minor clay-size lime mudstone and silt to fine sand-size fossils, very fine to fine quartz sand and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subrounded quartz sand; skeletal fragments, pelecypods, encrusting and branching bryozoans, serpulids and gastropods; trace to 10 percent quartz sand; trace black N1 phosphorite and heavy mineral grains; 30 percent interparticle, moldic, intraparticle and bored porosity; high hydraulic conductivity; ramp; hard when wet
88.0 - 91.0	No recovery
91.0 - 95.2	Pelecypod lime rudstone and floatstone with skeletal grain-dominated lime packstone and mud-dominated packstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly medium sand and pebble-size fossils and clay-size lime mudstone; minor silt to fine sand-size fossils, very fine to coarse (mainly very fine to fine) sand-size quartz sand, and very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subrounded quartz sand; skeletal fragments, pelecypods, sand dollars, and *Vermicularia*; trace to 30 percent quartz sand; trace black N1 phosphorite and heavy mineral grains; 30 percent interparticle, moldic, intraparticle, bored, and shelter porosity; high hydraulic conductivity; ramp; hard to moderately hard when wet
95.2 - 97.0	No recovery
97.0 - 99.5	Pelecypod lime rudstone and floatstone with skeletal grainstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly medium sand and pebble-size fossils; minor silt to fine sand-size fossils, very fine to coarse (mainly very fine to fine) quartz sand, and very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subrounded quartz sand; skeletal fragments, pelecypods, serpulids, *Vermicularia*, gastropods, and trace coral; 10 percent quartz sand; trace black N1 phosphorite and heavy mineral grains; 30 percent interparticle, moldic, intraparticle, bored, and shelter porosity; high hydraulic conductivity; ramp; hard to moderately hard when wet
99.5 - 101.0	No recovery
101.0 - 107.0	Pelecypod lime floatstone and rudstone with quartz sand-rich skeletal grain-dominated packstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly medium sand and pebble-size fossils; minor clay-size lime mudstone, silt to fine sand-size fossils, very fine to coarse (mainly very fine to fine) quartz sand, and very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; skeletal fragments, pelecypods, serpulids, gastropods and bryozoans; 10 to 30 percent quartz sand; 1 percent black N1 phosphorite and heavy mineral grains; 25 percent interparticle, moldic, intraparticle, bored and shelter porosity; high hydraulic conductivity; ramp; hard to moderately hard when wet
107.0 - 108.0	No recovery
108.0 - 115.0	Pelecypod lime floatstone and rudstone with quartz sand-rich skeletal mud-dominated packstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly medium sand and pebble-size fossils, very fine to fine quartz sand and clay-size lime mudstone; minor silt to fine sand-size fossils, very fine and medium to very coarse quartz sand, and very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subangular very fine to fine quartz sand and subangular to subrounded medium to very coarse quartz sand; skeletal fragments, pelecypods, gastropods, serpulids and bryozoans; 20 to 45 percent quartz sand; 2 percent black N1 phosphorite and heavy mineral grains; 25 percent interparticle, moldic, intraparticle, bored and shelter porosity; high hydraulic conductivity; ramp; hard to moderately hard when wet

Depth (feet below land surface)	Lithologic description of well C-1182
115.0 - 122.0	Quartz sand-rich pelecypod lime floatstone with quartz sand-rich skeletal mud-dominated packstone matrix and skeletal-rich quartz sandstone with lime mudstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; mainly medium sand and pebble-size fossils, very fine to fine quartz sand and clay-size lime mudstone; minor silt to fine sand-size fossils, very fine and medium to very coarse quartz sand, and very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subangular very fine to fine quartz sand and subangular to subrounded medium to very coarse quartz sand; skeletal fragments, pelecypods, gastropods, sand dollars, and serpulids; 30 to 70 percent quartz sand; 2 percent black N1 phosphorite and heavy mineral grains; 25 percent interparticle, moldic, intraparticle, bored, and shelter porosity; high hydraulic conductivity; ramp; hard to moderately hard when wet
122.0 - 128.0	No recovery
128.0 - 131.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor terrigenous clay, silt-size quartz sand, very fine sand to pebble-size fossils and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; skeletal fragments and pelecypods; 15 to 20 percent black N1 phosphorite grains; trace heavy mineral grains; trace mica; 15 percent interparticle porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; burrowed
131.0 - 131.8	No recovery
131.8 - 135.5	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; minor terrigenous clay, silt-size quartz sand, very fine sand to pebble-size fossils (mainly pebble size) and very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; 10 to 35 percent thin-shelled pelecypods; 20 to 30 percent black N1 phosphorite grains; trace heavy mineral grains; trace mica; 15 percent interparticle porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable
135.5 - 136.0	No recovery
136.0 - 140.2	Quartz sand; yellowish-gray 5Y light-olive-gray 7/2, 5Y 6/1; mainly very fine quartz sand; minor terrigenous clay, silt-size quartz sand, very fine sand- to pebble-size fossils (mainly pebble size) and very fine to medium sand-size (mainly very fine) phosphorite and very fine sand-size heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; 10 to 30 percent thin-shelled pelecypods; 30 percent black N1 phosphorite grains; trace heavy mineral grains; trace mica; 10 percent interparticle porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable
140.2 - 140.8	No recovery
140.8 - 145.5	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 6/1; mainly very fine quartz sand; minor terrigenous clay, silt-size quartz sand, very fine sand to pebble-size fossils (mainly pebble-size) and very fine sand to small pebble-size (mainly very fine) phosphorite and very fine sand-size heavy mineral grains; very well sorted quartz sand; angular to subangular quartz sand; absent to 10 percent thin-shelled pelecypods in upper half of interval; 30 to 40 percent black N1 phosphorite grains; trace heavy mineral grains; trace mica; 10 percent interparticle porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; coarse phosphorite float in quartz sand matrix possibly indicating deposition as a mass flow or reworking by bioturbation
145.5 - 150.0	Terrigenous mudstone with minor quartz sand laminations; olive-gray 5Y 4/1 terrigenous mudstone, pale-olive 10Y 6/2; mainly terrigenous clay, silt to very fine quartz sand, very fine sand to very coarse sand-size (mainly very fine) phosphorite, very fine sand-size heavy mineral grains, fine to medium sand-size benthic foraminifers and trace pebble-size quartz sandstone intraclasts; very well sorted quartz sand; angular to subangular quartz sand; benthic foraminifers and fish scales; 20 to 40 percent black N1 phosphorite grains, trace heavy minerals and trace mica in quartz-sand laminations; trace quartz sandstone intraclasts; less than 5 percent interparticle porosity; very low hydraulic conductivity; subtidal marine, distal shelf; soft when wet; coarse phosphorite float in quartz sand matrix possibly indicating deposition as a mass flow; very finely laminated mudstone in part; trace horizontal *Ophiomorpha*(?), possibly compacted round tube
150.0 - 154.5	Terrigenous mudstone, light-olive-gray 5Y 5/2, yellowish-gray 5Y 7/2; mainly terrigenous clay and fine to medium sand-size foraminifers; small benthic foraminifers; less than 5 percent interparticle porosity; very low hydraulic conductivity; subtidal marine, distal shelf; soft when wet; very finely laminated mudstone in part; trace burrowing that includes horizontal *Ophiomorpha*(?), possibly compacted round tube; discontinuous laminations that are benthic foram lime grainstones (80 percent forams), hydraulically sorted lag deposit
154.5 - 160.0	Diatomaceous terrigenous mudstone, yellowish-gray 5Y 7/2; mainly terrigenous clay and fine to medium sand-size diatoms and foraminifers; diatoms, small benthic foraminifers and fish scales; less than 5 percent interparticle porosity; very low hydraulic conductivity; subtidal marine, distal shelf; soft when wet; very finely laminated mudstone in part; trace burrowing
160.0 - 170.0	Diatomaceous terrigenous mudstone, yellowish-gray 5Y 7/2; mainly terrigenous clay and fine to medium sand-size diatoms and foraminifers and very fine sand-size phosphorite grains; abundant diatoms, minor small benthic foraminifers and fish scales; trace black N1 phosphorite grains and mica less than 5 percent interparticle porosity; very low hydraulic conductivity; subtidal marine, distal shelf; soft when wet; very finely laminated mudstone in part; trace burrowing
170.0 - 171.0	Quartz sandstone with abundant terrigenous clay matrix, yellowish-gray 5Y 7/2; mainly silt to very fine quartz sand and terrigenous clay; minor medium to very coarse quartz sand, very fine to fine sand-size phosphorite and fine to medium sand-size foraminifers; moderately sorted, angular to subangular, very fine to fine quartz sand and subangular to subrounded, medium to very coarse quartz sand; 15 percent black N1 phosphorite grains; 10 percent small benthic foraminifers; 10 percent interparticle porosity; low hydraulic conductivity; subtidal marine, distal shelf(?); soft when wet; cohesive

Depth (feet below land surface)	Lithologic description of well C-1182
171.0 - 174.0	No recovery
174.0 - 198.5	Quartz sandstone with minor terrigenous clay matrix, light-olive-gray 5Y 5/2, minor yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor terrigenous clay; medium to very coarse-size quartz sand, very fine to fine sand-size phosphorite and pebble-size pelecypods; moderately sorted, angular to subangular, very fine to fine, and subangular to subrounded medium to very coarse quartz sand; 15 percent black N1 phosphorite grains; trace large thin-shelled pelecypods; 10 percent interparticle porosity; low hydraulic conductivity; subtidal marine, distal shelf(?); soft when wet; cohesive
198.5 - 194.0	Quartz sandstone with minor terrigenous clay matrix, light-olive-gray 5Y 5/2, minor yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor terrigenous clay; very fine to fine sand-size phosphorite; well sorted quartz sand; angular to subangular quartz sand; 15 percent black N1 phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; subtidal marine, distal shelf(?); soft when wet; cohesive
194.0 - 195.0	No recovery
195.0 - 197.2	Quartz sandstone with minor terrigenous clay matrix, light-olive-gray 5Y 5/2, minor yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor clay-size terrigenous clay; very fine to fine sand-size phosphorite; well sorted quartz sand; angular to subangular quartz sand; 15 percent black N1 phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; subtidal marine, distal shelf(?); soft when wet; cohesive
197.2 - 197.6	Silty terrigenous mudstone, yellowish-gray 5Y 7/2; mainly terrigenous clay; minor very fine to fine sand-size phosphorite; abundant small benthic foraminifers; 3 percent black N1 phosphorite grains; less than 5 percent interparticle porosity; very low hydraulic conductivity; subtidal marine, distal shelf(?); soft when wet; cohesive
197.6 - 199.8	Quartz sandstone with minor terrigenous clay matrix, light-olive-gray 5Y 5/2, minor yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor terrigenous clay; very fine to fine sand-size phosphorite; well sorted quartz sand; angular to subangular quartz sand; 15 percent black N1 phosphorite grains; 10 percent interparticle porosity; low hydraulic conductivity; subtidal marine, distal shelf(?); soft when wet; cohesive; heavily bioturbated
199.8 - 200.0	No recovery

Baker's Grade Core

Florida Geological Survey well number	**W-17750**
GWSI number	**C-1183**
Total depth	**179 feet**
Cored from	**0 to 179 feet**
County	**Collier**
Location	**SW, sec. 7, T49S, R32E**
Latitude	**26°15′04″**
Longitude	**81°10′23″**
Elevation	**15 feet**
Completion date	**July 4, 1998**
Other types of available logs	**Gamma ray, induction, spontaneous potential, single-point resistivity**
Owner	**U.S. Geological Survey**
Driller	**Florida Geological Survey**
Core described by	**Kevin J. Cunningham**
Undifferentiated quartz sand and minor limestone	**0 to 5.9 feet**
Tamiami Formation	**5.9 to 86 feet**
Pinecrest Sand Member	**5.9 to 40.6 feet**
Ochopee Limestone Member	**40.6 to 83 feet**
Unnamed formation	**83 to 109 feet**
Peace River Formation	**109 to 179 feet**
Water-table aquifer	**0 to 5.9 feet**
Upper confining unit	**5.9 to 40.6 feet**
Gray limestone aquifer	**40.6 to 83 feet**
Lower confining unit	**83 to 179 feet**

Depth (feet below land surface)	Lithologic description of well C-1183
0.0 - 2.0	Quartz sand, very pale orange 10YR 8/2, pale-yellowish-brown 10YR 6/2; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor medium quartz sand; very fine to fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subrounded to rounded quartz sand; trace phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; modern roots in upper 1 foot of interval
2.0 - 3.8	Quartz sand, very pale orange 10YR 8/2, pale-yellowish-brown 10YR 6/2 and mottling with 10YR 7/4 grayish-orange; black N1 phosphorite and heavy mineral grains; mainly fine quartz sand; minor very fine and medium to coarse quartz sand; very fine to fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subrounded to rounded quartz sand; 1 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity and trace root-mold porosity; moderate hydraulic conductivity; soft when wet; friable; minor root molds lined with dusky-brown 5YR 2/2 organic stain
3.8 - 4.0	Quartz sand-rich lime mudstone, very pale orange 10YR 8/2, dark-yellowish-orange 10YR 6/6, grayish-orange 10YR 7/4; mainly clay-size lime mud and very fine quartz sand; very well sorted quartz sand; subangular to subrounded quartz sand; 5 percent vuggy porosity; low hydraulic conductivity; hard when wet; very well consolidated and cemented; iron-oxide staining suggests subaerial exposure at 3.8 feet
4.0 - 5.9	Quartz sand, very pale orange 10YR 8/2, pale-yellowish-brown 10YR 6/2; black N1 phosphorite and heavy mineral grains; mainly fine quartz sand; minor very fine and medium to coarse quartz sand; very fine to fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subrounded to rounded quartz sand; trace phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
5.9 - 6.0	Quartz sandstone, light-gray N7, grayish-orange 10YR 7/4, pale-yellowish-orange 10YR 8/6, dark-yellowish-orange 10YR 6/6; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor medium to coarse quartz sand; very fine to fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subrounded to rounded quartz sand; trace phosphorite and heavy mineral grains; 5 percent vuggy porosity; low hydraulic conductivity; hard when wet; well cemented with calcite; abrupt contact with soft sand above and iron-oxide staining suggests possible subaerial exposure surface at 5.9 feet
6.0 - 6.6	Fill with lithology from interval between 4 and 5.9 feet
6.6 - 8.0	Quartz sand, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor clay-size lime mud and terrigenous clay; fine to coarse sand-size skeletal fragments; very fine to fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; trace skeletal fragments; trace phosphorite and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable
8.0 - 10.5	Quartz sand, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor clay-size lime mud and terrigenous clay; fine sand to large pebble-size fossils; very fine to fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; 5 percent pelecypod fragments, barnacles, benthic foraminifers; trace to 2 percent phosphorite and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable
10.5 - 11.0	No recovery
11.0 - 24.0	Quartz sand, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor clay-size lime mud and terrigenous clay; fine sand to large pebble-size fossils; very fine to fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; 5 percent pelecypod fragments, barnacles, benthic foraminifers; trace to 2 percent phosphorite and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf, below wave base; soft when wet; friable; moderately bioturbated
24.0 - 25.0	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor clay-size lime mud and terrigenous clay; fine sand to large pebble-size fossils; very fine to fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; 5 percent pelecypod fragments, barnacles, benthic foraminifers; trace to 2 percent phosphorite and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf below wave base; soft when wet; friable; moderately bioturbated
25.0 - 27.5	Terrigenous mudstone interlaminated with quartz sand, 5Y 6/1 light-olive-gray mudstone; yellowish-gray 5Y 8/1 quartz sand; black N1 phosphorite and heavy mineral grains; mainly clay-size terrigenous mud; minor very fine quartz sand; very fine to fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; abundant benthic foraminifers; trace to 3 percent phosphorite and heavy mineral grains; trace mica; less than 5 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf below storm wave base; prodelta(?), soft when wet; quartz sand, friable; moderately bioturbated; abrupt irregular contact at 25 feet; soft sediment loading may have produced irregular contact at 25 feet; coarsening upward succession from 27.5 to 5.9 feet
27.5 - 31.0	Quartz sand, yellowish-gray 5Y 7/2 and 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay; fine sand to large pebble-size fossils; very fine to fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; minor skeletal fragments; trace phosphorite, and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf below wave base; soft when wet; friable; moderately bioturbated; minor terrigenous mudstone laminations

Depth (feet below land surface)	Lithologic description of well C-1183
31.0 - 31.7	Terrigenous mudstone, yellowish-gray 5Y 7/2 and 5Y 8/1; mainly terrigenous clay and silt-size quartz sand; absent to 5 percent pelecypods and skeletal fragments; trace in situ plant roots; trace intergrain microporosity; very low hydraulic conductivity; marine siliciclastic shelf; prodelta(?); soft when wet; well consolidated
31.7 - 32.5	Terrigenous mudstone, light-olive-gray 5Y 8/1, grayish-yellow 5Y 8/4; mainly terrigenous clay and silt-size quartz sand; trace in situ plant roots; trace intergrain microporosity; very low hydraulic conductivity; marine siliciclastic shelf; prodelta(?); soft when wet; well consolidated; bioturbated
32.5 - 34.5	Terrigenous mudstone with minor quartz sand laminations, yellowish-gray 5Y 7/2, light-olive-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly terrigenous clay; minor silt and very fine quartz sand, very fine sand-size phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; minor benthic foraminifers; trace fish scales(?) and fish teeth(?); trace in situ plant roots; 1 to 3 percent phosphorite grains, trace intergrain microporosity in mudstone; 5 percent intergrain porosity in sand; very low hydraulic conductivity; marine siliciclastic shelf below storm wave base; prodelta(?); soft when wet; well consolidated mudstone and friable sand; bioturbated
34.5 - 35.0	Quartz sand, yellowish-gray 5Y 8/1; black N1 and moderate-yellowish-brown 10YR 6/6 phosphorite grains; black N1 heavy mineral grains; mainly very fine to fine quartz sand; very fine sand to granule-size phosphorite; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded quartz sand; less than 10 percent pelecypods and barnacles; less than 10 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf below wave base; soft when wet; friable
35.0 - 36.0	Terrigenous mudstone with minor quartz sand laminations, yellowish-gray 5Y 8/1, moderate-yellowish-brown (10YR 6/6); black N1 phosphorite and heavy mineral grains; mainly terrigenous clay and very fine quartz sand; minor silt and fine quartz sand; very fine to very coarse sand-size phosphorite; very fine sand-size heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; abundant benthic foraminifers; minor skeletal fragments and pelecypods; trace in situ plant roots; trace intergrain microporosity in mudstone; 5 percent intergrain porosity in sand; very low hydraulic conductivity; marine siliciclastic shelf below storm wave base; prodelta(?); soft when wet; well consolidated mudstone and friable sand
36.0 - 40.0	Terrigenous mudstone with minor quartz sand laminations, yellowish-gray 5Y 8/1, light-olive-gray 5Y 6/1; mainly clay-size terrigenous clay; minor silt and fine quartz sand; very well sorted quartz sand; subangular to subrounded quartz sand; abundant benthic foraminifers; trace in situ plant roots; trace intergrain microporosity in mudstone; 5 percent intergrain porosity in sand; very low hydraulic conductivity; marine siliciclastic shelf below storm wave base and above base photic zone; prodelta(?); soft when wet; well consolidated mudstone and friable sand; irregular discontinuous sand laminations; bioturbated
40.0 - 40.6	Terrigenous mudstone with minor quartz sand laminations, light-olive-gray 5Y 6/1; mainly terrigenous clay; minor silt-size quartz sand; abundant benthic foraminifers; trace intergrain microporosity in mudstone; very low hydraulic conductivity; marine siliciclastic shelf below storm wave base; prodelta(?); soft when wet; well consolidated
40.6 - 40.7	*Cheilostome* bryozoan, pelecypod lime rudstone with skeletal mud-dominated packstone matrix, black N1 to light-gray N7; black N1 phosphorite grains; mainly clay-size lime mudstone and silt to very large pebble-size fossils; minor very fine quartz sand; very fine to coarse sand-size phosphorite grains; very well sorted quartz sand; subangular to subrounded quartz sand; *Cheilostome* bryozoans, pelecypods, encrusting bryozoans; trace phosphorite grains; 25 percent moldic porosity; moderate hydraulic conductivity; mid-ramp; hard when wet; well cemented; uppermost 1 inch is a blackened (N1 to N4) surface (maximum flooding surface or maximum starvation surface; probably phosphatic) with 1 inch of microrelief that contains overhanging microtopography (terrigenous mudstone from interval above fills microtopography)
40.7 - 44.0	*Vermicularia* lime bindstone and pelecypod lime rudstone with grain-dominated lime packstone and skeletal lime grainstone matrix, medium-dark-gray N4 to light-gray N7; black N1 phosphorite grains; mainly clay-size lime mudstone and silt to very large pebble-size fossils; minor very fine quartz sand; very fine to medium sand-size phosphorite grains; very well sorted quartz sand; subangular to subrounded quartz sand; *Vermicularia*, pelecypods, skeletal fragments, encrusting bryozoans; 10 to 20 percent quartz sand; trace to 1 percent phosphorite grains; 30 percent moldic and intergrain porosity; high hydraulic conductivity; mid-ramp; hard when wet; well cemented
44.0 - 45.5	Pelecypod lime floatstone with skeletal lime grainstone matrix, medium-dark-gray N4 to light-gray N7; black N1 phosphorite grains; mainly very fine sand to pebble-size fossils; minor very fine to medium quartz sand; very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods, *Vermicularia*, barnacles; trace quartz sand; trace phosphorite grains; 35 percent moldic and intergrain porosity; high hydraulic conductivity; mid-ramp; hard when wet; well cemented
45.5 - 47.0	No recovery
47.0 - 49.5	Pelecypod lime floatstone with skeletal mud-dominated lime packstone and skeletal lime grainstone matrix, medium-light-gray N6 to very light gray N8; black N1 phosphorite grains; mainly clay-size lime mudstone and very fine sand to pebble-size fossils; minor very fine quartz sand; very fine sand-size phosphorite grains; very well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods, barnacles, bryozoans, serpulids; trace to 10 percent quartz sand (increases upward); trace phosphorite grains; 30 percent moldic, intergrain, and intragrain porosity; high hydraulic conductivity; mid-ramp; hard when wet; well cemented; color darkens upward

Depth (feet below land surface)	Lithologic description of well C-1183
49.5 - 50.8	Pelecypod lime rudstone with skeletal lime grainstone matrix, medium-light-gray N6 to very light gray N8, yellowish-gray 5Y 8/1; black N1 phosphorite grains; mainly very fine sand to pebble-size fossils; minor very fine quartz sand; very fine sand-size phosphorite grains; very well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods, barnacles, bryozoans, serpulids; trace to 10 percent quartz sand; trace phosphorite grains; 35 percent moldic, intergrain, and intragrain porosity; very high hydraulic conductivity; mid-ramp; hard when wet; well cemented; color lightens upward; abrupt contact with interval below
50.8 - 52.4	Pelecypod lime rudstone with quartz sand, skeletal mud-dominated lime packstone and skeletal lime grainstone matrix; light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; black N1 phosphorite grains; mainly clay-size lime mudstone and silt to pebble-size fossils; minor very fine to very coarse quartz sand; very fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal fragments, pelecypods, barnacles; 10 to 25 percent quartz sand; trace phosphorite grains; 25 percent moldic, intragrain porosity; moderate hydraulic conductivity; mid-ramp; hard when wet; well cemented; color lightens upward; one of microrelief with overhanging microtopography on upper bounding surface (abrupt contact) at 50.8 feet
52.4 - 55.0	No recovery
55.0 - 56.3	Pelecypod lime rudstone with quartz sand, skeletal mud-dominated lime packstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; black N1 phosphorite grains; mainly clay-size lime mudstone, silt- to pebble-size fossils and very fine to fine quartz sand; minor very fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal fragments, pelecypods, sand dollars; 35 to 45 percent quartz sand; less than 2 percent phosphorite grains; 25 percent moldic, shelter porosity; moderate hydraulic conductivity; mid-ramp; hard when wet; well cemented
56.3 - 61.0	No recovery
61.0 - 62.5	Pelecypod lime rudstone with quartz sand, skeletal grain-dominated lime packstone matrix, light-gray N7 to very light gray N8, yellowish-gray 5Y 8/1; black N1 phosphorite grains; mainly silt to pebble-size fossils and very fine to coarse quartz sand; minor clay-size lime mud; very fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal fragments, pelecypods, barnacles, oysters, bryozoans, serpulids; 45 percent quartz sand; less than 5 percent phosphorite grains; 25 percent moldic, intergrain porosity; moderate hydraulic conductivity; mid-ramp; hard when wet; well cemented
62.5 - 63.0	Quartz sandstone with skeletal rudstone framework, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor very fine sand to pebble-size fossils; medium to very coarse quartz sand; very fine to coarse sand-size phosphorite grains; very fine sand-size heavy minerals; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal fragments, barnacles, pelecypods, bryozoans; 65 percent quartz sand; 5 percent phosphorite grains; trace heavy mineral grains; 20 percent intergrain, moldic porosity; moderate hydraulic conductivity; moderately hard when wet; moderately cemented
63.0 - 65.0	No recovery
65.0 - 67.0	Quartz sandstone with skeletal rudstone framework, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor very fine sand to pebble-size fossils; medium to very coarse quartz sand; very fine to coarse sand-size phosphorite grains; very fine sand-size heavy minerals; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal fragments, barnacles, pelecypods, bryozoans; 65 percent quartz sand; 5 percent phosphorite grains; trace heavy mineral grains; 20 percent intergrain, moldic porosity; moderate hydraulic conductivity; moderately hard when wet; moderately cemented
67.0 - 69.0	No recovery
69.0 - 72.8	Quartz sandstone with gastropod, pelecypod rudstone framework; yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor very fine sand to pebble-size fossils; medium to very coarse quartz sand; very fine to coarse sand-size phosphorite grains; very fine sand-size heavy minerals; moderately sorted quartz sand; subangular to rounded quartz sand; *Turritella* gastropods, pelecypods, sand dollars, oysters, serpulids, bryozoans; 70 percent quartz sand; less than 5 percent phosphorite grains; trace heavy mineral grains; 25 percent intergrain, moldic porosity; moderate hydraulic conductivity; moderately hard when wet; moderately cemented
72.8 - 74.0	No recovery
74.0 - 76.7	Quartz sandstone supporting skeletal floatstone, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor very fine sand to pebble-size fossils; medium to granule-size quartz sand; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy minerals; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal, pelecypods, bryozoans, barnacles, serpulids, *Turritella* gastropods; less than 5 percent phosphorite grains; trace heavy mineral grains; 20 percent intergrain, moldic porosity; moderate hydraulic conductivity; moderately hard when wet; moderately cemented
76.7 - 78.0	No recovery
78.0 - 80.0	Quartz sandstone with pelecypod rudstone framework, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly fine quartz sand; minor terrigenous mud matrix; very fine sand to pebble-size fossils; very fine and medium to granule-size quartz sand; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy minerals; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods, skeletal, barnacles, *Turritella* gastropods; less than 5 percent phosphorite grains; trace heavy mineral grains; 25 percent intergrain, moldic porosity; moderate hydraulic conductivity; moderately hard when wet; moderately cemented
80.0 - 81.0	No recovery

Depth (feet below land surface)	Lithologic description of well C-1183
81.0 - 81.7	Quartz sandstone with pelecypod rudstone framework, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly fine quartz sand; minor terrigenous clay matrix; very fine sand to pebble-size fossils; very fine and medium to granule-size quartz sand; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy minerals; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods, skeletal, barnacles, *Turritella* gastropods; less than 5 percent phosphorite grains; trace heavy mineral grains; 25 percent intergrain, moldic porosity; moderate hydraulic conductivity; moderately hard when wet; moderately cemented
81.7 - 82.5	Quartz sandstone with pelecypod rudstone framework, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; very fine sand to pebble-size fossils; very fine and medium to coarse-size quartz sand; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy minerals; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods, gastropods; less than 5 percent phosphorite grains; trace heavy mineral grains; 20 percent intergrain, moldic porosity; moderate hydraulic conductivity; moderately hard when wet; moderately cemented
82.5 - 87.0	No recovery
87.0 - 90.2	Quartz sandstone, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; coarse sand to pebble-size fossils; very fine phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; 20 percent skeletal grains including thin-shelled pelecypods and *Turritella* gastropods; 25 percent phosphorite grains; trace heavy mineral grains; 15 percent intergrain, minor moldic porosity; low hydraulic conductivity; moderately hard to soft when wet; moderately cemented to friable
90.2 - 91.0	No recovery
91.0 - 92.0	Quartz sandstone, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; coarse sand to pebble-size fossils; very fine phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; 20 percent skeletal grains including thin-shelled pelecypods, oysters; 25 percent phosphorite grains; trace heavy mineral grains; 15 percent intergrain, minor moldic porosity; low hydraulic conductivity; moderately hard to soft when wet; moderately cemented to friable
92.0 - 96.0	No recovery
96.0 - 96.1	Quartz sandstone, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; coarse sand to pebble-size fossils; very fine phosphorite and heavy mineral grains; very well sorted quartz sand; subangular to subrounded quartz sand; 20 percent skeletal grains including thin-shelled pelecypods, oysters; 25 percent phosphorite grains; trace heavy mineral grains; 15 percent intergrain, minor moldic porosity; low hydraulic conductivity; moderately hard to soft when wet; moderately cemented to friable
96.1 - 101.0	No recovery
101.0 - 101.8	Quartz sandstone, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; trace fine sand to granule-size quartz grains; coarse sand-size to pebble-size fossils; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; well sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine sand- to granule-size quartz sand; 10 percent moderately thick-shelled pelecypods; 25 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine sand- to granule-size quartz grains floating in matrix of very fine san-size quartz grains
101.8 - 102.0	No recovery
102.0 - 106.0	Quartz sandstone, light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; trace fine sand to granule-size quartz grains; coarse sand to pebble-size fossils; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; well sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine sand- to granule-size quartz sand; less than 5 percent pelecypods; 25 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine sand to granule-size quartz grains floating in matrix of very fine sand-size quartz grains
106.0 - 109.0	Quartz sandstone, light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; trace fine sand to granule-size quartz grains; coarse sand to pebble-size fossils; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; well sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine sand to granule-size quartz sand; trace skeletal and pelecypod fragments; 25 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine sand to granule-size quartz grains floating in matrix of very fine sand-size quartz grains
109.0 - 112.7	Quartz sandstone, light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand and terrigenous clay matrix; minor fine sand to granule-size quartz grains; very fine sand to granule-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine sand to granule-size quartz sand; trace to 2 percent fine sand to granule-size quartz grains; 25 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine sand to granule-size quartz grains floating in matrix of very fine sand-size quartz grains; thin laminations of terrigenous clay

Depth (feet below land surface)	Lithologic description of well C-1183
112.7 - 113.7	Silty terrigenous mudstone, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; mainly terrigenous clay and silt-size quartz grains; trace intergrain microporosity; very low hydraulic conductivity; minor thin laminations and lenses of very fine sand-size quartz sand; uncommon horizontal laminations
113.7 - 114.0	No recovery
114.0 - 120.0	Silty terrigenous mudstone, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; mainly terrigenous clay and silt-size quartz grains; trace intergrain microporosity; very low hydraulic conductivity; minor thin laminations and lenses of very fine quartz sand; uncommon horizontal laminations
120.0 - 123.5	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size- quartz sand; trace to 5 percent fine very coarse sand-size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains
123.5 - 128.0	No recovery
128.0 - 131.0	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size quartz sand; trace to 5 percent fine to very coarse sand-size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains; bioturbated
131.0 - 132.5	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size quartz sand; trace to 5 percent fine to very coarse sand-size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains; bioturbated; minor thin laminations of clay-rich matrix
132.5 - 134.0	No recovery
134.0 - 137.0	Quartz sandstone, light-olive-gray 5Y 5/2 and 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size quartz sand; 5 to 15 percent fine to very coarse sand-size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains; bioturbated
137.0 - 139.5	Quartz sandstone, light-olive-gray 5Y 5/2, 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size quartz sand; 10 to 30 percent fine to very coarse sand-size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains; bioturbated
139.5 - 141.0	No recovery
141.0 - 145.0	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine to very coarse quartz sand; minor terrigenous clay matrix; very fine sand to small pebble-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz grains; less than 5 percent phosphorite grains; trace pelecypods; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; mixture of framework composed of coarse sand-size quartz grains and very fine sand-size quartz grains
145.0 - 146.5	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine to medium quartz sand; minor coarse quartz sand; terrigenous clay matrix; very fine to coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz grains; 15 percent phosphorite grains; trace pelecypods; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; coarse sand-size quartz grains floating in a finer matrix of quartz sand
146.5 - 147.0	No recovery
147.0 - 149.3	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine to medium quartz sand; minor coarse quartz sand; terrigenous clay matrix; very fine to coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz grains; 15 percent phosphorite grains; trace pelecypods; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; coarse sand-size quartz grains floating in a finer matrix of quartz sand

Depth (feet below land surface)	Lithologic description of well C-1183
149.3 - 152.2	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size quartz sand; 5 to 10 percent fine to very coarse sand-size quartz grains; 10 to 15 percent phosphorite grains; trace thin-shelled pelecypods; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains; abrupt contact at 149.3 feet
152.2 - 153.0	No recovery
153.0 - 160.0	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size quartz sand; trace to 10 percent fine to very coarse sand-size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace to 3 percent pelecypod shells; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains
160.0 - 163.0	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine to very coarse sand-size quartz grains; very fine to very coarse sand-size phosphorite grains; very fine sand-size heavy mineral grains; very well to moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse quartz sand; trace to 5 percent fine to very coarse sand-size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace to 3 percent pelecypod shells; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fine to very coarse sand-size quartz grains floating in matrix of very fine sand-size quartz grains
163.0 - 166.5	Quartz sandstone, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor terrigenous clay matrix; fine sand to granule-size quartz grains; very fine sand to granule-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to subrounded very fine quartz sand and subrounded to rounded fine to very coarse sand-size quartz sand; 5 to 60 percent fine sand to granule size quartz grains; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; trace sharks teeth; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; vertical mixture of coarse quartz sand supporting framework and very fine quartz sand supporting framework
166.5 - 170.0	Quartz sandstone, light-olive-gray 5Y 5/2, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine medium quartz sand; minor terrigenous clay matrix; coarse sand to granule-size quartz grains; very fine sand to granule-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable
170.0 - 170.5	No recovery
170.5 - 171.0	Quartz sandstone, light-olive-gray 5Y 5/2, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine medium quartz sand; minor terrigenous clay matrix; coarse sand to granule-size quartz grains; very fine sand to granule-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable
171.0 - 175.0	Quartz sandstone, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly fine to medium-size quartz sand; minor terrigenous clay matrix; very fine and coarse sand to granule-size quartz sand; very fine sand to granule-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded; less than 5 percent phosphorite grains; trace heavy mineral grains; trace mica; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; clay lamination at 173.4 feet
175.0 - 177.2	Quartz sandstone, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly medium-size quartz sand; very fine to fine and coarse to very coarse sand-size quartz sand; very fine to medium sand-size phosphorite grains; very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded; less than 3 percent phosphorite grains; trace heavy mineral grains; trace mica; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
177.2 - 179.0	No recovery

L-3 Canal Core

Florida Geological Survey well number	Not applicable
Well number	HE-1110
Total depth	160 feet
Cored from	0 to 160 feet
County	Hendry
Location	NE, SW, sec. 22, T47S, R34E
Latitude	26°23′09″
Longitude	80°55′48″
Elevation	15 feet
Completion date	April 14, 1998
Other types of available logs	Gamma ray, induction, spontaneous potential, single-point resistivity
Owner	U.S. Geological Survey
Driller	South Florida Water Management District
Core described by	Kevin J. Cunningham
Undifferentiated surficial quartz sand and Pinecrest Sand Member	0 to 35 feet
Tamiami Formation	0 to 148 feet
Ochopee Limestone Member	35 to 148 feet (top based on gamma-ray log)
Unnamed formation	148 to 160 feet
Upper confining unit	0 to 35 feet
Gray limestone aquifer	35 to 148 feet
Top of lower confining unit	148 feet

Depth (feet below land surface)	Lithologic description of well HE-1110
0.0 - 5.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium phosphorite and fine to coarse skeletal fragments; ranges from very fine to coarse; well sorted quartz grains; minor skeletal fragments; trace to 3 percent phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; friable; very soft
5.0 - 10.0	Quartz sand, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone and very fine to fine quartz sand; minor medium quartz sand and medium to very coarse skeletal fragments; ranges from clay to coarse; moderately sorted quartz sand; 10 percent skeletal fragments; 10 percent interparticle and pin-point porosity; low hydraulic conductivity; abundant lime mudstone matrix; moderately hard when wet; cohesive
10.0 - 15.0	Quartz sand, very pale orange 10YR 8/2; mainly very fine to fine quartz sand; minor medium quartz sand, medium to very coarse fossils, and medium to coarse phosphorite; ranges from very fine to coarse; well sorted quartz sand; 15 percent skeletal fragments and broken bivalves; trace black phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; friable; very soft when wet
15.0 - 20.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium sand to pebble-size fossils and very fine to medium phosphorite; ranges from very fine to pebble size; well sorted quartz sand; 15 percent skeletal fragments, bivalves and trace echinoid spines; 3 percent black phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; friable; very soft when wet
20.0 - 25.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium sand to pebble-size fossils and very fine to medium phosphorite; ranges from very fine to pebble size; well sorted quartz sand; 15 percent skeletal fragments, bivalves and trace echinoid spines and oysters; 3 percent black phosphorite grains; 20 percent interparticle porosity; moderate hydraulic conductivity; friable; very soft when wet
25.0 - 30.0	Bivalve lime rudstone with matrix of quartz sand-rich skeletal lime packstone and skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine to fine quartz sand and pebble-size bivalves; minor medium to granule skeletal fragments and very fine to fine phosphorite; ranges from clay to pebble size; well sorted quartz sand; skeletal fragments, bivalves, *Vermicularia* echinoid spines and gastropods; 40 to 60 percent quartz sand; 3 percent black phosphorite grains; 15 percent moldic, interparticle, intraparticle, and bored porosity; moderate hydraulic conductivity; poorly cemented to moderately cemented; friable to moderately friable; moderately hard to hard
30.0 - 35.0	Quartz sand, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone matrix, very fine to fine quartz sand; minor medium sand to pebble-size fossils and very fine to fine phosphorite grains; ranges from clay to pebble size; well sorted quartz sand; 15 percent bivalves and skeletal fragments; 5 percent black phosphorite grains; 20 percent moldic and minor interparticle, intraparticle, and bored porosity; moderate hydraulic conductivity; friable; soft
35.0 - 40.0	Bivalve lime rudstone with matrix of quartz sand-rich skeletal lime packstone and skeletal-rich quartz sand, light-gray N7 to very light gray N8 and yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine to fine quartz sand and pebble-size bivalves; minor medium to granule skeletal fragments and very fine to fine phosphorite; ranges from clay to pebble size; well sorted quartz sand; bivalves, skeletal fragments, gastropods and minor bryozoans and *Vermicularia*; 40 to 60 percent quartz sand; 3 percent black phosphorite grains; 20 percent moldic, interparticle, intraparticle, and bored porosity; moderate hydraulic conductivity; poorly cemented to moderately cemented; friable to moderately friable; moderately hard to hard
40.0 - 45.0	Bivalve lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal lime packstone; light-gray N7 to very light gray N8; mainly clay-size lime mudstone, very fine to fine quartz sand and pebble-size bivalves; minor very fine to granule skeletal fragments and cobble-size oysters; ranges from clay to cobble size; well sorted quartz sand; bivalves, skeletal fragments, bryozoans and echinoids (sand dollars); 20 to 40 percent quartz sand; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; poorly to well cemented; friable to well consolidated; soft to hard
45.0 - 50.0	Bivalve lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal lime grainstone, medium-gray N5 to very light gray N8 and yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; minor medium to coarse quartz sand and cobble-size bivalves; ranges from clay to cobble size; moderately sorted quartz sand; bivalves, skeletal fragments, bryozoans, and echinoids (sand dollars); 20 percent quartz sand; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; poorly to moderately cemented; friable to moderately friable
50.0 - 55.0	Bivalve lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal lime grainstone, light-gray N7 to very light gray N8 and yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; minor clay-size lime mudstone; ranges from clay to pebble size; well sorted quartz sand; skeletal fragments, bivalves, echinoids (sand dollars), bryozoans, gastropods and barnacles; 20 percent quartz sand; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; poorly to moderately cemented; friable to well consolidated

Depth (feet below land surface)	Lithologic description of well HE-1110
55.0 - 60.0	Skeletal fragment lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal lime grainstone, medium-light-gray N6 to very light gray N8 and yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; minor clay-size lime mudstone and very fine to fine phosphorite grains; ranges from clay to pebble size; well sorted quartz sand; skeletal fragments, bivalves, echinoids (sand dollars), gastropods and barnacles; 20 to 40 percent quartz sand; trace to 3 percent black phosphorite; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; moderately to well cemented; moderately friable to well consolidated
60.0 - 65.0	Skeletal fragment lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal lime grainstone; medium-light-gray N6 to very light gray N8; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; minor clay-size lime mudstone and very fine to fine phosphorite grains; ranges from clay to pebble size; well sorted quartz sand; skeletal fragments, bivalves, and echinoids (sand dollars); 20 to 40 percent quartz sand; 3 percent black phosphorite; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; mainly poorly cemented, ranges from poorly to well cemented; mainly moderately friable, ranges from moderately friable to well consolidated
65.0 - 70.0	Skeletal fragment lime rudstone with matrix of quartz sand-rich skeletal well washed lime packstone and quartz sand-rich skeletal lime packstone; medium-light-gray N6 to very light gray N8 and yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine to fine quartz sand, medium sand to pebble-size fossils and very fine to very phosphorite grains; ranges from clay to pebble size; well sorted quartz sand; skeletal fragments and bivalves; 20 to 40 percent quartz sand; trace black phosphorite; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; moderately to well cemented; moderately friable to well consolidated
70.0 - 80.0	Skeletal fragment lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal lime packstone; medium-light-gray N6 to very light gray N8; mainly clay-size lime mudstone, very fine to fine quartz sand and medium sand to pebble-size fossils; minor very fine to fine phosphorite grains; ranges from clay to pebble size; well sorted quartz sand; skeletal fragments, bivalves, and echinoids (sand dollars); 20 to 40 percent quartz sand; trace black phosphorite; 20 percent moldic, interparticle, intraparticle; and bored porosity; high hydraulic conductivity; moderately to well cemented; moderately friable to well consolidated
80.0 - 85.0	Skeletal fragment lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone; medium-light-gray N6 to very light gray N8; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; minor clay-size lime mudstone, very fine to fine phosphorite grains and cobble-size oysters; ranges from clay to cobble size; well sorted quartz sand; skeletal fragments, bivalves, echinoids (sand dollars), gastropods, oysters, and *Vermicularia*; 20 percent quartz sand; 3 percent black phosphorite; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; poorly to well cemented; friable to well consolidated
85.0 - 90.0	Skeletal fragment lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal packstone; medium-light-gray N6 to very light gray N8; mainly clay-size lime mudstone, very fine to fine quartz sand and medium sand to pebble-size fossils; minor very fine to fine phosphorite grains and cobble-size bivalves; ranges from clay to cobble size; well sorted quartz sand; skeletal fragments, bivalves, echinoids (sand dollars), gastropods, *Vermicularia*, bryozoans, and serpulids; 20 percent quartz sand; 3 percent black phosphorite; 20 percent moldic, interparticle, intraparticle and bored porosity; high hydraulic conductivity; poorly to moderately cemented; friable to well consolidated
90.0 - 95.0	Skeletal fragment and bivalve lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal grainstone, light-gray N7 to white N9; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; minor clay-size lime mudstone, very fine to fine phosphorite grains and cobble-size bivalves; ranges from clay to cobble size; well sorted quartz sand; skeletal fragments, bivalves, *Vermicularia*, serpulids, bryozoans, gastropods, and echinoids (sand dollars); 20 to 40 percent quartz sand; trace black phosphorite; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; poorly to moderately cemented; friable to well consolidated
95.0 - 100.0	Skeletal fragment and bivalve lime rudstone with matrix of quartz sand-rich skeletal well-washed lime packstone and quartz sand-rich skeletal grainstone; light-gray N7 to white N9; mainly very fine to fine quartz sand and medium sand to pebble-size fossils; minor clay-size lime mudstone, very fine to fine phosphorite grains; ranges from clay to pebble size; well sorted quartz sand; skeletal fragments, bivalves (minor *Pecten*), *Vermicularia*, serpulids, bryozoans, gastropods, and echinoids (sand dollars); 20 to 40 percent quartz sand; trace black phosphorite; 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; poorly to moderately cemented; friable to well consolidated; local *Vermicularia* bindstones (reefs)

Depth (feet below land surface)	Lithologic description of well HE-1110
100.0 - 115.0	Skeletal fragment lime rudstone with matrix of skeletal well-washed lime packstone with matrix of quartz sand-rich lime mud or quartz sand and quartz sand-rich skeletal grainstone, light-gray N7 to white N9 and yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and medium sand- to pebble-size fossils; minor clay-size lime mudstone, medium to coarse quartz sand, very fine to medium phosphorite grains and cobble-size bivalves, oysters, and sand dollars; ranges from clay to cobble size; moderately sorted quartz sand; skeletal fragments, bivalves (minor *Pecten*), *Vermicularia*, serpulids, bryozoans, echinoids (sand dollars), gastropods, barnacles, and oysters; 20 to 60 percent quartz sand; trace to 5 percent black phosphorite; trace glauconite grains (dark-yellowish-green 10GY 4/4) at 105 to 110 feet 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; moderately to well cemented; moderately friable to well consolidated; local *Vermicularia* bindstones (reefs); caved, fine to medium, loose, quartz sand (grayish-orange 10YR 7/4, moderate-yellowish-brown 10YR 5/4 and very pale orange 10YR 8/2)
115.0 - 120.0	Skeletal fragment lime rudstone with matrix of skeletal lime packstone with matrix of quartz sand-rich lime mud or quartz sand, light-gray N7 to very light gray N8; mainly clay-size lime mudstone, fine quartz sand and medium sand to pebble-size fossils; minor very fine and medium to coarse quartz sand and very fine to medium phosphorite; ranges from clay to pebble size; moderately sorted quartz sand; skeletal fragments, bivalves, gastropods, bryozoans, serpulids, and barnacles; 20 to 60 percent quartz sand; trace to 5 percent black N1 and minor moderate-yellowish-brown 10YR 5/4 phosphorite; trace glauconite grains (dark-yellowish-green 10GY 4/4); 20 percent moldic, interparticle, intraparticle, and bored porosity; high hydraulic conductivity; poorly to well cemented; friable to well consolidated
120.0 - 125.0	Skeletal fragment-rich quartz sandstone, light-gray N7 to very light gray N8; mainly fine quartz sand; minor very fine and medium quartz sand, medium sand to pebble-size fossils and very fine to medium phosphorite grains; ranges from clay to pebble size; moderately sorted quartz sand; 20 to 40 percent fossils including skeletal fragments, bivalves, echinoids (sand dollars), gastropods, barnacles, and serpulids; 5 percent black N1 and minor moderate-yellow-brown 10YR 5/4 phosphorite; 15 percent moldic, interparticle, and intraparticle porosity; moderate hydraulic conductivity; poorly to well cemented; friable to well consolidated; trace lime mud matrix
125.0 - 130.0	Skeletal fragment-rich quartz sand, very light gray N8; mainly very fine and fine quartz sand; minor medium quartz sand, medium sand to pebble-size fossils and very fine to medium phosphorite grains; ranges from very fine to pebble size; well sorted quartz sand; 15 percent fossils including skeletal fragments, bivalves, and barnacles; 5 percent black N1 and minor moderate-yellowish-brown 10YR 5/4 phosphorite; 20 percent interparticle porosity; moderate; very poorly cemented; very friable; very soft
130.0 - 135.0	Skeletal fragment-rich quartz sand and skeletal floatstone with matrix of skeletal-rich quartz sandstone matrix, light-gray N7 to very light gray N8; mainly very fine and fine quartz sand; minor medium quartz sand, medium sand to pebble-size fossils, very fine to medium phosphorite grains and cobble-size oysters; ranges from very fine to cobble size; well sorted quartz sand; 15 percent fossils including skeletal fragments, bivalves, serpulids, encrusting foraminifers, oysters, bryozoans and echinoids (sand dollars); 3 percent black N1 phosphorite; 20 percent interparticle, moldic, and intraparticle porosity; moderate hydraulic conductivity; poorly to moderately cemented; very friable to moderately friable
135.0 - 140.0	Bivalve-rich quartz sand and gastropod rudstone with matrix of skeletal-rich quartz sandstone matrix; light-gray N7 to very light gray N8; mainly very fine and fine quartz sand; minor medium quartz sand, medium sand to pebble-size fossils and very fine to medium phosphorite grains; ranges from very fine to pebble size; well sorted quartz sand; 40 to 70 percent quartz sand; skeletal fragments, bivalves, gastropods (*Turritella*) and *Vermicularia*; 5 to 10 percent black N1 phosphorite; 20 percent interparticle and moldic porosity; moderate hydraulic conductivity; poorly to well cemented; friable to well consolidated; minor lime mudstone in sandstone matrix of rudstone
140.0 - 145.0	Bivalve rudstone with matrix of skeletal-rich quartz sandstone matrix, light-gray N7 to very light gray N8; mainly very fine and fine quartz sand; minor medium sand- to pebble-size fossils and very fine to fine phosphorite grains; ranges from very fine to pebble size; well sorted quartz sand; 40 to 60 percent quartz sand; bivalves and gastropods (*Turritella*); 5 to 10 percent black N1 phosphorite; 20 percent interparticle and moldic porosity; moderate hydraulic conductivity; moderately to well cemented; moderately friable to well consolidated
145.0 - 148.0	Bivalve rudstone with matrix of skeletal-rich quartz sandstone matrix, very light gray N8; mainly very fine and fine quartz sand; minor medium sand to cobble-size fossils, cobble-size bivalves and very fine to fine phosphorite grains; ranges from very fine to cobble size; well sorted quartz sand; 40 to 60 percent quartz sand; bivalves, gastropods (*Turritella*) and bryozoans; 5 to 10 percent black N1 phosphorite; 20 percent interparticle and moldic porosity; moderate hydraulic conductivity; moderately to well cemented; moderately friable to well consolidated
148.0 - 160.0	Quartz sand, light-gray N7 to very light gray N8; mainly very fine quartz sand; minor fine quartz sand, medium sand to pebble-size fossils and very fine to fine phosphorite grains; ranges from very fine to pebble size; well sorted quartz sand; minor bivalves and skeletal fragments; 15 to 20 percent black N1 phosphorite; 20 percent interparticle porosity; low hydraulic conductivity; very poorly cemented; very friable; very soft; trace to minor clay matrix

Windmill Road Core

Florida Geological Survey well number	W-17764
GWSI number	HE-1112
Total depth	151 feet
Cored from	0 to 151 feet
County	Hendry
Location	SE, NE, sec. 12, T48S, R31E
Latitude	26°19′15″
Longitude	81°10′35″
Elevation	21 feet
Completion date	October 3, 1998
Other types of available logs	Gamma ray, induction, spontaneous potential, single-point resistivity
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham (cored with a compression core from 0 to 60 feet and a rotary core from 60 to 151 feet)
Undifferentiated quartz sand and minor limestone	0 to 14 feet
Tamiami Formation	14 to 80.2 feet
Pinecrest Sand Member	14 to 46.2 feet
Ochopee Limestone Member	42.6 to 64 feet
Unnamed formation	64 to 80.2 feet
Peace River Formation	80.2 to 149.7 feet
Water-table aquifer	0 to 46.2 feet
Gray limestone aquifer	46.2 to 80.2 feet
Lower confining unit	80.2 to 149.7 feet

Depth (feet below land surface)	Lithologic description of well HE-1112
0.0 - 0.9	Quartz sand, grayish-orange 10YR 7/4; black N1 organic soil and grains; mainly fine quartz sand; minor very fine and medium to coarse quartz sand; well sorted quartz sand; subangular to rounded quartz sand; 5 to 10 percent organic grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; modern roots throughout interval; black organic soil in upper and lower 1 inch of interval
0.9 - 2.2	Quartz sand, light-gray N7 to very light gray N8; black N1 organic soil and grains; mainly fine to medium quartz sand; minor very fine and coarse quartz sand; well sorted quartz sand; subangular to rounded quartz sand; 10 percent organic grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; modern roots throughout interval
2.2 - 6.8	Quartz sand, very pale orange 10YR 8/2, grayish-orange 10YR 7/4, pale-yellowish-brown 10YR 6/2, moderate-yellowish-brown 10YR 5/4; black N1 phosphorite and heavy mineral grains; mainly fine to medium quartz sand; minor very fine and coarse quartz sand, very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subangular to rounded quartz sand; trace phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; trace modern roots throughout interval
6.8 - 7.0	No recovery
7.0 - 12.0	Quartz sand, very pale orange 10YR 8/2, pale-yellowish-brown 10YR 6/2, moderate-yellowish-brown 10YR 5/4; black N1 phosphorite and heavy mineral grains; mainly very fine to medium quartz sand; minor coarse quartz sand, very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subangular to rounded quartz sand; trace phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; trace modern roots throughout interval
12.0 - 14.0	No recovery
14.0 - 18.1	Quartz sand, very pale orange 10YR 8/2, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly fine to medium quartz sand; minor very fine and coarse quartz sand, very fine to medium sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 to 10 percent skeletal fragments; 3 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable
18.1 - 19.0	No recovery
19.0 - 23.0	Quartz sand, very pale orange 10YR 8/2, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly fine to medium quartz sand; minor very fine and coarse quartz sand, very fine to very coarse fossils, very fine to medium sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 to 15 percent skeletal fragments, pelecypods, barnacles; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable
23.0 - 24.7	Quartz sand, yellowish-gray 5Y 8/1, very pale orange 10YR 8/2; black N1 phosphorite and heavy mineral grains; mainly fine to coarse quartz sand; minor very fine and very coarse quartz sand, very fine sand to very large pebble-size fossils, very fine to very coarse sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 to 15 percent skeletal fragments, pelecypods; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable
24.7 - 25.0	No recovery
25.0 - 26.7	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly fine to coarse quartz sand; minor very fine and very coarse quartz sand, very fine sand to very large pebble-size fossils, very fine to very coarse sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 to 15 percent skeletal fragments, pelecypods; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable
26.7 - 28.0	No recovery
28.0 - 32.2	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly fine to medium quartz sand; minor very fine and coarse to very coarse quartz sand, very fine sand to large pebble-size fossils, very fine to very coarse sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 to 15 percent skeletal fragments, pelecypods, barnacles; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; bioturbated
32.2 - 33.0	No recovery

Depth (feet below land surface)	Lithologic description of well HE-1112
33.0 - 35.0	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine to medium quartz sand; minor coarse to very coarse quartz sand, very fine sand to large pebble-size fossils, very fine to very coarse sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 to 15 percent skeletal fragments, pelecypods; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; bioturbated
35.0 - 36.5	No recovery
36.5 - 37.0	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine to medium quartz sand; minor coarse to very coarse quartz sand, very fine sand to large pebble-size fossils, very fine to very coarse sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 to 15 percent skeletal fragments, pelecypods; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; bioturbated
37.0 - 38.0	No recovery
38.0 - 41.5	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine to medium quartz sand; minor coarse to very coarse quartz sand, very fine sand to large pebble-size fossils, very fine to very coarse sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 percent skeletal fragments, pelecypods; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; bioturbated
41.5 - 43.0	No recovery
43.0 - 46.2	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine to medium quartz sand, minor coarse to very coarse quartz sand, very fine sand to large pebble-size fossils, very fine to very coarse sand-size phosphorite, very fine to fine heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; minor rounded quartz sand; 5 percent skeletal fragments, pelecypods; 3 to 5 percent phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; bioturbated
46.2 - 46.6	Mechanically broken and disturbed pelecypod lime floatstone with skeletal lime grainstone and grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; black N1 phosphorite; mainly fine sand- to pebble-size fossils and fossil fragments; minor silt to very fine fossil fragments, lime mud, very fine quartz sand, very fine to medium sand-size phosphorite grains; well sorted quartz sand; subangular quartz sand; skeletal fragments, pelecypods; 5 percent quartz sand; trace phosphorite grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; mid-ramp; soft to moderately soft when wet; poorly cemented; friable
46.6 - 47.0	No recovery
47.0 - 47.8	Mechanically broken and disturbed pelecypod lime floatstone with skeletal lime grainstone and grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; black N1 phosphorite; mainly fine sand to pebble-size fossils and fossil fragments; minor silt to very fine fossil fragments, lime mud, very fine quartz sand, very fine to medium sand-size phosphorite grains; well sorted quartz sand; subangular quartz sand; skeletal fragments, pelecypods; 5 percent quartz sand; trace phosphorite grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; mid-ramp; soft to moderately soft when wet; poorly cemented; friable
47.8 - 48.0	No recovery
48.0 - 51.0	Mechanically broken and disturbed pelecypod lime floatstone and rudstone with skeletal lime grainstone and grain-dominated lime packstone matrix and minor *Vermicularia* lime bindstone, medium-light-gray N6 to very light gray N8; black N1 phosphorite; mainly fine sand to pebble-size fossils and fossil fragments; minor silt to very fine fossil fragments, lime mud, very fine quartz sand, very fine to medium sand-size phosphorite grains; well sorted quartz sand; subangular quartz sand; skeletal fragments, pelecypods, *Vermicularia*, bryozoans, gastropods, serpulids; 5 percent quartz sand; 3 percent phosphorite grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; mid-ramp; moderately cemented
51.0 - 60.0	Mechanically broken and disturbed pelecypod lime floatstone and rudstone with skeletal lime grainstone and grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; black N1 phosphorite; mainly fine sand to pebble-size fossils and fossil fragments; minor silt to very fine fossil fragments, lime mud, very fine to medium quartz sand, very fine to medium sand-size phosphorite grains; well sorted quartz sand; subangular quartz sand; skeletal fragments, pelecypods, *Vermicularia*, bryozoans, echinoids; 5 percent quartz sand; 3 percent phosphorite grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; mid-ramp; poorly to moderately cemented; friable in part
60.0 - 60.8	Mechanically broken and disturbed pelecypod lime floatstone and rudstone with skeletal lime grainstone and grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; black N1 phosphorite; mainly fine sand to pebble-size fossils and fossil fragments; minor silt to very fine fossil fragments, lime mud, very fine to medium quartz sand, very fine to medium sand-size phosphorite grains; well sorted quartz sand; subangular quartz sand; skeletal fragments, pelecypods, *Vermicularia*, bryozoans, echinoids, oysters; 5 percent quartz sand; 3 percent phosphorite grains; 25 percent intergrain and moldic porosity; high hydraulic conductivity; mid-ramp; poorly to moderately cemented; friable in part
60.8 - 61.0	No recovery

Depth (feet below land surface)	Lithologic description of well HE-1112
61.0 - 61.2	Pelecypod lime rudstone with quartz-sand rich skeletal grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly fine sand to pebble-size fossils and fossil fragments, very fine quartz sand; minor fine to very coarse quartz sand, silt to very fine fossil fragments, lime mud, fine to coarse sand-size phosphorite grains, very fine to fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal fragments, pelecypods, bryozoans, oysters, gastropods; 25 to 45 percent quartz sand; 5 percent phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; high hydraulic conductivity; mid-ramp; hard when wet; well cemented; possible 1-inch thick phosphorite hard ground at 61 feet
61.2 - 64.0	Pelecypod lime rudstone with quartz-sand rich skeletal grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly fine sand to pebble-size fossils and fossil fragments, very fine quartz sand; minor fine to very coarse quartz sand, silt to very fine fossil fragments, lime mud, very fine to coarse sand-size phosphorite grains, very fine to fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz sand; skeletal fragments, pelecypods, bryozoans, oysters, gastropods; 25 to 45 percent quartz sand; 5 percent phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; high hydraulic conductivity; mid-ramp; hard when wet; well cemented
64.0 - 67.0	No recovery
67.0 - 70.2	Quartz sandstone with pelecypod rudstone framework, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, fine to coarse sand-size phosphorite grains, very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz sand; 20 to 35 percent pelecypods, gastropods, barnacles, skeletal fragments, oysters; 5 percent phosphorite and heavy mineral grains; 20 percent intergrain and moldic porosity; high hydraulic conductivity; marine siliciclastic shelf; hard when wet; well cemented
70.2 - 74.0	No recovery
74.0 - 77.0	Quartz sandstone with pelecypod rudstone framework; light-gray N7 to very light gray N8; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, fine to coarse sand-size phosphorite grains, very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz sand; 20 to 35 percent pelecypods, gastropods, skeletal fragments, barnacles, coral; 5 percent phosphorite and heavy mineral grains; 20 percent intergrain and moldic porosity; high hydraulic conductivity; marine siliciclastic shelf; hard when wet; well cemented
77.0 - 78.0	Quartz sandstone with pelecypod rudstone framework, light-gray N7 to very light gray N8; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite; black N1 heavy mineral grains; mainly very fine quartz sand; minor fine to coarse quartz sand, granule to pebble-size fossils, very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subangular to rounded quartz sand; 25 percent pelecypods, gastropods; 15 percent phosphorite and heavy mineral grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; marine siliciclastic shelf; moderately hard to hard when wet; well cemented
78.0 - 80.0	No recovery
80.0 - 80.2	Quartz sandstone with pelecypod rudstone framework, light-gray N7 to very light gray N8; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite; black N1 heavy mineral grains; mainly very fine quartz sand; minor fine to coarse quartz sand, granule to pebble-size fossils, very fine sand-size phosphorite and heavy mineral grains, terrigenous clay; well sorted quartz sand; subangular to rounded quartz sand; 25 percent pelecypods, gastropods; 15 percent phosphorite and heavy mineral grains; trace terrigenous clay matrix; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; marine siliciclastic shelf; moderately hard to hard when wet; well cemented
80.2 - 80.9	Quartz sandstone, yellowish-gray 5Y 8/1; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite; black N1 heavy mineral grains; mainly very fine quartz sand; minor very fine sand-size phosphorite and heavy mineral grains; terrigenous clay; well sorted quartz sand; subangular to subrounded quartz sand; 5 percent pelecypods; 20 percent phosphorite and heavy mineral grains; trace terrigenous clay matrix, trace mica; 15 percent intergrain and very minor moldic porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; poorly cemented
80.9 - 81.0	No recovery
81.0 - 83.5	Quartz sand, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, very fine sand-size phosphorite; minor very fine sand-size heavy mineral grains, terrigenous clay; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 15 percent thin-shelled pelecypods; 20 percent phosphorite and heavy mineral grains; trace terrigenous clay matrix; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented
83.5 - 87.0	No recovery
87.0 - 93.5	Quartz sand, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, very fine sand-size phosphorite grains; minor fine to coarse sand-size phosphorite, very fine sand-size heavy mineral grains, granule to large pebble-size pelecypods, terrigenous clay; well sorted quartz sand; subangular to subrounded quartz sand; 5 percent thin-shelled pelecypods; 20 to 25 percent phosphorite and heavy mineral grains; trace terrigenous clay matrix; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented
93.5 - 96.0	No recovery

Depth (feet below land surface)	Lithologic description of well HE-1112
96.0 - 97.2	Quartz sand, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, very fine sand-size phosphorite grains; minor fine to coarse sand-size phosphorite, very fine sand-size heavy mineral grains, granule to large pebble-size pelecypods, terrigenous clay; well sorted quartz sand; subangular to subrounded quartz sand; trace to 5 percent thin-shelled pelecypods; 20 to 25 percent phosphorite and heavy mineral grains; trace terrigenous clay matrix; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented
97.2 - 101.0	No recovery
101.0 - 105.5	Quartz sand, light-olive-gray 5Y 6/1 to 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, very fine sand-size phosphorite; minor very fine to very coarse quartz sand, fine sand- to small pebble-size phosphorite grains, very fine sand-size heavy mineral grains, terrigenous clay; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 25 percent phosphorite and heavy mineral grains; trace fine to very coarse quartz sand; trace terrigenous clay matrix; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; coarser quartz sand and phosphorite grains floating in very fine quartz sand matrix
105.5 - 107.6	Quartz sand, light-olive-gray 5Y 6/1 to 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, very fine sand-size phosphorite; minor very fine to very coarse quartz sand, fine sand to small pebble-size phosphorite grains, very fine sand-size heavy mineral grains, terrigenous clay; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 25 percent phosphorite and heavy mineral grains; trace fine to very coarse quartz sand; 5 percent terrigenous clay matrix and laminations; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; coarse quartz sand and phosphorite grains floating in very fine quartz sand matrix; bioturbated; laminations of silty terrigenous mudstone
107.6 - 108.0	No recovery
108.0 - 110.5	Quartz sand with laminations of silty terrigenous mudstone, light-olive-gray 5Y 6/1 to 5Y 5/2 quartz sand; olive-gray 5Y 4/1 clay laminations; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, very fine sand-size phosphorite, terrigenous clay; minor very fine sand-size heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 25 percent phosphorite and heavy mineral grains; trace fine to very coarse quartz sand; 5 percent terrigenous clay matrix and laminations; trace mica; 5 percent intergrain porosity; very low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated including horizontal burrows; laminations of silty terrigenous mudstone
110.5 - 116.2	Terrigenous mudstone, olive-gray 5Y 4/1 clay laminations; light-olive-gray 5Y 6/1 to 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly clay-size terrigenous mudstone; minor very fine quartz sand, very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 25 percent phosphorite and heavy mineral grains; trace mica; less than 5 percent intergrain microporosity; very low hydraulic conductivity; marine siliciclastic shelf; soft when wet; bioturbated including horizontal burrows filled with quartz sand
116.2 - 120.0	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor fine quartz sand, very fine sand-size phosphorite and heavy mineral grains, terrigenous clay matrix; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 10 percent phosphorite and heavy mineral grains; trace mica; trace terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated; abrupt color change and reduction in percentage of phosphorite grains at top of interval of 116.2 feet
120.0 - 125.8	Quartz sand, light-olive-gray 5Y 5/2 quartz sand, black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor fine quartz sand, very fine sand-size phosphorite and heavy mineral grains, terrigenous clay matrix; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 15 percent phosphorite and heavy mineral grains; trace mica; trace terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated
125.8 - 128.0	No recovery
128.0 - 130.5	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor fine quartz sand, very fine sand-size phosphorite and heavy mineral grains, terrigenous clay matrix; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 10 percent phosphorite and heavy mineral grains; trace mica; trace terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated
130.5 - 131.0	No recovery
131.0 - 138.0	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor fine quartz sand, very fine sand-size phosphorite and heavy mineral grains, terrigenous clay matrix; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 15 percent phosphorite and heavy mineral grains; trace mica; trace terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated

Depth (feet below land surface)	Lithologic description of well HE-1112
138.0 - 140.5	Quartz sand. light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor fine to coarse quartz sand, very fine sand-size phosphorite and heavy mineral grains, terrigenous clay matrix; well sorted quartz sand; subangular to subrounded very fine quartz sand; subrounded to rounded fine to coarse quartz sand; 5 to 15 percent phosphorite and heavy mineral grains; less than 10 percent fine to coarse quartz sand; trace mica; trace terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated; fine to coarse quartz sand floating in very fine quartz sand matrix
140.5 - 141.0	No recovery
141.0 - 143.3	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor fine to very coarse quartz sand, very fine to coarse sand-size phosphorite grains, very fine sand-size heavy mineral grains, terrigenous clay matrix; moderately sorted quartz sand; subangular to rounded quartz sand; 5 to 10 percent phosphorite and heavy mineral grains; 10 to 35 percent fine to very coarse quartz sand; trace to 5 percent thin-shelled pelecypods; trace mica; trace terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated; fine to coarse quartz sand floating in very fine quartz sand matrix
143.3 - 144.5	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand, terrigenous clay; minor fine to very coarse quartz sand, very fine to coarse sand-size phosphorite grains, very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz sand; 5 to 10 percent phosphorite and heavy mineral grains; 10 to 35 percent fine to very coarse quartz sand; trace to 5 percent thin-shelled pelecypods; trace mica; abundant terrigenous clay matrix; 10 percent intergrain porosity; very low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated; fine to coarse quartz sand floating in very fine quartz sand matrix
144.5 - 145.0	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly medium to coarse quartz sand; minor very fine to fine and very coarse quartz sand; terrigenous clay; very fine to coarse sand-size phosphorite grains, very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz sand; 5 to 10 percent phosphorite and heavy mineral grains; 15 percent thin-shelled pelecypods; trace mica; uncommon terrigenous clay matrix; 20 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated
145.0 - 146.0	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly medium to coarse quartz sand; minor very fine to fine and very coarse quartz sand; terrigenous clay; very fine to coarse sand-size phosphorite grains, very fine sand-size heavy mineral grains; moderately sorted quartz sand; subangular to rounded quartz sand; 5 to 10 percent phosphorite and heavy mineral grains; 15 percent thin-shelled pelecypods; trace mica; uncommon terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated
146.0 - 149.7	Quartz sand, light-olive-gray 5Y 5/2 quartz sand; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor fine to medium quartz sand; terrigenous clay; very fine to coarse sand-size phosphorite grains, very fine sand-size heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 10 percent phosphorite and heavy mineral grains; trace thin-shelled pelecypods; trace mica; uncommon terrigenous clay matrix; 15 percent intergrain porosity; low hydraulic conductivity; marine siliciclastic shelf; soft when wet; friable; very poorly cemented; bioturbated
149.7 - 151.0	No recovery

Prison No. 1 Core

Florida Geological Survey well number	W-17782
GWSI number	HE-1113
Total depth	151 feet
Cored from	0 to 151 feet
County	Hendry
Location	SE, SE, sec. 16, T48S, R31E
Latitude	26°18′05″
Longitude	81°13′17″
Elevation	20 feet
Completion date	October 27, 1998
Other types of available logs	Gamma ray, induction, spontaneous potential, single-point resistivity
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham (cored with a compression core from 0 to 35 feet and a rotary core from 35 to 151 feet)
Undifferentiated quartz sand and minor limestone	0 to 12 feet
Tamiami Formation	12 to 50.1 feet
Pinecrest Sand Member	12 to 33 feet
Ochopee Limestone Member	33 to 50.1 feet
Unnamed formation	50.1 to 81 feet
Peace River Formation	81 to 150.7 feet
Water-table aquifer	0 to 12 feet
Upper confining unit	12 to 35 feet
Gray limestone aquifer	35 to 50.1 feet
Lower confining unit	50.1 to 150.7 feet

Depth (feet below land surface)	Lithologic description of well HE-1113
0.0 - 3.0	Quartz sand, pale-yellowish-brown 10YR 6/2, dark-yellowish-brown 10YR 4/2; black N1 organic soil and grains; mainly very fine to fine quartz sand; minor quartz silt and medium to coarse quartz sand and silt to fine sand-size organic grains; well sorted quartz sand; angular to subrounded quartz sand; 5 to 10 percent organic grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
3.0 - 4.0	Quartz sand, very pale orange 10YR 8/2; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor quartz silt, medium to coarse quartz sand and very fine to fine phosphorite and heavy mineral grains; well sorted quartz sand; angular to subrounded quartz sand; trace phosphorite and heavy mineral grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
4.0 - 4.8	Quartz sand, mottled very pale orange 10YR 8/2, grayish-orange 10YR 7/4, pale yellowish-brown 10YR 6/2, dark - yellowish-brown 10YR 4/2; black N1 phosphorite and heavy mineral grains; mainly very fine to fine quartz sand; minor quartz silt, medium to coarse quartz sand, and very fine to fine phosphorite and heavy mineral grains; well sorted quartz sand; angular to subrounded quartz sand; trace phosphorite and heavy mineral grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
4.8 - 6.0	Quartz sand, very pale orange 10YR 8/2, grayish-orange 10YR 7/4; black N1 phosphorite and heavy mineral grains; mainly very fine to coarse quartz sand; minor quartz silt and very fine to fine phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; trace phosphorite and heavy mineral grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
6.0 - 7.0	No recovery
7.0 - 10.0	Quartz sand, pale-yellowish-brown 10YR 6/2; black N1 phosphorite, heavy mineral and organic grains; mainly very fine to fine quartz sand; minor silt and medium to coarse quartz sand, very fine to fine phosphorite and heavy mineral grains, and very fine organic grains; well sorted quartz sand; angular to subrounded quartz sand; 5 percent organic grains; trace phosphorite and heavy mineral grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
10.0 - 12.0	Quartz sand, pale-yellowish-brown 10YR 6/2; black N1 phosphorite, heavy mineral and organic grains; mainly very fine to medium quartz sand; minor quartz silt, coarse quartz sand, very fine to fine phosphorite and heavy mineral grains, and very fine organic grains; moderately sorted quartz sand; angular to subrounded quartz sand; 5 percent organic grains; trace phosphorite and heavy mineral grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable
12.0 - 14.1	Quartz sand-rich terrigenous mudstone, yellowish-gray 5Y 7/2; mainly terrigenous clay and medium to coarse quartz sand; minor quartz silt and very fine to fine quartz sand; well sorted quartz sand; angular to subrounded quartz sand; trace to 30 percent quartz sand; trace pelecypods; less than 2 percent intergrain microporosity; very low hydraulic conductivity; soft when wet; hard dry; possible paleosol with oxidized diffuse nodules in upper part of interval with color of white N9, yellowish-gray 5Y 8/1, and dark-yellowish-orange 10YR 6/6
14.1 - 14.6	Quartz sand with marly terrigenous clay matrix, yellowish-gray 5Y 7/2 and 5Y 8/1; black N1 heavy mineral grains; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite grains; mainly terrigenous clay and silt to very fine quartz sand; minor fine to very coarse quartz sand, very fine to very coarse sand-size phosphorite grains and very fine sand-size heavy mineral grains; well sorted quartz sand; angular to subrounded quartz sand; trace phosphorite and heavy mineral grains; 5 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable
14.6 - 17.0	Quartz sand, yellowish-gray 5Y 7/2 and 5Y 8/1; black N1 heavy mineral grains; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite grains; mainly medium to coarse quartz sand; minor quartz silt, fine and very coarse quartz sand, very fine sand to small pebble-size fossils, terrigenous clay and lime mud, very fine to very coarse sand-size phosphorite grains and very fine sand-size heavy mineral grains; moderately sorted quartz sand; angular to rounded quartz sand; 10 to 15 percent pelecypods, barnacles, echinoid spines; trace phosphorite and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable
17.0 - 22.0	No recovery
22.0 - 22.9	Quartz sand, yellowish-gray 5Y 7/2; black N1 and light-brown 5YR 5/6 heavy minerals; black N1 phosphorite grains; mainly very fine to coarse quartz sand; minor quartz silt, very fine sand to small pebble-size fossils, clay-size terrigenous clay and lime mud, very fine to coarse sand-size phosphorite grains and very fine to medium sand-size heavy mineral grains; moderately sorted quartz sand; angular to rounded quartz sand; 10 to 20 percent skeletal fragments, pelecypods, barnacles; trace phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable
22.9 - 24.0	No recovery

Depth (feet below land surface)	Lithologic description of well HE-1113
24.0 - 25.75	Quartz sand, yellowish-gray 5Y 7/2; black N1 and light-brown 5YR 5/6 heavy minerals; black N1 phosphorite grains; mainly very fine to coarse quartz sand; minor quartz silt, very fine sand to small pebble-size fossils, terrigenous clay and lime mud, very fine to coarse sand-size phosphorite grains and very fine to medium sand-size heavy mineral grains; moderately sorted quartz sand; angular to rounded quartz sand; 10 to 20 percent skeletal fragments, pelecypods, barnacles; trace phosphorite and heavy mineral grains; 15 percent intergrain porosity; low ydraulic conductivity; soft when wet; friable
25.75 - 29.0	No recovery
29.0 - 32.3	Quartz sand, yellowish-gray 5Y 8/1; black N1 and light-brown 5YR 5/6 heavy minerals; black N1 phosphorite grains; mainly very fine to fine quartz sand; minor quartz silt, medium to coarse quartz sand, very fine sand to granule-size fossils, terrigenous clay and lime mud, and very fine to medium sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; 5 to 15 percent skeletal fragments, pelecypods, barnacles; trace phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated
32.3 - 33.0	Quartz sand, yellowish-gray 5Y 8/1; black N1 and light-brown 5YR 5/6 heavy minerals; black N1 phosphorite grains; mainly very fine to coarse quartz sand; minor quartz silt, very fine sand to granule-size fossils, terrigenous clay and lime mud, and very fine to medium sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; 10 to 20 percent skeletal fragments, barnacles, pelecypods; trace phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated
33.0 - 35.0	Pelecypod lime floatstone with skeletal grain and mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1 and 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very medium to very coarse fossils; minor clay-size lime mud, very fine to fine sand and granule to pebble-size fossils, quartz silt, very fine to medium quartz sand, and very fine to fine sand size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subangular quartz sand; skeletal fragments, pelecypods, barnacles, serpulids; trace phosphorite and heavy mineral grains; 15 percent intergrain and moldic porosity; low hydraulic conductivity; moderately hard when wet, moderately cemented; abrupt contact with quartz sand above
35.0 - 35.6	Pelecypod lime rudstone with quartz sand-rich, mud-dominated lime packstone matrix. yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly medium sand to large pebble-size fossils and clay-size lime mud; minor very fine to fine sand-size fossils, quartz silt, very fine to fine quartz sand, and very fine sand size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subangular quartz sand; skeletal fragments, pelecypods, barnacles, bryozoans, serpulids; trace to 20 percent quartz sand; trace phosphorite and heavy mineral grains; 25 percent moldic and intergrain porosity; high hydraulic conductivity; hard when wet, well cemented
35.6 - 41.0	No recovery
41.0 - 44.4	Pelecypod lime rudstone with skeletal grain-dominated lime packstone matrix, very pale orange 10YR 8/2; black N1 phosphorite and heavy mineral grains; mainly medium sand to large pebble-size fossils and very fine to fine quartz sand; minor clay-size lime mud, very fine to fine sand-size fossils, quartz silt, medium to very coarse quartz sand, and very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; skeletal fragments, pelecypods, barnacles, bryozoans, gastropods (including *Turritella*), serpulids, coral; 10 to 20 percent quartz sand; trace phosphorite and heavy mineral grains; 30 percent moldic and intergrain porosity; high hydraulic conductivity; hard when wet, well cemented
44.4 - 45.6	Pelecypod lime rudstone with skeletal grain-dominated lime packstone matrix, very pale orange 10YR 8/2; black N1 phosphorite and heavy mineral grains; mainly medium sand to large pebble-size fossils and very fine to fine quartz sand; minor clay-size lime mud, very fine to fine sand-size fossils, quartz silt, medium to very coarse quartz sand, and very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; skeletal fragments, pelecypods, barnacles, bryozoans, gastropods (including *Turritella*), serpulids, coral; 40 percent quartz sand; 3 percent phosphorite grains; trace heavy mineral grains; 30 percent moldic and intergrain porosity; high hydraulic conductivity; hard when wet, well cemented
45.6 - 48.0	No recovery
48.0 - 49.0	Pelecypod lime rudstone with skeletal-rich quartz sand matrix, very pale orange 10YR 8/2; black N1 phosphorite and heavy mineral grains; mainly medium sand to large pebble-size fossils and very fine to fine quartz sand; minor clay-size lime mud, very fine to fine sand-size fossils, quartz silt, medium to coarse quartz sand, and very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; skeletal fragments, pelecypods, gastropods (including *Turritella*), sand dollars, barnacles; 40 to 60 percent quartz sand; 3 percent phosphorite grains; trace heavy mineral grains; 30 percent moldic and intergrain porosity; high hydraulic conductivity; hard when wet, well cemented; quartz sandstone has minor lime mud matrix

Depth (feet below land surface)	Lithologic description of well HE-1113
49.0 - 50.1	*Turritella* pelecypod rudstone with quartz sand-rich skeletal packstone matrix and quartz sand with a framework of *Turritella* and pelecypods; yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly medium sand to large pebble-size fossils and very fine to fine quartz sand; minor clay-size lime mud, very fine to fine sand-size fossils, quartz silt, medium to coarse quartz sand, and very fine to fine sand-size phosphorite and heavy mineral grains; moderately sorted quartz sand; angular to subrounded quartz sand; *Turritella*, pelecypods, skeletal fragments, 40 to 60 percent quartz sand; 3 percent phosphorite grains; trace heavy mineral grains; 25 percent moldic and intergrain porosity; high hydraulic conductivity; hard when wet, well cemented; quartz sandstone has minor lime mud matrix
50.1 - 51.1	Quartz sandstone, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subangular quartz sand; trace to 15 percent skeletal fragments; 5 to 15 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; moderately soft when wet; friable; bioturbated
51.1 - 56.3	No recovery
56.3 - 57.9	Quartz sandstone, yellowish-gray 5Y 8/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subangular quartz sand; trace to 15 percent skeletal fragments; 15 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; moderately soft when wet; friable; bioturbated
57.9 - 60.0	No recovery
60.0 - 63.8	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, clay-size terrigenous clay, and very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subangular quartz sand; trace to 10 percent skeletal fragments and thin-shelled pelecypods; 15 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated
63.8 - 64.0	No recovery
64.0 - 68.9	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to very coarse sand-size phosphorite grains; well sorted quartz sand; angular to subangular quartz sand; trace to 5 percent skeletal fragments and thin-shelled pelecypods; 15 to 20 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated
68.9 - 70.0	No recovery
70.0 - 71.5	Quartz sand, yellowish-gray 5Y 7/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to very coarse sand-size phosphorite grains; well sorted quartz sand; angular to subangular quartz sand; trace to 5 percent thin-shelled pelecypods; 15 to 20 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated
71.5 - 75.5	Quartz sand, light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand-size phosphorite and heavy mineral grains; trace fine to very coarse sand-size phosphorite grains; well sorted quartz sand; angular to subangular quartz sand; trace to 5 percent thin-shelled pelecypods; 20 to 25 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated
75.5 - 76.0	No recovery
76.0 - 76.9	Quartz sand, light-olive-gray 5Y 6/1; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to very coarse sand-size quartz and phosphorite grains; well sorted quartz sand; angular to subangular quartz sand; trace to 5 percent thin-shelled pelecypods; 20 to 25 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; coarse quartz and phosphorite grains floating in very fine grain quartz sand matrix
76.9 - 81.0	No recovery

Depth (feet below land surface)	Lithologic description of well HE-1113
81.0 - 83.4	Quartz sand interlaminated with terrigenous mudstone, yellowish-gray 5Y 8/1 quartz sand; olive-gray 5Y 3/2 mudstone; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand and terrigenous clay; minor quartz silt, and very fine sand-size phosphorite and heavy mineral grains; trace fine to very coarse sand size quartz and phosphorite grains; well sorted quartz sand; angular to subrounded quartz sand; 20 percent phosphorite grains; trace heavy mineral grains; trace mica; trace fish scales; 15 percent intergrain porosity in quartz sand; trace porosity in mudstone; low hydraulic conductivity in quartz sand; very low in mudstone; quartz sand soft when wet; friable quartz sand; bioturbated; coarse quartz and phosphorite grains floating in very fine grain quartz sand matrix; mudstone laminated (about 1-inch thick)
83.4 - 87.0	Terrigenous mudstone interlaminated with yellowish-gray 5Y 8/1 quartz sand; olive-gray 5Y 3/2 mudstone; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand and terrigenous clay; minor quartz silt, and very fine sand-size phosphorite and heavy mineral grains; trace fine to very coarse sand-size quartz and phosphorite grains; well sorted quartz sand; angular to subrounded quartz sand; 20 percent phosphorite grains; trace heavy mineral grains; trace mica; trace fish scales; 15 percent intergrain porosity in quartz sand; trace porosity in mudstone; low hydraulic conductivity in quartz sand; very low in mudstone; quartz sand soft when wet; friable quartz sand; bioturbated; coarse quartz and phosphorite grains floating in very fine grain quartz sand matrix
87.0 - 88.0	No recovery
88.0 - 88.7	Terrigenous mudstone, olive-gray 5Y 3/2; mainly terrigenous clay; minor quartz silt; trace mica; trace fish scales; trace microporosity; very low hydraulic conductivity; hard when wet
88.7 - 89.0	No recovery
89.0 - 91.0	Terrigenous mudstone, olive-gray 5Y 3/2; mainly terrigenous clay; minor quartz silt; trace mica; trace microporosity; very low hydraulic conductivity; hard when wet
91.0 - 94.5	Terrigenous mudstone with minor diatoms, olive-gray 5Y 3/2; mainly terrigenous clay; minor quartz silt; trace to 5 percent diatoms; trace microporosity; very low hydraulic conductivity; hard when wet
94.5 - 94.7	Diatomaceous mudstone, yellowish-gray 5Y 7/2; mainly terrigenous clay; minor quartz silt; 20 to 40 percent diatoms; trace microporosity; very low hydraulic conductivity; moderately hard when wet
94.7 - 95.0	No recovery
95.0 - 97.6	Diatomaceous mudstone, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite grains; mainly clay-size terrigenous clay; minor quartz silt, very fine sand-size quartz sand and phosphorite grains; 20 to 40 percent diatoms; quartz sand contains 15 percent phosphorite grains; trace microporosity; very low hydraulic conductivity; moderately hard when wet; minor interlaminations of quartz sand
97.6 - 100.3	Quartz sand, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subangular quartz sand; 10 percent phosphorite grains; trace heavy mineral grains; trace mica; 10 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; minor disturbed laminations of terrigenous mudstone; very minor terrigenous clay matrix
100.3 - 101.0	No recovery
101.0 - 107.4	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand-size phosphorite and heavy mineral grains; well sorted quartz sand; angular to subangular quartz sand; 5 to 10 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; very minor terrigenous clay matrix
107.4 - 110.0	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to coarse quartz sand; well sorted quartz sand; angular to subrounded quartz sand; 5 to 10 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; very minor terrigenous clay matrix; coarse quartz grains floating in very fine quartz sand matrix
110.0 - 111.0	No recovery
111.0 - 118.0	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to medium quartz sand and fine to medium sand-size phosphorite grains; well sorted quartz sand; angular to subrounded quartz sand; 10 percent phosphorite grains; trace heavy mineral grains; trace mica; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; very minor terrigenous clay matrix; coarse quartz grains floating in very fine quartz sand matrix

Depth (feet below land surface)	Lithologic description of well HE-1113
118.0 - 120.3	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, fine to coarse quartz sand, terrigenous clay, and very fine sand-size phosphorite and heavy mineral grains; trace fine to medium sand-size phosphorite grains; moderately sorted quartz sand; angular to subrounded quartz sand; 10 percent phosphorite grains; 5 to 10 percent fine to coarse quartz sand; trace heavy mineral grains; trace mica; trace thin-shelled pelecypods; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; very minor terrigenous clay matrix; coarse quartz grains floating in very fine quartz sand matrix
120.3 - 121.0	No recovery
121.0 - 131.0	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, fine to coarse quartz sand, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to medium sand-size phosphorite grains; moderately sorted quartz sand; angular to subrounded quartz sand; 10 percent phosphorite grains; 5 to 10 percent fine to coarse quartz sand; trace heavy mineral grains; trace mica; trace thin-shelled pelecypods; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; very minor terrigenous clay matrix; coarse quartz grains floating in very fine quartz sand matrix
131.0 -142.0	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, fine to very coarse quartz sand, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to medium sand size phosphorite grains; moderately sorted quartz sand; angular to subrounded quartz sand; 10 percent phosphorite grains; trace to 70 percent fine to very coarse quartz sand; trace heavy mineral grains; trace mica; trace thin-shelled pelecypods; 10 to 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; minor terrigenous clay matrix
142.0 - 146.0	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, fine to coarse quartz sand, terrigenous clay, and very fine sand-size phosphorite and heavy mineral grains; trace fine to coarse sand-size phosphorite grains; moderately sorted quartz sand; angular to subrounded quartz sand; 5 percent phosphorite grains; trace to 15 percent fine to very coarse quartz sand; trace heavy mineral grains; trace mica; trace thin-shelled pelecypods; 10 to 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; minor terrigenous clay matrix; locally clay-rich matrix
146.0 - 150.7	Quartz sand, yellowish-gray 5Y 7/2, light-olive-gray 5Y 5/2; black N1 phosphorite and heavy mineral grains; mainly very fine quartz sand; minor quartz silt, fine to coarse quartz sand, terrigenous clay, and very fine sand size phosphorite and heavy mineral grains; trace fine to coarse sand-size phosphorite grains; moderately sorted quartz sand; angular to subrounded quartz sand; 3 percent phosphorite grains; trace to 15 percent fine to very coarse quartz sand; trace heavy mineral grains; trace mica; trace thin-shelled pelecypods; 10 to 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; bioturbated; minor terrigenous clay matrix; locally clay-rich matrix
150.7 - 151.0	No recovery

Prison No. 2 Core

Florida Geological Survey well number	W-17785
GWSI number	HE-1114
Total depth	181 feet
Cored from	0 to 181 feet
County	Hendry
Location	NW, sec. 18, T48S, R31E
Latitude	26°18′27″
Longitude	81°15′43″
Elevation	20 feet
Completion date	November 21, 1998
Other types of available logs	Induction log, gamma ray, spontaneous potential, resistivity
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham
Pamlico Sand	0 to 16 feet
Caloosahatchee Marl(?)	16 to 34 feet
Tamiami Formation	34 to 91 feet
Pinecrest Sand	34 to 63 feet
Ochopee Limestone	63 to 91 feet
Unnamed formation	91 to 113 feet
Peace River Formation	113 to 181 feet
Water-table aquifer	0 to 16 feet
Gray limestone aquifer	63 to 91 feet
Lower confining unit	91 to 181 feet

Depth (feet below land surface)	Lithologic description of well HE-1114
0 - 16	Quartz sand
16 - 34	Marl with oysters, soft when wet; minor sandy limestone
34 - 48	Quartz sand
48 - 63	Clay
63 - 91	Pelecypod rudstone
91 - 113	Quartz sand, very fine to fine with minor micrite matrix; 10 to 20 percent black phosphate grains
113 - 181	Very fine to fine quartz sand, minor medium to very coarse quartz grains; up to 25 percent black phosphate grains; local clay matrix or micrite matrix

Mustang Grade Core

Florida Geological Survey well number	W-17810
GWSI number	HE-1115
Total depth	221 feet
Cored from	0 to 221 feet
County	Hendry
Location	NW, NW, sec. 36, T45S, R30E
Latitude	26°31′53″
Longitude	81°17′09″
Elevation	32 feet
Completion date	January 23, 1999
Other types of available logs	Induction, gamma ray, spontaneous potential, resistivity
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham
Undifferentiated sand	0 to 4.5 feet
Caloosahatchee Marl(?)	4.5 to 18 feet
Tamiami Formation	18 to 123 feet
Pinecrest Sand	18 to 100 feet
Lower Tamiami Limestone	100 to 123 feet
Peace River Formation	123 to 221 feet
Water-table aquifer	0 to 4 feet
Gray limestone aquifer	100(?) to 123 feet
Lower confining unit	123 to 221 feet

Depth (feet below land surface)	Lithologic description of well HE-1115
0.0 - 4.5	Quartz sand
4.5 - 18.0	Sandy marl and quartz sand with micrite matrix
18.0 - 56.5	Quartz sand
56.5 - 100.0	Quartz sand
100.0 - 106.0	Pelecypod lime rudstone
106.0 - 108.0	*Vermicularia* boundstone
108 .0 - 122.0	Loose quartz sand
122.0 - 123.0	Pelecypod lime rudstone with oysters
123.0 - 221.0	Mainly quartz sand with clay matrix; top of unit at 123 feet is a sharp contact

L2 Core

Florida Geological Survey well number	W-17868
Well number	HE-1116
Total depth	201 feet
Cored from	0 to 201 feet
County	Hendry
Location	NW, SW, sec. 4, T46S, R34E
Latitude	26°30′23″
Longitude	80°56′52″
Elevation	18 feet
Completion date	March 11, 1999
Other types of logs available	Induction, gamma ray, spontaneous potential, single-point resistivity
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham
Undifferentiated quartz sand (Pamlico Sand?)	0 to 11 feet
Tamiami Formation	11 to 152 feet
Pinecrest sand member	11 to 46 feet
Ochopee Limestone Member	46 to 152 feet
Unnamed formation	152 to 191 feet
Peace River Formation	191 to 201 feet
Water-table aquifer	0 to 11 feet
Upper confining unit	11 to 31 feet
Gray limestone aquifer	31 to 152 feet
Lower confining unit	152 to 201 feet

Depth (feet below land surface)	Lithologic description of well HE-1116
0.0 - 9.5	Quartz sand, pale-yellowish-brown 10YR 6/2, grayish-orange 10YR 8/2, dark-yellowish-orange 10YR 6/6, moderate-yellowish-brown 6/2, dark-yellowish-brown 10YR 4/2; black N1 heavy minerals; mainly fine quartz sand; minor quartz silt to medium quartz sand and very fine to fine sand-size heavy mineral grains; well sorted quartz sand; subangular to subrounded quartz sand; trace heavy mineral grains; 25 percent intergrain porosity; moderate hydraulic conductivity; minor modern plant roots in upper 1 foot; very soft when wet; unconsolidated
9.5 - 11.0	No recovery
11.0 - 12.5	Quartz sand, yellowish-gray 5Y 7/2 and white N9; black N1 heavy mineral grains; black and 10YR 5/4 moderate-yellowish-brown phosphorite grains mainly fine quartz sand; minor silt to medium quartz sand and very fine sand size phosphorite and heavy mineral grains; trace clay; well sorted quartz sand; subangular to subrounded quartz sand; 5 percent pelecypods and undifferentiated fossil fragments; 5 percent phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; marine
12.5 - 20.0	Marl, white N9 to very light gray N8; mainly clay-size carbonate and minor quartz silt; trace undifferentiated fossil fragments; 5 percent microporosity; very low hydraulic conductivity; soft when wet; hard when dry; upper 1 inch very hard, wet, and contains dark-yellowish-gray 10YR 6/6 coloration (possible exposure surface); friable; marine; burrowed
20.0 - 20.5	No recovery
20.5 - 23.0	Quartz sand, yellowish-gray 5Y 7/2; black phosphorite grains mainly very fine quartz sand; minor silt and fine to coarse quartz sand, very fine to fine sand-size phosphorite grains and clay; moderate sorted quartz sand; subangular to subrounded quartz sand; 35 percent pelecypods and undifferentiated fossil fragments; 5 percent phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; fining upward; marine
23.0 - 24.0	Quartz sand, yellowish-gray 5Y 7/2; black phosphorite grains mainly coarse to very coarse quartz sand; minor silt and fine to medium quartz sand, very fine to fine sand-size phosphorite grains and trace clay; moderate sorted quartz sand; subangular to subrounded quartz sand; 35 percent pelecypods and undifferentiated fossil fragments; 5 percent phosphorite grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; fining upward; marine
24.0 - 31.0	No recovery
31.0 - 35.0	Quartz sand, yellowish-gray 5Y 7/2; black phosphorite grains mainly fine to coarse quartz sand; minor silt to very fine and very coarse quartz sand, very fine sand to granule-size phosphorite grains and clay; fine sand to pebble-size fossils; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods and undifferentiated fossil fragments; 3 percent phosphorite grains 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; fining upward; marine
35.0 - 38.5	No recovery
38.5 - 46.0	Quartz sand, yellowish-gray 5Y 7/2; black phosphorite grains mainly fine to coarse quartz sand; minor silt to very fine and very coarse quartz sand, very fine sand to granule-size phosphorite grains and clay; fine sand to pebble-size fossils; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods and undifferentiated fossil fragments; 3 percent phosphorite grains; 20 percent intergrain porosity; moderate hydraulic conductivity; soft when wet; friable; fining upward; marine
46.0 - 66.5	Pelecypod lime floatstone and rudstone with quartz sand-rich skeletal lime packstone matrix, medium-light-gray N6 to light-gray N8; black phosphorite grains; mainly fine sand to very large pebble size fossils; minor silt to coarse quartz sand, very fine sand size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; pelecypods, undifferentiated skeletal fragments, sand dollars, *Vermicularia*, gastropods, bryozoans, encrusting foraminifers; trace phosphorite grains; 25 percent moldic and intergrain porosity; moderate hydraulic conductivity; soft when wet; poorly consolidated and mechanically broken; local thin beds that are hard when wet and well cemented; marine; gradational contact with quartz sand above
66.5 - 75.5	No recovery
75.5 - 76.5	Pelecypod-rich quartz sandstone, light-gray N8; black phosphorite grains; mainly fine to medium quartz sand; minor silt to very fine and coarse to very coarse quartz sand, very fine to medium sand-size phosphorite grains; fine sand to large pebble-size fossils; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods, undifferentiated skeletal fragments, sand dollars, bryozoans; 2 percent phosphorite grains; 30 percent intergrain and moldic porosity; high hydraulic conductivity; hard when wet; well cemented
76.5 - 80.5	No recovery

Depth (feet below land surface)	Lithologic description of well HE-1116
80.5 - 81.5	Pelecypod-rich quartz sandstone, light-gray N8; black phosphorite grains; mainly fine to medium quartz sand; minor silt to very fine and coarse quartz sand, very fine to medium sand-size phosphorite grains; fine sand to large pebble-size fossils; moderately sorted quartz sand; subangular to rounded quartz sand; 20 percent pelecypods, undifferentiated skeletal fragments, sand dollars; 2 percent phosphorite grains; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; hard when wet; well cemented
81.5 - 87.5	No recovery
87.5 - 89.0	Pelecypod-rich quartz sandstone, light-gray N8; black phosphorite grains; mainly fine to medium quartz sand; minor silt to very fine and coarse quartz sand, very fine to medium sand-size phosphorite grains; fine sand to large pebble-size fossils; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods, undifferentiated skeletal fragments; 3 percent phosphorite grains; 25 percent intergrain and trace moldic porosity; moderate hydraulic conductivity; hard when wet; well cemented
89.0 - 100.5	No recovery
100.5 - 101.0	Pelecypod-rich quartz sandstone, light-gray N8; black phosphorite grains; mainly fine to medium quartz sand; minor silt to very fine and coarse quartz sand, very fine to fine sand-size phosphorite grains; fine sand to large pebble-size fossils; moderately sorted quartz sand; subangular to rounded quartz sand; 25 percent pelecypods, undifferentiated skeletal fragments; 2 percent phosphorite grains; 30 percent intergrain and trace moldic porosity; high hydraulic conductivity; hard when wet; well cemented
101.0 - 104.5	No recovery
104.5 - 107.5	Pelecypod-rich quartz sandstone, light-gray N8; black phosphorite grains; mainly fine to medium quartz sand; minor silt to very fine and coarse quartz sand, very fine to fine sand-size phosphorite grains; fine sand to large pebble-size fossils; moderately sorted quartz sand; subangular to rounded quartz sand; 20 to 35 percent pelecypods, undifferentiated skeletal fragments; 2 percent phosphorite grains; 25 percent intergrain and trace moldic porosity; moderate hydraulic conductivity; hard when wet; well cemented
107.5 - 121.0	No recovery
121.0 - 125.0	Pelecypod-rich quartz sandstone, light-gray N8; black phosphorite grains; mainly fine to medium quartz sand; minor silt to very fine and coarse quartz sand, very fine to fine sand-size phosphorite grains; fine sand to granule-size fossils; well sorted quartz sand; subangular to rounded quartz sand; pelecypods, undifferentiated skeletal fragments; 2 percent phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; minor lime mud matrix
125.0 - 130.0	Pelecypod-rich quartz sandstone and quartz sand-rich pelecypod lime mud-dominated and grain-dominated lime packstone, light-gray N8; black phosphorite grains; mainly fine to medium quartz sand; minor silt to very fine and coarse quartz sand, very fine to fine sand-size phosphorite grains; fine sand to granule-size fossils; well sorted quartz sand; subangular to rounded quartz sand; pelecypods, undifferentiated skeletal fragments, barnacles; trace to 2 percent phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; soft when wet; friable; minor lime mud matrix
130.0 - 132.0	No recovery
132.0 - 136.0	Pelecypod lime rudstone with pelecypod mud-dominated lime packstone matrix, light-gray N8; black phosphorite grains; mainly fine sand to pebble-size fossils, minor very fine to fine sand-size phosphorite grains; pelecypods, undifferentiated skeletal fragments, bryozoans; trace phosphorite grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet
136.0 - 138.0	Pelecypod lime rudstone with pelecypod quartz sand-rich mud-dominated lime packstone matrix, light-gray N8; black phosphorite grains; mainly fine sand to pebble-size fossils, minor very fine to fine sand-size quartz sand and phosphorite grains; well sorted quartz sand; subangular to rounded quartz sand; pelecypods, undifferentiated skeletal fragments, bryozoans; trace phosphorite grains; 25 percent intergrain porosity; moderate hydraulic conductivity; soft when wet
138.0 - 139.5	No recovery
139.5 - 143.5	*Turritella* and pelecypod lime rudstone and *Vermicularia* bindstone with quartz sandstone matrix, light-gray N8; black phosphorite grains; mainly fine sand to large pebble-size fossils and very fine to fine sand-size quartz sand; minor phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; *Vermicularia*, *Turritella*, pelecypods, undifferentiated skeletal fragments, bryozoans; 3 percent phosphorite grains; 30 percent moldic and intergrain porosity; high hydraulic conductivity; hard to moderately hard when wet; well to moderately cemented; minor lime mud matrix in quartz sandstone
143.5 - 145.0	No recovery

Depth (feet below land surface)	Lithologic description of well HE-1116
145.0 - 151.0	*Turritella* and pelecypod lime rudstone with skeletal-rich quartz sand matrix, light-gray N8; black phosphorite grains; mainly fine sand to large pebble-size fossils and fine sand-size quartz sand; minor very fine quartz sand and very fine to fine phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; *Vermicularia*, *Turritella*, pelecypods, undifferentiated skeletal fragments; 3 percent phosphorite grains; 30 percent moldic and intergrain porosity; high hydraulic conductivity; hard to moderately hard when wet; well to moderately cemented
151.0 - 152.0	No recovery
152.0 - 156.5	Quartz sand, yellowish-gray 5Y 8/1; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite grains; mainly very fine quartz sand; minor quartz silt, very fine sand-size phosphorite grains and very fine to coarse sand-size fossils; trace clay and mica; well sorted quartz sand; subangular to subrounded quartz sand; trace to 10 percent pelecypods, undifferentiated skeletal fragments; 5 to 10 percent phosphorite grains; 25 percent intergrain porosity; low to moderate hydraulic conductivity; soft when wet; friable
156.5 - 161.0	No recovery
161.0 - 167.5	Quartz sand, yellowish-gray 5Y 8/1; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite grains; mainly very fine quartz sand; minor quartz silt, very fine sand-size phosphorite grains and very fine to coarse sand-size fossils; trace clay and mica; well sorted quartz sand; subangular to subrounded quartz sand; trace to 10 percent pelecypods, undifferentiated skeletal fragments; 10 to 15 percent phosphorite grains; 25 percent intergrain porosity; low to moderate hydraulic conductivity; soft when wet; friable
167.5 - 168.5	No recovery
168.5 - 172.5	Quartz sand, yellowish-gray 5Y 8/1; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite grains; mainly very fine quartz sand; minor quartz silt, very fine sand-size phosphorite grains and very fine to coarse sand-size fossils; trace clay and mica; well sorted quartz sand; subangular to subrounded quartz sand; trace to 10 percent pelecypods, undifferentiated skeletal fragments; 10 to 15 percent phosphorite grains; 25 percent intergrain porosity; low to moderate hydraulic conductivity; soft when wet; friable
172.5 - 175.0	No recovery
175.0 - 183.0	Quartz sand, yellowish-gray 5Y 8/1; black N1 and dark-yellowish-orange 10YR 6/6 phosphorite grains; mainly very fine quartz sand; minor quartz silt, very fine sand size phosphorite grains and very fine to coarse sand-size fossils; trace clay and mica; well sorted quartz sand; subangular to subrounded quartz sand; trace to 10 percent pelecypods, undifferentiated skeletal fragments; 10 to 15 percent phosphorite grains; 25 percent intergrain porosity; low to moderate hydraulic conductivity; soft when wet; friable
183.0 - 189.3	Quartz sand, light-olive-gray 5Y 6/1; black N1 phosphorite grains; mainly very fine quartz sand; minor quartz silt, very fine sand size phosphorite grains and very fine to coarse sand-size fossils; trace clay and mica; well sorted quartz sand; subangular to subrounded quartz sand; trace to 10 percent pelecypods, undifferentiated skeletal fragments; 15 to 20 percent phosphorite grains; 25 percent intergrain porosity; low to moderate hydraulic conductivity; soft when wet; friable; burrowed
189.3 - 191.0	No recovery
191.0 - 196.5	Burrowed mixture of quartz sand and terrigenous clay, light-olive-gray 5Y 6/1 and olive-gray 5Y 4/1; black N1 phosphorite grains; mainly clay, quartz silt and very fine quartz sand; minor quartz silt, very fine sand size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace to 5 percent undifferentiated skeletal fragments and fish scales; 20 to 30 percent phosphorite grains; less than 5 to 20 percent intergrain porosity; very low to low hydraulic conductivity; soft when wet; friable; burrowed; quartz sand fills burrows
196.5 - 200.9	Terrigenous mudstone, light-olive-gray 5Y 6/1 and 5Y 5/2, olive-gray 5Y 4/1; black N1 phosphorite grains; mainly clay, quartz silt and very fine quartz sand; minor quartz silt, very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace to 5 percent undifferentiated skeletal fragments and fish scales; trace to 15 percent phosphorite grains; minor microporosity; very low hydraulic conductivity; moderately hard when wet; well consolidated; minor burrows filled with quartz sand
200.9 - 201.0	Diatomaceous mudstone, light-olive-gray 5Y 6/1; mainly clay minor microporosity; very low hydraulic conductivity; moderately hard when wet; well consolidated

Golightly Core

Florida Geological Survey well number	**W-17968**
Well number	**MO-177**
Total depth	**200 feet**
Cored from	**0 to 200 feet**
County	**Monroe**
Location	**T54S, R34E**
Latitude	**25°44′56″**
Longitude	**80°55′58″**
Elevation	**8 feet**
Completion date	**February 14, 1997**
Other types of available logs	**Gamma ray, induction, temperature, fluid velocity**
Owner	**U.S. Geological Survey**
Driller	**U.S. Geological Survey**
Core described by	**Ronald S. Reese**
Tamiami Formation, Ochopee Limestone Member	**0 to 78.2 feet**
Unnamed formation	**78.2 to 131.2 feet**
Peace River Formation	**131.2 to 200 feet**
Gray limestone aquifer	**0 to 78.2 feet (78.2 feet corresponds to results of flowmeter)**
Lower confining unit	**78.2 to 200 feet**

Depth (feet below land surface)	Lithologic description of well MO-177
0.0 - 1.4	Limestone, white N9; fine to coarse quartz sand in matrix; minor shells; minor moldic porosity; high hydraulic conductivity; hard but broken
1.4 - 2.0	Limestone, white N9; abundant fine to coarse sand grains in matrix; minor moldic porosity; low hydraulic conductivity; quartz sand fills some vertical dissolution cavities
2.0 - 3.3	Limestone, very pale orange 10YR 8/2, grayish-orange 10YR 7/4; abundant fine to coarse quartz sand; shell molds; minor moldic porosity; high hydraulic conductivity; hard
3.3 - 4.0	No recovery
4.0 - 6.7	Limestone, light-gray N7, light-olive-gray 5Y 6/1; trace quartz; local shells; moldic porosity; high hydraulic conductivity; locally hard and competent; locally broken
6.7 - 9.0	No recovery
9.0 - 12.0	Limestone, light-gray N7, light-olive-gray 5Y 6/1; trace quartz; local shells; moldic porosity; high hydraulic conductivity; locally hard and competent; locally broken
12.0 - 14.0	No recovery
14.0 - 14.4	Lime grainstone, very pale orange 10YR 8/2, grayish-orange 7/4; silty; up to granule size; interparticle porosity; high hydraulic conductivity; poorly sorted
14.4 - 15.0	No recovery
15.0 - 15.6	Limestone, gray to white; quartz sand-rich matrix in lower half of interval; interparticle porosity; high hydraulic conductivity; well sorted
15.6 - 16.0	No recovery
16.0 - 18.0	Limestone, very light gray N8, light-greenish-gray 5GY 8/1; molds and casts of mollusks; silty; moldic porosity; high to very high hydraulic conductivity; lime mud increases downward
18.0 - 19.0	No recovery
19.0 - 20.0	Limestone, very light gray N8, light-greenish-gray 5GY 8/1; molds and casts of mollusks; oyster fragments; silty; moldic porosity; high to very high hydraulic conductivity
20.0 - 21.6	Limestone, very light gray N8, light-greenish-gray 5GY 8/1; molds and casts of mollusks; oyster fragments; silty; moldic porosity; high hydraulic conductivity; hard
21.6 - 25.0	No recovery
25.0 - 25.2	Limestone, grayish-white; minor very fine quartz sand; very low hydraulic conductivity; hard and dense
25.2 - 30.0	No recovery
30.0 - 30.25	Carbonate sand, light-gray N7; coarse to pebble-size skeletal grains; less than 5 percent phosphorite; moderate to high hydraulic conductivity
30.25 - 32.0	Carbonate sand, light-gray N7, medium-light-gray N6; shell fragments; silty; 5 to 10 percent phosphorite grains; fine to pebble; low to moderate hydraulic conductivity; poorly sorted
32.0 - 33.0	No recovery
33.0 - 35.0	Carbonate sand, light-gray N7, medium-light gray N6; shell fragments; silty; 5 to 10 percent phosphorite grains; coarse to pebble; moldic; moderate to high hydraulic conductivity
35.0 - 35.5	Carbonate sand, medium-light-gray N6; silty matrix; medium to coarse; moldic porosity; moderate hydraulic conductivity
35.5 - 36.2	Carbonate sand, light-gray N7, medium-light-gray N6; shell fragments; silty; 5 to 10 percent phosphorite grains; coarse to pebble; moldic; moderate hydraulic conductivity
36.2 - 37.5	No recovery
37.5 - 38.3	Carbonate sand, light-gray N7; large shell fragments near base of interval; trace phosphorite grains; mainly very coarse to granule; high hydraulic conductivity; loose carbonate grains; poorly sorted
38.3 - 40.0	No recovery

Depth (feet below land surface)	Lithologic description of well MO-177
40.0 - 41.3	Carbonate sand, very light gray N8; mainly very fine to granule; low to moderate hydraulic conductivity; silty to muddy matrix; poorly sorted
41.3 - 45.0	No recovery
45.0 - 46.2	Carbonate sand, very light gray N8; mainly fine; low hydraulic conductivity; common quartz grains; silty to muddy matrix; moderately sorted
46.2 - 47.0	No recovery
47.0 - 47.5	Carbonate sand, very light gray N8; mainly fine and coarse to granule; low hydraulic conductivity; uncommon quartz grains; silty to muddy matrix; poorly sorted
47.5 - 50.0	Carbonate sand, light-gray N7 to medium-light-gray N6; mainly very fine to coarse; minor shells; trace to 3 percent phosphorite grains at 48.5 feet; low to moderate hydraulic conductivity; cohesive to crumbly; silty to muddy matrix
50.0 - 54.0	Carbonate sand, light-gray N7 to medium-light-gray N6; mainly fine to pebble; oysters; 1 to 3 percent phosphorite grains; low to moderate hydraulic conductivity; moderately cohesive to very crumbly; silty to muddy matrix
54.0 - 55.0	No recovery
55.0 - 55.8	Carbonate sand, light-gray N7 to medium-light-gray N6; mainly fine to large pebble; 1 to 3 percent phosphorite grains; low to moderate hydraulic conductivity; moderately cohesive to very crumbly; silty to muddy matrix
55.8 - 56.0	No recovery
56.0 - 57.9	Carbonate sand, light-gray N7 to medium-light-gray N6; mainly fine to large pebble; oysters; 1 to 3 percent phosphorite grains; low to moderate hydraulic conductivity; moderately cohesive to very crumbly; silty to muddy matrix
57.9 - 59.8	Carbonate sand, medium-gray N5 to medium-light-gray N6; fine to coarse; shell fragments; moderate to high hydraulic conductivity; minor silty matrix
59.8 - 60.0	No recovery
60.0 - 61.0	Carbonate sand, medium-gray N5 to medium-light-gray N6; fine to coarse; shell fragments; moderate to high hydraulic; minor silty matrix; moderate to well sorted
61.0 - 63.3	Carbonate sand, light-gray N7 to medium-light-gray N6; mainly very fine to coarse; minor large shell fragments; low to moderate hydraulic conductivity; crumbly; silty to muddy matrix
63.3 - 65.0	No recovery
65.0 - 69.0	Carbonate sand, light-gray N7; mainly silt to pebble; common shell fragments locally; low to moderate hydraulic conductivity; cohesive to friable; silty to muddy matrix
69.0 - 70.0	No recovery
70.0 - 74.0	Carbonate sand, light-gray N7 to medium-gray N6; mainly silty to pebble; large pebble-size shell fragments locally; low to moderate hydraulic conductivity; friable; silty to muddy matrix
74.0 - 75.0	No recovery
75.0 - 78.2	Carbonate sand, light-gray N7 to medium-gray N6; mainly silt to pebble; large pebble-size shell fragments locally; low to moderate hydraulic conductivity; friable; silty to muddy matrix
78.2 - 79.0	No recovery
79.0 - 83.2	Quartz sandstone, white N9 to very light gray N8 to yellowish-gray 5Y 8/1; fine sand-size quartz grains; well sorted; abundant gastropod molds; low hydraulic conductivity; hard and dense at top grading to friable at base; possible exposure surface at top
83.2 - 84.0	No recovery
84.0 - 85.3	Quartz sandstone, white N9 to very light gray N8 to yellowish-gray 5Y 8/1; fine sand-size quartz grains; well sorted; abundant gastropod molds; local high moldic porosity; moderate to high hydraulic conductivity; hard
85.3 - 86.8	No recovery
86.8 - 87.8	Quartz sandstone, light-greenish-gray 5GY 8/1; medium grain size; well sorted; trace very fine phosphorite black grains; low hydraulic conductivity; soft
87.8 - 90.0	No recovery

Depth (feet below land surface)	Lithologic description of well MO-177
90.0 - 93.1	Quartz sand, light-greenish-gray 5GY 8/1; fine with local fine to coarse grains; well with local bimodal sorting; minor shell fragments; trace very fine black phosphorite grains; low to moderate hydraulic conductivity
93.1 - 94.5	No recovery
94.5 - 97.5	Quartz sand, light-greenish-gray 5GY 8/1; fine with local fine to granule size; well with local bimodal sorting; minor shell fragments; trace very fine phosphorite black grains with minor fine to granule-size grains; low to moderate hydraulic conductivity
97.5 - 98.0	No recovery
98.0 - 100.0	Quartz sand, light-greenish-gray 5GY 8/1; very fine to fine with local very fine to granule; well with local bimodal sorting; lower 0.3 foot contains minor mollusk shells and trace to 3 percent very fine phosphorite grains with minor fine to granule-size grains; low to moderate hydraulic conductivity
100.0 - 104.0	Quartz sand, light-greenish-gray 5GY 8/1; very fine to fine with local very fine to granule; abundant granule-size grains; well with bimodal sorting; trace to 3 percent very fine phosphorite grains with minor fine to granule-size grains; contains abundant mollusk shells from 102 to 102.5 feet; low to moderate hydraulic conductivity
104.0 - 105.0	No recovery
105.0 - 108.0	Quartz sand, light-greenish-gray 5GY 8/1; fine to small pebble size; trace to 3 percent phosphorite grains in lower two-thirds and 3 to 10 percent phosphorite in upper one-third; moderate hydraulic conductivity (lower one-third) and moderate to high conductivity (upper two-thirds); interval coarsens upward from fine to medium sand size at base and from fine to small pebble size at top
108.0 - 110.0	No recovery
110.0 - 114.4	Quartz sand, very light gray N8; fine to granule grain size; trace to 3 percent phosphorite grains; moderate to high hydraulic conductivity (lower one-third) and moderate hydraulic conductivity (upper two thirds); interval fines upward from fine to granule size at base and from fine to medium at top
114.4 - 115.0	No recovery
115.0 - 117.5	Quartz sand, very light gray N8; fine to coarse grain size; 3 to 10 percent phosphorite grains; moderate hydraulic conductivity (lower two-thirds) and moderate to high hydraulic conductivity (upper one-third); interval coarsens upward from fine to medium to medium to coarse
117.5 - 118.0	No recovery
118.0 - 119.3	Quartz sand, very light gray N8; fine to small pebble grain size; 3 to 10 percent phosphorite grains; moderate hydraulic conductivity
119.3 - 119.5	No recovery
119.5 - 120.0	Quartz sand, very light gray N8; fine to granule grain size; 3 to 10 percent phosphorite grains; moderate hydraulic conductivity
120.0 - 124.5	No recovery
124.4 - 127.0	Quartz sand, greenish-gray 5GY 6/1; very fine to granule grain size; 5 percent phosphorite grains; low hydraulic conductivity (lower half) and moderate hydraulic conductivity (upper half); coarsens upward from very fine to fine at base to fine to granule at top; minor silt and clay matrix
127.0 - 129.5	Quartz sand, greenish-gray 5GY 6/1; very fine grain size; low hydraulic conductivity; minor silt and clay matrix
129.5 - 130.0	No recovery
130.0 - 131.2	Quartz sand, greenish-gray 5GY 6/1; very fine to medium; moderate hydraulic conductivity
131.2 - 133.2	Quartz sand and clay, greenish-gray 5GY 6/1 to olive-gray 5Y 4/; clay to very fine grain size; very low to low hydraulic conductivity
133.2 - 135.0	No recovery
135.0 - 143.0	Mudstone, olive-gray 5Y 4/1; clay grain size; very low hydraulic conductivity
143.0 - 143.3	Quartz sand, greenish-gray 5GY 6/1; mainly very fine with minor silt and medium to coarse grains; low hydraulic conductivity
143.3 - 145.0	No recovery

Depth (feet below land surface)	Lithologic description of well MO-177
145.0 - 147.9	Quartz sand, greenish-gray 5GY 6/1; mainly fine with minor medium to coarse; moderately sorted; 5 percent phosphorite grains; low to moderate hydraulic conductivity
147.9 - 148.8	Quartz sand, greenish-gray 5GY 6/1; mainly fine sand with minor silt and clay matrix; 3 to 10 percent phosphorite grains; low hydraulic conductivity
148.8 - 150.0	No recovery
150.0 - 150.8	Quartz sand, light-olive-gray 5Y 6/1 to olive-gray 5Y 4/1; very fine to fine grain size; low hydraulic conductivity
150.8 - 154.0	No recovery
154.0 - 156.0	Quartz sand, light-olive-gray 5Y 6/1 to olive-gray 5Y 4/1; very fine to fine grain size; low hydraulic conductivity
156.0 - 157.0	Quartz sand, light-olive-gray 5Y 6/1 to olive-gray 5Y 4/1; very fine to fine with minor medium to granule size; poorly sorted; 10 to 20 percent phosphorite grains; low to moderate hydraulic conductivity
157.0 - 159.7	Quartz sand, light-olive-gray 5Y 6/1 to olive-gray 5Y 4/1; mainly medium to coarse grain size; moderately to well sorted; 3 to 10 percent phosphorite grains; moderate to high hydraulic conductivity
159.7 - 160.0	No recovery
160.0 - 163.0	Quartz sand, light-gray N7; mainly medium to coarse with minor granule size; well sorted ; 3 to 5 percent phosphorite grains; high hydraulic conductivity
163.0 - 164.0	Quartz sand, light-gray N7; mainly medium grain size; moderately to well sorted; moderate hydraulic conductivity
164.0 - 166.5	Quartz sand, light-gray N7; mainly medium to coarse grain size; moderate to high hydraulic conductivity
166.5 - 167.5	Quartz sand, light-gray N7; mainly medium to coarse with minor granule and small pebble size; moderate to high hydraulic conductivity
167.5 - 168.5	Quartz sand, light-gray N7; mainly medium to coarse with minor clay matrix; low hydraulic conductivity; mottled coloration
168.5 - 170.0	No recovery
170.0 - 173.6	Quartz sand, greenish-gray 5GY 6/1; mainly fine to coarse with minor clay matrix; poorly sorted; low hydraulic conductivity
173.6 - 174.0	No recovery
174.0 - 179.3	Quartz sand, dusky-yellowish-green 10GY 3/2 to grayish-olive-green 5GY 3/2; mainly fine with minor medium to granule size and clay matrix; low hydraulic conductivity
179.3 - 180.0	No recovery
180.0 - 185.0	Quartz sand, dark-greenish-gray 5GY 4/1; mainly fine with minor clay matrix; very low to low hydraulic conductivity; minor alternations of quartz sand and mudstone
185.0 - 186.5	Quartz sand, dusky-yellowish-green 10GY 3/2 to grayish-olive-green 5GY 3/2; mainly fine with minor medium to granule size and clay matrix; very low to low hydraulic conductivity
186.5 - 187.0	No recovery
187.0 - 188.6	Quartz sand, dark-greenish-gray 5GY 4/1; mainly fine with minor medium to granule size and clay matrix; very low to low hydraulic conductivity
188.6 - 190.0	No recovery
190.0 - 200.0	Quartz sand, dark-greenish-gray 5GY 4/1 to grayish-olive-green 5GY 3/2; mainly very fine with minor fine to granule-size and clay matrix; very low hydraulic conductivity

Trail Center Core

Florida Geological Survey well number	W-17969
Well number	MO-178
Total depth	464 feet
Cored from	0 to 464 feet
County	Monroe
Location	NE, sec. 1, T54S, R34E
Latitude	25°48′15″
Longitude	80°52′31″
Elevation	10 feet
Completion date	April 4, 1997
Other types of available logs	Gamma ray, induction, temperature, fluid velocity, fluid conductivity, caliper, neutron
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Kevin J. Cunningham (for a description of 146.7 to 464 feet, see Weedman and others, 1999)
Miami Limestone	0 to 0.75 feet
Fort Thompson Formation	0.75 to 6.5 feet
Tamiami Formation	6.5 to 126.3 feet
Pinecrest Sand Member	6.5 to 46.5 feet
Ochopee Limestone Member	46.5 to 126.3 feet
Unnamed formation	126.3 to 237 feet
Top of Peace River Formation	237 feet
Water-table aquifer	0 to 25 feet
Upper confining unit	25 to 47.7 feet
Gray limestone aquifer	47.7 to 126.3 feet
Top of lower confining unit	126.3 feet
Top of sand aquifer	130 feet
Base of sand aquifer	165 feet?

Depth (feet below land surface)	Lithologic description of well MO-178
0.0 - 0.75	Pelecypod lime floatstone with pelmoldic grainstone to packstone matrix, very pale orange 10YR 8/2, grayish-orange 10YR 7/4, dark-yellowish-orange 10YR 6/6, light-brown 5YR 5/6; mainly clay-size lime mudstone, very fine to fine quartz sand and very fine sand to pebble-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; peloids, pelecypods, gastropods, bryozoans (including *Schizoporella*); 5 to 30 percent quartz sand; 20 percent vuggy and moldic porosity; moderate hydraulic conductivity; moderate; unit contains calcrete in part, hard when wet, well cemented
0.75 - 1.5	Quartz sand-rich calcrete, very pale orange 10YR 8/2, light-brown 5YR 5/6, grayish-orange 10YR 7/4, light-brown 5YR 6/4; very fine to coarse quartz sand, mainly fine to medium quartz sand and lime mudstone matrix; moderately sorted quartz sand; subangular to subrounded quartz sand; 10 to 70 percent quartz sand; 15 percent vuggy, and skeletal-mold and root-mold porosity; low hydraulic conductivity; autobrecciated, hard when wet, well cemented
1.5 - 4.0	No recovery
4.0 - 5.5	Pelecypod floatstone with matrix of quartz sandstone with lime mudstone matrix, very pale orange 10YR 8/2, light-brown 5YR 5/6, grayish-orange 10YR 7/4, light-brown 5YR 6/4; very fine to coarse quartz sand, mainly very fine to fine quartz sand and lime mudstone matrix; moderately sorted quartz sand; subangular to rounded quartz sand; pelecypods and skeletal fragments; 70 percent quartz sand; 15 percent vuggy, skeletal-mold and root-mold, and intergrain porosity; low hydraulic conductivity; hard when wet, well cemented
5.5 - 6.5	No recovery
6.5 - 7.0	Rubble of quartz sandstone with framework of pelecypod floatstone and rudstone, very pale orange 10YR 8/2, medium-light-gray N6 to very light gray N8; mainly very fine to fine quartz sand and pebble-size fossils; minor limestone and silt to granule-size fossils and medium to coarse quartz sand; moderately sorted; subangular to rounded quartz sand; pelecypods and skeletal fragments; 70 percent quartz sand; 15 percent intergrain porosity; moderate hydraulic conductivity; hard when wet, well cemented
7.0 - 10.0	No recovery
10.0 - 10.5	Rubble of calcrete and gray-colored limestone
10.5 - 11.4	Quartz sand with pelecypod rudstone framework, very pale orange 10YR 8/2, light-gray N7; mainly very fine to coarse quartz sand and pebble-size fossils; minor very fine to granule-size fossils and very coarse quartz sand; moderately sorted; subangular to subrounded quartz sand; pelecypods and skeletal fragments; 45 percent quartz sand; 25 percent intergrain porosity; moderate hydraulic conductivity; friable, poorly cemented
11.4 - 15.0	Quartz sand with pelecypod floatstone framework, yellowish-gray 5Y 8/1; mainly fine to medium quartz sand and granule to pebble-size fossils; minor very fine- to coarse-size fossils and very fine and coarse quartz sand; very fine to fine phosphorite and heavy mineral grains; moderately sorted; subangular to subrounded quartz sand; pelecypods and skeletal fragments; 60 percent quartz sand; trace black phosphorite and heavy mineral grains; 25 percent intergrain porosity; moderate hydraulic conductivity; friable, poorly cemented
15.0 - 20.0	No recovery
20.0 - 21.5	Pelecypod rudstone with skeletal, quartz-sand rich grainstone matrix, yellowish-gray 5Y 8/1; mainly medium to coarse quartz sand and very fine to pebble-size fossils; very fine to fine phosphorite and heavy mineral grains; well sorted; subrounded quartz sand; pelecypods, skeletal fragments gastropods; 25 percent quartz sand; trace black phosphorite and heavy mineral grain; 25 percent intergrain porosity; moderate hydraulic conductivity; friable, poorly cemented
21.5 - 25.0	No recovery
25.0 - 27.4	Pelecypod floatstone with quartz-sand and skeletal-rich grainstone and fossiliferous quartz sand matrix, yellowish-gray 5Y 8/1 and 5Y 7/2; mainly fine to medium quartz sand and medium to pebble-size fossils; minor very fine and coarse quartz sand; very fine to fine phosphorite and heavy mineral grains; trace clay matrix moderately sorted; subangular to rounded quartz sand; pelecypods, skeletal fragments, bryozoans, gastropods; 40 to 60 percent quartz sand; trace black phosphorite and heavy mineral grains; 20 percent intergrain and intragrain porosity; moderate hydraulic conductivity; friable, poorly cemented
27.4 - 28.5	No recovery
28.5 - 30.5	Fossiliferous quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium and coarse quartz sand, very fine to pebble-size fossils, very fine to fine phosphorite and heavy mineral grains with subordinate medium to coarse phosphorite grains; trace terrigenous clay; moderately sorted; subangular to rounded quartz sand; pelecypods, skeletal fragments; 75 percent quartz sand; trace black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; friable, poorly cemented
30.5 - 32.5	No recovery

Depth (feet below land surface)	Lithologic description of well MO-178
32.5 - 34.5	Fossiliferous quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor coarse quartz sand, very fine to pebble-size fossils, terrigenous clay, very fine to medium phosphorite grains and very fine to fine heavy mineral grains; well sorted; subangular to subrounded quartz sand; skeletal fragments, pelecypods; 60 percent quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 15 percent intergrain porosity; friable, poorly cemented
34.5 - 37.5	No recovery
37.5 - 44.0	Fossiliferous quartz sand, yellowish-gray 5Y 8/1 and light-gray N7; mainly fine to coarse quartz sand and medium to pebble-size fossils; minor very fine quartz sand, very fine to fine-size fossils, terrigenous clay, very fine to coarse phosphorite grains and very fine to fine heavy mineral grains; well sorted; subangular to subrounded quartz sand; skeletal fragments, pelecypods; 75 percent quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 15 percent intergrain porosity; medium hydraulic conductivity; friable, poorly cemented
44.0 - 45.0	No recovery
45.0 - 46.5	Fossiliferous quartz sand, yellowish-gray 5Y 8/1 and light-gray N7; mainly fine to coarse quartz sand and medium- to pebble-size fossils; minor very fine quartz sand, very fine to fine-size fossils, terrigenous clay, very fine to coarse phosphorite grains and very fine to fine heavy mineral grains; well sorted; subangular to subrounded quartz sand; skeletal fragments, pelecypods, sand dollars; 75 percent quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 15 percent intergrain porosity; medium hydraulic conductivity; friable, poorly cemented
46.5 - 47.7	Pelecypod lime rudstone and floatstone with quartz sand-rich skeletal lime wackestone matrix, very light gray N8; mainly very fine to pebble-size fossils and lime mudstone; minor very fine to medium quartz sand, very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; skeletal fragments, pelecypods; 10 to 20 percent quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 10 percent intergrain porosity; low hydraulic conductivity; moderately hard, moderate cementation
47.7 - 50.0	Pelecypod lime rudstone with skeletal lime grainstone and grain-dominated lime packstone matrix, very light gray N8; mainly very fine to pebble-size fossils and lime mudstone; minor very fine to medium quartz sand, and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; skeletal fragments, pelecypods; 10 to 20 percent quartz sand; trace black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate to high hydraulic conductivity; interval is mechanically broken; friable to moderately hard; poorly to moderately cemented
50.0 - 54.25	Pelecypod lime floatstone with skeletal grain-dominated and minor mud-dominated lime packstone matrix, light-gray N7 to very light gray N8; mainly medium to pebble-size fossils; minor very fine to fine quartz sand; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, bryozoans, *Vermicularia*, barnacles, coral; trace quartz sand; trace black phosphorite and heavy mineral grains; 25 percent moldic porosity, intergrain and intragrain porosity; moderate hydraulic conductivity; much of interval is mechanically broken; friable to moderately hard; poorly to moderately cemented
54.25 - 55.0	No recovery
55.0 - 55.4	Pelecypod lime floatstone with skeletal grain-dominated and minor mud-dominated lime packstone matrix, light-gray N7 to very light gray N8; mainly medium to pebble-size fossils; minor very fine to fine quartz sand; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, bryozoans, *Vermicularia*, barnacles, coral; trace quartz sand; trace black phosphorite and heavy mineral grains; 25 percent moldic, intergrain, and intragrain porosity; moderate hydraulic conductivity; much of interval is mechanically broken; friable to moderately hard; poorly to moderately cemented
55.4 - 57.25	Pelecypod lime floatstone and rudstone with skeletal mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1; mainly medium to pebble-size fossils and lime mudstone; minor very fine to fine quartz sand and very fine to fine-size fossils; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, bryozoans, *Vermicularia*, barnacles, coral; less than 5 percent quartz grains; trace black phosphorite and heavy mineral grains; 20 percent moldic porosity; low to moderate hydraulic conductivity; much of interval is mechanically broken; friable; poorly cemented
57.25 - 64.25	Pelecypod lime floatstone with quartz-sand, skeletal, clay-rich mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1; mainly medium to pebble-size fossils and lime mudstone; minor very fine to fine quartz sand, very fine to fine-size fossils, phosphorite and heavy mineral grains, and terrigenous clay; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, *Vermicularia*; 5 to 25 percent quartz grains; less than 5 percent black phosphorite and heavy mineral grains; trace mica; 15 percent moldic porosity; low hydraulic conductivity; friable; poorly cemented
64.25 - 65.0	No recovery
65.0 - 67.0	Pelecypod lime floatstone with quartz-sand, skeletal, clay-rich mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1; mainly medium to pebble-size fossils and lime mudstone; minor very fine to fine quartz sand, very fine to fine-size fossils, phosphorite and heavy mineral grains, and terrigenous clay; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, *Vermicularia*; 5 to 25 percent quartz grains; less than 5 percent black phosphorite and heavy mineral grains; trace mica; 15 percent moldic porosity; low hydraulic conductivity; friable; poorly cemented

Depth (feet below land surface)	Lithologic description of well MO-178
67.0 - 70.0	Pelecypod lime floatstone with quartz sand, skeletal, clay-rich mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly medium- to pebble-size fossils and lime mudstone; minor very fine to fine quartz sand, very fine to fine-size fossils, phosphorite and heavy mineral grains, and terrigenous clay; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, *Vermicularia*; 5 to 25 percent quartz grains; less than 5 percent black phosphorite and heavy mineral grains; trace mica; 15 percent moldic porosity; low hydraulic conductivity; friable; poorly cemented
70.0 - 72.0	Pelecypod lime floatstone and rudstone with skeletal, mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly medium to pebble-size fossils and lime mudstone; minor very fine to fine quartz sand, very fine to fine-size fossils, phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, sand dollars; less than 10 percent quartz grains; trace black phosphorite and heavy mineral grains; 20 percent moldic porosity; medium hydraulic conductivity; friable; poorly cemented; mechanically broken in part
72.0 - 75.0	Pelecypod lime rudstone with skeletal, mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly medium to pebble-size fossils and lime mudstone; minor very fine to fine quartz sand, very fine to fine-size fossils, phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods; trace quartz grains; trace black phosphorite and heavy mineral grains; 20 percent moldic porosity; medium hydraulic conductivity; friable; poorly cemented; mechanically broken in part
75.0 - 79.5	Pelecypod lime rudstone with skeletal, grain-dominated lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly medium to pebble-size fossils; minor very fine to fine quartz sand, lime mudstone, very fine to fine-size fossils, phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, serpulids; trace quartz sand; trace black phosphorite and heavy mineral grains; 25 percent moldic and interparticle porosity; medium to high hydraulic conductivity; friable; poorly cemented; mechanically broken in part
79.5 - 80.0	No recovery
80.0 - 86.0	Pelecypod lime floatstone with skeletal, quartzsand-rich, grain-dominated lime packstone and lime grainstone matrix, yellowish-gray 5Y 8/1; mainly very coarse to granule-size fossils and very fine quartz sand; minor fine to medium quartz sand, lime mudstone, very fine to coarse and pebble-size fossils, and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, bryozoans, barnacles, gastropods; 30 to 40 percent quartz sand; less than 5 percent black phosphorite and heavy mineral grains; 20 percent moldic porosity; medium hydraulic conductivity; friable; poorly cemented
86.0 - 88.5	Pelecypod lime floatstone with skeletal, quartz sand-rich, mud-dominated lime packstone and lime grainstone matrix, yellowish-gray 5Y 8/1; mainly very coarse to pebble-size fossils, very fine quartz sand and lime mudstone; minor fine to medium quartz sand, very fine to coarse fossils, terrigenous clay, very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods; 20 to 40 percent quartz sand; less than 5 percent black phosphorite and heavy mineral grains; 15 percent intergrain porosity; low hydraulic conductivity; moderately consolidated; moderately cemented
88.5 - 94.75	Pelecypod lime floatstone and rudstone with skeletal grain-dominated lime packstone and skeletal, quartzsand-rich, mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1; mainly very coarse to pebble-size fossils, very fine quartz sand; minor fine quartz sand, very fine to coarse fossils, very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, bryozoans, gastropods; trace to 30 percent quartz sand; trace to 5 percent black phosphorite and trace heavy mineral grains; 15 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
94.75 - 95.0	No recovery
95.0 - 95.5	Pelecypod lime floatstone and rudstone with skeletal grain-dominated lime packstone and skeletal, quartz-sand rich, mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1; mainly very coarse to pebble-size fossils, very fine quartz sand; minor fine quartz sand, very fine to coarse fossils, very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, bryozoans, gastropods; trace to 30 percent quartz sand; trace to 5 percent black phosphorite and trace heavy mineral grains; 15 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
95.5 - 98.75	Pelecypod lime rudstone with skeletal grain-dominated lime packstone and skeletal lime grainstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly very coarse to pebble-size fossils; minor fine quartz sand, very fine to coarse fossils, very fine to fine phosphorite and heavy mineral grains; well sorted; subangular quartz sand; pelecypods, skeletal fragments, gastropods, bryozoans, *Vermicularia*; less than 5 percent quartz sand; trace black phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; moderate to high hydraulic conductivity; poorly cemented; friable
98.75 - 100.0	No recovery

Depth (feet below land surface)	Lithologic description of well MO-178
100.0 - 104.5	Pelecypod lime rudstone with skeletal grain-dominated lime packstone and skeletal lime grainstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly very fine to pebble size fossils; minor fine quartz sand, very fine to fine phosphorite and heavy mineral grains; well sorted; subangular quartz sand; pelecypods, skeletal fragments, gastropods, bryozoans, sand dollars, serpulids; less than 10 percent quartz sand; less than 5 percent black phosphorite and trace heavy mineral grains; 25 percent intergrain and moldic porosity; moderate to high hydraulic conductivity; poorly cemented; friable
104.5 - 105.0	No recovery
105.0 - 111.0	Pelecypod lime rudstone with skeletal grain-dominated and mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly very fine to pebble-size fossils and very fine quartz sand; minor fine quartz sand, lime mudstone, and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, bryozoans, *Vermicularia*, oysters; less than 30 percent quartz sand; less than 3 percent black phosphorite and trace heavy mineral grains; 20 to 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
111.0 - 114.8	No recovery
114.8 - 115.3	Pelecypod lime rudstone with skeletal grain-dominated and mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1, light-gray N7 to very light gray N8; mainly very fine to pebble-size fossils and very fine quartz sand; minor fine quartz sand, lime mudstone, and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, gastropods, bryozoans, *Vermicularia*, oysters; less than 30 percent quartz sand; less than 3 percent black phosphorite and trace heavy mineral grains; 20 to 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
115.3 - 117.0	Pelecypod lime rudstone with skeletal grain-dominated lime packstone matrix, very pale orange 10YR 8/2; mainly very fine to medium and pebble-size fossils and very fine quartz sand; minor coarse to granule-size fossils, fine quartz sand, lime mudstone, and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, sand dollars, serpulids, bryozoans, barnacles; less than 20 percent quartz sand; trace black phosphorite and trace heavy mineral grains; 25 percent intergrain and moldic porosity; high hydraulic conductivity; poorly cemented; friable
117.0 - 118.8	Pelecypod lime rudstone with skeletal grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; mainly very fine to pebble-size fossils and very fine quartz sand; minor fine quartz sand, lime mudstone, and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, sand dollars, serpulids, bryozoans, barnacles; less than 20 percent quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; high hydraulic conductivity; poorly cemented; friable
118.8 - 120.0	No recovery
120.0 - 123.0	Pelecypod lime floatstone with skeletal, quartz sand-rich, grain-dominated lime packstone matrix, very pale orange 10YR 8/2; mainly very fine to pebble-size fossils and very fine to fine quartz sand; minor lime mudstone and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, bryozoans, gastropods; 10 to 40 percent quartz sand; trace black phosphorite and heavy mineral grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; poorly cemented; friable
123.0 - 124.5	Pelecypod lime floatstone with skeletal, quartz sand-rich, grain-dominated lime packstone matrix, light-gray N7 to very light gray N8; mainly very fine to pebble-size fossils and very fine to fine quartz sand; minor lime mudstone, and very fine to fine phosphorite and heavy mineral grains; well sorted; subangular to subrounded quartz sand; pelecypods, skeletal fragments, bryozoans, gastropods; 10 to 40 percent quartz sand; less than 5 percent black phosphorite and heavy mineral grains; 20 percent intergrain porosity; moderate hydraulic conductivity; poorly cemented; friable
124.5 - 125.0	No recovery
125.0 - 125.2	Pelecypod lime rudstone and pelecypod rudstone with skeletal, quartz sand-rich, mud-dominated, and grain-dominated lime packstone matrix, very pale orange 10YR 8/2; light-gray N7 to very light gray N8; mainly very fine to pebble-size fossils, very fine to fine quartz sand and lime mudstone; minor medium to very coarse quartz sand, lime mudstone, very fine to coarse phosphorite and very fine to fine heavy mineral grains; moderately sorted; subangular to rounded quartz sand; pelecypods, skeletal fragments; 10 to 45 percent quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 25 percent moldic porosity; moderate hydraulic conductivity; well cemented; hard
125.2 - 125.5	No recovery
125.5 - 126.3	Pelecypod lime rudstone and pelecypod rudstone with skeletal, quartzsand-rich, mud-dominated, and grain-dominated lime packstone matrix, very pale orange 10YR 8/2; light-gray N7 to very light gray N8; mainly very fine to pebble-size fossils, very fine to fine quartz sand and lime mudstone; minor medium to very coarse quartz sand, lime mudstone, very fine to coarse phosphorite and very fine to fine heavy mineral grains; moderately sorted; subangular to rounded quartz sand; pelecypods, skeletal fragments; 10 to 45 percent quartz sand; less than 3 percent black phosphorite and heavy mineral grains; 25 percent moldic porosity; moderate hydraulic conductivity; well cemented; hard

Depth (feet below land surface)	Lithologic description of well MO-178
126.3 - 127.0	Quartz sand, very pale orange 10YR 8/2; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, very fine to medium sand-size phosphorite grains and very fine to fine heavy minerals; moderately sorted; subangular to subrounded quartz sand; 10 to 20 percent skeletal grains; less than 3 percent black phosphorite and heavy mineral grains; 25 percent intergrain and moldic porosity; low hydraulic conductivity; very poorly cemented; friable; soft when wet
127.0 - 130.0	No recovery
130.0 - 132.6	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, very fine to medium sand-size phosphorite grains and very fine to fine heavy minerals; moderately sorted; subangular to subrounded quartz sand; 10 to 20 percent skeletal grains; less than 3 percent black phosphorite grains; trace heavy mineral grains; 25 percent moldic porosity; moderate hydraulic conductivity; very poorly cemented; friable; soft when wet
132.6 - 134.5	No recovery
134.5 - 137.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, very fine to medium sand-size phosphorite grains and very fine to fine heavy minerals; moderately sorted; subangular to subrounded quartz sand; 10 to 20 percent skeletal grains; less than 3 to 5 percent black phosphorite grains; trace heavy mineral grains; 25 percent intergrain and moldic porosity; low hydraulic conductivity; very poorly cemented; friable; soft when wet
137.0 - 137.3	Pelecypod floatstone and rudstone with quartz sand matrix, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and pebble-size fossils; minor medium to coarse quartz sand and fine to granule-size fossils; moderately sorted; subangular to subrounded quartz sand; pelecypod; 10 to 45 percent quartz sand; less than 3 to 5 percent black phosphorite and heavy mineral grains; 30 percent intergrain and moldic porosity; high hydraulic conductivity; moderately cemented; moderately hard
137.3 - 142.3	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, very fine to medium sand-size phosphorite grains and very fine to fine heavy minerals; moderately sorted; subangular to subrounded quartz sand; 5 percent skeletal grains; less than 3 percent black phosphorite grains; trace heavy mineral grains; 25 percent intergrain and moldic porosity; low hydraulic conductivity; very poorly cemented; friable; soft when wet
142.3 - 144.0	No recovery
144.0 - 146.7	Quartz sand, yellowish gray 5Y 8/1; mainly very fine to fine quartz sand; minor medium to very coarse quartz sand, very fine to medium sand-size phosphorite grains and very fine to fine heavy minerals; moderately sorted; subangular to subrounded quartz sand; 10 to 20 percent skeletal grains; less than 3 percent black phosphorite grains; trace heavy mineral grains; 25 percent intergrain and moldic porosity; low hydraulic conductivity; very poorly cemented; friable; soft when wet

West Loop Road Core

Florida Geological Survey well number	W-17973
Well number	MO-179
Total depth	250 feet
Cored from	0 to 250 feet
County	Monroe
Location	T54S, R33E
Latitude	25°45′40″
Longitude	81°03′34″
Elevation	6 feet
Completion date	March 11, 1997
Other types of available logs	Gamma ray, induction, neutron, fluid velocity
Owner	U.S. Geological Survey
Driller	U.S. Geological Survey
Core described by	Ronald S. Reese (for a description of 202 to 250 feet, see Weedman and others, 1999)
Fill	0 to 3 feet
Tamiami Formation, Ochopee Limestone Member	3 to 55.5 feet
Unnamed formation	55.5 to 165 feet
Peace River Formation	165 to 202 feet
Water-table aquifer	0 to 5 feet
Gray limestone aquifer	5 to 55.5 feet
Lower confining unit	55.5 to 202 feet

Depth (feet below land surface)	Lithologic description of well MO-179
0.0 - 0.8	Limestone, brownish-gray 5YR 4/1; moderate hydraulic conductivity; well cemented and locally broken
0.8 - 1.5	No recovery
1.5 - 2.0	Limestone, brownish-gray 5YR 4/1; moderate hydraulic conductivity; well cemented and locally broken
2.0 - 3.0	No recovery
3.0 - 5.0	Limestone, light-gray N7 to orange-gray 10YR 8/2; fine to medium quartz sand; low hydraulic conductivity; limestone is locally lime mudstone
5.0 - 7.0	Lime grainstone and packstone, very pale orange 10YR 8/2; mainly fine to granule; common moldic porosity; low to moderate hydraulic conductivity
7.0 - 7.5	Limestone, light-gray N7; local moldic porosity; low to high hydraulic conductivity; firm and locally broken
7.5 - 9.0	No recovery
9.0 - 9.5	Loose carbonate sand, very light gray N6 to light-gray N7; mainly very fine to granule; low to moderate hydraulic conductivity
9.5 - 11.0	No recovery
11.0 - 11.9	Carbonate sand, very pale orange 10YR 8/2; mainly very fine to pebble; locally abundant quartz grains; moderate to high hydraulic conductivity
11.9 - 13.0	No recovery
13.0 - 13.3	Carbonate sand to lime mudstone, white N9; mainly coarse grain size; ranges from mud to coarse; locally abundant quartz grains; low hydraulic conductivity
13.3 - 15.0	No recovery
15.0 - 15.5	Carbonate sand to lime mudstone, very pale orange 10YR 8/2; mainly medium to granule; ranges from mud to granule; locally abundant quartz grains; moderate hydraulic conductivity; minor lime mud matrix
15.5 - 18.0	No recovery
18.0 - 18.4	Carbonate sand to lime mudstone, very pale orange 10YR 8/2; mainly fine to coarse; ranges from mud to coarse; locally abundant quartz grains; low hydraulic conductivity; minor lime mud matrix
18.4 - 20.0	No recovery
20.0 - 21.5	Carbonate sand, very light gray N8 to white N9; mainly medium to pebble grain size; ranges from mud to pebble; shell fragments; low to moderate hydraulic conductivity; minor lime mud matrix
21.5 - 22.0	No recovery
22.0 - 23.0	Carbonate sand, very light gray N8 to white N9; mainly medium to pebble grain size; ranges from mud to pebble; shell fragments; low hydraulic conductivity; minor lime mud matrix
23.0 - 25.0	No recovery
25.0 - 27.0	Carbonate sand, very light gray N8; mainly medium to pebble grain size; ranges from mud to pebble; shell fragments; moderate hydraulic conductivity; minor lime mud matrix
27.0 - 27.6	No recovery
27.6 - 28.5	Carbonate sand, very light gray N8; mainly medium to pebble grain size; ranges from mud to pebble; shell fragments; low hydraulic conductivity; abundant lime mud matrix
28.5 - 30.0	No recovery
30.0 - 33.0	Carbonate sand, very light gray N8; mainly fine to pebble; shell fragments; low to moderate hydraulic conductivity
33.0 - 35.0	No recovery
35.0 - 35.5	Carbonate sand, very light gray N8; mainly fine to pebble; shell fragments; low to moderate hydraulic conductivity
35.5 - 36.0	No recovery
36.0 - 37.0	Lime grainstone and lime mudstone, very light gray N8 to light-greenish-gray 5GY 8/1; mainly fine to pebble grain size; common vuggy porosity; moderate and possibly high hydraulic conductivity
37.0 - 41.0	No recovery
41.0 - 44.0	Carbonate sand, very light gray N8; fine to pebble grain size; low to moderate hydraulic conductivity
44.0 - 45.0	No recovery
45.0 - 45.5	Well-washed lime packstone, very light gray N8; mainly fine to pebble grain size; ranges from mud to pebble; common moldic porosity; moderate hydraulic conductivity
45.5 - 47.0	No recovery
47.0 - 47.5	Limestone, very light gray N8; mainly granule to pebble grain size; ranges from mud to pebble; large shells; minor moldic porosity; low to moderate hydraulic conductivity; minor lime mud matrix

Depth (feet below land surface)	Lithologic description of well MO-179
47.5 - 50.0	No recovery
50.0 - 50.5	Limestone, very light gray N8 to white N9; mainly granule to pebble grain size; ranges from mud to pebble; shell fragments; possible large vugs; high hydraulic conductivity; common lime mud matrix
50.5 - 55.0	No recovery
55.0 - 55.5	Quartz-sand rich limestone, very light gray N8; mainly fine to granule grain size; fine to coarse sand; moldic porosity; low to moderate hydraulic conductivity
55.5 - 60.0	No recovery
60.0 - 63.0	Quartz sand, very light gray N8; mainly medium grain size; ranges from medium to coarse; moderate hydraulic conductivity; very minor clay matrix
63.0 - 65.0	No recovery
65.0 - 69.0	Quartz sand, yellowish-gray 5Y 7/2; mainly fine to coarse grain size; low to moderate hydraulic conductivity
69.0 - 70.0	No recovery
70.0 - 74.0	Quartz sand, light-gray N7; mainly fine grain size; ranges from clay to coarse; trace to 3 percent phosphorite grains; low hydraulic conductivity; minor clay matrix
74.0 - 75.0	No recovery
75.0 - 77.5	Quartz sand, light-gray N7; mainly very fine to fine; ranges from clay to coarse; trace to 3 percent phosphorite grains; low hydraulic conductivity; minor clay matrix
77.5 - 80.0	No recovery
80.0 - 83.5	Quartz sand, light-gray N7; mainly very fine to fine grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity; minor clay matrix at base of interval
83.5 - 85.0	No recovery
85.0 - 89.2	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly very fine to fine grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity; silty matrix
89.2 - 90.0	No recovery
90.0 - 94.5	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity
94.5 - 95.0	No recovery
95.0 - 99.0	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity at base of interval
99.0 - 100.0	No recovery
100.00 - 107.5	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity
107.5 - 108.0	No recovery
108.0 - 110.0	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity
110.0 - 117.0	Quartz sand, light-gray N7 to yellowish-gray 5Y 8/1; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity
117.0 - 120.0	No recovery
120.0 - 123.5	Quartz sand, light-gray N7; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity
123.5 - 125.0	No recovery
125.0 - 130.0	Quartz sand, light-gray N7; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity
130.0 - 134.0	Quartz sand, light-gray N7; mainly fine to granule grain size; trace to 3 percent phosphorite grains; moderate to high hydraulic conductivity
134.0 - 135.0	No recovery
135.0 - 137.8	Quartz sand, light-gray N7; mainly fine to granule grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity; minor clay matrix
137.8 - 140.0	No recovery
140.0 - 145.5	Quartz sand, light-gray N7; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low hydraulic conductivity; minor silt matrix
145.5 - 148.5	No recovery

Depth (feet below land surface)	Lithologic description of well MO-179
148.5 - 155.0	Quartz sand, light-gray N7; mainly fine to coarse grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity; minor silt matrix
155.0 - 159.5	Quartz sand, very light gray N8; mainly medium to coarse grain size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity
159.5 - 160.0	No recovery
160.0 - 165.0	Quartz sand, yellowish-gray 5Y 8/1 to light-gray N8 to medium-gray N5; mainly fine to pebble grain size; shell fragments; trace to 10 percent phosphorite grains; low to moderate hydraulic conductivity
165.0 - 169.5	Quartz sand, light-gray N8 to medium-gray N5; mainly fine to pebble grain size; shell fragments; trace to 3 percent phosphorite grains; low hydraulic conductivity; minor clay laminations
169.5 - 170.0	No recovery
170.0 - 175.0	Quartz sand, light-gray N8 to medium-gray N5; mainly fine to pebble grain size; shell fragments; trace to 3 percent phosphorite grains; low hydraulic conductivity; minor clay laminations
175.0 - 179.5	Quartz sand, light-gray N8 to medium-gray N5; mainly fine to granule size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity; minor clay laminations
179.5 - 180.0	No recovery
180.0 - 184.5	Quartz sand, light-gray N8 to medium-gray N5; mainly fine to granule size; trace to 3 percent phosphorite grains; low to moderate hydraulic conductivity; minor clay matrix
184.5 - 187.0	No recovery
187.0 - 190.0	Quartz sand, greenish-gray 5GY 6/1; mainly fine to medium grain size; low hydraulic conductivity; abundant clay matrix
190.0 - 195.0	Quartz sand, medium-gray N5 to light-gray N7 to greenish-gray 5GY 6/1; mainly fine to pebble size; ranges from clay to pebble; shell fragments; minor pebble-size phosphorite grains; mainly low with very low to low hydraulic conductivity at base; abundant clay matrix
195.0 - 200.0	Quartz sand, medium-gray N5 to greenish-gray 5GY 6/1; mainly fine grain size; ranges from clay to fine; very low to low hydraulic conductivity; mottled coloration; abundant clay matrix
200.0 - 202.0	Quartz sand, medium-gray N5 to greenish-gray 5GY 6/1; mainly very fine to fine grain size; ranges from clay to fine; very low to low hydraulic conductivity; mottled coloration; abundant clay matrix

G-200 Core Pumping Station

Florida Geological Survey well number	W-17554
GWSI number	PB-1703
Total depth	221 feet
Cored from	0 to 221 feet
County	Palm Beach
Location	SE, SW, sec. 35, T46S, R35E
Latitude	26°26′06″
Longitude	80°48′38″
Elevation	20 feet
Completion date	March 15, 1998
Other types of available logs	Induction resistivity, gamma ray, neutron, spontaneous potential, single-point resistivity, normal resistivity, caliper
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham
Levee fill	0 to 15 feet
Tamiami Formation	15 to 153 feet
Pinecrest Sand Member	15 to 79.5 feet
Ochopee Limestone Member	79.5 to 153 feet
Unnamed formation	153 to 194 feet
Peace River Formation	194 to 220 feet
Upper confining unit	18.5 to 79.5 feet
Gray limestone aquifer	79.5 to 92 feet
Lower confining unit	92 to 220 feet

Depth (feet below land surface)	Lithologic description of well PB-1703
0.0 - 7.0	No recovery
7.0 - 8.0	Large limestone block within levee fill
8.0 - 8.5	No recovery
8.5 - 9.0	Rubble and wood from levee fill
9.0 - 10.0	No recovery
10.0 - 10.5	Limestone rubble from levee fill
10.5 - 13.0	No recovery
13.0 - 14.0	Rubble of limestone and soil from levee
14.0 - 14.5	Soil
14.5 - 15.0	Rubble of limestone
15.0 - 15.5	Pelecypod lime floatstone with quartz sand-rich skeletal mud-dominated and grain-dominated lime packstone matrix, mottled yellowish-gray 5Y 8/1, medium-light-gray N6, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone, very fine quartz sand and very fine to pebble-size fossils; minor silt-size quartz and cobble-size fossils; very well sorted quartz sand; subangular quartz sand; skeletal fragments, pelecypods and gastropods; 20 percent quartz sand; 15 percent moldic, intraparticle, interparticle, and root-mold porosity; low hydraulic conductivity; subtidal marine; irregular relief on upper bounding exposure surface with local overhanging microtopography; local laminated calcrete (dark-yellowish-brown 10YR 4/2, pale-yellowish-brown 10YR 6/2) at top of upper bounding surface in microtopographic low
15.5 - 17.0	Pelecypod lime floatstone with quartz sand-rich skeletal lime wackestone, mottled very pale orange 10YR 8/2, pale-yellowish-brown 10YR 6/2, light-gray N7; mainly clay-size lime mudstone, very fine quartz sand and very fine to pebble-size fossils; minor silt-size quartz; very well sorted quartz sand; subangular quartz sand; skeletal grains, pelecypods and gastropods; 20 to 45 percent quartz sand; 15 percent moldic, vuggy, and root-mold porosity; low hydraulic conductivity; subtidal marine; irregular relief on upper bounding exposure surface with local overhanging microtopography; probably local calcrete, pale-yellowish-brown 10YR 6/2, dark-yellowish-brown 10YR 4/2; trace irregular root molds; borrowed
17.0 - 17.4	Rubble of limestone
17.4 - 18.0	Pelecypod lime rudstone and floatstone with matrix of skeletal, quartz sand-rich wackestone and quartz sandstone with abundant skeletal fragments and lime mudstone matrix, mottled yellowish-gray 5Y 8/1 and pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone, very fine quartz sand and pebble-size fossils; minor silt-size quartz and very fine sand to granule-size fossils; very well sorted quartz sand; subangular quartz sand; skeletal fragments and pelecypods; 25 to 60 percent quartz sand; 15 percent moldic and vuggy porosity; low hydraulic conductivity; subtidal marine;
18.0 - 18.5	No recovery
18.5 - 20.0	Skeletal-rich quartz sandstone with lime mudstone matrix, mottled medium-dark-gray N4 to dark-gray N5, yellowish-gray 5Y 8/1; mainly lime mudstone, very fine sand size quartz sand and pebble-size fossils; minor silt-size quartz sand and very fine sand to granule-size fossils; very well sorted quartz sand; subangular quartz sand; skeletal fragments and pelecypods; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine;
20.0 - 20.8	Skeletal-rich quartz sandstone, yellowish-gray 5Y 8/1; mainly lime mud and very fine quartz sand; minor silt-size quartz sand, very fine to pebble-size fossils and very fine sand-size phosphorite grains; very well sorted quartz sand; subangular quartz sand; 30 percent skeletal fragments and pelecypods; 1 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet
20.8 - 22.0	No recovery
22.0 - 23.5	Skeletal-rich quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor clay-size lime mud, silt-size quartz sand, very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; very well sorted quartz sand; subangular; skeletal fragments, pelecypods, and gastropods; 3 percent black N1 phosphorite; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet;
23.5 - 24.0	No recovery
24.0 - 24.5	Rubble
24.5 - 26.8	Skeletal-rich quartz sand, yellowish-gray 5Y 7/2, pale-yellowish-brown 10YR 6/2; mainly very fine quartz sand; minor clay-size lime mud, silt-size quartz sand, very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; very well sorted quartz sand; subangular quartz sand; skeletal fragments, pelecypods, gastropods, and branching bryozoans; 3 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet
26.8 - 29.0	No recovery
29.0 - 29.5	Rubble

Depth (feet below land surface)	Lithologic description of well PB-1703
29.5 - 33.0	Skeletal lime rudstone with grain-dominated skeletal lime packstone matrix, yellowish-gray 5Y 7/2, pale-yellowish-brown 10YR 6/2; mainly fine sand to granule-size fossils; minor clay-size lime mudstone, silt to very fine sand and pebble-size fossils, very fine to fine sand-size quartz sand and very fine sand-size phosphorite grains; up to medium pebble-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods, gastropods and bryozoans; trace to 5 percent quartz sand; trace black N1 phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; subtidal marine; unconsolidated, pelecypod, skeletal rudstone facies; soft when wet; noncemented; unconsolidated
33.0 - 34.0	No recovery
34.0 - 43.0	Skeletal lime rudstone with grain-dominated skeletal lime packstone matrix, yellowish-gray 5Y 7/2, pale-yellowish-brown 10YR 6/2; mainly fine sand to granule-size fossils; minor clay-size lime mudstone, silt to very fine sand and pebble-size fossils, very fine to fine quartz sand and very fine sand-size phosphorite grains; trace large pebble-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods, gastropods, and bryozoans; trace to 5 percent quartz sand; trace black N1 phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; subtidal marine; unconsolidated, pelecypod, skeletal rudstone facies; soft when wet; noncemented; unconsolidated; possible calcrete, pale-yellowish-brown 10YR 6/2 and abrupt contact at 42.9 feet, cobble-size lithoclast above contact
43.0 - 43.5	No recovery
43.5 - 46.5	Skeletal lime rudstone with grain-dominated skeletal lime packstone matrix, yellowish-gray 5Y 7/2, pale-yellowish-brown 10YR 6/2; mainly fine sand to granule-size fossils; minor clay-size lime mudstone, silt to very fine sand and pebble-size fossils, very fine to fine sand-size quartz sand and very fine sand-size phosphorite grains; trace large pebble-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods, gastropods, and bryozoans; trace to 5 percent quartz sand; trace black N1 phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; subtidal marine; unconsolidated, pelecypod, skeletal rudstone facies; soft when wet; noncemented; unconsolidated
46.5 - 46.6	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor clay-size lime mud matrix, medium quartz sand, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace to 20 percent skeletal fragments and pelecypods; 3 to 5 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; noncemented; minor white pelecypod fragments and disarticulated pelecypods
46.6 - 47.5	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor clay-size lime mud matrix, medium quartz sand, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace to 20 percent skeletal fragments and pelecypods; 3 to 5 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; noncemented; minor white pelecypod fragments and disarticulated pelecypods
47.5 - 48.5	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine to fine quartz sand; minor clay-size lime mud matrix, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular quartz sand; trace to 20 percent skeletal fragments and pelecypods; 3 to 5 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; noncemented
48.5 - 53.75	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor clay-size lime mud matrix, very fine sand to pebble size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular quartz sand; trace to 20 percent skeletal fragments and pelecypods; 3 to 5 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; noncemented
53.75 - 55.0	No recovery
55.0 - 63.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor clay-size lime mud matrix, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular quartz sand; trace to 20 percent skeletal fragments and pelecypod fragments; 5 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; noncemented; possible well-cemented hard ground at 55 feet
63.0 - 64.5	Quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor clay-size lime mud matrix, medium quartz sand and very fine sand to large pebble-size fossils; well sorted quartz sand; subangular to subrounded quartz sand; 20 percent skeletal fragments and pelecypod fragments; 5 percent black N1 phosphorite grains; 25 percent intergrain and moldic porosity; low hydraulic conductivity; subtidal marine
64.5 - 68.0	No recovery
68.0 - 71.0	Quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and terrigenous clay matrix, minor medium quartz sand, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 percent skeletal fragments and pelecypod fragments; 3 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine
71.0 - 74.5	Quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor terrigenous clay matrix, medium quartz sand, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 25 percent skeletal fragments and pelecypod fragments; 5 percent black N1 phosphorite grains; 15 percent intergrain and moldic porosity; low hydraulic conductivity; subtidal marine

Depth (feet below land surface)	Lithologic description of well PB-1703
74.5 - 75.5	Quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine to medium quartz sand; minor terrigenous clay matrix, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 25 percent skeletal fragments and pelecypod fragments; 5 percent black N1 phosphorite grains; 15 percent intergrain and moldic porosity; low hydraulic conductivity; subtidal marine
75.5 - 76.0	Terrigenous mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay matrix; minor silt to very fine quartz sand; 1 percent intergrain porosity; very low hydraulic conductivity; subtidal marine
76.0 - 79.5	Quartz sandstone, yellowish-gray 5Y 8/1; mainly very fine to medium quartz sand; minor terrigenous clay matrix, very fine sand to pebble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 5 to 25 percent skeletal fragments and pelecypod fragments; 5 percent black N1 phosphorite grains; 15 percent intergrain and moldic porosity; low hydraulic conductivity; subtidal marine
79.5 - 80.5	Pelecypod lime rudstone with skeletal, quartz sand-rich, mud-dominated lime packstone matrix, medium-light-gray N6 to very light gray N8; mainly clay-size lime mudstone, fine to medium quartz sand and very fine sand to pebble-size fossils; moderately sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods, sand dollars and epibiontic bryozoans and serpulids; 30 percent quartz sand; 5 percent phosphorite grains; 20 percent moldic and intergrain porosity; moderate hydraulic conductivity; subtidal marine; hard when wet; well cemented
80.5 - 81.0	Rubble
81.0 - 82.0	Pelecypod lime rudstone with skeletal, quartz sand-rich, mud-dominated lime packstone matrix, medium-light-gray N6 to very light gray N8; mainly clay-size lime mudstone, fine to medium quartz sand and very fine sand to pebble-size fossils; moderately sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments, pelecypods and epibiontic bryozoans and serpulids; 30 percent quartz sand; 5 percent black N1 phosphorite grains; 20 percent moldic and intergrain porosity; moderate hydraulic conductivity; subtidal marine; hard when wet; well cemented
82.0 - 85.0	No recovery
85.0 - 88.0	Skeletal-rich quartz sandstone and pelecypod lime rudstone with skeletal, quartz sand-rich lime grainstone matrix; medium-light-gray N6 to very light gray N8; yellowish-gray 5Y 8/1; mainly fine quartz sand; minor very fine sand and medium quartz sand, very fine sand and pebble-size fossils, and very fine to fine sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; 30 to 70 percent skeletal fragments, pelecypods, serpulids, gastropods and sand dollars; 5 percent black N1 phosphorite grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; subtidal marine; hard when wet; well cemented
88.0 - 91.0	No recovery
91.0 - 91.5	Quartz sandstone, yellowish-gray 5Y 8/1; mainly fine to medium quartz sand; minor very fine to coarse-size quartz sand, very fine sand to pebble-size fossils and very fine to coarse sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 percent skeletal fragments and pelecypod fragments; 5 percent black N1 phosphorite grains; 20 percent intergrain and moldic porosity; moderate hydraulic conductivity; subtidal marine; hard when wet; well cemented
91.5 - 101.0	No recovery
101.0 - 103.0	Quartz sand, yellowish-gray 5Y 8/1; mainly fine to medium quartz sand; minor very fine quartz sand, fine to coarse sand-size fossils and fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; 10 percent skeletal fragments; 5 to 10 percent black N1 phosphorite grains; 20 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; trace lime mud matrix
103.0 - 105.5	No recovery
105.5 - 107.0	Quartz sand, yellowish-gray 5Y 8/1; mainly fine to medium quartz sand; minor clay-size lime mud, very fine quartz sand, fine sand to granule-size fossils and fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; 30 percent skeletal fragments; 5 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
107.0 - 109.0	No recovery
109.0 - 111.0	Skeletal-rich quartz sand, yellowish-gray 5Y 8/1, white N9; mainly fine to medium quartz sand and clay-size lime mud; minor very fine quartz sand, fine sand to pebble-size fossils and fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; 40 percent skeletal fragments, pelecypods and *Vermicularia*; 1 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
111.0 - 111.5	No recovery
111.5 - 115.5	Skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor clay-size lime mud, medium quartz sand, very fine sand to pebble-size fossils and very fine to fine sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments; 1 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; trace lime mud matrix
115.5 - 116.5	No recovery

Depth (feet below land surface)	Lithologic description of well PB-1703
116.5 - 118.2	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor clay-size lime mud, medium and coarse to very coarse quartz sand, very fine sand to pebble-size fossils and very fine to coarse sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; 5 percent skeletal fragments and pelecypods; 5 to 10 percent black N1 phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; trace lime mud matrix
118.2 - 121.0	No recovery
121.0 - 125.0	Quartz sand, yellowish-gray 5Y 8/1; mainly fine quartz sand; minor clay-size lime mud, medium to very coarse quartz sand, very fine sand to coarse-size fossils and very fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; trace skeletal fragments; 5 to 10 percent black N1 phosphorite grains; 20 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine; very soft when wet; friable; very poorly cemented
125.0 - 126.5	No recovery
126.5 - 127.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor clay-size lime mud, medium to coarse quartz sand, very fine sand to coarse-size fossils and fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; trace skeletal fragments; 5 to 10 percent black N1 phosphorite grains; 20 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine; very soft when wet; friable; very poorly cemented
127.0 - 129.5	No recovery
129.5 - 130.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to medium quartz sand; minor clay-size lime mud, coarse to very coarse quartz sand, very fine sand to granule-size fossils and fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; trace skeletal fragments; 5 to 10 percent black N1 phosphorite grains; 20 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine; very soft when wet; friable; very poorly cemented
130.0 - 136.5	No recovery
136.5 - 140.5	Skeletal-rich quartz sand and skeletal, quartz sand-rich, grain-dominated lime grainstone, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and very fine sand to pebble-size fossils; minor clay-size lime mud, medium to coarse quartz sand and very fine to medium sand-size phosphorite grains; moderately sorted quartz sand; subangular to subrounded quartz sand; 40 to 60 percent skeletal fragments; 3 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
140.5 - 141.0	No recovery
141.0 - 144.0	Skeletal lime rudstone with skeletal, quartz sand-rich, grain-dominated lime packstone matrix, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and very fine sand and pebble-size fossils; minor clay-size lime mudstone and very fine to fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments and pelecypods; 20 percent quartz sand; 1 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine
144.0 - 146.5	Skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine sand-size quartz sand; minor clay-size lime mud, very fine sand to pebble-size fossils and very fine to fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments; 5 to 10 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
146.5 - 147.0	No recovery
147.0 - 153.0	Interbedded skeletal lime rudstone with skeletal, quartz sand-rich, grain-dominated lime packstone matrix and skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand and very fine sand and pebble-size fossils; minor clay-size lime mudstone and very fine to fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; skeletal fragments and pelecypods; 20 to 80 percent quartz sand; 2 to 10 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine
153.0 - 154.0	No recovery
154.0 - 160.0	Skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor clay-size lime mud, fine quartz sand; very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments and pelecypods; 5 to 10 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
160.0 - 161.0	No recovery
161.0 - 161.5	Skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor clay-size lime mud, fine quartz sand; very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments and pelecypods; 5 to 10 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
161.5 - 168.0	No recovery

Depth (feet below land surface)	Lithologic description of well PB-1703
168.0 - 170.5	Skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor clay-size lime mud, fine quartz sand; very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments and pelecypods; 5 to 10 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
170.5 - 172.0	No recovery
172.0 - 173.0	Skeletal-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand and clay-size lime mud; minor fine quartz sand; very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments and pelecypods; 5 to 10 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; lime mud matrix
173.0 - 173.8	Skeletal-rich quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand and clay-size lime mud; minor fine quartz sand; very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments and pelecypods; 5 to 10 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; lime mud matrix
173.8 - 174.5	No recovery
174.5 - 179.8	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; minor clay-size lime mud, fine quartz sand; very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace to 10 percent skeletal fragments and pelecypods; 10 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
179.8 - 181.0	No recovery
181.0 - 185.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand; minor clay-size lime mud, fine quartz sand; very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace to 10 percent skeletal fragments and pelecypods; 10 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix; abrupt contact with microtopography at 184.7 feet., slightly more lime mud matrix above abrupt contract
185.0 - 187.0	Skeletal quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand and very fine sand to pebble-size fossils; minor clay-size lime mud, fine quartz sand and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 20 to 40 percent skeletal fragments and pelecypods; 2 to 3 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
187.0 - 188.0	No recovery
188.0 - 190.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand and very fine sand to pebble-size fossils; minor clay-size lime mud, fine quartz sand and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 10 to 20 percent skeletal fragments and pelecypods; 10 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
190.0 - 193.0	No recovery
193.0 - 194.0	Quartz sand, yellowish-gray 5Y 7/2; mainly very fine quartz sand and very fine sand to pebble-size fossils; minor clay-size lime mud, fine quartz sand and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; 10 to 20 percent skeletal fragments and pelecypods; 10 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor lime mud matrix
194.0 - 195.0	Quartz sand, pale-olive 10Y 6/2; mainly very fine quartz sand; minor terrigenous clay and very fine-sand size phosphorite grains; very well sorted quartz sand; subangular and subrounded quartz sand; 15 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor terrigenous clay matrix
195.0 - 196.3	Quartz sand, pale-olive 10Y 6/2; mainly very fine quartz sand; minor terrigenous clay and very fine sand-size phosphorite grains; very well sorted quartz sand; subangular to subrounded quartz sand; 15 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor terrigenous clay matrix
196.3 - 197.0	No recovery
197.0 - 204.5	Quartz sand, pale-olive 10Y 6/2; mainly very fine quartz sand, minor terrigenous clay, very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace skeletal 15 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor terrigenous clay matrix
204.5 - 206.0	No recovery

Depth (feet below land surface)	Lithologic description of well PB-1703
206.0 - 208.0	Quartz sand, pale-olive 10Y 6/2; mainly very fine quartz sand; minor terrigenous clay, very fine sand to pebble-size fossils and very fine sand-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; trace skeletal fragments; 15 percent black N1 phosphorite grains; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor terrigenous clay matrix
208.0 - 211.8	Quartz sand, light-olive-gray 5Y 5/2; mainly very fine quartz sand and very fine sand-size phosphorite grains; minor terrigenous clay, very fine sand to pebble-size fossils and medium sand to small pebble-size phosphorite grains; well sorted quartz sand; subangular to subrounded quartz sand; subrounded to rounded phosphorite grains; trace skeletal fragments (one cobble-size pelecypod mold); 20 percent black N1 phosphorite grains (1 percent medium sand to small pebble-size phosphorite grains); 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; friable; very poorly cemented; minor terrigenous clay matrix
211.8 - 213.0	Interlaminated quartz sand, silty terrigenous mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay, silt to very fine quartz sand and very fine phosphorite grains; well sorted quartz sand; subangular quartz sand; subrounded to rounded phosphorite grains; 20 percent black N1 phosphorite grains; 2 percent mica; 5 percent intergrain porosity; very low hydraulic conductivity; marine prodeltaic(?); flooding unit(?); soft when wet; friable quartz sand
213.0 - 213.5	No recovery
213.5 - 214.0	Interlaminated quartz sand, silty terrigenous mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay, silt to very fine quartz sand and very fine phosphorite grains; well sorted quartz sand; subangular quartz sand; subrounded to rounded phosphorite grains; 20 percent black N1 phosphorite grains; 2 percent mica; 5 percent intergrain porosity; very low hydraulic conductivity; marine prodeltaic(?); flooding unit(?); soft when wet; friable quartz sand; phosphate pebble float in sandy, silty mudstone at base of unit
214.0 - 215.2	Silty mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay and very fine phosphorite grains; subrounded to rounded phosphorite grains; 20 percent black N1 phosphorite grains; 2 percent mica; trace intergrain porosity; very low hydraulic conductivity; soft when wet
215.2 - 215.7	Quartz sand-rich, silty mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay, very fine quartz sand and very fine phosphorite grains; minor medium sand to medium pebble-size phosphorite grains; well sorted quartz sand; subangular to angular quartz sand; subrounded to rounded phosphorite grains; 20 percent black N1 phosphorite grains; 2 percent mica; trace sharks teeth; trace intergrain porosity; very low hydraulic conductivity; base of submarine debris flow(?); soft when wet; medium sand to pebble-size phosphorite grains floating in mudstone matrix
215.7 - 216.0	Quartz, sand-rich, silty mudstone, light-olive-gray 5Y 5/2; mainly terrigenous clay, very fine quartz sand and very fine sand and medium pebble-size phosphorite grains; well sorted quartz sand; subangular to angular quartz sand; subrounded to rounded phosphorite grains; 20 percent black N1 phosphorite grains; 2 percent mica; trace intergrain porosity; very low hydraulic conductivity; base of submarine debris flow(?); soft when wet; medium sand to pebble-size phosphorite grains floating in mudstone matrix
216.0 - 217.5	Diatomaceous terrigenous mudstone, light-olive-gray 5Y 5/2; terrigenous clay; minor fine sand-size diatoms and silt-size quartz sand; diatoms; trace porosity; very low hydraulic conductivity transgressive marine; soft when wet; irregular upper bounding surface; possible maximum flooding surface and downlap at 216 feet(?)
217.5 - 220.0	Diatomaceous terrigenous mudstone, light-olive-gray 5Y 5/2; clay-size terrigenous and minor fine sand-size diatoms; silt-size quartz sand; diatoms; trace porosity; very low hydraulic conductivity; transgressive marine; soft when wet
220.0 - 221.0	No recovery

Sod Farm Core

Florida Geological Survey well number	W-17747
GWSI number	PB-1704
Total depth	200.5 feet
Cored from	0 to 200.5 feet
County	Palm Beach
Location	SE, SE, NE, sec. 31, T46S, R38E
Latitude	26°23′59″
Longitude	80°34′34″
Elevation	11 feet
Completion date	April 30, 1998
Other types of available logs	Gamma ray, induction resistivity, single-point resistivity, spontaneous potential
Owner	U.S. Geological Survey
Driller	Florida Geological Survey
Core described by	Kevin J. Cunningham
Fill	0 to 2.3 feet
Peat	2.3 to 2.7 feet
Lake Flirt Marl	2.7 to 5.5 feet
Lake Okeelanta(?) beds	5.5 to 49.5 feet
Tamiami Formation	49.5 to 157.2 feet
Pinecrest Sand Member	49.5 to 73.3 feet
Ochopee Limestone member	73.3 to 157.2 feet
Unnamed formation	157.2 to 197.5 feet
Upper confining unit	2.7 to 73.3 feet
Gray limestone aquifer	73.3 to 172.5 feet
Lower confining unit	172.5 to 197.5 feet

Depth (feet below land surface)	Lithologic description of well PB-1704
0.0 - 0.5	Lime mudstone rubble, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone and very fine quartz sand; well sorted quartz sand; 5 percent moldic and root-mold porosity; very low hydraulic conductivity; intertidal; hard when wet
0.5 - 2.0	No recovery
2.0 - 2.3	Lime mudstone rubble, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone and very fine quartz sand; well sorted quartz sand; 5 percent moldic and root-mold porosity; very low hydraulic conductivity; intertidal; hard when wet
2.3 - 2.7	Peat, black N1; terrigenous clay and organics, silt and very fine quartz sand and organics; minor pebble-size fossils; well sorted quartz sand; low-spired gastropods and pelecypods; 25 percent intergrain; moderate hydraulic conductivity; freshwater swamp; soft when wet; shallowing upward cycle top at 2.3 feet.
2.7 - 3.2	Marl, very light gray N8; mainly clay-size lime mud; minor silt-size quartz sand; 20 percent root-mold, intergrain, and desiccation-crack porosity; low hydraulic conductivity; freshwater lake; soft when wet
3.2 - 5.5	No recovery
5.5 - 5.75	Limestone rubble
5.75 - 6.0	Gastropod lime wackestone, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone; minor very fine sand to pebble-size fossils; gastropods (*Seminolina wilsoni*); 10 percent root-mold and enlarged root-mold porosity; low hydraulic conductivity; freshwater lake or pond; hard when wet; irregular microtopography on upper bounding exposure surface; irregular root molds; mangrove(?) root molds, some solution enlarged and some with organics of root still in place; shallowing upward cycle top at 5.75 feet.
6.0 - 6.5	Lime mudstone, very pale orange 10YR 8/2; mainly clay-size lime mudstone; minor very fine to fine sand-size fossils; skeletal fragments; gastropods (including *Seminolina wilsoni*); 10 percent root-mold and semivertical solution-enlarged channel porosity; low hydraulic conductivity; freshwater lake or pond; hard when wet; burrowed; irregular, semivertical root molds; channel porosity has very high vertical hydraulic conductivity
6.5 - 7.0	Gastropod, quartz sand-rich lime wackestone, pale-yellowish-brown 10YR 6/2, medium-gray N5 to light-gray N7; mainly clay-size lime mudstone and very fine quartz sand; minor very fine sand to pebble-size fossils; very well sorted quartz sand; skeletal fragments; low-spired gastropods (including *Seminolina wilsoni*); 25 percent quartz sand; 10 percent root-mold and moldic porosity; low hydraulic conductivity; freshwater lake or pond; hard when wet; burrowed; irregular semivertical root molds (larger root molds maybe mangrove and locally solution enlarged); solution-enlarged root molds filled with younger pelecypod lime floatstone
7.0 - 7.5	Pelecypod gastropod, quartz sand-rich lime wackestone and mudstone, mottled pale-yellowish-brown 10YR 6/2, light-brown 5YR 5/6, moderate-yellowish-brown 10YR 5/4, medium-light-gray N6, grayish-orange 10YR 7/4; mainly clay-size lime mudstone and very fine quartz sand; minor very fine sand to pebble-size fossils; very well sorted quartz sand; pelecypods and gastropods; 10 to 20 percent quartz sand; 10 percent moldic and desiccation-crack porosity; low hydraulic conductivity; restricted bay or lagoon; hard when wet; curved-plane and craze-plane desiccation cracks
7.5 - 8.75	No recovery
8.75 - 9.0	Lime mudstone, mottled pale-yellowish-brown 10YR 6/2, light-brown 5YR 5/6, moderate-yellowish-brown 10YR 5/4, medium-light-gray N6, grayish-orange 10YR 7/4; mainly clay-size lime mudstone and very fine quartz sand; minor coarse sand to pebble-size fossils; very well sorted quartz sand; trace pelecypods and gastropods; 5 to 20 percent quartz sand; 5 percent vuggy and desiccation-crack porosity; very low hydraulic conductivity; restricted bay or lagoon; hard when wet; craze-plane desiccation cracks; burrowed
9.0 - 10.3	Lime mudstone and gastropod lime wackestone, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone and very fine quartz sand; minor very fine sand to pebble-size fossils; very well sorted quartz sand; gastropods (including *Seminolina wilsoni*); 25 percent quartz sand; 10 percent root-mold, moldic, and intragrain porosity; very low hydraulic conductivity; freshwater lake or pond; poor recovery, partly rubble; exposure surface at upper bounding surface at 9.0 feet, very pale orange 10YR 8/2, pale-yellowish-brown 10YR 6/2, laminated crust at upper bounding surface; laminated crust overlies brecciated lime mudstone with desiccation cracks; irregular root molds; top of shallowing upward cycle at upper bounding surface at 9.0 feet.
10.3 - 11.0	No recovery
11.0 - 11.6	Lime mudstone, mottled very pale orange 10YR 8/2 and light-gray N7; clay-size lime mudstone; no fossils; 15 percent root-mold porosity; low hydraulic conductivity; hypersaline pond; hard when wet; irregular semivertical root molds; burrowed
11.6 - 12.1	Pelmoldic lime grainstone, very pale orange 10YR 8/2; mainly very fine to fine sand-size peloidal molds; minor medium sand to pebble-size skeletal molds; molds of peloids and skeletal fragments; 15 percent moldic, root mold, and solution-enlarged root-mold porosity; low hydraulic conductivity; possible marine beach; hard when wet
12.1 - 12.7	Skeletal lime grainstone, very pale orange 10YR 8/2; mainly very fine to coarse sand-size fossils; minor granule to pebble-size fossils; rare cobble-size fossils; skeletal fragments, peloids, pelecypods, gastropods, peneroplids, serpulids, miliolids; 30 percent intergrain and intragrain porosity; low hydraulic conductivity; marine inner shelf; moderately hard when wet; moderately friable

Depth (feet below land surface)	Lithologic description of well PB-1704
12.7 - 13.7	Gastropod lime mudstone and wackestone, pale-yellowish-brown 10YR 6/2, very pale orange 10YR 8/2, medium-gray N5; mainly clay-size lime mudstone and pebble-size fossils; minor granule-size fossils; low-spired gastropods (including *Seminolina wilsoni*), and minor high-spired gastropods and pelecypods; 10 percent intragrain, root-mold, solution enlarged root-mold, and desiccation-crack porosity; very low hydraulic conductivity; freshwater pond or lake; irregular to overhanging microtopography on upper bounding exposure surface at 12.7 feet; semivertical and craze desiccation cracks; trace 1-mm diameter irregular root molds; abundant root molds and solution enlarged root molds (mangrove?) partly filled with freshwater facies and inner shelf facies from 12.1 to 12.7 feet; burrowed; top of upper shallowing cycle at 12.7 feet
13.7 - 14.0	Gastropod lime rudstone and floatstone with skeletal fragment, mud-dominated, and grain-dominated lime packstone matrix, pale-yellowish-brown 10YR 6/2, very pale orange 10YR 8/2, medium-gray N5; mainly very fine sand to pebble size fossils; minor clay-size lime mudstone; high spired gastropods and trace pelecypods; 30 percent intragrain and intragrain porosity; moderate hydraulic conductivity; restricted bay or lagoon
14.0 - 14.4	Rubble of gastropod lime rudstone and floatstone with skeletal fragment, mud-dominated, lime packstone matrix; pale-yellowish-brown 10YR 6/2, very pale orange 10YR 8/2, medium-gray N5 mainly clay size lime mudstone and very fine sand to pebble-size fossils; high spired gastropods and trace pelecypods; 20 percent intragrain and intragrain porosity; low hydraulic conductivity; restricted bay or lagoon; very poor recovery; rubble
14.4 - 15.0	Marl, very pale orange 10YR 8/2; mainly lime mudstone; no fossils; 10 percent intergrain porosity; very low hydraulic conductivity; restricted bay, lagoon or freshwater lake
15.0 - 15.5	Rubble
15.5 - 16.5	Lime mudstone and gastropod lime wackestone, grades from light-gray N7 at base to very pale orange 10YR 8/2 at top of interval; mainly clay-size lime mudstone; minor very fine sand to pebble-size fossils; gastropods; 20 percent root-mold, solution-enlarged root-mold and moldic porosity; low hydraulic conductivity; tidal-flat pond; hard when wet; irregular and local overhanging microtopography on upper bounding, subaerial exposure surface; irregular root molds; 3- to 10-mm diameter, irregular, semivertical root molds (mangrove?), locally solution enlarged; local solution-enlarged root molds filled with transgressive lime grainstone; top of shallowing upward cycle at upper bounding surface at 15.5 feet
16.5 - 17.0	Pelecypod-gastropod lime rudstone and floatstone with skeletal-peloid lime grainstone matrix, very pale orange 10YR 8/2; mainly clay-size lime mudstone; minor very fine sand to pebble-size fossils; skeletal fragments, peloids, pelecypods, and gastropods; 30 percent intergrain, intragrain, and root-mold porosity; moderate hydraulic conductivity; marine inner shelf shoal or restricted bay or lagoon shoal; local root molds lined with grayish-orange 10YR 7/4 calcrete
17.0 - 19.0	No recovery
19.0 - 19.5	Limestone rubble
19.5 - 22.5	No recovery
22.5 - 22.7	Limestone rubble
22.7 - 23.3	Gastropod lime wackestone with marl matrix, very pale orange 10YR 8/2; mainly clay-size lime mudstone; minor very fine sand to pebble-size fossils; gastropods (including abundant *Seminolina wilsoni*); 10 percent intergrain and root-mold porosity; very low hydraulic conductivity; freshwater pond or lake; soft when wet; semivertical, irregular root molds; interval shallows upward; lower 2 inches contains more shells and no root molds; top of shallowing upward cycle between 22.7 and 17 feet.
23.3 - 27.5	No recovery
27.5 - 27.7	Loose marine fossils including pelecypods, gastropods, sand dollars, minor branching porites, encrusting bryozoans, and lithoclasts of pelecypod lime rudstone and floatstone;
27.7 - 27.85	Calcrete, grayish-orange 10YR 7/4; mainly clay-size calcrete; 20 percent semivertical solution-channel, vuggy, root mold, and desiccation-crack porosity; high hydraulic conductivity; subaerial exposure; hard when wet; root molds; top of shallowing-upward cycle at 27.7 feet.
27.85 - 28.0	Pelecypod lime floatstone with skeletal lime wackestone matrix, medium-gray N5; clay-size lime mudstone and granule to pebble-size fossils; pelecypods, skeletal fragments; 20 percent semivertical solution channel, vuggy, root mold, and desiccation-crack porosity; high hydraulic conductivity; marine inner shelf
28.0 - 34.3	No recovery
34.3 - 35.2	Rubble of calcrete and pelecypod lime floatstone as in interval between 27.7 and 28 feet
35.2 - 35.5	Pelecypod gastropod lime floatstone with skeletal lime grainstone and skeletal, grain-dominated, lime packstone matrix, very pale orange 10YR 8/2; mainly fine sand to pebble-size fossils; minor clay-size lime mudstone and very fine sand-size fossils and up to small pebble-size lithoclasts; pelecypods, gastropods, skeletal fragments, and pelecypod lime rudstone and floatstone lithoclasts; 25 percent intergrain porosity; moderate hydraulic conductivity; marine inner shelf shoal
35.5 - 37.5	No recovery

Depth (feet below land surface)	Lithologic description of well PB-1704
37.5 - 38.5	Pelecypod gastropod lime floatstone with skeletal lime grainstone and skeletal, mud-dominated, and grain-dominated lime packstone matrix, very pale orange 10YR 8/2; mainly very fine sand to pebble-size fossils; minor clay-size lime mudstone, cobble-size fossils, and up to small pebble-size lithoclasts; pelecypods, gastropods, skeletal fragments, and lithoclasts of medium-gray N5 to medium-light-gray N6 pelecypod lime rudstone and floatstone; 25 percent intergrain porosity; low to moderate hydraulic conductivity; marine inner shelf
38.5 - 40.5	No recovery
40.5 - 40.8	Rubble of pelecypod lime floatstone as in interval from 37.5 to 38.5 feet
40.8 - 42.0	No recovery
42.0 - 42.2	Gastropod lime mudstone, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone; minor coarse sand to pebble-size fossils; gastropods (including *Seminolina wilsoni*); 10 percent intragrain, root mold, and pinpoint vug porosity; low hydraulic conductivity; freshwater lake or pond; semivertical root molds (mangrove?)
42.2 - 43.0	Gastropod lime rudstone and floatstone with skeletal mud-dominated and grain-dominated lime packstone, pale-yellowish-brown 10YR 6/2; mainly clay-size lime mudstone and coarse sand to pebble-size fossils; gastropods (including *Seminolina wilsoni* and *Seminolina clewistonense*) and possible pelecypods; 25 percent root-mold, intragrain, and intergrain porosity; moderate hydraulic conductivity; freshwater lake or pond
43.0 - 43.5	Gastropod lime floatstone with skeletal grainstone matrix, pale-yellowish-brown 10YR 6/2; mainly very fine sand to pebble size fossils; gastropods (including *Seminolina wilsoni*) and pelecypods; 30 percent intergrain and intragrain porosity; moderate hydraulic conductivity; freshwater lake or pond
43.5 - 46.0	No recovery
46.0 - 46.5	Rubble of gastropod lime floatstone as in interval from 43 to 43.5 feet
46.5 - 49.5	No recovery
49.5 - 52.0	Pelecypod lime rudstone with skeletal, quartz sand-rich lime grainstone and minor skeletal, quartz sand-rich, grain-dominated lime packstone, medium-gray N5 to light-gray N7; mainly very fine sand-size quartz sand and coarse sand to pebble-size fossils; minor clay-size lime mudstone and very fine to medium fossils; very well sorted quartz sand; pelecypods, gastropods, skeletal fragments, and trace nonhermatypic corals and bryozoans; 40 percent quartz sand; 20 to 25 percent intergrain, intragrain, shelter, and root mold porosity; moderate hydraulic conductivity; subtidal marine; well cemented; hard when wet; irregular root molds; probably local calcrete lines subaerial upper bounding surface; top of shallowing upward cycle at upper bounding surface 49.5 feet
52.0 - 53.0	No recovery
53.0 - 53.5	Rubble of pelecypod lime rudstone and floatstone with skeletal, quartz sand-rich lime grainstone, medium-gray N5 to light-gray N7; mainly very fine quartz sand and very fine sand-size to pebble-size fossils; very well sorted quartz sand; pelecypods, gastropods, sand dollars, and serpulid tubes; 40 percent quartz sand; 25 percent intergrain and intragrain porosity; moderate hydraulic conductivity; subtidal marine; well cemented; hard when wet
53.5 - 57.0	No recovery
57.0 - 57.1	Quartz sand matrix with skeletal rudstone framework and quartz sand supporting skeletal floatstone matrix, medium-light-gray N6; mainly very fine sand size quartz sand and very fine sand size to pebble-size fossils; well sorted quartz sand; pelecypods and skeletal grains; 10 percent intergrain and intragrain porosity; low hydraulic conductivity; subtidal marine; well cemented; hard when wet
57.1 - 60.5	No recovery
60.5 - 62.0	Quartz sand, very pale orange 10YR 8/2; mainly fine to medium quartz sand; minor very fine quartz sand and very fine sand to small pebble-size fossils; very fine to fine sand-size phosphorite grains; well sorted quartz sand; 20 percent skeletal fragments, pelecypods, and gastropods; 3 percent black N1 phosphorite grains; 25 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine; friable; soft when wet
62.0 - 65.5	No recovery
65.5 - 66.0	Quartz sand, very pale orange 10YR 8/2; mainly very fine to fine quartz sand; minor very fine to medium sand-size fossils; very fine to fine sand-size phosphorite grains; well sorted quartz sand; 20 percent skeletal fragments; 3 percent black N1 phosphorite grains; 25 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine; friable; soft when wet
66.0 - 67.5	No recovery
67.5 - 69.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine to fine quartz sand; minor very fine to coarse sand-size fossils; very fine to fine sand-size phosphorite grains; well sorted quartz sand; 20 percent skeletal fragments and pelecypods; 5 percent black N1 phosphorite grains; 25 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine; friable; soft when wet
69.0 - 72.5	No recovery
72.5 - 72.7	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor very fine sand to pebble-size fossils; very well sorted quartz sand; 40 percent skeletal fragments; 25 percent intergrain porosity; moderate hydraulic conductivity; friable; soft when wet; likely cave

Depth (feet below land surface)	Lithologic description of well PB-1704
72.7 - 73.3	Quartz sand, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly very fine quartz sand; minor very fine sand to granule-size fossils; very well sorted quartz sand; 40 percent skeletal fragments and pelecypods; 15 percent intergrain porosity; low hydraulic conductivity; friable; soft when wet
73.3 - 75.0	Skeletal lime grainstone, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly very fine sand to medium sand-size fossils; minor very fine sand to pebble-size fossils; skeletal fragments, pelecypods, gastropods, and trace bryozoans; 30 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine shoal; very poorly cemented, loose, unconsolidated grains; soft when wet
75.0 - 76.5	Skeletal lime grainstone, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly very fine sand to coarse sand size fossils; minor granule to small pebble-size fossils; skeletal fragments, pelecypods, gastropods, and trace bryozoans; 30 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine shoal; very poorly cemented, loose, unconsolidated grains; soft when wet
76.5 - 77.5	No recovery
77.5 - 79.5	Skeletal lime grainstone, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly fine sand to medium sand-size fossils; minor very fine sand and coarse sand to small pebble-size fossils; skeletal fragments, pelecypods, and gastropods; 30 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine shoal; very poorly cemented, loose, unconsolidated grains; soft when wet
79.5 - 80.5	No recovery
80.5 - 81.3	Skeletal lime grainstone, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly find to medium sand-size fossils; minor very fine sand and coarse sand to small pebble-size fossils; skeletal fragments, pelecypods, and gastropods; 30 percent intergrain porosity; moderate hydraulic conductivity; subtidal marine shoal; very poorly cemented, loose, unconsolidated grains; soft when wet
81.3 - 82.5	No recovery
82.5 - 84.5	Skeletal, mud-dominated and grain-dominated lime packstone, yellowish-gray 5Y 8/1, very light gray N8; mainly clay-size lime mudstone and very fine sand to medium sand-size fossils; minor coarse sand to small pebble-size fossils and very fine to medium sand-size quartz sand; moderately sorted quartz sand; skeletal fragments, pelecypods, gastropods, bryozoans, and serpulids; 10 percent quartz sand; 20 percent intergrain, solution-enlarged channel, moldic, rootmold, and intragrain porosity; low matrix hydraulic conductivity and very high solution-enlarged channel hydraulic conductivity; subtidal marine; semivertical root molds; solution channels partly filled with transgressive very pale orange 10YR 8/2 skeletal lime grainstone; subaerial exposure at bounding surface at 82.5 feet
84.5 - 85.0	Rubble of lime packstone as in interval from 82.5 to 84.5 feet. with very thick oysters
85.0 - 87.5	No recovery
87.5 - 88.75	Pelecypod lime rudstone with matrix of skeletal fragment-rich quartz sandstone with lime mud matrix, light-olive-gray 5Y 6/1, dark-gray N3 to medium-light-gray N6; mainly clay-size lime mudstone, very fine to medium quartz sand and very fine sand to medium sand-size fossils; minor coarse sand to small pebble-size fossils and very fine to medium quartz sand; moderately sorted quartz sand; skeletal fragments, pelecypods, gastropods, and trace bryozoans; 70 percent quartz sand; 20 percent moldic, intergrain, and possible solution-channel porosity; moderate hydraulic conductivity; subtidal marine
88.75 - 91.8	Pelecypod lime rudstone and floatstone with skeletal, quartz sand-rich lime grainstone and skeletal, quartz sand-rich grain-dominated lime packstone matrix. yellowish-gray 5Y 8/1 and light-gray N7; mainly very fine to fine quartz sand and very fine sand to pebble-size fossils; minor clay-size lime mudstone; moderately sorted quartz sand; skeletal fragments, pelecypods, gastropods, and sand dollars; 40 percent quartz sand; 30 percent moldic, intergrain, and intragrain porosity; high hydraulic conductivity; subtidal marine; upper bounding surface (88.75 feet) is an abrupt surface that contains a laminated calcrete overlain by a black N1 phosphorite crust; upper bounding surface is a subaerial exposure surface
91.8 - 92.8	No recovery
92.8 - 93.2	Rubble of pelecypod lime floatstone with skeletal, quartz sand-rich lime wackestone matrix, very pale orange 10YR 8/2; mainly clay-size lime mudstone, very fine quartz sand and granule to pebble-size fossil fragments; minor fine sand to granule-size fossils; very well sorted quartz sand; pelecypods and sand dollars; 30 percent quartz sand
93.2 - 97.0	No recovery
97.0 - 98.0	Rubble of pelecypod lime floatstone with skeletal, quartz sand-rich lime wackestone matrix, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine quartz sand and granule- to pebble-size fossil fragments; minor fine sand to granule-size fossils; very well sorted quartz sand; pelecypods; 30 percent quartz sand
98.0 - 100.5	No recovery
100.5 - 101.0	Rubble
101.0 - 106.3	Mostly rubble with pelecypod lime rudstone with skeletal, grain-dominated lime packstone matrix, yellowish-gray 5Y 8/1, medium-light-gray N6 to light-gray N7; mainly medium sand-size fossils; minor clay-size lime mudstone, fine to medium sand-size fossils and very fine quartz sand; pelecypods, skeletal fragments, encrusting bryozoans, barnacles, and echinoid spines; 10 percent quartz sand; intergrain, moldic, and intragrain porosity; moderate hydraulic conductivity
106.3 - 110.0	No recovery

Depth (feet below land surface)	Lithologic description of well PB-1704
110.0 - 114.5	Pelecypod-skeletal lime rudstone and floatstone with skeletal, quartz sand-rich lime packstone matrix, very light gray N8, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine quartz sand and coarse sand and pebble-size fossils; minor fine to medium sand-size fossils; very well sorted quartz sand; pelecypods, skeletal fragments, encrusting bryozoans; 5 percent intergrain porosity; very low hydraulic conductivity; subtidal marine; soft when wet
114.5 - 116.3	Pelecypod-skeletal lime rudstone with matrix of mud-dominated lime packstone with marl matrix, very light gray N8, yellowish-gray 5Y 8/1; mainly clay-size marl and fine to granule-size fossils; minor very fine sand-size fossils; pelecypods, skeletal fragments, and echinoids; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet; possible flooding surface at 114.5 feet
116.3 - 120.5	No recovery
120.5 - 121.2	Pelecypod skeletal lime rudstone with matrix of mud-dominated lime packstone with marl matrix, very light gray N8, yellowish-gray 5Y 8/1; mainly clay-size marl and fine to granule-size fossils; minor very fine sand-size fossils; pelecypods, skeletal fragments, and echinoids; 10 percent intergrain porosity; low hydraulic conductivity; subtidal marine; soft when wet
121.2 - 122.0	No recovery
122.0 - 124.5	Pelecypod, quartz sand-rich lime grainstone, yellowish-gray 5Y 8/1 to light-olive-gray 5Y 6/1; mainly very fine sand to granule-size fossils and very fine quartz sand; minor pebble-size fossils; well sorted quartz sand; pelecypods and skeletal fragments; 25 percent intergrain and moldic porosity; moderate hydraulic conductivity; subtidal marine; poorly to moderately cemented; soft to moderately hard when wet
124.5 - 127.5	No recovery
127.5 - 128.0	Skeletal lime grainstone, yellowish-gray 5Y 8/1; mainly very fine to coarse sand-size fossils; minor granule- to pebble-size fossils; skeletal fragments and pelecypods; 25 percent moldic and intergrain porosity; moderate hydraulic conductivity; subtidal marine; moderately cemented; moderately hard when wet
128.0 - 129.5	Skeletal lime grainstone, light-olive-gray 5Y 6/1; mainly very fine to fine fossils and very fine quartz sand; minor terrigenous clay, silt-size quartz sand and medium to coarse sand-size fossils, and very fine to fine phosphorite grains; well sorted quartz sand; skeletal fragments; 10 percent quartz sand; 5 percent black N1 phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; subtidal marine; poorly cemented; soft when wet
129.5 - 133.2	No recovery
133.2 - 135.2	Skeletal, quartz sand-rich lime grainstone, light-olive-gray 5Y 6/1; mainly very fine to medium fossils and very fine quartz sand; minor terrigenous clay, silt-size quartz sand and medium to coarse quartz sand, and very fine to fine phosphorite grains; well sorted quartz sand; skeletal fragments, pelecypods and sand dollars; 30 percent quartz sand; 5 percent black N1 phosphorite grains; 20 percent intergrain porosity; low hydraulic conductivity; subtidal marine; poorly cemented; soft when wet
135.2 - 135.5	Pelecypod lime rudstone with skeletal, quartz sand-rich lime wackestone matrix, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine quartz sand and pebble-size fossils; minor silt-size quartz sand, cobble-size fossils and very fine to fine phosphorite grains; well sorted quartz sand; pelecypods, skeletal fragments; 30 percent quartz sand; 5 percent black N1 phosphorite grains; 20 percent moldic and intergrain porosity; moderate hydraulic conductivity; subtidal marine; moderately cemented; moderately hard
135.5 - 140.5	No recovery
140.5 - 144.5	Pelecypod lime rudstone with skeletal, quartz sand-rich, mud-dominated lime packstone matrix, yellowish-gray 5Y 8/1; mainly clay-size lime mudstone, very fine quartz sand and coarse sand to pebble-size fossils; minor silt-size quartz sand, fine to medium sand-size fossils, and very fine to fine phosphorite grains; well sorted quartz sand; skeletal fragments, pelecypods, and serpulids; 20 to 40 percent quartz sand; 5 percent black N1 phosphorite grains; 20 percent moldic and intergrain porosity; moderate hydraulic conductivity; subtidal marine; poorly to moderately cemented; soft to moderately hard when wet
144.5 - 147.5	No recovery
147.5 - 148.5	Pelecypod lime rudstone with skeletal, quartz sand-rich lime grainstone matrix, yellowish-gray 5Y 8/1; mainly coarse sand to pebble-size fossils and very fine quartz sand; minor silt-size quartz sand, fine to medium sand-size fossils and very fine phosphorite grains; well sorted quartz sand; skeletal fragments, pelecypods, and serpulids; 30 percent quartz sand; 5 percent black N1 phosphorite grains; 25 percent moldic and intergrain porosity; moderate hydraulic conductivity; subtidal marine; poorly to moderately cemented; soft to moderately hard when wet
148.5 - 154.5	No recovery
154.5 - 157.2	Pelecypod lime rudstone with skeletal, mud-dominated and grain-dominated lime packstone matrix, yellowish-gray 5Y 8/1 and very light gray N8; mainly very fine sand to pebble-size fossils and very fine quartz sand; minor clay-size lime mudstone, silt-size quartz sand, cobble-size fossils and very fine phosphorite grains; well sorted quartz sand; skeletal fragments, pelecypods, encrusting bryozoans, gastropods, and serpulids; 10 to 40 percent quartz sand; 3 percent black N1 phosphorite grains; 25 percent intergrain, moldic, and intragrain porosity; moderate hydraulic conductivity; subtidal marine; moderately to well cemented; moderately hard to hard when wet
157.2 - 160.5	No recovery

Depth (feet below land surface)	Lithologic description of well PB-1704
160.5 - 162.3	Pelecypod-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand and coarse sand to pebble-size fossils; minor clay-size lime mud, silt-size quartz sand, cobble-size fossils and very fine phosphorite grains; well sorted quartz sand; pelecypods, skeletal fragments and gastropods; 60 percent quartz sand; 5 percent black N1 phosphorite grains; 25 percent intergrain, moldic, and intragrain porosity; moderate hydraulic conductivity; subtidal marine; moderately cemented; moderately hard when wet
162.3 - 167.5	No recovery
167.5 - 172.0	Pelecypod-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand and coarse sand to pebble-size fossils; minor clay-size lime mud, silt-size quartz sand, cobble-size fossils, and very fine phosphorite grains; well sorted quartz sand; pelecypods, skeletal fragments, and gastropods; 60 percent quartz sand; 5 percent black N1 phosphorite grains; 25 percent intergrain, moldic, and intragrain porosity; moderate hydraulic conductivity; subtidal marine; moderately cemented; moderately hard when wet
172.0 - 173.2	No recovery
173.2 - 180.0	Pelecypod-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor fine sand to pebble-size fossils, clay-size terrigenous and lime mud, silt-size quartz sand, cobble-size fossils and very fine phosphorite grains; very well sorted quartz sand; 30 to 40 percent pelecypods, skeletal fragments, and gastropods; 5 to 10 percent black N1 phosphorite grains; 20 percent intergrain, moldic, and intragrain porosity; low hydraulic conductivity; subtidal marine; moderately cemented; moderately hard when wet
180.0 - 180.5	No recovery
180.5 - 185.0	Pelecypod-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor fine sand to pebble-size fossils, clay-size terrigenous mud, silt-size quartz sand, cobble-size fossils, and very fine phosphorite grains; very well sorted quartz sand; 20 to 40 percent pelecypods, skeletal fragments and gastropods; 5 to 10 percent black N1 phosphorite grains; 20 percent intergrain, moldic, and intragrain porosity; low hydraulic conductivity; subtidal marine; poorly to moderately cemented; soft to moderately hard when wet
185.0 - 187.5	No recovery
187.5 - 191.0	Pelecypod-rich quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor fine sand to pebble-size fossils, terrigenous clay and lime mud, silt-size quartz sand, cobble-size fossils and very fine phosphorite grains; very well sorted quartz sand; 30 to 40 percent pelecypods, skeletal fragments, and gastropods; 10 to 15 percent black N1 phosphorite grains; 20 percent intergrain moldic and intragrain porosity; low hydraulic conductivity; subtidal marine; moderately cemented; moderately hard when wet
191.0 - 192.0	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor clay-size terrigenous mud, silt-size quartz sand and very fine phosphorite grains; well sorted quartz sand; 10 to 15 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; friable; poorly cemented; soft when wet
192.0 - 194.5	No recovery
194.5 - 197.5	Quartz sand, yellowish-gray 5Y 8/1; mainly very fine quartz sand; minor clay-size terrigenous mud, silt-size quartz sand, and very fine phosphorite grains; well sorted quartz sand; 10 to 15 percent black N1 phosphorite grains; 15 percent intergrain porosity; low hydraulic conductivity; subtidal marine; friable; poorly cemented; soft when wet
197.5 - 200.5	No recovery

Appendix III

Thin-Section Descriptions of Rock Samples from Selected Cores as Determined for this Study

USGS local well No.	Core name
C-1141	Bear Island Campground Core
C-1142	Noble’s Farm Core
C-1173	Sabine Road Core
C-1176	Turner River Road Core
C-1178	Sunniland No. 2 Core
C-1180	Big Cypress Headquarter’s Core
C-1181	Cypress Lane Core
C-1182	Alligator Alley East Core
C-1183	Baker’s Grade Core
HE-1110	L-3 Canal Core
MO-178	Trail Center Core

Bear Island Campground Core

Local well No.	C-1141
Sample number	HHW-1
Sample depth	37.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SE, SW, sec. 29, T49S, R31E
Latitude	26°10′58″
Longitude	81°14′52″
Formation	Ochopee Limestone Member
Rock type	Pelecypod quartz sand-rich, grain-dominated and mud-dominated lime packstone
Description	Very fine (100 microns) to very coarse (1.5 millimeters) quartz sand, mainly medium (300 to 500 microns) quartz sand, moderate sorting of quartz, angular to subrounded quartz, mainly subangular quartz, low to high sphericity quartz grains, mainly moderate to high sphericity; very poorly sorted carbonate grains
Grain types	50 percent broken pelecypods, 20 percent quartz sand, 2 percent encrusting forams(?), 2 percent intraclasts, 1 percent broken large benthic forams, 1 percent echinoid plates, trace globular planktic forams, trace feldspar
Diagenesis	20 to 40 percent porosity, mainly interparticle and moldic porosity, minor intraparticle, 20 to 40 percent porosity; common bladed calcite cement, 15 to 25 micron long (silt size) irregular to minor isopachous

Local well No.	C-1141
Sample number	HHW-2
Sample depth	60.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SE, SW, sec. 29, T49S, R31E
Latitude	26°10′58″
Longitude	81°14′52″
Formation	Unnamed formation
Rock type	Skeletal-rich quartz sandstone (quartz sand matrix supports pelecypod floatstone)
Description	Very fine (100 microns) to granule (3 millimeters) size quartz sand, mainly fine (200 microns) to medium (400 microns), moderate sorting, subangular to rounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	75 percent quartz sand, abundant disarticulated and/or broken pelecypods, 1 percent feldspar, 1 percent broken large benthic forams, trace echinoids
Diagenesis	20 percent interparticle porosity, 20 percent moldic porosity, trace intraparticle porosity; 20 to 50 percent micron long irregular to minor isopachous bladed calcite cement (silt size)

Noble's Farm Core

Local well No.	C-1142
Sample number	HHW-3
Sample depth	63 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, NW, sec. 7, T49S, R33E
Latitude	26°14′17″
Longitude	81°04′24″
Formation	Ochopee Limestone Member
Rock type	Pelecypod grain-dominated lime packstone
Description	Silt (50 microns) to granule (3 millimeters) size quartz sand, mainly very fine (100 microns) to fine (150 microns), poor sorting, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	Abundant disarticulated and/or broken pelecypods, 10 percent quartz sand, 1 percent broken large benthic forams, trace broken bryozoans and echinoids
Diagenesis	20 percent interparticle porosity, 5 percent moldic porosity, trace intraparticle porosity; 20 to 50 micron long irregular to minor isopachous bladed calcite cement (silt size)

Local well No.	C-1142
Sample number	HHW-4
Sample depth	85 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, NW, sec, 7 T49S, R33E
Latitude	26°14′17″
Longitude	81°04′24″
Formation	Ochopee Limestone Member
Rock type	Pelecypod quartz sand-rich mud-dominated and grain-dominated lime packstone
Description	Silt (50 microns) to granule (3 millimeters) size quartz sand, mainly very fine (100 microns) to fine (250 microns), poor sorting, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	Abundant disarticulated and/or broken pelecypods, 25 percent quartz sand, 3 percent intraclasts, 1 percent broken large benthic forams, trace encrusting forams, echinoids, and globular planktic forams
Diagenesis	35 percent interparticle and moldic porosity, trace intraparticle porosity; 20 to 50 micron long irregular to minor isopachous bladed calcite cement (silt size)

Sabine Road Core

Local well No.	C-1173
Sample number	HHW-7
Sample depth	77.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, NW, sec. 6, T50S, R33E
Latitude	26°09′53″
Longitude	81°04′17″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with mud-dominated grain-dominated lime packstone matrix
Description	Silt (50 microns) to very coarse (1.5 millimeters) size quartz sand, mainly very fine (100 microns) to fine (150 microns), moderate sorting, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	Abundant disarticulated pelecypods and broken pelecypods, 10 percent quartz sand, 3 percent echinoids, trace large benthic forams (up to 1 millimeter long) and ostracods, trace feldspar
Diagenesis	30 percent moldic and interparticle porosity, minor intraparticle porosity; 25 micron long irregularly distributed minor bladed calcite cement (silt size)

Local well No.	C-1173
Sample number	HHW-8
Sample depth	97.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, NW, sec. 6, T50S, R33E
Latitude	26°09′53″
Longitude	81°04′17″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime rudstone with quartz sand-rich skeletal lime wackestone matrix
Description	Silt (50 microns) to granule (2.5 millimeters) size quartz sand, mainly very fine (120 microns) to fine (250 microns), moderate sorting, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	Abundant disarticulated pelecypods and broken pelecypods, 45 percent quartz sand, 1 percent large benthic forams, trace globular planktonic forams, trace feldspar
Diagenesis	30 percent moldic porosity, minor intraparticle porosity; common 25 micron long irregularly and isopachous bladed calcite cement (silt size)

Turner River Road Core

Local well No.	C-1176
Sample number	HHW-9
Sample depth	14 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, NW, sec 6, T51S, R31E
Latitude	26°03′38″
Longitude	81°15′49″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with skeletal mud-dominated, grain-dominated lime packstone
Description	Silt (50 microns) to medium (260 microns) size quartz sand, mainly very fine (120 microns) to fine (200 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	20 percent disarticulated pelecypods and broken pelecypods, 5 percent quartz sand, 2 percent large benthic forams up to 2 millimeters long, 1 percent echinoids, trace miliolids
Diagenesis	30 percent moldic and interparticle porosity, minor intraparticle porosity; common 50 to 150 micron long irregularly and isopachous bladed calcite cement

Local well No.	C-1176
Sample number	HHW-10
Sample depth	36 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, NW, sec. 6, T51S, R31E
Latitude	26°03′38″
Longitude	81°15′49″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with mud-dominated and grain-dominated lime packstone matrix
Description	Silt (50 microns) to medium (500 microns) size quartz sand, mainly very fine (120 microns) to fine (260 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	20 percent disarticulated pelecypods and broken pelecypods, 15 percent quartz sand, 1 percent large benthic forams up to 1.5 millimeters long, trace echinoids and biserial foram
Diagenesis	15 percent moldic and interparticle porosity, minor intraparticle porosity; common equant pore fill calcite cement, common 50 to 75 micron long irregularly and isopachous bladed calcite cement

Sunniland No. 2 Core

Local well No.	C-1178
Sample number	HHW-11
Sample depth	55.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, NW, sec. 2 T49S, R30E
Latitude	26°14′53″
Longitude	81°17′44″
Formation	Ochopee Limestone Member
Rock type	Quartz sandstone with micrite matrix
Description	Silt (50 microns) to granule (3.5 millimeters) size quartz sand, mainly very fine (120 microns) to fine (250 microns), moderate sorting, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	85 percent quartz sand, 2 percent pelecypod molds
Diagenesis	15 percent moldic and root-mold porosity; minor 150 micron long calcite cement with a flat top on crystal and minor equant calcite associated with long flat-topped crystals, calcrete matrix(?)

Local well No.	C-1178
Sample number	HHW-12
Sample depth	78.8 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, NW, sec. 2, T49S, R30E
Latitude	26°14′53″
Longitude	81°17′44″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with skeletal quartz sand-rich lime wackestone matrix
Description	Silt (50 microns) to coarse (1 millimeter) size quartz sand, mainly very fine (120 microns) to medium (400 microns), well sorted, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	45 percent quartz sand, abundant pelecypods; trace gastropods, bryozoans, miliolids, and other benthic foraminifers
Diagenesis	10 percent moldic and small vug porosity; equant to short bladed (150 microns) isopachous, calcite cement post-dated by equant calcite spar pore-fill

Local well No.	C-1178
Sample number	HHW-13
Sample depth	91.3 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, NW, sec. 2, T49S, R30E
Latitude	26°14′53″
Longitude	81°17′44″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime rudstone with skeletal quartz sand-rich lime wackestone matrix
Description	Silt (50 microns) to medium (400 microns) size quartz sand, mainly very fine (70 microns) to fine (150 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	45 percent quartz sand, abundant pelecypods
Diagenesis	10 percent moldic porosity; partial mold-fill with 0.2 to 0.5 millimeter long elongated to equant calcite

Sunniland No. 2 Core (Continued)

Local well No.	C-1178
Sample number	HHW-14
Sample depth	124.8 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, NW, sec. 2, T49S, R30E
Latitude	26°14′53″
Longitude	81°17′44″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with skeletal mud-dominated and grain-dominated lime packstone matrix
Description	Silt (50 microns) to medium (400 microns) size quartz sand, mainly very fine (70 microns) to fine (150 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	10 percent quartz sand; pelecypods, large benthic forams up to 250 microns long, bryozoans, echinoids, peloids, and gastropods
Diagenesis	30 percent moldic and interparticle porosity; no visible cement

Local well No.	C-1178
Sample number	HHW-15
Sample depth	142.9 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, NW, sec. 2, T49S, R30E
Latitude	26°14′53″
Longitude	81°17′44″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with skeletal quartz sand-rich lime wackestone matrix
Description	Silt (50 microns) to coarse (1 millimeter) size quartz sand, mainly fine (180 microns) to medium (400 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	45 percent quartz sand; pelecypods, large benthic forams up to 1 millimeter long, bryozoans, echinoids
Diagenesis	30 percent moldic porosity, minor intraparticle porosity; minor 25 micron long bladed irregular to isopachous calcite cement, poorly cemented

Big Cypress Headquarter’s Core

Local well No.	C-1180
Sample number	HHW-5
Sample depth	21.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SE, NE, sec. 16 T49S, R34E
Latitude	25°53′45″
Longitude	81°19′24″
Formation	Ochopee Limestone Member
Rock type	Benthic foram, pelecypod lime grainstone
Description	Silt (50 microns) to granule (3 millimeters) size quartz sand, mainly very fine (120 microns) to medium (350 microns), poor sorting, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	20 percent broken pelecypods, 5 percent quartz sand; trace gastropod, echinoids and biserial forams
Diagenesis	10 percent moldic and interparticle porosity; mainly abundant block calcite cement up to 150 millimeters, 100 to 180 micron long irregular to minor isopachous bladed calcite cement possible microcodium

Local well No.	C-1180
Sample number	HHW-6
Sample depth	37.7 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SE, NE, sec. 16 T49S, R34E
Latitude	25°53′45″
Longitude	81°19′24″
Formation	Ochopee Limestone Member
Rock type	Skeletal-rich quartz sandstone (quartz-sand matrix supports pelecypod floatstone with common micrite matrix)
Description	Silt (50 microns) to very coarse (1.5 millimeters) size quartz sand, mainly fine (200 microns) to medium (500 microns), moderate sorting, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	80 percent quartz sand, abundant disarticulated pelecypods and broken pelecypods, trace echinoids
Diagenesis	20 percent moldic and interparticle porosity; common micrite occluding interparticle voids; 25 to 50 micron long irregular to minor isopachous bladed calcite cement (silt size)

Cypress Lane Core

Local well No.	C-1181
Sample number	HHW-16
Sample depth	42 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 35, T49S, R31E
Latitude	26°10′02″
Longitude	81°12′03″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with skeletal mud-dominated and grain-dominated lime packstone matrix
Description	Silt (50 microns) to fine (250 microns) size quartz sand, mainly very fine (80 microns) to fine (200 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	15 percent quartz sand; abundant pelecypods, echinoids, bryozoans; trace globular planktonic forams, trace feldspar
Diagenesis	25 percent moldic and interparticle porosity, trace bored porosity; poorly cemented

Local well No.	C-1181
Sample number	HHW-17
Sample depth	61 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 35, T49S, R31E
Latitude	26°10′02″
Longitude	81°12′03″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with pelecypod quartz sand-rich, mud-dominated lime packstone matrix
Description	Silt (50 microns) to very coarse (1.5 millimeters) sized quartz sand, mainly fine (150 microns) to coarse (600 microns), poorly sorted, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	40 percent quartz sand; pelecypods, at least 1 millimeter long broken benthic forams, echinoids; trace feldspars
Diagenesis	20 percent moldic porosity, trace intraparticle porosity and bored porosity; voids lack cement

Local well No.	C-1181
Sample number	HHW-18
Sample depth	74 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 35, T49S, R31E
Latitude	26°10′02″
Longitude	81°12′03″
Formation	Ochopee Limestone Member
Rock type	Pelecypod mud-dominated and grain-dominated lime packstone
Description	Silt (50 microns) to granule (2.5 millimeters) size quartz sand, mainly fine (150 microns) to medium (400 microns), poorly sorted, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	10 percent quartz sand; pelecypods, broken large benthic forams, echinoid, intraclasts, peloids
Diagenesis	Underterminable porosity percentage, trace intraparticle porosity and bored porosity, mainly interparticle and moldic porosity; lacks cement in voids

Cypress Lane Core (Continued)

Local well No.	C-1181
Sample number	HHW-19
Sample depth	84 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 35 T49S, R31E
Latitude	26°10′02″
Longitude	81°12′03″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime rudstone with skeletal quartz sand-rich, mud-dominated and grain-dominated lime packstone
Description	Silt (50 microns) to granule (2.5 millimeters) size quartz sand, mainly very fine (100 microns) to fine (250 microns), poorly sorted, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	35 percent quartz sand; mostly broken pelecypods, broken large benthic forams at least 1.5 millimeters; minor serpulids, echinoids; trace bryozoans
Diagenesis	40 percent porosity mainly moldic, minor interparticle, trace bored porosity, trace intraparticle porosity; irregular to isopachous up to 100 micron long bladed calcite cement

Local well No.	C-1181
Sample number	HHW-20
Sample depth	96 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 35, T49S, R31E
Latitude	26°10′02″
Longitude	81°12′03″
Formation	Ochopee Limestone Member
Rock type	Pelecypod-rich quartz sandstone with mud-dominated and grain-dominated lime mud matrix
Description	Silt (50 microns) to granule (3 millimeters) size quartz sand, mainly very fine (100 microns) to fine (150 microns), poorly sorted, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	75 percent quartz sand, abundant broken pelecypods and echinoids, trace feldspar
Diagenesis	15 percent porosity mainly moldic, minor interparticle, trace intraparticle porosity; irregular to isopachous up to 100 micron long bladed calcite cement that post-dates mold formation

Alligator Alley East Core

Local well No.	C-1182
Sample number	HXP-16
Sample depth	17.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Pinecrest Sand Member
Rock type	Quartz sand
Description	Silt (40 microns) to medium (450 microns) size quartz sand, mainly very fine (75 microns) to fine (150 microns) quartz sand, well sorted, angular to subrounded, low to high sphericity; patchy distribution of lime mud matrix
Grain types	2 percent heavy minerals grains, 1 percent plagioclase, 1 percent phosphorite grains, trace skeletal fragments
Diagenesis	20 percent intergrain porosity; low permeability because 10 percent lime mud matrix; lime mud may be microcrystalline dolomite (silt size)

Local well No.	C-1182
Sample number	HXP-17
Sample depth	37.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Pinecrest Sand Member
Rock type	Quartz sand
Description	Silt (40 microns) to medium (350 microns) size quartz sand, mainly very fine (100 microns) to fine (150 microns) quartz sand, well sorted, granular to subrounded, low to high sphericity
Grain types	2 percent heavy mineral grains, 1 percent plagioclase, 1 percent phosphorite grains, trace benthic and globular planktic foraminifers, trace microcline
Diagenesis	20 percent intergrain porosity; patchy distribution of 15 percent lime mud matrix; low hydraulic conductivity

Local well No.	C-1182
Sample number	HXP-18
Sample depth	45 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Pinecrest Sand Member
Rock type	Quartz sand
Description	Silt (50 microns) to medium (300 microns) size quartz sand; mainly very fine (100 microns) to fine (150 microns) quartz sand, well sorted, angular to subrounded, low to high sphericity
Grain types	3 percent heavy minerals, 1 percent benthic forams, trace pelecypods; trace plagioclase, microcline and phosphorite grains
Diagenesis	20 percent intergrain porosity; patchy distribution of 15 percent lime mud; low hydraulic conductivity

Alligator Alley East Core (Continued)

Local well No.	C-1182
Sample number	HXP-19
Sample depth	53.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Pinecrest Sand Member
Rock type	Lime mud-rich terrigenous mudstone
Description	Silt (30 microns) to medium (350 microns) size quartz sand, mainly very fine (70 microns) to fine (150 microns) quartz sand, well sorted, angular to subrounded, low to high sphericity; one 900-micron coarse quartz grain
Grain types	40 to 60 percent lime mud (≤10 percent micron diameter), 5 to 25 percent quartz grains, trace skeletal fragments; trace plagioclase, phosphorite grains and heavy mineral grains
Diagenesis	10 percent microcrystalline porosity; areas with abundant microcrystalline dolomite are more porous

Local well No.	C-1182
Sample number	HXP-20
Sample depth	62 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	89°59′21″
Formation	Pinecrest Sand Member
Rock type	Quartz sand-rich, terrigenous mudstone
Description	Silt (40 microns) to medium (400 microns) size quartz sand, mainly very fine (100 microns) to fine (150 microns) quartz sand, moderately sorted, angular to subangular, low to high sphericity; matrix mainly lime mud mixed with terrigenous clay
Grain types	20 to 45 percent quartz grains, 3 percent heavy minerals; trace plagioclase, microcline and phosphorite grains
Diagenesis	15 percent microcrystalline porosity; very low hydraulic conductivity

Local well No.	C-1182
Sample number	HXP-21
Sample depth	129 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Unnamed formation
Rock type	Quartz sand
Description	Silt (40 microns) to fine (250 microns) size quartz sand, mainly very fine (100 microns) to fine (150 microns) quartz sand; medium to very coarse sand-size intraclasts
Grain types	15 percent phosphorite grains, 5 to 10 percent terrigenous mud matrix; ≤5 percent skeletal grains including benthic forams, echinoid fragments, and pelecypod fragments; 2 percent heavy minerals, 1 percent terrigenous mud intraclasts, 1 percent plagioclase and microcline
Diagenesis	20 percent intergrain porosity; low hydraulic conductivity

Alligator Alley East Core (Continued)

Local well No.	C-1182
Sample number	HXP-22
Sample depth	143 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Peace River Formation
Rock type	Terrigenous clay-rich quartz sand
Description	Silt (30 microns) to fine (200 microns) size quartz sand, mainly very fine (100 microns) to fine (150 microns) quartz sand, moderately sorted, angular to subrounded, low to high sphericity; silt (50 microns) to very coarse (1,300 microns) phosphorite grains, mainly very fine (100 microns) to fine (150 microns) phosphorite grains; medium (200 to 500 microns) grain intraclasts of terrigenous clay and micrite; 10 to 30 micron carbonate grains subhedral to euhedral calcite and possibly dolomite
Grain types	30 percent terrigenous clay matrix, 30 percent phosphorite grains; 1 percent skeletal grains, including benthic forams and pelecypod fragments
Diagenesis	20 to 30 percent intergrain porosity, but much may be due to expansion of grains and creation of porosity during impregnation; matrix well distributed throughout intergrain area; low hydraulic conductivity

Local well No.	C-1182
Sample number	HXP-23
Sample depth	147.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Peace River Formation
Rock type	Benthic foram terrigenous mudstone
Description	Mainly terrigenous clay; subordinate 3 to 15 micron carbonate grains with some euhedral dolomite crystals 10 to 15 micron diameter and silt to very fine sand size quartz grains
Grain types	35 percent micrite, 10 percent quartz grains, 5 to 10 percent benthic forams
Diagenesis	10 percent microporosity and intragrain porosity, but much may be due to expansion of grains and creation of porosity during impregnation; very low hydraulic conductivity

Local well No.	C-1182
Sample number	HXP-24
Sample depth	170 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Peace River Formation
Rock type	Diatomaceous terrigenous mudstone
Description	Silt (20 microns) to fine (140 microns) size quartz sand, mainly silt (50 microns) to very fine (80 microns) quartz sand, moderately sorted quartz grains, angular to subangular, low to high sphericity
Grain types	40 percent terrigenous clay, 20 percent benthic forams, 20 percent diatoms, 20 percent quartz grains
Diagenesis	25 percent microporosity and intergrain porosity; very low hydraulic conductivity

Alligator Alley East Core (Continued)

Local well No.	C-1182
Sample number	HXP-25
Sample depth	185 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Peace River Formation
Rock type	Quartz sand
Description	Silt (30 microns) to very coarse (1,400 microns) size quartz sand, mainly very fine (70 microns) to fine (150 microns) quartz sand, poorly sorted, angular to subrounded, low to high sphericity
Grain types	15 percent phosphorite grains, 10 percent terrigenous mud matrix unevenly distributed, 1 percent heavy minerals, trace benthic forams, trace plagioclase
Diagenesis	Original grain packing disturbed by sample preparation, cannot accurately estimate porosity, but likely ~20 percent; low permeability

Local well No.	C-1182
Sample number	HXP-26
Sample depth	192.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	NW, sec. 1, T50S, R33E
Latitude	26°10′11″
Longitude	80°59′21″
Formation	Peace River Formation
Rock type	Quartz sand
Description	Silt (25 percent) to medium (400 microns) size quartz sand, mainly very fine (90 microns) to fine (130 microns) quartz, well sorted, angular to subrounded, low to high sphericity; very fine to fine sand-size phosphorite grains
Grain types	15 percent phosphorite grains, 5 percent terrigenous mud matrix, 3 percent heavy minerals, 1 percent plagioclase and microcline
Diagenesis	Original grain packing disturbed by sample preparation, cannot accurately estimate porosity, but likely ~20 percent

Baker's Grade Core

Local well No.	C-1183
Sample number	HXP-1
Sample depth	12.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 7, T49S, R32E
Latitude	26°15′04″
Longitude	81°10′23″
Formation	Pinecrest Sand Member
Rock type	Quartz sand
Description	Silt (0.02 millimeter) to fine (0.2 millimeter) size quartz sand, mainly fine (140-180 millimeters) sand, well sorted, angular to subrounded, low to high sphericity, grain dominated texture, but patchy distribution of lime mud matrix with occludes, locally, intergrain porosity
Grain types	10 percent lime mud matrix, 1 to 2 percent heavy minerals, 1 percent broken pelecypod fragments, 1 percent plagioclase grains, trace benthic forams
Diagenesis	20 percent intergrain porosity; low hydraulic conductivity

Local well No.	C-1183
Sample number	HXP-2
Sample depth	39.5 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 7, T49S, R32E
Latitude	26°15′04″
Longitude	81°10′23″
Formation	Pinecrest Sand Member
Rock type	Quartz sand-rich, terrigenous clay-rich, lime mudstone
Description	Silt (20 microns) to fine (200 microns) size quartz sand, mainly very fine (80 microns) to fine (180 microns), well sorted quartz, angular to subrounded, low to high sphericity, mud-supported rock
Grain types	5 to 20 percent quartz grains, 1 percent heavy minerals, 1 percent benthic forams, trace globular planktic forams and skeletal fragments
Diagenesis	5 percent microporosity; very low hydraulic conductivity

Baker's Grade Core (Continued)

Local well No.	C-1183
Sample number	HXP-3
Sample depth	109 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 7, T49S, R32E
Latitude	26°15′04″
Longitude	81°10′23″
Formation	Unnamed formation
Rock type	Quartz sand
Description	Silt (40 microns) to fine (220 microns) size quartz sand, mainly very fine (80-120 microns) quartz sand, angular to subrounded, well sorted, low to high sphericity; 1 percent coarse to very coarse quartz sand, very fine to coarse phosphorite grains, very fine heavy minerals
Grain types	15 to 20 percent phosphorite grains, 1 to 3 percent heavy mineral grains; trace skeletal fragments and broken pelecypod fragments, sponge spicules(?); trace plagioclase, trace clay
Diagenesis	20 percent intergrain porosity; moderate hydraulic conductivity

Local well No.	C-1183
Sample number	HXP-4
Sample depth	115 feet
Described by	Kevin J. Cunningham
County	Collier
Location	SW, sec. 7, T49S, R32E
Latitude	26°15′04″
Longitude	81°10′23″
Formation	Peace River Formation
Rock type	Terrigenous clay-rich microcrystalline dolomite
Description	Silt (30 microns) to fine (200 microns) size quartz sand, silt to fine, mainly very fine (80-100 microns) quartz sand, angular to subrounded, low to high sphericity; silt-size (5-20 microns) dolomite crystals
Grain types	≤70 percent microcrystalline dolomite, 10 percent quartz grains, trace skeletal fragments
Diagenesis	~10 percent intercrystalline microporosity; euhedral dolomite crystals

L-3 Canal Core

Local well No.	HE-1110
Sample number	HHW-21
Sample depth	57.5 feet
Described by	Kevin J. Cunningham
County	Hendry
Location	NE, SW, sec. 22, T47S, R34E
Latitude	26°23′10″
Longitude	80°55′48″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime rudstone with skeletal quartz sand-rich mud-dominated packstone and wackestone matrix
Description	Silt (50 microns) to coarse (625 microns) size quartz sand, mainly very fine (100 microns) to fine (200 microns), poorly sorted, angular to subrounded, mainly subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	Mostly broken pelecypods, 20 percent quartz sand, 10 percent echinoids; 1 percent feldspar; trace gastropods and ostracods
Diagenesis	40 percent porosity mainly moldic, trace interparticle and intraparticle porosity; very little to no cement

Local well No.	HE-1110
Sample number	HHW-22
Sample depth	101.5 feet
Described by	Kevin J. Cunningham
County	Hendry
Location	NE, SW, sec. 22, T47S, R34E
Latitude	26°23′10″
Longitude	80°55′48″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime rudstone with skeletal quartz sand-rich, mud-dominated packstone matrix
Description	Silt (50 microns) to medium (500 microns) size quartz sand, mainly very fine (100 microns) to medium (375 microns), moderately sorted, angular to subrounded, mainly subangular to subrounded, low to high sphericity, mainly moderate to high sphericity
Grain types	Mostly broken pelecypods, 45 percent quartz sand, 1 percent feldspar; minor up to 0.5 millimeter long benthic forams, echinoids, trace gastropods
Diagenesis	45 percent porosity mainly moldic and interparticle, minor intraparticle and bored porosity; minor irregular craze-plane desiccation(?) cracks; common irregular to isopachous bladed (up to 150 microns) calcite in interparticle voids

Local well No.	HE-1110
Sample number	HHW-23
Sample depth	142.5 feet
Described by	Kevin J. Cunningham
County	Hendry
Location	NE, SW, sec. 22, T47S, R34E
Latitude	26°23′10″
Longitude	80°55′48″
Formation	Ochopee Limestone Member
Rock type	Quartz sandstone matrix with pelecypod rudstone framework
Description	Silt (50 microns) to medium (375 microns) size quartz sand, mainly very fine (100 microns) to fine (250 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity; mud-dominated and grain-dominated lime mudstone matrix
Grain types	60 percent quartz sand, mostly broken pelecypods; minor gastropods, echinoids; trace ostracods and small benthic forams; trace feldspar
Diagenesis	35 percent porosity mainly moldic and interparticle, trace intraparticle and bored porosity; common irregular to isopachous bladed (up to 75 microns long) calcite post-date formation of moldic voids

Trail Center Core

Local well No.	MO-178
Sample number	HHW-24
Sample depth	67.5 feet
Described by	Kevin J. Cunningham
County	Monroe
Location	NE, sec. 1, T4S, R34E
Latitude	25°48′15″
Longitude	80°52′31″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with skeletal quartz sand-rich, mud-dominated and grain-dominated packstone matrix
Description	Silt (50 microns) to medium (500 microns) size quartz sand, mainly fine (200 microns) to medium (375 microns), well sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	Mostly broken pelecypods, 25 percent quartz sand; trace up to 1 millimeter long benthic forams, bryozoans, globular planktonic forams, echinoids; trace feldspar
Diagenesis	35 percent porosity mainly moldic and interparticle, minor intraparticle and bored porosity; minor irregular to isopachous bladed (up to 100 microns long) calcite lining interparticle voids

Local well No.	MO-178
Sample number	HHW-25
Sample depth	115.5 feet
Described by	Kevin J. Cunningham
County	Monroe
Location	NE, sec. 1, T4S, R34E
Latitude	25°48′15″
Longitude	80°52′31″
Formation	Ochopee Limestone Member
Rock type	Pelecypod lime floatstone with skeletal grain-dominated lime packstone matrix
Description	Silt (50 microns) to coarse (625 microns) size quartz sand, mainly medium (250-325 microns), moderately sorted, angular to subrounded, mainly subangular, low to high sphericity, mainly moderate to high sphericity
Grain types	Mostly broken pelecypods, 5 percent quartz sand, minor sand dollars and echinoid spines, trace long broken benthic forams up to 1.5 millimeters and planktonic forams
Diagenesis	35 percent porosity mainly moldic and interparticle, minor intraparticle and bored porosity; minor irregular to isopachous bladed (up to 75 microns long) calcite lining interparticle voids and minor up to 25 micron long lining molds