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## Preliminary Report

# Hydrogeologic Investigation of the Floridan Aquifer System, Reedy Creek Improvement District Orange County, Florida

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## EXECUTIVE SUMMARY

The *2000 Kissimmee Basin Water Supply Plan* (KB Plan) was the first look at the long-term water use conditions for areas located north of Lake Okeechobee within the South Florida Water Management District (SFWMD or District).

The findings of the KB Plan suggest that the groundwater supplies in Osceola County area may not be sufficient to meet the 2020 (1-in-10 drought year) water supply needs. The continued use of the Upper Floridan Aquifer (UFA) may affect wetlands, reduce spring flow and possibly be a factor in the formation of sinkholes in this area. However, these conclusions are predicated on a limited amount of geologic and hydrologic information in this region. In particular, information regarding the Lower Floridan Aquifer (LFA) is very limited.

The highest ranked recommendation of the KB Plan is to gather additional hydrogeologic information on the Floridan Aquifer System (FAS) to better resolve the uncertainty of future water use affects. Towards that end, three FAS exploratory sites were completed in the Kissimmee Basin Planning Area over the past five years. This report summarizes results from one of those sites located at the Reedy Creek Improvement District (RCID). This well will supply information needed to characterize the water supply potential of the LFA and for use in the development of a groundwater flow model, which will support future planning and regulatory decisions.

The FAS test site described in this report is located on in southwest Orange County on RCID property (**Figure 1**). The test/monitor well is located in the southeast quadrant of Section 23 of Township 24 South, Range 27 East. The geographic coordinates of the RCID test/monitor well are 28° 22'43.7" N latitude and 81° 35' 15.9" W longitude relative to the North American Datum of 1983 (NAD 1983). Land surface was surveyed at 68.2 feet relative to the National Geodetic Vertical Datum of 1929 (NGVD 1929). The RCID site was selected to augment existing hydrogeologic data and to provide broad, spatial coverage within the Kissimmee Basin Planning Area.

The scope of the investigation consisted of testing a LFA well and constructing to Florida Department of Environmental Class V, Group 8 well standards. The well identified as ORF-60 was drilled to a total depth of 2,100 feet below land surface (bls). The contractor constructed a telescoping type well in various stages, completing it into a distinct hydrogeologic zone within the LFA from 1,160 to 1,280 feet bls.

The SFWMD provided oversight during all well drilling, construction and testing operations. The Diversified Drilling Corporation (DDC), a Tampa based corporation was responsible for all drilling, well construction and testing services at the RCID site. The cost of this project (\$375,000) was mutually shared by RCID, SFWMD and Orange County Utilities.

The main findings of the exploratory drilling and testing program at this site are as follows:

- The top of the FAS as defined by the Southeastern Geological Society AdHoc Committee on Florida Hydrostratigraphic Unit Definition (1986) was identified at a depth of approximately 80 feet below land surface (bls).
- A 10-inch inner diameter exploratory well was successfully constructed and tested at the RCID site in accordance with FDEP Class V, Group 8, well standards.
- Lithologic and geophysical logs, specific capacity and aquifer performance test results indicate moderate production capacity in Zone A of the UFA (80 to 250 feet bls) and very good production capacity in Zone B of the UFA (300 to 740 feet bls).
- Water quality data from 220 to 715 feet bls indicate that chloride and total dissolved solids in the UFA waters meet potable drinking water standards with chloride and total dissolved solids concentrations of five and 134 milligrams per liter, respectively.
- Lithologic information and geophysical logs obtained from OSF-60 indicates that low porosity/permeability, poorly indurated grainstones and moderately to well indurated, wackestones and crystalline dolostones occur from 740 to 1,160 feet bls, These low permeable sediments act as a confining unit that effectively isolates the UFA from the LFA.
- Lithologic and geophysical logs and specific capacity test results indicate very good production capacity of the LFA “Zone A” from 1,170 to 1,280 feet bls. This zone yielded a specific capacity value of 116 gpm/foot of drawdown at pump rate of 2,210 gpm with a calculated transmissivity of 232,000 gpd/ft.
- Composite water quality sampling of ORF-60 (1,170 to 1,280 feet bls) indicate that chloride and total dissolved solids meet potable drinking water standards with chloride and total dissolved solids concentrations of eight and a 160 milligrams per liter, respectively.
- Lithologic data and production-type logs (e.g. flow, temperature logs) indicate very good production from flow zones between 1,170 and 1,195 feet bls and 1,215 to 1,270 feet bls. Below 1,270 feet bls, the productive capacity is limited (as indicated by the fluid-type logs) suggesting lower permeable—semi-confining units near the base of the monitor zone.
- Lithologic data, geophysical logs and packer test results indicate good production capacity of the LFA “Zone B” from 1,860 to 1,970 feet bls. This zone yielded a specific capacity value of 116 gpm/foot of drawdown with chloride and total dissolved solids concentrations of seven and 148 milligrams per liter (mg/L), respectively.

- The base of the Underground Source of Drinking Water, those waters having TDS concentrations less than 10,000 mg/L, was not encountered at the total depth of 2,100 feet bls.



## INTRODUCTION

### Background

The *2000 Kissimmee Basin Water Supply Plan* (KB Plan) was the first look at the long-term water use conditions for areas located north of Lake Okeechobee within the South Florida Water Management District (SFWMD or District).

The findings of the KB Plan suggest that the groundwater supplies in Orange County area may not be sufficient to meet the 2020 (1-in-10 drought year) water supply needs. The continued use of the Upper Floridan Aquifer (UFA) may affect wetlands, reduce spring flow and possibly be a factor in the formation of sinkholes in this area. However, these conclusions are predicated on a limited amount of geologic and hydrologic information in this region. In particular, information regarding the Lower Floridan Aquifer (LFA) is very limited.

The highest ranked recommendation of the KB Plan is to gather additional hydrogeologic information on the lower portion of Floridan Aquifer System (FAS) to better resolve the uncertainty of future water use affects. Towards that end, three FAS exploratory sites were completed in the Kissimmee Basin Planning Area over the past five years. This report summarizes results from one of those sites located at the Reedy Creek Improvement District (RCID).

The RCID, Orange County Utilities (OCU) and the South Florida Water Management (SFWMD) have a mutual interest concerning the aquifer characteristics and water quality of the LFA in southwest Orange County. The primary objective of this study was to construct and test a single-zone LFA test/monitor well on RCID property that will provide additional hydrogeologic information on the lower portion of FAS in support of the KB Plan. Data collected from testing and long-term monitoring will be instrumental in the development of revised groundwater modeling efforts and other consumptive use analyses. The RCID site is presently part of SFWMD's long-term water level and water quality FAS monitoring network.

The LFA test site described in this report is located in southern Orange County within the RCID (**Figure 1**). The LFA test/monitor well is located in the southeast quadrant of Section 23 of Township 24 South, Range 27 East. The geographic coordinates of the RCID test/monitor well are 28° 22'43.7" N latitude and 81° 35' 15.9" W longitude (NAD, 1983). Land surface elevation of 131 feet relative to the National Geodetic Vertical Datum (NGVD) of 1929 was determined from a U.S. Geological Survey 7.5 minute topographic map.

## Project Description

Site preparation and equipment mobilization at the project site began on March 1, 2003. A single zone well was constructed to facilitate long-term monitoring of the LFA (identified as ORF-60). This test/monitor well was drilled to a total depth of 2,100 feet below land surface (bls) and completed between 1,170 and 1,280 feet bls.

The SFWMD provided oversight during all well drilling, construction and testing operations. The Diversified Drilling Corporation (DDC), a Tampa based corporation was responsible for all drilling, well construction and testing services at the RCID site. This project was completed on July 10, 2003 at a cost of \$375,000.

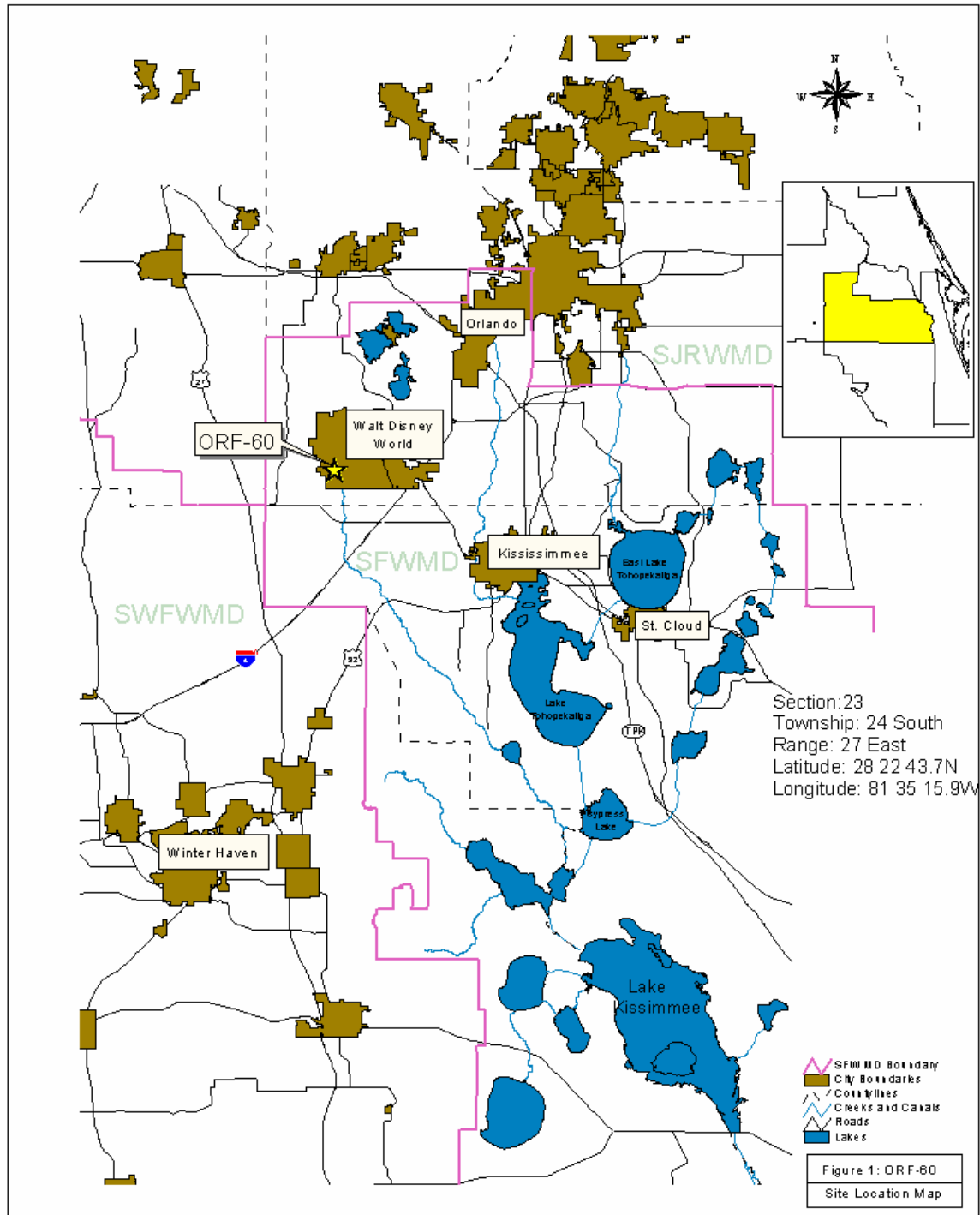


Figure 1. Project Location Map.

## EXPLORATORY DRILLING AND WELL CONSTRUCTION

### RCID Lower Floridan Aquifer Monitor Well – ORF-60

On March 1, 2003, the DDC delivered drilling and support equipment to begin site preparation for drilling and construction of a Lower Floridan Aquifer monitor well (referred to as ORF-60). The DDC cleared and rough graded the site and then constructed a two-foot thick, drilling pad using crushed limestone. The drilling pad served to reduce impacts to adjacent areas during normal drilling, testing and construction activities.

Mud rotary and reverse-air techniques were used during drilling operations. Closed-circulation mud rotary drilling was used to advance a nominal 10-inch diameter pilot hole from land surface to 250 feet bls. The DDC employed the reverse-air, open circulation method to drill the pilot-hole from 250 to 2,100 feet bls due to a highly permeable, fractured/cavernous dolostone/limestone sequence encountered below 250 feet bls, which would prohibit continued mud circulation.

The SFWMD used formation samples (well cuttings), packer and specific capacity test results and geophysical logs to determine the actual casing setting depths. Once identified, the contractor reamed the pilot hole to specified diameter and depth for the selected casing setting. Three concentric carbon steel casings (24-, 18- and 10-inch diameter) were used in the construction of the LFA monitor well.

On March 10, 2003, the contractor (DDC) drilled the pilot hole to a depth of 103 feet bls using a 12.75-inch diameter bit via the mud rotary method. They then reamed (over-drilled) the 12.75-inch pilot hole to a depth of 103 feet bls using a nominal 29-inch diameter staged bit reamer. Both the pilot hole and reamed borehole were completed on March 11, 2003. The DDC then installed 24-inch diameter pit casing from land surface to 90 feet bls and pressure grouted back to surface. Once installed, the contractor continued pilot-hole drilling operations (using a 9.875-inch diameter bit) to 250 feet bls via the mud rotary method. The nominal 10-inch diameter pilot-hole pilot hole was re-circulated and conditioned before being geophysically logged from 90 to 250 feet bls. A composite of the geophysical log traces from geophysical log run no. 2 is provided in **Appendix A**.

On March 20, 2003, the contractor reamed the nominal 10-inch diameter pilot-hole to a depth of 226 feet bls using a nominal 22-inch diameter staged bit reamer. Once completed, the reaming tool was tripped to the bottom of the borehole and the hole conditioned before being geophysically logged (4-arm caliper and natural gamma ray). The contractor then installed 18-inch diameter (0.375 inch wall thickness) steel casing from land surface to 220 feet bls. Once installed, the surface casing was grouted to land surface using 536 cubic feet of ASTM Type II neat cement.

Once the surface casing was installed, the DDC switched to the reverse-air method to continue the nominal 10-inch pilot-hole through the Eocene-aged Avon Park Formation to a depth of 715 feet bls. On April 1, 2003, the SFWMD conducted a step-

drawdown test on the open-hole section from 220 to 715 feet bls. Upon successful completion of the step-drawdown test, the contractor continued to drill the nominal 10-inch pilot-hole via the reverse-air to a depth of 998 feet bls. MV Geophysical Services conducted formation evaluation and production logging operations in the open hole section from 220 to 998 feet bls. A composite of the geophysical log traces from geophysical log run no. 3 is provided in **Appendix A**.

On April 9, 2003, the contractor completed drilling of the pilot-hole to the target depth of 1,350 feet bls and reverse-air developed the open-hole section for subsequent geophysical logging operations. On April 11, 2003, MV Geophysical Services conducted formation evaluation and production logging operations in the open-hole section from 220 to 1,350 feet bls. A composite of the geophysical log traces from geophysical log run no. 4 is provided in **Appendix A**.

Review and analysis of lithologic and geophysical log data from the pilot hole to a depth of 1,350 feet bls indicates that the top of the LFA occurs at a depth of approximately 1,160 feet bls, at the contact between low permeable carbonates and moderately to highly permeable dolostones. The reasons for setting the final 10-inch diameter casing at the site to a depth of 1,170 feet bls are to:

1. Seal off permeable section of the Upper Floridan and eliminate the downward flow component within the borehole due to lower hydraulic heads present in the LFA below 1,160 feet bls.
2. Facilitate reverse-air-drilling operations through underlying permeable horizons of the FAS to 2,100 feet bls.
3. Locate the casing in a competent rock unit to reduce under-mining (erosion) at its base because of induced (pumped) high velocity upward flow and establish the upper limits of the long-term LFA monitor interval.
4. Evaluate flow characteristics of the lower portion of the FAS within the open-hole interval of 1,170 to 2,100 feet bls.

On April 23, 2003, the DDC installed the 10-inch-diameter steel production casing (ASTM A53, Grade B, 0.365-inch wall thickness) to a depth of 1,170 feet bls. They then successfully grouted the annulus to land surface in multiple stages using a combination of ASTM Type II neat cement and bentonite-cement slurry. Pumped volumes, slurry type and resulting cement levels, as measured by a temperature log and physical hard tag after each cement stage are summarized in **Table 1**.

**Table 1.** Pumped Volumes, Slurry Type and Cement Levels for LFA Monitor Well Test.

Stage No.	Volume	Slurry Type	Temp	Hard Tag
1	76 barrels	Neat cement	975 feet bls	982 feet bls
2	90 barrels	8% bentonite-cement slurry	855 feet bls	850 feet bls
3	116 barrels	12% bentonite-cement slurry	784 feet bls	785 feet bls
4	137 barrels	12% bentonite-cement slurry	576 feet bls	570 feet bls
5	137 barrels	12% bentonite-cement slurry	372 feet bls	375 feet bls
6a	81 barrels	12% bentonite-cement slurry		
6b	62 barrels	Neat cement	316 feet bls	320 feet bls
7	63 barrels	Neat cement	308 feet bls	310 feet bls
8	63 barrels	Neat cement	310 feet bls	306 feet bls
9	63 barrels	Neat cement	300 feet bls	301 feet bls
10	63 barrels	Neat cement	270 feet bls	275 feet bls
11	63 barrels	Neat cement	150 feet bls	150 feet bls
12	33 barrels	Neat cement		Land Surface

As part of the casing integrity verification, a pressure test on the 10-inch diameter production casing was successfully completed on May 12, 2003. The wellhead was sealed at the surface with a temporary header to facilitate the test. Next, the well was filled with water and pressurized to approximately 100-pound per square inch (psi) with a high-pressure pump. During the course of the 60 minute pressure test, the total pressure within the 10-inch diameter casing decreased 2 psi, representing a 2 percent decline - well within the FDEP Underground Injection Control test tolerance limit of +/- 5 percent. In addition, a cement bond log (CBL) was conducted to evaluate the bond quality between the annular cement, the 10-inch diameter production casing string and the rock formations. The recorded wave-amplitude curve from the CBL infers that the 10-inch diameter steel casing is well supported by the annular cement with good contact with the rock formation and no discernable voids within the annular space.

Upon successfully completing the casing pressure test and CBL, the DDC continued to drill a nominal 8-inch diameter pilot-hole via reverse-air rotary method from 1,350 feet bls to a total depth of 2,100 feet bls. Upon completion, the contractor developed the open-hole section via reverse-air and prepared it for subsequent

geophysical logging operations. On June 13, 2003, MV Geophysical Services conducted formation evaluation and production logging operations in the open-hole section from 1,170 to 2,100 feet bls. A composite of the geophysical log traces from geophysical log run no. 7 is provided in **Appendix A**.

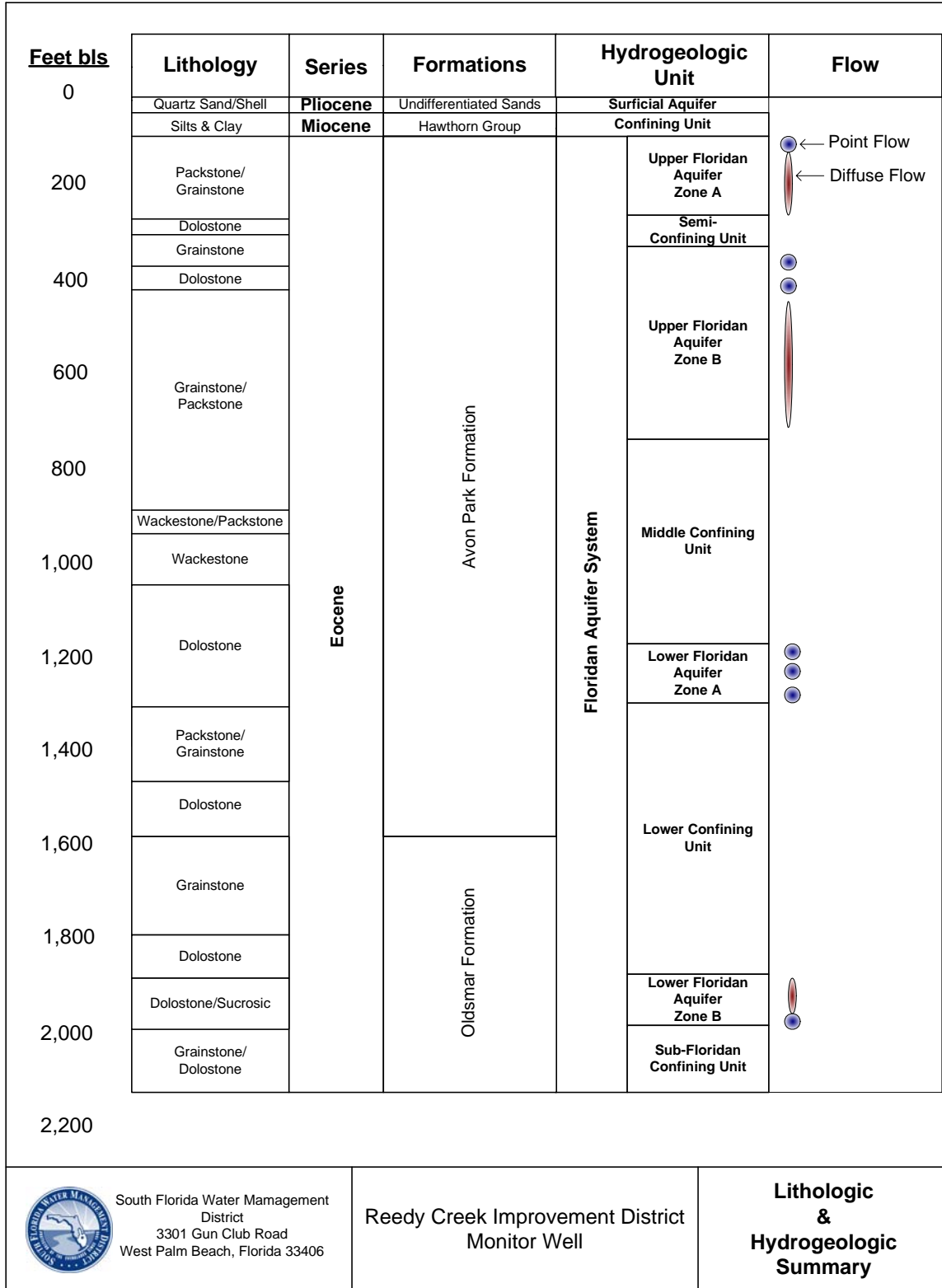
Based on lithologic and geophysical log data, two packer tests were conducted in the open-hole section from 1,510 to 1,540 feet bls and 1,935 to 1,975 feet bls. After testing operations were completed, the DDC back-plugged the nominal 8-inch diameter borehole to 1,280 feet bls. Cement levels used to back plug the pilot hole provided the lower limit of the LFA monitor interval.

In summary, the LFA monitor well identified as ORF-60 at the RCID site was constructed using 10-inch diameter steel casing and completed with an open hole monitor interval of 1,170 to 1,280 feet bls.

## HYDROSTRATIGRAPHIC FRAMEWORK

The SFWMD collected geologic formation samples (well cuttings) from the pilot hole during drilling operations of the LFA monitor well and separated them based on their dominant lithologic or textural characteristics, and to a lesser extent color. The onsite geologist washed then described the samples using the Dunham (1962) classification scheme. The SFWMD's onsite lithologic descriptions are summarized in **Appendix B**. The District sent these samples to the Florida Geological Survey (FGS) for further analysis and long-term storage identified using the reference number **W-18445**. An electronic version of the lithologic description is available from the FGS Web site: <http://www.dep.state.fl.us/geology/>.

Two major aquifer systems underlie this site, the Surficial Aquifer System (SAS) and the FAS with the FAS being the focus of this test well program. These aquifer systems are composed of multiple, discrete aquifers separated by low permeability "confining" units that occur throughout this Tertiary/Quaternary-aged sequence. **Figure 2** shows a generalized lithostratigraphic and hydrogeologic section underlying the RCID site.



**Figure 2.** Generalized Lithostratigraphic and Hydrogeologic Section – RCID Site.

The Floridan Aquifer System (FAS) consists of a series Tertiary Age limestone and dolostone units. The system includes permeable sediments of the Ocala Limestone, Avon Park Formation and the Oldsmar Formation. The Paleocene age Cedar Keys Formation with evaporitic gypsum and anhydrite beds forms the lower boundary of the FAS (Miller 1986). This lithostratigraphic unit was not penetrated at a total depth of 2,100 feet bls at this location.

Lithologic information obtained from drill cuttings indicates that undifferentiated quartz sands occur from land surface to 30 feet bls and form the Surficial Aquifer. Hawthorn Group sediments are present from approximately 30 feet to 80 feet bls and consist predominately of soft non-indurated detrital clays, silts and poorly indurated mudstones (see lithologic log – **Appendix B**). These low permeability sediments act as an intermediate confining unit separating the Surficial Aquifer from the FAS.

The top of the FAS, as defined by the Southeastern Geological Society AdHoc Committee on Florida Hydrostratigraphic Unit Definition (1986), coincides with the top of a vertically continuous permeable carbonate sequence. The Upper Floridan Aquifer (UFA) consists of thin water bearing horizons with high permeability interspersed within thick units of middle-Eocene age sediments with low permeability. At this site, the top of the FAS occurs at a depth of 80 feet bls, which coincides with a change in lithology that occurs below 80 feet bls as identified in the well cuttings and sonic log. These sediments are poorly indurated, high porosity, wackestones-packstones of the Upper Avon Park Formation.

Two discrete zones were identified in the UFA separated by a semi-confining unit. These two productive horizons are designated as “Zone A and Zone B” consistent with nomenclature used in O’Reilly et al., 2002. Zone A corresponds to the upper one-third of the aquifer and coincides with the uppermost part of the Avon Park Formation. The top of this interval is marked by a minor lost circulation horizon (permeable zone) at 80 feet bls near the contact between the Hawthorn Group and Avon Park Formation. The natural gamma log from 80 to 170 feet bls produces thin, intermittent, high-gamma radiation peaks, associated primarily with intervals of high phosphate sand/silt content within low to moderately permeable limestone units. At 170 feet bls, the lithology changes from a tan grainstone containing phosphate grains to a phosphate-free, cream colored, poorly to moderately indurated, packstones and grainstones. This contact is marked by a significant attenuation of the natural gamma ray activity, increased resistivity values and sonic transit times. These moderately permeable carbonates continue from 170 to 250 feet bls. A well indurated, low permeability, gray colored mudstone unit defines the lower limits of Zone A at 250 feet.

An intervening semi-confining unit separates Zone A from Zone B in the UFA composed of competent, well-indurated, low permeability, crystalline dolostone unit interbedded with moderately indurated, tan colored, grainstones and crystalline limestones that occur from 250 to 300 feet bls.

Zone B corresponds to the lower two-thirds of the UFA with the majority of water production from 310 to 425 feet bls that corresponds to fractured and cavernous dolostone units in the upper portion of the Avon Park Formation. Significant water production occurs at 310 feet bls with minor production at 400 feet bls, as indicated by the flowmeter and temperature logs (see run no. 3 – **Appendix A**). Smaller, less productive intervals continue from 425 to 740 feet bls through poorly to moderately indurated, friable packstone and grainstone units as evident in the flowmeter or temperature log traces and seen on the borehole video log.

At this site, the middle semi-confining unit, which separates the Upper and Lower Floridan aquifers occurs at 740 feet bls. The top of semi-confining unit is composed of poorly indurated low permeability grainstones that continue to 880 feet bls. Through this upper section, a transition in formation water quality occurs, noted by lower formation and fluid resistivity values (see run no. 3 – **Appendix A**). Moderately to well indurated, low porosity/permeability wackestones occur from 880 to 1,070 feet bls, which become more dolomitic and interbedded from 1,025 to 1,060 feet bls. Well-indurated, low permeability, cream to tan colored, crystalline dolostones continue from 1,060 feet to 1,160 feet bls. These low porosity/permeability, well-indurated units cause a decrease in sonic transit times with a corresponding decrease in porosity and a relatively gauge borehole (i.e., similar to the diameter of the drill bit). In addition, these low permeable sediments have very little productive capacity, as indicated by the flowmeter and temperature logs (see geophysical log run no. 4 – **Appendix A**). This 420-foot section of low permeability sediments effectively isolates the Upper and Lower Floridan aquifers.

The LFA underlies the middle semi-confining unit. The top of the LFA at this site was identified at 1,160 feet bls where the dolostones becomes more sucrosic and permeable in nature. Through the LFA, the formation resistivity, sonic transit times and caliper log traces vary significantly in response to fractures and solution features. In addition, the flowmeter log traces indicated significant downward flow below 1,170 feet bls. These sections of the borehole are associated with good to excellent secondary permeability (e.g., fractured and cavernous). Review the borehole video survey confirmed the presence of highly productive zone of secondary permeability.

An specific capacity test was conducted on the interval from 1,170 to 1,280 feet bls. Analysis of the test data yielded a specific capacity of 116 gallon per minute per foot (gpm/ft) of drawdown at a pump rate of 2,610 gpm with a calculated transmissivity of 232,000gpd/ft (Discroll 1989). The hydraulic and lithologic data indicate the LFA is highly productive, but confined in nature. Results of laboratory analyses conducted on water samples from the LFA indicate that inorganic constituents meet potable drinking water standards. Low permeability sediments of the Avon Park Formation mark the base of the LFA Zone A at 1,280 feet bls.

The Lower Avon Park Formation and upper section of the Oldsmar Formation from 1,280 to 1,860 feet bls consists of low permeable moderately indurated, dolomitic wackestones and packstones and well indurated, dense crystalline dolostones. Formation samples do not show evidence of large-scale secondary porosity development, and the

temperature and flowmeter log traces indicate limited water production, which supports the overall confining nature of this interval.

A low to moderately permeable dolostone unit occurs from 1,860 to 1,970 feet bls. The change in lithology from a dolomitic limestone to dolostone is noted by individual geophysical log traces. The induction and sonic logs show a slight increase in formation resistivity and lower sonic transit times, which are indicative of well-indurated dolostones. A minor flow zone, present near the bottom of this dolostone sequence was initially identified during reverse-air drilling when flow rates from the well bore increased. Lithologic data and minor deflections in the temperature log and information from the borehole video log confirmed small productive horizons from 1,860 to 1,970 feet bls. This interval was identified as Zone B within the LFA. Low permeable sediments of lower part of the Oldsmar Formation mark the base of the LFA at 1,970 feet bls.

Hard, dense dolostone and well-indurated limestone units with anhydrite are present from 1,970 feet bls to a total depth of 2,100 feet bls. These low permeable units form the sub-Floridan confining unit—lower limits of the FAS. Review of the borehole video log in concert with the production log data and formation samples confirm the confining nature of this lowermost interval.

## HYDROGEOLOGIC TESTING

The SFWMD collected specific information during the drilling program to determine the lithologic, hydraulic and water-quality characteristics of the FAS at this site. These data were to be used in the final design of the Lower Floridan Aquifer monitor well for use in site-specific aquifer tests, and a long-term water level and water-quality monitoring program. **Figure 3** summarizes the well construction and test results from the RCID site.

### Formation Fluid Sampling

During reverse-air drilling of the pilot-hole, samples were taken from circulated return fluids (composite formation water) at 30-foot intervals (average length of drill rod) from 250 feet bls to 1,350 feet bls. Water quality measurements on the reverse-air returns were not taken below 1,350 feet bls due to equipment availability. A Hydrolab<sup>®</sup> multi-parameter probe was used to measure field parameters on each sample, which included temperature, specific conductance and pH. **Figure 4** shows field determined specific conductance values and calculated total dissolved solids (TDS) concentrations with respect to depth using the following equation  $TDS = \text{Specific Conductance} * 0.65$  (Hem, 1994).

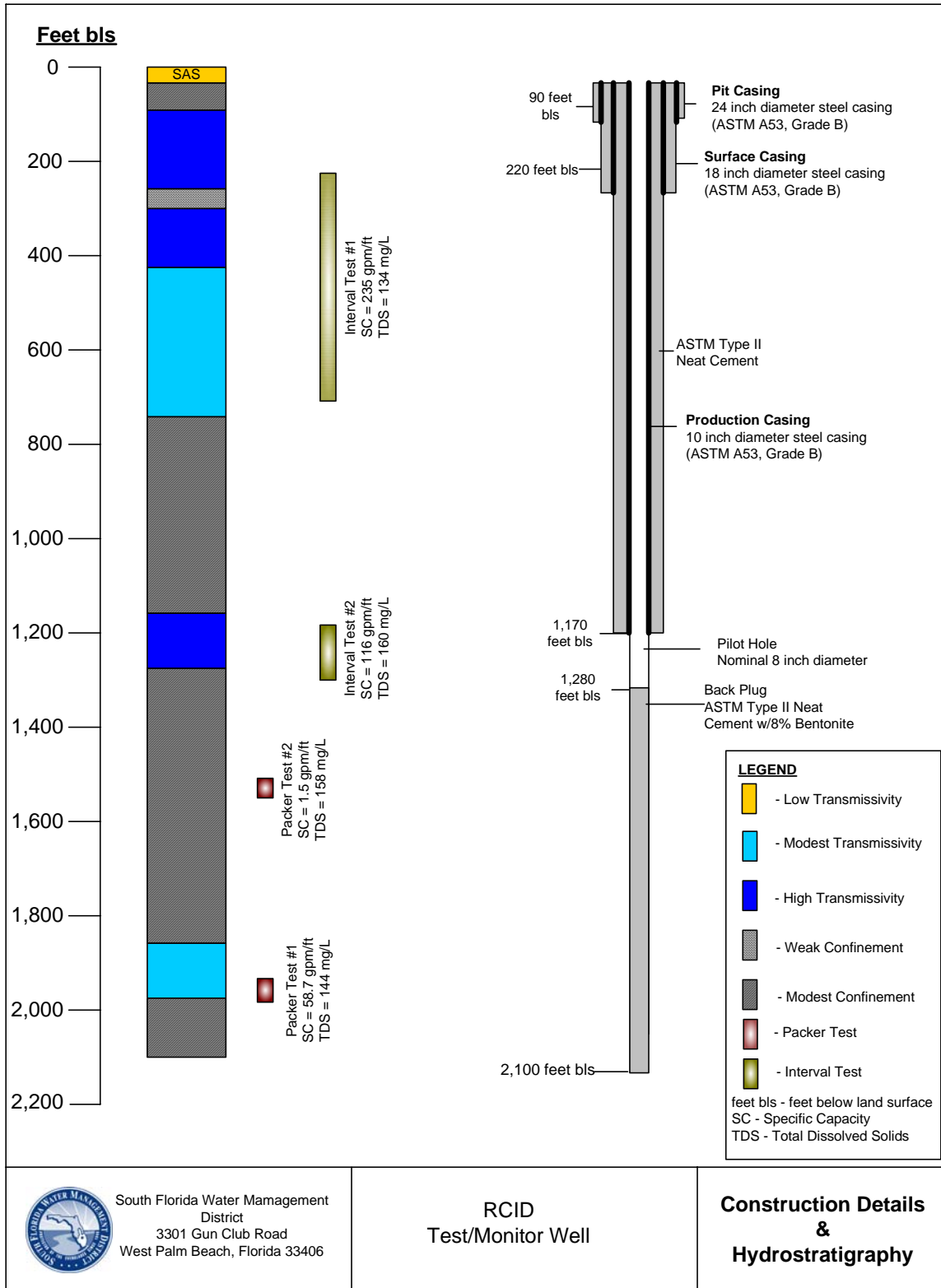


Figure 3. Well Construction and Testing Summary – RCID Site.

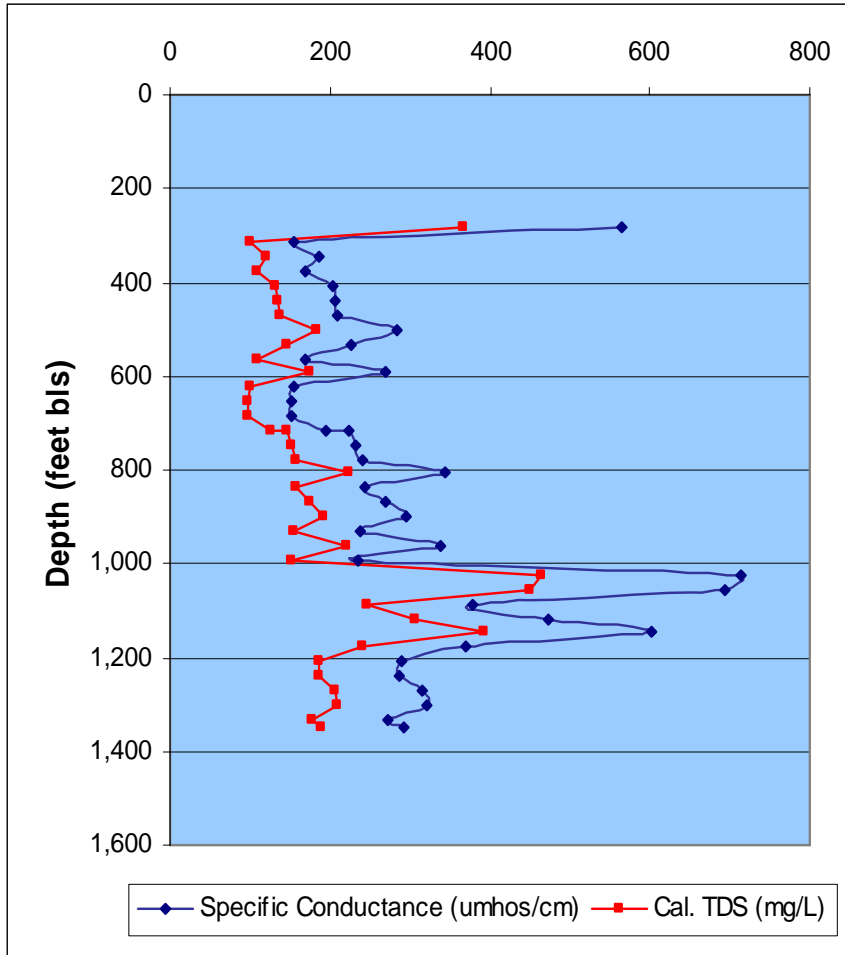


Figure 4. Water Quality with Depth – Reverse Air Returns.

## Geophysical Logging

Geophysical logging was conducted in the pilot-holes after each stage of drilling and before reaming of the boreholes for casing installations. The resulting logs provide a continuous record of the physical properties of the subsurface formations and their respective fluids. These logs were later used to assist in the interpretation of lithology, provide estimates of permeability, porosity, bulk density and resistivity of the aquifer and formation water. In addition, the extent of confinement of discrete intervals can be discerned qualitatively from the individual logs.

The geophysical logging contractor(s) downloaded the data directly from the onsite logging processor onto diskettes using log ASCII standard (LAS) version 1.2 or 2.0 format. Geophysical log traces from the various log runs for ORF-60 are provided in **Appendix A. Table 2** is a summary of the geophysical logging program conducted at this site. The original geophysical logs and video surveys from the Intercession City site are archived (SFWMD reference no. 095-000014) and available for review at the SFWMD headquarters in West Palm Beach, Florida.

**Table 2.** Summary of Geophysical Logging Activities at the RCID Site.

Run #	Date	Logging Company	Logged Interval (ft. bls)	Caliper	Natural Gamma Ray	S P	Dual Induct.	Sonic	Flow-Meter	Temp	Fluid Resist	Video
1	03/17/03	SRE	0 - 250	x	x	x	x	x				
2	03/20/03	MVG	0 - 220	x	x							
3	04/03/03	MVG	220 - 714	x	x	x	x	x	x	x	x	x
4	04/11/03	MVG	220 - 1350	x	x	x	x	x	x	x	x	x
5	04/22/03	MVG	220 - 1172	x	x							
6	Multiple	MVG	0 - 1170		x					x		
7	06/13/03	SRE	1165 - 2102	x	x	x	x	x	x	x	x	x

SRE = Southern Resource Exploration  
MVG = MV Geophysical Services, Inc.  
Measuring Point Elevation is Land Surface at 131 feet NGVD, 1929

## Straddle Packer Tests

The SFWMD conducted a series of straddle-packer tests within the FAS between 1,510 and 1,970 feet bls. The purpose of these tests was to gain water quality and production capacity data on discrete intervals. The SFWMD selected intervals based on lithologic, geophysical logs, borehole video surveys and hydraulic and water quality considerations using all available data.

The contractor purged the packer intervals a minimum of three borehole volumes or until field parameters of samples collected from the discharge pipe had stabilized. Then the SFWMD obtained individual groundwater samples. A limit of +/-5 percent variation in consecutive field parameter readings was used to determine chemical stability. District staff used a Hydrolab® multi-parameter probe to measure field parameters including temperature, specific conductance and pH on each sample. District personnel collected unfiltered and filtered water in accordance with SFWMD sampling protocol. The water samples were placed on ice and transported to the SFWMD water quality laboratory where they were analyzed for inorganic constituents using U.S. Environmental Protection Agency (USEPA) and/or Standard Method procedures (SFWMD 2000). **Table 3** lists the field parameters and laboratory determined water quality results for the individual packer and specific capacity tests.

**Table 3.** Water Quality Data obtained during Packer and Specific Capacity Tests.

Inorganic Water Quality Data from the RCID Drill Site, Orange County, Florida.												
Identifier	Depth Interval (ft. bls)	Cations				Anions				Field Parameters		
		Na <sup>+</sup> mg/L	K <sup>+</sup> mg/L	Ca <sup>2+</sup> mg/L	Mg <sup>2+</sup> mg/L	Cl <sup>-</sup> mg/L	Alka as CaCO <sub>3</sub> mg/L	SO <sub>4</sub> <sup>2-</sup> mg/L	TDS mg/L	Specific Conduct. umhos/cm	Temp ° C	pH s.u.
ORF-60_SC1	220-715	3.5	0.7	37.0	7.4	5.1	116	7.5	134	236	23.18	7.45
ORF-60_PT2	1510-1540	3.9	0.8	34.0	10.0	4.9	114	22.2	158	260	27.08	7.50
ORF-60_PT1	1930-1970	3.8	0.6	35.0	8.9	7.2	115	8.6	144	264	25.87	7.71

ft. bls = feet below land surface SC= Specific Capacity o C = degree Celsius  
mg/L = milligrams per liter PT = Packer Test  
umhos/cm = micromhos per centimeter s.u. = standard unit

The Hazen-Williams equation was used to calculate the friction (head) losses for all drawdown data because of induced flow up the drill pipe. These head losses were then used to correct the drawdown data for specific capacity determinations. Curve-matching techniques were not used to determine transmissivity values from the drawdown or recovery data. These tests generally involve partial penetration, have significant friction loss due to small pipe diameter, and have short pumping periods, which violate basic assumption of the various analytical methods. **Table 4** lists the pertinent hydraulic information from the individual packer and specific capacity tests.

**Table 4.** Summary of Hydraulic Data obtained from Packer and Specific Capacity Tests.

Identifier	Depth (ft. bls)	Pump Rate (gpm)	Pump Duration (min)	Corrected Drawdown (feet)	Calculated Specific Capacity (gpm/ft)
ORF60-SC1	220-715	2610	60	11.5	235.0
ORF60-SC2	1170-1280	1135	60	9.7	116.8
ORF60-PT2	1510-1540	72	125	15.9	4.5
ORF60-PT1	1930-1970	150	100	2.6	57.5

ft .bls = feet below land surface SC = Specific Capacity Test  
gpm = gallons per minute PT = Packer Test  
gpm/ft = gallons per minute per foot of drawdown

## Groundwater Quality Monitoring Program

Upon completion of well construction of ORF-60, background water quality samples were collected and analyzed to determine basic water quality characteristics (temperature, pH and specific conductance), as well as primary and secondary drinking water standards (Rule 62-550, F.A.C.) and minimum criteria parameters (Rule 62-520, F.A.C.).

Unfiltered and filtered water samples were taken directly from the discharge point into appropriate type of sample containers. Water samples were collected in accordance with Florida Department of Environmental Protection sampling protocol. Once collected, all water samples were preserved and immediately placed on ice in a closed container and transported to a laboratory operated by Advanced Environmental Laboratories, Inc. (Tampa, Florida). The samples were analyzed for primary and secondary drinking water standards and minimum criteria parameters using USEPA and/or Standard Method procedures. **Table 5** summarizes the analytical results of the inorganic constituents from the completed LFA monitor well.

**Table 5.** Composite Water Quality Data from Completed Monitor Well – ORF-60.

Inorganic Water Quality Data from the RCID Drill Site, Orange County, Florida.												
Identifier	Depth Interval (ft. bls)	Cat ions				Anions			TDS mg/L	Field Parameters		
		Na <sup>+</sup> mg/L	K <sup>+</sup> mg/L	Ca <sup>2+</sup> mg/L	Mg <sup>2+</sup> mg/L	Cl <sup>-</sup> mg/L	Alka as CaCO <sub>3</sub> mg/L	SO <sub>4</sub> <sup>2-</sup> mg/L		Specific Conduct. umhos/cm	Temp ° C	pH s.u.
ORF-60	1170-1280	3.6	1.1	37	11	7.6	110	12.0	160	347	23.29	7.80

mg/L = milligrams per liter ft. bls = feet below land surface o C = degree Celsius  
umhos/cm = microumhos per centimeter S.U.= standard unit

## SUMMARY

The top of the FAS as defined by the Southeastern Geological Society AdHoc Committee on Florida Hydrostratigraphic Unit Definition (1986) was identified at a depth of approximately 80 feet below land surface (bls).

1. A 10-inch inner diameter exploratory well at the RCID site was successfully constructed and tested in accordance with FDEP Class V, Group 8, well standards.
2. Lithologic and geophysical logs, specific capacity and aquifer performance test results indicate moderate production capacity in Zone A of the UFA and very good production capacity in Zone B of the UFA
3. Water quality data from 220 to 715 feet bls indicate that chloride and total dissolved solids in the Upper Floridan Aquifer waters meet potable drinking water standards with chloride and total dissolved solids concentrations of five and 134 milligrams per liter, respectively.
4. Lithologic information and geophysical logs obtained from OSF-60 indicates that low porosity/permeability, poorly indurated grainstones and moderately to well indurated, wackestones and crystalline dolostones occur from 740 to 1,160 feet bls, These low permeable sediments act as a confining unit that effectively isolates the UFA from LFA.
5. Lithologic and geophysical logs and specific capacity test results indicate very good production capacity of the LFA “Zone A” from 1,170 to 1,280 feet bls. This zone yielded a specific capacity value of 116 gpm/foot of drawdown at pump rate of 2,210 gpm with a calculated transmissivity of 232,000 gpd/ft.
6. Composite water quality sampling of ORF-60 (1,170 to 1,280 feet bls) indicate that chloride and total dissolved solids meet potable drinking water standards with chloride and total dissolved solids concentrations of eight and a 160 milligrams per liter, respectively.
7. The lithologic data and production-type logs (e.g. flow, temperature logs) indicates very good production from flow zones between 1,170 and 1,195 feet bls and 1,215 to 1,270 feet bls. Below 1,270 feet bls, the productive capacity is limited (as indicated by the fluid-type logs) suggesting lower permeable—semi-confining units near the base of the proposed monitor interval.
8. Lithologic and geophysical logs and packer test results indicate good production capacity of the LFA “Zone B” from 1,860 to 1,970 feet bls. This zone yielded a specific capacity value of 116 gpm/foot of drawdown with chloride and total dissolved solids concentrations of seven and 148 milligrams per liter, respectively.

9. The base of the Underground Source of Drinking Water, those waters having TDS concentrations greater than 10,000 mg/L, was not encountered at a total depth of 2,100 feet bls.

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# APPENDIX A

## Lithologic Description

**Table A-1.** Lithologic Description – Reedy Creek FAS Test.

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reed Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
0	10	White, well sorted medium quartz sand, good permeability
10	30	Brown, well sorted, medium quartz sand, good permeability
30	35	Brown, well sorted, medium quartz sand, abundant gray clay
35	55	Gray silty lime mudstone
55	80	Greenish gray phosphatic lime mudstone
80	90	Light brown wackestone, medium hard, interparticle porosity
90	105	Light brown packstone, medium hard, interparticle porosity
105	170	Tan grainstone, friable, occasional phosphate, interparticle porosity
170	200	Cream-colored grainstone, friable, common echinoid fossils, moldic porosity
200	215	Cream-colored packstone, friable, common echinoid fossils, moldic porosity
215	250	Cream-colored grainstone, friable, common echinoid fossils, moldic porosity
255	260	Cream-colored grainstone, friable, common echinoid and dictyoconus fossils, moldic porosity, 15% gray mudstone, hard low permeability
260	265	Brown dolomite, friable, crystalline, low permeability, 15% gray mudstone, low permeability
265	275	Brown dolomite, friable, crystalline, low permeability, 30% gray mudstone, low permeability
275	295	Cream-colored grainstone, friable, common echinoid and dictyoconus fossils, moldic porosity
295	300	Cream-colored mudstone, very friable, intergranular porosity, 5% tan crystalline dolomite
300	310	Cream-colored grainstone, friable, common echinoid and dictyoconus fossils, moldic

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reedy Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
310	315	Tan mudstone, friable, intergranular and vuggy porosity, 5% light gray crystalline dolomite
315	320	Cream-colored dolomite/crystalline limestone, hard, low permeability
320	325	Tan mudstone, friable, intergranular and vuggy porosity, 5% light gray crystalline dolomite
325	335	Cream-colored mudstone, friable, dictyoconus fossils, intergranular and vuggy porosity, 5% light gray crystalline dolomite
335	340	Cream-colored/tan grainstone, friable, moldic porosity, 15% brown crystalline dolomite
340	345	Cream-colored/tan grainstone, friable, dictyoconus fossils, moldic porosity, 15% brown crystalline dolomite
345	350	Cream-colored grainstone/crystalline limestone, friable, moldic porosity
350	355	Cream-colored/tan grainstone, friable, dictyoconus fossils, moldic porosity, 15% brown crystalline dolomite
355	360	Cream-colored/tan grainstone, friable, echinoid and dictyoconus fossils, moldic porosity, 15% brown crystalline dolomite and tan lime mud
360	365	Dark brown dolomite, crystalline, low permeability
365	370	Cream-colored/tan grainstone, friable, dictyoconus fossils, moldic porosity, 15% brown crystalline dolomite
370	375	Tan dolomite, crystalline, low permeability
375	380	Tan dolomite, crystalline, low permeability, some soft off-white lime mud
380	390	Dark brown dolomite, crystalline, low permeability
390	400	Dark brown dolomite, crystalline, some vugs on larger cutting fragments
400	405	Gray lime mud, very soft, some tan crystalline dolomite, hard, some vugs of larger fragments
405	425	Tan grainstone, friable, moldic and intergranular porosity

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b> <b>SFWMD Reedy Creek Test Well</b> <b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
425	440	Cream-colored grainstone, friable, moldic and intergranular porosity
440	445	Cream-colored grainstone, friable, echinoid fossils, moldic and intergranular porosity
445	455	Cream-colored grainstone, friable, mainly moldic and intergranular porosity, some vuggy porosity
455	465	Cream-colored grainstone, friable, echinoid fossils, moldic and intergranular porosity
465	485	Tan grainstone, friable, mollusk fossils, moldic and intergranular porosity, some vuggy porosity
485	490	Tan grainstone, friable, moldic, vuggy and intergranular porosity
490	500	Tan grainstone, friable, mollusk fossils, moldic and intergranular porosity, some vuggy porosity
500	520	Light gray grainstone, friable, mollusk fossils, moldic and intergranular porosity, some vuggy porosity
520	540	Tan grainstone, friable, mollusk fossils, moldic and intergranular porosity, some vuggy porosity
540	550	Tan mudstone, friable, vuggy and moldic porosity
550	595	Tan packstone-grainstone, hard, mollusk fossils, vuggy and moldic porosity
595	605	Brown packstone-grainstone, hard, vuggy and moldic porosity
605	610	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity
610	615	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, some hard crystalline dolomite
615	620	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity
620	625	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, some hard crystalline dolomite
625	645	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reedy Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
645	650	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, some hard crystalline dolomite
650	655	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity
655	660	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, <5% white calcite and gray dolomite
660	665	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, some hard crystalline dolomite
665	675	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity
675	680	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, some hard crystalline dolomite and tan/brown calcite
680	700	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity
700	705	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, some hard crystalline dolomite
705	735	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity
735	750	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite
750	755	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite, 2% crystalline calcite
755	765	Cream-colored packstone-grainstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite
765	770	Cream-colored packstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite
770	780	Cream-colored mudstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite
780	815	Tan grainstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reedy Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
815	820	Tan packstone, friable, mollusk fossils, vuggy and moldic porosity, 10% gray crystalline dolomite
820	825	Tan grainstone, friable, mollusk fossils, vuggy and moldic porosity, 20% white/gray crystalline dolomite
825	835	Tan grainstone, friable, mollusk fossils, vuggy and moldic porosity, 10% white/gray crystalline dolomite
835	840	Tan grainstone, friable, mollusk fossils, vuggy and moldic porosity, 20% gray/black crystalline dolomite
840	845	Tan grainstone, friable, mollusk fossils, vuggy and moldic porosity, 1% crystalline calcite
845	855	Tan grainstone, friable, mollusk fossils, vuggy and moldic porosity
855	865	Cream-colored grainstone, friable, mollusk fossils, vuggy and moldic porosity, 20% gray crystalline dolomite
865	870	Cream-colored grainstone, friable, mollusk fossils, vuggy and moldic porosity, 20% soft gray clay/lime mud, 10% gray crystalline dolomite
870	875	Tan wackestone -packstone, friable, mollusk fossils, vuggy and moldic porosity, 10% soft brown clay/lime mud, 10% gray crystalline calcite
875	880	Tan wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 10% gray crystalline dolomite, 5% soft brown clay/lime mud
880	890	Cream-colored wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 20% soft white clay/lime mud "chalky", 10% gray crystalline dolomite
890	895	Cream-colored wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 10% gray crystalline dolomite, 5% soft white clay/lime mud "chalky"
895	900	Cream-colored wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 25% Cream-colored/tan crystalline dolomite
900	905	Cream-colored wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 10% gray crystalline dolomite, 5% soft white clay/lime mud "chalky"
905	915	Tan wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 25% tan crystalline dolomite

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reedy Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
915	920	Tan wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 30% dark brown crystalline dolomite
920	925	Tan wackestone-packstone, friable, mollusk fossils, vuggy and moldic porosity, 10% dark brown crystalline dolomite
925	930	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 5% white crystalline dolomite
930	940	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 1% white crystalline dolomite
940	950	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 40% soft, white clay/lime mud "chalky", 5% white crystalline limestone
950	955	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 1% white crystalline dolomite
955	960	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 40% soft, white clay/lime mud "chalky", 5% white crystalline limestone
960	980	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 1% white crystalline dolomite
980	985	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 1% white crystalline dolomite, 1% crystalline limestone
985	995	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 10% white crystalline dolomite, 10% crystalline limestone
995	1,000	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 20% white crystalline dolomite
1,000	1,005	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 20% white crystalline dolomite, 1% crystalline limestone
1,005	1,010	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 20% white crystalline dolomite, 5% dark brown clay/lime mud, 1% crystalline limestone
1,010	1,015	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 20% white crystalline dolomite, 1% crystalline limestone

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b> <b>SFWMD Reedy Creek Test Well</b> <b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
1,015	1,020	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 20% white crystalline dolomite, 15% dark brown clay/lime mud, 1% crystalline limestone
1,020	1,025	Tan wackestone, friable, mollusk fossils, vuggy and moldic porosity, 30% white crystalline dolomite
1,025	1,030	Tan/Cream-colored crystalline dolomite, hard, 20% soft, gray clay/lime mud, low permeability
1,030	1,035	Tan/Cream-colored crystalline dolomite, hard, 10% tan packstone, friable, mollusk fossils, vuggy and moldic porosity
1,035	1,040	Tan/Cream-colored crystalline dolomite, hard, 10% soft, white clay/lime mud, low permeability
1,040	1,045	Tan packstone, friable, mollusk fossils, vuggy and moldic porosity, 30% white crystalline dolomite
1,045	1,050	Tan/Cream-colored crystalline dolomite, hard, 40% tan packstone, friable, mollusk fossils, vuggy and moldic porosity
1,050	1,060	Tan/Cream-colored crystalline dolomite, hard, 10% tan packstone, friable, mollusk fossils, vuggy and moldic porosity
1,060	1,070	Tan/Cream-colored crystalline dolomite, hard, vuggy, 5% white crystalline limestone
1,070	1,080	Tan/Cream-colored crystalline dolomite, hard, vuggy
1,080	1,090	Dark brown crystalline dolomite, hard, vuggy
1,090	1,100	Cream-colored/tan crystalline dolomite, hard, vuggy
1,100	1,105	Cream-colored/tan crystalline dolomite, hard, vuggy, 5% tan packstone, friable, mollusk fossils, vuggy and moldic porosity
1,105	1,110	Cream-colored/tan crystalline dolomite, hard, vuggy
1,110	1,115	Cream-colored/tan crystalline dolomite, hard, vuggy, fewer vugs than previous interval
1,115	1,120	Cream-colored/tan crystalline dolomite, hard, vuggy
1,120	1,130	Cream-colored/tan crystalline dolomite, hard, vuggy, 5% dark brown clay/lime mud

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reedy Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
1,130	1,135	Cream-colored/tan crystalline dolomite, hard, vuggy, fewer vugs than previous interval
1,135	1,140	Cream-colored/tan crystalline dolomite, hard, vuggy, 15% white crystalline limestone
1,140	1,150	Cream-colored/tan crystalline dolomite, hard, vuggy, 5% white crystalline limestone
1,150	1,160	Cream-colored/tan crystalline dolomite, hard, vuggy, fewer vugs than the previous interval, 5% white crystalline limestone
1,160	1,165	Brown crystalline dolomite, hard, vuggy, fewer vugs than the previous interval, 5% white crystalline limestone
1,165	1,170	Brown crystalline dolomite, hard, vuggy, fewer vugs than the previous interval, 1% white crystalline limestone
1,170	1,180	Dark brown dolomite, hard, "sucrosic", some vugs, otherwise low permeability
1,180	1,185	Tan packstone, friable, mollusk fossils, vuggy and moldic porosity, 40% dark brown dolomite, hard, "sucrosic"
1,185	1,205	Tan dolomite, hard, "sucrosic", some vugs, otherwise low permeability, 5% tan crystalline dolomite
1,205	1,210	Dark brown dolomite, hard, "sucrosic", some vugs, otherwise low permeability, 5% dark brown crystalline dolomite
1,210	1,215	Tan dolomite, hard, "sucrosic", some vugs, otherwise low permeability, 5% tan crystalline dolomite
1,215	1,230	Dark brown dolomite, hard, "sucrosic", 30% tan grainstone, friable, intergranular porosity
1,230	1,235	Dark brown dolomite, hard, "sucrosic", dense, low permeability
1,235	1,240	Dark brown dolomite, hard, "sucrosic", dense, low permeability, 10% dark brown crystalline dolomite
1,240	1,245	Gray crystalline dolomite, hard, dense, low permeability, 40% dark brown dolomite, hard, "sucrosic", vuggy
1,245	1,250	Dark brown dolomite, hard, "sucrosic", vuggy, 40% gray crystalline dolomite, hard, dense, low permeability

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b> <b>SFWMD Reedy Creek Test Well</b> <b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
1,250	1,255	Gray crystalline dolomite, hard, dense, low permeability, 40% dark brown dolomite, hard, "sucrosic", vuggy
1,255	1,265	Tan dolomite, hard, "sucrosic", some vugs, 30% tan packstone, friable, mollusk fossils, vuggy and moldic porosity
1,265	1,270	Gray crystalline dolomite, hard, dense, low permeability, 40% dark brown dolomite, hard, "sucrosic", vuggy
1,270	1,275	Tan dolomite, hard, "sucrosic", some vugs, 15% off-white packstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite
1,275	1,285	Tan dolomite, hard, "sucrosic", some vugs, 5% gray crystalline dolomite
1,285	1,320	Tan dolomite, hard, "sucrosic", some vugs, 30% off-white packstone, friable, mollusk fossils, vuggy and moldic porosity, 5% gray crystalline dolomite
1,320	1,340	Tan packstone, friable, mollusk fossils, vuggy and moldic porosity, 20% gray crystalline dolomite, hard, low permeability
1,340	1,345	Tan/gray packstone, friable, mollusk fossils, vuggy and moldic porosity, 20% gray crystalline dolomite, hard, low permeability
1,345	1,350	Gray packstone, friable, mollusk fossils, vuggy and moldic porosity, 5% brown crystalline dolomite, hard, low permeability
1,350	1,370	Gray grainstone, friable, mollusk fossils, vuggy and moldic porosity, hard, low permeability
1,370	1,385	Gray grainstone, friable, mollusk fossils, vuggy and moldic porosity, 5% anhydrite, hard, low permeability
1,385	1,430	Gray grainstone, friable, mollusk fossils, vuggy and moldic porosity, 5% anhydrite, 20% brown dolomite, hard, low permeability
1,430	1,445	Gray grainstone, friable, mollusk fossils, vuggy and moldic porosity, 5% anhydrite, hard, low permeability
1,445	1,460	Dark brown to brown dolomite, hard, "sucrosic", some vugs, 10% light gray grainstone, friable, mollusk fossils, vuggy and moldic porosity
1,460	1,480	Dark brown to brown dolomite, hard, "sucrosic", some vugs, 10% anhydrite
1,480	1,490	Dark brown to brown dolomite, hard, "sucrosic", some vugs, 45% anhydrite

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reedy Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
1,490	1,500	Dark brown to brown dolomite, hard, "sucrosic", some vugs, 45% anhydrite, interbedded with white sticky clay
1,500	1,515	Brown dolomite, hard, "sucrosic", some vugs, 45% anhydrite
1,515	1,520	Brown dolomite, hard, "sucrosic", some vugs, 45% anhydrite, interbedded with white sticky clay
1,520	1,535	Brown dolomite, hard, "sucrosic", some vugs, 30% anhydrite
1,534	1,545	Brown dolomite, hard, "sucrosic", some vugs, 30% anhydrite, interbedded with gray sticky clay
1,545	1,550	Brown dolomite, hard, "sucrosic", some vugs, 30% anhydrite
1,550	1,560	Brown dolomite, hard, "sucrosic", some vugs, 20% anhydrite, interbedded with gray sticky clay
1,560	1,580	Light gray grainstone, moderately hard, vuggy porosity, 5% anyhydrite, 15% brown dolomite, hard, low permeability
1,580	1,585	Light brown packstone, moderately hard, vuggy porosity, 5% anyhydrite, low permeability
1,585	1,600	Light brown and light gray grainstone, moderately hard, vuggy porosity, 5% anyhydrite, good permeability
1,600	1,615	Light brown and gray grainstone, moderately hard, vuggy porosity, 5% anyhydrite, good permeability
1,615	1,635	Light brown and gray grainstone, moderately hard, micritic, good permeability
1,635	1,640	Light brown and gray grainstone, friable, micritic, good permeability
1,640	1,655	Light brown grainstone, friable, micritic, good permeability
1,655	1,665	Light gray grainstone, friable, micritic, good permeability
1,665	1,680	Light brown grainstone, friable, micritic, good permeability
1,680	1,690	Light brown grainstone, friable, micritic, 10% phosphate, good permeability

**Table A-1. Lithologic Description – Reedy Creek FAS Test (Continued).**

<b>Lithologic Log – ORF60</b> <b>SFWMD Reedy Creek Test Well</b> <b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
1,690	1,725	Light brown dolomite, hard, crystalline, low permeability
1,725	1,740	Brown dolomite, hard, crystalline, < 10% tan grainstone, low permeability
1,740	1,750	Light tan grainstone, friable, micritic, 20% brown dolomite, moderate permeability
1,750	1,755	Very light tan grainstone, hard, micritic, 15% brown dolomite, moderate permeability
1,755	1,765	Very light tan grainstone, hard, micritic, 25% brown dolomite, moderate permeability
1,765	1,775	Tan grainstone, moderately hard, micritic, good permeability
1,775	1,780	Dark brown dolomite, hard, crystalline, 40% tan grainstone, low permeability
1,780	1,785	Light tan/light gray grainstone, hard, sucrosic, good permeability
1,790	1,805	Brown dolomite, hard, crystalline, low permeability
1,805	1,820	Gray dolostone, moderately hard, low permeability
1,820	1,835	Brown dolomite, very hard, crystalline, low permeability
1,835	1,855	Dark brown dolomite, very hard, crystalline, low permeability
1,855	1,865	Very light brown dolomite, very hard, crystalline, low permeability
1,865	1,870	Off white grainstone, moderately hard, sucrosic, good permeability
1,870	1,880	Off white grainstone, moderately hard, sucrosic, 15% brown dolomite, good permeability
1,880	1,885	Gray and tan grainstone, moderately hard, sucrosic, 20% brown dolomite
1,885	1,915	Brown dolomite, very hard, crystalline, low permeability
1,915	1,925	Gray grainstone, hard, sucrosic, good permeability
1,925	1,955	Brown dolomite, very hard, crystalline, low permeability
1,955	1,960	Light gray grainstone, hard, sucrosic, 10% shell fragments, good permeability

**Table A-1.** Lithologic Description – Reedy Creek FAS Test (Continued).

<b>Lithologic Log - ORF-60</b>		
<b>SFWMD Reedy Creek Test Well</b>		
<b>Orange County, Florida</b>		
<b>Depth in Feet (bls)</b>		<b>Lithologic Description ORF-60</b>
<b>From</b>	<b>To</b>	
1,960	1,965	Brown dolomite, very hard, crystalline, low permeability
1,965	1,970	Light gray grainstone, hard, sucrosic, 10% shell fragments, good permeability
1,970	1,990	Brown dolomite, very hard, crystalline, low permeability
1,990	2,015	Tan and light gray grainstone, friable, sucrosic, good permeability
2,015	2,095	Gray grainstone, hard, sucrosic, good permeability
2,095	2,100	Dark gray packstone, hard, sucrosic, 20% white lime mud, low permeability

## APPENDIX B

### Geophysical Logs

AHT10	Shallow Induction
AHT30	Medium Induction
AHT90	Deep Induction
CNCF	Calculated porosity
CPS	Count per Second
DDTMP	Dynamic Delta Temperature
DFRES	Dynamic Fluid Resistivity
DPHZ	Density Porosity
DTMP	Dynamic Temperature Gradient
degF	Degrees Fahrenheit
DT	delta transient time
DTMP	delta temperature
DTCO	delta transient time – Compression Wave
DTSM	delta transient time – Shear Wave
FLOWN	Flow-meter - Dynamic
FLOWNS	Flow-meter - Static
FT	feet
Ft/min	feet per minute
FRES	Fluid Resistivity
GAPI	gamma American Petroleum Institute units
GR	gamma ray
g/c <sup>3</sup>	grams per cubic centimeter
HCAL	density caliper
in	inches
LSPD	Line Speed - downward
MV	Millivolts
OHMM	ohm-meters

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PEFZ	photoelectric effect
QFlown	Corrected Flowmeter
RILD	deep induction log
RILM	medium induction log
RLL3	shallow focused resistivity
SP	spontaneous potential
TEMP	temperature gradient
Usec/ft	microseconds per foot
VCL	Volume - Clay
VCLC	Volume - Limestone
VDOL	Volume – Dolomite
VP/VS	Velocity Primary vs. Velocity Secondary
XCAL	x-caliper
YCAL	y-caliper

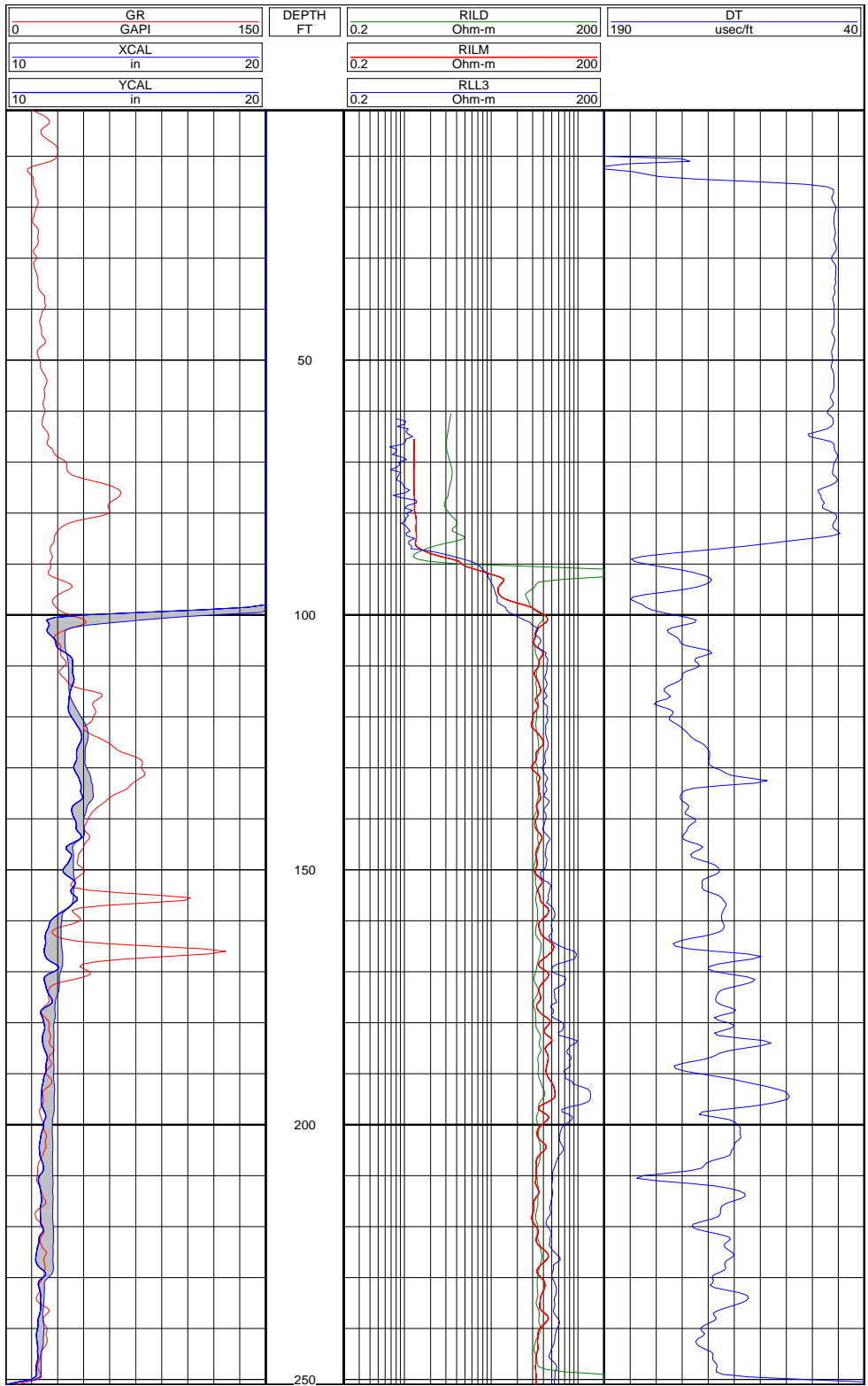


Figure B-1. Geophysical Logs Run No.2 – ORF-60 (0 to 250 feet bls).

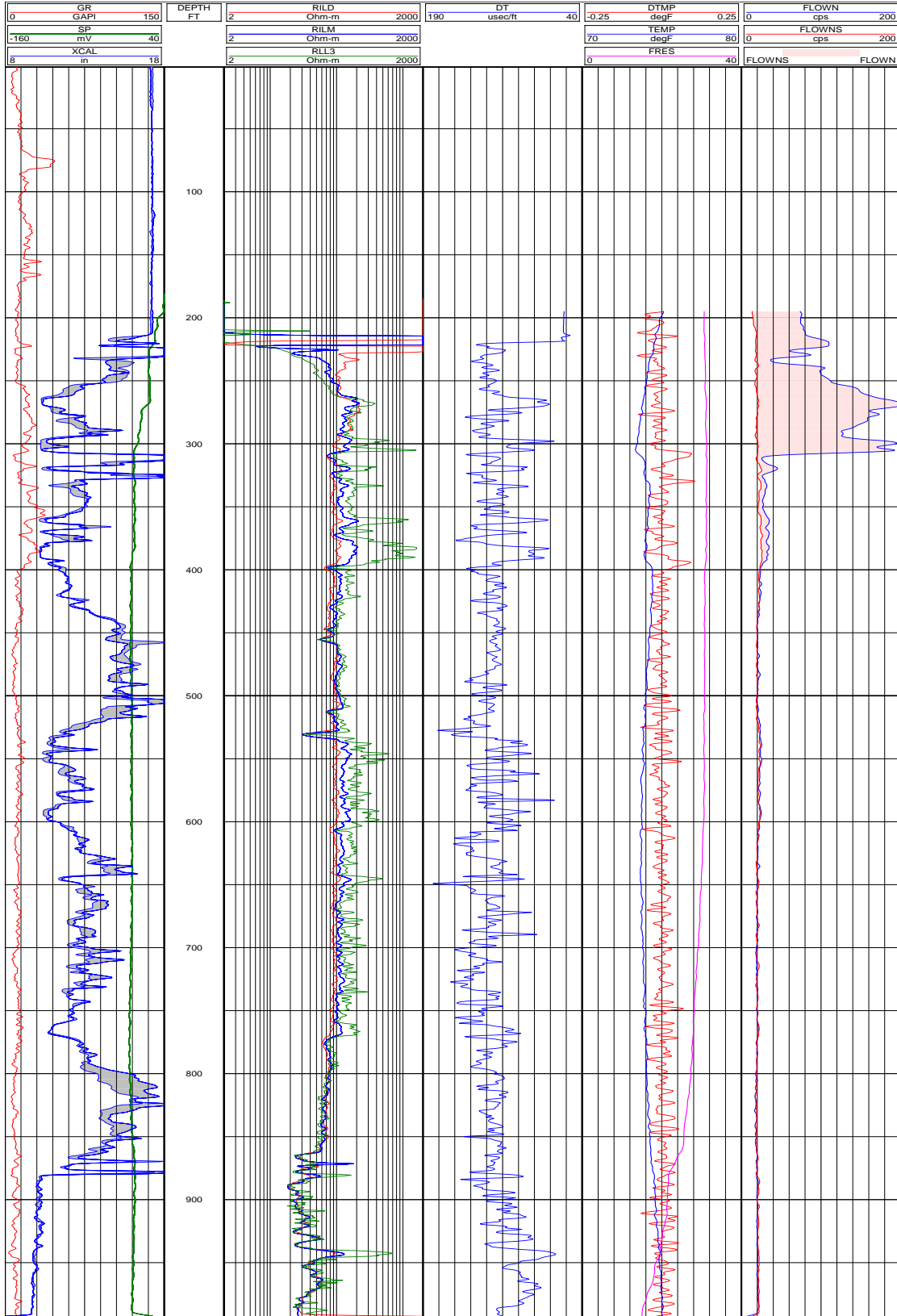


Figure B-2. Geophysical Log Run No.3 – ORF-60 (0 to 995 feet bls).

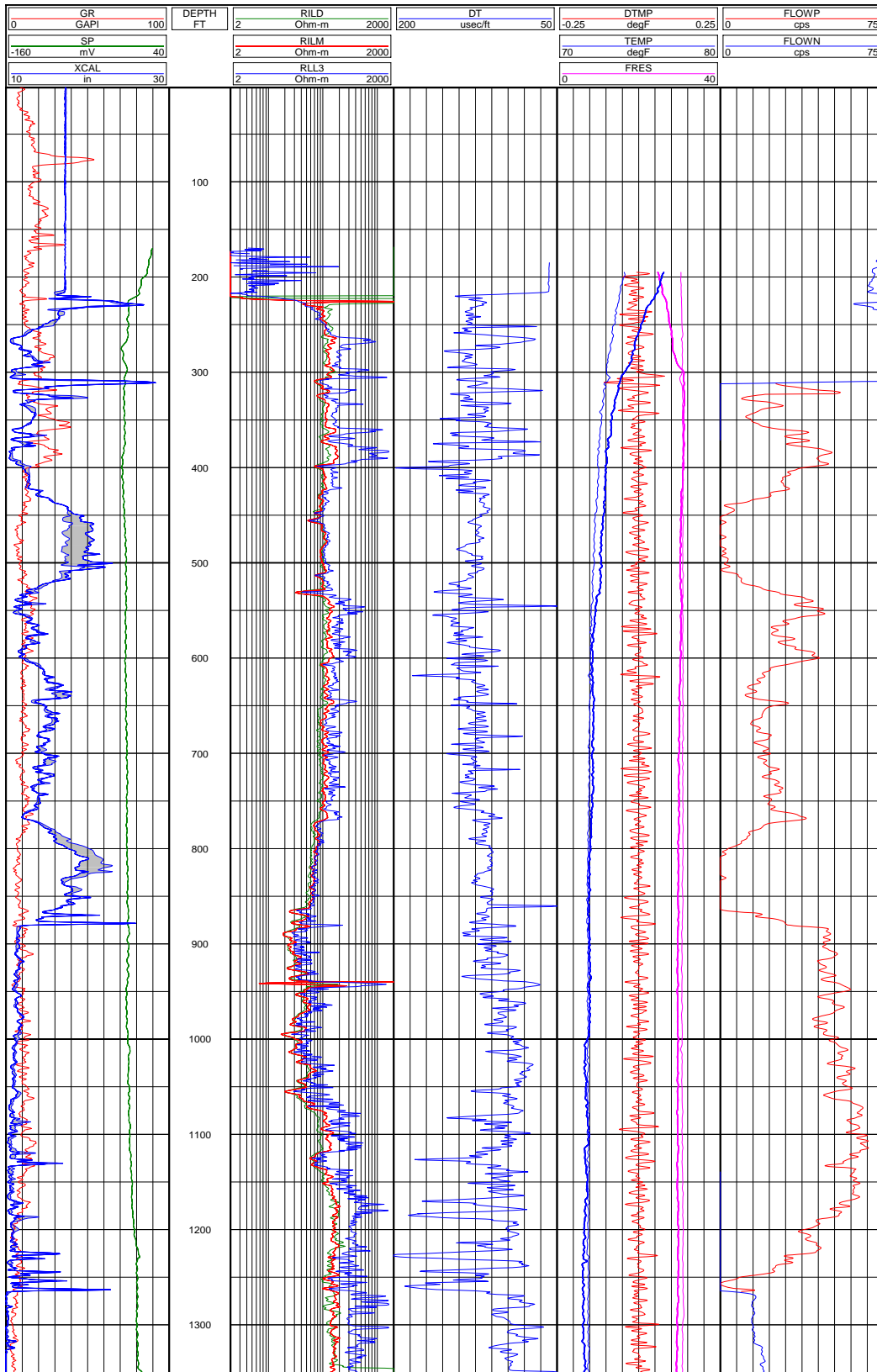


Figure B-3. Geophysical Log Run No.4 – ORF-60 (0 to 1,350 feet bls).

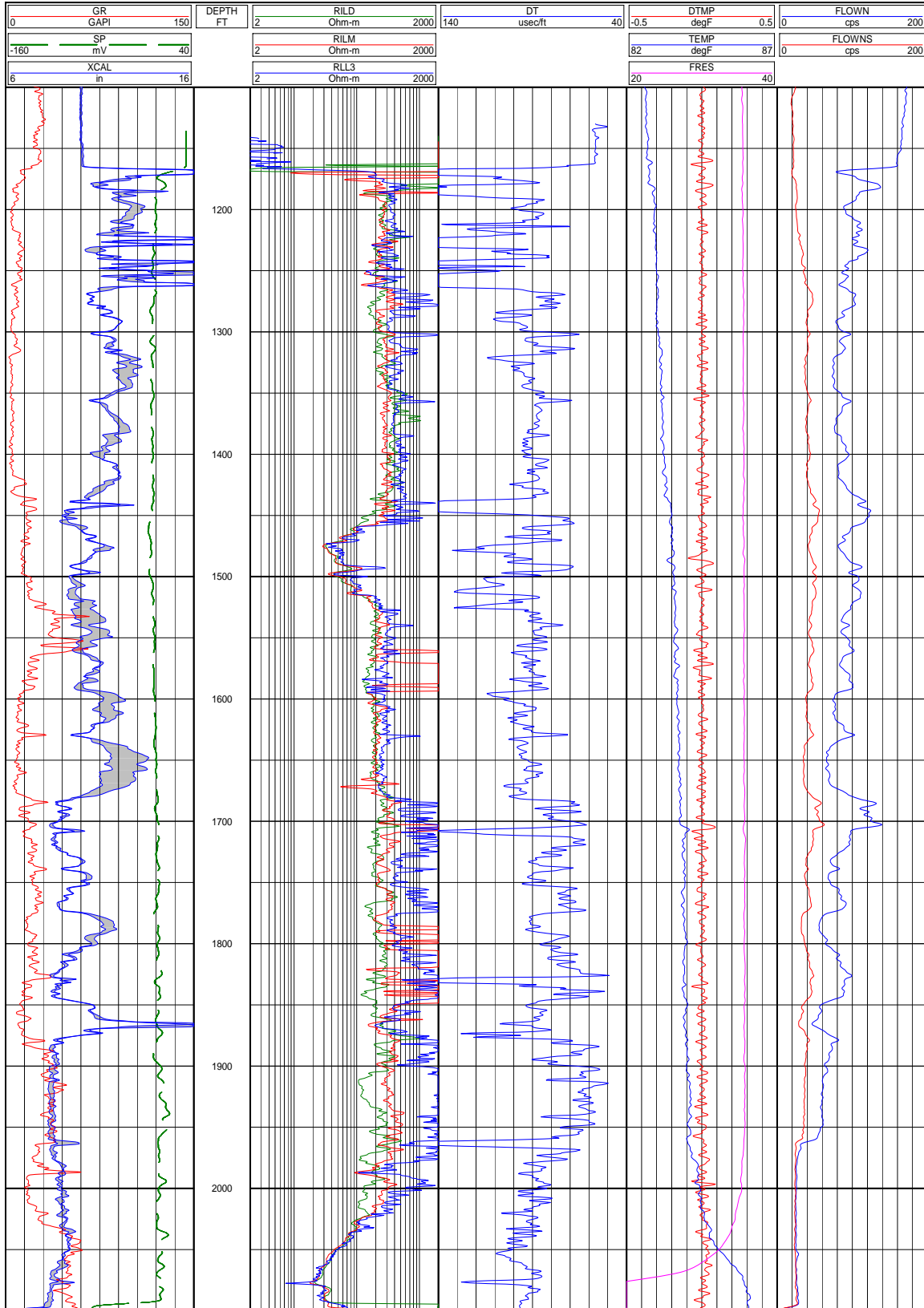


Figure B-4. Geophysical Log Run No.7 – ORF-60 (1,100 to 2,200 feet bls).