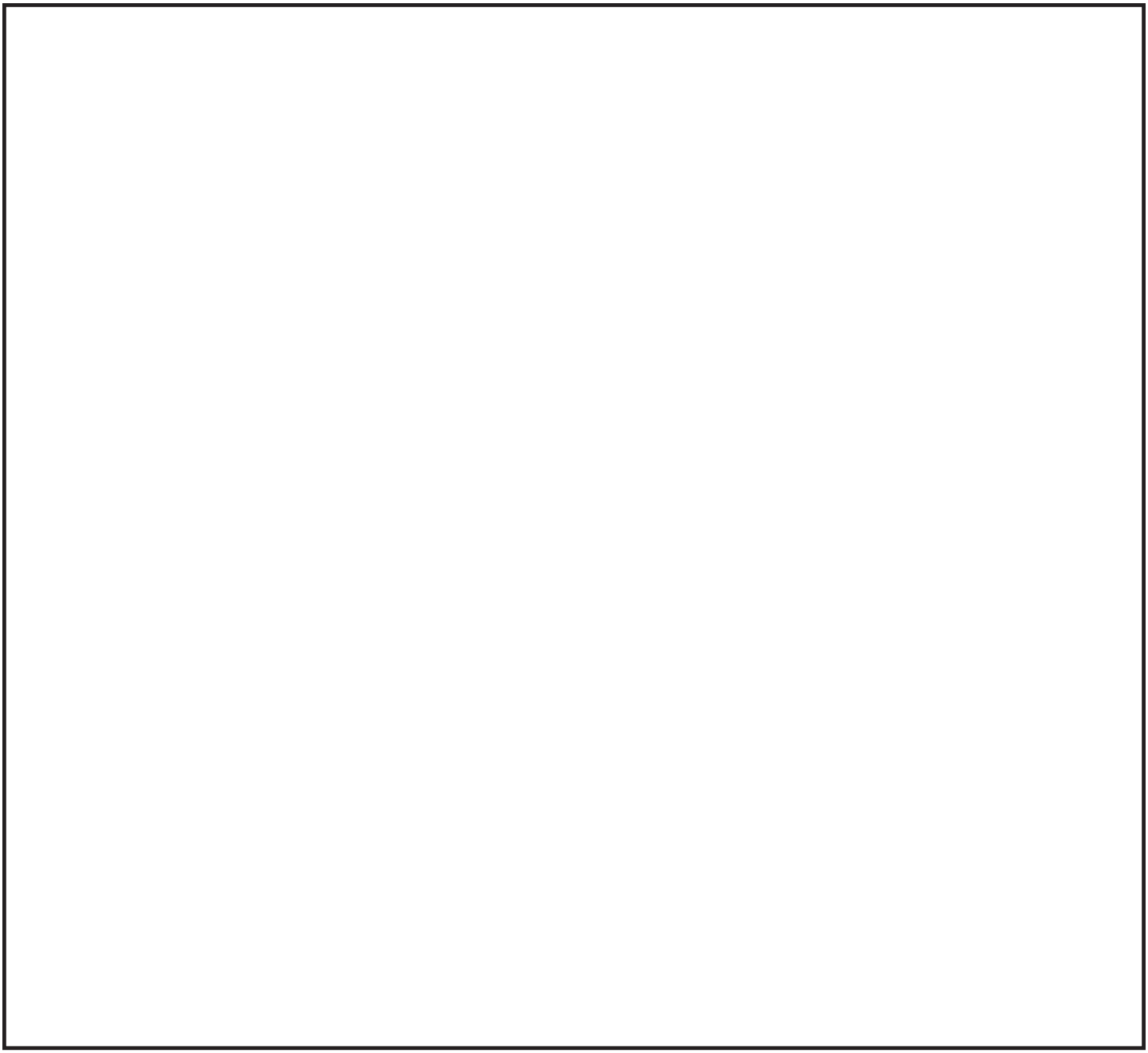
Southwest Florida
Water Management District

Well Construction at the West Citrus Well Site in Citrus County, Florida

Southwest Florida Water Management District
Geohydrologic Data Section

January 2018



Cover Photo: Permanent monitor wells at the West Citrus Well Site in Citrus County, Florida in order from left to right: U FLDN AQ MONITOR, SURF AQ MONITOR, and SALTWATER INTERFACE MONITOR. Photograph by Julia Zydek.

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The hydrogeologic evaluations and interpretations contained in *Well Construction at the West Citrus Well Site in Citrus County, Florida* have been prepared by or approved by a licensed Professional Geologist in the State of Florida, in accordance with Chapter 492, Florida Statutes.

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Date: 1-18-2018

Foreword

The Geohydrologic Data Section administers the Regional Observation and Monitor-well Program (ROMP) at the Southwest Florida Water Management District (District). The ROMP was started in 1974 in response to the need for hydrogeologic information by the District. The focus of the ROMP is to quantify the flow characteristics and water quality of the groundwater systems that serve as the primary source of water supply within southwest Florida. The original design of the ROMP consisted of an inland 10-mile grid network composed of 101 well sites and a coastal transect network composed of 57 coastal monitor transects of two to three well sites each. The number of wells at a well site varies with specific regional needs; usually two to five permanent monitor wells are constructed at each site. The numbering system for both networks generally increases from south to north with ROMP-labeled wells representing the inland grid network and TR-labeled wells representing the coastal transect network.

The ROMP networks have been the primary means for data collection; however, in recent years, changing District directives have created the need for more project-specific data collection networks outside the original two well networks for various programs throughout the District. The broad objectives at each well site are to determine the geology, hydrology, water quality, and hydraulic properties, and to install wells for long-term monitoring, depending on the goal of each project. Site activities include coring, testing, and well construction. These activities provide data for the hydrogeologic and groundwater quality characterization of the well sites. These characterizations are used to ensure the monitor wells are properly designed. At the completion of each well site, a summary report is generated and can be found at the District's website at www.watermatters.org/data. The monitor wells form the backbone of the District's long-term aquifer monitoring networks, which supply critical data for the District's regional models and hydrologic conditions reporting.

Sandie Will

Manager

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Conversion Factors and Datums

Multiply	By	To obtain
	Length	
inch (in)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	0.004047	square kilometer (km^2)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^2)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Temperature	
Celsius (°C)	°F = (1.8 x °C) + 32	Fahrenheit (°F)
Fahrenheit (°F)	°C = (°F – 32) / 1.8	Celsius (°C)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Elevation, as used in this report, refers to distance above the vertical datum.

Abbreviations and Acronyms

bls	below land surface
CGWQMN	Coastal Groundwater Quality Monitoring Network
District	Southwest Florida Water Management District
fig.	figure
Huss	Huss Drilling, Incorporated
mg/L	milligram per Liter
µS/cm	microSiemens per centimeter
NAVD88	North American Vertical Datum of 1988
ND Model	Northern District regional groundwater flow model
NDWRAP	Northern District Water Resources Assessment Project
PVC	polyvinyl chloride
WCP	well construction permit
WMIS	Water Management Information System
WQMP	Water Quality Monitoring Program

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By Julia Zydek

Introduction

The Geohydrologic Data Section of the Southwest Florida Water Management District (District) conducted a detailed hydrogeologic investigation of a new well site in Citrus County, Florida. The data collected at the West Citrus well site will be used by the District to align with its mission to manage and protect water resources. The data will assist in establishing the vertical and geographic extent of the saltwater interface within the Upper Floridan aquifer as well as be used to refine the groundwater flow models for the evaluation of future water supply assessments and to establish minimum flow and level criteria.

The West Citrus well site was selected for further investigation to support the Northern District Water Resources Assessment Project (NDWRAP), the Northern District regional groundwater flow model (ND Model), and the District's Coastal Groundwater Quality Monitoring Network (CGWQMN). The NDWRAP was initiated to assess the impacts of groundwater withdrawals, monitor the saltwater/freshwater interface, identify areas of poor groundwater quality, determine the nature of flow to major springs, and monitor groundwater levels in both the surficial and Upper Floridan aquifers in the northern six-county region of the District. The Northern District encompasses all of Hernando, Citrus, and Sumter Counties as well as portions of Pasco, Marion, and Levy Counties. Figure 1 presents a map of the Northern District Drilling Plan sites.

Additionally, this site has been identified as critical towards improving the calibration of the ND Model, the District Wide Regulatory model, and future simulations of saltwater interface movement. The ND Model is used to establish and evaluate the status of minimum flows and levels for the Homosassa, Chassahowitzka, Gum Spring, Rainbow Spring, and Silver Spring systems. It was recently expanded to include all of Marion County and the District's Northern Planning Region for resource assessments. Permanent monitor wells constructed at this site include a surficial aquifer monitor, an Upper Floridan aquifer monitor, and a saltwater interface monitor. Long-term water level data will be collected from the Upper Floridan aquifer monitor well. The saltwater interface monitor well will be incorporated into the Water Quality Monitoring Program (WQMP) as part of the CGWQMN to monitor the saltwater interface.

The West Citrus monitor well site was completed on December 6, 2016. This report details the well construction, hydrostratigraphy, and water quality at the West Citrus well site. The data collected at this well site supports the mission of the District to provide accurate, cost effective, and defensible data for use in the management and protection of the state's water resources and related natural systems.

Acknowledgments

Special thanks to Huss Drilling, Incorporated, for their continued professionalism.

Site Location

The West Citrus well site is in southwestern Citrus County approximately one mile southeast of the Chassahowtizka River. It is in the southwest ¼ of the southwest ¼ of Section 36, Township 20 South, and Range 17 East at latitude 28° 42′ 00.64″ north and longitude 82° 34′ 08.05″ west (fig. 2). The land surface elevation is approximately 8.76 feet above the North American Vertical Datum of 1988 (NAVD88). The West Citrus well site is located on the District-owned Chassahowitzka Wildlife Management Area. Figure 2 presents the location the West Citrus well site.

The West Citrus well site can be found by proceeding through the intersection of U.S. Highway 98/W. Ponce De Leon Boulevard and U.S. Route 19 and continuing onto Miss Maggie Drive for approximately 1 mile, turning left (south) onto S Riviera Drive for 0.6 miles, turning left (east) onto W. Southhampton Court for approximately 500 feet, keeping right at the curve and continuing onto S. Riviera Drive for 0.4 miles, and following the dirt road for approximately 450 feet to the well site.

The West Citrus well site is in the Northern Gulf Coastal Lowlands physiographic region of west-central Florida (White, 1970). It is situated between the Coastal Swamps physiographic region 0.35 miles to the west and the Brooksville Ridge physiographic region 2.18 miles to the east. The West Citrus well site is in the Chassahowitzka River Drainage

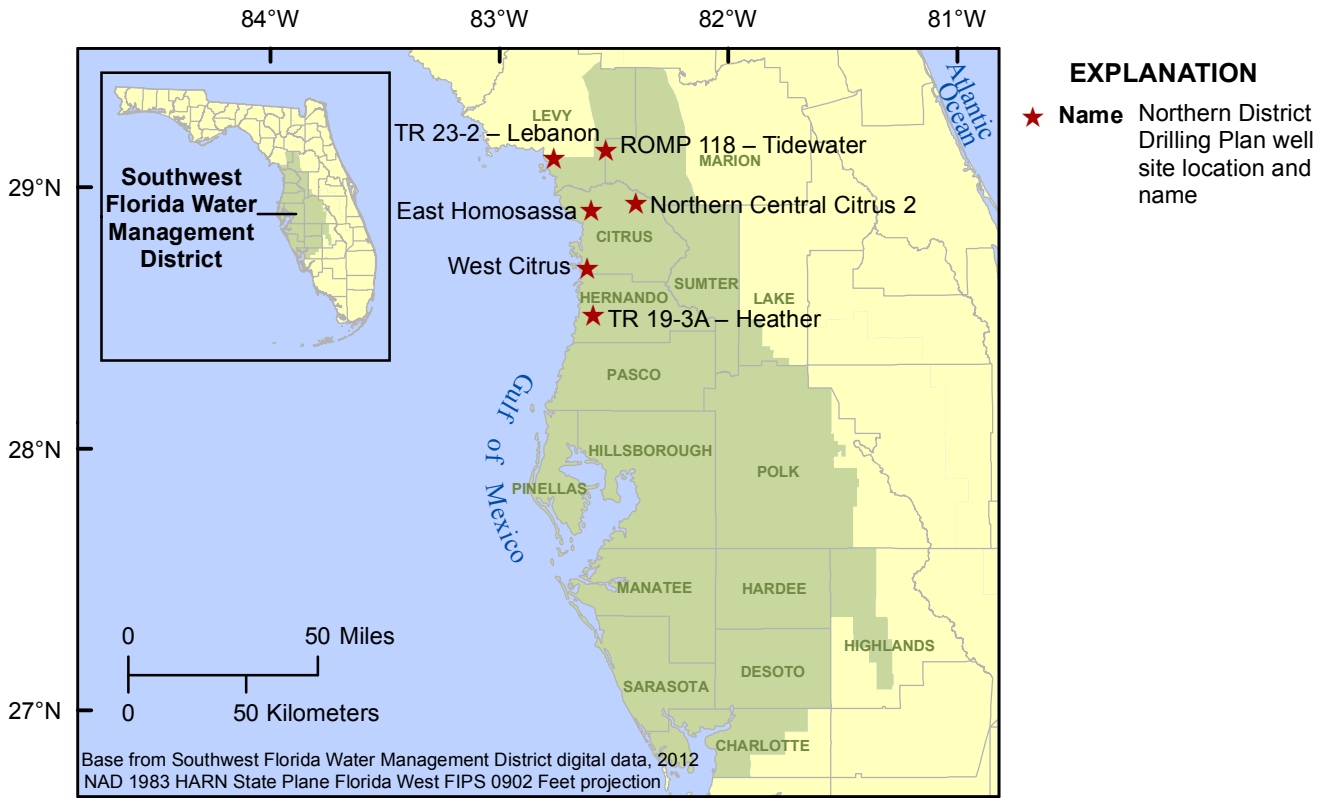


Figure 1. Northern District Drilling Plan well sites

Basin. The Chassahowitzka Springs Group is an important hydrological feature to the area as it discharges groundwater from the Upper Floridan aquifer to the headwaters of the Chassahowitzka River.

Methods

The West Citrus well site investigation was conducted using a variety of methods to collect hydrogeologic data including lithologic, geophysical, water level, and water quality data. The following sections provide the data collection method details specific to the West Citrus well site. Data collected at this well site are available for download from the District's website: www.swfwmd.state.fl.us using the Water Management Information System (WMIS). Data collection sites (wells) from this well site are compiled under the portfolio named West Citrus. As of September 2017, available data include water quality and water level data. Lithologic, geophysical, and stratigraphic data will be available in the future. This report, well construction details, and survey data are also available for download from the WMIS.

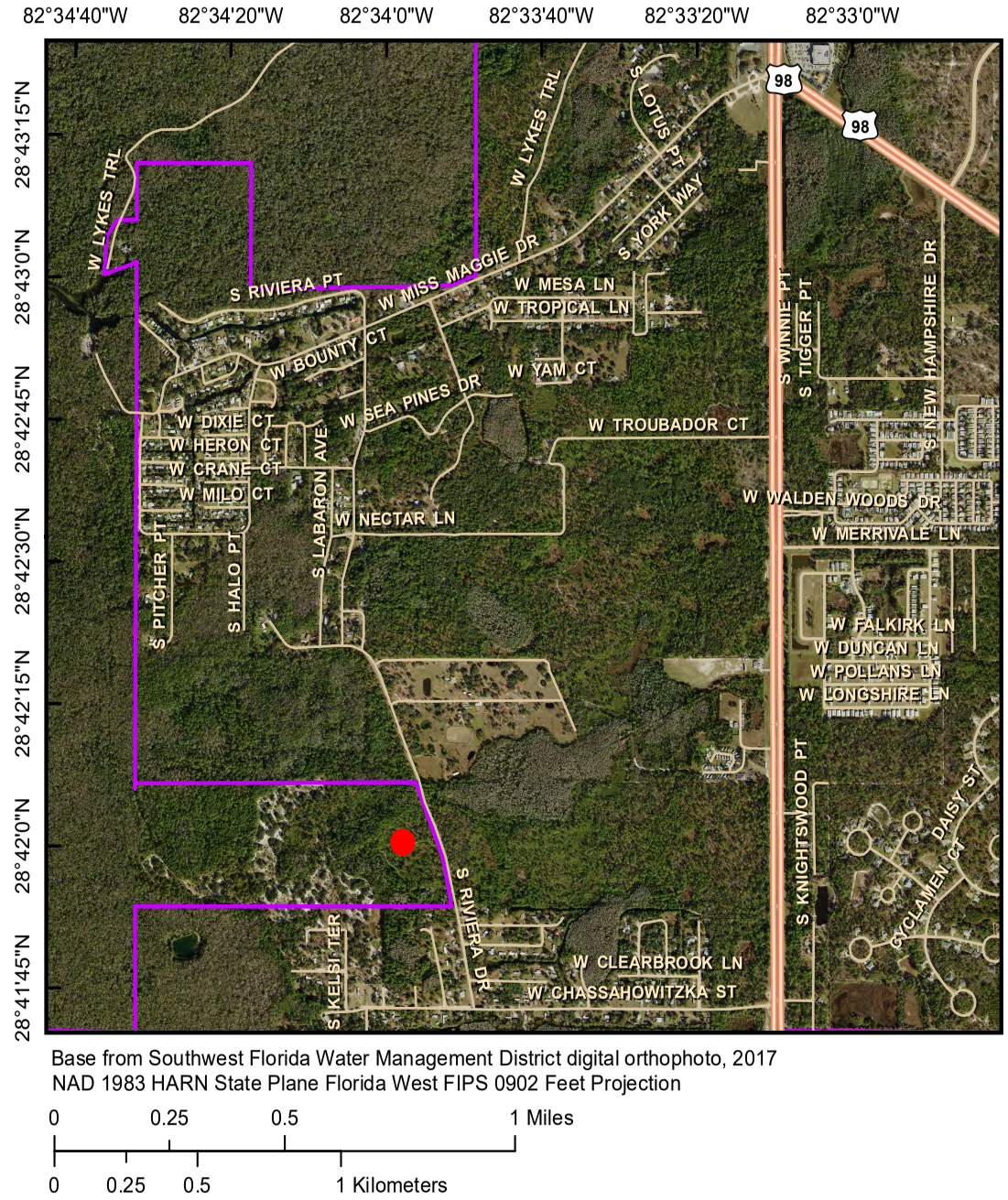
Lithologic Sampling

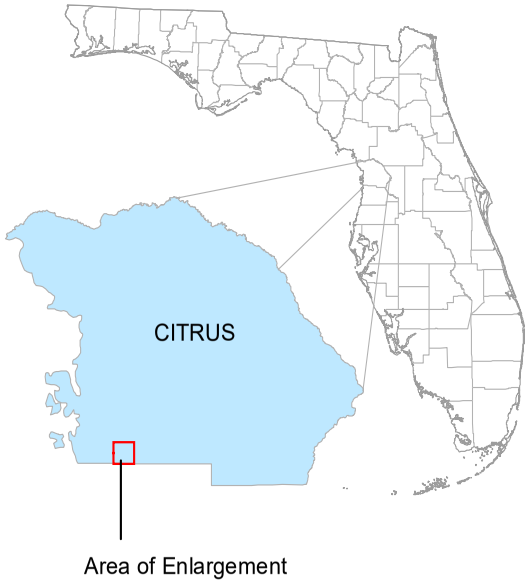
Prior to well construction, lithologic samples were collected using a Failing 500 drill rig equipped for split-spoon sampling. The split-spoon sampler was advanced using a 140-pound hammer through 4.5-inch hollow-stem augers, which acted as temporary casing and held the bore hole open. Continuous lithologic samples were collected in two-foot intervals from land surface to 24 feet below land surface (bls). Eight-inch polyvinyl chloride (PVC) casing was then set to 20 feet bls. Split-spoon sampling was continued to refusal at 38 feet bls.

Following this, Huss Drilling, Incorporated (Huss) performed hydraulic rotary coring using 3-inch HQ steel coring rods and the Failing 500 drill rig to collect continuous lithologic samples from 38 to 80 feet bls in 10-foot intervals using the wireline retrieval method. Next, Huss relocated the Failing 500 drill rig to a second core hole and resumed rotary coring from 80 to 350 feet bls. The samples were boxed, described, and photographed by the onsite geologist.

Water Quality Sampling

Eight groundwater samples were collected while core drilling. Seven samples were collected from discrete intervals isolated by an off-bottom packer, and one sample was collected using the thief sampler after the first suite of geophysical logs were run. The seven isolated samples were collected using a 3-inch Typhoon submersible pump. A portion of each sample was analyzed in the field for specific conductance, pH, temperature, chloride, and sulfate. The remainder of each





EXPLANATION

West Citrus Saltwater Interface Monitor Well Site
Section/Township/Range: S36/T20S/R17E
Latitude: 28° 42' 0.64" N
Longitude: 82° 34' 8.05" W

SWFWMD Acquired Fee boundary

Directions

In Homosassa, proceed through the intersection of U.S. Highway 98/W Ponce De Leon Boulevard and U.S. Route 19 and continuing onto Miss Maggie Drive for approximately one mile, turning left (south) onto S Riviera Drive for 0.6 miles, turning left (east) onto W Southhampton Court for approximately 500 feet, keeping right at the curve and continuing onto S Riviera Drive for 0.4 miles, and following the dirt road for approximately 450 feet to the well site.

Base from Southwest Florida Water Management District digital orthophoto, 2017
NAD 1983 HARN State Plane Florida West FIPS 0902 Feet Projection

0 0.25 0.5 1 Miles
0 0.25 0.5 1 Kilometers

Figure 2. Well site location for the West Citrus well site in Citrus County, Florida

sample was processed and delivered to the District's Chemistry Laboratory for additional parameter analyses (Southwest Florida Water Management District, 2009). Additional readings of specific conductance, pH, and temperature were recorded from drilling discharge at various intervals during core drilling.

Geophysical Logging

Geophysical logs are used to delineate stratigraphic units; identify permeable zones and confining units; characterize water quality; and determine well casing points and grouting requirements. Borehole geophysical logs were collected at the West Citrus well site. All logs were collected by District staff using District-owned Century® geophysical logging equipment during three sessions at this well site (table 1 and appendix A).

The first suite of logs was run on November 9, 2016 in the second core hole after exploratory core drilling was completed. The 4-inch drill rods were tripped from 350 to 160 feet bls and the tools were run in the 4-inch drill rods and the open hole from 350 feet bls to land surface. The 8044C multifunction tool was run from 0.8 to 358.2 feet bls, the 9165C caliper/gamma-ray tool was run from 0.2 to 358.4 feet bls, and the 9511C induction tool was run twice from 132.6 to 355.8 feet bls and 136.8 to 355.6 feet bls.

The second suite of logs was run on November 29, 2016, in the saltwater interface monitor well. The tools were run in the 8-inch PVC casing that was set at 80 feet, prior to setting the 4-inch PVC casing. The 8044C multifunction tool was run from 1 to 279.8 feet bls, the 9165C caliper/gamma-ray tool was run from land surface to 280.2 feet bls, and the 9511C

Table 1. Summary of geophysical logs collected at the West Citrus well site in Citrus County, Florida

[MM/DD/YYYY, month/day/year; ft, feet; bls, below land surface; MULTI, multifunction; CAL, caliper; GAM, gamma; PVC, polyvinyl chloride; The multifunction tool includes natural gamma-ray, single-point resistance, short normal 16-inch resistivity, long normal 64-inch resistivity, fluid resistivity, spontenous potential, specific conductance, and temperature parameters; geophysical log diagrams are in appendix A]

Logged Date (MM/DD/YYYY)	Well Name	Logged Interval (ft bls)	Casing Type	Casing Depth (ft bls)	Borehole Diameter (inches)	Geophysical Tool(s)
11/9/2016	WEST CITRUS CORE-HOLE 2	0.8-358.2	Steel	160	4	MULTI (8044C)
11/9/2016	WEST CITRUS CORE-HOLE 2	132.6-355.8	Steel	160	4	INDUCTION (9511C)
11/9/2016	WEST CITRUS CORE-HOLE 2	136.8-355.6	Steel	160	4	INDUCTION (9511C)
11/9/2016	WEST CITRUS CORE-HOLE 2	0.2-358.4	Steel	160	4	CAL/GAM (9165C)
11/29/2016	WEST CITRUS SALTWATER INTERFACE MONITOR	1.00-279.8	PVC	80	8	MULTI (8044C)
11/29/2016	WEST CITRUS SALTWATER INTERFACE MONITOR	0.6-277.2	PVC	80	8	INDUCTION (9511C)
11/29/2016	WEST CITRUS SALTWATER INTERFACE MONITOR	0-280.2	PVC	80	8	CAL/GAM (9165C)
12/6/2016	WEST CITRUS SALTWATER INTERFACE MONITOR	0-325.2	PVC	283	4	CAL/GAM (9165C)
12/6/2016	WEST CITRUS SALTWATER INTERFACE MONITOR	0.6-321.2	PVC	283	4	INDUCTION (9511C)

induction tool was run from 0.6 to 277.2 feet bls.

The third suite of logs was run on December 6, 2016, in the saltwater interface monitor well after construction was completed. The tools were run in the 4-inch PVC casing that was set at 283 feet bls and in the open hole. The 9165C caliper/gamma-ray tool was run from land surface to 325.2 feet bls and the 9511C induction tool was run from 0.6 to 321.2 feet bls.

Well Construction

Monitor well construction at the West Citrus well site was completed by Huss and supervised by a District geologist. Permanent monitor wells were constructed for long-term water level and water quality monitoring. A total of three monitor wells were constructed, including one permanent surficial aquifer monitor well and two permanent Upper Floridan aquifer monitor wells (fig. 3). The two permanent Upper Floridan aquifer monitor wells were constructed to monitor the water elevation of the Upper Floridan aquifer and to monitor the water quality and elevation of the saltwater/freshwater interface. In this report, the saltwater/freshwater interface is defined as the depth below land surface where the chloride concentration in groundwater begins to exceed 1,000 milligrams per liter (mg/l).

The Upper Floridan aquifer monitor well (District site ID 877605) was constructed between October 25 and 28, 2016, the saltwater interface monitor well (District site ID 877606) was constructed between October 28 and December 2, 2016, and the surficial aquifer monitor well (District site ID 877604) was constructed on December 2, 2016. The completed wells were equipped with water level recorders by the District's Hydrologic Data Section for long-term groundwater level monitoring. Additionally, the Upper Floridan aquifer monitor and the saltwater interface monitor wells were entered into the District's Water Quality Monitoring Program for long term water quality monitoring.

Prior to well construction, exploratory split-spoon samples were collected from land surface to refusal at 38 feet bls. Huss switched to exploratory HQ wire-line coring using mud as the drilling fluid from 38 to 350 feet bls. Continuous 3-inch core samples were collected from 38 to 350 feet bls. These samples were used to characterize the hydrostratigraphy of the site and to aid in the design of the monitor wells.

A summary of well construction details is provided in table 2. Well construction as-built diagrams for the two core holes, surficial aquifer monitor well, Upper Floridan aquifer monitor well, and saltwater interface monitor well are presented in appendix B. Daily logs for coring and well construction operations are available from the District's online document storage database. Additional well construction details can be found in the District's WMIS.

Upper Floridan Aquifer Monitor Well

The Upper Floridan aquifer monitor well was constructed between October 25 and 28, 2016, using the Failing 500 drill rig under Well Construction Permit (WCP) number 853940. The well construction specifications are depicted in appendix B, figure B1. The well is open to the Ocala Limestone and is used to monitor the groundwater level and quality of the Upper Floridan aquifer.

Huss drilled a 12-inch nominal borehole from land surface to 20 feet bls and installed 21 feet of 8-inch schedule 40 PVC casing from one foot above land surface to 20 feet bls. Nine bags of neat cement and three bags of Quick Gel were installed in the annulus from 20 feet bls to land surface.

Huss then performed split-spoon sampling from 20 to 38 feet bls, ending when competent limestone was reached. Next, Huss began coring from 38 to 80 feet bls using HQ core rods. The core hole was then reamed to 58 feet bls using an 8-inch bit. Sixty feet of 4-inch schedule 40 PVC casing was installed to the bottom of the borehole. One bag of Hole Plug was installed in the annulus and tagged at 55 feet bls. Thirteen bags of neat cement and five bags of Quick Gel were installed in the annulus from 55 feet bls to land surface.

Next, Huss drilled the open hole below the 4-inch casing from 58 to 80 feet bls using a 3⅞-inch drill bit. The well was developed after installation for 25 minutes and subsequently used as the water supply well for the remainder of the coring and well construction operations.

Saltwater Interface Monitor Well

The saltwater interface monitor well was constructed between October 28 and December 2, 2016, using the Failing 500 drill rig under WCP 853939. The well construction specifications are depicted in appendix B, figure B2. The well is open to the Avon Park Formation and is used to monitor the groundwater level and quality of the saltwater interface within the Upper Floridan aquifer.

Huss began construction of the saltwater interface monitor well by drilling a 16-inch pilot hole from land surface to competent rock at 23 feet bls. Next, Huss installed 24 feet of 12-inch PVC casing to 23 feet bls. Fourteen bags of neat cement and six bags of Quick Gel were installed in the annulus from 23 feet bls to land surface. Following this, Huss drilled inside the 12-inch PVC casing using a 6-inch bit from 23 to 80 feet bls, then set 5-inch temporary steel casing at 80 feet bls.

Wire-line core drilling with a nominal 3-inch diameter core bit began at 80 feet and continued to 350 feet bls. The saltwater interface was identified in the interval between 300 and 350 feet bls. To better target the 1,000 milligrams per Liter (mg/L) chloride isochlor, the core hole was back plugged to 320 feet bls. Eighty feet of 8-inch schedule 40 PVC casing was installed to 80 feet bls. Thirty bags of neat cement, seven bags of Quick Gel, and one bag of bentonite were installed in the annulus from 80 feet bls to land surface.

Figure 3. Well site layout for the West Citrus well site in Citrus County, Florida

Huss then reamed the 3-inch core hole from 80 to 320 feet bls using an 8-inch drill bit and set 280 feet of 4-inch schedule 40 PVC casing equipped with two 4 X 8-inch packers to 280 feet bls. Thirty-seven bags of neat cement were installed in the annulus, followed by five bags of pea gravel. The annulus was tagged at 210 feet bls, and 36 more bags of neat cement and five bags of pea gravel were installed in the annulus. The annulus was tagged at 207 feet bls. A variance permit was issued allowing Huss to fill a void in the annulus with pea gravel. This 15-inch void is evident on the geophysical logs at approximately 165 feet bls. Fifty bags of pea gravel were installed in the annulus, which was then tagged at 155 feet bls. Huss then installed approximately 25 pounds of bentonite on top of the gravel from 150 to 155 feet bls. Thirty-eight bags of neat cement were then installed in the annulus. After the well installation was completed, the well was developed for 60 minutes.

Surficial Aquifer Monitor Well

The surficial aquifer monitor well was constructed on December 2, 2016, using the Failing 500 drill rig under WCP number 855282. The well construction specifications are depicted in appendix B, figure B3. The well is open to the undifferentiated sand and clay sediments and is used to monitor the groundwater level in the surficial aquifer.

Five feet of 4-inch schedule 40 PVC casing and five feet of 4-inch PVC 0.010-inch slotted well screen were installed to 10 feet bls. Five bags of 20-30 silica sand were installed from 10 to four feet bls. One bag of neat cement was installed in the annular space from four feet bls to land surface. After installation was completed, the well was developed for 110 minutes. At the end of all well construction, three-foot risers were added to each of the wells and lockable metal well covers and concrete pads were installed around the finished wells.

Geology

The lithostratigraphy of the West Citrus well site is based on lithologic samples collected from split-spoon sampling from land surface to 38 feet bls and exploratory coring that was conducted from 38 to 350 feet bls. The geologic units encountered at the well site include, in ascending order, the Avon Park Formation, the Ocala Limestone, and the undifferentiated sand and clay deposits. A stratigraphic column detailing the lithostratigraphy encountered at the well site is presented in figure 4. The lithologic log is presented in appendix C. Digital photographs of the lithologic core samples are presented in appendix D.

The portion of the Avon Park Formation (Middle Eocene) encountered during exploratory coring extends from 157.5 to 350 feet bls. The base of the formation was not reached during coring. The Avon Park Formation primarily consists of sucrosic dolostones, wackestones, packstones, and mudstones that are generally grayish orange, very pale orange, light gray, and dark grayish brown, very fine to coarse grained, moderate to well indurated, and are moderately to highly altered with varying porosity. Organics are present throughout the formation as laminae.

Fossil molds and fragments observed within this formation primarily include echinoids, mollusks including gastropods, and benthic foraminifera such as miliolids. The foraminifera *Cushmania americana* appear at 191.5 feet bls and between 200 and 205 feet bls. The appearance of the echinoid *Neolaganum dalli*, which is a fossil characteristic of the Avon Park Formation, is present from 303.9 to 320.5 feet bls and 326 to 330 feet bls. Additionally, fractures, burrows, molds,

Table 2. Summary of well construction details at the West Citrus well site in Citrus County, Florida

[SID, site identification; ft, feet; bls, below land surface; WCP No., well construction permit number, ; well locations are shown in figure 2; well as-built diagrams are in appendix B]

SID	Well Name	Open Interval (ft bls)	Constructed By	Start Date (MM/DD/YYYY)	Complete Date (MM/DD/YYYY)	Status	WCP No.(s)
875936	WEST CITRUS COREHOLE 1	0-80	Huss Drilling, Inc.	10/25/2016	10/26/2016	Inactive	853940
875942	WEST CITRUS COREHOLE 2	0-350	Huss Drilling, Inc.	10/28/2016	11/16/2016	Inactive	853939
877604	WEST CITRUS SURF AQ MONITOR	5-10	Huss Drilling, Inc.	12/2/2016	12/2/2016	Active	855282
877605	WEST CITRUS U FLDN AQ MONITOR	60-80	Huss Drilling, Inc.	10/25/2016	10/28/2016	Active	853940
877606	WEST CITRUS SALTWATER INTERFACE MONITOR	280-320	Huss Drilling, Inc.	10/28/2016	12/2/2016	Active	853939

and vugs are lined with calcite crystals from 195 to 200 feet bls, 206 to 210 feet bls, and 220 to 221 feet bls. A spike in gamma-ray activity between 190 and 200 feet bls (appendix A, figure 3) likely corresponds to the organic material described on the lithologic log, in which the organics are said to be prominent throughout the first two feet of the description interval at 190 feet bls. Average core recovery through the Avon Park Formation is approximately 96 percent.

At the West Citrus well site, the late Eocene age Ocala Limestone extends from 17 to 157.5 feet bls. The top of the Ocala Limestone is picked at the top of the very first instance of limestone fragments in pale yellowish brown, very fine to fine grained clayey sand. The diagnostic benthic foraminifera, *Lepidocyclina ocalana* and *Nummulites ocalanus* were identified near the top of the unit. The general lithology of the Ocala Limestone at this location consists of white to light gray, poorly to well indurated, fine to medium grain size, highly fossiliferous weathered limestone, packstone, wackestone, and grainstone. Additional fossil molds and fragments observed include bryozoa, coral, mollusks, echinoids, brachiopods, benthic foraminfera such as pelecypods, and worm holes. The porosity of the limestone is predominantly intergranular, vugular, fracture, and moldic. Core recovery for the Ocala Limestone is approximately 93 percent.

At the West Citrus well site, the Pliocene to Holocene age undifferentiated sand and clay unit is present from land surface to 17 feet bls. The interval from land surface to 10 feet bls consists of very fine light gray to yellowish gray sand with root fragments. From 10 to 16 feet bls, the sample consists of pale yellowish to moderate yellowish brown, fine-grained sandy clay.

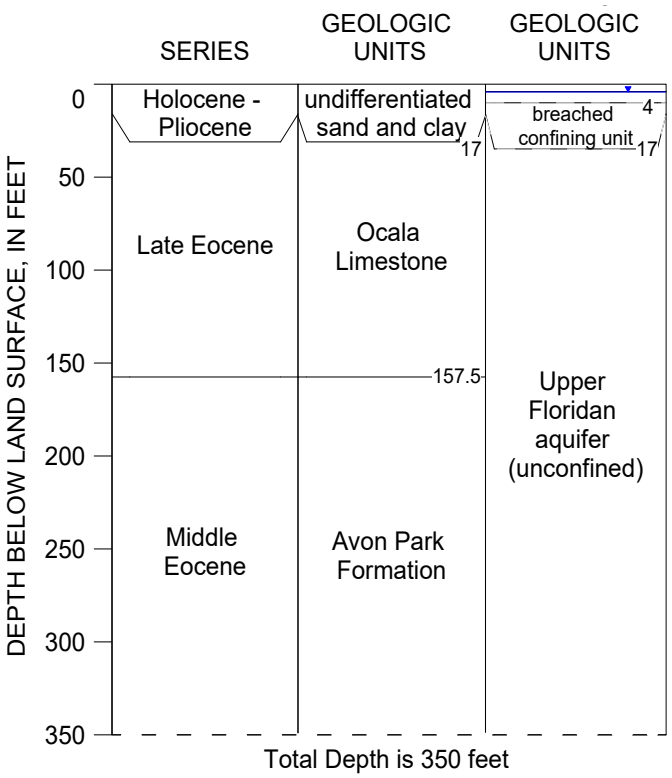


Figure 4. Stratigraphic column detailing the hydrogeologic setting at the West Citrus well site in Citrus County, Florida

Hydrogeology

The characterization presented below is based on the results of all data collected during exploratory coring and testing, including lithologic, water level, water quality, discharge flow rates, and geophysical log data. The hydrogeologic units delineated at the West Citrus well site include a breached confining unit and the unconfined Upper Floridan aquifer. A representation of the hydrogeology at the West Citrus well site is presented in figure 4.

Very fine-grained sands of the undifferentiated sand and clay deposits occur from land surface to 10 feet bls. Throughout much of Florida, these sands would typically comprise the unconfined surficial aquifer containing the water table. However, this site occurs in a region of west-central Florida where the limestone is at or near land surface and the surficial aquifer is frequently absent due to very thin, discontinuous and/or breached basal confinement.

A thin, low-permeability layer of pale to moderate yellowish-brown, fine-grained sandy clay to clayey sand occurs from 10 to the top of limestone at 16 feet bls. However, data show this material does not form an effective confining unit between the surficial sands and the underlying Upper Floridan aquifer. Basal confinement of the surficial sediments in this region is known to be local to absent, very thin, sandy, and often breached by karst features which cause the Upper Floridan and surficial aquifer water levels to be very close to coincident. A hydrograph of water level data over time from the surficial and the Upper Floridan aquifer monitor wells constructed at this site (fig. 5) shows nearly coincident water levels that deviate slightly (roughly 0.5 feet) following storm events as water in the surficial sands mound up and then gradually equilibrate as time passes. Thus, the low-permeability sediments do not restrict, but only temporarily retard vertical recharge to the Upper Floridan aquifer. This suggests a true surficial aquifer is not present at this site and supports the criteria for a 'regionally unconfined Upper Floridan aquifer' (Ron Basso, SWFWMD, written communication, 2014).

At the West Citrus well site, the Upper Floridan aquifer is considered unconfined and extends from land surface to beyond the depth of exploratory coring at 350 feet bls (fig. 4). Figure 5 presents the hydrograph of the monitor wells at the West Citrus well site. The saltwater interface monitor well water levels are lower relative to the shallow Upper Floridan and surficial aquifer monitor well water levels in the hydrograph. This is due to the higher chloride concentration of the saltwater interface monitor well being higher than that of the shallow Upper Floridan aquifer monitor well. The heads from the deeper well have not been corrected for density due to elevated salinity concentration.

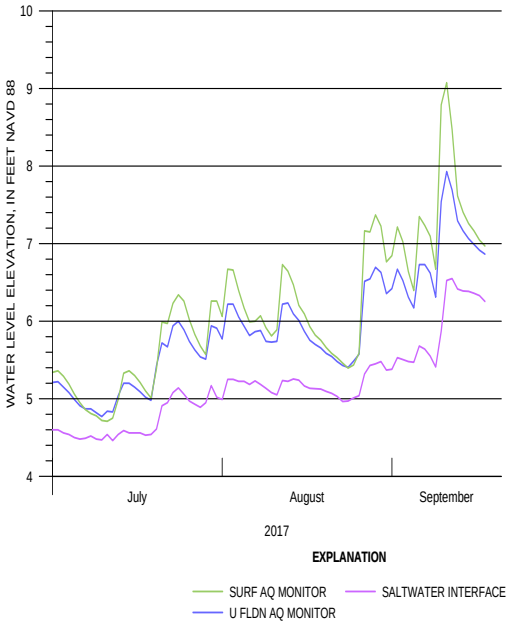


Figure 5. Hydrograph of the monitor wells at the West Citrus well in Citrus County, Florida

The Upper Floridan aquifer consists of rocks of the Avon Park Formation and the Ocala Limestone that have intergranular, vugular, fracture, and moldic porosity. Although discharge flow rates in the Upper Floridan aquifer during exploratory coring ranged from 20 to 30 gallons per minute (gpm) and sometimes less than 10 gpm in smaller sample intervals, regional studies and aquifer performance testing suggests permeability in the shallow parts of the Upper Floridan aquifer is extremely high due to secondary karst porosity. Observed moderate discharge rates may misrepresent actual productivity since discharge water in the shallow weathered limestones can be very turbid with weathered limestone particulates during coring process but would potentially increase significantly if time was spent developing the borehole. The lithology from 300 to 350 feet bls is described as well indurated crystalline dolostone, which can reduce discharge flow rates.

Static water level data were measured almost daily within the composite core hole (fig. 6). The static water level of the core hole primarily ranged from 4.68 to 5.31 feet NAVD88 during exploratory coring within the Upper Floridan aquifer (appendix F). The water level dropped almost 3.5 feet between 300 and 350 feet bls and is likely the result of increasing salinity and density which suppresses the actual head.

Groundwater Quality

The groundwater quality characterization at the West Citrus well site is based on the results of eight groundwater samples and multifunction geophysical logs collected during exploratory coring. The water quality samples were collected primarily in 50-foot intervals, except for the last two samples which were collected in 22 and 32-foot intervals to locate the 1,000 mg/L isochlor. Field readings of chlorides and sulfates were taken during sample collection from surface discharge using a YSI 9300 Photometer. Figure 7 and appendix H, table 2 show the concentration of chloride measured in the field rose from 5.7 to 1800 mg/L between water quality sample numbers 4 (sample interval 150 to 200 feet bls) and 5 (sample interval 325 to 350 feet bls). Concentrations again increased to over 10,000 mg/L in water quality sample number 6 (sample interval 300 to 350 feet bls). This is evident in the multifunction geophysical log where there is a spike in specific conductivity from approximately 500 to 5,000 microSiemens per centimeter (µS/cm) at approximately 325 feet bls (appendix A, figure 1). The core hole was subsequently back plugged to 320 feet bls to ensure that the open hole interval of the final well intersected the 1,000 mg/L isochlor. Two more chloride field readings were collected, one at an interval between 300 and 322 feet bls, and the other between 290 and 322 feet bls using an off-bottom packer to simulate the final well design (appendix H, table 1). The chloride field readings were 2,350 and 1,700 mg/L, respectively. It was decided that the final configuration of the saltwater interface monitor well have an open hole interval from 280 to 320 feet bls. The groundwater quality sample acquisition sheets are presented in appendix G. The field and laboratory results for the groundwater quality samples are presented in Appendix H, tables 1 and 2, respectively.

Eight water quality samples were collected from the Upper Floridan aquifer at various depth intervals between 130 and 350 feet bls. The secondary drinking water standards for chloride, sulfate, total dissolved solids (TDS), and iron are 250 mg/L, 250 mg/L, 500 mg/L, and 0.3 mg/L (300 micrograms per liter, µg/L), respectively (U.S. Environmental Protection Agency, 2012). The water quality sample results show that groundwater is within secondary standards with respect to TDS, chloride to a depth of 300 feet bls (samples 1 through 4). TDS values at these depths are 185, 203, 233, and 218 mg/L. Chloride values at these depths are 5.6, 8.9, 37.3, and 41.9 mg/L. Groundwater is within secondary standards with respect to sulfate to a depth of 322 feet bls (samples 1 through 4 and 7 through 8). Sulfate values at these depths are 0.7, 2, 4.8, 6.2, 147.47, and 140.97 mg/L. The first water quality sample to exceed the secondary drinking water standard due to TDS, chloride, and sulfate is water quality (WQ) sample number 5 (from 325 to 350 feet bls) with a concentration of 3,530, 1,848, and 256 mg/L, respectively. Iron concentrations exceed secondary drinking water standards at depths between 130 and 150, 150 and 200, and 300 and 350 feet bls (samples 1, 2, and 6). Iron concentrations at these depths are 2.22, 0.33, and 2.05 µg/L, respectively. Water quality data are presented in figure 7

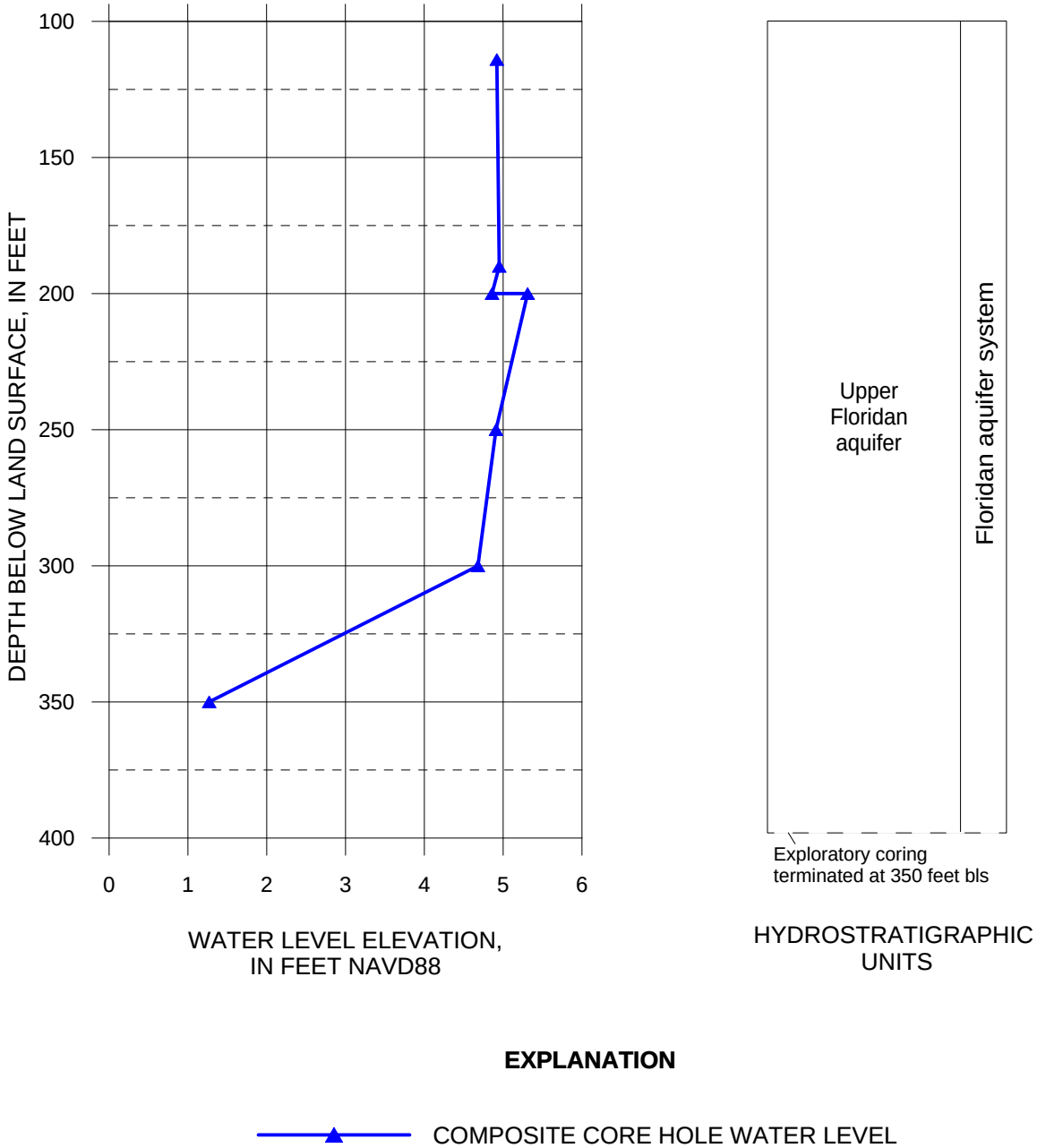


Figure 6. Static water level profile collected during exploratory core drilling and testing at the West Citrus well site in Citrus County, Florida

and appendix H, table 2.

Major ion concentrations generally increase with depth in the core hole until a depth of 325 feet bls (sample 5) where concentrations decrease. The equivalent weights, percent equivalent weights, and water type for each sample are presented in appendix H, table 3. The primary cations measured throughout the core hole are calcium, magnesium, and sodium; and the primary anions are bicarbonate, sulfate, and chloride. The dominant water type of the Upper Floridan aquifer is calcium bicarbonate to an approximate depth of 300 feet bls. The dominant water type of the remaining 50 feet of Upper Floridan aquifer explored is sodium chloride.

Select molar ratios were calculated to assess water quality changes with depth (figure 8 and appendix H, table 4). The gypsum track illustrates the interaction between fresh water and evaporites (gypsum and anhydrite). The dolomite track primarily identifies fresh water affected by dolomite. The sodium chloride track depicts effects from connate or seawater. The chloride to sulfate molar ratio on the gypsum track spikes between 300 and 310 feet bls before decreasing between 320 and 340 feet bls because both ions are increasing but chloride increases at a faster rate. The calcium to bicarbonate and

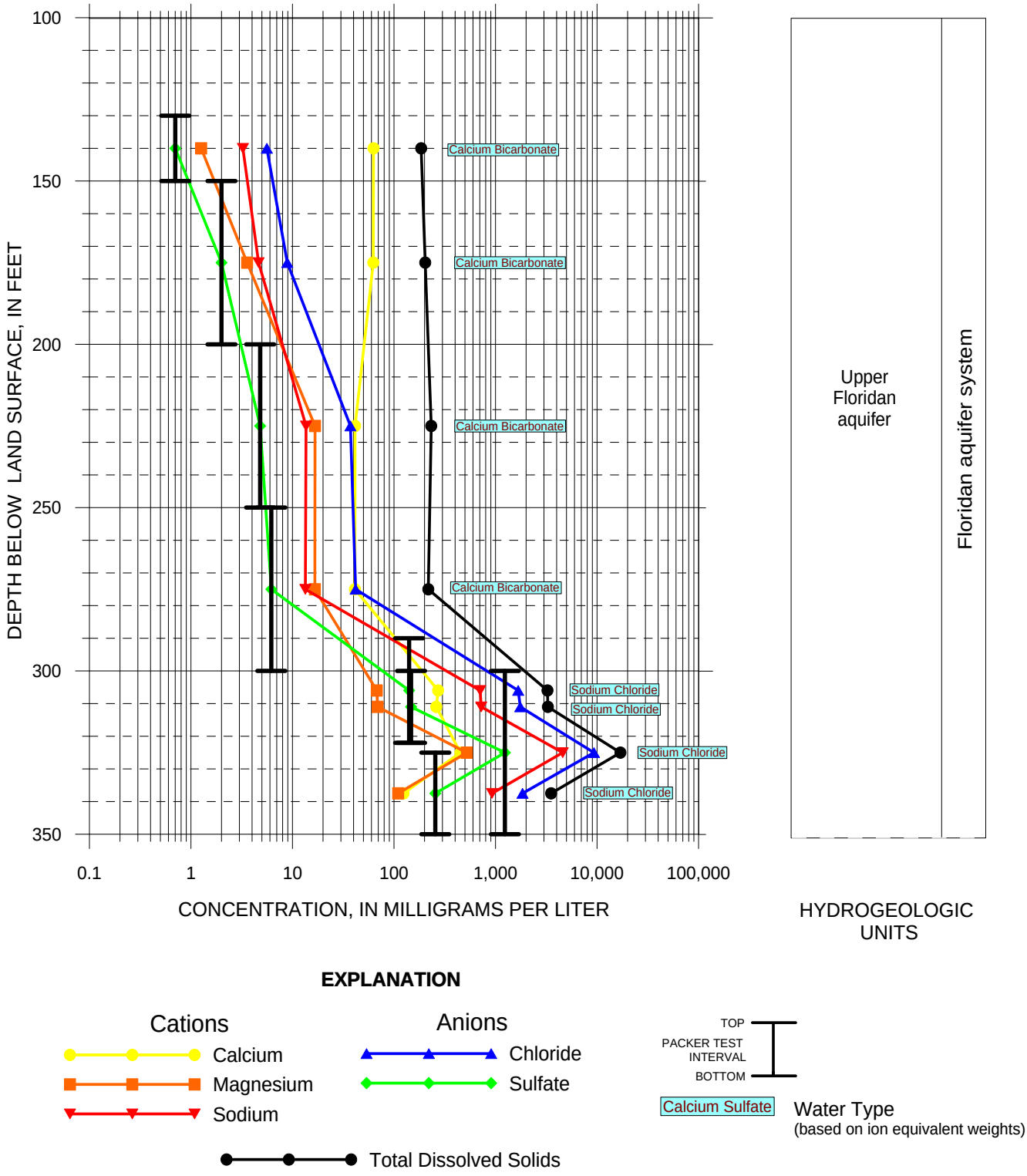


Figure 7. Select cations and anions, and total dissolved solids with depth for groundwater quality samples collected at the West Citrus well site in Citrus County, Florida

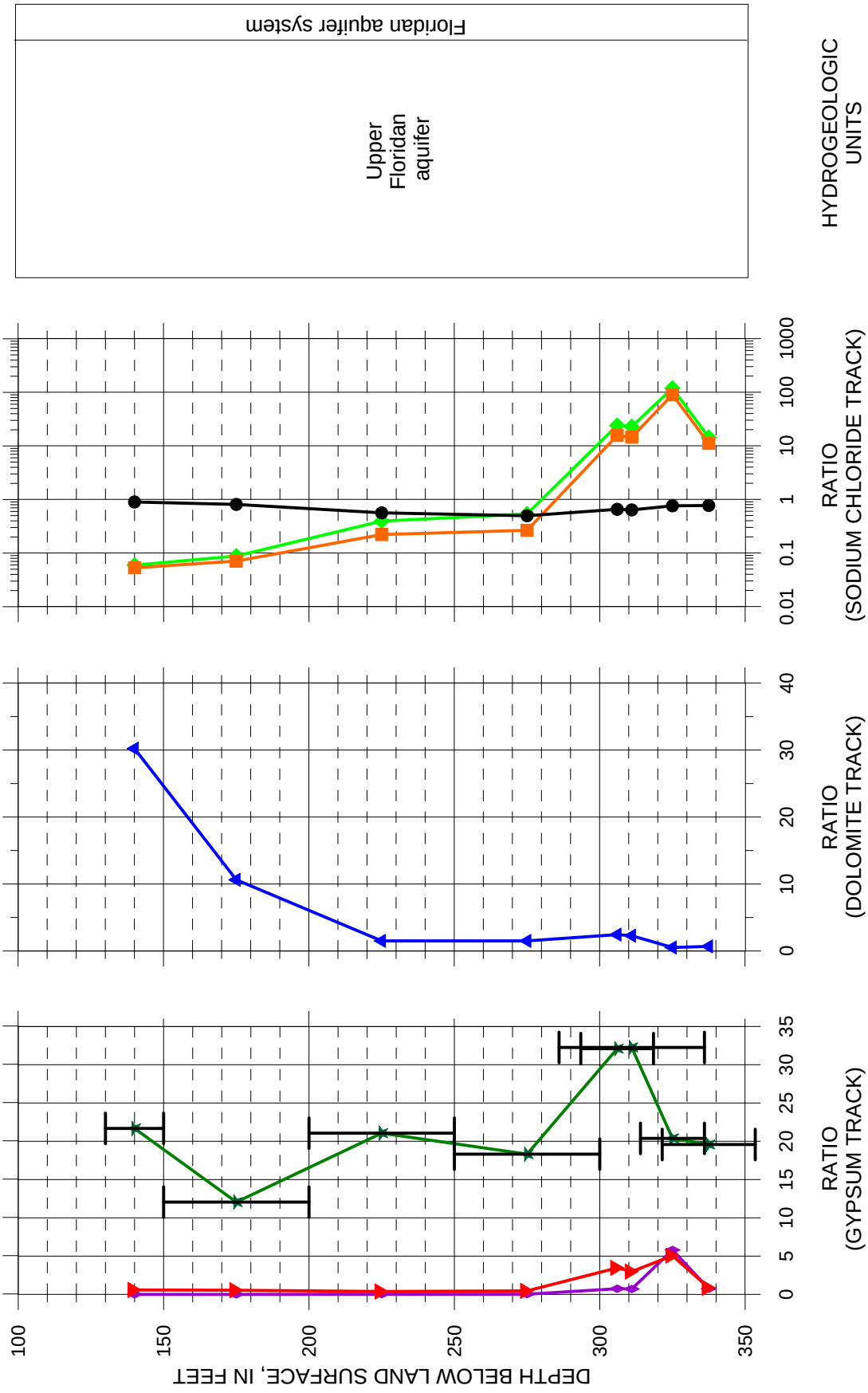


Figure 8. Select molar ratios with depth for groundwater quality samples collected at the West Citrus well site in Citrus County, Florida

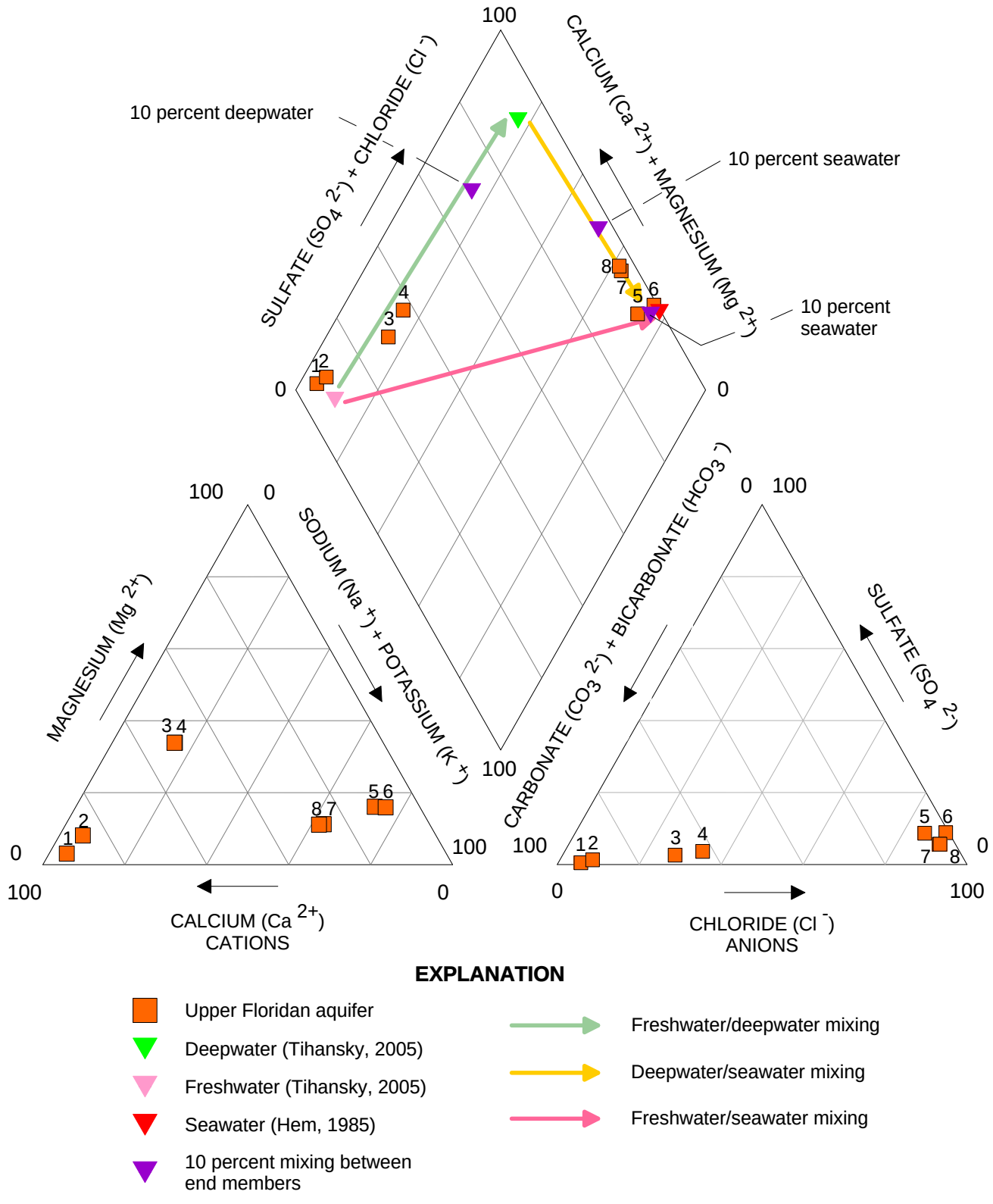


Figure 9. Piper Diagram of groundwater quality samples collected at the West Citrus well site in Citrus County, Florida

sulfate to bicarbonate molar ratios do not indicate significant influence from evaporites as these minerals were not identified in the core at these depths. The calcium to magnesium molar ratio on the dolomite track decreases with depth and levels off between 220 and 310 feet bls before decreasing again between 320 and 340 feet bls, indicating no influence from gypsum or anhydrite on the groundwater as these minerals were not identified in the core at these depths. This is also an indication of increased interaction with dolomite. The sodium to chloride molar ratios on the sodium chloride track show very little notable variation with depth because both ion concentrations are increasing at similar rates. The chloride to bicarbonate and sodium to bicarbonate molar ratios both spike between 270 and 330 feet bls because as bicarbonate concentrations decrease, both chloride and sodium concentrations increase.

Relative abundance trends of each major cation and anion species analyzed for in the groundwater quality samples collected at the West Citrus well site are presented on a Piper (1944) diagram as percent milliequivalents (fig. 9). Groundwater samples 1 through 4 collected within the Upper Floridan aquifer plot in the middle left of the quadrilateral, which is typical for calcium bicarbonate water types not influenced by deepwater or seawater mixing (Tihansky, 2005). Water quality samples 5 through 8 plot at the middle right of the quadrilateral and the end of the freshwater/seawater mixing trends described by Tihansky (2005). The transition on the quadrilateral plot between samples 4 and 5 directly along the freshwater/seawater mixing trend is expected near the coastline when intersecting the saltwater interface.

Summary

Three monitor wells were constructed at the West Citrus well site in Citrus County, Florida. The Upper Floridan aquifer monitor well was constructed in October of 2016, the saltwater interface monitor well was constructed from October 28, 2016 to December 2, 2016, and the surficial aquifer monitor well was constructed in December of 2016.

The wells were constructed as part of the NDWRAP, the ND Model, and the CGWQMN to monitor groundwater levels in the surficial and the Upper Floridan aquifers, as well as the water level and water quality of the saltwater interface. The casing and total depths of the surficial aquifer monitor well are 5 feet and 10 feet bls, respectively. The casing and total open hole depths of the Upper Floridan aquifer monitor well are 58 and 80 feet bls, respectively. The casing and total open hole depths of the saltwater interface monitor well are 280 and 320 feet, respectively. The wells are secured with locking well covers, surveyed, and groundwater levels and quality are currently being monitoring by the District's Hydrologic Data Section and the WQMP.

Prior to well construction, exploratory split-spoon and hydraulic rotary core samples were collected to delineate the hydrogeology of the well site. The general geology at the well site is, in ascending order from oldest to youngest, the Avon Park Formation from 157.5 feet below land surface to the total depth of exploration of 350 feet bls; the Ocala Limestone from 17 to 157.5 feet bls; and undifferentiated sand and clay from land surface to 17 feet bls. The hydrogeology at the West Citrus well site includes, in descending order, a surficial aquifer from land surface to 10 feet bls; a confining unit from 10 to 17 feet bls; and the Upper Floridan aquifer from 17 feet bls to possibly beyond 350 feet bls.

The primary purpose of this well site was to locate the saltwater/freshwater interface as defined by the 1,000 mg/L isochlor. The saltwater interface monitor well was designed and constructed so that the open hole interval would intersect the interface. At the time of well construction, the chloride concentration was 1,700 mg/L, which is slightly higher than the intended 1,000 mg/L. Changes in water quality in this well will be monitored by the District's WQMP.

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Appendix A. Geophysical Log Suites for the West Citrus Well Site in Citrus County, Florida

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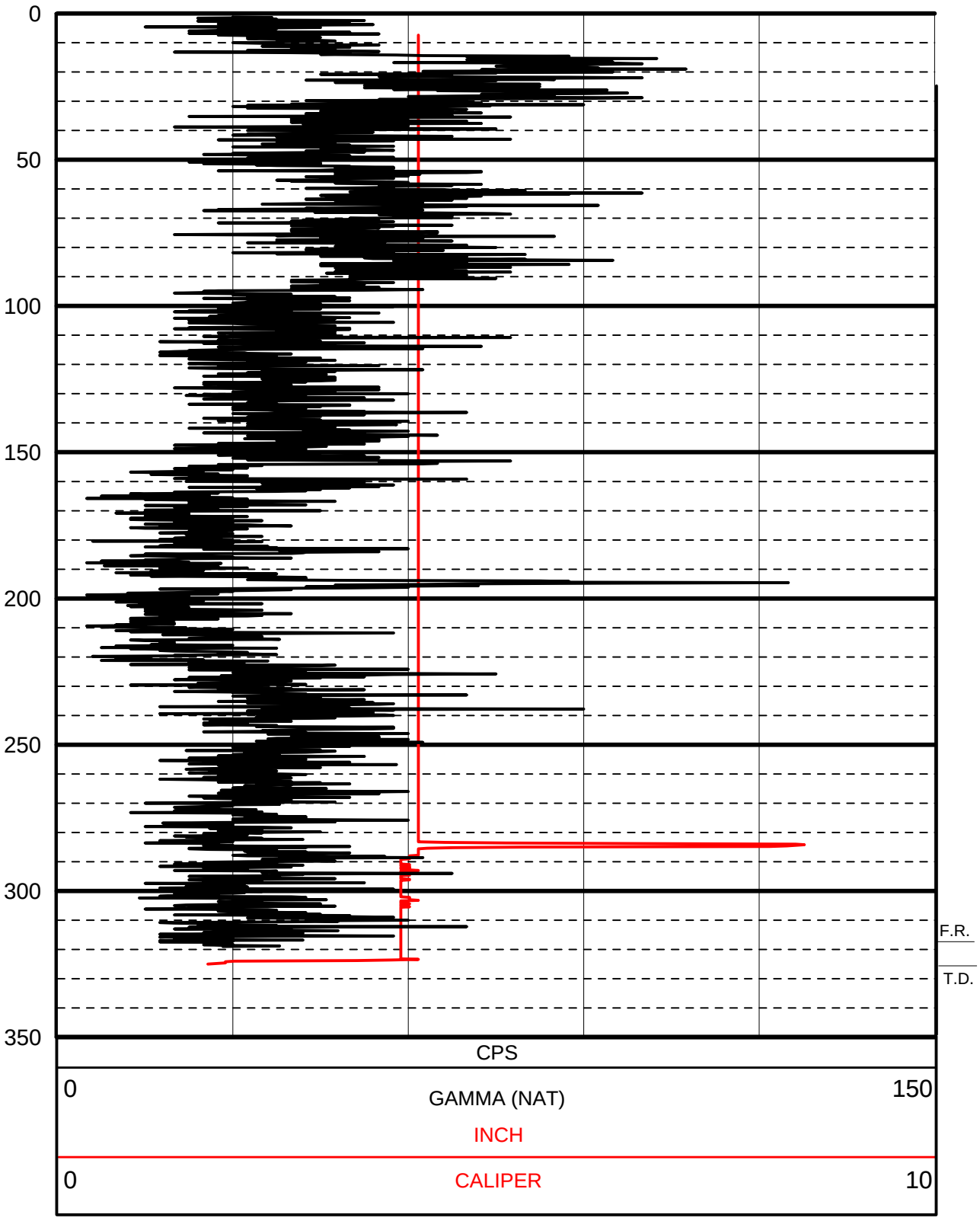
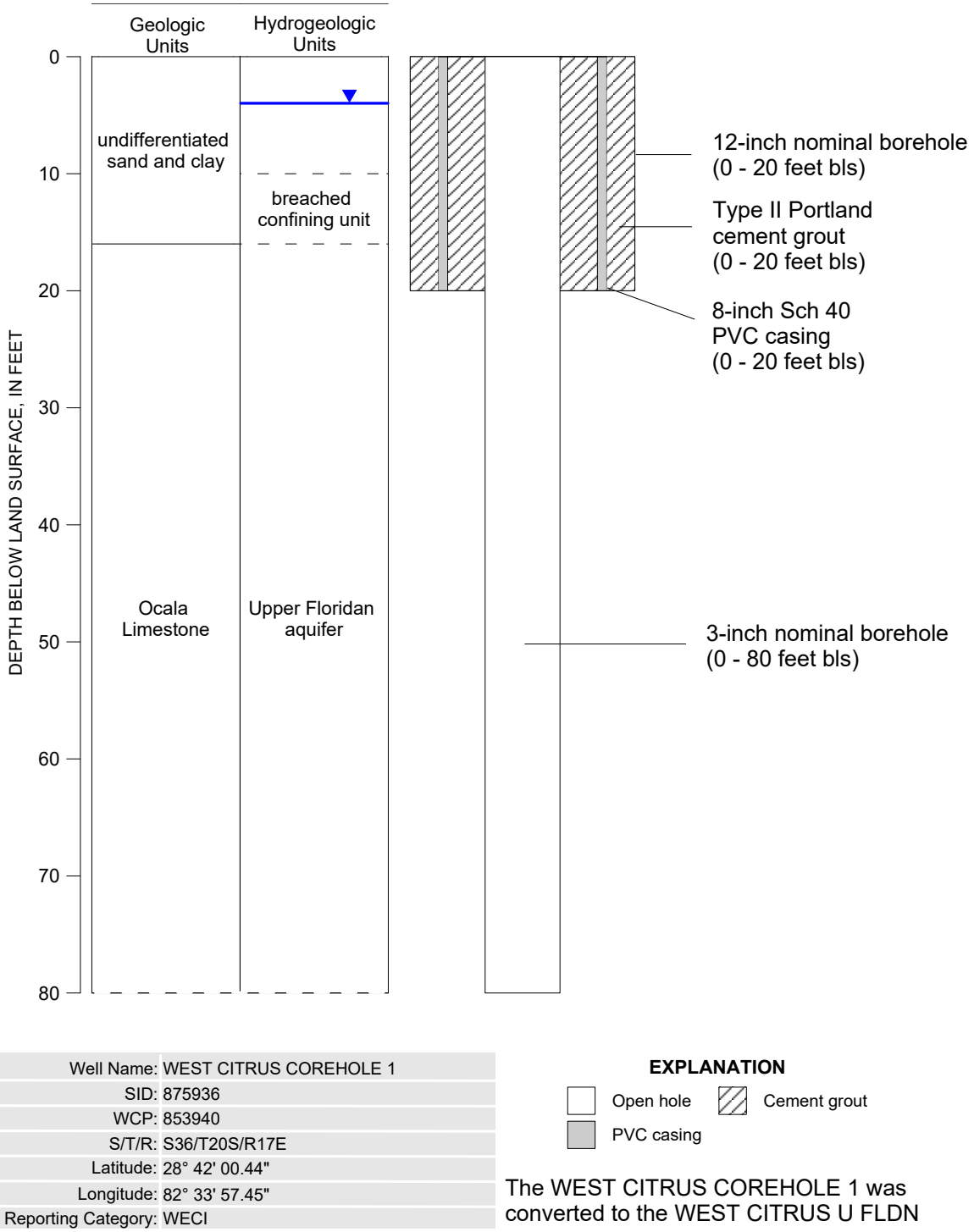


Figure A7. Geophysical log suite for the SALTWATER INTERFACE MONITOR well from land surface to 283 feet below land surface conducted at the West Citrus well site in Citrus County, Florida. The logging was performed on December 6, 2016, using the 9511C (induction) tool. The log was run in the borehole with four-inch polyvinyl chloride casing at 283 feet below land surface. The vertical axis scale is 2 inches per 100 feet. Horizontal axes for tracks 1 and 3 are linear and track 2 is logarithmic. The first read (F.R.) is 312.2 feet below land surface.

Appendix B. Well As-built Diagrams for the West Citrus Well Site in Citrus County, Florida



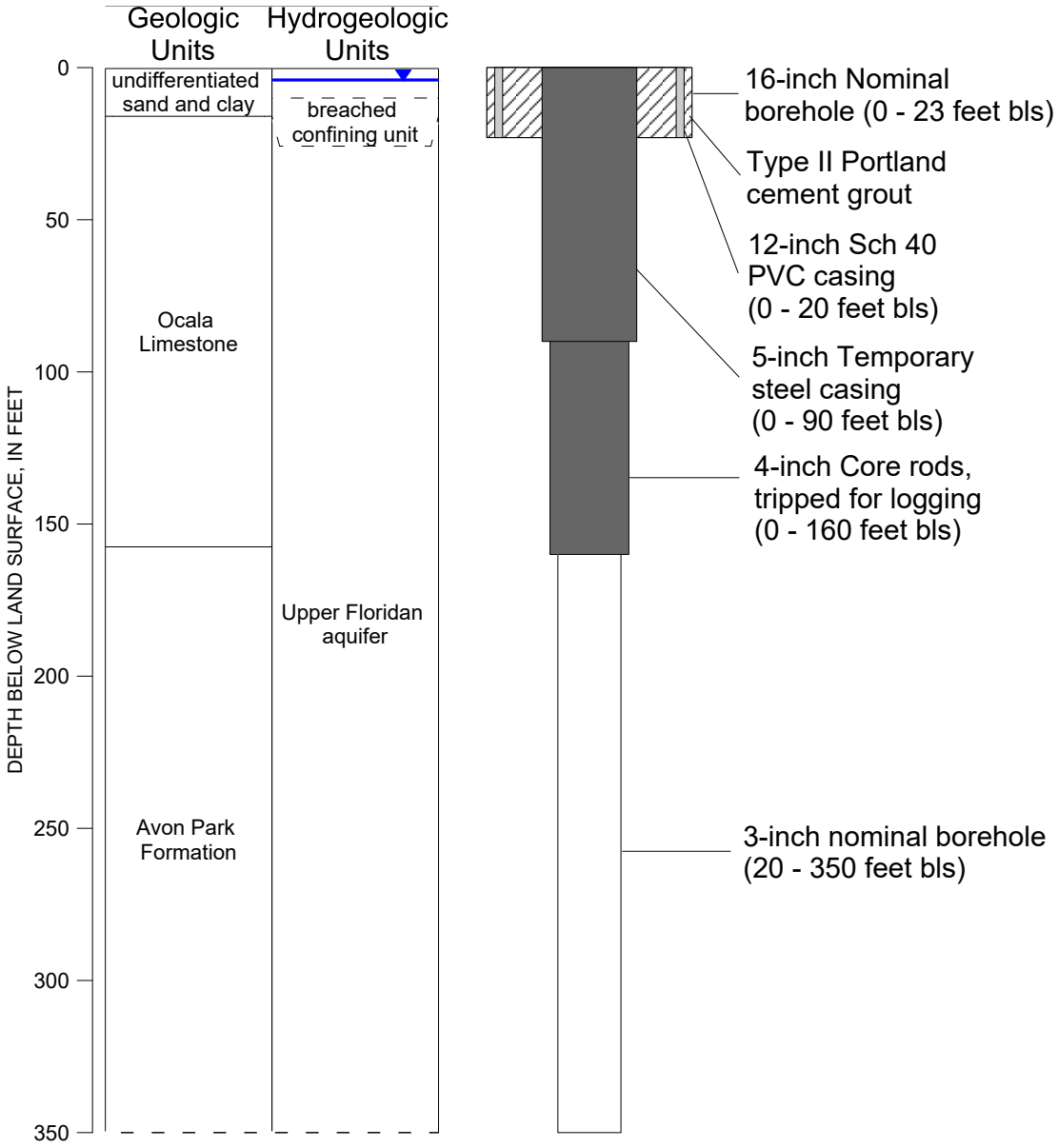
Well Name:	WEST CITRUS COREHOLE 1
SID:	875936
WCP:	853940
S/T/R:	S36/T20S/R17E
Latitude:	28° 42' 00.44"
Longitude:	82° 33' 57.45"
Reporting Category:	WECI

EXPLANATION

Open hole
Cement grout
PVC casing

The WEST CITRUS COREHOLE 1 was converted to the WEST CITRUS U FLDN

Figure B1. Well as-built diagram for the COREHOLE 1 at the West Citrus well site in Citrus County, Florida



Well Name:	WEST CITRUS COREHOLE 2
SID:	875942
WCP:	853939
S/T/R:	S36/T20S/R17E
Latitude:	28° 42' 0.64" N
Longitude:	82° 34' 8.05" W
Reporting Category:	WECI
Const. Began:	10/28/2016
Const. Complete:	11/16/2016

EXPLANATION

Open hole
PVC casing
Cement grout
Galvanized steel rods

The WEST CITRUS COREHOLE 2 was converted to the WEST CITRUS SALTWATER INTERFACE MONITOR after the 1,700 mg/l chloride interface was encountered.

Figure B2. Well as-built diagram for the COREHOLE 2 at the West Citrus well site in Citrus County, Florida

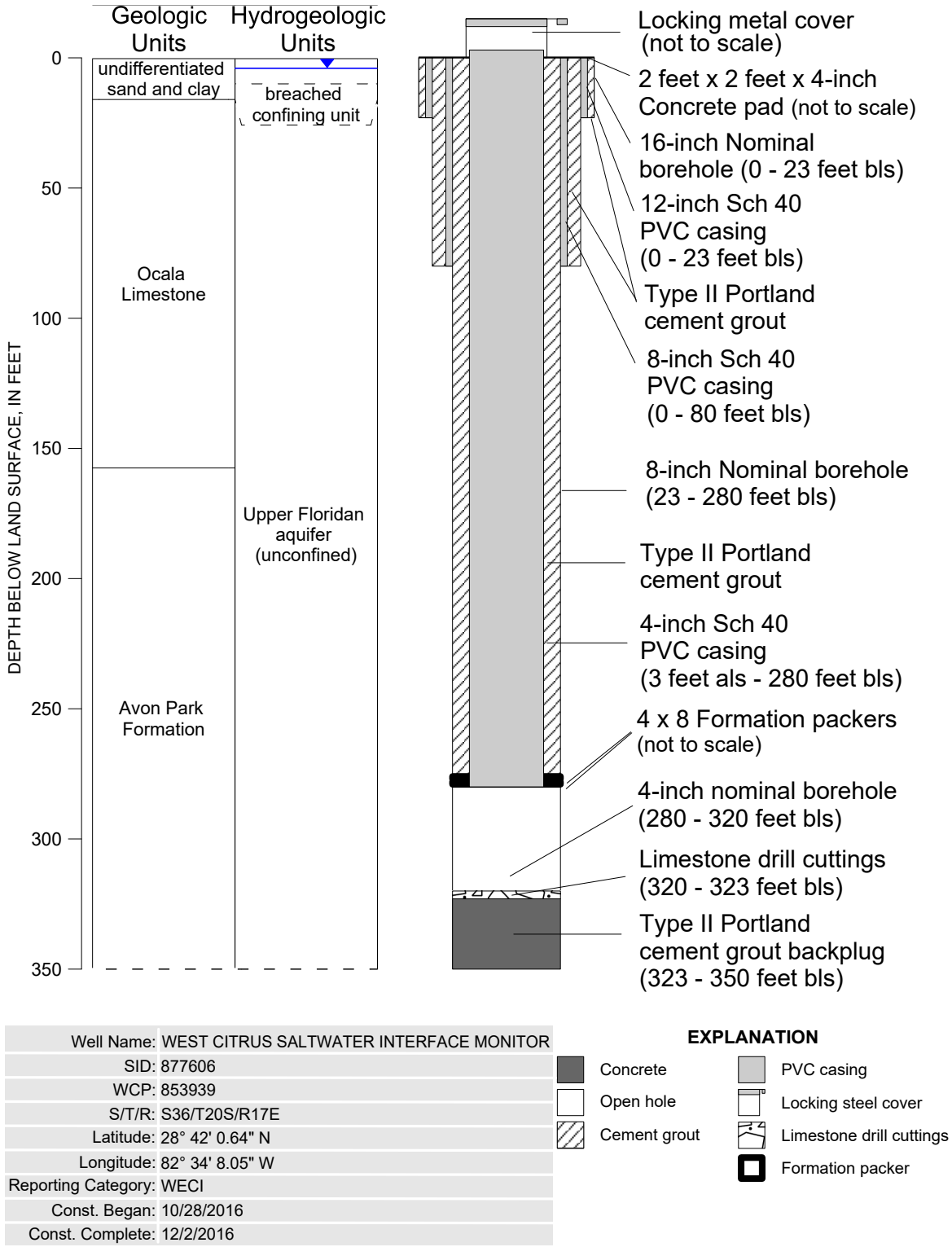
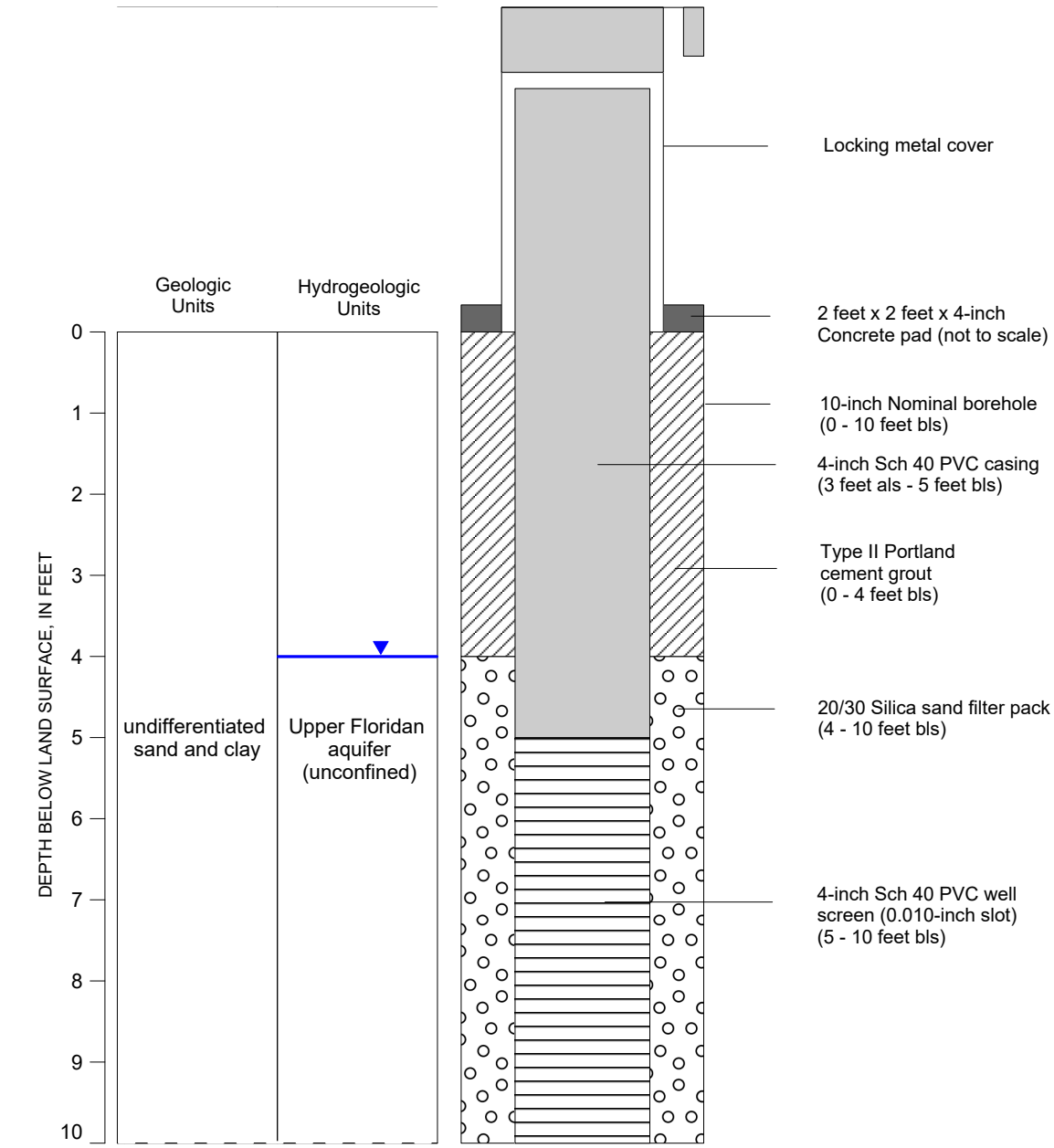
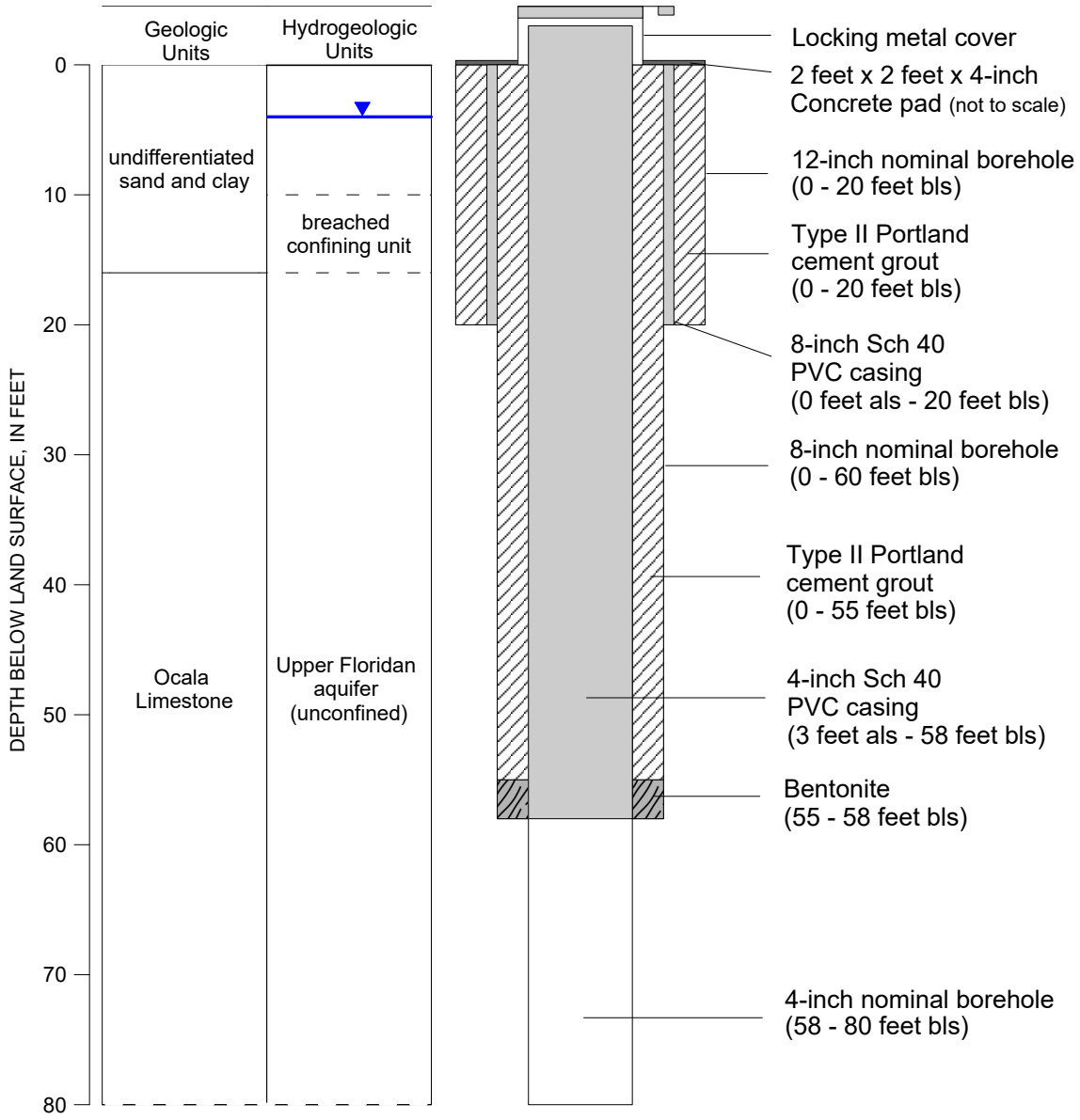


Figure B3. Well as-built diagram for the SALTWATER INTERFACE MONITOR at the West Citrus well site in Citrus County, Florida



Well Name:	WEST CITRUS SURF AQ MONITOR
SID:	877604
WCP:	855282
S/T/R:	S36/T20S/R17E
Latitude:	28° 42' 00.49"
Longitude:	82° 33' 57.38"
Reporting Category:	WECI
Const. Began:	12/2/2016
Const. Complete:	12/2/2016

Figure B4. Well as-built diagram for the SURF AQ MONITOR at the West Citrus well site in Citrus County, Florida



Well Name:	WEST CITRUS U FLDN AQ MONITOR
SID:	877605
WCP:	853940
S/T/R:	S36/T20S/R17E
Latitude:	28° 42' 00.44"
Longitude:	82° 33' 57.45"
Reporting Category:	WECI
Const. Began:	10/25/2016
Const. Complete:	10/28/2016

EXPLANATION

Concrete
Open hole
Cement grout
PVC casing
Locking steel cover
Bentonite

Figure B5. Well as-built diagram for the U FLDN AQ MONITOR at the West Citrus well site in Citrus County, Florida

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Appendix C. Lithologic Logs for the Samples Collected at the West Citrus Well Site in Citrus County, Florida

Appendix C1. Lithologic Log for COREHOLE 1 at the West Citrus Well Site in Citrus County, Florida

LITHOLOGIC WELL LOG PRINTOUT

SOURCE - FGS

WELL NUMBER: W-19634
TOTAL DEPTH: 80 FT.
23 SAMPLES FROM 0 TO 80 FT.

COUNTY: CITRUS
LOCATION: LAT = 28° 42' 0.44"
LON = 82° 33' 57.45"

ELEVATION: FT

COMPLETION DATE:
OWNER/DRILLER:/
WORKED BY: ZACHARY R. ZARRANZ 2017
WELL NAME: West Citrus Core Hole 1; See West Citrus Core Hole 2 (W-19635) for intervals 85'-350'.

0	-	17	090UDSC Undifferentiated Sand and Clay
17	-		124OCAL Ocala Limestone

0	-	1	Sand; Light Gray (N7) To Light Olive Gray (5Y 6/1) Intergranular Grain Size: Fine; Range: Very Fine To Medium Roundness: Sub-angular To Sub-rounded; Medium Sphericity Unconsolidated Induration Accessory Minerals: Clay-3%; Plant Remains-3%; Organics-1%; Iron Stain-<1% Loose sediment in box so exact footage is estimated. Fine grained sand with few clay iron stained chunks, plant roots, and organics.
4	-	8	Sand; Very Light Orange (10YR 8/2) To Light Yellowish Orange (10YR 8/6) Intergranular Grain Size: Fine; Range: Very Fine To Coarse Roundness: Sub-angular To Sub-rounded; Medium Sphericity Unconsolidated Induration Accessory Minerals: Clay-2%; Organics-1% Loose sediment in box so exact footage is estimated. Fine grained sand with parts coated in orange silt. Organics present
8	-	10	Sand; White (N9) To Moderate Yellowish Brown (10YR 5/4) Intergranular Grain Size: Fine; Range: Very Fine To Coarse Roundness: Sub-angular To Sub-rounded; Medium Sphericity Unconsolidated Induration Accessory Minerals: Clay-5%; Phosphatic Sand-1% Loose sediment in box so exact footage is estimated. Fine grained sand with trace phosphate and an increasing clay content.

10	-	13	Clay; Light Yellowish Orange (10YR 8/6) To Moderate Yellowish Brown (10YR 5/4) Intergranular Poor Induration Cement Type(s): Clay Matrix Accessory Minerals: Quartz Sand-30%; Phosphatic Sand-2%; Organics-<1% First indurated interval, sandy clay with trace phosphate and trace organics.
13	-	17	Sand; Very Light Orange (10YR 8/2) To Grayish Brown (10YR 6/2) Intergranular Grain Size: Fine; Range: Very Fine To Coarse Roundness: Angular To Sub-rounded; Medium Sphericity Poor Induration Cement Type(s): Clay Matrix Accessory Minerals: Clay-20%; Phosphatic Sand-2%; Organics-<1%; Limestone-<1% Clayey Sand with trace phosphate sand, limestone in trace amounts is seen for the first time at the bottom of this interval.Top of Ocala Limestone.
17	-	22	Limestone; Grayish Brown (10YR 6/2) To White (N9) Intergranular Grain Type: Calcilutite; Skeletal Grain Size: Very Fine; Range: Very Fine To Fine Poor Induration Cement Type(s): Calcilutite Matrix; Clay Matrix Sedimentary Structures: Interbedded Accessory Minerals: Quartz Sand-10%; Clay-8%; Phosphatic Sand-2% Other Features: Fossiliferous Fossils: Mollusks Limestone and sandy clay interbedded. Dark brown clay and quartz sand around weathered poorly indurated limestone. Fossiliferous interval where Ocala Limestone index fossils are seen for the first time. Quartz sand, clay, and phosphate sand are in this interval.
22	-	23	Limestone; Grayish Brown (10YR 6/2) To White (N9) Intergranular Grain Type: Calcilutite; Skeletal Grain Size: Very Fine; Range: Very Fine To Fine Poor Induration Cement Type(s): Calcilutite Matrix; Clay Matrix Sedimentary Structures: Interbedded Accessory Minerals: Quartz Sand-5%; Clay-4%; Phosphatic Sand-1% Other Features: Fossiliferous Fossils: Mollusks Similar interbedded interval and by 23 feet the dark clay is gone and limestone dominates the lithology going forward. Quartz sand, clay, and phosphate sand are in this interval as cavings.
23	-	28	Wackestone; White (N9) To Light Yellowish Orange (10YR 8/6) Intergranular Grain Type: Calcilutite; Skeletal

Grain Size: Very Fine; Range: Very Fine To Fine
Poor Induration
Cement Type(s): Calcilutite Matrix
Other Features: Friable; Chalky; Fossiliferous
Fossils: Mollusks
Intergranular wackestone that is friable and poorly indurated. Fossils are present but weathered limestone makes it harder to discern them.

28 - 33 Wackestone; White (N9) To Light Yellowish Orange (10YR 8/6)
Intergranular
Grain Type: Calcilutite; Skeletal
Grain Size: Very Fine; Range: Very Fine To Fine
Poor Induration
Cement Type(s): Calcilutite Matrix
Other Features: Friable; Chalky; Fossiliferous
Fossils: Mollusks
Similar to above, friable limestone, fossils are hard to see because of calcilutite coating of grains.

33 - 38 Wackestone; White (N9) To Light Yellowish Orange (10YR 8/6)
Intergranular
Grain Type: Calcilutite; Skeletal
Grain Size: Very Fine; Range: Very Fine To Fine
Poor Induration
Cement Type(s): Calcilutite Matrix
Other Features: Friable; Chalky; Fossiliferous
Fossils: Mollusks
Final interval of rubbly friable wackestone, next interval is more well indurated and more granular than this interval which is calcilutite dominated.

38 - 43 Grainstone; White (N9) To Very Light Orange (10YR 8/2)
Intergranular
Grain Type: Skeletal; Calcilutite
Grain Size: Medium; Range: Fine To Medium
Moderate Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%; Iron Stain-<1%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Echinoid; Mollusks; Gastropods
Moderately indurated grainstone that in this interval teeters closely to packstone/grainstone line. Highly fossiliferous and trace calcite and iron stain.

43 - 46.5 Packstone; White (N9) To Very Light Orange (10YR 8/2)
Intergranular
Grain Type: Skeletal; Calcilutite
Grain Size: Medium; Range: Very Fine To Medium
Moderate Induration
Cement Type(s): Calcilutite Matrix

Accessory Minerals: Calcite-1%

Other Features: Fossiliferous

Fossils: Echinoid; Mollusks; Gastropods; Brachiopod

Less fossiliferous interval, still a packstone but more calcilutite. Lepidocyclina dominates the fossil assemblage in this interval.

46.5 - 50 Wackestone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Calcilutite; Skeletal

Grain Size: Very Fine; Range: Very Fine To Fine

Poor Induration

Cement Type(s): Calcilutite Matrix

Other Features: Chalky

Fossils: Benthic Foraminifera

Calcilutite dominated interval where fossils are not as evident as above, more chalky and no real vugs or molds in this interval.

Intergranular

50 - 52 Packstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Skeletal; Calcilutite

Grain Size: Medium; Range: Very Fine To Medium

Moderate Induration

Cement Type(s): Calcilutite Matrix

Accessory Minerals: Calcite-1%

Other Features: Fossiliferous

Fossils: Benthic Foraminifera; Echinoid; Mollusks; Gastropods

Fossiliferous chalky packstone, where fossils are present and highly concentrated but with depth and within the center of the core the fossils are not as prevalent.

52 - 57 Packstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Skeletal; Calcilutite

Grain Size: Fine; Range: Very Fine To Medium

Poor Induration

Cement Type(s): Calcilutite Matrix

Accessory Minerals: Calcite-1%

Other Features: Fossiliferous

Fossils: Fossil Molds; Benthic Foraminifera; Gastropods

More calcilutite dominated interval, where fossils and molds are present on the outside of the core, but when hit with rock hammer, fossils are not as prevalent in the middle of the core.

57 - 64 Packstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular, Moldic

Grain Type: Skeletal; Calcilutite

Grain Size: Fine; Range: Very Fine To Medium

Poor Induration

Cement Type(s): Calcilutite Matrix

Other Features: Fossiliferous; Chalky

Fossils: Fossil Molds; Benthic Foraminifera; Mollusks; Gastropods

Similar to above, when fractured with hammer, fossils are prevalent in the center of the core. Predominately Lepidocyclina and Nummulites.

62 - 64 Packstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Skeletal; Calcilutite

Grain Size: Fine; Range: Very Fine To Medium

Poor Induration

Cement Type(s): Calcilutite Matrix

Other Features: Fossiliferous; Chalky

Fossils: Fossil Molds; Benthic Foraminifera; Mollusks; Gastropods

Similar to above, highly fossiliferous packstone.

64 - 69 Packstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Skeletal; Calcilutite

Grain Size: Fine; Range: Very Fine To Medium

Poor Induration

Cement Type(s): Calcilutite Matrix

Accessory Minerals: Calcite-1%

Other Features: Fossiliferous; Chalky

Fossils: Fossil Molds; Benthic Foraminifera; Mollusks; Gastropods

More fossiliferous and granular than above, packstone with Lepidocyclina and Nummulites with other fossils and molds.

69 - 71.5 Packstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Skeletal; Calcilutite

Grain Size: Fine; Range: Very Fine To Fine

Poor Induration

Cement Type(s): Calcilutite Matrix

Other Features: Fossiliferous; Chalky

Fossils: Benthic Foraminifera; Mollusks; Gastropods

Packstone with smoother chalk like texture on the outside of the core. Highly fossiliferous interval where fossils are not seen on the outside of core like the other intervals in this box and others. With depth tending back to fossils seen on the outside

71.5 - 73 Grainstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Skeletal; Calcilutite

Grain Size: Medium; Range: Very Fine To Medium

Poor Induration

Cement Type(s): Calcilutite Matrix

Other Features: Fossiliferous; Chalky; Friable

Fossils: Benthic Foraminifera; Mollusks; Gastropods

Much more dense concentration of foraminifera. Interval is friable and tends back to the chalk like interval.

73 - 80 Packstone; White (N9) To Very Light Orange (10YR 8/2)
Intergranular

Grain Type: Skeletal; Calcilutite
Grain Size: Fine; Range: Very Fine To Fine
Poor Induration
Cement Type(s): Calcilutite Matrix
Other Features: Fossiliferous; Chalky
Fossils: Benthic Foraminifera; Mollusks
Finer grained packstone with smoother chalk like texture similar to an interval above this. Forams still present just not as concentrated as in the interval above this. Less than 100% recovery, slightly rubbly.

78 - 80 Packstone; White (N9) To Very Light Orange (10YR 8/2)
Intergranular, Moldic
Grain Type: Skeletal; Calcilutite
Grain Size: Fine; Range: Very Fine To Fine
Poor Induration
Cement Type(s): Calcilutite Matrix
Other Features: Fossiliferous; Chalky
Fossils: Benthic Foraminifera; Mollusks; Fossil Molds
Similar to above, slighlty moldic porosity. Rubbly recovery and less than 100% recovery. See W-19635 for intervals 80'-350'.

Appendix C2. Lithologic Log for COREHOLE 2 West Citrus Well Site in Citrus County, Florida

LITHOLOGIC WELL LOG PRINTOUT

SOURCE - FGS

WELL NUMBER: W-19635
TOTAL DEPTH: 80 FT.
76 SAMPLES FROM 80 TO 350 FT.

COUNTY: CITRUS
LOCATION: LAT = 28° 42' 0.35"
LON = 82° 33' 57.33"

ELEVATION: FT

COMPLETION DATE:
OWNER/DRILLER:/
WORKED BY: ZACHARY R. ZARRANZ 2017
WELL NAME: West Citrus Core Hole 2; See West Citrus Core Hole 1 (W-19634) for intervals 0'-80'.

80	-	157.5	124OCAL	Ocala Limestone
157.5	-		124AVPK	Avon Park Formation

80 - 85 Wackestone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic
Grain Type: Calcilutite; Skeletal
Grain Size: Very Fine; Range: Very Fine To Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous; Chalky
Fossils: Fossil Molds; Benthic Foraminifera; Mollusks; Coral
About 80% recovery for this entire box, as one full row is empty and recovery is rubbly. Wackestone with chalky calcilutite, slight recrystallization, and fossil molds.

85 - 90 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic
Grain Type: Skeletal; Calcilutite
Grain Size: Very Fine; Range: Very Fine To Medium
Moderate Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous; Chalky
Fossils: Fossil Molds; Mollusks; Gastropods
Similar to above, slightly more moldic porosity.

90 - 95 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular
Grain Type: Skeletal; Biogenic
Grain Size: Very Fine; Range: Very Fine To Medium

Moderate Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous
Fossils: Fossil Molds; Mollusks; Benthic Foraminifera; Bryozoa
Larger mollusk fossils, over two inches across, as well as more fossiliferous in general. Lithology similar to above, full recovery.

95 - 100 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic
Grain Type: Skeletal; Biogenic
Grain Size: Fine; Range: Very Fine To Medium
Moderate Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Burrowed
Other Features: Fossiliferous
Fossils: Fossil Molds; Mollusks; Benthic Foraminifera; Bryozoa
Similar to above, burrowed portion of interval clearly dug out and structured. Large mollusk molds present. Overall highly fossiliferous packstone.

100 - 104.5 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic
Grain Type: Skeletal; Calcilutite
Grain Size: Fine; Range: Very Fine To Medium
Good Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-2%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Mollusks; Fossil Molds
Similar to above, more condensed fossil assemblages in this interval.

104.5 - 110 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Pinpoint
Grain Type: Skeletal; Biogenic
Grain Size: Very Fine; Range: Very Fine To Medium
Good Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Fossil Molds
More calcilutite in this interval. Still fossiliferous but not nearly as dense amount of fossils as above.

110 - 115 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic
Grain Type: Skeletal; Biogenic
Grain Size: Very Fine; Range: Fine To Medium
Good Induration

Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Burrowed
Accessory Minerals: Calcite-2%
Other Features: Fossiliferous
Fossils: Fossil Molds; Benthic Foraminifera; Mollusks; Gastropods
Moldic packstone with a trace amount of organics and quartz sand on the outside of core, most likely is the result of post drilling process.

115 - 120 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic, Pinpoint
Grain Type: Skeletal; Skeletal Cast
Grain Size: Very Fine; Range: Very Fine To Medium
Good Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Burrowed
Other Features: Fossiliferous
Fossils: Fossil Molds; Gastropods; Echinoid; Benthic Foraminifera
Similar to above, highly moldic packstone with fossils and fossil molds throughout interval. A yellow stain on the inside of the core at ~199.5'.

120 - 120.5 Wackestone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular
Grain Type: Skeletal; Calcilutite
Grain Size: Very Fine; Range: Very Fine To Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Other Features: Fossiliferous; Low Recrystallization
Fossils: Benthic Foraminifera
Small interval of low recrystallized wackestone, just below this the foram assemblage of the limestone is the same.

120.5 - 125 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic, Pinpoint
Grain Type: Skeletal; Skeletal Cast
Grain Size: Very Fine; Range: Very Fine To Coarse
Moderate Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Miliolids; Gastropods; Fossil Molds
Much less Lepidocyclina and Nummulites. More of a miliolid packstone, almost a grainstone just still noticeable calcilutite.

125 - 130 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic, Pinpoint
Grain Type: Skeletal; Calcilutite
Grain Size: Very Fine; Range: Very Fine To Medium
Good Induration

Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Mollusks; Gastropods; Coral
Similar to above, large brachiopod molds still persist, as well as other fossils and molds that are present throughout the interval.

130 - 135 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Moldic, Pinpoint
Grain Type: Skeletal; Biogenic
Grain Size: Very Fine; Range: Very Fine To Medium
Good Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Miliolids; Gastropods; Mollusks; Coral
Similar to above, smooth but moldic texture of the outside of the core. Tending toward a grainstone. There is crystal growth within the vug spaces.

135 - 140 Grainstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Pinpoint
Grain Type: Skeletal; Calcilutite
Grain Size: Very Fine; Range: Very Fine To Medium
Moderate Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Miliolids
Crystal growth continues and is most noticeable at ~137.5'. Molds are less prevalent and much smaller in this interval. Miliolid grainstone is consistent and only sparingly is this interval calcilutite is more than 10-15%.

140 - 145 Packstone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Pinpoint
Grain Type: Skeletal; Calcilutite
Grain Size: Very Fine; Range: Very Fine To Medium
Good Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Calcite-1%
Other Features: Fossiliferous
Fossils: Benthic Foraminifera; Miliolids; Fossil Molds; Mollusks
Crystal growth still present around vugs. Packstone with more calcilutite than above. Large mollusk shell and shell fragments at the base of this interval and seen in the interval below.

145 - 150 Packstone; White (N9) To Light Yellowish Orange (10YR 8/6)
Intergranular, Moldic, Pinpoint
Grain Type: Skeletal; Calcilutite
Grain Size: Very Fine; Range: Very Fine To Medium

Moderate Induration

Cement Type(s): Calcilutite Matrix

Accessory Minerals: Calcite-2%

Other Features: Fossiliferous; Low Recrystallization

Fossils: Benthic Foraminifera; Mollusks; Miliolids; Gastropods; Fossil Molds

Crystal growth within vugs and on the outside of the core continues. Moldic porosity increases with depth as does iron staining, which is present within the core from ~149'-150'. Fossils are present within the miliolid packstone.

150 - 152 Packstone; White (N9) To Yellowish Gray (5Y 8/1)

Intergranular, Moldic, Pinpoint

Grain Type: Skeletal; Calcilutite

Grain Size: Very Fine; Range: Very Fine To Medium

Good Induration

Cement Type(s): Calcilutite Matrix

Accessory Minerals: Calcite-3%

Other Features: Fossiliferous; Medium Recrystallization

Fossils: Fossil Molds; Brachiopod; Gastropods; Benthic Foraminifera

More recrystallized packstone, with iron stain at the base of the interval. Highly moldic porosity and calcite crystal growth not just within vugs, but now throughout core.

152 - 155.5 Packstone; White (N9) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Skeletal; Crystals

Grain Size: Very Fine; Range: Microcrystalline To Medium

Good Induration

Cement Type(s): Calcilutite Matrix

Sedimentary Structures: Laminated

Accessory Minerals: Calcite-4%; Organics-<1%

Other Features: Medium Recrystallization; Fossiliferous

Fossils: Miliolids; Benthic Foraminifera; Fossil Molds

Archaias present within the miliolid packstone. Moderate recrystallization throughout the interval that increases with depth. Trace organics in one thin layer at 155.5'. Top of Avon Park Formation at 155.5'. Decision to make formation pick based upon over

155.5 - 157.5 Packstone; Very Light Orange (10YR 8/2) To Grayish Orange (10YR 7/4)

Intergranular

Grain Type: Skeletal; Calcilutite

Grain Size: Very Fine; Range: Very Fine To Fine

Good Induration

Cement Type(s): Calcilutite Matrix; Dolomite

Sedimentary Structures: Laminated

Accessory Minerals: Organics-1%

Other Features: Medium Recrystallization; Fossiliferous; Dolomitic

Fossils: Miliolids; Fossil Molds; Benthic Foraminifera

Recrystallized packstone, with organic laminations and a dolomitic component.

157.5 - 158 Dolostone; Very Light Orange (10YR 8/2) To Grayish Orange (10YR 7/4)

Intergranular; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Very Fine To Fine
Good Induration
Cement Type(s): Dolomite
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization
Dolostone interval, last 6 inches of box where the last row is empty. Organics dispersed and a layer is at the base of the interval.

158 - 160 No Sample;

160 - 162 Dolostone; Grayish Brown (10YR 6/2) To Yellowish Gray (5Y 8/1)
Intergranular; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-5%
Laminated dolostone with organics throughout interval, very good induration where interval below is more rubbly and less dense and crystalline. Poor recovery for box as 164'-170' is empty.

162 - 164 Dolostone; Grayish Brown (10YR 6/2) To Yellowish Gray (5Y 8/1)
Intergranular, Fracture; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled
Accessory Minerals: Organics-1%
Fractured dolostone with rubbly recovery compared to interval above. Organics less definitively bedded. Poor recovery for box as 164'-170' is empty.

164 - 170 No Sample;

170 - 175 Dolostone; Grayish Orange (10YR 7/4) To Grayish Brown (10YR 6/2)
Intergranular, Pinpoint, Moldic; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Microcrystalline To
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-2%
Fossils: Fossil Molds
Dolostone with pinpoint vugs and moldic porosity less so. Organic laminations where they are very defined and almost look like plant fossils. Fossil molds of forams present.

175 - 177 Dolostone; Grayish Brown (10YR 6/2) To Grayish Orange (10YR 7/4)
Intergranular, Moldic, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration

Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-1%
Other Features: Fossiliferous
Fossils: Fossil Molds; Echinoid; Mollusks
Highly moldic dolostone with the top of the interval marked by an organic lamination. With depth tending to more densely laminated and darker dolostone with more organics.

177 - 178 Dolostone; Moderate Yellowish Brown (10YR 5/4) To Dark Yellowish Brown (10YR 4/2)
Intergranular, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Interval with densely laminated organics.

178 - 180 Wackestone; Yellowish Gray (5Y 8/1) To Grayish Brown (10YR 6/2)
Intergranular
Grain Type: Calcilutite; Skeletal
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Calcilutite Matrix; Dolomite
Accessory Minerals: Dolomite-12%; Calcite-2%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Wackestone coated in organics and partially dolomitized. Fossil molds present and some molds have become crystallized calcite. Less than 100% recovery.

180 - 181.5 Wackestone; Grayish Orange (10YR 7/4) To Yellowish Gray (5Y 8/1)
Intergranular, Pinpoint
Grain Type: Skeletal; Skeletal Cast
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Calcilutite Matrix; Dolomite
Accessory Minerals: Dolomite-20%
Other Features: Dolomitic
Fossils: Fossil Molds
Wackestone with dolomitic influence where dolomite crystals are increasing with depth. Where dolomite conversion completely occurs within the next two feet of core.

181.5 - 185 Dolostone; Grayish Brown (10YR 6/2) To Moderate Yellowish Brown (10YR 5/4)
Intergranular, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite; Calcilutite Matrix
Accessory Minerals: Organics-1%
Fossils: Fossil Molds

Calcareous dolostone. Cemented forams still present in interval.

185 - 187.5 Dolostone; Moderate Yellowish Brown (10YR 5/4) To Dark Yellowish Brown (10YR 4/2)
Intergranular, Pinpoint, Moldic; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Accessory Minerals: Organics-1%
Other Features: Sucrosic
Fossils: Fossil Molds; Gastropods
Dolostone with pinpoint vugs and some molds throughout interval. Pinpoint vugs abruptly stop at 187.5'

187.5 - 192 Limestone; Yellowish Gray (5Y 8/1) To Black (N1)
Intergranular
Grain Type: Calcilutite; Skeletal
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Moderate Induration
Cement Type(s): Calcilutite Matrix; Organic Matrix
Sedimentary Structures: Interbedded; Laminated
Accessory Minerals: Organics-30%
Gray interval where organic laminations dominate interval. Limestone and organics interbedded and there are intraclasts. In the interval at the base. The gray organic interbedding continues for another foot after this interval.

192 - 196 Mudstone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Pinpoint
Grain Type: Calcilutite; Skeletal
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Laminated
Accessory Minerals: Organics-2%; Calcite-<1%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Mudstone with low recrystallization throughout interval and fine molds within core as well as pinpoint vugs on the outside of core.

196 - 200 Mudstone; Yellowish Gray (5Y 8/1) To Grayish Brown (10YR 6/2)
Intergranular, Low Permeability
Grain Type: Calcilutite; Skeletal
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Similar to above, organic laminations dissipate. Pinpoint vugs present, more so within the inside of the core. Large fossil mold at the base of the interval, smaller ones seen throughout.

200 - 202 Wackestone; Yellowish Gray (5Y 8/1) To Grayish Orange (10YR 7/4)
Intergranular, Low Permeability
Grain Type: Skeletal; Calcilutite
Grain Size: Very Fine; Range: Very Fine To Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization
Fossils: Fossil Molds; Mollusks; Gastropods; Coral
Gray wackestone that is highly fossiliferous. This interval exhibits low recrystallization, recrystallization is concentrated around corals and other fossil molds. Organics presents intermittently. Potential barnacle fossils seen.

202 - 206 Wackestone; Yellowish Gray (5Y 8/1) To Light Olive Gray (5Y 6/1)
Intergranular
Grain Type: Calcilutite; Skeletal
Grain Size: Microcrystalline; Range: Microcrystalline To Medium
Good Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Mottled
Accessory Minerals: Organics-1%
Other Features: Medium Recrystallization
Fossils: Cones; Fossil Molds; Mollusks; Gastropods
Lighter slightly mottled wackestone, equally fossiliferous to the interval below but recrystallization destroys the skeletal remains, but molds remain mostly intact. Potential barnacle fossils seen.

206 - 210 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Low Permeability, Moldic; Highly (50-90%); Euhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Accessory Minerals: Calcite-1%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Hard dense dolostone with calcite crystal growth in the vug/mold space. Fractured dolostone has its ends coated in calcilutite.

210 - 215 Dolostone; Yellowish Gray (5Y 8/1) To Grayish Orange (10YR 7/4)
Intergranular, Pinpoint, Low Permeability; Highly (50-90%); Euhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Accessory Minerals: Calcite-1%; Iron Stain-<1%
Other Features: Low Recrystallization
Fossils: Fossil Molds; Gastropods
Similar to above, more pinpoint vugs seen on the outside and inside of core. Highly moldic with trace iron stain at base of interval. Crystal growth still present in pinpoint vugs, but not in every vug, growth is more sporadic.

215 - 219.5 Dolostone; Yellowish Gray (5Y 8/1) To Grayish Orange (10YR 7/4)
Intergranular, Low Permeability, Pinpoint; Highly (50-90%); Euhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled
Accessory Minerals: Organics-1%; Iron Stain-<1%
Fossils: Fossil Molds
Similar to above, more dense and less vugular. Organic mottling throughout the last couple feet of the interval and the base of it is marked by a friable organic dolostone.

219.5 - 221 Dolostone; Yellowish Gray (5Y 8/1) To Grayish Brown (10YR 6/2)
Intergranular; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Moderate Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled; Laminated
Accessory Minerals: Organics-4%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Mottled organic interval where organics are more prominent in this interval. Few fossil molds. Samples go back to massive dense dolostone below.

221 - 225 Dolostone; Yellowish Gray (5Y 8/1) To Dark Yellowish Orange (10YR 6/6)
Intergranular, Pinpoint, Low Permeability; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled; Streaked
Accessory Minerals: Organics-2%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Pinpoint vugs throughout interval. Dense massive interval where the only accessory is mottled dolostone that appears in the interval with some organics streaks as well.

225 - 228 Dolostone; Light Yellowish Orange (10YR 8/6) To Dark Yellowish Orange (10YR 6/6)
Intergranular; Highly (50-90%); Euhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Massive
Accessory Minerals: Organics-<1%
Euhedral dolostone that when fractured is very granular and not very recrystallized.

228 - 233 Dolostone; Very Light Orange (10YR 8/2) To Grayish Orange (10YR 7/4)
Intergranular, Pinpoint, Low Permeability; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine

Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization
Fossils: Fossil Molds; Echinoid; Gastropods
Neolaganum dalli seen as molds. Dolostone with pinpoint vugs throughout and fossil molds. Crystallinity tends to anhedral with depth as do laminations.

233 - 235 Dolostone; Dark Yellowish Orange (10YR 6/6) To Moderate Yellowish Brown (10YR 5/4)
Intergranular, Pinpoint, Possibly High Permeability; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Other Features: Low Recrystallization
Fossils: Fossil Molds
More porous interval of dolostone that is most porous at 234'. Tending toward highly moldic dolostone.

235 - 237 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Moldic, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Other Features: Fossiliferous; Low Recrystallization
Fossils: Fossil Molds; Echinoid; Gastropods; Mollusks
Highly moldic dolostone. Fossil molds recrystallized as fractured fossils internal structure is destroyed.

237 - 239.5 Dolostone; White (N9) To Yellowish Gray (5Y 8/1)
Intergranular, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Moderate Induration
Cement Type(s): Dolomite
Fossils: Fossil Molds
White dolostone that becomes less moldic and more chalky and less indurated, base of interval marked by organic laminations.

239.5 - 241 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Moderate Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization
Softer chalkier interval with few organic laminations and low recrystallization.

241 - 242.1 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Possibly High Permeability, Moldic; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Moderate Induration
Cement Type(s): Dolomite
Other Features: Low Recrystallization
Fossils: Fossil Molds
Porous weathered light dolostone with vugs on the inside of the core with low recrystallization.

242.1 - 246.5 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Moderate Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated; Mottled
Accessory Minerals: Organics-3%
Other Features: Low Recrystallization
Organic laminations and mottling throughout interval. Mostly anhedral crystallinity and low recrystallization

246.5 - 248 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Pinpoint, Moldic; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Moldic interval. With minor laminations and recrystallization.

248 - 250 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled; Laminated
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization; Chalky
Chalkier interval with organic mottling and low recrystallization. Fossils and molds are not present as microcystalline dolostone dominates interval.

250 - 255 Dolostone; Yellowish Gray (5Y 8/1) To Yellowish Gray (5Y 7/2)
Intergranular, Low Permeability; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Massive; Laminated; Mottled

Accessory Minerals: Organics-3%

Very consistent massive dolostone, mottled and laminated with organics. Similar to above, and this similar lithology persists till the end of the box at 259.5' where recrystallization is noticeable.

255 - 259.5 Dolostone; Yellowish Gray (5Y 8/1) To Yellowish Gray (5Y 7/2)

Intergranular, Low Permeability, Pinpoint; Highly (50-90%); Anhedral

Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine

Good Induration

Cement Type(s): Dolomite

Sedimentary Structures: Massive; Laminated; Mottled

Accessory Minerals: Organics-3%

Fossils: Fossil Molds

Slightly moldic at 258', but similar to above in the consistent microcrystalline dolostone with organics.

259.5 - 260.5 Dolostone; Yellowish Gray (5Y 8/1) To Grayish Orange (10YR 7/4)

Intergranular, Pinpoint; Highly (50-90%); Subhedral

Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine

Good Induration

Cement Type(s): Dolomite

Sedimentary Structures: Laminated

Accessory Minerals: Organics-1%

Other Features: Medium Recrystallization

Fossils: Fossil Molds

Recrystallized dolostone that marks a contact where, wackestone begins to dominate lithology again. Color change does not make it noticeable but when tested with HCl and Alizarin red, limestone is confirmed as rock type.

260.5 - 265 Wackestone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)

Intergranular

Grain Type: Calcilutite; Skeletal

Grain Size: Very Fine; Range: Microcrystalline To Fine

Good Induration

Cement Type(s): Calcilutite Matrix

Sedimentary Structures: Laminated

Accessory Minerals: Organics-1%

Other Features: Low Recrystallization

Organic laminations at the top of the interval, but consistent white wackestone dominated by calcilutite.

265 - 270 Wackestone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)

Intergranular, Pinpoint

Grain Type: Calcilutite; Skeletal

Grain Size: Very Fine; Range: Microcrystalline To Fine

Good Induration

Cement Type(s): Calcilutite Matrix

Other Features: Low Recrystallization

Fossils: Fossil Molds

Similar to above, increased recrystallization with depth and few fossil molds throughout interval.

270 - 271 Dolostone; Grayish Brown (10YR 6/2) To Moderate Yellowish Brown (10YR 5/4)
Intergranular, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Other Features: Medium Recrystallization
single bed of dolostone with pinpoint vugs. Back to limestone in the next interval.

271 - 276 Wackestone; Yellowish Gray (5Y 8/1) To Grayish Brown (10YR 6/2)
Intergranular, Pinpoint, Moldic
Grain Type: Calcilutite; Skeletal
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Laminated
Accessory Minerals: Organics-<1%
Other Features: Low Recrystallization
Fossils: Fossil Molds; Echinoid
Similar to previous wackestone interval. More pinpoint vugs but similar lithology and low recrystallization. Crystal growth in the vug space is present in this interval.

276 - 280 Wackestone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Pinpoint
Grain Type: Calcilutite; Skeletal
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Laminated
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization
Similar to above, trace laminations and low recrystallization throughout interval.

280 - 285 Wackestone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular
Grain Type: Calcilutite; Skeletal
Grain Size: Very Fine; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Laminated
Accessory Minerals: Organics-3%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Similar to above, laminations continue throughout as well as recrystallization.

285 - 290 Wackestone; Yellowish Gray (5Y 8/1) To Grayish Brown (10YR 6/2)
Intergranular
Grain Type: Calcilutite; Skeletal

Grain Size: Very Fine; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Sedimentary Structures: Laminated; Mottled
Accessory Minerals: Organics-2%
Other Features: Low Recrystallization
Fossils: Fossil Molds
Similar to above, consistent wackestone with low recrystallization. Organics are seen in other parts of the interval, more than just laminations.

290 - 295 Wackestone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Pinpoint
Grain Type: Calcilutite; Skeletal
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Other Features: Low Recrystallization
Fossils: Fossil Molds
Similar to above, fossil molds and casts are more evident in this interval as calcilutite is not as dominant throughout this interval as above.

295 - 300 Wackestone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Pinpoint
Grain Type: Calcilutite; Skeletal
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Calcilutite Matrix
Other Features: Low Recrystallization
Fossils: Fossil Molds
Bedding contact at 296'. Again similar to above, with increased recrystallization with depth.

300 - 303.6 Wackestone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular
Grain Type: Calcilutite; Skeletal Cast
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Calcilutite Matrix; Dolomite
Accessory Minerals: Dolomite-10%
Other Features: Dolomitic
Fossils: Fossil Molds
Wackestone that has a dolomitic influence. Dolomite crystals are present throughout the interval and increase with depth to where the next interval is completely dolomitized.

303.6 - 307.3 Dolostone; Dark Yellowish Orange (10YR 6/6) To Moderate Yellowish Brown (10YR 5/4)
Intergranular, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration

Cement Type(s): Dolomite
Accessory Minerals: Organics-1%
Other Features: Sucrosic
Fossils: Fossil Molds
Sucrosic dolomite with abundant pinpoint vugs, some fossil molds and overall consistent lithology. Base of interval marked by organic laminations.

307.3 - 312 Dolostone; Moderate Yellowish Brown (10YR 5/4) To Dark Yellowish Orange (10YR 6/6)
Intergranular, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Other Features: Medium Recrystallization; Sucrosic
Fossils: Fossil Molds; Echinoid
Similar to above, entire interval is not sucrosic but the majority of the interval is. Echinoid molds are present and the only identifiable mold in the interval.

312 - 316 Dolostone; Dark Yellowish Orange (10YR 6/6) To Light Yellowish Orange (10YR 8/6)
Intergranular, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Very Fine; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Other Features: Sucrosic; Medium Recrystallization
Fossils: Fossil Molds; Echinoid
Similar to above, at 314' dolostone color lightens to more yellow than brown, but crystallinity remains constant in this interval. Again echinoid molds are the only identifiable fossil in the interval.

316 - 320.5 Dolostone; Moderate Yellowish Brown (10YR 5/4) To Dark Yellowish Orange (10YR 6/6)
Intergranular, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Other Features: Sucrosic; Low Recrystallization
Fossils: Fossil Molds
Dolomite with more pinpoint vugs than above, low recrystallization.

320.5 - 322 Dolostone; Grayish Brown (10YR 6/2) To Light Olive Gray (5Y 6/1)
Intergranular; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled
Accessory Minerals: Organics-1%
Hard dolostone with anhedral crystals and organic mottling.

322 - 323.5 Dolostone; Dark Yellowish Orange (10YR 6/6) To Grayish Orange (10YR 7/4)
Intergranular, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Other Features: Medium Recrystallization
Permeable interval where the top of the interval is weathered and recrystallized.

323.5 - 328 Dolostone; Yellowish Gray (5Y 8/1) To Very Light Orange (10YR 8/2)
Intergranular, Moldic, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled
Accessory Minerals: Organics-1%
Other Features: Low Recrystallization; Chalky
Fossils: Fossil Molds
Moldic interval that has less molds with depth. Some organic mottling and recrystallization across the interval. Around fractures within the interval chalky texture is evident.

328 - 332 Dolostone; Moderate Yellowish Brown (10YR 5/4) To Dark Yellowish Orange (10YR 6/6)
Intergranular, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Other Features: Sucrosic; Low Recrystallization
Fossils: Fossil Molds; Echinoid
Brownish sucrosic dolostone. Fossil molds present and are mostly molds of echinoids in this interval.

332 - 336 Dolostone; Grayish Brown (10YR 6/2) To Dark Yellowish Brown (10YR 4/2)
Intergranular, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-1%
Other Features: Sucrosic; Medium Recrystallization
Hard dolostone with laminations of organics, between the laminations are dense pinpoint vugs, sucrosic texture and as well recrystallized dolostone with no pinpoint vugs.

336 - 341 Dolostone; Dark Yellowish Orange (10YR 6/6) To Grayish Brown (10YR 6/2)
Intergranular, Fracture, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Accessory Minerals: Organics-2%

Other Features: Sucrosic; Low Recrystallization
Fossils: Fossil Molds
Organic laminations at the top and at the base of this interval. Anhedral dolomite with pinpoint vugs and fossil molds. Molds of more than just echinoids in this interval.

341 - 343 Dolostone; Grayish Orange (10YR 7/4) To Moderate Yellowish Brown (10YR 5/4)
Intergranular, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Mottled
Accessory Minerals: Organics-<1%
Dolostone with mottling at the base of the interval. Crystalline throughout.

343 - 345.6 Dolostone; Grayish Orange (10YR 7/4) To Moderate Yellowish Brown (10YR 5/4)
Intergranular, Moldic, Pinpoint; Highly (50-90%); Subhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated
Other Features: Chalky; Medium Recrystallization
Fossils: Fossil Molds
More moldic interval, with chalky texture on the inside of the core in places within this interval.

345.6 - 350 Dolostone; Very Light Orange (10YR 8/2) To Grayish Brown (10YR 6/2)
Intergranular, Pinpoint; Highly (50-90%); Anhedral
Grain Size: Microcrystalline; Range: Microcrystalline To Very Fine
Good Induration
Cement Type(s): Dolomite
Sedimentary Structures: Laminated; Mottled
Accessory Minerals: Organics-<1%
Fossils: Fossil Molds; Echinoid
Laminations present with trace organics at 347.5' and 349.5'. Trace mottlings at the base of the interval. Pinpoint vugs and echinoid fossil molds throughout. Total depth of West Citrus CH-2

Appendix D. Digital Photographs of Core Samples Retrieved from the West Citrus Well Site in Citrus County, Florida

Appendix D1. Digital Photographs of Core Samples Retrieved from COREHOLE 1 at the West Citrus Well Site in Citrus County, Florida


GSA
CM
IN


HQ BTM
GSA
CM
IN


GSA
CM
IN


GSA
CM
IN


GSA
CM
IN
BTM


GSA
CM
IN
BTM

Appendix D1. Digital Photographs of Core Samples Retrieved from COREHOLE 2 at the West Citrus Well Site in Citrus County, Florida


GSA
CM
IN


Weg Cons
GSA
CM
IN


GSA
CM
IN


GSA
CM
IN


BTM
GSA
CM
IN


GSA
CM
IN


GSA
CM
IN


GSA
CM
IN


GSA
CM
IN
202
204
206
208
210


GSA
CM
IN
BTM
212
214
216
218
220


GSA
CM
IN


GSA
CM
IN


242
244
246
248
240
242
244
246
248
GSA
CM
IN
Loc? Recent core removed


252
254
256
258
250
252
254
256
258
260
GSA
CM
IN
PROJECT
FROM
TO


GSA
CM
IN
260
262
264
266
268


GSA
CM
IN
270
272
274
276
278
280


GSA
CM
IN


GSA
CM
IN


GSA
CM
IN

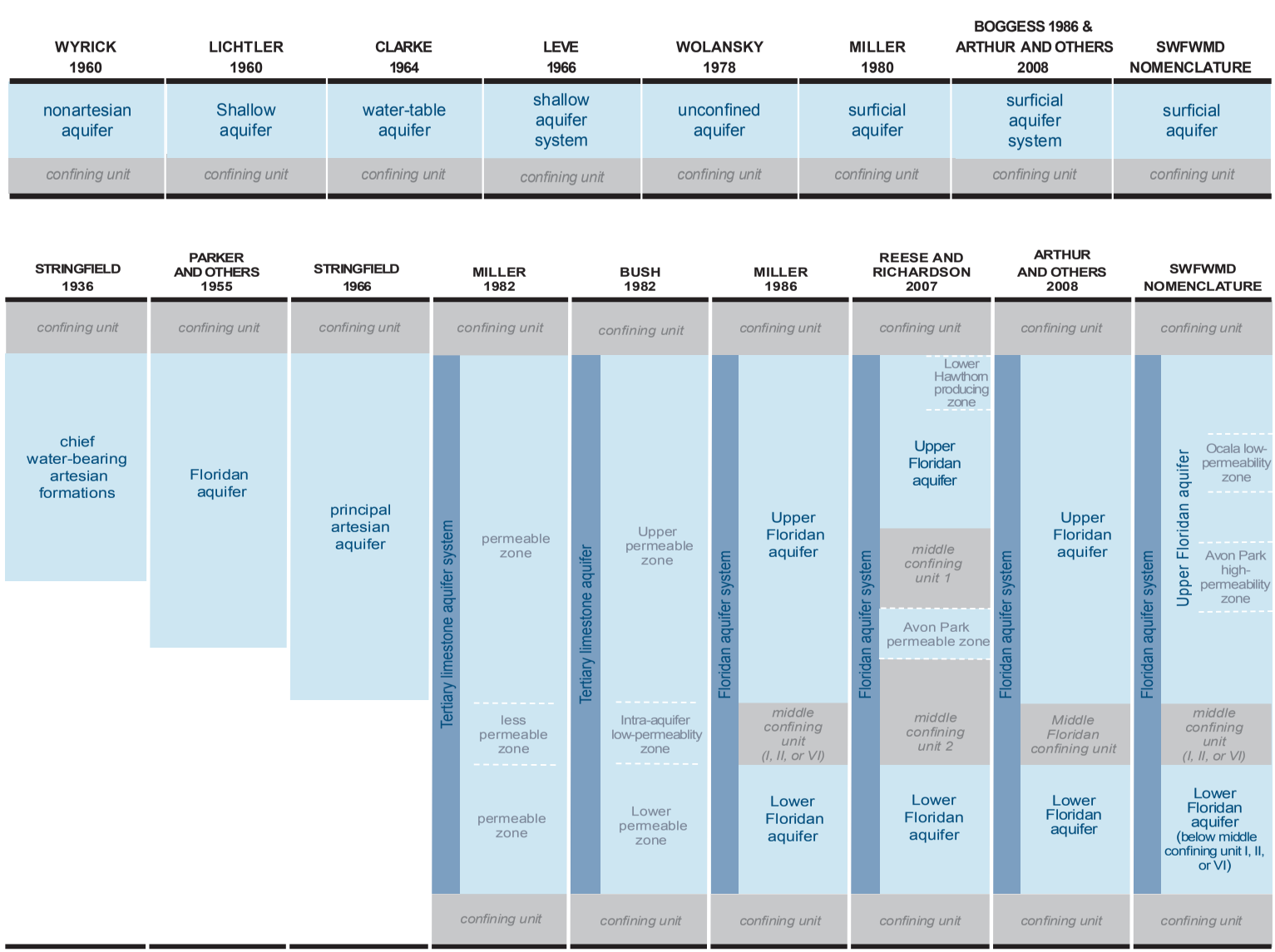

GSA
CM
IN


GSA
CM
IN


GSA
CM
IN


GSA
CM
IN

Appendix E. Correlation Charts for Hydrostratigraphic Units Identified at the West Citrus Well Site in Citrus County, Florida



[Terms shown are for hydrogeologic units present within the Southwest Florida Water Management District]

Figure E1. Nomenclature of (A), the surficial aquifer, (B), the Floridan aquifer system used for the West Citrus well site compared to names in previous reports.

Appendix F. Daily Water Levels Recorded During Exploratory Core Drilling and Testing at the West Citrus Well Site in Citrus County, Florida

[MM/DD/YYYY, month/day/year; HH:MM, hour:minute; ft, feet; bls, below land surface; btoc, below top of casing; NAVD88, North American Veritcal Datum of 1988; --, not recorded; well locations are shown in figure 3; well as-built well diagrams are in appendix B]

Date (MM/DD/YYYY)	Time (HH:MM)	Deepest Casing Depth (ft bls)	Core Hole Total Depth (ft bls)	Core Hole Static Water Level (ft btoc)	Core Hole Static Water Level (ft bls)	Core Hole Static Water Level (ft NAVD88)	Comments
11/1/2016	8:54	80	114	6.07	3.84	4.92	stick up: 2.23 ft
11/2/2016	8:15	80	190	6.11	3.81	4.95	stick up: 2.30 ft
11/3/2016	8:35	80	200	6.31	3.9	4.86	stick up: 2.41 ft
11/4/2016	8:27	160	200	6.15	3.45	5.31	stick up: 2.70 ft
11/7/2016	9:19	160	250	6.5	3.85	4.91	stick up: 2.65 ft
11/8/2016	--	160	300	6.42	4.08	4.68	stick up: 2.34 ft
11/9/2016	--	160	350	9.85	7.49	1.27	stick up: 2.36 ft

Appendix G. Water Quality Data Acquisition Forms for the West Citrus Well Site in Citrus County, Florida

WATER QUALITY SAMPLE ACQUISITION

WQ No. 1

General Information

Wellsite	West Citrus	Date	11/1/2016
Well	COREHOLE 2	Time	13:16
SID#	875942	Performed by	J. Zydek, T. Gates

Well Depth (ft bls)	150	Packed Interval (ft-ft bls)	130-150
Casing (HW) Depth (ft bls)	130	Packed Interval (m-m bls)	39.6-45.7
Casing (HW) Diameter (in.)	3	Initial Test Interval WL (ft bls)	3.99
Hole Diameter (in.)	3	Initial Annulus WL (ft bls)	7.25

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1	0.38	g/ft	X	130	ft (interval)	=	49	gallons
2	0.5	g/ft	X	20	ft (interval)	=	10	gallons
				TOTAL PURGE VOLUME (one) =			59	gallons

Pump Method: 3" submerisble pump set @ 50' btoc (47' bls)

Airline Length: 110 feet

Discharge Rate (gpm): 30 gpm

Purge Volume /Discharge Rate: 2 minutes **X THREE =** 6 minutes

+ 60 min to remove 1400 gal added during coring (airlift at 23 gpm for 60 min)

Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer

Comments: packer installed @ 12:30 pm TOC = 2.23

packer set WL = 6.21' btoc (3.98' bls) ending WL = 6.23' btoc

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft pumping WL = 19.6' btoc

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge			
Time	Sp. Cond.	Temp.	pH
12:57	337	22.93	7.02
12:58	336	22.92	7.05
12:59	336	22.92	7.14
13:00	336	22.91	7.18
13:01	336	22.91	7.2
13:02	336	22.91	7.22

Start Purge 12:49

End Purge 13:15

Sample Time 13:16

LIMS Sample ID: 200921773
LIMS Sub ID: 100071848

Multimeter Serial #02D1017AB

Photometer Serial # A09121570-d56b

Sp. Cond. (µS/cm)	330	Chloride (mg/l)	4.4
Temperature (°C)	22.91	Sulfate (mg/l)	6
pH (SU)	7.28	pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

WATER QUALITY SAMPLE ACQUISITION

WQ No. 2A

General Information

Wellsite	West Citrus	Date	11/2/2016
Well	COREHOLE 2	Time	13:16
SID#	875942	Performed by	J. Zydek, T. Gates

Well Depth (ft bls)	200	Packed Interval (ft-ft bls)	180-200
Casing (HW) Depth (ft bls)	180	Packed Interval (m-m bls)	55-61
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	3.29
Hole Diameter (in.)	3.5	Initial Annulus WL (ft bls)	3.29

after setting packer

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1		g/ft	X	180	ft (interval)	=	117 gallons
2		g/ft	X	20	ft (interval)	=	10 gallons
					TOTAL PURGE VOLUME (one) =		127 gallons

*volume calculated using excel purge volume calculator

Pump Method 3" submerisble pump set @ 75' btoc

Airline Length 110 feet

Discharge Rate (gpm) gpm

Purge Volume /Discharge Rate 117 minutes **X THREE =** minutes

Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer

Comments: Set pump @ 75' btoc TOC = 2.23

WL before packer = 3.38' bls packer set WL = 3.29' bls

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; op[illegible](NQ)=0.3623 gal/ft

Sample not collected

Test Information

Multimeter Serial #

Water Quality During Purge			
Time	Sp. Cond.	Temp.	pH

Start Purge _____

End Purge _____

Sample Time _____

Pump went dry @ this interval. Decide to set packer @ 160' above a large void. Info on WQ 2B sheet

Multimeter Serial # _____ Photometer Serial #

Sp. Cond. (µS/cm)		Chloride (mg/l)	
Temperature (°C)		Sulfate (mg/l)	
pH (SU)		pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? Y or (N)

WATER QUALITY SAMPLE ACQUISITION

WQ No. 2B

General Information

Wellsite West Citrus — Date 11/2/2016
Well COREHOLE 2 — Time 13:30
SID# 875942 — Performed by J. Zydek, T. Gates

Well Depth (ft bls)	200	Packed Interval (ft-ft bls)	160-200
Casing (HW) Depth (ft bls)	160	Packed Interval (m-m bls)	48.8-61
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	
Hole Diameter (in.)	3.5	Initial Annulus WL (ft bls)	

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1	0.38	g/ft	X	160	ft (interval)	=	61	gallons
2	0.5	g/ft	X	40	ft (interval)	=	20	gallons
					TOTAL PURGE VOLUME (one) =		81	gallons

'+160 min to remove 2895 gal added during coring

Pump Method 3" jetsub set @ bls
Airline Length 110 feet
Discharge Rate (gpm) gpm
Purge Volume /Discharge Rate 81/ minutes **X THREE =** minutes

airlift gpm = 18

Collection Method: Surface Discharge or Wireline Bailer or Nested Bailer

Comments: packer installed @ TOC =
packer set WL =

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; ops ole(NQ)=0.3623 gal/ft pumping WL =

Sample not collected

Test Information

Multimeter Seria 02D1017AB

Water Quality During Purge			
Time	Sp. Cond.	Temp.	pH

Start Purge
End Purge
Sample Time

No sample today. Spent most of day trying to fix packer. Sample to be collected on 11/3/16

Multimeter Serial # 02D1017AB

Photometer Serial # A09121570-d56b

Sp. Cond. (µS/cm)		Chloride (mg/l)	
Temperature (°C)		Sulfate (mg/l)	
pH (SU)		pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? Y or (N)

WATER QUALITY SAMPLE ACQUISITION

WQ No. 2C

General Information

Wellsite: West Citrus — Date: 11/3/2016
Well: COREHOLE 2 — Time: 9:00-11:00
SID#: 875942 — Performed by: J. Zydek, T. Gates

Well Depth (ft bls)	200	Packed Interval (ft-ft bls)	150-200
Casing (HW) Depth (ft bls)	150	Packed Interval (m-m bls)	46-61
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	6.32
Hole Diameter (in.)	4	Initial Annulus WL (ft bls)	---

5" casing dropped

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1		g/ft	X	180	ft (interval) =	33	gallons
2		g/ft	X	20	ft (interval) =	56	gallons
					TOTAL PURGE VOLUME (one) =	89	gallons

*volume calculated using excel purge volume calculator

Pump Method: 3" submerisble pump
Airline Length: 110 feet
Discharge Rate (gpm): 20 gpm
Purge Volume /Discharge Rate: 89/20 minutes **X THREE =** 13.5 minutes
Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer
Comments: ending WL = 6.30' btoc

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge

Time	Sp. Cond.	Temp.	pH
9:28	372	23.23	6.34
9:33	361	23.23	7.14
9:38	358	23.24	7.17
9:43	356	23.25	7.18
9:48	357	23.26	7.18
9:53	355	23.24	7.19

Start Purge: 9:23
End Purge: 9:53
Sample Time: 9:53

LIMS Sample ID 200922591
LIMS Sub ID 100071900

Multimeter Serial #02D1017AB

Sp. Cond. (µS/cm)	355
Temperature (°C)	23.24
pH (SU)	7.19

Photometer Serial # A09121570-d56b

Chloride (mg/l)	5.7
Sulfate (mg/l)	<<
pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

WATER QUALITY SAMPLE ACQUISITION

WQ No. 3

General Information

Wellsite: West Citrus | Date: 11/7/2016
Well: COREHOLE 2 | Time: 9:55-10:56
SID#: 875942 | Performed by: J. Zydek, T. Gates

Well Depth (ft bls)	250	Packed Interval (ft-ft bls)	200-250
Casing (HW) Depth (ft bls)	200	Packed Interval (m-m bls)	61-76
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	6.53' btoc
Hole Diameter (in.)	4	Initial Annulus WL (ft bls)	

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1		g/ft	X		ft (interval)	=	76 gallons
2		g/ft	X		ft (interval)	=	33 gallons
				TOTAL PURGE VOLUME (one) =			109 gallons

*volume calculated using excel purge volume calculator

Pump Method: 3" submerisble pump set
Airline Length: 170 feet
Discharge Rate (gpm): 20 gpm
Purge Volume /Discharge Rate: 5.5 minutes **X THREE =** 16.5 minutes
Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer
Comments: pump set @ 75' btoc; starting WL @ 6.53 btoc

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge

Time	Sp. Cond.	Temp.	pH
10:34	537	23.54	7.25
10:36	465	23.58	7.37
10:41	451	23.53	7.41
10:46	443	23.52	7.4
10:51	438	23.51	7.39
10:56	437	23.51	7.4

Start Purge: 10:33
End Purge: 10:56
Sample Time: 10:56

LIMS Sample ID 200922918
LIMS Sub ID 100071934

Multimeter Serial #02D1017AB

Sp. Cond. (µS/cm)	437
Temperature (°C)	23.51
pH (SU)	7.4

Photometer Serial # A09121570-d56b

Chloride (mg/l)	30
Sulfate (mg/l)	<1
pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

WATER QUALITY SAMPLE ACQUISITION

WQ No. 4

General Information

Wellsite: West Citrus — Date: 11/8/2016
Well: COREHOLE 2 — Time: 8:40
SID#: 875942 — Performed by: T. Gates

TOC = 2.34

Well Depth (ft bls)	300	Packed Interval (ft-ft bls)	250-300
Casing (HW) Depth (ft bls)	250	Packed Interval (m-m bls)	76-91
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	6.43 inflated
Hole Diameter (in.)	4	Initial Annulus WL (ft bls)	6.39
Note: 1ft = 0.3048 m		WL before packer inflated	6.42 BTOC

Purge Volume (gallons)

1		g/ft X		ft (interval) =	33	gallons	*volume
2		g/ft X		ft (interval) =	75	gallons	calculated
			TOTAL PURGE VOLUME (one) =		108	gallons	using excel purge volume calculator

Pump Method: 3" submerisble pump
Airline Length: feet
Discharge Rate (gpm): 5 gpm
Purge Volume /Discharge Rate: 108/5 minutes **X THREE =** 65 minutes
Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer
Comments: WL dd = 64.3' BTOC @ 9:35

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge

Time	Sp. Cond.	Temp.	pH
9:35	456	24.31	7.48
9:45	395	24.51	7.59
9:50	388	24.59	7.61
9:55	387	24.65	7.62
10:09	397	24.76	7.63
10:18	396	24.79	7.63
10:26	395	24.82	7.64
10:31	395	24.82	7.64
10:42	395	24.66	7.64

Start Purge: 9:35
End Purge: 10:43
Sample Time: 10:42

LIMS Sample ID: 200923320
LIMS Sub ID: 100071952

Multimeter Serial #02D1017AB 05A1729AF

Sp. Cond. (µS/cm)	395
Temperature (°C)	24.66
pH (SU)	7.64

Photometer Serial # A09121570-d56b

Chloride (mg/l)	42
Sulfate (mg/l)	0
pH (SU)	---

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

WATER QUALITY SAMPLE ACQUISITION

WQ No. 5

General Information

Wellsite West Citrus — Date 11/9/2016
Well COREHOLE 2 — Time
SID# 875942 — Performed by J. Zydek, T. Gates

Well Depth (ft bls)	350	Packed Interval (ft-ft bls)	325
Casing (HW) Depth (ft bls)	160	Packed Interval (m-m bls)	
Casing (HW) Diameter (in.)	3	Initial Test Interval WL (ft bls)	
Hole Diameter (in.)	4	Initial Annulus WL (ft bls)	

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1		g/ft	X		ft (interval)	=	gallons
2		g/ft	X		ft (interval)	=	gallons
				TOTAL PURGE VOLUME (one) =			gallons

Pump Method
Airline Length feet
Discharge Rate (gpm) gpm
Purge Volume /Discharge Rate minutes **X THREE =** minutes
Collection Method: Surface Discharge or Wireline Bailer or Nested Bailer
Comments: Sample collected using geophysical thief

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge			
Time	Sp. Cond.	Temp.	pH

Start Purge N/A
End Purge N/A
Sample Time 13:25

LIMS Sample ID 200923570
LIMS Sub ID 100071976

Multimeter Serial #02D1017AB

Photometer Serial # A09121570-d56b

Sp. Cond. (µS/cm)	6318	Chloride (mg/l)	1800
Temperature (°C)	25.59	Sulfate (mg/l)	170
pH (SU)	6.99	pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

WATER QUALITY SAMPLE ACQUISITION

WQ No. 6

General Information

Wellsite: West Citrus — Date: 11/9/2016
Well: COREHOLE 2 — Time: 14:41
SID#: 875942 — Performed by: J. Zydek, T. Gates

stickup = 2.36

Well Depth (ft bls)	350	Packed Interval (ft-ft bls)	300-350
Casing (HW) Depth (ft bls)	160	Packed Interval (m-m bls)	91-107
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	9.85
Hole Diameter (in.)	4	Initial Annulus WL (ft bls)	---

packer set

Note: 1ft = 0.3048 m

9.95 ending packer WL

Purge Volume (gallons)

1		g/ft	X		ft (interval)	=	115 gallons
2		g/ft	X		ft (interval)	=	33 gallons
				TOTAL PURGE VOLUME (one) =			148 gallons

*volume calculated using excel purge volume calculator

Pump Method: 3" submerisble pump
Airline Length: 170 feet
Discharge Rate (gpm): gpm
Purge Volume /Discharge Rate: 148/30 minutes **X THREE =** 15 minutes
Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer
Comments: ending packer WL = 9.95' btoc

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge

Time	Sp. Cond.	Temp.	pH
15:02	26044	24.25	6.9
15:07	26525	24.29	6.99
15:12	26708	24.31	7.01
15:17	26837	24.33	7.01
15:22	26894	24.34	7.01
15:27	26940	24.35	7.01
15:32	26993	24.36	7.01
15:36	27021	24.36	7.01

Start Purge: 14:52
End Purge: 15:37
Sample Time: 9:53

LIMS Sample ID: 200923569
LIMS Sub ID: 100071976

Multimeter Serial #02D1017AB

Photometer Serial # A09121570-d56b

Sp. Cond. (µS/cm)	27021	Chloride (mg/l)	>10000
Temperature (°C)	24.56	Sulfate (mg/l)	
pH (SU)	7.01	pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

WATER QUALITY SAMPLE ACQUISITION

WQ No. 7

General Information

Wellsite: West Citrus | Date: 11/15/2016
Well: COREHOLE 2 | Time: 8:42-11:41
SID#: 875942 | Performed by: J. Zydek

Well Depth (ft bls)	322	Packed Interval (ft-ft bls)	300-322
Casing (HW) Depth (ft bls)	300	Packed Interval (m-m bls)	91.5-98.2
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	6.55/2.31
Hole Diameter (in.)	4	Initial Annulus WL (ft bls)	---

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1		g/ft X		ft (interval) =	113	gallons	*volume calculated using excel purge volume calculator
2		g/ft X		ft (interval) =	14	gallons	
				TOTAL PURGE VOLUME (one) =	127	gallons	

Pump Method: 3" submersible pump
Airline Length: 170 feet
Discharge Rate (gpm): gpm
Purge Volume /Discharge Rate: 127/8.6 minutes **X THREE =** 45 minutes
Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer
Comments:

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge

Time	Sp. Cond.	Temp.	pH
10:14	3335	24.03	7.84
10:21	5454	24.3	8.83
10:28	5621	24.48	8.72
10:35	5653	24.54	8.67
10:42	5696	24.56	8.6
10:49	5716	24.6	8.52
10:56	5724	24.64	8.45

Start Purge 10:00
End Purge 10:58
Sample Time 10:57

LIMS Sample ID 200924399
LIMS Sub ID 100072017

Multimeter Serial #02D1017AB

Sp. Cond. (µS/cm)	5724
Temperature (°C)	24.64
pH (SU)	8.45

Photometer Serial # A09121570-d56b

Chloride (mg/l)	2350
Sulfate (mg/l)	100
pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

WATER QUALITY SAMPLE ACQUISITION

WQ No. 8

General Information

Wellsite: West Citrus | Date: 11/15/2016
Well: COREHOLE 2 | Time: 11:41
SID#: 875942 | Performed by: J. Zydek

Well Depth (ft bls)	322	Packed Interval (ft-ft bls)	290-322
Casing (HW) Depth (ft bls)	290	Packed Interval (m-m bls)	88.4-98.2
Casing (HW) Diameter (in.)	3.06	Initial Test Interval WL (ft bls)	
Hole Diameter (in.)	4	Initial Annulus WL (ft bls)	

Note: 1ft = 0.3048 m

Purge Volume (gallons)

1		g/ft X		ft (interval) =	111	gallons	*volume
2		g/ft X		ft (interval) =	21	gallons	calculated
				TOTAL PURGE VOLUME (one) =	132	gallons	using excel purge volume calculator

Pump Method: 3" submerisble pump
Airline Length: 170 feet
Discharge Rate (gpm): 8.6 gpm
Purge Volume /Discharge Rate: 132/8.6 minutes **X THREE =** 45 minutes
Collection Method: (Surface Discharge) or Wireline Bailer or Nested Bailer
Comments: stick up = 2.3

Note: NQ=0.2301 gal/ft; HW=0.6528 gal/ft; open hole(NQ)=0.3623 gal/ft

Test Information

Multimeter Serial # 02D1017AB

Water Quality During Purge

Time	Sp. Cond.	Temp.	pH
12:10	5724	24.06	8.13
12:17	5533	24.46	8.33
12:24	5547	24.59	8.42
12:33	5605	24.63	8.32
12:38	5605	24.66	8.34
12:45	5608	24.7	8.26

Start Purge: 12:00
End Purge: 12:47
Sample Time: 12:45

LIMS Sample ID: 200924400
LIMS Sub ID: 100072017

Multimeter Serial #02D1017AB

Sp. Cond. (µS/cm)	5608
Temperature (°C)	24.7
pH (SU)	8.26

Photometer Serial # A09121570-d56b

Chloride (mg/l)	1700
Sulfate (mg/l)	108
pH (SU)	

Samples Sent to District's Laboratory for Standard Complete Analysis? (Y) or N

Appendix H. Water Quality Data for Samples Collected at the West Citrus Well Site in Citrus County, Florida

Table H1. Field data for the water quality samples collected at the West Citrus well site in Citrus County, Florida

[No., Number; SID, site identification; MM/DD/YYYY, month/day/year; HH:MM, hour:minute; ft, feet; bls, below land surface; ℃, degrees Celsius; SU, standard units; µmhos/cm, micromhos per centimeter; Cl^{1-}, chloride, mg/L, milligrams per Liter; SO_4^{2-}, sulfate; >, greater than; <<, below detection]

Water Quality Sample No.	Monitor Well SID No.	Date (MM/DD/YYYY)	Time (HH:MM)	Sample Interval (ft bls)	Temperature (°C)	pH (SU)	Specific Conductance (µmhos/cm)	Major Anions		Sample Collection Methods/ Remarks
								Cl^{1-} (mg/L)	SO_4^{2-} (mg/L)	
1	875942	11/1/2016	13:16	130-150	22.91	7.28	330	4.4	6	Surface discharge using 3-inch submersible pump
2	875942	11/3/2016	9:53	150-200	23.24	7.19	355	5.7	<<	Surface discharge using 3-inch submersible pump
3	875942	11/7/2016	10:56	200-250	23.51	7.4	437	30	<<	Surface discharge using 3-inch submersible pump
4	875942	11/8/2016	10:43	250-300	24.66	7.64	395	42	<<	Surface discharge using 3-inch submersible pump
5	875942	11/9/2016	13:25	325-350	25.59	6.99	6318	1800	17	Thief sample during geophysical logging
6	875942	11/9/2016	15:37	300-350	24.56	7.01	27021	>10,000	<<	Surface discharge using 3-inch submersible pump
7	875942	11/15/2016	10:57	300-322	24.64	8.45	5724	2350	100	Surface discharge using 3-inch submersible pump
8	875942	11/15/2016	12:46	290-322	24.7	8.26	5608	1700	108	Surface discharge using 3-inch submersible pump

Table H2. Laboratory data for the water quality samples collected at the West Citrus well site in Citrus County, Florida

[No., Number; SID, site identification; MM/DD/YYYY, month/day/year; HH:MM, hour:minute; ft, feet; bls, below land surface; SU, standard units; µmhos/cm, K^{1+}, potassium; Fe^{2+}, iron; Sr^{2+}, strontium; si, silica; SiO_2, silicon dioxide; $CaCO_3$, calcium carbonate]

Water Quality Sample No.	Monitor Well SID No.	Date (MM/DD/YYYY)	Time (HH:MM)	Sample Interval (ft bls)	pH (SU)	Specific Conductance (µmhos/cm)	Major Anions		
							Cl^{1-} (mg/L)	SO_4^{2-} (mg/L)	HCO_3^{1-} (mg/L)
1	875942	11/1/2016	13:16	130-150	8.24	328	5.6	0.7	163.2
2	875942	11/3/2016	9:53	150-200	8.22	354.3	8.9	2	174.5
3	875942	11/7/2016	10:56	200-250	8.32	439.6	37.3	4.8	163.8
4	875942	11/8/2016	10:43	250-300	8.3	405.6	41.9	6.2	134.3
5	875942	11/9/2016	13:25	325-350	8.12	6299.1	1,847.92	255.52	221.5
6	875942	11/9/2016	15:37	300-350	7.96	26624.7	9,331.25	1,235.63	135.6
7	875942	11/15/2016	10:57	300-322	7.93	5693.9	1,753.69	147.47	132.9
8	875942	11/15/2016	12:46	290-322	7.95	5579.4	1,673.56	140.97	120

[Q] Sample was held beyond holding time. Field pH is used in analyses due to a 15 minute holding time.

[U] The ion was analyzed for but not detected. Value is reported as the method detection limit.

[K] The actual value is less than the value given.

Table H3. The equivalent weight and percent equivalent weight for select ions and the water type for water quality

[NO., Number; ft, feet; bls, below land surface; Ca^{2+}, calcium; Mg^{2+}, magnesium; Na^{1+}, sodium; HCO_3^{1-}, bicarbonate; Cl^{1-}, chloride; SO_4^{2-}, sulfate; meq/L, presented as HCO31- because CO32- and H2CO3 are considered negligible in groundwaters with pH less than 8.3 standard units (SU) (Hem, 1985); See tables

Water Quality Sample No.	Sample Interval (ft bls)	Cations							
		Ca^{2+}		Mg^{2+}		Na^{1+}		K^{1+}	
		meq/L	%	meq/L	%	meq/L	%	meq/L	%
1	130-150	3.13	92.6%	0.10	3.07%	0.14	4.18%	3.58E-03	0.11%
2	150-200	3.12	86.2%	0.29	8.12%	0.20	5.58%	4.86E-03	0.13%
3	200-250	2.06	50.8%	1.37	33.88%	0.59	14.58%	0.03	0.74%
4	250-300	2.06	51.0%	1.37	33.86%	0.58	14.45%	0.03	0.72%
5	325-350	6.19	11.0%	9.05	16.08%	40.24	71.48%	0.82	1.45%
6	300-350	22.50	8.4%	42.96	15.95%	200.10	74.30%	3.76	1.40%
7	300-322	13.02	25.8%	5.68	11.25%	31.45	62.31%	0.32	0.64%
8	290-322	13.57	27.1%	5.57	11.11%	30.71	61.24%	0.30	0.59%

micromhos per cemtimeter; Cl1-, chloride; mg/L, milligrams per Liter; SO42-, sulfate; HCO_3^{1-}, bicarbonate; Ca^{2+}, calcium; Mg^{2+}, magnesium; Na^{1+}, sodium;

Major Cations									
Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{1+} (mg/L)	K^{1+} (mg/L)	Fe^{2+} (mg/L)	Sr^{2+} (mg/L)	Si as SiO_2 (mg/L)	Total Dissolved Solids (mg/L)	Total Alkalinity CaCO3 (mg/L)	Comments
62.8	1.26	3.25	0.14[I]	2,220	0.08[I]	6[N1]	185	163.2	Surface discharge using 3-inch submersible pump
62.5	3.57	4.64	0.19[I]	327	0.1	6.6[N1]	203	174.5	Surface discharge using 3-inch submersible pump
41.3	16.7	13.6	1.17	22.4[I]	0.29	8[N1]	233	163.8	Surface discharge using 3-inch submersible pump
41.2	16.6	13.4	1.14	22.8	0.29	11.1[N1]	218	134.3	Surface discharge using 3-inch submersible pump
124	110	925	32	12.4[I]	1.54	6.3[N1]	3530	221.5	Thief sample during geophysical logging
451	522	4,600	147	2,050	5.89	8.7[N1]	17000	135.6	Surface discharge using 3-inch submersible pump
261	69	723	12.7	5.6[U]	1.45	10.8[N1]	3280	132.9	Surface discharge using 3-inch submersible pump
272	67.7	706	11.6	5.6[U]	1.46	10.5[N1]	3250	120	Surface discharge using 3-inch submersible pump

samples collected at the West Citrus well site in Citrus County, Florida

milliequivalents per liter; %, percent; Ls., limestone; Fm., Formation; U FLDN AQ, Upper Floridan aquifer; MCU II, middle confining unit II; total alkalinity is H1 and H2 for sample site ideentification (SID) numbers]

Anions						
HCO_3^{1-}		Cl^{1-}		SO_4^{2-}		
meq/L	%	meq/L	%	meq/L	%	Water Type
2.67	93.9%	0.16	5.5%	0.01	0.51%	Calcium Bicarbonate
2.86	90.7%	0.25	8.0%	0.04	1.32%	Calcium Bicarbonate
2.68	70.0%	1.05	27.4%	0.10	2.60%	Calcium Bicarbonate
2.20	62.7%	1.18	33.7%	0.13	3.68%	Calcium Bicarbonate
3.63	5.9%	52.13	85.3%	5.32	8.71%	Sodium Chloride
2.22	0.8%	263.23	90.4%	25.73	8.83%	Sodium Chloride
2.18	4.0%	49.47	90.4%	3.07	5.61%	Sodium Chloride
1.97	3.8%	47.21	90.6%	2.93	5.63%	Sodium Chloride

Table H4. Select molar ratios for water quality samples collected at the West Citrus well site in Citrus County, Florida

[No., number; ft, feet; bls, below land surface; Cl^{1-}, chloride; SO_4^{2-}, sulfate; Ca^{2+}, calcium; HCO_3^{1-}, bicarbonate; Mg^{2+}, magnesium; Na^{1+}, sodium; total alkalinity is used as HCO_3^{1-} because CO_3^{2-} and H_2CO^3 are considered negligible in groundwaters with pH less than 8.3 standard units (SU) (Hem, 1985); See tables H1 and H2 for sample site identification (SID) numbers]

Water Quality Sample No.	Open Interval (ft bls)	Cl^{1-}:SO_4^{2-}	Ca^{2+}:HCO_3^{1-}	SO_4^{2-}:HCO_3^{1-}	Ca^{2+}:Mg^{2+}	Cl^{1-}:HCO_3^{1-}	Na^{1+}:HCO_3^{1-}	Na^{1+}:Cl^{1-}
1	130-150	21.68	0.59	0.00	30.23	0.06	0.05	0.89
2	150-200	12.06	0.55	0.01	10.62	0.09	0.07	0.80
3	200-250	21.06	0.38	0.02	1.50	0.39	0.22	0.56
4	250-300	18.31	0.47	0.03	1.51	0.54	0.26	0.49
5	325-350	19.60	0.85	0.73	0.68	14.36	11.08	0.77
6	300-350	20.46	5.06	5.79	0.52	118.44	90.03	0.76
7	300-322	32.23	2.99	0.70	2.29	22.71	14.44	0.64
8	290-322	32.17	3.45	0.75	2.44	24.00	15.61	0.65

Southwest Florida
Water Management District