

Tree Hill Nature Center Geothermal Heating & Cooling System

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Tree Hill Nature Center Geothermal Project

- Design and Installation of an Open Loop, Geothermal Heating and Cooling System for the facility located at 7152 Lone Star Road.
- System to replace the outdated and underperforming air-to-air HVAC system currently operating at the facility.
- Opportunity to showcase a modern, energy efficient geothermal heating and cooling system using the Intermediate Aquifer System (IAS)- Hawthorn Group rather than the underlying Floridan Aquifer System, Duval County's primary source of drinking water

Aerial Photograph of Tree Hill Nature Center Facility



Oblique Aerial Photograph of Facility



Project Funding Sources

- Department of Energy, Energy Efficiency Community Block Grant Funds: \$ 31,000 (Ordinance 2010-440-E)
- City of Jacksonville, Environmental Protection Board: \$35,000 (Ordinance 2011-359-E)

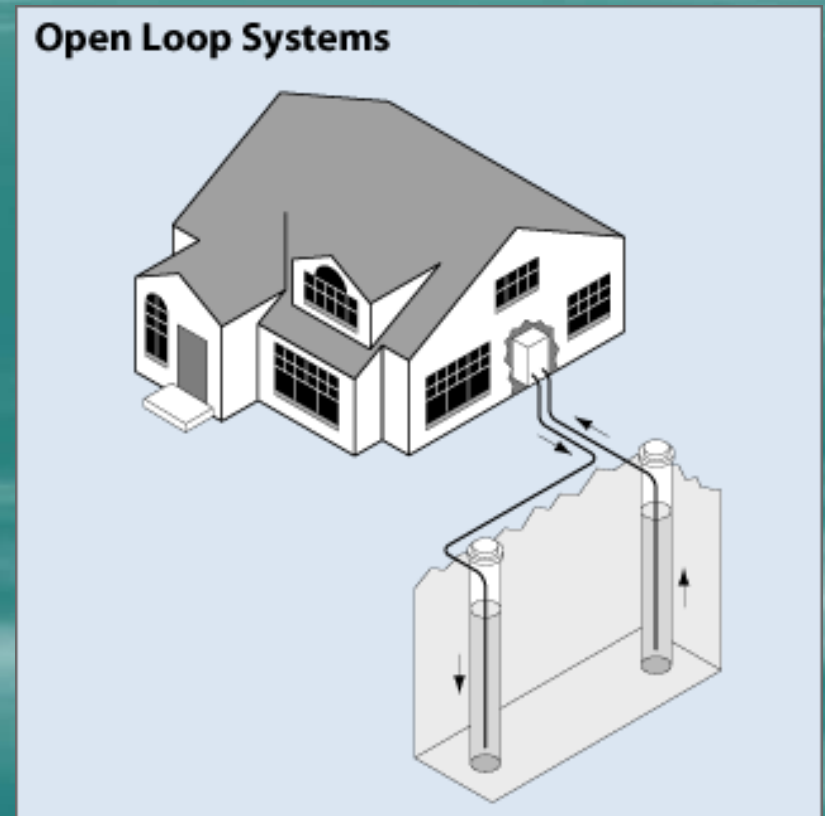
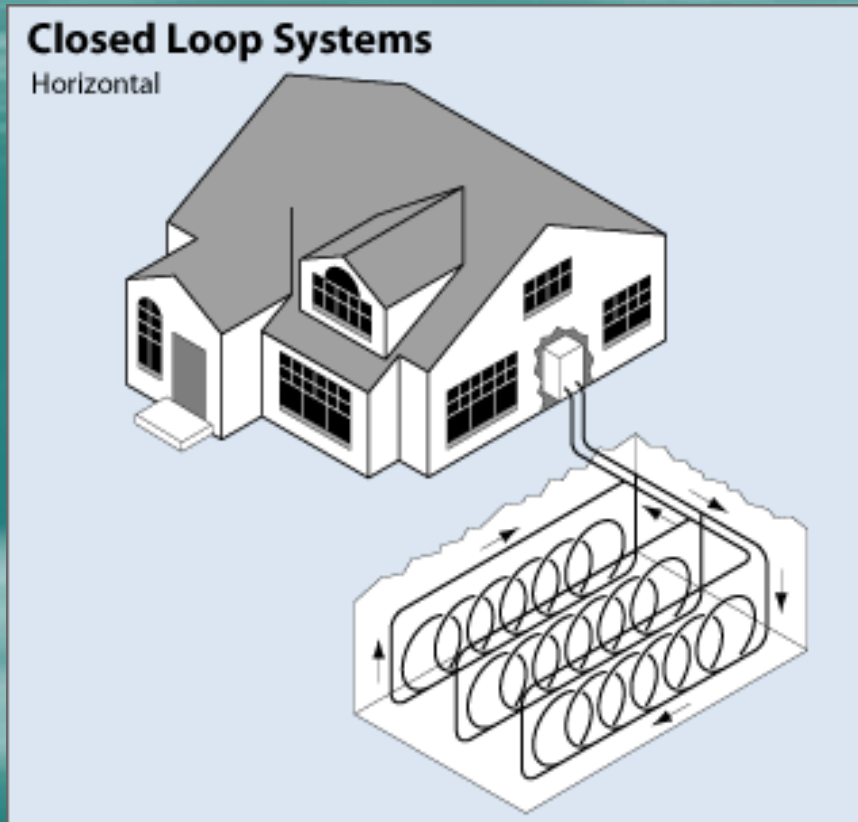
Project Objectives

- Showcase efficient, clean energy Geothermal System.
- Gather data on aquifer hydrogeologic characteristics and groundwater quality to provide objective information on the IAS-Hawthorn Group and encourage its use for appropriate secondary uses such as geothermal, irrigation etc.
- Monitor performance and energy efficiency of new system, as well as groundwater and well parameters.
- Create an educational component for Tree Hill Nature Center visitors

Geothermal Basics

- Geothermal Systems, also referred to as Ground Source Heat Pumps, use the constant temperature of the earth as the heat exchange medium instead of the outside air temperature. The systems use the earth as heat source in the winter or a heat sink in the summer.
- The primary types of systems include closed loop and open loop systems.

Closed and Open Loop Systems



The Tree Hill Project proposes the use of an Open Loop System with one groundwater supply and one return well.

Hydrogeologic Background

- Three major aquifer systems:
 - Surficial
 - Intermediate
 - Floridan

Hydrogeologic Framework - SJRWMD

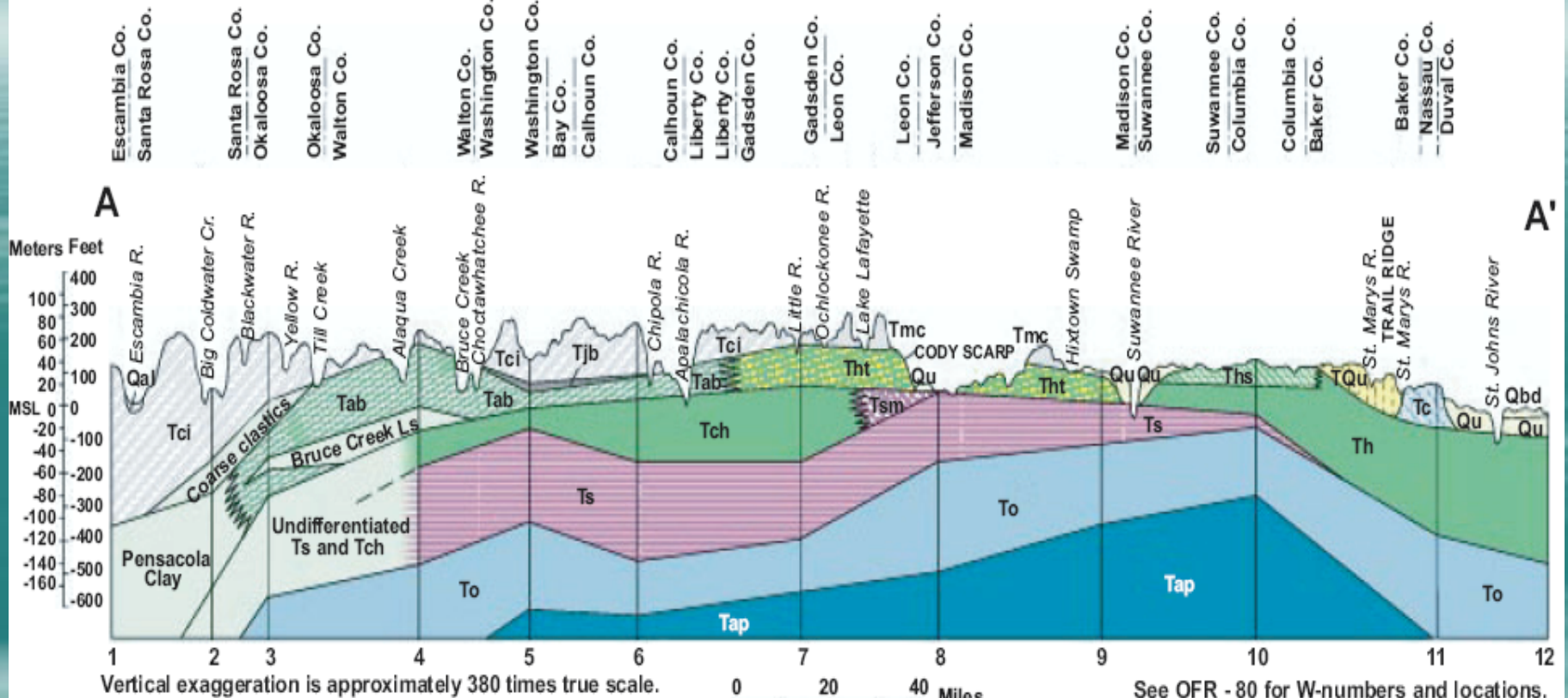
Series	Lithostratigraphic Unit	Hydrostratigraphic Unit
Holocene Pleistocene Pliocene	Undifferentiated marine terrace and fluvial sediments Nashua Formation, Cypresshead Formation, and Tamiami Formation	Surficial Aquifer System (SAS)
Miocene	Hawthorn Group	Intermediate Aquifer System or Intermediate Confining Unit (IAS/ICU)
Oligocene Eocene	Suwannee Limestone Ocala Limestone Avon Park Formation Oldsmar Formation	Floridan Aquifer System (FAS)

Floridan Aquifer System

- Primary drinking water supply for Duval County.
- Composed of Eocene age and older limestone units.
- Highly productive, heavily used aquifer.
- The Top of Floridan, represented by the top of the Ocala Limestone, lies at approximately 300 feet NGVD in the southeastern portion of the county and is deeper than 600 feet NGVD in northeastern Duval County.
- Confined Aquifer.

Geologic Map of the State of Florida - Cross Section A-A'

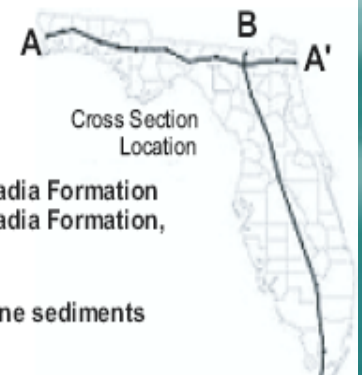
by Thomas M. Scott, P. G. #99, Kenneth M. Campbell, Frank R. Rupert, Jonathan D. Arthur,
Thomas M. Missimer, Jacqueline M. Lloyd, J. William Yon, and Joel G. Duncan



- Quaternary**
- Holocene**
- Qh Holocene sediments
- Pleistocene/Holocene**
- Qal Alluvium
 - Qbd Beach ridge and dune
 - Qu Undifferentiated sediments
- Pleistocene**
- Qa Anastasia Formation
 - Qk Key Largo Limestone

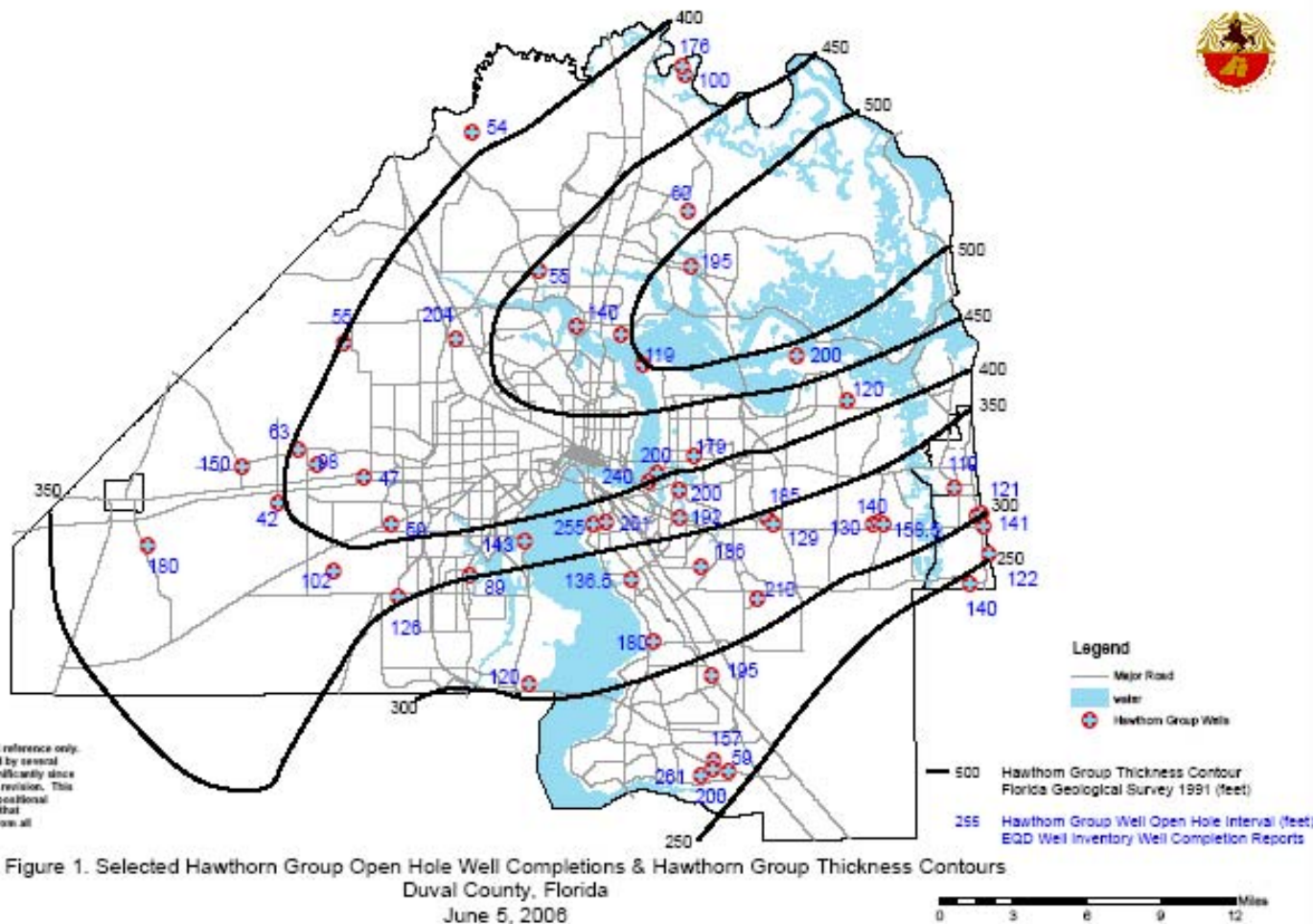
- Tertiary**
- Pliocene**
- Tc Cypresshead Formation
 - Tci Citronelle Formation
 - Tmc Miccosukee Formation
 - Tic Intracoastal Formation
 - Tt Tamiami Formation
 - Tjb Jackson Bluff Formation
- Miocene/Pliocene**
- Thcc Hawthorn Group, Coosawatchie Formation, Charlton Member

- Oligocene/Miocene**
- Tha Hawthorn Group, Arcadia Formation
 - That Hawthorn Group, Arcadia Formation, Tampa Member
- Oligocene**
- Tro Residuum on Oligocene sediments
 - Ts Suwannee Limestone
 - Tsm Suwannee Limestone



Intermediate Aquifer System

- Consists of the sand, shell, clay, and carbonate rock units of the Miocene Age Hawthorn Group - Characterized by phosphatic sediments.
- Serves as the confining unit for the underlying Floridan Aquifer System
- Locally, productive water-bearing zones within the Intermediate Aquifer System are used for domestic, irrigation, and other secondary uses (“Salt & Pepper Wells”) – Confined Aquifer
- Intermediate Aquifer System ranges in thickness from less than 250 feet in the southeastern portion of the county to more than 500 feet thick in northeastern Duval County.
- Heterogeneous aquifer – Variable well yields across Duval County (< 10 GPM to > 60 GPM)



South

← Approximately 490 feet →

North

Drawing Not to Scale

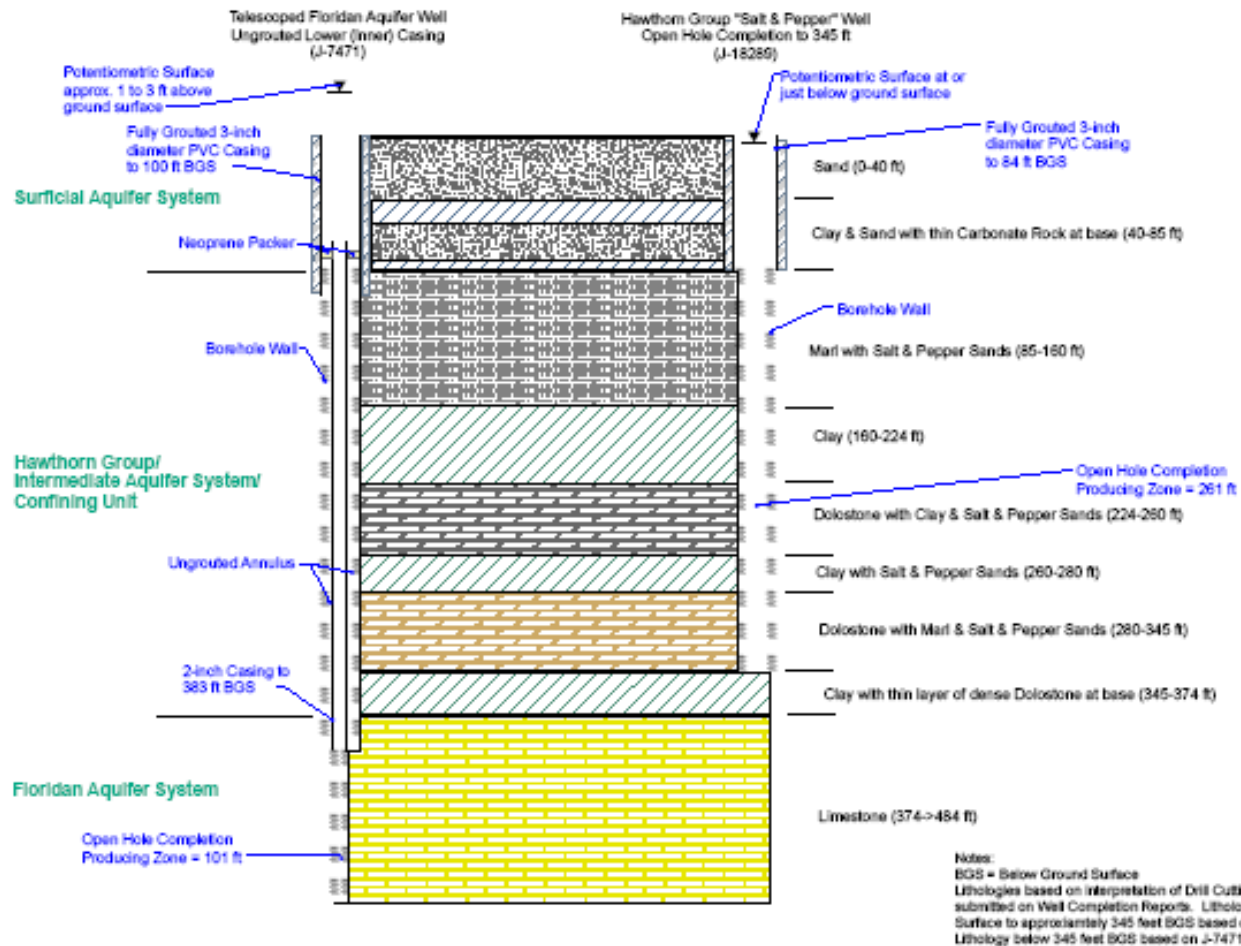


Figure 2. Well Construction Profiles: Hawthorn Group "Salt & Pepper" Well and Telescoped Floridan Aquifer Well with Lithology
Deeder Lane
Southern Duval County, Florida
June 7, 2006

Surficial Aquifer System

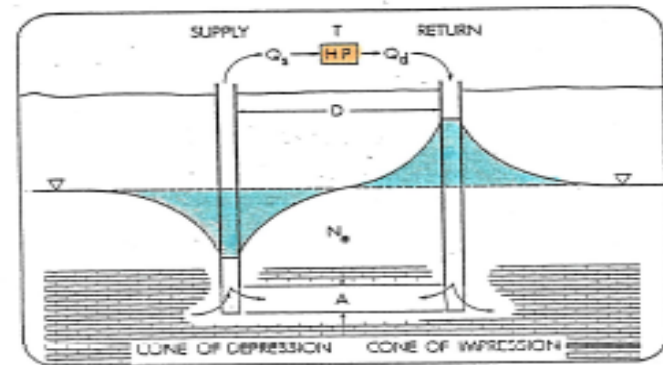
- Consists primarily of recent, undifferentiated sandy marine terrace and fluvial deposits. The Pliocene age sands of the Cypresshead Formation are mapped in western portion of the county. A basal limestone unit is the most productive water-bearing zone within the Surficial Aquifer System.
- Wells in this aquifer system are often used locally for domestic, irrigation, and other secondary uses.
- The thickness of the SAS generally ranges from approximately 50 to 150 feet thick within Duval County.

Hydrogeologic Considerations for Geothermal Systems

- Well Yield and Drawdown – A general rule of thumb requires approximately 2 to 2.5 GPM per ton of heating/cooling system load.
- Separation Distance between Supply Well and Return Well – Designed to ensure heat buildup does not occur within the aquifer and prevent short circuiting of heated return water to the supply well.
- Water Temperature and Quality – Designed to provide water with an adequate temperature difference from the outside air and minimal dissolved minerals.

Supply and Return Wells

- Calculation of the required separation distance between the supply and return well can be estimated using analytical or numerical modeling.



$$D = \sqrt{\frac{T \times Q \times 25}{N_s \times A}}$$

- D = DISTANCE BETWEEN WELLS, IN FEET
 T = AVERAGE HEATING OR COOLING PERIOD, IN DAYS
 Q = FLOW RATE, IN GALLONS PER MINUTE
 N_s = EFFECTIVE AQUIFER POROSITY
- | | |
|-------------------------|-----------|
| SAND, FINE | .20 |
| MEDIUM | .25 |
| COARSE | .30 |
| DUNE | .45 |
| SHELL, COQUINA | .35 - .40 |
| LIMESTONE, SHALLOW-ROCK | .20 - .30 |
| FLORIDAN | .20 |
- A = THICKNESS OF AQUIFER AT RETURN WELL, IN FEET OF PENETRATION BY SCREEN OR OPEN HOLE
 25 = STANDARD CONVERSION FACTOR

Energy Audit

- A Facility Energy Assessment Report for the Tree Hill Nature Center was completed by Performance Engineering Group, Inc. in April 2011.
- The report recommended the installation of an unit with a minimum capacity of 15 tons.
- Bid Specifications for the mechanical HVAC system were also prepared by Performance Engineering Group, Inc.

Project Tasks

- Task 1: Test Existing Intermediate Aquifer System Well on site to determine well yield, specific capacity, and water temperature/quality.
- Task 2: Complete drilling, construction, and testing of Supply/Return Wells and run piping to facility.
- Task 3: Install HVAC equipment
- Task 4: Install signage, test/monitor system and supply and return wells

Existing IAS Well

- Well reportedly 360 feet deep
- 5-inch casing at surface
- Installed in 1998 by O.E Smith and Sons
- Used for irrigation and various uses
- Groundwater Field Parameters measured by EQD 8/9/2011:
 - pH: 10.73
 - Specific Cond: 523 umhos/cm
 - Temperature: 23.38°C (74.08°F)



Existing SAS Well

- Well depth measured at approximately 79 feet BGS
- 2-inch steel casing
- Open Hole completion within limestone unit of the Surficial Aquifer System
- Located approximately 40 feet from the IAS well
- Water Level at 25.39 feet BTOC on 8/9/2011



Tasks 1 & 2: General Scope of Work for Hydrogeologic Data Collection

- Lithologic logging of drill cuttings generated during well installation.
- Specific capacity testing of supply and return well during well development.
- Perform aquifer pumping test on supply or return well using the other IAS well and the existing SAS on-site well as observation wells.
- Collect baseline samples for major cations/anions, nutrients, TDS, and selected metals analyses. Samples for the same constituents will also be collected at the end of the aquifer pumping test.
- Preparation of a technical report sealed by a groundwater professional registered in the State of Florida (P.G./P.E.)

Project Status

- Tree Hill Nature Center is currently in the process of requesting bids for Tasks 1 & 2.
- Tasks 1, 2, and 3 are projected for completion within approximately four months from the start of site work.

For Additional Information:

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