is driven by indoor usage, it tends to not have high peaks and valleys in month-to-month variability, as shown in **Figure B-1**.

Reuse Demand Variability

Demand data for the reclaimed water reuse system in the ESA does not extend as far back as 1995. In the absence of long term historical reclaimed water PAR demands from EWRF, theoretical irrigation demand data was developed using available meteorological data. The method is based on estimating net irrigation as the difference between crop evapotranspiration (ET_c) and effective rainfall (P_e) as described by Kisekka et al (2016), as shown below:

$$Net\ Irrigation\ (I)\ =\ ET_c - P_e$$

The crop evapotranspiration, which quantifies the water lost from the root zone to atmosphere through soil evaporation and crop evapotranspiration, can be estimated as follows:

$$ET_c\ =\ ET_o \times K_c$$

Where: ET_o is reference evapotranspiration
K_c is the crop coefficient.

The effective rainfall can be estimated based on an empirical method developed by United States Department of Agriculture-Natural Resources and Conservation Service (USDA-NRCS) called TR-21 (USDA, 1970) as described below:

$$P_e(inches) = SF\times[0.70917\ P_t^{0.82416} - 0.1156]\times[\ 10^{0.02426\ ET_c}]$$

Where: P_t is monthly precipitation (inches)
ET_c is the crop evapotranspiration (inches)
SF is the soil water storage factor

The soil water storage factor (SF) is estimated based on usable soil water storage depth (D) using a third-order polynomial equation, as defined below:

$$SF = 0.531747 + 0.295164\ D - 0.057697\ D^2 + 0.003804\ D^3$$

Where: D is the usable soil water storage (inches)

The SFWMD uses the above method to determine allocations for its water use permits (WUPs). While the SFWMD approach uses a modified Blaney-Criddle method to determine evapotranspiration (ET) from long-term average daily meteorological data, daily estimations of ET_o were available for all of Orange County on a 2-kilometer grid basis for 1995-2017 from the U.S. Geological Survey (USGS). Using the ET_o data for east Orange County (Lake Nona region), monthly ET_c was estimated using K_c data for sod (SJRWMD, 2008), as shown in **Table B-1**.

Table B-1. Monthly Crop Coefficient

Month	K_c
1	0.92
2	0.92
3	0.92
4	0.98
5	0.98
6	0.92
7	0.88
8	0.88
9	0.88
10	0.88
11	0.88
12	0.88

A usable soil water storage depth (*D*) of 0.2 was used for east Orange County (SFWMD, 2015) for estimating *SF*. Using the above formulae, estimates of net irrigation were developed for each month during the 1995-2017 period. Gross irrigation was estimated using an irrigation efficiency of 80% for micro-sprinkler systems (Kisekka et al., 2016), a commonly used method for irrigation in Florida.

The theoretical irrigation estimates developed from the above method were highly variable, as they were based entirely on weather (rainfall and ET) and not consistent with the observed data for the area. During high rainfall months, the above method predicted no net irrigation requirement on several occasions, which is not realistic. In actual practice, most irrigation systems are on timer and therefore carry on with irrigation cycles even during wet periods. Therefore, the theoretical estimates were adjusted during a calibration process to match actual PAR irrigation data from OCU's ESA and SSA. For the calibration, monthly irrigation was limited to a minimum of 0.2 inches/month, and a power function calibration factor was used as described below.

$$Y = aX^b$$

Where; *Y* is the calibrated irrigation (inches/month)
X is the estimated irrigation (inches/month)
a and *b* are calibrated factors

The best calibration between the estimated and observed irrigation values from ESA and SSA was achieved using values of a = 1 and b = 0.55 in the power function. As shown in **Figure B-2** the simulated reuse irrigation demand peaking factors for the period from 1995 through 2017 ranged from 0.35 to 1.92, which is similar to actual historical monthly peaking factors observed for the OCU ESA and SSA.

Figure B-3 shows that the frequency distribution of calibrated monthly peaking factor matches well with the actual historical monthly peaking factors observed for the ESA and SSA. The calibrated estimates of irrigation peaking factors matched reasonably well with the actual peaking factors for both the SSA and the ESA and therefore were deemed adequate for use in the water budget modeling exercise.

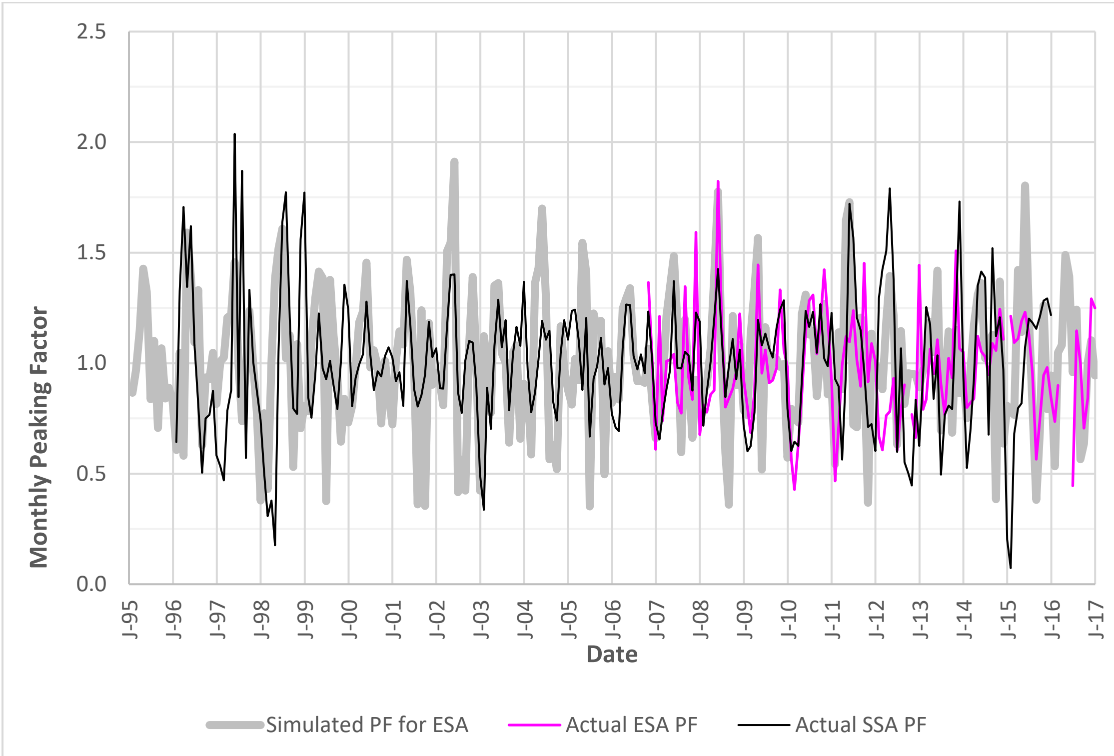

Figure B-2. Simulated and Actual Monthly PAR Irrigation Demand Peaking Factors

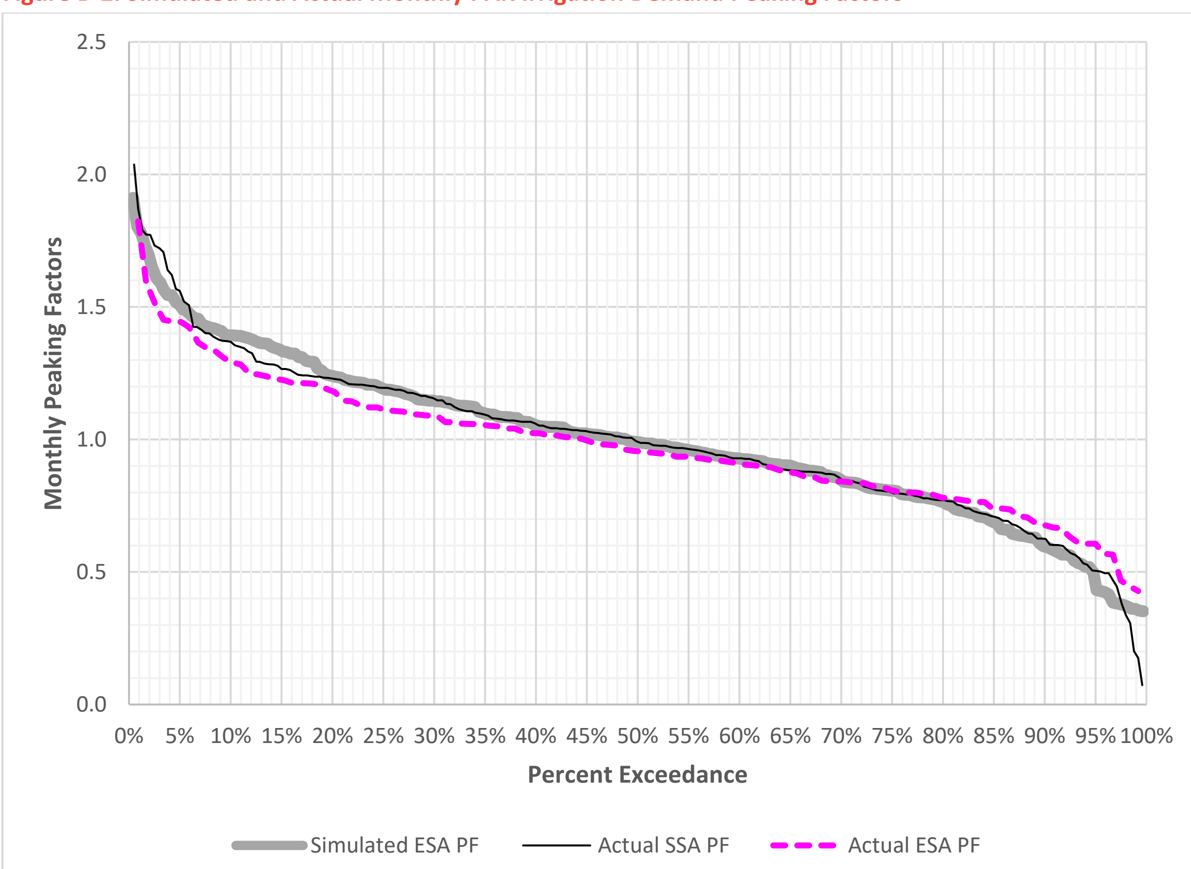

Figure B-3. Frequency Distribution of Simulated and Actual Reuse Irrigation Demand Monthly Peaking Factors

Stanton Energy Center Demand Variability

Figure B-4 shows the historical reclaimed water flows sent to the Orlando Utilities Commission's Stanton Energy Center (SEC) for the 23-year period and the historical monthly peaking factors developed for the SEC monthly demand. As shown in **Figure B-4**, the monthly demand variability at the SEC can be quite variable, reaching a high of 1.89 times annual average, but also dropping to 0.33 during periods of low demand.

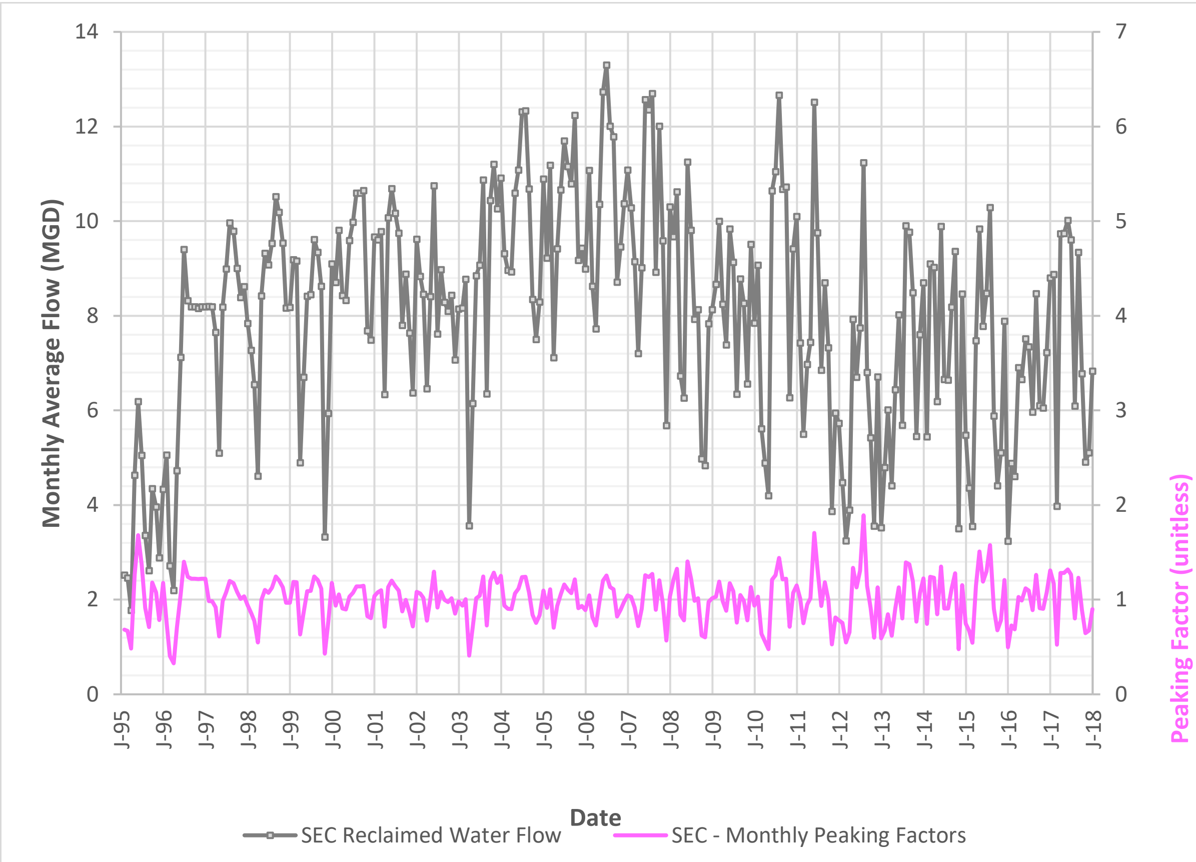

Figure B-4. Historical Reclaimed Water Flow to SEC and Normalized Monthly Peaking Factors

Wetland Hydration Demand Development

Reclaimed water augmentation to meet the minimum hydration demand for the wetlands was estimated by assuming a fixed demand of 1.0 million gallons per day (MGD) annual average daily flow (AADF) for each month, which needed to be met by the combination of rainfall and reclaimed water. Recharge from rainfall directly over the 300-acre wetland was estimated. Reclaimed water augmentation in the model was provided for months when the rainfall volume over the 300-acre wetland was less than 1 MGD AADF. For the 23-year period, the hydration demand of the wetlands met by reclaimed water augmentation was estimated to be about 0.3 MGD AADF, varying between 0.14 and 0.46 MGD AADF, consistent with estimates from previous studies.

Wet Weather Facilities

Wet weather flow from EWRF currently can be sent to the on-site rapid infiltration basins (RIBs), the on-site wetlands, or to the Orlando Easterly Wetland (OEW) system via the City or Orlando's Eastern Regional Reclaimed Water Distribution System (ERRWDS). While flows to the on-site RIBs and wetlands are constrained by the limits in EWRF's Operational Permit, actual limits to flows to these systems comes from practical operation of these systems. Flow to the OEW system is constrained by the available capacity in the City's pipeline at the time of a wet weather event.

RIBs

To model the response of a RIB site in a water budget model, it is important to know the time-variant infiltration capacity of that RIB site. However, a RIB loading study has not been conducted at EWRF to determine site specific estimates of reliable annual average and peak short-term (e.g., monthly) infiltration capacities. Historical data suggests that the EWRF RIBs may have less functional capacity than their permitted capacity of 2.5 MGD AADF. For the purposes of the water budget analysis herein, a functional limit of 1.2 MGD AADF was assumed for the RIBs. A peak month flow constraint for the RIBs was estimated largely based on the above ground storage capacity of the RIBs with some infiltration. For a water depth of 4 feet, the total above ground storage in the 90-acres of RIBs was estimated to be nearly 117 MG, or 3.8 MGD average daily flow (ADF) for the month. Assuming about 1 MGD of infiltration, a maximum month flow constraint of 4.8 MGD ADF for the RIBs was found to be reasonable for use in the water budget analysis, and consistent with historical monthly flow records.

Wetlands

Although, the EWRF wetlands are permitted for 12.2 MGD AADF, it is uncertain whether the wetlands can sustain such flows for an extended period with the current wetland structure and performance. Therefore, a variable range of wetland flows was used for the water budget analysis. For a peak monthly flow limitation, a fixed value of 14.2 MGD ADF was used, as this is the observed historical peak flow sent in a single month. Wetland vegetation usually can withstand high flow variability, but for short periods of time. Highly variable flow through wetlands for longer periods can be detrimental to its vegetation. Therefore, a fixed maximum month value was used for the water budget analysis. It should be noted that the analysis of possible adverse impacts due to the assumed peak month flow of 14.2 MGD for the wetlands was not included in the scope for this project.

ERRWDS

While the agreement with the City allows EWRF to use a peaking factor of 3.0 for flows sent into the ERRWDS, the actual flows to the OEW system via ERRWDS are subject to available capacity in the City system. A small monthly peaking factor of 1.5 was assumed for potential EWRF wet weather flows into the ERRWDS. Therefore, for water budget modeling, ERRWDS flows were constrained at 4.0 MGD AADF annual average and 6.0 MGD ADF peak month flow. The ERRWDS constraints used in the model provide a conservative approach to determining the future wet weather needs for EWRF.

Model Setup

For the 23-year simulation period, the normalized series of reclaimed water supply peaking factors, shown in **Figure B-1**, was converted into a predicted (future) series of anticipated actual monthly flows (over a 23-year period of climatic variability) by multiplying the monthly peaking factors by the projected future AADF supply for the Phase VI planning horizon (i.e., 31 MGD AADF). Similarly, the normalized series of reuse demand peaking factors for both PAR demand and SEC demand, shown in **Figure B-2** and **Figure B-4**, were converted into predicted (future) monthly demands by multiplication of the projected future annual average reuse demands for Phase VI. Reclaimed water augmentation for wetland hydration was estimated each month as rainfall deficit from the estimated 1.0 MGD AADF minimum wetland hydration need. Finally, a future storage capacity of 24 million gallons (MG) in ground storage tanks (GSTs) (12 MG at EWRF, 10 MG at ESA Storage and Repump Facility (SRF) and 2 MG at Lake Pickett SRF) was used in the water budget model for the assumed EWRF Phase VI flow conditions.

For any given month, if the reclaimed water supply exceeded the demand, excess water was sent to storage (up to the available storage volume), and conversely, for months when demand exceeded the supply, any available water in storage was used to help meet the demands. To simulate wet weather discharge (during months when excess reclaimed water was left over after meeting the demands and storage capacity), any remaining excess reclaimed water was directed to wet weather facilities in the following sequence: (1) Wetlands, (2) RIBs, and (3) ERRWDS, subject to the individual constraints for each facility.

Using the 23-year water budget model, the predicted needs for future supplemental supply and additional wet weather discharge facility capacity were determined as follows:

- For any month when the reclaimed water demand exceeded the supply from the plant and the GSTs, the unmet demand was the supplemental supply need predicted for that month.
- In contrast, if reclaimed water supply remained after meeting all demands, filling available storage and sending the maximum feasible to the wetlands, RIBs and the OEW system, the computed leftover supply represented the predicted need for additional wet weather management facility capacity for that month.

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Appendix B

REPORT OF GEOTECHNICAL ENGINEERING INVESTIGATION, EASTERN WATER RECLAMATION FACILITY (GEC, 2003)

Report of Geotechnical Engineering Investigation

EASTERN WATER RECLAMATION FACILITY

CONTRACT "B"

Orange County, Florida

GEC Project No. 1904G

48-25453 7001

Received
SEP 07 2005
Central Dist. SLERP

Geotechnical and Environmental Consultants, Inc.

Geotechnical and Environmental Consultants, Inc.

August 15, 2003

Boyle Engineering Corporation
320 East South Street
Orlando, Florida 32801

Received
SEP 01 2005
Central Dist. SLERP

48-2545337001

Attention: Mr. Dwayne Kreidler, P.E.

Subject: Report of Geotechnical Engineering Investigation
EASTERN WATER RECLAMATION FACILITY
CONTRACT "B"
Orange County, Florida
GEC Project No. 1904G

Dear Mr. Kreidler:

Geotechnical and Environmental Consultants, Inc. (GEC) is pleased to present this Report of Geotechnical Engineering Investigation for the above-referenced project. This investigation was performed in general accordance with the scope of work presented in our Proposal No. 2974G dated October 14, 2002 and authorized by your Sub-Consultant Agreement dated July 16, 2003. The purpose of this investigation was to explore soil and groundwater conditions at the site and use the data obtained to develop geotechnical engineering recommendations to assist in the design and construction of the foundations for the storage tank and peripheral buildings. This report documents our field investigation and presents our geotechnical engineering recommendations for the water reclamation facility plant improvements.

GEC appreciates the opportunity to be of service to you on this project and we trust that the information contained in this report is sufficient to meet your current needs. If you have any questions regarding this report, or if we may be of further assistance, please contact us.

Very truly yours,

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS, INC.

Sharon D. Beverly 8/15/03
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Project Engineer
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Table of Contents

48-254537001

Received
SEP 07 2005
Central Dist. SLERP

1.0 SITE AND PROJECT DESCRIPTIONS

The project area is located in Section 3, Township 23 South, Range 31 East in Orange County, Florida. More specifically, the site is the Eastern Water Reclamation Facility Expansion located on the south side of Alafaya Trail, north of the main entrance to Curtis H. Stanton Energy Plant.

The existing Eastern Water Reclamation Facility (EWRF) and approximate expansion limits for this report are shown on the USGS Oviedo SW Quadrangle map on Figure 1 in the Appendix. Site grades are level at approximately +75 to +77 feet NGVD based on the quadrangle map.

Four 3.0 million-gallon tanks are ultimately planned for the site, as are two peripheral buildings. Each tank will have a diameter of 120 feet and will be approximately 40 feet tall at the center. Water level in the tank will typically reach 35.5 feet. One tank will be built as part of the initial construction. The other tanks will be constructed at a later time. The two at-grade peripheral buildings are a pump station which will occupy 1550 ft^2 and a motor control building which will occupy 800 ft^2. This study does not include any pavement or stormwater ponds, or recommendations for the three (3) future storage tanks.

2.0 SCS SOIL SURVEY REVIEW

The Soil Conservation Service (SCS) Soil Survey of Orange County was reviewed to obtain near-surface soils and groundwater information at the subject site. According to the SCS map, surficial soils in the vicinity of the site are described in the following table:

48-25453700 1

Table 1
SCS Soil Information

Soil Unit Map No.	Soil Name	Depth (in)	Description	USCS Soil Classification Symbol	Depth to Seasonal High Groundwater Level (ft)
34	Pomello fine sand	0 - 80	Sand, fine sand	SP, SP-SM	2 - 3.5
44	Smyrna fine sand	0 - 80	Sand, fine sand	SP, SP-SM, SM	0 - 1

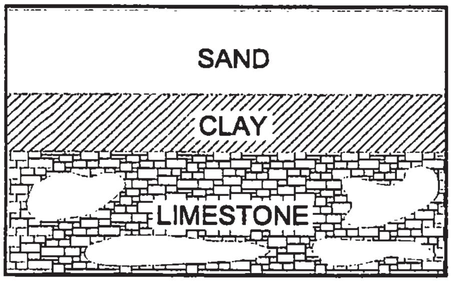
Pomello fine sand is described as moderately well drained and appearing on low ridges on flatwoods. Slopes for Pomello fine sand range from 0 to 5 percent.

Smyrna fine sand is described as nearly level and very poorly drained sand, found in broad flatwood areas.

Information contained in the SCS Soil Survey is very general and may be outdated. It may not therefore be reflective of actual soil and groundwater conditions, particularly if recent development in the site vicinity has modified soil conditions or surface/subsurface drainage.

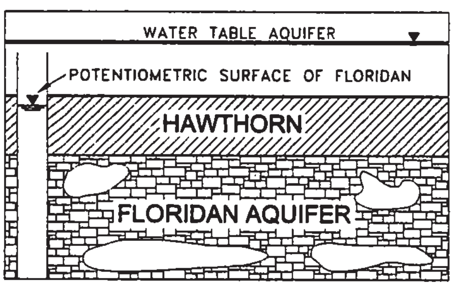
Please refer to Figure 2 for the SCS Soil Survey map.

3.0 AREA GEOLOGY



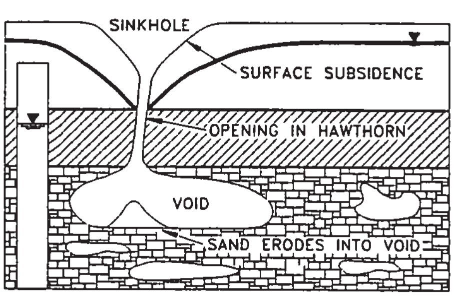
Karst Geology of Central Florida

Due to its prevalent geology, referred to as karst, Central Florida is prone to the formation of sinkholes, or large, circular depressions created by local subsidence of the ground surface. The nature and relationship of the three sedimentary layers typical of Central Florida geology cause sinkholes. The deepest, or basement, layer is a massive cavernous limestone formation known as the Floridan aquifer. The Floridan aquifer limestone is overlain by a silty or clayey sand, clay, phosphate, and limestone aquitard (or flow-retarding layer) ranging in thickness from nearly absent to greater than 100 feet and locally referred to as the Hawthorn formation. The Hawthorn formation is in turn overlain by a 40 to 70-foot thick surficial layer of sand, bearing the water table aquifer. The likelihood of sinkhole occurrence at a given site within the region is determined by the relationship among these three layers, specifically by the water (and soil)-transmitting capacity of the Hawthorn formation at that location.



Central Florida Aquifer Systems

The water table aquifer is comprised of Recent and Pleistocene sands and is separated from the Eocene limestone of the Floridan aquifer by the Miocene sands, clays and limestone of the Hawthorn formation. Since the thickness and consistency of the Hawthorn layer is variable across Central Florida, the likelihood of groundwater flow from the upper to the lower aquifer (known as aquifer recharge) will also vary by geographical location. In areas where the Hawthorn formation is absent, water table groundwater (and associated sands) can flow downward to cavities within the limestone aquifer, like sand through an hourglass, recharging the Floridan aquifer, and sometimes causing the formation of surface sinkholes. This process of subsurface erosion associated with recharging the Floridan aquifer is known as raveling. Thus, in Central Florida, areas of effective groundwater recharge to the Floridan aquifer have a higher potential for the formation of surface sinkholes.



Sinkhole Formation Mechanism

No method of geological, geotechnical, or geophysical

> ... the site lies in an area where the risk of sinkhole formation is low compared to the overall risk across Central Florida.

exploration is known that can accurately predict the occurrence of sinkholes. It is common geotechnical practice in Central Florida to make a qualitative prediction of sinkhole risk on the basis of local geological conditions in the vicinity of a particular site. Based on our review of the U.S. Geological Survey Map entitled "Recharge and Discharge Areas of the Floridan Aquifer in the St. Johns River Water Management District and Vicinity, Florida," 1984, the site lies in an area of low to moderate recharge and, therefore, we can conclude that the site lies in an area where the risk of sinkhole formation is low compared to the overall risk across Central Florida. The potentiometric surface of the Floridan aquifer at the expansion site is about +35 to +36 NGVD according to the September 2002 USGS map entitled "Potentiometric Surface of the Upper Floridan Aquifer in the St. John's River Water Management District and Vicinity, Florida." Since the water table at the site is at much higher elevation, artesian flow is unlikely.

4.0 SUBSURFACE EXPLORATION

In addition to consulting the sources of information previously discussed for regional and site specific soils data, GEC conducted a subsurface exploration to evaluate soil and groundwater conditions.

Subsurface conditions were investigated by performing five Standard Penetration Test (SPT) borings (B-1 through B-5) at the proposed water reclamation facility expansion. Borings B-1 through B-3 were drilled in the proposed storage tank area to a depth of 100 feet and borings B-4 and B-5 were drilled in each of the proposed peripheral building locations to a depth of 25 feet. The borings were surveyed by Buchheit and Associates, Inc. Figure 3 provides a boring location plan for the site.

4.1 SPT Borings

SPT borings were drilled in accordance with ASTM Procedure D-1586. The boreholes were advanced by the rotary wash method with bentonite-based mud used as the circulating fluid to stabilize the borehole. GEC's field crew obtained SPT samples continuously in the borings to a depth of 10 feet and at 5-foot depth intervals thereafter. A GEC engineering technician supervised the drilling operation, and collected, examined and visually classified the samples. He then packaged representative portions of each sample for transport to our laboratory for further examination and laboratory testing. Borings B-1 through B-3 were grouted on completion.

4.2 Laboratory Testing

Selected soil samples retrieved from the borings were tested in accordance with Florida Standard Testing Methods (FM). Florida Standard Testing Methods are adaptations of recognized standard methods, e.g., ASTM and AASHTO, which have been modified to accommodate Florida's geological conditions. The GEC laboratory has been certified by the Construction Materials Engineering Council (CMEC). Our laboratory testing program is summarized below:

Summary of Laboratory Testing Program

Type of Test	Number of Tests
Percent fines (FM 1 - T88)	8

Laboratory soil test results are shown on the boring logs on the Boring Results Sheet in the Appendix.

4.3 Groundwater Measurement

A GEC engineering technician measured the depth to groundwater in the boreholes at the time of drilling and again after approximately 24 hours. Hand auger borings were performed near the SPT boreholes to obtain groundwater levels. At the completion of borings B-1 through B-3, the boreholes were grouted. Once the 24-hour groundwater measurement was recorded, the hand auger boreholes were then backfilled with soil cuttings to prevailing ground surface.

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS

Figure 4 in the Appendix presents the results of our SPT borings. The boring logs describe the soil layers using the Unified Soil Classification System (USCS) symbol (e.g., SP-SM) and ASTM soil descriptions (e.g., sand with silt). We based our soil classifications and descriptions on visual examination and the laboratory testing presented in this report.

The boring results indicate subsurface conditions only at the specific boring locations at the time of our field exploration.

Subsurface conditions, including groundwater levels, at other locations on the subject site may differ from conditions we encountered by our subsurface exploration. Moreover, conditions at the boring locations can change over time. Groundwater levels fluctuate seasonally and soil conditions can be altered by earthmoving operations.

The depths and thicknesses of the subsurface strata indicated on the boring logs were extrapolated from samples obtained at different depths in the borings. The actual transition between soil layers may be different than indicated. *These stratification lines were used for our analytical purposes. Earthwork quantity estimates based on the results of the borings will vary from the actual quantities measured during construction.*

5.1 Boring Results

In general, the SPT borings encountered interbedded layers of loose to dense fine sand with silt (SP-SM) and silty fine sand (SM). Borings B-1 through B-3 also encountered strata of dense to very dense silty fine sand (SM) from about 55 feet below ground surface to boring termination at 100 feet below ground surface. Some shell and "hardpan" were encountered in the borings and traces of elastic silt were encountered in some. No surficial organic soils such as peat or muck were encountered. For specific soil profiles at the boring locations, please refer to the Boring Results sheet (Figure 4) in the Appendix.

5.2 Groundwater Levels

We estimate seasonal high water levels at about 1.5 feet below existing ground surface.

Our technician identified groundwater levels between 1.5 and 2.1 feet below ground surface. We estimate seasonal high water levels at about 1.5 feet below existing ground surface.

Groundwater levels can vary seasonally and with changes in subsurface conditions at boring locations. Alterations in surface and/or subsurface drainage brought about by site development can also affect groundwater levels. *Therefore, groundwater depths measured at different times or at different locations on the site can be expected to vary from the one measured by GEC during this investigation.*

For purposes of this report, the estimated seasonal high groundwater level is defined as the groundwater level that is anticipated at the end of the wet season during a "normal rainfall" year under pre-development site conditions. We define a "normal rainfall" year as a year in which rainfall quantity and distribution were at or near historical averages.

6.0 ANALYSES AND DESIGN RECOMMENDATIONS

The sampling and testing methods used indicate subsurface conditions only at the specific boring locations...

The analyses and recommendations contained in this report are based in part on limited soil sampling, penetration testing and groundwater measurements obtained from our borings. The sampling and testing methods used indicate subsurface conditions only at the specific boring locations