TIERRA

September 21, 2018

AIM Engineering & Surveying, Inc.
5300 Lee Boulevard
Lehigh Acres, FL 33971

Attn: Mr. James E. Toombs, P.E.
Mr. Daniel Schroeder, P.E.

RE: Report of Geotechnical Engineering Services
Southwest Florida Water Management District (SWFWMD)
Water Control Structure
Tsala Apopka Golf Course Structure Modification
Citrus County, Florida
Tierra Project No. 6511-18-143

Gentlemen:

Tierra, Inc. (Tierra) has completed the geotechnical engineering study for the above referenced project. The results of the study are provided herein.

Should there be any questions regarding the report, please do not hesitate to contact our office at (813) 989-1354. Tierra would be pleased to continue providing geotechnical services throughout the implementation of the project. We look forward to working with you and your organization on this and future projects.

Respectfully Submitted,

TIERRA, INC.

Erick M. Frederick, P.E.
Senior Geotechnical Engineer
Florida License No. 63920

Larry P. Moore, P.E.
Principal Geotechnical Engineer
Florida License No. 47673

7351 Temple Terrace Highway • Tampa, FL 33637
Phone (813) 989-1354 • Fax (813) 989-1355
Florida Certificate No. 6486

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PROJECT DESCRIPTION

Project Information

The project site is located at the Inverness Golf and Country Club within Citrus County.

Based on the information provided by AIM Engineering & Surveying, Inc. (AIM) which consisted of the SWFWMD Structure Profile Report revised 2012, we understand that the subject water control structure regulates flow in a canal between Floral City Pool and the Inverness Pool in order to maintain desirable water levels in Lake Tsala Apopka. It is our understanding that the existing control structure is planned to have the structure flow gates replaced with larger gates. The results of the geotechnical exploration in this report are provided to assist the design team with the design of the flow gate replacements.

Scope of Services

The objective of our study was to obtain information concerning subsurface conditions at the proposed project site in order to provide engineering soil parameters and geotechnical recommendations to the design team for the design of the flow gate replacements. Tierra performed the following:

1. Reviewed the “Inverness, Florida” Quadrangle Map published by the United States Geological Survey (USGS), as well as the Soil Survey of Citrus County, Florida, published by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

2. Executed a program of subsurface exploration consisting of three (3) Standard Penetration Test (SPT) borings and two hand auger borings, subsurface sampling, and field testing. The SPT borings were performed to depths ranging from 15 to 40 feet below grade. The hand auger borings were performed to depths on the order of 5 feet below grade.

3. Performed one (1) field permeability test.

4. Visually classified the samples in the laboratory using the Unified Soil Classification System (USCS). Identified soil conditions at the boring locations.

5. Recorded the encountered groundwater level.

6. Prepared this engineering report that summarizes the course of study pursued, the field data generated, subsurface conditions encountered and our engineering recommendations in each of the pertinent topic areas.

The scope of our services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, groundwater, or air, on or below or around this site. The scope of our services did not include determination of the potential for sinkhole activity. Any statements in this report or on the boring logs regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of our client.

SITE AND SUBSURFACE CONDITIONS

General Site Information

The project site is located north of East Sandpiper Drive in Citrus County, Florida. The project location is in proximity to residential areas and the Inverness Golf and Country Club.

USGS Quadrangle Maps

Based on the “Inverness, Florida” United States Geological Survey (USGS) Quadrangle Map, the natural ground elevation at the project site is on the order of +45 feet to +50 feet, National Geodetic Vertical Datum of 1929 (NGVD).

USDA Soil Survey

Based on a review of the Citrus County Soil Survey published by the USDA NRCS, it appears that there is one (1) primary soil-mapping unit noted within the vicinity of the project. The general soil description is presented in the following paragraph and table, as described in the Soil Survey.

Basinger Fine Sand (Map Unit: 5) – The Basinger component makes up 80 percent of the map unit. Slopes are 0 to 2 percent. This component is on drainageways on marine terraces on coastal plains. The parent material consists of sandy marine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 6 inches during June, July, August, September, October and November. Organic matter content in the surface horizon is about 1 percent. This soil meets hydric criteria. The soil has a slightly sodic horizon within 30 inches of the soil surface.

SUMMARY OF USDA SOIL SURVEY CITRUS COUNTY, FLORIDA							
USDA Map Symbol and Soil Name	**Soil Classification**				**pH**	**Seasonal High Water Table**	
	Depth (in)	**USCS**	**AASHTO**	**Permeability (in/hr)**		**Depth (feet)**	**Months**
(5) Basinger	0-3	SP	A-3	6.0-20.0	3.5-7.3	0.0-1.0	June-Nov
	3-8	SP, SP-SM	A-2-4, A-3	6.0-20.0	3.5-7.3		
	8-24	SP, SP-SM	A-2-4, A-3	6.0-20.0	3.5-7.3		
	24-80	SP, SP-SM	A-2-4, A-3	6.0-20.0	3.5-7.3		

It should be noted that information contained in the USDA NRCS Soil Survey may not be reflective of current subsurface conditions, particularly if recent development in the project vicinity has modified existing soils or surface/subsurface drainage.

Subsurface Conditions

The subsurface conditions within the vicinity of the project were explored using three (3) Standard Penetration Test (SPT) boring drilled to depths ranging from 15 feet to 40 feet below the ground surface and two (2) hand auger borings performed to a depth of 5 feet below grade.

The borings were located in the field using a Garmin eTrex® hand-held Global Positioning System (GPS) unit with a reported accuracy of ±10 feet. The approximate boring locations are presented on the **Boring Location Plan** in the **Appendix**.

The SPT borings were performed with the use of a drill rig using Bentonite Mud drilling procedures. The soil sampling was performed in general accordance with American Society for Testing and Materials (ASTM) Test Designation D-1586. The initial 4 feet were manually augered to verify utility clearance. SPT resistance N-values were then recorded to a depth of 10 feet and on intervals of 5 feet thereafter to the boring termination depth. The soil samples were classified in the field and transported to our laboratory for review.

The hand auger borings were performed by manually advancing a bucket auger into the ground typically in six inch increments. As each soil type was revealed, samples were collected and transported to our laboratory for review.

The soil strata encountered in the borings performed at the project site are summarized in the following table:

Stratum Number	Soil Description	USCS Symbol
1	Gray to Brown SAND to SAND with Silt (SP/SP-SM)	SP/SP-SM
2	Gray Sandy CLAY	CL/CH
3	Weathered Limestone	--(1)
4	Gray Clayey SAND	SC
--(1) USCS nomenclature does not include a classification for natural limestone		

The subsurface soil stratification is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The soil profiles included in the **Appendix** should be reviewed for specific information. These profiles include soil descriptions, stratifications, and penetration resistances. The stratifications shown on the boring profile represents the conditions only at the actual boring location. Variations in soil stratigraphy should be expected. The stratifications represent the approximate boundary between subsurface soils and the actual transition may be gradual.

Groundwater Information

The groundwater table was measured at a depth of 3 feet to 3½ feet below the existing grade within the borings performed. The encountered groundwater level is depicted adjacent to the soil profiles in the **Appendix**.

It should be noted that groundwater levels tend to fluctuate during periods of prolonged drought and extended rainfall and may be affected by man-made influences. In addition, a seasonal effect will also occur in which higher groundwater levels are normally recorded in rainy seasons.

Field Permeability Tests

One (1) field permeability test was performed at the location of hand auger HA-1. The test was performed within the Stratum 1 (SP/SP-SM) sandy soils at a depth of approximately 3 feet below existing grade at the location of HA-1. This location is depicted on the **Boring Location Plan** in the **Appendix**. The field permeability test was performed in general accordance with the 1978 U.S. Department of the Interior, Bureau of Reclamation Earth Manual. Based on the results of the field permeability test performed, the coefficient of permeability is 13 feet per day (ft/day). It should be noted that this value was measured within the surficial sand Stratum No. 1 and the rate is the un-factored field value and as such the design engineer should apply the appropriate factor of safety for the proposed design.

RECOMMENDATIONS

General

The results of the borings performed are presented on the **Soil Profiles** in the **Appendix**. The design team should review the information provided in the **Appendix** as it pertains to the proposed design. Tierra has prepared a table of soil parameters to be used by the structural engineer for the design of the proposed sheet pile walls.

The Contractor shall be responsible for all construction requirements based on the subsurface soil and groundwater conditions encountered. If buried organic soils, debris, or unsuitable material is encountered during construction, they should be removed and replaced with clean, compacted engineered fill in accordance with project requirements.

On-Site Soil Suitability

The suitability of the soil for reuse for the project should be evaluated against the project engineering fill requirements. Variations in the subsurface stratifications should be expected between borings. Fill should be placed in accordance with current County requirements.

In general, the soils of Stratum 1 (SP/SP-SM) may be moved and used for grading purposes, site leveling, general engineering fill, and trench backfill, provided the fill is free of organic materials, clay, debris or any other material deemed unsuitable for construction and evaluated against engineering fill requirements.

Site Preparation

Prior to construction, the location of any existing underground utilities within the construction area should be established. Material suitable for re-use may be stockpiled; however, any material stockpiled for re-use shall be tested for conformance to material specifications as indicated in the following sections of this report. Provisions should then be made to relocate any interfering utility lines within the construction area to appropriate locations and backfilling the resulting excavations with compacted structural fill. In this regard, it should be noted that if abandoned underground pipes are not properly removed or plugged, they might serve as conduits for subsurface erosion, which subsequently may result in excessive settlement.

Drainage and Groundwater Concerns

The groundwater level presented in this report is the level that was measured at the time of our field activities. Fluctuation should be anticipated. We recommend that the Contractor determine the actual groundwater levels at the time of the construction to determine groundwater impact on his construction procedure. Care should be given to open excavations and site grading to minimize ponding of surface water.

Excavations

Excavations and temporary side slopes should comply with the Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 C.F.R., s. 1926.650, Subpart P, all subsequent revisions or updates of OSHA's referenced standard adopted by the Department of Labor and Employment Security and Florida's Trench Safety Act, Section 553.62, Florida Statutes.

We are providing this information solely as a service to our client. Tierra does not assume responsibility for construction site safety or the Contractor's or other party's compliance with local, state, and federal safety or other regulations.

Sheet Pile Considerations

We understand that the existing sheet pile will be replaced for the structure modification. Provided in the Appendix of this report are recommended soil parameters for sheet pile wall design.

Clayey soils were encountered beneath the surficial sandy soils and the clayey soils were then underlain by weathered limestone.

To lessen the amount of seepage that will occur from the upstream portion of the control structure, we recommend that the sheet piles extend into the clayey soils encountered at depths ranging from about 20 to 25 feet below grade. The limits of sheet pile extending to the east and west of the control structure should be determined using the permeability test result provided herein (13 feet per day) within the surficial sand strata.

REPORT LIMITATIONS

The conclusions and recommendations contained in this report are opinions based on the site conditions and project layout described herein and further assume that the conditions observed in the exploratory borings is representative of the subsurface conditions throughout the site, i.e., the subsurface conditions elsewhere on the site are the same as those disclosed by the boring. If, during construction, subsurface conditions different from those encountered in the exploratory borings are observed, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary.

If there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if conditions or project layout are changed due to natural causes or construction operations at or adjacent to the site, we recommend that this report be reviewed to determine the applicability of conclusions and recommendations considering the changed conditions and time lapse.

This report was prepared for the exclusive use of AIM Engineering & Surveying, Inc. and their clients for evaluating the design of the project as it relates to the geotechnical aspects discussed herein. It should be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions included in this report. Unanticipated soil conditions may require that additional expense be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

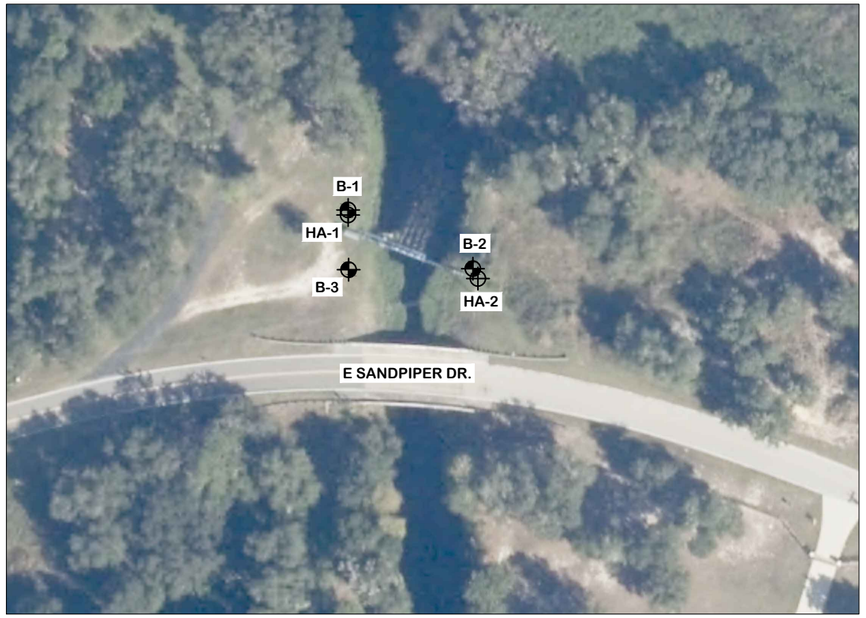
Appendix

Boring Location Plan and Soil Profiles
Recommended Soil Parameters for Sheet Pile Walls

BORING LOCATION PLAN

0 100'

PLAN SCALE

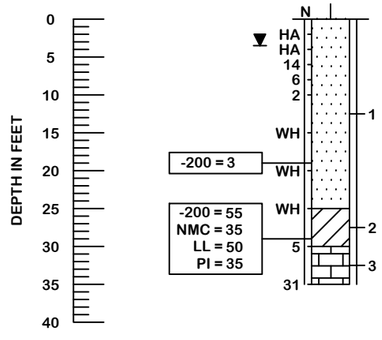


LEGEND

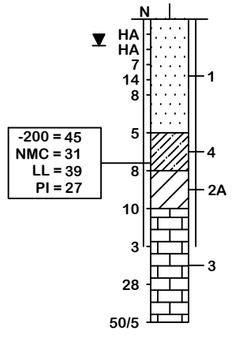
1	GRAY TO BROWN SAND TO SAND WITH SILT (SP/SP-SM)	
2	GRAY SANDY CLAY (CL/CH)	
3	WEATHERED LIMESTONE	
4	GRAY CLAYEY SAND (SC)	
	A - WITH LIMESTONE	
	APPROXIMATE LOCATION OF SPT BORING	
	APPROXIMATE LOCATION OF AUGER BORING	
	GROUNDWATER LEVEL ENCOUNTERED DURING INVESTIGATION	

N	SPT N-VALUE IN BLOWS/FOOT FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED)
SP	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2488) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW
50/4	NUMBER OF BLOWS FOR 4 INCHES OF PENETRATION
HA	HAND AUGERED TO VERIFY UTILITY CLEARANCES
WH	FELL UNDER WEIGHT OF ROD AND HAMMER
| |	CASING
-200	PERCENT PASSING #200 SIEVE
NMC	NATURAL MOISTURE CONTENT (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
EASTING	EASTING COORDINATE REFERENCED TO THE FLORIDA STATE PLANE COORDINATE SYSTEM, FLORIDA WEST ZONE, N.A.D. 83 DETERMINED USING HAND-HELD GARMIN ETREX EQUIPMENT WITH A REPORTED ACCURACY OF 10 FEET
NORTHING	NORTHING COORDINATE REFERENCED TO THE FLORIDA STATE PLANE COORDINATE SYSTEM, FLORIDA WEST ZONE, N.A.D. 83 DETERMINED USING HAND-HELD GARMIN ETREX EQUIPMENT WITH A REPORTED ACCURACY OF 10 FEET

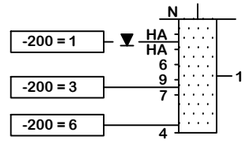
BOR # B-1
EASTING 567199
NORTHING 1628106
DATE 8/21/2018
DRILLER D. STAKELIN
HAMMER AUTOMATIC
RIG CME-55



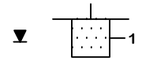
BOR # B-2
EASTING 567282
NORTHING 1628068
DATE 8/21/2018
DRILLER D. STAKELIN
HAMMER AUTOMATIC
RIG CME-55



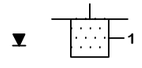
BOR # B-3
EASTING 567200
NORTHING 1628067
DATE 8/21/2018
DRILLER D. STAKELIN
HAMMER AUTOMATIC
RIG CME-55

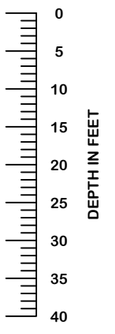


BOR # HA-1
EASTING 567199
NORTHING 1628103
DATE 8/10/2018
DRILLER A. WELCH



BOR # HA-2
EASTING 567285
NORTHING 1628061
DATE 8/10/2018
DRILLER A. WELCH





AUTOMATIC HAMMER	
GRANULAR MATERIALS- RELATIVE DENSITY	SPT (BLOWS/FT.)
VERY LOOSE	LESS THAN 3
LOOSE	3 TO 8
MEDIUM	8 TO 24
DENSE	24 TO 40
VERY DENSE	GREATER THAN 40
SILTS AND CLAYS CONSISTENCY	SPT (BLOWS/FT.)
VERY SOFT	LESS THAN 1
SOFT	1 TO 3
FIRM	3 TO 6
STIFF	6 TO 12
VERY STIFF	12 TO 24
HARD	GREATER THAN 24

DRAWN BY: SW
CHECKED BY: EMF
APPROVED BY: EMF
DATE: SEP 2018
ENGINEER OF RECORD: ERICK M. FREDERICK, P.E.
FLORIDA LICENSE NO.: 63920

TIERRA
7351 Temple Terrace Highway
Tampa, Florida 33637
Phone: 813-989-1354 Fax: 813-989-1355
FL Cert. No.: 6486

SCALE: NOTED
PROJECT NUMBER: 6511-18-143

GEOTECHNICAL ENGINEERING SERVICES
SWFWMD WATER CONTROL STRUCTURE
TSALA APOPKA GOLF COURSE STRUCTURE MODIFICATION (P231)
CITRUS COUNTY, FLORIDA

SHEET 1

RECOMMENDED SOIL PARAMETERS FOR SHEET PILE WALLS

SWFWMD Weir Control Structure
Tsala Apopka Golf Course Structure Modification
TIERRA PROJECT NO. 6511-18-143

Soil Classification	Depth Below Grade (ft)		Unit Weight (pcf)		Cohesion/ Ultimate Shear Strength (psf)	Internal Friction Angle	Wall Friction Angle[(1)]
	from	to	Saturated/ Total	Effective			
VERY LOOSE SAND TO CLAYEY SAND	0	20	105	43	0	28°	14°
FIRM SANDY CLAY TO CLAY	20	25	115	53	625	0°	---
WEATHERED LIMESTONE	25	40	125	63	5,000	0°	---

(1) Wall friction angles and adhesion values apply to steel only.