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▼ Groundwater ▼ Environmental ▼ Geotechnical ▼ Construction Materials Testing

**June 23, 2020**
**GPGT-19-067**

**To:** **GAI Consultants, Inc.**
**618 East South Street, Suite 700**
**Orlando, Florida, 32801**

**Attention: Frank Bellomo, PLA**

**Subject:** **Geotechnical Investigation, Proposed Pine Meadows Conservation Area Site Improvements, Lake County, Florida**

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Dear Mr. Bellomo:

As requested, Andreyev Engineering, Inc. (AEI) has completed a geotechnical investigation for the above referenced project location. The purpose of this geotechnical investigation and evaluation will be to assess the shallow soil and groundwater conditions and provide recommendations for site development, foundation design, pavement section design, and evaluation of the proposed stormwater retention pond areas. Stormwater runoff from the proposed site improvements will be routed into two proposed stormwater retention areas.

This report presents the results of our geotechnical investigation along with an evaluation of the soil and groundwater conditions encountered. In addition, it provides geotechnical engineering recommendations for site preparation, foundation design, pavement section design, and aquifer parameters for stormwater retention system design.

## SITE LOCATION AND DESCRIPTION

The subject site is located in Section 25 Township 18 South, and Range 26 East, in Lake County, Florida. We have included the U.S.G.S. Topographic Map, which depicts the location of the site, is presented on the on the attached **Figure 1**. In addition, the Natural Resources Conservation Service (NRCS) Soil Map, which depicts the location and general soil types of the subject site and is presented on the attached **Figure 2**.

## PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to explore subsurface soil and groundwater conditions at this site for foundation support of the proposed structures on shallow foundations and provide recommendations for site preparation, foundation design, pavement section design, and selection of aquifer parameters for retention pond design. The boring locations were selected by representatives of GAI Consultants, Inc., and the boring locations were surveyed and staked by representatives of Booth, Ern, Straughan, and Hiott, Inc prior to performing fieldwork.

The scope of this investigation included:

- Drilled six (6) Standard Penetration Test (SPT) borings, designated as F-1 through F-5 and B-7, to depths of 15 to 20 feet below ground surface, within proposed structural foundation areas, for general foundation evaluation.

- Drilled five (5) machine auger borings, designated as B-1 through B-5, to a depth of 15 feet below ground surface within the two proposed stormwater retention areas.

- Collected one (1) bulk sample of fine sand material at the location of B-1, remolded one permeability tube sample in our soil laboratory, and conducted laboratory permeability testing on the remolded permeability tube sample to assess soil hydraulic conductivity.

- Drilled one (1) manual auger boring, designated as B-6, to a depth of 7 feet below ground surface within the proposed paved parking/drive area.

Samples were recovered from the borings and returned to AEI's laboratory for visual classification and stratification. Soil strata were classified according to the Unified Soil Classification System (USCS). Approximate boring locations are shown on **Figure 3**, results of the Standard Penetration Test (SPT) borings and auger borings, in profile form, are presented on **Figure 4**. On the profiles, horizontal lines designating the interface between differing materials represent approximate boundaries. The actual transition between layers is typically gradual.

## NATURAL RESOURCES CONSERVATION SERVICE SOIL SURVEY

The publication titled "Soil Survey of Lake County, Florida" published by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) was reviewed. For your reference, we have included a portion of the NRCS Soil Map which depicts the location of the subject site on the attached **Figure 2**. The two soil map units for the subject project location are identified as:

*Soil Map Unit 14:* ***Eureka Loamy Fine Sand, 0 to 2 Percent Slopes***

*Brief Description:* "This is a nearly level, poorly drained soil that has a clayey subsoil. It occupies low areas. **The water table is within a depth of 10 inches during periods of average rainfall. During dry periods, it is at a depth of 10 to 20 inches.** Permeability is very slow, available water capacity is high, and natural fertility is medium. In a representative profile, the surface layer is very dark grayish-brown loamy fine sand about 5 inches thick. The subsurface layer is mottled dark grayish-brown loamy fine sand about 3 inches thick. The subsoil is about 82 inches thick. The upper 6 inches is dark gray clay mottled with yellowish brown and red. The next 37 inches is gray sandy clay that has red and dark red mottles. The next 11 inches is gray sandy clay mottled with red, dark red, and grayish brown, and the lower 28 inches is gray clay mottled with red and strong brown."

**Soil Map Unit 16:* ***Fellowship Fine Sandy Loam, Depressional***

*Brief Description:* "This soil consists of poorly drained and very poorly drained soils that are more than 80 inches thick. Fellow ship soils are formed in clayey marine sediments. They are on uplands of Peninsular Florida. **Poorly drained on uplands with a seasonal high water table at depths of 0.5 to 1.5 feet for 1 to 4 months in most years and very poorly drained in depressions with a water table at or above the surface for much of the year.**"

* This soil map unit is not present in the 1975 NRCS Soil Survey publication for Lake County, including revisions made to soil descriptions in 2004, and has been interpreted from an adjacent or nearby county's NRCS Soil Survey publication.

## SOIL AND GROUNDWATER CONDITIONS

The soil types encountered at the boring locations are presented in the form of soil profiles on the attached **Figure 4**. The stratification presented is based on visual examination of the recovered soil samples and the interpretation of the field logs by a geotechnical engineer.

In general, the borings encountered the following soil Strata:

- Dark Brownish Gray to Dark Reddish Gray to Grayish Brown to Gray Clay (Stratum 1)
- Grayish Brown to Dark Grayish Brown Clayey Fine Sand (Stratum 2)
- Dark Gray Organic Clay (Stratum 3)
- Dark Gray to Dark Grayish Brown Sandy Clay (Stratum 4)
- Gray to Brown to Dark Gray to Dark Grayish Brown to Pinkish Gray Slightly Silty to Silty Fine Sand (Stratum 5)
- Light Brown Fine Sand (Stratum 6)
- Limerock Pavement Base (Stratum 7)

Standard Penetration Test (SPT) borings measure soil density using a split spoon sampler advanced by a 140-pound hammer dropped repeatedly a distance of 30 inches. The N-value, which is shown next to the corresponding depths of the boring profile, is the number of blows by the hammer required to advance the split spoon sampler one (1) foot. Split spoon sampling was conducted continuously in the upper 10 feet and at 5-foot intervals thereafter. Also included, adjacent to the SPT borings, are the blow counts or "N" values. The "N" values have been empirically correlated with various soil properties and are considered to be indicative of the relative density of cohesionless soils and the consistency of cohesive material. Upon completion of drilling, the SPT boreholes were backfilled with additional bentonite and soil materials.

Correlation of the SPT-N values with relative density, unconfined compressive strength and consistency are provided in the following table:

| **Coarse-Grained Soils** | | **Fine Grained Soils** | | |
|---|---|---|---|---|
| Penetration Resistance N (blows/ft) | Relative Density of Sand | Penetration Resistance N (blows/ft) | Unconfined Compressive Strength of Clay (tons/ft$^2$) | Consistency of Clay |
| 0-4 | Very Loose | <2 | <0.25 | Very Soft |
| 4-10 | Loose | 2-4 | 0.25-0.50 | Soft |
| 10-30 | Medium-Dense | 4-8 | 0.50-1.00 | Medium |
| 30-50 | Dense | 8-15 | 1.00-2.00 | Stiff |
| >50 | Very Dense | 15-30 | 2.00-4.00 | Very Stiff |
| | | >30 | >4.00 | Hard |

Please refer to **Figures 3** and **4** for boring locations, strata depths, and encountered soil conditions. The stratification lines represent the approximate boundaries between soil types. The actual transition may be gradual. Minor variations not considered important to our engineering evaluations may have been abbreviated or omitted for clarity.

## Groundwater Conditions

At the time of drilling, groundwater was encountered at depths ranging between 1.0 and 1.5 feet at F-1 through F-5, at B-7 and at B-6. After allowing for stabilization within slotted pvc pipe, groundwater was measured between 0.6 and 7.6 feet at B-1 through B-5. Based on the encountered subsurface conditions, our local experience, review of the NRCS Soil Survey, and antecedent rainfall conditions, the normal seasonal high groundwater level is estimated to exist in a perched condition, at or near the existing ground surface, slightly above the semi impermeable to poorly permeable Strata 1, 3, and 4 clay and sandy clay, during periods of heavy or extended rainfall.

# EVALUATIONS AND RECOMMENDATIONS

## General

Based on the results of this investigation and our evaluation of the encountered subsurface conditions, it is our opinion that the site soils appear generally suitable to support the proposed structures as planned, provided that proper site soil preparation and soil densification are carried out. Strata 1, 3, and 4 clay and sandy clay was encountered at shallow depths, at all boring locations. These soils can exhibit variable plasticity characteristics and may be difficult to properly compact. Dependent on planned site grades, a two-foot separation should be maintained between the bottom of building slabs, bottom of footing elevations, bottom of the pavement base, and the top of any Strata 1, 3, and 4 clay soils.

Conventional pavement section design and construction using flexible or semi flexible pavement sections will also be possible at this site, provided that a two-foot separation is maintained between the bottom of the pavement base and the top of any Strata 1, 3, and 4 clay and sandy clay in order to prevent perched groundwater from affecting the pavement section.

Dependent on planned site grades, the proposed stormwater retention areas, located in the vicinities of B-1 through B-5 appear limited for shallow dry stormwater retention pond design and may be better suited for wet stormwater retention/detention pond design. The on-site Stratum 6 sandy soil, excavated from the proposed retention pond areas, should be suitable for general fill purposes.

More specific recommendations for the building areas, paved parking/drive areas, and stormwater retention pond areas are provided below.

## Site Preparation

The building areas, including boat ramp area, and parking/drive areas, plus a minimum margin of 5 feet beyond their outer lines, should be cleared and stripped to remove all surface vegetation, roots, topsoil, organic debris, or any other encountered deleterious materials. A two-foot separation should be maintained between the bottom of building slabs, bottom of footing elevations, bottom of the pavement base and the top of any Strata 1, 3, and 4 clay and sandy clay soils in order to limit differential settlement to the proposed overlying structures. Dewatering may be necessary, to properly prepare and compact the subgrade soils and construct the proposed site improvements, if construction commences during periods of high groundwater. The exposed foundation subgrade soils for the building areas should then be proof rolled and compacted to a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Specification D-1557 before any fill material is placed. Compaction should be completed to a depth of 2 feet below exposed subgrade. The exposed subgrade within pavement areas should be proof rolled and compacted to a minimum of 95% of the soil's modified Proctor maximum dry density to a depth of 1 foot. All fill required to bring the site to final grade should be inorganic, non-plastic, granular soil (clean sands) with less than 10% passing a U.S #200 sieve. In structural areas, the fill should be placed in level lifts not to exceed 12 inches loose and should be compacted to a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Specification D-1557. In-place density tests should be performed on each lift by an experienced engineering technician working under the direction of a registered geotechnical engineer to verify that the recommended degree of compaction has been achieved. We suggest a minimum testing frequency of one (1) test per lift per 2,500 square feet of area within structural limits and one (1) test per lift per 10,000 square feet in pavement areas. This fill should extend a minimum of 5 feet beyond building lines to prevent possible erosion or undermining of footing bearing soils. Further, fill slopes should not exceed 2 horizontal to 1 vertical (2H: 1V). All fill placed in utility line trenches and adjacent to footings beneath slabs on grade should also be properly placed and compacted to the specifications stated above. However, in these restricted working areas, compaction should be accomplished with lightweight, hand-guided compaction equipment and lift thicknesses should be limited to a maximum of 4 inches loose thickness.

## Foundation Design

Once the existing subgrade and new fill soils in the proposed structural support areas have been prepared in accordance with the preceding recommendations, the proposed buildings can be constructed on a system of conventional shallow spread or strip footings bearing at minimum depths below the finished floor elevations. A two-foot separation should be maintained between the bottom of footing elevations and the top of any Strata 1, 3, and 4 clay soils. Footings, which bear in densified existing soils or in new structural fill, may be designed based on a maximum allowable bearing pressure of 2,500 pounds per square foot. Minimum footing dimensions of 18 inches for strip footings and 24 inches for column footings should be used even though the maximum allowable bearing pressures may not be fully developed in all cases. Footings should bear at least 18 inches below finished exterior grades. For monolithic slab or post tension slab construction, footings should bear at least 16 inches below finished exterior grades. Footing subgrade soils should be approved by the geotechnical engineer prior to placement of concrete and steel. As a minimum acceptance criterium, the footing subgrade soils should be compacted to a minimum density of 95% of the soils modified Proctor maximum dry density for a depth of 24 inches.

## <u>Paved Areas</u>

In general, the compacted subsurface soils will be suitable for support of a flexible (limerock) or semi-flexible (soil-cement) type pavement base after subgrade preparation. The use of one system over another is normally governed by the depth to the encountered and/or seasonal high groundwater table. Soil cement is typically used in areas where the wet season groundwater table levels are within 12 inches of the proposed bottom of the pavement subbase. A two-foot separation should be maintained between the bottom of the pavement base course and the top of any encountered Strata 1, 3, and 4 clay and sandy clay in order to prevent perched groundwater from affecting the pavement section and causing premature pavement section failure. As a possible pavement design alternative, AEI also presents recommendations for a rigid pavement section.

Typical flexible and semi-flexible pavement sections are as follows:

**Limerock Base**

<u>1-1/2” to 2-1/2” asphaltic concrete wearing surface</u>

<u>6” to 8" limerock base course</u>, quality of limerock to be in accordance with current Florida Department of Transportation specifications and compacted to a minimum density equivalent to 98 percent of the modified Proctor maximum density (AASHTO T-180).

<u>12” stabilized subbase</u> with minimum Limerock Bearing Ratio (LBR) of 40 percent. The subbase should be compacted to a minimum density equivalent to 98 percent of the modified Proctor maximum density (AASHTO T-180). The subgrade material, below the subbase, shall be compacted to minimum density of 98% of the modified Proctor maximum density of the soil.

**Soil-Cement Base**

<u>1-1/2” to 2-1/2” asphaltic concrete wearing surface</u>

<u>6” to 8" soil-cement base</u> designed and constructed in accordance with current Portland Cement Association recommended methods.

<u>12” subgrade</u> consisting of free draining natural fine sand or fine sand fill with less than 7 percent passing a U.S. #200 sieve. Subgrade to be compacted to a minimum density of 98 percent of the modified Proctor maximum density (AASHTO T-180).

**Crushed Concrete Base**

1-1/2” to 2-1/2” asphaltic concrete wearing surface

6” to 8” crushed concrete base with the quality of crushed concrete to be in accordance with current Florida Department of Transportation specifications and should have a minimum Limerock Bearing Ratio (LBR) of 150 and be compacted to at least 98 percent of the Modified proctor maximum dry density per ASTM D-1557

12” stabilized subbase with minimum Limerock Bearing Ratio (LBR) of 40 percent. The subbase should be compacted to a minimum density equivalent to 98 percent of the modified Proctor maximum density per ASTM D-1557. The subgrade material, below the subbase, shall be compacted to minimum density of 98% of the modified Proctor maximum density of the soil per ASTM D-1557.

| Type of Development | ADT (average daily traffic) | Base Thickness | Wearing Surface Thickness |
|---|---|---|---|
| Recreational | < 1,500 | 6" | 1 ½" |
| | >1,500 | 8" | 2 ½" |

The pavement section should be designed based on expected traffic including truck loads. Traffic should not be allowed on the subgrade prior to placement of the base to avoid rutting. The final pavement thickness design should be checked by the project civil engineer using data contained in this report and anticipated traffic conditions.

As a possible pavement section design alternative, AEI presents recommendations for a rigid pavement section as follows:

**Rigid Pavement**

6” reinforced concrete wearing surface: Designed to withstand the design traffic loads and jointed to reduce the chances for crack development. The concrete should have a minimum unconfined compressive strength of 3,000 psi.

12" subgrade: consisting of free draining natural fine sand or fine sand fill. Subgrade to be compacted to a minimum density equivalent to 98 percent of the modified Proctor maximum density (AASHTO T-180).

## Retention Pond Areas

Based on the results of the borings and permeability tests and dependent on planned site grades, the proposed stormwater retention areas, located in the vicinities of B-1 through B-5, appear marginally suitable for shallow dry stormwater retention, due to the site’s prevalent surficial Strata 1, 3, and 4 clays and the encountered shallow groundwater levels, and wet stormwater retention/detention may be a better design alternative. For shallow dry stormwater retention pond design the aquifer base should be assumed to exist at the top of the Strata 1, 3, and 4 clays, and the normal seasonal high groundwater level is estimated to exist in a perched condition, slightly above the Strata 1, 3, and 4 clay soils during periods of heavy or extended rainfall. For wet stormwater retention/detention pond design, the estimated normal seasonal high groundwater table level is estimated to exist at the existing ground surface elevation, and the normal seasonal low groundwater table level is estimated to exist at a depth of about 5 feet below the existing ground surface elevation. On-site Stratum 6 sandy soil, excavated from the proposed retention pond areas, should be suitable for general fill purposes.

## Excavations

Any and all excavations should be constructed in accordance with applicable local, state and federal regulation including those outlined by the Occupational Safety and Health Administration (OSHA). It is the contractor's sole responsibility for designing and constructing safe and stable excavations. Excavations should be sloped, benched or braced as required to maintain stability of the excavation sides and bottoms. Excavations should take into account loads resulting from equipment, fill stockpiles and existing construction. Any shoring need to maintain a safe excavation should be designed by a professional engineer registered in the State of Florida in accordance with local, state and federal guidelines.

## LIMITATIONS

This report has been prepared for the exclusive use of GAI Consultants, Inc., and their designers, based on our understanding of the project as stated in this report. Any modifications in design concepts from the description stated in this report should be made known to AEI for possible modification of recommendations presented in this report. This exploration was performed in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made as to the professional advice presented herein. Statements regarding all geotechnical recommendations are for use by the designers and are not intended for use by potential contractors. The geotechnical exploration and recommendations submitted herein are based on the data obtained from the soil borings presented on **Figure 4**. The report does not reflect any variations which may occur adjacent to, between, or away from the borings. The nature and extent of the variations between the borings may not become evident until during construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report. An on-site visit may be required by a geotechnical engineer to note the characteristics of the variations during the construction period. This geotechnical study investigated the soil conditions within the proposed building areas, to drilled depths of 15 to 20 feet below ground surface and was not intended to investigate deeper soil conditions with regards to the presence or absence of Karst activity.

## CLOSURE

AEI appreciates the opportunity to participate in this project, and we trust that the information herein is sufficient for your immediate needs. If you have any questions or comments concerning the contents of this report, please do not hesitate to contact the undersigned.

Sincerely,

ANDREYEV ENGINEERING, INC.

This item has been digitally signed and sealed by Ray Jones, P.E. on 6/30/20.

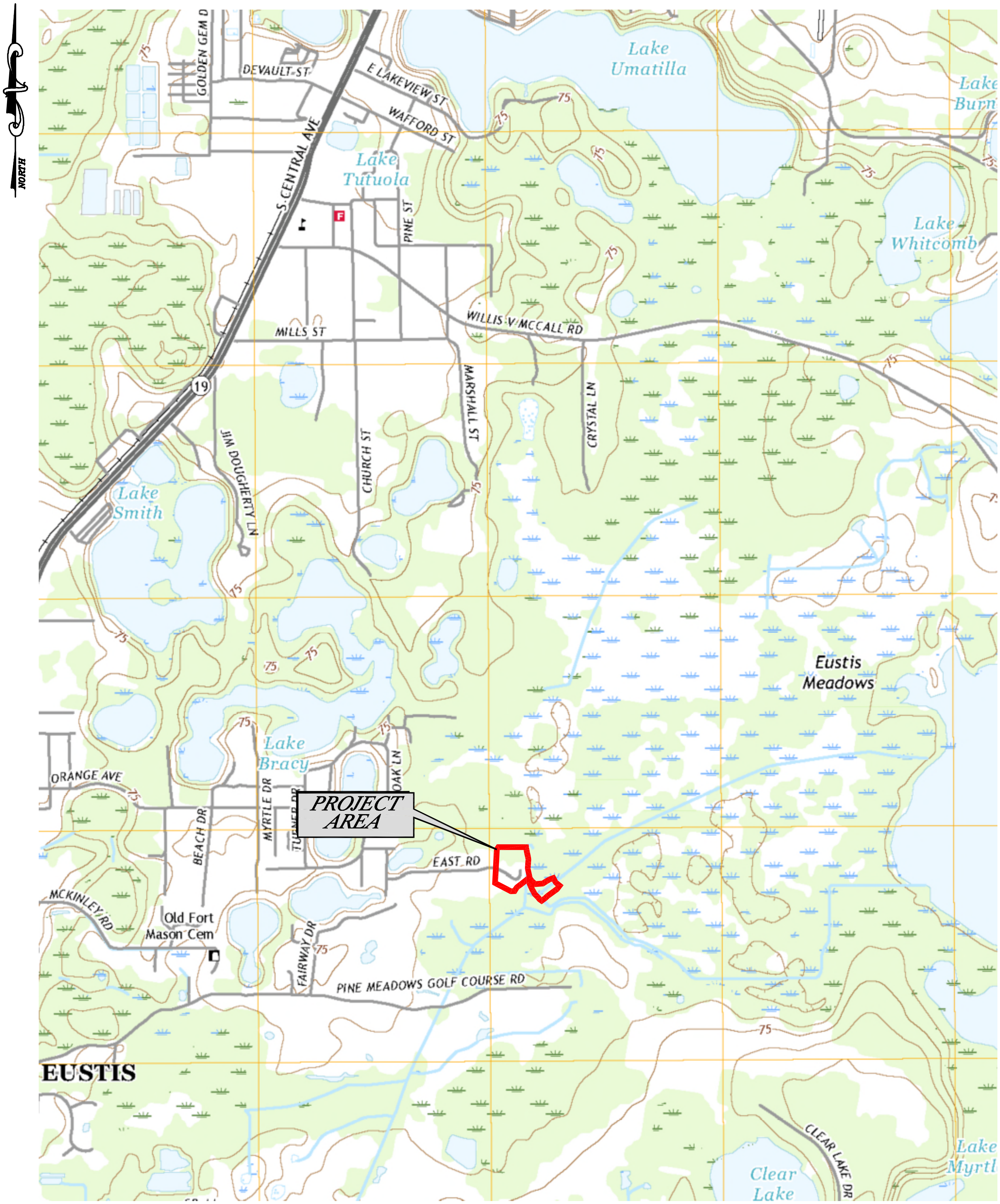
Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

RAYMOND W. JONES
LICENSE
NO. 58079
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

Mark L. Jung
Senior Project Manager

Raymond W. Jones, P.E.
Vice President
Florida Registration No.58079

# FIGURES




REFERENCE:
U.S.G.S. UMATILLA, FLA.
QUADRANGLE MAP
DATED 2018
SECTION 25
TOWNSHIP 18 SOUTH
RANGE 26 EAST

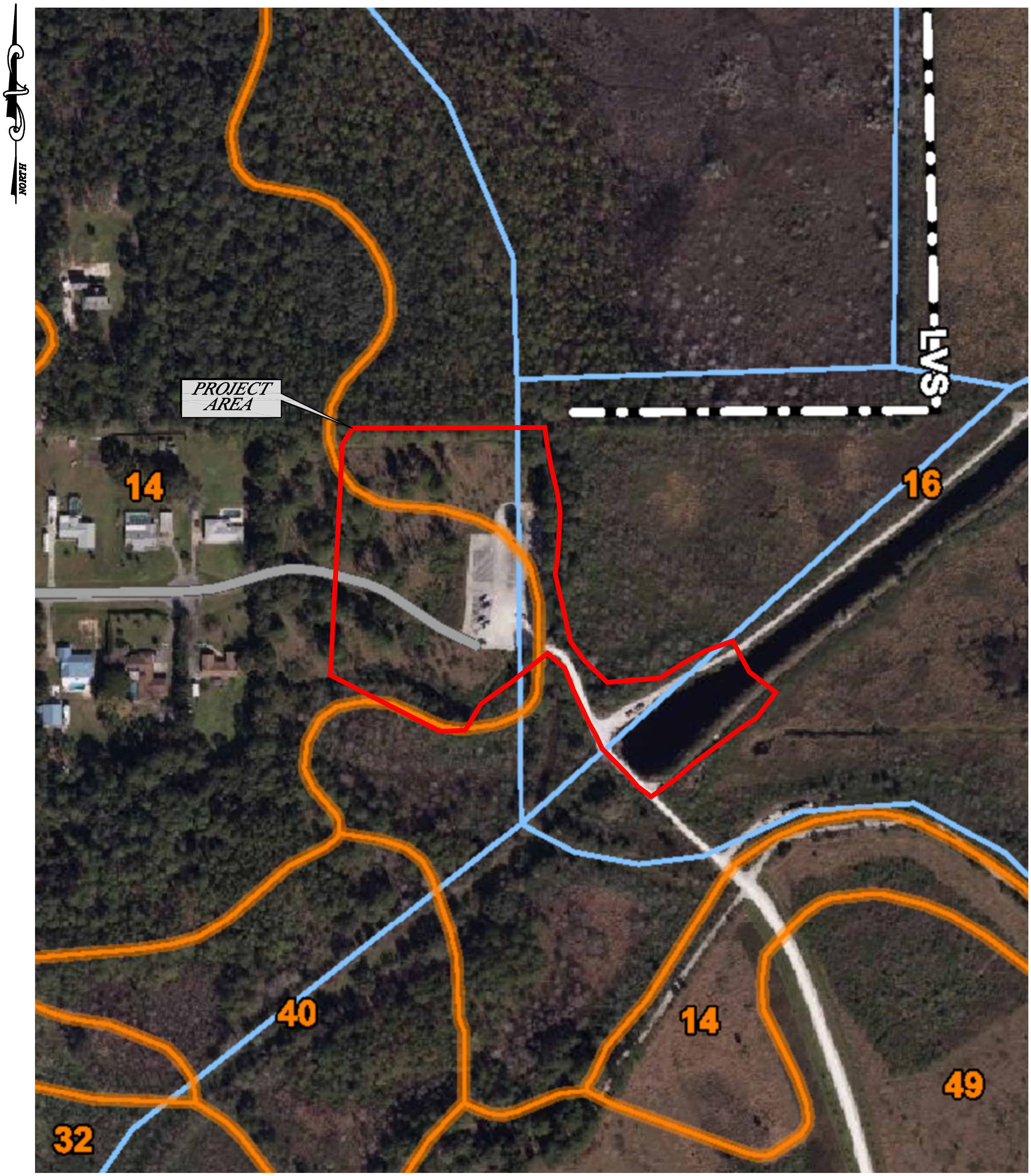
Andreyev Engineering, Inc.

GEOTECHNICAL INVESTIGATION

**PROPOSED PINE MEADOWS CONSERVATION AREA SITE IMPROVEMENTS**

LAKE COUNTY, FL

| APPROXIMATE SCALE: | DATE: 06/23/20 | ENGINEER: RJ | U.S.G.S. TOPOGRAPHIC MAP |
|---|---|---|---|
| 1"=2000' | PN: GPGT-19-067 | DRAWN BY: DLS | FIGURE 1 |




LEGEND:

14 EUREKA LOAMY FINE SAND
16 FELLOWSHIP FINE SANDY LOAM, DEPRESSIONAL

REFERENCE:
U.S.D.A. N.R.C.S. WEB SOIL SURVEY

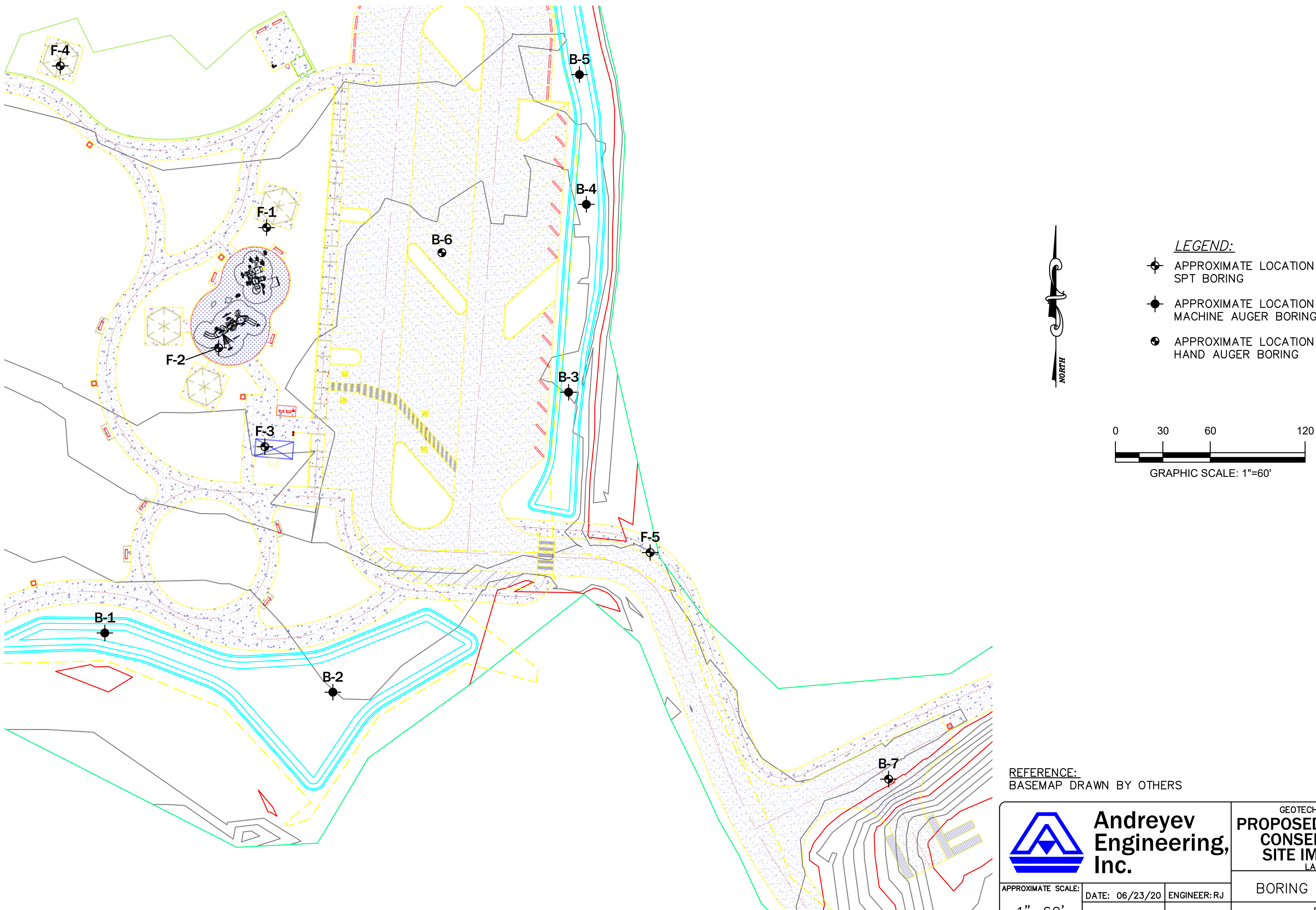
Andreyev Engineering, Inc.

GEOTECHNICAL INVESTIGATION

**PROPOSED PINE MEADOWS CONSERVATION AREA SITE IMPROVEMENTS**

LAKE COUNTY, FL

| APPROXIMATE SCALE: | DATE: 06/23/20 | ENGINEER: RJ | N.R.C.S. SOIL SURVEY MAP |
|---|---|---|---|
| 1"=300' | PN: GPGT-19-067 | DRAWN BY: DLS | FIGURE 2 |

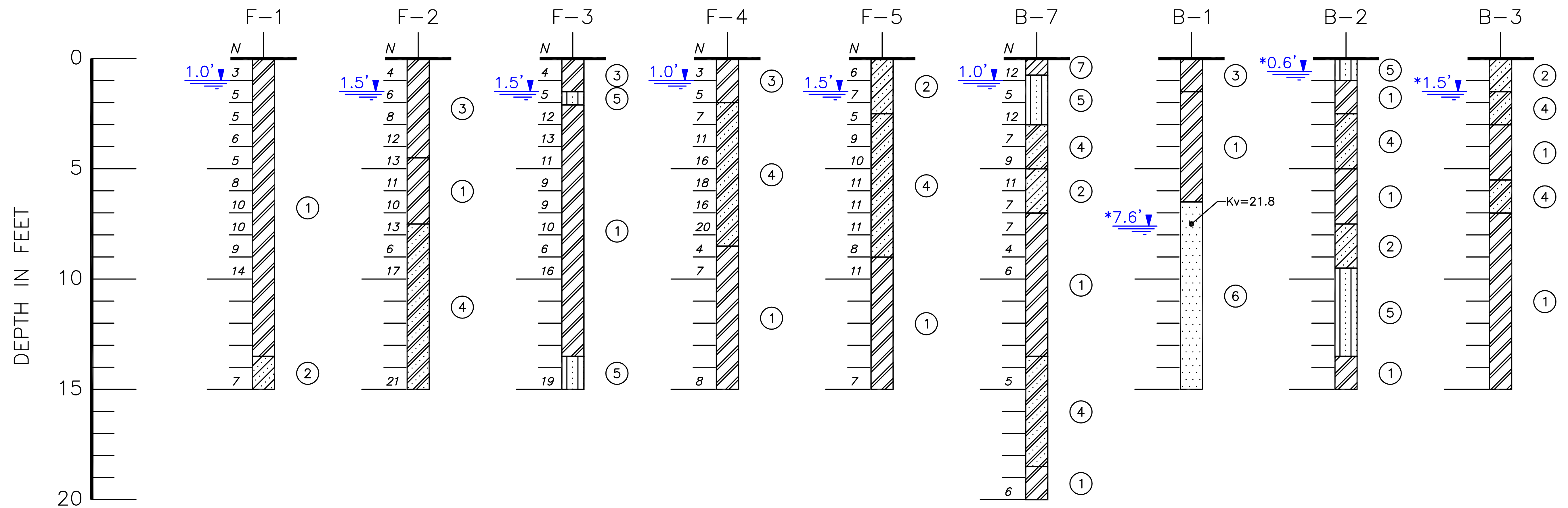


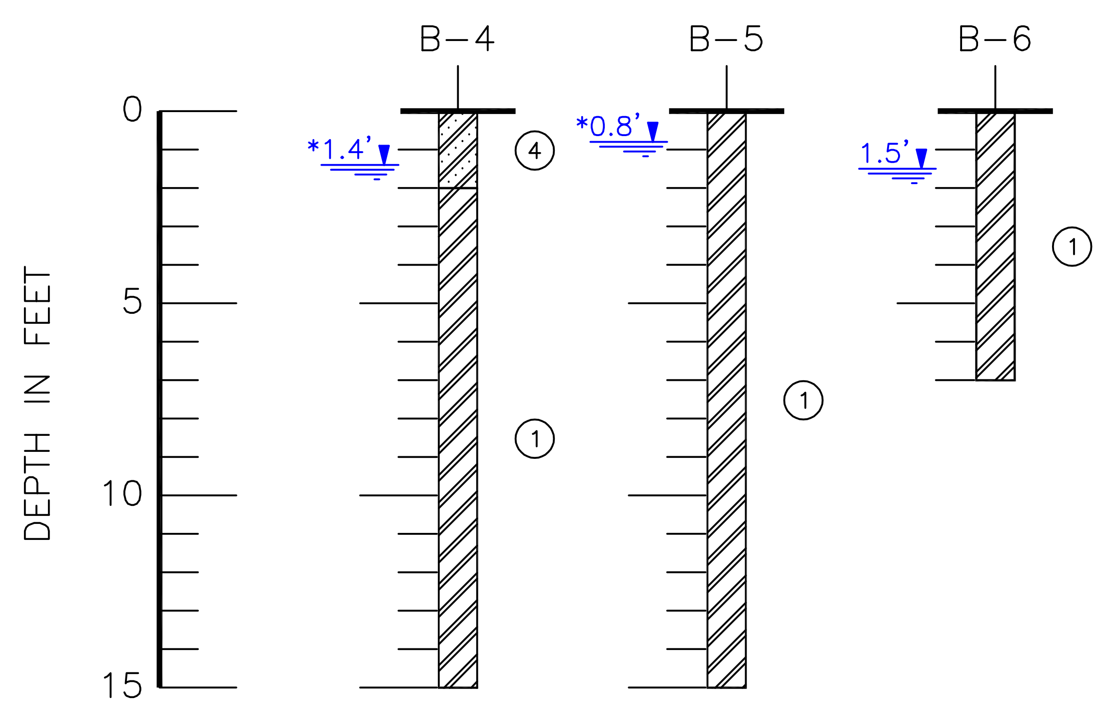

LEGEND:

- APPROXIMATE LOCATION OF SPT BORING
- APPROXIMATE LOCATION OF MACHINE AUGER BORING
- APPROXIMATE LOCATION OF HAND AUGER BORING

REFERENCE:
BASEMAP DRAWN BY OTHERS

| | | | |
|---|---|---|---|
| Andreyev Engineering, Inc. | | | GEOTECHNICAL INVESTIGATION<br>PROPOSED PINE MEADOWS CONSERVATION AREA SITE IMPROVEMENTS<br>LAKE COUNTY, FL |
| APPROXIMATE SCALE:<br>1"=60' | DATE: 06/23/20<br>PN: GPGT-19-067 | ENGINEER: RJ<br>DRAWN BY: DLS | BORING LOCATION PLAN<br>FIGURE 3 |




*LEGEND:*

1 DARK BROWNISH GRAY TO DARK REDDISH GRAY TO GRAYISH BROWN TO GRAY CLAY (CH)

2 GRAYISH BROWN TO DARK GRAYISH BROWN CLAYEY FINE SAND (SC)

3 DARK GRAY ORGANIC CLAY (CL)

4 DARK GRAY TO DARK GRAYISH BROWN SANDY CLAY (CL)

5 GRAY TO BROWN TO DARK GRAY TO DARK GRAYISH BROWN TO PINKISH GRAY SLIGHTLY SILTY TO SILTY FINE SAND (SP-SM)(SM)

6 LIGHT BROWN FINE SAND (SP)

7 LIMEROCK PAVEMENT BASE

*(SP)* UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL

1.0' DEPTH TO GROUNDWATER, AT THE TIME OF DRILLING ON JUNE 15, 2020

* DEPTH TO STABILIZED GROUNDWATER, JUNE 19, 2020

*N* STANDARD PENETRATION RESISTANCE, IN BLOWS PER FOOT

*Kv* VERTICAL COEFFICIENT OF PERMEABILITY, IN FEET PER DAY

**Andreyev Engineering, Inc.**

GEOTECHNICAL INVESTIGATION

**PROPOSED PINE MEADOWS CONSERVATION AREA SITE IMPROVEMENTS**

LAKE COUNTY, FL

| APPROXIMATE SCALE: 1"=5' | DATE: 06/25/20 | ENGINEER: RJ | SOIL PROFILES |
|---|---|---|---|
| | PN: GPGT-19-067 | DRAWN BY: DLS | FIGURE 4 |