GSE Engineering & Consulting, Inc.

SINKHOLE SUSCEPTIBILITY STUDY AND NEAR SURFACE GEOTECHNICAL EXPLORATION

GRU 63 ACRE ACRE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE PROJECT NO. 14588

Prepared For:

GAINESVILLE REGIONAL UTILITIES

NOVEMBER 2020

Certificate of Authorization No. 27430

GSE Engineering & Consulting, Inc.

November 2, 2020

Mr. Zach Tucker
Gainesville Regional Utilities
P.O. Box 147117, Station E3-F
Gainesville, Florida 32614-7117

Subject: Sinkhole Susceptibility Study and Near Surface Geotechnical Exploration
GRU 63-Acre Wetland Site
Alachua County, Florida
GSE Project No. 14588

Dear Mr. Tucker:

GSE Engineering & Consulting, Inc. (GSE) is pleased to submit this sinkhole susceptibility study and near surface geotechnical exploration for the above referenced project.

Presented herein are a summary, findings, and conclusions of the field and laboratory services, including considerations and recommendations related to sinkhole potential at the site and for preliminary wetland and recharge/infiltration basin designs. Our services were provided consistent with GSE Proposal No. 2020-131 dated April 9, 2020 authorized through GRU Purchase Order 4510048348 dated April 14, 2020, respectively.

We appreciate this opportunity to assist Gainesville Regional Utilities on this project. If you have any questions or comments concerning this report, please contact us.

Sincerely,

GSE Engineering & Consulting, Inc.

JOAKIM B. NORDQVIST
LICENSE
No. 42681
STATE OF FLORIDA
PROFESSIONAL ENGINEER

This item has been digitally signed and sealed by
Joakim B Nordqvist
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1.0 INTRODUCTION

GSE Engineering & Consulting, Inc. (GSE) has completed this sinkhole susceptibility study and near surface geotechnical exploration for the proposed constructed wetland site. The site is located in western Alachua County, Florida. The services were performed in general accordance with Tasks 1, 2, 3, 4 and 5 of GSE Proposal No. 2020-131 dated April 9, 2020 authorized through GRU Purchase Order 4510048348 dated April 14, 2020.

GSE has also completed a limited subsurface site evaluation of the adjoining 12+ acre parcel to the north. The report summarizing the findings is included in Appendix C. The services for that parcel were performed in general accordance with Tasks 1, 2 and 3 of GSE Proposal No. 2020-131A dated July 10, 2020 authorized through GRU Purchase Order 4510049530 dated August 17, 2020. This report incorporates, references, and considers the findings for this adjoining site.

1.1 Project Description

GRU is conducting due diligence related work in regards to potentially purchasing two adjoining 63+ and 12+ acre parcels for the construction of a groundwater recharge wetland. The site is located just south of SW 24th Avenue on the west side of SW 122nd Street (Parker Road). The location of the 63+ acre site is presented as Figure 1. The Alachua County Property Appraiser (ACPA) identifies the property as Parcel No. 04433-000-000. According to the ACPA the parcel is approximately 63.38 (63+) acres.

GRU provided GSE with preliminary information about the project including a site plan illustrating site boundaries and Lidar topographic data for the area. The size and location of the proposed wetland and/or recharge area will be selected as part of design. Once the wetland has been constructed, the property will likely also serve as a park with public access.

As part of due diligence, GSE was requested to conduct a sinkhole susceptibility study and recharge wetland geotechnical exploration to support preliminary design efforts. The area is karstic and GRU requested GSE evaluate the site to establish if there are areas where the recharge feature should not be sited to reduce overall sinkhole risk within the constructed wetland. This report summarizes the sinkhole susceptibility study and near surface geotechnical exploration.

1.3 Purpose

The purpose of the sinkhole susceptibility study was to establish and characterize the relative potential for sinkhole development to occur at the site. This information will be utilized for evaluating the suitability of the site for the planned constructed wetland. In addition, the study was intended to allow for strategically locating wetland cell(s) in areas where sinkhole features appear to be less abundant or pronounced. The objective was also to identify larger anomaly features that could represent areas of increased risk for potential for large collapses (i.e. 30+ feet diameter) in an effort to avoid siting the recharge and other possible site improvements in these areas.

The near surface geotechnical investigation was conducted to provide additional information and physical (including drainage) characteristics of the near surface soils (i.e. to a depth of 15 feet) across the site.

1.4 Scope of Services

For the 63+ acre parcel, the scope of services (Task 1, 2, 3, 4 & 5) outlined in GSE Proposal No. 2020-131 have been completed and are reported herein. In addition, piezometers were installed in general accordance with Alternate 1 of the proposal. Provided services are summarized below. The scope of services provided for the 12+ acre parcel is summarized in the report included as Appendix C.

Task 1 – Review of Published Information

- Reviewed Lidar elevation data for the site and identify on-site areas of closed depressions.
- Reviewed readily available pertinent area geological publications.
- Reviewed the State of Florida recorded sinkhole occurrence database
- Reviewed in-house geotechnical information for the general area.

Task 2 – Geophysical Survey

- Coordinated the Geophysical Services with Geoview, Inc. (subconsultant).
- Visited the site and coordinated bush-hogging with GRU representatives/contractor.
- Conducted a GPR survey. The GPR data was collected by towing the GPR instrument array using an all-terrain vehicle. The GPR survey was performed in accessible areas to the all-terrain vehicle.
- Reviewed the findings of the GPR survey with GRU/consultants in a videoconference meeting.
- Conduct an ERI survey. The ERI was collected using an electrode spacing of 10 feet. Approximately 9,930 linear feet of data was collected.
- Prepared a site plan with the identified GPR and ERI geophysical anomalies.
- Reviewed the results of the geophysical survey findings with GRU/consultants in a videoconference meeting to refine the scope of the SPT boring program.
- Conducted an engineering site visit to observe and compare site conditions relative to collected published information and geophysical findings.
- Prepared a site exploration plan for the standard penetration test (SPT) soil borings.

Task 3 – Standard Penetration Test (SPT) Boring Program

- Laid out the proposed SPT boring locations.
- Clear utilities at the site through Sunshine One Call.
- Mobilize to the site with truck or track mounted drilling equipment.
- Advanced SPT borings to and penetrating portions of the limestone formation at twenty (20) locations considering the findings of the geophysical survey.
- Re-mobilized to the site to advance one (1) additional SPT boring to further characterize subsurface conditions in one area.
- With exception of the proposed piezometer locations, SPT soil borings were abandoned consistent with Water Management District guidelines. The piezometer locations were filled with sand to allow for installation of piezometers at these six (6) locations.
- Performed visual classification of the soil samples obtained from the soil borings to confirm field classifications.

- Conduct laboratory tests to confirm and establish the engineering properties of near surface soils. This will include percent fines, full grain size, natural moisture content, and up to fifteen vertical permeability tests.
- Prepared SPT boring logs.
- Reviewed the results of the geophysical survey and SPT boring findings with GRU/consultants in a videoconference meeting.

Task 4 – Near Surface Geotechnical Exploration

- Prepared a plan illustrating proposed auger boring locations for review and input by GRU/consultants.
- Laid out the proposed auger boring locations.
- Cleared utilities at the site through Sunshine One Call.
- Mobilized to the site with drilling equipment.
- Performed thirty (30) auger borings to 15 feet bls (below land surface) to evaluate near surface soil conditions across the site.
- Performed visual classification of the soil samples obtained from the soil borings to confirm field classifications.
- Conducted laboratory tests to confirm and establish the engineering properties of near surface soils. This will include percent fines, full grain size, natural moisture content, and up to fifteen vertical permeability tests.

Task 5 – Summary Sinkhole Study Characterization Report

GSE has prepared this summary report specifically addressing the following items:

- Existing site conditions.
- Exploration, testing and sampling methods.
- A discussion of the regional geological conditions and soil survey information.
- Subsurface soil conditions encountered and soil classifications.
- Depth to groundwater at the time of the exploration, if encountered.
- Summary of on-site sinkhole potential.
- A discussion of the SPT boring results and whether indicators of sinkhole activity or potential sinkhole activity are present and the potential for sinkhole development in the area.
- A generalized discussion of conditions that can induce sinkhole activity, and considerations to reduce this risk.
- Present alternative recommendations related to addressing the potential sinkhole conditions (if present).
- Review of current GRU field procedures and practices for addressing sinkholes.
- Preliminary recommendations considering, incorporating and modifying GRU current practices as considered appropriate for on-going management of the infiltration areas to address sinkholes that may develop post construction.
- A discussion of near surface soils and implications related to proposed infiltration areas.
- Preliminary recommended hydraulic conductivity parameters and seasonal high-water table related to the wetland treatment system infiltration area.

2.0 FIELD AND LABORATORY TESTS

The procedures used for field sampling and testing are in general accordance with industry standards of care and established geotechnical engineering and geological practices for this geographic region. This section provides a summary of field and laboratory tests performed.

2.1 Ground Penetrating Radar and Electrical Resistivity Imaging Surveys

The Ground Penetrating Radar (GPR) survey was performed at the site by GeoView, Inc. (GeoView) as a subconsultant to GSE from April 27 through 30, 2020. The Electrical Resistivity Imaging (ERI) survey was performed from May 18 through 22, 2020. The surveys were conducted over approximately 63-acre site. The findings are summarized in the GeoView (GeoView Project No. 31405) report in the Appendix dated May 27, 2020. A summary of the surveys field and interpretation procedures is provided below.

The GPR survey was conducted along a series of perpendicular transects spaced approximately 20 feet apart. The configuration of the GPR transects was modified as necessary to accommodate site conditions. Additional parallel transects were performed in accessible portions of the southern portion of the site along the tree rows.

The GPR data was collected with a Mala radar system using a 250 MHz antenna and a time range setting of 206 nano-seconds. This equipment configuration provided an average exploration depth of 10 to 15 feet below land surface (bls).

The ERI survey was conducted using the Advanced Geosciences, Inc. Sting R8 automatic electrode resistivity system. Nine ERI transects were performed using an electrode spacing of 10 feet. The transect lines ranged in length from 1,080 to 1,110 feet with a total combined length of 9,930 feet.

A dipole-dipole combined with an inverse Schlumberger electrode configuration was used with a maximum “n value” of ten. The ERI data was analyzed using EarthImager 2D, a computer inversion program, which provides two-dimensional vertical cross-sectional resistivity model (pseudo section) of the subsurface.

The positions of the geophysical transect lines were recorded using a Trimble GeoXH Global Positioning System (GPS). A Wide Area Augmentation System (WAAS) was used to augment GPS with additional signals for increasing the reliability, integrity, accuracy and availability of the GPS signal. By using WAAS, an accuracy of less than 3 feet in the horizontal dimension was achieved. In areas near dense tree canopy, the accuracy of the GPS signal was typically reduced.

The findings of the combined GPR and ERI surveys are illustrated on Figure 2. A more detailed description of the GPR methods, survey and findings is included in the referenced GeoView report in the Appendix.

A GPR survey was also conducted for the adjoining 12+ acre site. The findings are provided in the report included as Appendix C. The GPR anomalies for the adjoining site are also shown on Figure 2.

2.2 Standard Penetration Test (SPT) Borings

This exploration included twenty (21) Standard Penetration Test (SPT) borings advanced to depths of 20 to 105 feet bls. The majority of the borings were performed in the areas of GPR and ERI anomalies identified through the geophysical survey. The borings were located at the site using the Geoview figures, GPS coordinates, and obvious site features as reference. The boring locations should be considered approximate. Twenty of the soil borings were performed from June 1 through 12, 2020. SPT boring B-21 was performed at a later date on July 22, 2020 concurrent with the near surface investigation. The SPT locations are shown on Figures 2 & 2A.

The soil borings were performed with a drill rig employing mud rotary drilling techniques and SPT in accordance with ASTM D1586. The SPTs were performed continuously to 10 feet and at 5-foot intervals thereafter. Soil samples were obtained at the depths where the SPTs were performed. The soil samples were classified in the field, placed in sealed containers, and returned to our laboratory for further evaluation.

After drilling to the sampling depth and flushing the borehole, the standard two-inch O.D. split-barrel sampler was seated by driving it 6 inches into the undisturbed soil. Then the sampler was driven an additional 12 inches by blows of a 140-pound hammer falling 30 inches. The number of blows required to produce the next 12 inches of penetration were recorded as the penetration resistance (N-value). These values and the complete SPT boring logs are provided in Section 6.1.

Upon completion of the sampling, fourteen (15) of the twenty (21) boreholes were abandoned in accordance with Water Management District guidelines. The remaining six (6) boreholes were filled with sand to allow for the installation of piezometers at these locations.

For the adjoining 12+ acre parcel, five (5) SPT borings were advanced to depth ranging from 30 to 97 feet bls. The SPT boring locations for the adjoining site are also shown on Figure 2.

2.3 Piezometers/Monitoring Wells

Six piezometers were installed at the site. GSE had intended and proposed for the piezometer to serve as temporary points to allow for initial stable groundwater elevation measurements. Following this initial data collection, they would be removed and boreholes backfilled. During discussions with GRU it became clear that there would be added benefit to have these serve as longer term monitoring points to allow for additional groundwater elevation measurements.

As these piezometers would remain over a longer term, they would be considered as monitoring wells by the Water Management District. As result, GSE retained a licensed water well contractor (Groundwater Protection dba Drillpro, LLC) to assist with the piezometer installations. The piezometers were completed in such a manner such they may serve as constructed monitoring wells that (if desired) could be used for groundwater sampling purposes as well.

Piezometers (P-1 through P-6) were installed in six (6) SPT boreholes (B-3, B-6, B-9, B-13, B-18 and B-20). The piezometers were installed using the direct penetration technology (DPT) method on July 1, 2 & 8, 2020.

The DPT was advanced through the sand used to backfill the +/-3-inch diameter SPT boring to the intended depth of the piezometer. The piezometer piping was then inserted to the bottom of the DPT. Five (P-1, P-2, P-3, P-4 & P-6) of the piezometers were completed to 40 feet and one (P-5) to 48 feet bls.

Piezometer piping consisted of 1-inch diameter PVC casing. The bottom 10 feet was screened (0.1-inch slots) and the remaining piping solid. The annular space between the DPT boring and piping was backfilled with 20/30 gradation sand to approximately 2 feet above the screened interval. The balance of the borehole was then filled with cement grout to the ground surface. The piezometer was completed and protected at the surface with a 4-inch square aluminum above ground casing. The completion details for the piezometers is included in Appendix B.

The six top of piezometer casing elevations and locations was established through surveying. CHW Professional Consultants provided the surveying services.

On July 22, 2020 GSE conducted groundwater depth measurements at the piezometers using an electronic water level indicator. The water level measurements were then used to estimate the groundwater elevations. The piezometer locations, top of casing elevations, depth to groundwater and calculated groundwater elevations are presented in Table 1 in Section 4.5.

2.4 Auger Borings

This exploration included thirty (30) auger borings advanced to depths of 15 feet bls across the site. The borings were located at the site using the provided site plan and obvious site features as reference. The boring locations should be considered approximate. The auger borings were performed between July 21 and 22, 2020.

The auger borings were performed in accordance with ASTM D1452. The borings were performed with flight auger equipment that was rotated into the ground in a manner that reduces soil disturbance. After penetrating to the required depth, the auger was retracted and the soils collected on the auger flights were field classified and placed in sealed containers. Representative samples of each stratum were retained from the auger boring.

The approximate locations of the auger borings are indicated on the attached Figures 2 & 2B. Results from the auger borings are provided in Section 7.2.

2.5 Soil Laboratory Tests

The soil samples recovered from the SPT and auger borings were returned to our laboratory and examined to confirm the field descriptions. Representative samples were then selected for laboratory testing. The laboratory tests consisted of thirty (30) percent soil fines passing the No. 200 sieve determinations, thirty (30) natural moisture content determinations, seven (7) Atterberg Limits tests, and fifteen (15) constant head hydraulic conductivity tests. These tests were performed in order to aid in classifying the soils and to further evaluate their engineering properties. The laboratory test results are provided in Section 7.3.

3.0 REVIEW OF PUBLISHED DATA

The following section provides a review of readily available published data.

3.1 Review of Published Topographic Data

The topography at the site is gently sloping and rolling. Alachua County Growth Management Lidar data indicates the ground surface elevations at the site range between elevations of 74 to 88 feet NGVD[1]. There is what can be described as a slight north to south aligned ridge on the west central portion of the site, which extends off site predominately to the north and more narrowly to the south. In this area, elevations range between approximately 80 and 88 feet NGVD.

The Lidar data does not identify well defined and pronounced closed depressions on-site. There are well defined closed depressions in relatively close proximity on adjacent sites to the east, west and south. Closed depressions can be but are not necessarily an indicator of sinkholes, and could represent other landforms.

3.2 Review of Published Hydrological Data

The Floridan aquifer in the vicinity of the site has an elevation on the order of 40 to 50 feet[2]. This elevation is below land surface, indicating a downward hydraulic gradient occurs at the site. The site appears to fall within the Rum Island/Gilchrist Blue Spring springshed[3].

The Floridan aquifer is generally unconfined in this area. A perched near surface groundwater can be present in some areas where confining soils are more uniform. Where present the surficial groundwater is often a transient condition that occurs during prolonged wet periods and tends to recede and disappear during extended dry periods.

3.3 Review of Published Soil Survey Information

The site is mapped with three soil series by the Soil Conservation Service (SCS) Soil Survey for Alachua County[4]. The following soil descriptions are from the Soil Survey.

Arredondo fine sand, 0 to 5 percent slopes – This nearly level to gently sloping, well-drained soil is in both small and large areas of uplands. Slopes are smooth to convex. The areas are irregular in shape and range from about 10 to 160 acres in size.

Typically, the surface layer is dark grayish brown fine sand about 8 inches thick. The subsurface layer is fine sand to a depth of 49 inches. The upper 23 inches is yellowish brown, and the lower 18 inches is brownish yellow. The subsoil extends to a depth of 86 inches or more. The upper 5 inches is yellowish brown loamy sand; the next 10 inches is yellowish brown sandy clay loam, and the lower 22 inches is dark yellowish brown sandy clay and sandy clay loam.

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[1] Alachua County Growth Management Website. https://mapgenius.alachuacounty.us/

[2] Potentiometric Surface of the Upper Floridan Aquifer in the St. Johns River Water Management District and Vicinity, Florida, May 2009, U.S. Geological Survey.

[3] http://my.ees.ufl.edu/symposium2010/downloads/All_Presentations-PDF/Day_2-Thursday_2-25/Hydrologic1_830_2-25/Upchurch_Hydrologic1_830_2-25.pdf (Accessed on July 20, 2020)

[4] Soil Survey of Alachua County, Florida. Soil Conservation Service, U.S. Department of Agriculture.

Included with this soil in mapping are small depressional areas of soils that have a very dark gray or black surface layer 8 to 24 inches thick. This layer overlies gray sandy material. These areas are shown by wet spot symbols. Also included are small areas of Fort Meade, Gainesville, Kendrick, and Millhopper soils.

A few areas of this soil include Arredondo soils that have 5 to 8 percent slopes. Some areas of this soil in the western part of the county have small spots of strongly acid to medium acid soil material 40 to 70 inches deep to calcareous limestone. Limestone boulders, fragments of limestone, and sinkholes are in some areas of this soil, mainly in the limestone plain sections of the western part of the county. Most of these boulders are siliceous. The sinkholes and the boulders are shown by appropriate map symbols. Total included areas are about 15 percent.

In this Arredondo soil, the available water capacity is low in the sandy surface and subsurface layers and low to medium in the loamy subsoil. Permeability is rapid in the surface and subsurface layers and moderately slow to moderate in the loamy subsoil. Natural fertility is low in the sandy surface and subsurface layers and medium in the finer textured subsoil. Organic matter content is low. The water table in this soil is at a depth of more than 72 inches. Surface runoff is slow.

Pedro-Jonesville complex, 0 to 5 percent slopes. This complex consists of small areas of nearly level to gently sloping, well drained Pedro and Jonesville soils that are so intermixed that they cannot be separated at the scale of mapping. Slopes are smooth to slightly convex. Mapped areas of this complex are irregular in shape and range from about 10 to 50 acres. These soils are intermixed across the landscape. Individual areas of each soil range from about 1/10 of an acre to 3 acres.

Pedro fine sand makes up about 40 to 55 percent of each mapped area. Typically, the soil has a dark gray fine sand surface layer about 5 inches thick. The subsurface layer is light yellowish brown sand about 7 inches thick. The subsoil is strong brown sandy clay loam about 5 inches thick. The underlying material to a depth of 72 inches or more is white, partially decomposed limestone soft enough to be dug with light power equipment, such as a backhoe.

In the Pedro soil, the available water capacity is low in the sandy surface and subsurface layers and medium in the thin, loamy subsoil. Permeability is rapid in the sandy surface and subsurface layers and moderately rapid in the loamy subsoil. Organic matter content is low, and natural fertility is low to medium. Surface runoff is slow. The water table is below a depth of 72 inches.

Jonesville sand makes up about 35 to 45 percent of each mapped area. Typically, the surface layer is dark gray sand about 7 inches thick. The subsurface layer is pale brown sand to a depth of 29 inches. The subsoil extends to a depth of 33 inches. It is brownish yellow sandy clay loam. Below this is limestone to a depth of 80 inches or more. This limestone is partially weathered and soft enough to be dug with light power equipment.

In the Jonesville soil, the available water capacity is low in the surface layer and very low to low in the subsurface layer. It is low in the subsoil. Permeability is rapid in the surface and subsurface layers and moderately slow in the subsoil. Organic matter content is moderately low. Natural fertility is low to medium. Surface runoff is slow. The water table is more than 72 inches below the surface.

Jonesville-Cadillac-Bonneau complex, 0 to 5 percent slopes - This complex consists of small areas of nearly level to gently sloping, well drained Jonesville and Cadillac soils and moderately well drained Bonneau soils. These soils are so intermixed that they cannot be separated at the scale of mapping. These soils are intermixed across the landscape. Individual areas of each soil range from about 1/10 of an acre to 5 acres. Mapped areas of this complex are irregular in shape and range from about 25 5o 125 acres.

Jonesville sand makes up about 45 to 55 percent of each mapped area. Typically, the soil has a dark gray sand surface layer about 7 inches thick. The subsurface layer is pale brown fine sand to a depth of 29 inches. The subsoil extends to a depth of 33 inches and is brownish yellow sandy clay loam. Below this is white limestone to a depth of 80 inches or more. This limestone is soft enough to be dug with light power equipment, such as a back hoe.

In the Jonesville soil, the available water capacity is low in the sandy surface layer, low to very low in the sandy subsurface layer, and medium in the loamy subsoil. Permeability is rapid in the sandy surface and subsurface layers and moderately slow to moderate in the loamy subsoil. Organic matter content is moderately low. Natural fertility is low to medium. Surface runoff is slow. The water table is at a depth of more than 72 inches.

Cadillac fine sand makes up about 25 to 35 percent of each mapped area. Typically, the surface layer is dark gray fine sand about 7 inches thick. The subsurface layer is fine sand to a depth of 52 inches. The upper 22 inches is light yellowish brown, and the lower 33 inches is very pale brown. The subsoil extends to a depth of 76 inches. The upper 7 inches is yellowish brown fine sandy loam, and the lower 17 inches is strong brown sandy clay loam. Between a depth of 76 and 118 inches, the underlying material is clay. The upper 22 inches is yellowish brown and has mottles, and the lower 20 inches is gray and has some limestone fragments.

In the Cadillac soil, the available water capacity is low in the sandy surface and subsurface layers and medium in the loamy subsoil. Permeability is rapid in the sandy layers and slow to moderate in the loamy subsoil. Organic matter content is low to moderately low. Natural fertility is low in the sandy surface and subsurface layers and medium in the loamy subsoil. The water table in this soil is at a depth of more than 72 inches. Surface runoff is slow.

Bonneau fine sand makes up about 5 to 10 percent of each mapped area. Typically, the surface layer is dark gray fine sand about 9 inches thick. The subsurface layer is brownish yellow fine sand to a depth of 29 inches. The subsoil is sandy clay loam that extends to a depth of 84 inches or more. The upper 9 inches is yellowish brown, and the lower 47 inches is gray and has yellowish and brownish mottles.

In the Bonneau soil, the water table is about 50 to 72 inches below the surface for 1 to 3 months during most years. During dry seasons, it is more than 72 inches below the surface. Permeability is moderately rapid to rapid in the sandy surface and subsurface layers. It is moderately slow to moderate in the upper part of the subsoil and very slow to slow in the lower part. The available water capacity and the natural fertility are low in the sandy surface and subsurface layers and medium in the subsoil. Organic matter content is low to moderately low.

Included with these soils in mapping are many areas of soils that have pedon characteristics similar to the Pedro soils. Also included are some soils that have a grayish brown, sandy surface layer; a pale brown, sandy subsurface layer that extends a depth of 20 to 40 inches; and a yellowish brown or strong brown sandy clay loam subsoil that reaches a depth of more than 60 inches. Some soils have sandy surface and subsurface layers 40 to 50 inches thick, a subsoil 4 to 10 inches thick that is yellowish brown or strong brown sandy loam or sandy clay loam, and soft, white limestone at a depth of about 45 to 60 inches. Included in some areas are soils that have fine sand surface and subsurface layers less than 20 inches thick, a yellowish brown or strong brown sandy clay subsoil, and soft limestone at a depth of about 30 to 50 inches. Some areas have included soils that have pedon characteristics similar to the Arredondo and Candler soils. Limestone boulders and sinkholes are common. About 12 acres mapped as this complex along the Santa Fe River is occasionally flooded. Total included areas are 5 to 15 percent of each mapped area.

The soils encountered by the borings are generally consistent with the County Soil Survey mappings.

3.4 Review of Published Regional Geology

The site is located within the southwestern portion of Alachua County. Alachua County straddles two physiographic provinces: Northern Highlands and Coastal Lowlands[5]. A broad karst escarpment known as the Cody Scarp separates these two provinces. The subject site is located within the western Coastal Lowlands geological area of the County

The Northern Highlands, which lie north and east of the Cody Scarp, are underlain by a thick sequence of relatively impermeable Miocene to Pleistocene sediments. Because of this thick sequence of sediments, the Northern Highlands Province contains few karst features. This upland plateau is nearly level, sloping gently to the west, north and east. Elevation ranges from about 150 to 200 feet above sea level. The plateau, which originally extended completely across the county, has many swamps. Sinkholes are not common within the plateau, but a few are found near its margin.

Thin Plio-Pleistocene sediments overlying thin and discontinuous, residual Miocene strata and Eocene limestone characterize the Lowlands. Karst features are numerous in the Lowlands. The western plains region has low relief. Elevation ranges from about 50 to 80 feet above sea level. The plain is devoid of stream channels, but it is dotted with sinks and limestone mines. While the Ocala Limestone is essentially near the surface in this region, many of the old sinks have become filled (some to a depth of 250 feet) with sand, clayey sand, and sandy clay.

These soil materials come from marine submergence, soil creep and slumping, and stream transport from the Northern Highlands. This sinkhole fill tends to mask many of the karst irregularities of the Ocala surface.

[5] White, W.A., 1970. The Geomorphology of the Florida Peninsula. Florida Geological Survey, Bulletin 51.

The Cody Scarp, which separates the Northern Highlands from the Coastal Lowlands, contains large sinkholes, sinking streams, and other karst features. The bottoms of the karst features often penetrate to the Ocala Limestone and the depressions are usually filled with organic soils, fluvial and lacustrine sediments, and clay-rich soils. The hills within the scarp contain Miocene sediments similar to the Northern Highlands Province. Many of the large, flat-bottomed lakes and wet prairies are associated with the scarp and represent coalescent sinkholes known as poljes and uvalas. Many of these level prairies and lakes, most of which are near or below 60 feet NGVD, are associated with ground water levels.

Three major geologic formations occur at or near the surface within the county. These formations have influenced soil development. They are, in order of decreasing age, the Ocala Limestone of Eocene age, the Miocene to Pliocene Hawthorn Group, and the Plio-Pleistocene Terrace Deposits.

The Ocala Limestone underlies the entire county; exposures are common in the Coastal Lowlands in the southern and western parts of the county. Here a limestone plain is formed which is covered by a veneer of loose sand in most places. Thin and discontinuous beds of clay-rich soils may also occur in this region of the county. The Ocala Limestone consists of soft, white to cream colored, chalky, limestone that is approximately 98 percent calcium carbonate. Boulders and irregular masses of chert are common near the top. In many areas the Ocala is cavernous and fractured.

The Miocene Hawthorn Group includes at least three formations in Alachua County. These are, from bottom to top, the Penny Farms Formation, Marks Head Formation, and Coosawhatchie Formation[6]. All three formations consist of varying proportions of interbedded clay, sand, limestone, and dolostone, all of which are phosphatic. The Hawthorn Group crops out in isolated areas around the town of Micanopy and in an irregular pattern along the Cody Scarp from Lochloosa Lake northwestward through Gainesville and into the north-Northern and northwestern part of the county. Much of the outcrop area is hill and valley terrain created by the formation of karst features at the foot of the escarpment. A thin veneer of loose sands of the older Plio-Pleistocene Terrace deposits covers the Hawthorn Group of sediments in the Cody Scarp and Northern Highlands. The Hawthorn Group lies unconformably on the solution-pitted Ocala Limestone surface.

The most recent formation is a surface mantle of fine to medium sand, silt, and clay that formed as Pliocene and Pleistocene sea levels fluctuated and periodically inundated portions of the county. Primarily, the terrace deposits overlie the Hawthorn Group. They are exposed in the Northern and eastern parts of the county.

3.5 Review of State Sinkhole Information and GSE In-House Geotechnical Information

GSE reviewed readily available published information on the Florida Map Direct[7] on-line system. Two database layers were queried as summarized below.

[6] Scott, T.M., 1988. The Lithostratigraphy of the Hawthorn Group (Miocene) of Florida. Florida Geological Survey, Bulletin No. 59.

[7] https://ca.dep.state.fl.us/mapdirect.

The *State of Florida Sinkhole Types* GIS layer is an assessment as part of a 1985 cooperative effort between the US geological survey and multiple State agency partners to summarize the types of sinkholes that occur within various areas of the State. The subject site is located within an area described as having Type I characteristics. The area as characterized as typically having a *"bare or thinly covered limestone"* where sinkholes *"are few, generally shallow and broad and develop gradually. Solution sinkholes dominate"*.

The *Florida Subsidence Incident Report* GIS layer represents reported subsidences. The database has been compiled by the Florida Department of Environmental Protection and Florida Geological Survey. These have not always been confirmed or verified as sinkholes and may represent other landforms. Furthermore, many of the incidents have not been field verified. There were not subsidence incidences reported within one-mile of the subject site. Multiple incidences were reported in excess of one-mile.

GSE reviewed in-house geotechnical information for the general area. GSE has extensive geotechnical experience in the western portion of Alachua County including for the Alachua County School Board and other private clients in the immediate area of the subject site. Area information and experience was considered and in some cases reviewed as part of this investigation.

4.0 63+ ACRE PARCEL FINDINGS

This section presents our field and laboratory program findings.

4.1 Site Observations

Mr. Joakim (Jay) B. Nordqvist, P.E. initially visited the subject site accompanied by GRU and other consultants on March 6, 2020. Subsequent visits were made to the site by Mr. Nordqvist and support GSE Staff to coordinate and conduct the field services described herein.

The site is currently undeveloped open and wooded land. The northern and central portions of the site are mostly open field with wooded areas and ground cover including grass, shrubs, and cacti. The southern portion of the site is more densely wooded with planted pine trees. The site was mostly easily accessible by foot and vehicle.

Overall, site topography can be described as gently sloping and rolling. Smaller incidental broad depressional features were identified. Some of the off-site closed depressional features were identified during the published topography review were confirmed through visual observations of adjacent property. These and other areas were observed to determine if there are compelling indications of active sinkhole conditions on-site. No compelling indications of active sinkholes on-site were identified during our site visits. No areas of standing water were observed on-site.

4.2 Ground Penetrating Radar (GPR)

The GPR survey was conducted across the 63+ acre site. The area of the survey was selected by GeoView and GSE. Figure 2 illustrates the GPR anomaly areas identified. A complete discussion of the GPR methods and findings are presented in the GeoView report in the Appendix. The geophysical results were discussed during several progress meetings with GRU and consultant representatives. The following has been taken directly from the GeoView report and slightly edited for the purpose of this discussion.

Results of the GPR survey indicated the presence of a well-defined, highly variable set of GPR reflectors at an approximate depth range of 1 to 8 feet bls. The reflector set is associated with the lithological contact between the surficial sand stratum and underlying clayey sediments or weathered limestone.

The GPR data observed a high degree of variability in the depth of the reflector set. This variability is characteristic of a highly weathered epi-karst terrain common to this area. The majority of the variability in epi-karst terrain can be attributed to surficial erosion of the limestone surface rather than settlement due to an underlying void or cavity.

Four hundred and seventy-six (476) GPR suspected karst features were identified at the project site. Anomalies 1 through 31 were classified as “Level A” anomalies and Anomalies 32 through 476 were classified as “Level B” anomalies.

The Level A anomalies were characterized by a downwarping of approximately 5 to 10 feet toward a common center. In addition, a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. These represent the more pronounced GPR features identified.

The Level B anomalies were characterized by a moderate downwarping of 1 to 5 feet toward a common center and/or a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. Type B anomalies were observed in the upper 5 to 10 feet of the soils and do not appear to continue with depth. These anomalies are more likely associated with surficial weathering or erosional activities characteristic of epi-karst terrain rather than sinkhole activity.

It is noted that additional minor and small features may be present between the transects that would not be observed by the GPR data.

4.3 ERI Results

The ERI survey was conducted on nine (9) transects spread across the site. The transect locations were selected by GeoView and GSE with input from GRU and consultant representative based on the results of the GPR survey. Figure 2 illustrates the ERI transect lines and anomaly areas identified. A complete discussion of the ERI methods and findings are presented in the GeoView report in the Appendix. The following was taken directly from the GeoView report and slightly modified for the purpose of this discussion.

Analysis of the ERI transects indicate the presence of a mixture of high to low resistivity earth materials to an approximate depth range of 40 to 60 feet bls (represented in blue to red on the ERI transects). This mixed resistivity layer is most likely associated epikarst conditions where the relative percentages of sand, clays, weathered limestone and competent limestone are both vertically and horizontally highly variable. This mixed resistivity layer is underlain by a moderate to high resistivity layer (represented in yellow to red) to the maximum depth of the ERI results. This moderate to high resistivity layer is most likely associated with competent limestone.

Eleven (11) ERI anomalies were identified across the project site. The ERI anomalies are characterized by two levels of apparent severity, where Level A anomalies are most severe and Level B less severe.

Level A anomalies are characterized by the intrusion of these surficial layer materials throughout the entire identified depth of the competent limestone. Level B anomalies are characterized by a localized intrusion of more than 20 to 30 feet of the surficial resistivity layer materials into the underlying suspected layer of competent limestone.

It is not possible based upon the resistance of the surficial materials intruding or breaching the lower moderate to high resistivity layer to determine whether these intruding materials are associated with clays, weathered limestone or possible voids. The SPT boring program was conducted in order to further evaluate and characterize these findings.

4.4 SPT Boring Results

Twenty-one (21) SPT borings were performed at the site. The SPT boring locations are illustrated on Figures 2 & 2A. The boring locations were selected considering the findings of the GPR & ERI results, site topography, and to provide for a general spatial overview across the site. The actual locations were selected by GeoView and GSE with input from GRU and consultant representatives. The intent of the borings was to further explore potential sinkhole activity identified by the GPR/ERI survey and provide for characterization of the site soils. The SPT borings logs summarizing the results are provided in Section 7.1.

The borings indicate the soil conditions across the site are variable. The borings generally encountered a sandy layer of poorly graded sand, sand with clay, sand with silt, and silty sand (SP, SP-SC, SP-SM, SM) to depths ranging from 1.5 to 58.5 feet bls. This was underlain by clayey to very clayey sand (SC, SC/CL) and interbedded strata of clay-rich soils consisting of sandy clay, clay with sand, and clay (CL/CH) to the limestone formation. The limestone formation was encountered starting at depths ranging from ground surface to 93 feet bls. Several borings encountered clayey to very clayey sand or clay-rich soils interbedded within the limestone formation.

The poorly graded sand, sand with clay, sand with silt, and silty sand (SP, SP-SC, SP-SM, SM) ranged from very loose to dense conditions with N-values ranging from 2 to 48 blows per foot. The underlying clayey to very clayey sand (SC, SC/CL) are generally in a loose to dense condition with N-values ranging from 5 to 40 blows per foot. The clay-rich soils (CL/CH) are generally in a very soft to hard condition with N-values ranging from 0 to 38 blows per foot. The limestone ranged from very soft to very hard with N-values ranging from 0 to 97 blows per foot.

Weight-of-hammer (WOH) strength (B-15 (69-69.5 feet bls) and weight-of-rod (WOR) strength (B-5 (38.5-40 feet bls), B-14 (30-38 feet bls) & B-19 (28.5-34 feet bls)) materials were encountered within the epikarst zone or within the limestone formation. Losses of drilling fluid circulation occurred within B-1 (28.5 feet bls), B-2 (28.5 feet bls), B-3 (38 feet bls), B-4 (93.5 feet bls), B-5 (38 feet bls), B-6 (18 feet bls), B-7 (53 feet bls), B-10 (8 feet bls), B-11 (23 feet bls), B-12 (26 feet bls), B-13 (ground surface), B-14 (21 & 27.5 feet bls), B-16 (11 feet bls), B-17 (43.5 feet bls), B-18 (48.5 feet bls), B-19 (27 feet bls), B-20 (28.5 feet bls), and B-21 (58 feet bls).

The water table was not recorded in the majority of SPT borings at the time of our exploration due to the nature of mud rotary drilling. Stabilized water table measurements were obtained more than 24 hours after drilling. Stabilized measurement encountered groundwater at depths ranging from 30+ to 40+ feet bls. Stabilized water table was measured at B-3 (21.3 feet bls) and B-8 (4.2 feet bls) at shallower depths and recorded as “muddy”.

The estimated top of limestone formation surface at the individual boring locations is illustrated on Figure 3A. The ground surface elevation was estimated using Lidar survey information. Figure 3B represents the thickness of the unconsolidated (soil) above the limestone formation. These figures include an interpolation of the top of limestone elevation (Figure 3A) and soil thickness (Figure 3B) between locations and across the 63+ acre site. These figures also include and reflect auger borings (Section 4.6) where limestone was encountered within the depth explored.

4.5 Piezometer Groundwater Measurement Results

Six piezometers were installed at the site. On July 22, 2020 GSE conducted groundwater depth measurements referenced to the top of casing at the piezometers using an electronic water level indicator. The water level measurements were then used to estimate the groundwater elevations. The following Table summarizes the piezometer locations, top of casing elevations, depth to groundwater and calculated groundwater elevations.

Table 1 - Groundwater Elevation Summary

Piezometer Location	CHW Survey			GSE Observations July 22, 2020	
	Coordinates[1]		Top of Casing Elevation[2] (ft)		
	Northing (ft)	Easting (ft)		Depth to GW (ft)	Groundwater Elevation (ft)
P-1	231,916.46	2,610,785.20	87.10	40.090	**47.01**
P-2	231,935.72	2,612,131.25	83.56	36.135	**47.43**
P-3	231,628.90	2,610,255.05	83.56	36.585	**46.98**
P-4	231,495.87	2,611,630.82	80.72	33.315	**47.41**
P-5	231,113.68	2,611,027.29	91.29	43.820	**47.47**
P-6	231,218.34	2,612,334.93	80.46	32.575	**47.89**

1. Coordinates are based on Florida State Plane North Zone, NAD 83 (2011).
2. Vertical datum is based on North American Vertical Datum of 1988 (NAVD 88).

Groundwater was encountered approximately 30 to 40 feet below grade at the piezometer locations. The groundwater flow across the site is interpreted to be towards the northwest. The groundwater elevations and interpreted groundwater flow direction are presented on Figure 4.

4.6 Auger Boring Results

Thirty (30) auger borings were performed at the site. The auger boring locations were conducted to evaluate near surface soil conditions (i.e. upper 15 feet). The intent of the auger borings was to provide for a general characterization of the near surface soil and drainage characteristics across the site. Results from the auger borings are provided in Section 7.2. The auger boring locations are indicated on Figures 2 & 2B.

The auger borings indicate the near-surface soil conditions across the site are relatively variable. The borings typically encountered surficial sandy soils consisting of poorly graded sand, sand with silt, silty sand, and sand with clay (SP, SP-SM, SM, SP-SC) overlying interbedded strata of clayey to very clayey sand (SC, SC/CL), sandy clay, clay with sand, and clay (CL/CH), and limestone. The surficial sand layer ranged in thickness from 1 to 15 feet. Eight of the auger borings encountered limestone at depths ranging from 1 to 12.5 feet bls.

The water table was not encountered by the auger borings at the time of our exploration.

The estimated depth of the near surface "sandier" soil profile (SP, SP-SM, SP-SC, SM) overlying clay-rich soils or limestone are illustrated on Figure 3C. For purposes of this discussion, "sandier" soils have been generally defined as soils with less than 12 percent clay fines. This figure presents an interpolation of the sandier soil thickness between SPT and auger boring locations and across the 63+ acre site.

4.7 Laboratory Soil Analysis

Selected soil samples recovered from the soil borings were analyzed for natural moisture content, the percent fines passing the No. 200 sieve, Atterberg Limits tests, and constant head hydraulic conductivity tests. Selected soil samples were collected from depths ranging from 0 to 70 feet bls. These tests were performed to confirm visual soil classification and evaluate their engineering properties. The complete laboratory report is provided in Section 7.3.

Laboratory tests were conducted on soil samples consisting of sand with silt, silty sand, clayey sand, very clayey sand, sandy clay, and clay with sand. The tested sand with silt (SP-SM) contained 5.1 to 9.9 percent soil fines passing the No. 200 sieve with natural moisture contents of 3.7 to 23 percent. The tested silty sand (SM) contained 12 percent soil fines passing the No. 200 sieve with a natural moisture content of 7.5 percent.

The tested clayey sand (SC) contained 17 to 23 percent soil fines passing the No. 200 sieve with natural moisture contents of 11 to 24 percent. The tested very clayey sand (SC/CL) contained 31 to 45 percent soil fines passing the No. 200 sieve with natural moisture contents of 19 to 34 percent. The tested sandy clay (CL/CH) contained 54 to 56 percent soil fines passing the No. 200 sieve with natural moisture contents of 27 percent. The tested clay with sand (CL/CH) contained 72 to 82 percent soil fines passing the No. 200 sieve with natural moisture contents of 36 to 77 percent.

Atterberg Limits tests indicate the tested very clayey sand (SC/CL) has Liquid Limit (LL) values of 31 to 51, Plastic Limit (PL) values of 14 to 15, and Plasticity Index (PI) values of 17 to 36. This corresponds to a material with low (LL $<$ 50 and PI $<$ 25) to marginal (50 $\leq$ LL $\leq$ 60 and 25 $\leq$ PI $\leq$ 35) potential for expansive behavior[8]. The tested sandy clay (CL/CH) has LL values of 54 to 69, PL values of 19, and PI values of 35 to 50. This corresponds to a material with marginal (50 $\leq$ LL $\leq$ 60 and 25 $\leq$ PI $\leq$ 35) to high (LL $>$ 60 and PI $>$ 35) potential for expansive behavior. The tested clay with sand (CL/CH) has LL values of 54 to 82, PL values of 16 to 27, and PI values of 38 to 55. This corresponds to a material with marginal (50 $\leq$ LL $\leq$ 60 and 25 $\leq$ PI $\leq$ 35) to high (LL $>$ 60 and PI $>$ 35) potential for expansive behavior. With one exception, the clay rich soils tested had natural moisture contents within the plastic and liquid limit moisture ranges. The sample selected from SPT boring B-19 had a natural moisture content exceeding the liquid limit.

The constant head hydraulic conductivity test results indicate the near-surface sand with silt (SP-SM) has coefficient of permeability values of 5.4 to 20 feet per day. The tested silty sand (SM) has a coefficient of permeability value of 11 feet per day. The tested clayey sand (SC) has coefficient of permeability values ranging from 0.6 to 11 feet per day. One clayey sand sample was reported as exhibiting “no flow”.

[8] U.S. Department of the Army USA, 1983, Foundations in Expansive Soils, TM 5-818-7, p. 4-1.

5.0 12+ ACRE PARCEL FINDINGS

This section summarizes our field and laboratory program and findings for the adjoining 12+ acre parcel. The intent of the evaluation was to provide a limited review of subsurface conditions, and evaluate if similar subsurface conditions could be expected to be present on this adjoining parcel. The report prepared for the site is summarized in the *Limited Subsurface Site Evaluation* report (GSE Report No. 14588A) is included in Appendix C. Please refer to that document for more detailed information related to the summary provided below.

As part of this investigation, GPR was conducted within readily accessible areas of the site. GeoView, GSE, and GRU and consultants then reviewed the geophysical data to select the SPT boring locations. SPT borings were then advanced to the limestone formation. Laboratory testing was conducted on representative samples to confirm visual classifications and establish physical characteristics of the soils. The data was then evaluated considering the findings for both the 12+ acre and 63+ acre sites.

Thirty-one (31) GPR suspected karst features were identified. Anomalies 32 and 33 were classified as “Level A” anomalies and the remainder were classified as “Level B” anomalies. Five (5) SPT boring locations were selected to characterize the subsurface conditions.

Two SPT borings (B-22 & B-24) were advanced in the center of the GPR anomalies. A third SPT (B-26) was advanced in the Anomaly 32 approximately 30 feet west of the center. The two borings (B-22 & B-26) within Anomaly 32 investigated two independent apparent “downwarping” areas.

SPT-25 was performed within a topographic closed depressional area. B-23 was advanced between the two Level A GPR anomalies. The intent of this boring placement was to characterize subsurface conditions outside of the Level A and depressional feature areas and for comparison purposes.

The SPT borings encountered soil and rock conditions consistent with this area of western Alachua County. The borings generally encountered a sandy layer of poorly graded sand, sand with clay, sand with silt, and silty sand (SP, SP-SC, SP-SM, SM) underlain by clayey to very clayey sand (SC, SC/CL) with interbedded strata of sandy clay, clay with sand, and clay (CL/CH) to the limestone formation. The water table was recorded in two of the borings at depths ranging from 34 to 35 feet bls. The measured groundwater is interpreted as the potentiometric surface of the Floridan Aquifer.

The overall soil strength patterns of B-22, B-23 and B-26 are not indicative of sinkhole activity. Two of the SPT borings, B-24 and B-25, encountered conditions indicative of sinkhole activity. Subsurface conditions encountered by these two borings are discussed below.

Boring B-24 was performed within the center of a Level A GPR anomaly. Very loose sand with silt and sand with clay (SP-SM, SP-SC) was penetrated from the ground surface to 28.5 feet bls. This was underlain by medium dense very clayey sand (SC/CL) overlying very soft to soft sandy clay (CL/CH) to a depth of 39.5 feet bls at the top of the very soft to very hard limestone. The boring was terminated at 58.8 feet bls in limestone.

A loss of drilling fluid circulation occurred near ground surface and was not regained during the advancement of the boring to the termination depth. WOR events were recorded from 8.5 to 23 feet bls within the sand with silt. The depth to groundwater was not recorded.

Boring B-25 was performed within a closed depressional area. The boring penetrated sand with silt (SP-SM) overlying interbedded strata of sand with clay, clayey to very clayey sand, and clay-rich soils (SP-SC, SC, SC/CL, CL/CH) to 63.5 feet bls. This was underlain by silty sand (SM) to the termination depth of 97 feet bls. The boring was terminated due to drill and hammer refusal in what is interpreted as the limestone formation.

A loss of drilling fluid circulation occurred at 52 feet bls within unconsolidated soils profile of the boring. WOH strength soil was encountered from 64 to 65 feet bls within the silty sand (SM). The near Ocala limestone formation appeared absent at this location with underlying limestone formation being encountered at approximately 97 feet bls. The depth to groundwater was recorded at 34 feet bls.

Low strength materials (WOH or WOR) were encountered within the unconsolidated soils overlying the limestone formation in borings B-24 and B-25 from approximately 8.5 to 23 feet bls and 64 to 65 feet bls, respectively. Furthermore, an overall pattern of decreasing soil strength with depth accompanied by drilling fluid circulation losses within the unconsolidated portion of the profile was encountered at these locations. These conditions are consistent with active sinkhole activity. Further discussion related to the implications of these findings is summarized in Section 6.3.

6.0 SINKHOLE SUSCEPTIBILITY EVALUATION

6.1 General

The following evaluation considers the GPR & ERI geophysical surveys, SPT soil borings and laboratory test data, and experience with similar sites and subsurface conditions. In this section of the report, we present our evaluations as it relates to sinkhole potential for the site.

6.2 Area Sinkhole Development Potential

A sinkhole may be defined as a depression or hole at the surface ground caused by a collapse or subsidence of the surface layer. In Florida, sinkholes generally fit into three categories. These include solution (chimney) sinkholes, cover-subsidence sinkholes, and cover-collapse sinkholes. Each is briefly described below.

- Solution sinkholes (chimney) usually occur where there is little or no sediment cover over the limestone.
- Cover-subsidence sinkholes occur where thick permeable sediments cover the limestone. In this case, the void in the rock is filled by sediments raveling downward from above. Eventually, the ground surface often shows a gentle circular depression.
- Cover-collapse sinkholes occur where sediments overlying the void in the rock formation collapse resulting in visible surface collapse at ground surface.

Sinkhole activity refers geological conditions that result or may be reasonably be expected to result in settlement or systematic weakening of the earth supporting surface improvements due to movement or raveling of soils, sediments, or rock materials into subterranean voids created by the effect of water on a limestone or similar rock formation. The presence of sinkhole activity represents a condition indicating the presence or imminent potential development of a sinkhole.

Geologically, the site is located in the central-western portion of Alachua County within the Ocala Limestone regional geology. This area of Alachua County is referred to as the Coastal lowlands, which is typically highly karstic and has a higher risk for sinkhole activity compared to other areas of the County.

Site development and drainage improvement are the most common contributing causes of sinkholes in Alachua County. With that said, sinkholes also develop in undeveloped areas. Sinkholes most commonly occur in areas where large amounts of water are diverted, held, and allowed to infiltrate. Sinkholes generally result from the erosion of sandy soils through cracks in the clay and limestone as a result of surface water infiltration.

Sinkholes in this area develop with most frequency within storm water management facilities (SWMF). This can be attributed to the storage and infiltration of large volumes of water in concentrated areas, where historically, this condition did not exist. Furthermore, excavation of the soils as part of SWMF construction often exposes or approaches pinnacles within the underlying limestone formation, making them more prone to sinkhole development.

GSE has experience with sinkholes in western Alachua County including the subject area. This includes sinkholes that have occurred within +/- 1 mile of the site. GSE has evaluated and assisted with remediation of sinkholes. Many of the sinkholes that have developed are chimney type features. These are typically 10 feet in diameter and less and 5 to 15 feet deep. These chimney features typically have a relatively small diameter solution channel (sockets) within the limestone formation that occurs within the upper 5 to 10 feet. There are also cases of larger sinkholes having developed on the order of 30+ feet in diameter and 25+ feet deep. In these cases pinnacled portions of the limestone formation are often observed near the ground surface but the openings and fissures that allowed the soil to collapse within the formation occur at the deeper depths.

6.3 Evaluation of GPR & ERI and SPT Soil Borings Findings

The GPR and ERI surveys identified multiple anomaly areas. The identified GPR (63+ acre & 12+ acre parcels) and ERI (63+ acre parcel) anomalies are illustrated on Figure 2. This is expected for the area of the subject site.

The more pronounced and well defined GPR and ERI anomalies were identified as Level A features. These represented the more likely areas where sinkhole development could occur. Multiple SPT borings were advanced in the center of these features.

Less pronounced and defined GPR and ERI anomalies were identified as Level B features. Some of the boring locations were selected to evaluate these less prominent anomalies. In addition, for comparison purposes two SPT borings were performed in areas where no anomalies were identified. The intent of the boring placement was to provide for a general characterization of subsurface conditions across the site, and determine if sinkhole activity is present in the anomaly areas.

The SPT borings encountered soil and rock conditions consistent with this area of western Alachua County. The borings generally encountered a sandy layer of poorly graded sand, sand with clay, sand with silt, and silty sand (SP, SP-SC, SP-SM, SM) underlain by clayey to very clayey sand (SC, SC/CL) with interbedded strata of sandy clay, clay with sand, and clay (CL/CH) to the limestone formation.

Overall the limestone formation was encountered slightly deeper than expected for this area of the County at multiple locations across the site. With this said, the depth to limestone is expected to vary abruptly within very short lateral distances. That is function of the pinnacle and erosional characteristics of the Ocala limestone formation in this area of the County. The SPT borings confirmed the limestone formation varied between very soft to very hard. This variability in strength is expected, and partially attributed to variability in limestone weathering and presence of voids within the formation.

Epikarst represents the geological transition from the unconsolidated to the underlying rock formation. This transition zone often displays weaker soil/rock conditions accompanied by drilling fluid circulation losses. Loss of soil strength and drilling fluid circulation losses were identified by many of the borings within the epikarst portion of the boring profiles. In addition, low strength material (WOH or WOR) was encountered within the epikarst at boring location B-5 from approximately 38.5 to 40 feet bls.

These represent expected and typical conditions at this transition, and in and of itself are not an indicator of sinkhole activity. The conditions encountered within the epikarst are evaluated and considered in overall boring material strength encountered above and below this section of the individual boring profiles.

One SPT borings identified a non-active paleosink (SPT B-4). In addition, potential for future near surface sinkhole activity was evident at one SPT boring location (SPT B-10). There were no indications of active sinkhole activity at the SPT boring locations. To illustrate the SPT findings, examples of the more notable conditions and features encountered by individual borings are described below.

SPT B-4 was conducted within a Level A ERI anomaly. The boring penetrated sand with clay (SP-SC) and clayey sand (SC) to 93 feet bls, where limestone was encountered. The boring was terminated in limestone at 105 feet bls. A loss of drilling fluid circulation occurred at 93.5 feet bls. No WOH or WOR strength soil or rock was encountered. The near Ocala limestone formation appeared absent at this location with underlying limestone formation being encountered at approximately 93 feet. The depth to groundwater was not recorded.

The SPT B-4 boring profile is indicative of a paleosink (ancient relic infilled feature). The overall strength pattern and lack of drilling fluid loss in the unconsolidated portion of the soil profile confirms that this is a non-active paleosink feature. This infilled feature does not have compelling indicators to suggest current active or expected future sinkhole activity.

In order to further characterize and confirm the non-active paleosink condition in the area of SPT B-4, SPT boring B-21 was conducted to the west between B-4 and B-3 within the ERI anomaly area. The boring was located approximately 525 feet east of the end of ERI transect line S4-E4. SPT boring B-21 did not encounter sinkhole conditions.

SPT B-5 was performed within a Level A GPR anomaly. Very loose increasing to medium dense sand (SP, SP-SC) was penetrated from the ground surface to 27.5 feet. A decreasing soil strength profile in clay was then encountered between 27.5 and 41 feet bls overlying limestone. Limestone was penetrated to the 60 feet boring termination depth. A loss of drilling fluid circulation occurred in the unconsolidated clay at 38 feet bls. The depth to groundwater was not recorded. The clay at 33.5 to 35 feet had 79 percent fines with a natural moisture content of 63 percent. The Atterberg limits test of the clay at 38.5 to 40 feet has 78 percent fines with a liquid limit of 82 percent and natural moisture content of 77 percent.

Although the groundwater depth was not recorded at this location, considering the depth recorded at other borings, it is expected that groundwater is present within 30 to 40 feet bls. The presence of groundwater explains the increasing moisture content (approaching the liquid limit) with depth approaching the clay/limestone interface. The high and increasing moisture with depth supports the lower SPT N-values recorded between 35 and 40 feet. The overall soil strength profile penetrated by SPT B-5 is not indicative of active sinkhole conditions.

SPT B-10 was performed near but not within a Level B GPR anomaly. Loose increasing to medium dense clayey sand (SC) was penetrated from the ground surface to 6 feet. A medium dense decreasing to loose sand with clay (SP-SC) was then encountered to 14.5 feet bls overlying limestone. The boring was terminated at 58.7 feet bls in limestone. A loss of drilling fluid circulation occurred in the unconsolidated clay at 8 feet bls. No WOH or WOR events were recorded. The stabilized depth to groundwater was 38.6 feet.

Boring B-10 represents a location where a chimney type sinkhole could occur. Although active sinkhole activity was not clearly identified, the loss of sandy soil strength with depth and drilling fluid circulation loss in the unconsolidated portion of the profile indicates there is potential for future induced sinkhole collapse. This would be expected to potentially occur if a drainage basin was placed in this immediate area. Considering the depth to limestone, a smaller chimney sinkhole on the order of 5 to 10 feet in diameter and 15 feet deep would be expected to potentially occur under this scenario.

SPT B-14 was performed within a Level A ERI anomaly. Very loose to medium dense sand (SP-SC, SC) was penetrated from the ground surface to 4.5 feet. Stiff increasing to very stiff clay (CL/CH) was then encountered to 13.5 feet bls overlying limestone. The boring was terminated at 60 feet bls in limestone. A WOR event was recorded between 30 and 38 feet within the limestone formation. A loss of drilling fluid circulation occurred at the transition to limestone at 13.5 feet and within the limestone formation at 27.5 feet bls. The stabilized depth to groundwater was 31.5 feet.

The WOR event represents an interbedded condition within the limestone formation. This is an expected occurrence and does not represent a sinkhole condition. The event occurred at a depth consistent with fluctuations in the groundwater table. It is possible that rising and falling groundwater over geological time could have influenced this condition. The losses of drilling fluid circulation are expected and associated with epikarst and porous nature of the limestone.

SPT B-12 was performed with one of the more prominent Level A GPR anomaly areas. Very loose sand (SP) was penetrated to 4 feet underlain by clay (CL/CH) to 5.5 feet bls. A lens of limestone was then encountered from 5.5 to 9 feet bls overlying an interbedded lens of clay (CL/CH) penetrated to 12.5 feet underlain by limestone to 39.8 feet bls. A loss of drilling fluid circulation occurred within the limestone formation at 26 feet bls. No WOH or WOR events were recorded. The depth to groundwater was not recorded.

No indications of sinkhole activity were encountered within SPT B-12. The interbedded near surface layer of clay could be indicative of an infilled chimney within the limestone formation.

SPT B-15 was conducted within one of the more prominent Level A ERI anomaly. Medium dense sand (SP) was penetrated to 6 feet underlain by stiff to very stiff clay (CL/CH) to 12 feet bls. Limestone was then encountered to the 98.6 feet boring termination depth. No loss of drilling fluid circulation was recorded. A WOH event was recorded at 69 to 69.5 feet bls within the limestone formation. The depth to groundwater was recorded at 32 feet bls at the time of drilling.

No indications of sinkhole activity were encountered within SPT B-15. The 6-inch WOH event represents the seating blow count. This interval is not used in calculation of the N-value as it can be disturbed during drilling and not actually be representative the actual material strength of the interval.

SPT B-8 was conducted near but not within a Level A GPR anomaly. Stiff to very stiff clay (CL/CH) to 4 feet bls. Limestone was then encountered to the 20 feet boring termination depth. No loss of drilling fluid circulation was recorded. No WOR or WOH events were recorded. The stabilized depth to groundwater was recorded at 4.2 feet.

No indications of sinkhole activity were encountered within SPT B-8. The near surface groundwater is attributed to a perched condition associated with the clay soils and does not represent the Floridan Aquifer. Groundwater was not recorded at the time of drilling.

Boring B-19 encountered WOR strength material within the limestone formation from approximately 28.5 to 34 feet bls. This interbedded condition is an expected occurrence and does not represent sinkhole activity.

With noted exceptions of SPT borings B-24 and B-25, the SPT borings on the 12+ acre site encountered similar conditions to the 63+ acre site. B-24 and B-25 encountered conditions consistent with active sinkhole activity. Low strength materials (WOH or WOR) were encountered within the unconsolidated soils overlying the limestone formation in borings B-24 and B-25 from approximately 8.5 to 23 feet bls and 64 to 65 feet bls, respectively. Furthermore, an overall pattern of decreasing soil strength with depth accompanied by drilling fluid circulation losses within the unconsolidated portion of the profile was encountered at these locations.

GSE re-visited the site 2 to 3 weeks following B-24 having been completed to observe the area. No surface expression (subsidence or depression) was readily apparent in the area before or after the boring having been completed.

There was no alignment between the Level A ERI and GPR anomaly areas. There was correlation at one Level A GPR and Level B ERI anomaly areas (GPR Anomaly 10 & ERI Anomaly along Transect Line S2 – E2). SPT B-17 advanced in this area did not encounter indications of sinkhole activity. There was limited overlap of Level B GPR and ERI anomalies in some areas. This overall lack of correlation can be attributed to the GPR survey generally focusing on the upper 20+/- feet and the ERI survey evaluating deeper conditions.

Overall, with limited exceptions, there was no well-defined clear correlation between the SPT boring findings and the ERI and GPR anomalies. In most cases the GPR and ERI anomaly areas did not overlap. This lack of correlation was somewhat surprising.

Figures 3A and 3B provide an interpolation of the estimated top of limestone elevation and thickness of soil overlying limestone, respectively. These visual representations should be considered in context, as the depth to limestone has been shown and is expected to vary within short lateral distances, the plans are not necessarily representative of actual depth to rock between boring locations.

The Figures 3A & 3B interpretations of the relatively widely spaced (+/- 1 to 2-acre) SPT and auger boring data suggest the limestone may overall be shallower along the central portion of the site, generally corresponding to an area from the eastern property boundary to approximately two-thirds of the property to the west. It is conceivable that this could represent a ridge. With this said, considering the widely spaced borings advanced as part of this investigation, variable and deeper depths to the limestone in this area would not be unexpected. Additional subsurface investigation should be considered if further evidence is desired to confirm this shallower limestone formation occurrence in this area

Figures 3A & 3B also indicate there may be a deeper occurrence of the limestone formation in the areas of B-4 (63+ acre parcel) and B-25 (12+ acre parcel) on the north central portion of the site. Limestone was encountered at 93 and 97 feet, respectively, at these locations. These borings are spaced on the order of 300+ feet apart. In order to determine if these are anomalous conditions or indicative of a connected geological feature, supplemental investigation would be needed to further characterize the area.

6.4 Near Surface Geotechnical Exploration

The near surface geotechnical exploration confirmed variable near surface conditions encountered by the SPT boring program, and consistent with this western Alachua County area. Generally, a layer of surficial sand layer (SP, SP-SM, SP-SC, SM) overlies interbedded clayey sand (SC) and clay (CL/CH), and limestone. Deeper interbedded sandier deposits also occur within the clay rich soil deposits.

The depth of the surficial sand layer ranged from 1 to 15 feet at the auger boring locations. This is consistent with conditions encountered by the SPT borings. Laboratory tests determined these sands have hydraulic conductivities on the order of 5 to 20 feet per day.

Laboratory testing on the underlying clayey soils were determined to have variable amounts of clay (ranging between 18 and 23 percent fines). The hydraulic conductivity of these clayey sands determined to range between 0.6 and 11 feet per day. One clayey sand sample was reported as a “no flow” condition. This indicates the test method could not be used to estimate the hydraulic conductivity (expected to be less than 0.1 feet per day).

The constant head laboratory permeability test is most effective at establishing permeability characteristics of sands with 15 or less percent fines. The permeability test results and values on samples with greater than 15 percent fines need to considered in the context of the test method limitations and percent fines contents of the soil. Experience indicates that these clayey sands with 25 percent and less fines typically have at least one order of one magnitude less permeability than the overlying sand deposits. Actual in-situ drainage characteristics of these soils are expected to range between 0.1 to 1.0 feet per day. To more firmly establish actual in-situ permeability of these soils, field permeability tests and triaxial cell laboratory tests should be conducted.

Clay rich soils with greater than 25 percent fines are estimated to have at least an additional order of magnitude less permeability than the above discussed clayey sands. These are typically considered as confining soil as part of design considerations. Although internal drainage through the heterogenous subsurface conditions will occur due to the presence of more permeable sand seams, temporary perching of groundwater can occur in these soils during prolonged heavy rainfall and extended wet periods.

In areas where these higher clay fine content soils are more uniform, isolated areas of a transient near surface perched groundwater tables can and are expected to occur. This can become especially apparent when large quantities of water are diverted to and stored in these areas (i.e. man-made improvements or natural drainage characteristics). Often these perched conditions occur in smaller footprint areas, as larger drainage areas tend to have more variable subsurface conditions allowing for drainage through more permeable areas to occur.

Figure 3C provides an illustration and interpolation of the depth of near surface "sandier" soils (SP, SP-SM, SP-SC, SM). Review of the figures suggests contiguous areas may have overall shallower and deeper deposits of soil. In order to confirm and fully characterize near surface soil deposit depths, supplemental subsurface characterization should be considered and confirm these apparent trends identified by the widely spaced borings of this evaluation.

6.5 Groundwater

Stabilized groundwater table measurements in the borings at the time of our exploration generally identified groundwater at depths ranging between 30+ to 40+ feet bls. The measured groundwater is interpreted as the potentiometric surface of the Floridan Aquifer. Stabilized water tables were measured at B-3 (21.3 feet bls) and B-8 (4.2 feet bls) at shallower depths and recorded as "muddy". Considering estimated site elevations these are expected to represent perched conditions within in the borehole and not expected to be representative of an actual water table. Groundwater was not encountered at the auger boring locations.

Six piezometers were installed at the site. The top of casing elevations were surveyed by CHW. The depth to groundwater was measured at the six locations to establish the groundwater elevations. The estimated groundwater elevations were presented in Section 4.5. Based on the groundwater elevation measurements, the groundwater (Floridan Aquifer) is interpreted to flow towards the northwest across the site. (Figure 4).

It is expected that groundwater will temporarily perch on top of the clay rich soils after periods of heavy prolonged and seasonal rainfall. Estimated seasonal high groundwater levels are indicated on the boring logs. The temporarily perched groundwater should be expected, especially if excavations are made into the clay rich soils that result in a "bowl" or "swimming pool" type effect. Construction of on-site wetlands could result in perched groundwater in some areas where underlining confining soils are more continuous on-site, and needs to be considered as part of the design.

6.6 Subject Site Sinkhole Development Potential

Sinkhole activity was not identified at the 63+ acre site. Sinkhole activity was identified at two borings (B-24 & B-25) on the adjoining to the north 12+ acre parcel. The due diligence evaluation undertaken for the two parcels may be characterized as a comprehensive preliminary investigation.

Considering the area geology, off-site depressional features, GPR and ERI survey results, and SPT boring results, with the possible exception of one area, the combined 75+ acre site is considered no more likely than other sites in this western portion of Alachua County for sinkhole development. The deeper occurrence of the limestone formation (i.e. 30 to 50 feet) and lack of sinkhole indicators in multiple borings is actually advantageous in that many of the sinkholes that develop in this area typically result from the presence of near surface limestone and pinnacles (i.e. upper 5 to 10 feet bls). With that said, sinkhole activity was identified on the 12+ acre parcel relatively near the northern boundary of the 63+ acre site.

The declining soil strength pattern with depth identified by Boring B-24 represents a subsurface condition where a cover collapse or chimney type sinkhole could occur. Although ground cover collapse or a ground surface depression in the area was not identified, there remains potential for a future sinkhole collapse to occur in this area. There is no way to predict if or when such collapse may occur, but rather that a potential exists that is considered more probable than other areas where such conditions are absent. Considering the depth to limestone, if a cover collapse or chimney sinkhole developed it would probably be on the order of 20 to 50 feet in diameter.

The B-25 boring profile is interpreted as an infilled paleosink feature similar to that encountered by the non-active paleosink identified by B-4 on the larger adjoining 63+ acre site. However, the overall reduction in soil strength with depth accompanied with the loss of drilling fluid circulation in B-25 suggests this feature may be active. This boring was conducted within a closed depression. This provides further evidence of subsidence having occurred in this area. It is not clear when this depressional feature developed. It could represent a relic and not recent surface expression.

In order to determine the actual extent and implication of conditions encountered in the area of B-24 and B-25 and select the appropriate course of action, supplemental investigation should be conducted as part of the site development design process.

Introducing concentrated volumes of surface water infiltration often results in sinkhole development in this area of the County, and this should be anticipated and expected. Chimney type sinkhole features (i.e. 5 to 10 feet diameter +/- 10 feet deep) may occur within the proposed infiltration areas and could represent an on-going repair and maintenance issue. These represent the most common sinkholes that develop in this area of Alachua County.

7.0 PRELIMINARY DESIGN CONSIDERATIONS

This section presents preliminary design considerations and alternative for siting the constructed wetland, reducing sinkhole development risk, and recommendations for addressing sinkholes that may occur during or post construction.

7.1 Constructed Wetland Siting

Generally, the site is considered suitable for placement of the proposed constructed wetland. However, based on the preliminary information obtained in the area of B-24 and B-25, additional subsurface exploration of this area should be conducted as part of the actual cell location selection process. Depending on actual findings and conditions based on the additional characterization, avoidance through a buffer area or remedial measures could be considered and evaluated as part the design.

It is conceivable the subsurface condition encountered by SPT B-10 could be more prone to a localized small sinkhole to develop (Section 5.3). Although it is not suggested that an infiltration area could be constructed at this location, this may represent design and construction consideration. Also, this single data point finding should not be interpreted to suggest or preclude similar conditions being present in other areas.

The groundwater (Florida Aquifer) was generally encountered 30 to 40 feet below grade. Perched groundwater table measurements were identified at two SPT boring locations (Section 5.4). These are not interpreted as an actual water table. The near surface investigation (thirty (30) auger borings to 15 feet bls) did not encounter a water table.

The presence and depth of near surface sandy soil (SP, SP-SM, SP-SC) could be considered as part of the wetland cell siting. The presence of deeper and laterally continuous sandy areas may be advantageous in facilitating water infiltration. Furthermore, sandy soils excavated in one area of the site may be used as fill where needed in other portions of the site. Figure 3C provides an interpolation of the depth of this layer across the site. Additional subsurface investigation should be conducted to further evaluate and confirm the actual variation of this near surface sandy soil layer in areas of possible or planned design.

In reviewing the SPT and auger boring profiles, the surficial sand deposits at the locations ranged in depth from 0 to 58+ feet. In ten (10) of the SPT borings 1.5 to 9.5 feet of sandy soil was penetrated. In excess of 15 feet of near surface sandy soil was encountered at eight (8) of the twenty-one (21) boring locations. The auger borings encountered surficial sand deposits at the locations ranging in depth from 1 to 15 feet.

The soils encountered by the borings across the site confirm the presence of variable near surface conditions. The clay-rich soils encountered appear to be discontinuous both vertically and laterally (i.e. perforated). This “perforated” soil profile is further evident based on the lack of a surficial water table being present at the majority of borings.

Although localized temporarily perched groundwater can occur in areas of clay-rich soils underlying the sandier near surface deposits, this would be expected to represent a transient condition, as the perched water will tend to find and drain through perforated areas (including interbedded sand seams and deeper sand deposits). As a result, when excavations are made into these clay rich soil deposits and surface water is diverted to them, it is expected they will tend to hold the water for extended periods of time dependent mainly on the presence of near surface interbedded sand seams and the deeper sand and limestone deposits.

Due to this internal drainage phenomenon, it is not expected that a wetland area can be maintained in the absence of a continuous water source. In this case, the reclaimed water represents a continuous water source to maintain the wetland. It is recommended that flexibility in the application rate be provided to accommodate the actual infiltration rate that will occur as a result of the internal drainage characteristics of the underlying natural heterogenous soil profile in the wetland areas. This flexibility could be accomplished by providing multiple interconnected wetland cells that are independently controlled, managed and operated.

In addition to the continuously saturated wetland areas, dry infiltration management areas could also be considered and incorporated into the design to effectively allow flexibility in managing water elevations within the wetlands. These should preferably be constructed in areas where the bottom of the infiltration area is maintained above the clay-rich soil deposits. Should clayey sand and very clayey sand (SC) deposits be determined to be present within these areas or be encountered during construction, these soils be undercut and sloped laterally to extend to sandier conditions to promote and allow for lateral drainage and prevent a persistent perched water table.

Undercut areas should be backfilled with higher permeability sandy soil (typically with 12 percent or less fines). On-site sandy materials meeting material requirements may be used for this purpose. The intent of this undercutting and backfilling is to provide a more uniform sand layer that encourages lateral and vertical migration of water to the deeper sand deposits, and to reduce the potential for soil fines leaching out and covering the infiltration basin bottom. Equipment machinery traffic on the exposed clayey sand surface during construction should be avoided to maintain some of the inherent drainage characteristics of this soil. The surface of the exposed clay-rich soil should be scarified prior to fill placement.

In reviewing the boring log data, it should be considered that large differences in the vertical extent of near surface sand are likely to be present within short lateral distances. In this area of Alachua County it is common to encounter sand, clayey sand, clay, and limestone pinnacles at the bottom of a 25+/- feet long trench excavated to a depth of 5 feet or less.

7.2 Preliminary Infiltration Area Design Parameters

This section provides preliminary infiltration area design parameters based on the field and laboratory testing program. These are intended for preliminary design and planning purposes.

Laboratory permeability tests indicate the surficial layer of sand and sand with clay (SP, SP-SC) has coefficients of permeability in the range of 5 to 20 feet per day. Clayey sand with less than 25 percent soil fines are considered semi-confining with estimated coefficients of permeability in the range of 0.1 to 1.0 feet per day. The clayey to very clayey sand (in excess of 25 percent fines) and clay encountered by the borings should be considered to be confining soils.

Based upon the findings and test results, two sets of preliminary design parameters are presented below. The parameters consider the results of the permeability tests, variability in site soils, the above described undercutting program, and our experience with the soils.

Option 1 – Near Surface Sandy Soil with Confining Layer

In this case, the surficial sands are considered to provide for the infiltration, with the underlying clay-rich soils representing the confining layer

1. Base elevation of effective or mobilized aquifer (average depth of confining layer). The confining layer in an area considers the depth to the clayey sand or clay portion of the boring profiles. Within a proposed improvement area, the average or mean surficial sand depths encountered by the borings is used to establish this depth.
2. Unsaturated average vertical infiltration rate of 13 feet per day.
3. Horizontal hydraulic conductivity equal to 18 feet per day.
4. Specific yield (fillable porosity) of 25 percent.
5. The estimated average seasonal high groundwater table depth equal to 0.5 feet bls above the confining layer.

Option 2 – Unconfined Soil Profile to the Florida Aquifer

This case considers the entire soil and rock profile encountered by the borings. An overall effective average is provided with the confining layer being represented by the total depth of borings in the immediate area.

1. Base elevation of effective or mobilized aquifer (average depth of confining layer). Within a proposed improvement area, the depth to the confining layer should be set to the depth of the corresponding area SPT boring(s).
2. Average unsaturated vertical infiltration rate of 3 feet per day.
3. Horizontal hydraulic conductivity equal to 5 feet per day.
4. Specific yield (fillable porosity) of 20 percent.
5. The estimated average seasonal high groundwater table depth equal to depth of Floridan aquifer (i.e. 30-40 +/- feet). This depth can be estimated from the piezometer data.

The above values do not consider a factor of safety. For drainage design a factor of safety of 2 is generally recommended and typically applied to the provided infiltration and hydraulic conductivity values. The basin bottom should be at least 12-inches and preferably 24-inches above the average depth of the confining layer.

The unsaturated average vertical infiltration rate and horizontal hydraulic conductivity represent design parameters used in sizing infiltration areas. The provided values represent unsaturated conditions that are typically applied to dry retention area design. The wetland system will result in a saturated condition in the underlying soils, which will affect the overall infiltration and drainage rates and characteristics. To establish and estimate the actual saturated system infiltration performance, groundwater mounding analysis will be conducted as part of the design. As a result, the importance to consider the entire design process and considerations when evaluating the above presented parameters cannot be overstated.

7.3 Factors to Further Reduce and Mitigate Sinkhole Development Risk

Measures can be taken in an effort further reduce or mitigate sinkhole development. As discussed, smaller diameter vertically limited chimney type sinkhole development are expected to be more likely to occur during or post construction.

Limiting the depths of the wetlands reduces removal of existing near surface soil cover reducing the potential for approaching or exposing shallow limestone pinnacles. This can reduce the overall potential for sinkhole development.

Where limestone pinnacles are encountered within infiltration areas, undercutting and soil replacement at least 3 feet below the basin bottom could help reduce sinkhole formation. These limestone pinnacle areas can be more prone to sinkhole development. Low fines content clayey sands (i.e. 11 to 15 percent) could be considered in these undercut areas to help protect and reduce water infiltration directly through the pinnacle areas. Use of clay rich soils would need to be considered as part design in establishing the effective infiltration rate for the entire basin area.

Reducing the size of individual wetland cells could assist in sinkhole development mitigation. While not eliminating the occurrence, the affected area could possibly be taken “off-line” to allow for repairs.

During construction, loading of the wetland cells (with water) could be conducted once approximate design grades are established in an effort to pre-collapse sinkhole conditions. This approach can mitigate areas where sinkholes may develop, and thereby reducing the potential for them occurring post-construction. This type of program is intended to cause sinkholes to occur during construction, to allow for their repair, and thus possibly reducing the overall post construction sinkhole occurrence at the site. This approach does require a reliable large quantity water source. This method was implemented during construction of the City of Ocala Constructed Wetland project. We were informed that multiple sinkholes were addressed as part of construction using this approach.

Another pre-construction remedial measure involves a stone column improvement plan (also referred to as vibro-compaction) to collapse potential areas of sinkholes. This approach could be considered for areas with subsurface conditions similar to those encountered at B-24. Stone columns will help to induce potential sinkholes that are imminent on the site. The stone column method consists a combination of induced subsurface vibration and introduction of gravel into the subsurface resulting is subsurface densification. It can be conducted using a dry or wet method.

Stone column improvement induces vibrations into the subsurface, and these vibrations have the potential for collapsing pre-existing sinkhole conditions or inducing ground collapse, which usually occurs around the vibrator, but can also occur away from the vibrator. The collapsed areas are infilled with onsite or imported fill soils. It is our experience that stone column improvement in karstic geology such as what is present at this site should not be performed within 100 feet of existing structures. Pre-construction and post damage assessment surveys of nearby existing buildings and/or vibration monitoring during construction is often conducted for this type of program.

Remediation techniques for sinkholes that occur during or post construction will depend on the type and size of the feature, depth to limestone, and other distinguishing features that may be present. The location and intent of the area where the feature is present can also be a consideration. For example, a feature occurring within an infiltration basin location may not necessarily need to be plugged with cement grout which would reduce the infiltration characteristics of the area. However, continually filling the sinkhole with a porous media may not be cost efficient either. This should be evaluated on an individual basis. Section 7.4 provides recommended approaches for sinkhole repairs.

Applying water through sheet flow and providing infiltration over a larger area effectively decreasing the depth of the water column can also be beneficial in reducing sinkhole development. Where possible, a water column height of 24 inches or less should be considered for the design. Increased water column head (i.e. depth of water) can promote the formation of induced sinkholes.

Maintaining constant moisture within the infiltration area can also reduce the potential for sinkhole development. Cyclic drying and wetting of infiltration areas may result and allow the clay rich soils to become dry, brittle, and crack allowing soil raveling and water infiltration. Sinkholes often occur following extended droughts followed by prolonged and/or intense rainfall events.

7.4 Review of GRU Sinkhole & Outcrop Repair Details

GSE was requested to review and provide input for a plan titled *Sinkhole & Outcrop Repair Details* dated August 10, 2015 prepared by GRU. This plan illustrates repair methods to address shallow chimney type sinkhole conditions. In addition, it provides procedures for over-excavating and backfilling limestone pinnacles within drainage areas.

GSE concurs with the repair methods for the “Deep Sinkhole/Cavity Repair”. It appears the intent of this repair method is to allow for drainage to continue through the collapse feature. It is anticipated that 3+ feet of sand is placed on top of the No. 57 Stone to provide for water treatment and separation from the limestone formation requirements.

It is possible the use of the geotextile fabric could be eliminated. GSE has found that using the illustrated approach, a layered system that includes placement of pea gravel sized aggregate followed by coarse “builders” sand, can reduce the potential for the finer surface sand particles to bypass and ravel through the No 57 stone. Sand is still placed at the top (minimum of 3 feet) in this case. Our approach is presented in the Sinkhole Remediation Recommendations section below.

With respect to the repair of the “Shallow Sinkhole/Cavity Repair” our experience has shown that backfilling with sand often leads to re-development of the features. If the repair intent is to continue to allow infiltration to occur, consideration could be given to backfilling the lower section of the chimney/cavity in a similar manner as described for the deeper repair. A minimum of 3 feet of sand cover should still be used in this case to provide water treatment.

7.5 Sinkhole Remediation Recommendations

Should sinkholes occur on-site they will need to be remediated. The following sections provide general guidelines for addressing shallow and deeper sinkholes that may develop on-site.

7.5.1 Near Surface Shallow Sinkhole Features

Typically, two types of shallow sinkholes tend to occur in western Alachua County. One is a continuous circular socket penetrating the limestone formation and visible at the limestone surface. In these cases, limestone is visible around the entire solution channel. The other form typically includes a ground cover collapse or shallow broad chimney-type feature. In these cases, the rock formation is typically visible for portions of the depression, and the limestone formation is typically within 15 to 25 feet bls. We recommend the following remediation measures be considered for these occurrences.

7.5.2 Continuous Circular Socket (Chimney)

These features tend to be 2+ feet in diameter or less and typically occur within the upper 5 feet of the ground surface. These sinkholes are often addressed through direct injection of flowable fill (+/- 900 psi) low strength cement based grout to permanently seal off the feature. If the intent is to maintain drainage through the feature, then the procedure outlined below for the Shallow Broad Chimney may be utilized.

When using this approach, prior to filling, the depth of the feature should be measured. If the feature is 5 feet deep or more, placing smaller pieces of concrete debris, limestone boulders, and/or No. 57 type stone to 5 feet within the ground surface may reduce grout quantities required to fill the void. Deeper features can be interconnected with deeper conduits which could result in large grout takes. Placement of concrete debris, limestone boulders, and/or No. 57 Stone is intended to fill the lower portion of the feature and then allowing the upper 5 feet to serve as a “plug”. If a truck (10 cubic yards) or more of grout is injected, it is recommended initial set (+/-8 hours) be allowed to occur. Then additional grout may be placed in this matter until the feature is filled to the ground surface. The intent of this repair is to seal off the chimney within the rock formation. If limestone is exposed within 3 feet of the basin bottom, over excavation and backfilling is recommended to provide the required minimum separation between the drainage area bottom and limestone formation.

7.5.3 Shallow Broad Chimney-Type Sinkhole

These sinkholes are typically 30 feet in diameter or less and 15 to 25 feet deep. The limestone formation is typically visible on the sides of the collapse along portions of the sinkhole sidewalls. In these cases the following two similar approaches may be considered as discussed below. One is intended to address and seal off the feature. The other is to allow drainage to continue to occur through the repair.

- Over-excavate the area to expose the area of the depressional features and limestone outcrops/chimneys/cavities that may be present. Stockpile soil and limestone for reuse. Excavation should be limited to the depth achievable with trackhoe or similar equipment (anticipated to be 8 to 12 feet below existing grade).
- Evaluate the exposed area and develop an area specific remedial plan based on conditions encountered.

Remedial Measures may incorporate the following:

- If large chimney (s)/cavern(s) are encountered in the limestone formation that may become exposed, place limerock boulders and/or cement grout in the bottom of the depression. Free-fall of materials is encouraged to allow for interlocking between individual boulders and the soil/rock of the sinkhole. Initially placed boulders should be 3 feet in diameter or less, and preferably vary in size to allow for interlocking. The overlying boulders should be 1 feet or less in diameter and placed to fill larger gaps between the underlying boulders. The rock surface should be "worked" (i.e. moved, rocked, tamped, shifted) with the excavator bucket to confirm the boulders are as interlocked as practical.

  - ***Option 1*** – The intent of this option is to seal the feature. The original drainage characteristics will be reduced or eliminated.

    Backfill with imported mixed clayey sand, clay, small rock (i.e. less than 3-inch diameter) material to within 12 to 18-inches of existing adjoining ground surface. The material should have in excess of 25 percent fines. The material should be observed by a Geotechnical Engineer at the source location prior to transport to confirm the material meets the intent of these recommendations.

  - ***Option 2*** – The intent of this option is to stabilize the sinkhole feature and reduce the potential for future development in the subject area while maintaining the original drainage characteristics.

    Backfill with No. 57 Stone aggregate (limerock or recycled concrete) to a minimum of 2 feet above the boulders.

    The surface should then be backfilled with pea gravel sized aggregate (limerock or recycled concrete) to 1+ foot above the No. 57 Stone surface.

    The surface should then be backfilled with coarse (concrete mix) sand to 1+ foot above the pea gravel surface.

    Although not used in standard sinkhole remediation in Alachua County, recent advancements in porous grout could be considered and utilized in lieu of the above to strengthen the soils while allowing for water infiltration through the grout mixture. The benefit would be a cementitious mixture with porous characteristics. The disadvantage of the porous grout materials is its higher porosity and lower unit weight. A buoyant force on this porous grout could develop due to the mounding of the Floridan aquifer that may occur. Material placed above the porous grout (i.e. sand) could help to counteract buoyant forces should they occur. This material could be considered on a case by case basis. The viability of this alternative would need to be further evaluated in the context of the actual design.

    Materials should be placed in 1 foot or less lifts tamped firm using the excavator bucket or other comparable effective means approved by the Geotechnical Engineer.

    Maintain 3 feet of separation between the top of the coarse sand and ground surface.

- The remainder of the excavation should subsequently be backfilled with the on-site or imported (less than 10 percent fines) sand. The backfilled excavation shall match the original contour and slopes of the area.
- Excess materials shall be hauled off-site.
- The area should be filled with topsoil & seeded or sodded to re-establish grass cover or re-planted as needed.

The intent of the above guideline recommendations is to address broad shallow depressional type sinkhole features. Site specific conditions will influence the implementation and combination of the above remedial recommendations based on actual field conditions encountered during the initial excavation. The proposed program does not preclude future sinkhole development in other portions of the infiltration area.

Another potential approach is to develop and implement a stone column subsurface improvement program for the area of the collapse. The benefit of this approach is the drainage characteristics of the subsurface may be less altered as a result of grout not being injected. This would basically involve a combination of stone and sandy fill to stabilize and fill the sinkhole. A working platform or other measures may have to be established to allow access for the vibrator and rig used for the stone columns or vibro-compaction equipment.

If the limestone formation and cause of the collapse is not exposed through excavation, additional exploration may be necessary to address the condition consistent with the deeper features repair recommendation below.

7.5.4 Deeper Features

In some cases it becomes impractical to excavate and repair the sinkhole features. When the limestone formation is 15+ feet an alternate approach may be the preferred or more practical repair alternative. In these cases we recommend the following be considered.

- Visually assess the sinkhole feature.
- Conduct one or more SPTs penetrating 10+ feet into the limestone formation. The actual number of borings will be site-specific and condition dependent.
- Considering the depth to the limestone formation, develop a deep grout injection program to address the sinkhole condition. The cement grouting program will include a series of injection points in the center spaced approximately 10 to 15 feet on-center and around the perimeter of the sinkhole.
- A typical compaction cement grout mix with a slump between 4 and 6 inches should be used, pumped at slow enough rates such that the grout will densify and not hydro-fracture the soil.

The deep cement grout injection is intended to compact and improve the density of sandy soils and seal the limestone surface to reduce the potential for future soil raveling. The total quantity of cement grout required often varies based on site conditions, but on average will typically take less than 10 cubic yards per grout point. The initial grout pipe depth often varies consistent with the variability of the limestone formation surface. An average grout pipe depth and expected range can typically be estimated based on the SPTs that are performed in the area.

Grouting operations should be performed under the observation of the geotechnical engineer. The specialty grouting contractor should submit the proposed grouting systems and proposed installation methods to the geotechnical engineer for approval. Continuous elevation monitoring of nearby structure(s) by the contractor may be necessary to identify and prevent unnecessary upward movement of the structure. Deep grouting programs are typically limited to 10 to 15 feet and deeper due to potential for short circuiting and heave at the ground surface as a result of the high pressure grouting.

Another potential approach is to develop and implement a stone column subsurface improvement program for the area of the collapse. The benefit of this approach is the drainage characteristics of the subsurface may be less altered as a result of grout not being injected. This would basically involve a combination of stone and sandy fill to stabilize and fill the sinkhole. A working platform or other measures may have to be established to allow access for the vibrator and rig used for the stone columns or vibro-compaction equipment.

7.6 Further Site Characterization

The information provided herein is intended to be used for and assist with the preliminary project design planning and development. As the location, elements, and actual design parameters for the constructed wetland are established, supplemental geotechnical services will need to be conducted to meet and address site specific requirements and design elements for the proposed system(s).

8.0 FIELD DATA

8.1 Standard Penetration Test (SPT) Boring Logs

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Fax: (352)377-0335

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-1

DATE PERFORMED 7/22/2020

DRILLING CONTRACTOR Whitaker Drilling, Inc.

GROUND WATER LEVELS:

LOGGED BY WDI

AT TIME OF DRILLING NE

CHECKED BY KPF

ESTIMATED SEASONAL HIGH >15 ft

NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0	AU 1	(SP-SM) Brown and gray SAND with silt
3.5	AU 2	(SC) Brown and orange clayey SAND
7.0	AU 3	(SC) Gray clayey SAND
11.5	AU 4	(SP-SC) Gray SAND with clay
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-2

DATE PERFORMED 7/22/2020

DRILLING CONTRACTOR Whitaker Drilling, Inc.

GROUND WATER LEVELS:

LOGGED BY WDI

AT TIME OF DRILLING NE

CHECKED BY KPF

ESTIMATED SEASONAL HIGH 5.0 ft, perched

NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0	AU 1	(SP-SM) Gray SAND with silt
2.0	AU 2 PS	(SP-SM) Pale gray and brown SAND with silt *%PASS-200 = 8.7* *MC = 6* *k_h = 16 ft/day*
5.5	AU 3, AU 4	(CL/CH) Brown, gray and orange sandy CLAY with trace of limestone *%PASS-200 = 56* *MC = 27* *LL = 69* *PL = 19* *PI = 50*
15.0		Bottom of borehole at 15.0 feet.

(Continued Next Page)

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PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-3

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0		AU 1	(SP-SM) Gray and brown SAND with silt
3.0		AU 2	(SP) Pale brown and gray SAND
7.0		AU 3	(SC) Brown, gray and orange clayey SAND
		AU 4 PS	*%PASS-200 = 20* *MC = 15* *k_h = 0.6 ft/day*
15.0			Bottom of borehole at 15.0 feet.

BORING NUMBER A-4

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0		AU 1	(SP-SM) Gray and brown SAND with silt
1.5		AU 2	(SP) Pale brown SAND
6.0		AU 3 PS	(SP-SM) Pale gray and brown SAND with silt *%PASS-200 = 6.6* *MC = 4.5* *k_h = 18 ft/day*
12.0		AU 4	(SP-SC) Brown SAND with clay
15.0			Bottom of borehole at 15.0 feet.

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PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-5

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0	AU 1	(SP-SM) Gray and brown SAND with silt
2.0	AU 2	(SC) Brown and gray clayey SAND
7.0	AU 3, AU 4	(SP-SC) Gray and brown SAND with clay
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-6

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 1.0 ft, perched
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0	AU 1	(SP-SM) Gray and brown SAND with silt
1.5	AU 2	(CL/CH) Brown and orange CLAY with trace of limestone
6.0	AU 3	(CL/CH) Brown, gray and orange CLAY with trace of limestone
10.5	AU 4	(CL/CH) Brown and orange CLAY with sand and trace of limestone
15.0		Bottom of borehole at 15.0 feet.

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PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-7

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
LOGGED BY WDI
AT TIME OF DRILLING NE
CHECKED BY KPF
ESTIMATED SEASONAL HIGH 5.0 ft, perched
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 2.5	AU 1	(SP-SM) Gray SAND with silt
2.5 – 5.5	AU 2 PS	(SP-SM) Brown and gray SAND with silt *%PASS-200 = 8.3* *MC = 4.6* *k_h = 8.3 ft/day*
5.5 – 11.0	AU 3	(CL/CH) Gray, brown and orange CLAY with sand and trace of limestone
11.0 – 15.0	AU 4	(CL/CH) Gray and brown CLAY with trace of limestone

Bottom of borehole at 15.0 feet.

BORING NUMBER A-8

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
LOGGED BY WDI
AT TIME OF DRILLING NE
CHECKED BY KPF
ESTIMATED SEASONAL HIGH >15 ft
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 1.5	AU 1	(SP-SM) Brown and gray SAND with silt
1.5 – 6.5	AU 2	(SP) Pale brown and gray SAND
6.5 – 15.0	AU 3, AU 4	(SP-SC) Brown SAND with clay

Bottom of borehole at 15.0 feet.

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PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-9

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 7.0 ft, perched
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.5	AU 1 PS	(SM) Brown and gray silty SAND *%PASS-200 = 12* *MC = 7.5* *k_h = 11 ft/day*
3.5 – 7.5	AU 2	(SP-SC) Brown and orange SAND with clay and trace of limestone ▽ (7.0 ft)
7.5 – 12.5	AU 3	(CL/CH) Brown and orange sandy CLAY *%PASS-200 = 54* *MC = 27* *LL = 54* *PL = 19* *PI = 35*
12.5 – 15.0	AU 4	(CL/CH) Brown CLAY with trace of limestone

Bottom of borehole at 15.0 feet.

BORING NUMBER A-10

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 5.5 ft, perched
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 4.0	AU 1	(SP-SM) Brown and gray SAND with silt
4.0 – 6.0	AU 2	(SC) Brown and gray clayey SAND ▽ (5.5 ft)
6.0 – 11.5	AU 3	(CL/CH) Brown, orange and gray CLAY with sand and trace of limestone
11.5 – 15.0	AU 4	(CL/CH) Brown and orange CLAY with sand and trace of limestone

Bottom of borehole at 15.0 feet.

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PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-11

DATE PERFORMED 7/21/2020

DRILLING CONTRACTOR Whitaker Drilling, Inc.

GROUND WATER LEVELS:
- AT TIME OF DRILLING NE
- ESTIMATED SEASONAL HIGH >15 ft

LOGGED BY WDI

CHECKED BY KPF

NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.5	AU 1	(SP-SM) Brown and gray SAND with silt
3.5 – 5.0	AU 2	(SP-SM) Pale brown and gray SAND with silt
5.0 – 12.0	AU 3	(SC) Brown, orange and gray clayey SAND
12.0 – 15.0	AU 4	(SP-SC) Gray and brown SAND with clay
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-12

DATE PERFORMED 7/21/2020

DRILLING CONTRACTOR Whitaker Drilling, Inc.

GROUND WATER LEVELS:
- AT TIME OF DRILLING NE
- ESTIMATED SEASONAL HIGH 6.0 ft, perched

LOGGED BY WDI

CHECKED BY KPF

NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 4.0	AU 1 PS	(SP-SM) Brown and gray SAND with silt *%PASS-200 = 8.1* *MC = 4.9* *k_h = 13 ft/day*
4.0 – 6.5	AU 2	(SP-SC) Brown, gray and orange SAND with clay (▽ at 6.0 ft)
6.5 – 12.0	AU 3	(CL/CH) Gray and brown sandy CLAY with trace of limestone
12.0 – 15.0	AU 4	(SC) Brown, gray and orange clayey SAND
15.0		Bottom of borehole at 15.0 feet.

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BORING NUMBER A-13

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 10.0 ft, perched
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 1.0	AU 1	(SP-SM) Gray SAND with silt
1.0 – 10.5	AU 2, AU 3	(SC) Brown, gray and orange clayey SAND (estimated seasonal high water at 10.0 ft)
10.5 – 13.5	AU 4	(CL/CH) Gray and brown CLAY with sand
13.5 – 15.0	AU 5	(SC) Orange clayey SAND with limestone
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-14

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.0	AU 1	(SP-SM) Gray and brown SAND with silt
3.0 – 7.0	AU 2	(SC) Brown and orange clayey SAND
7.0 – 15.0	AU 3, AU 4	(SC) Brown and gray clayey SAND
15.0		Bottom of borehole at 15.0 feet.

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BORING NUMBER A-15

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 2.0 ft, perched
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 2.5	AU 1 PS	(SP-SM) Gray and brown SAND with silt *%PASS-200 = 9.9* *MC = 6.5* *k_h = 9.8 ft/day* (Estimated seasonal high water level symbol at 2.0 ft)
2.5 – 12.0	AU 2; AU 3	(SC/CL) Brown, gray, and orange very clayey SAND *%PASS-200 = 37* *MC = 21*
12.0 – 15.0	AU 4	(CL/CH) Orange, green and gray CLAY
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-16

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.0	AU 1	(SP-SM) Brown and gray SAND with silt
3.0 – 6.0	AU 2	(SP) Pale brown and gray SAND
6.0 – 12.0	AU 3	(SP-SC) Brown and orange SAND with clay
12.0 – 15.0	AU 4 PS	(SC) Gray, brown and orange clayey SAND *%PASS-200 = 17* *MC = 11* *k_h = 11 ft/day*
15.0		Bottom of borehole at 15.0 feet.

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PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-17

DATE PERFORMED 7/22/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
LOGGED BY WDI
CHECKED BY KPF
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 10.0 ft, perched
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION	Depth to bottom
0 – 1.5	AU 1	(SP-SM) Brown and gray SAND with silt	1.5
1.5 – 7.5	AU 2	(SP-SC) Brown and gray SAND with clay and trace of limestone	7.5
7.5 – 10.5	AU 3	LIMESTONE (estimated seasonal high water level at 10.0 ft)	10.5
10.5 – 15.0	AU 4	(CL/CH) Gray CLAY with trace of limestone	15.0

Bottom of borehole at 15.0 feet.

BORING NUMBER A-18

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
LOGGED BY WDI
CHECKED BY KPF
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 1.5 ft, perched
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION	Depth to bottom
0 – 2.0	AU 1 PS	(SP-SM) Brown and gray SAND with silt *%PASS-200 = 8.7* *MC = 5.6* *k_h = 9.4 ft/day*	2.0
2.0 – 11.5	AU 2, AU 3	(CL/CH) Brown CLAY with sand and trace of limestone	11.5
11.5 – 15.0	AU 4	LIMESTONE	15.0

Bottom of borehole at 15.0 feet.

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BORING NUMBER A-19

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
LOGGED BY WDI
AT TIME OF DRILLING NE
CHECKED BY KPF
ESTIMATED SEASONAL HIGH >15 ft
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0		(SP-SM) Brown SAND with silt
3–5	AU 1 PS	*%PASS-200 = 5.1* *MC = 4.3* *k_h = 18 ft/day*
6.0	AU 2	(SC) Brown and orange clayey SAND
11.5	AU 3	(SP-SC) Orange and gray SAND with clay
13.0	AU 4	(SP) Pale gray and brown SAND
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-20

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
LOGGED BY WDI
AT TIME OF DRILLING NE
CHECKED BY KPF
ESTIMATED SEASONAL HIGH >15 ft
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0	AU 1	(SP-SM) Gray and brown SAND with silt
1.0	AU 2	LIMESTONE
7–7.5	AU 3	
13–13.5	AU 4	
15.0		Bottom of borehole at 15.0 feet.

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PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-21

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
NOTES
LOGGED BY WDI
CHECKED BY KPF

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.0	AU 1	(SP-SM) Gray SAND with silt
3.0 – 11.5	AU 2, AU 3	(SC) Brown and orange clayey SAND
11.5 – 15.0	AU 4	(SC) Gray and brown clayey SAND
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-22

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
NOTES
LOGGED BY WDI
CHECKED BY KPF

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 2.5	AU 1	(SP-SM) Gray and brown SAND with silt
2.5 – 6.0	AU 2 PS	(SC) Brown and orange clayey SAND *%PASS-200 = 23* *MC = 15* *k_h = 10 ft/day*
6.0 – 10.5	AU 3	(SC) Brown, gray and orange clayey SAND
10.5 – 15.0	AU 4	LIMESTONE
15.0		Bottom of borehole at 15.0 feet.

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BORING NUMBER A-23

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 2.0	AU 1	(SP-SM) Gray and brown SAND with silt
2.0 – 6.0	AU 2	(SC) Brown and orange clayey SAND
6.0 – 15.0	AU 3, AU 4	(SC) Gray, brown and orange clayey SAND
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-24

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.5	AU 1	(SP-SM) Gray and brown SAND with silt
3.5 – 5.5	AU 2	(SP) Brown SAND
5.5 – 15.0	AU 3, AU 4 PS	(SC) Brown, gray, and orange clayey SAND *%PASS-200 = 18* *MC = 11*
15.0		Bottom of borehole at 15.0 feet.

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PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-25

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 10.0 ft, perched
NOTES
LOGGED BY WDI
CHECKED BY KPF

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.5	AU 1; AU 2	(SP-SM) Gray and brown SAND with silt
3.5 – 10.5	AU 3 PS	(SP-SM) Pale gray and brown SAND with silt *%PASS-200 = 5.3* *MC = 3.7* *k_h = 20 ft/day*
10.5 – 12.5	AU 4	(SC/CL) Gray, green and brown very clayey SAND *%PASS-200 = 45* *MC = 24; LL = 51; PL = 15; PI = 36*
12.5 – 15.0	AU 5	LIMESTONE
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-26

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
NOTES
LOGGED BY WDI
CHECKED BY KPF

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0 – 3.0	AU 1	(SP-SM) Gray and brown SAND with silt
3.0 – 13.0	AU 2; AU 3 PS	(SP-SM) Pale brown and gray SAND with silt *%PASS-200 = 6.9* *MC = 8.7* *k_h = 11 ft/day*
13.0 – 15.0	AU 4	(SP) Pale gray and brown SAND
15.0		Bottom of borehole at 15.0 feet.

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PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-27

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0	AU 1	(SP-SM) Brown and gray SAND with silt
3.0	AU 2	(SP) Pale gray and brown SAND
6.5	AU 3	LIMESTONE
13.5	AU 4	(SP) Brown SAND with trace of limestone
15.0		Bottom of borehole at 15.0 feet.

BORING NUMBER A-28

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 1.0 ft, perched
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION
0	AU 1	(SP-SM) Brown and gray SAND with silt
1.5	AU 2, AU 3	(SC/CL) Brown and gray very clayey SAND with trace of limestone
11.0	AU 4	LIMESTONE
15.0		Bottom of borehole at 15.0 feet.

(Continued Next Page)

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CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

BORING NUMBER A-29

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH 1.5 ft, perched
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION	Bottom depth (ft)
0	AU 1 PS	(SP-SM) Brown and gray SAND with silt *%PASS-200 = 8.4* *MC = 6.2* *k_h = 5.4 ft/day*	2.0
	AU 2	(SC/CL) Brown and orange very clayey SAND *%PASS-200 = 33* *MC = 19*	7.5
5	AU 3, AU 4	LIMESTONE	15.0
10			
15		Bottom of borehole at 15.0 feet.	

BORING NUMBER A-30

DATE PERFORMED 7/21/2020
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
AT TIME OF DRILLING NE
ESTIMATED SEASONAL HIGH >15 ft
LOGGED BY WDI
CHECKED BY KPF
NOTES

DEPTH (ft)	SAMPLE TYPE NUMBER	MATERIAL DESCRIPTION	Bottom depth (ft)
0	AU 1	(SP-SM) Gray SAND with silt	1.5
	AU 2, AU 3, AU 4	LIMESTONE	15.0
5			
10			
15		Bottom of borehole at 15.0 feet.	

8.2 Auger Boring Logs

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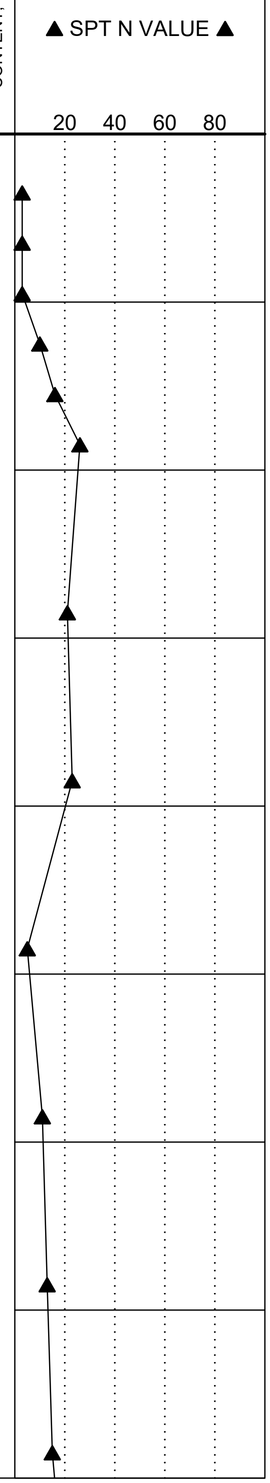
BORING NUMBER B-1

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/4/20 **COMPLETED** 6/4/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 10.0 ft, perched
NOTES
AFTER DRILLING 38.1 ft (6/10/2020)

CONTACT DEPTH (ft)	MATERIAL DESCRIPTION
0	(SP) Very loose brown and orange SAND
5	(SP) Very loose to loose pale gray and brown SAND
7	(SC) Medium dense orange, brown, and gray clayey SAND
11	(CL/CH) Very stiff green and orange CLAY with sand
18.5	(SC/CL) Loose to medium dense gray, brown, and orange very clayey SAND
27	Soft to very hard LIMESTONE *Loss of circulation at 28.5 ft bls*

SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
SPT 1	2-1-2 (3)					
SPT 2	2-1-2 (3)					
SPT 3	3-1-2 (3)					
SPT 4	3-4-6 (10)					
SPT 5	7-7-9 (16)					
SPT 6	11-13-13 (26)					
SPT 7	11-9-12 (21)					
SPT 8	11-11-12 (23)					
SPT 9	3-2-3 (5)					
SPT 10	5-5-6 (11)					
SPT 11	1-1-12 (13)					
SPT 12	8-7-8 (15)					



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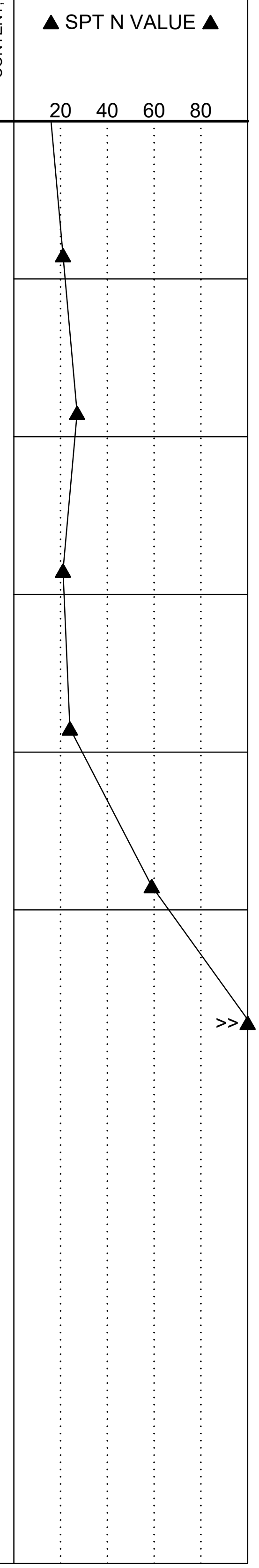
BORING NUMBER B-1

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
40	Soft to very hard LIMESTONE *(continued)*								
45			SPT 13	8-9-12 (21)					
50			SPT 14	7-10-17 (27)					
55			SPT 15	10-11-10 (21)					
60			SPT 16	14-12-12 (24)					
65			SPT 17	47-29-30 (59)					
	Bottom of borehole at 68.7 feet.	68.7	SPT 18	50/2"					



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BORING NUMBER B-2

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/5/20 **COMPLETED** 6/5/20
GROUND ELEVATION ______ **HOLE SIZE** ______
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 17.5 ft, perched
NOTES ______
AFTER DRILLING 36.7 ft (6/10/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)
0	(SP) Very loose brown and gray SAND	3
3	(SP) Very loose to loose pale gray and brown SAND	13.5
13.5	(SP-SC) Loose brown and orange SAND with clay (estimated seasonal high water level at 17.5 ft)	18.5
18.5	(CL/CH) Firm brown and orange CLAY with trace of limestone	24
24	(CL/CH) Firm gray CLAY	28.5
28.5	(CL/CH) Firm brown, gray, and orange CLAY with sand and trace of limestone *Loss of circulation at 28.5 ft bls*	33.5
33.5	(CL/CH) Firm gray, brown, and orange CLAY (after drilling water level at 36.7 ft)	38.5
38.5	(CL/CH) Stiff gray CLAY with sand	

SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
SPT 1	1-2-2 (4)					
SPT 2	1-2-2 (4)					
SPT 3	3-2-3 (5)					
SPT 4	3-4-3 (7)					
SPT 5	3-3-5 (8)					
SPT 6	4-3-3 (6)					
SPT 7	3-3-3 (6)					
SPT 8	1-3-4 (7)					
SPT 9	2-2-5 (7)					
SPT 10	4-2-3 (5)					
SPT 11	3-3-3 (6)					
SPT 12	3-6-4 (10)					

▲ SPT N VALUE ▲ (20 40 60 80)

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BORING NUMBER B-2

CLIENT Gainesville Regional Utilities

PROJECT NUMBER 14588

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ (20 40 60 80)
40		(CL/CH) Stiff gray CLAY with sand *(continued)*	42								
		Soft to hard LIMESTONE									
45				SPT 13	16-15-10 (25)						25
50				SPT 14	10-4-7 (11)						11
55				SPT 15	7-5-6 (11)						11
60			62	SPT 16	20-19-20 (39)						39

Bottom of borehole at 62.0 feet.

Boring terminated due to drilling refusal

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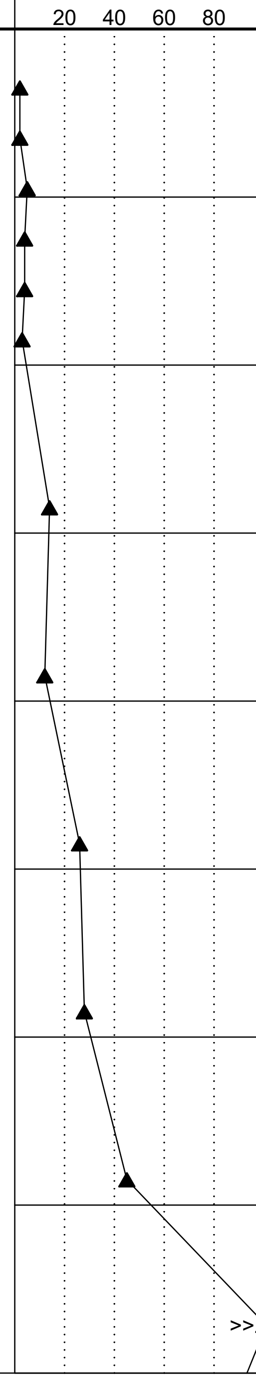
BORING NUMBER B-3

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/11/20 **COMPLETED** 6/11/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 21.0 ft
NOTES
AFTER DRILLING 21.3 ft (Muddy) (6/10/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Very loose brown and gray SAND								
			SPT 1	2-1-1 (2)					
		3.5	SPT 2	1-1-1 (2)					
5	(SP) Very loose to loose pale gray and brown SAND		SPT 3	1-2-3 (5)					
			SPT 4	1-2-2 (4)					
			SPT 5	2-2-2 (4)					
10			SPT 6	2-1-2 (3)					
		13.5							
15	(SC) Medium dense brown and orange clayey SAND		SPT 7	5-6-8 (14)					
20			SPT 8	6-6-6 (12)					
		23							
25	(CL/CH) Very stiff gray, green, and orange CLAY with flint rock		SPT 9	26-15-11 (26)					
		29							
30	Moderately hard to very hard LIMESTONE		SPT 10	7-11-17 (28)					
35			SPT 11	23-20-25 (45)					
	Loss of circulation at 38 ft bls								
40			SPT 12	50/2"					

▲ SPT N VALUE ▲



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BORING NUMBER B-3

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ 20 40 60 80
40		Moderately hard to very hard LIMESTONE *(continued)*									
45			45	SPT 13	27-31-39 (70)						
		Bottom of borehole at 45.0 feet.									

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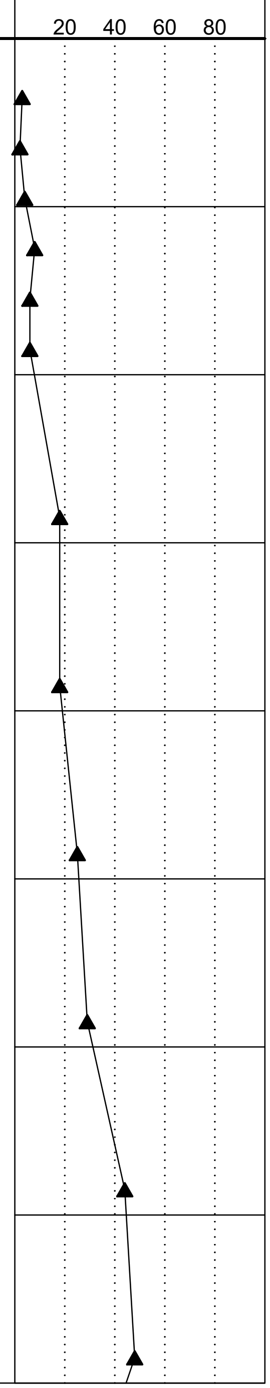
BORING NUMBER B-4

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/12/20 **COMPLETED** 6/12/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
▼ **AT TIME OF DRILLING** NR
LOGGED BY WDI **CHECKED BY** KPF
▽ **ESTIMATED SEASONAL HIGH** 40.0 ft
NOTES
▼ **AFTER DRILLING** NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SC) Very loose to loose brown SAND with clay								
			SPT 1	2-1-2 (3)					
	Weight-of-hammer from 3 to 3.5 ft bls		SPT 2	1-0-2 (2)					
5			SPT 3	1-2-2 (4)					
			SPT 4	3-3-5 (8)					
			SPT 5	4-3-3 (6)					
10			SPT 6	3-3-3 (6)					
15	(SP-SC) Medium dense brown, and gray SAND with clay	13.5	SPT 7	7-8-10 (18)					
20	(SP-SC) Medium dense to dense pale gray and brown SAND with clay	18.5	SPT 8	8-8-10 (18)					
25			SPT 9	8-11-14 (25)					
30			SPT 10	10-13-16 (29)					
35			SPT 11	17-21-23 (44)					
40 ▽			SPT 12	15-21-27 (48)					

▲ SPT N VALUE ▲



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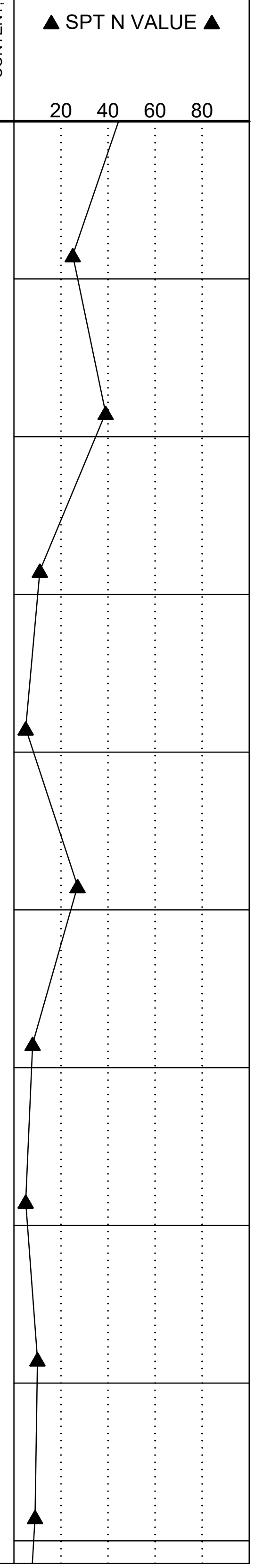
BORING NUMBER B-4

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
40	(SP-SC) Medium dense to dense pale gray and brown SAND with clay *(continued)*								
45			SPT 13	5-8-17 (25)					
		48.5							
50	(SP-SC) Dense brown and orange SAND with clay		SPT 14	23-21-18 (39)					
		53.5							
55	(SP-SC) Medium dense brown SAND with clay		SPT 15	6-6-5 (11)					
		58.5							
60	(SC) Loose dark green and gray clayey SAND		SPT 16	3-2-3 (5)				23	24
		63.5							
65	(SP-SM) Loose to medium dense dark brown and gray SAND with silt		SPT 17	7-12-15 (27)					
70			SPT 18	2-4-4 (8)				7.2	23
75			SPT 19	3-2-3 (5)					
80			SPT 20	6-6-4 (10)					
85			SPT 21	3-5-4 (9)					



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BORING NUMBER B-4

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ (20 40 60 80)
		(SP-SM) Loose to medium dense dark brown and gray SAND with silt *(continued)*									
90				SPT 22	3-3-2 (5)						
			93								
		Moderately hard to hard gray LIMESTONE *Loss of circulation at 93.5 ft bls*									
95				SPT 23	8-11-19 (30)						
100				SPT 24	14-27-20 (47)						
105			105								
		Bottom of borehole at 105.0 feet.									

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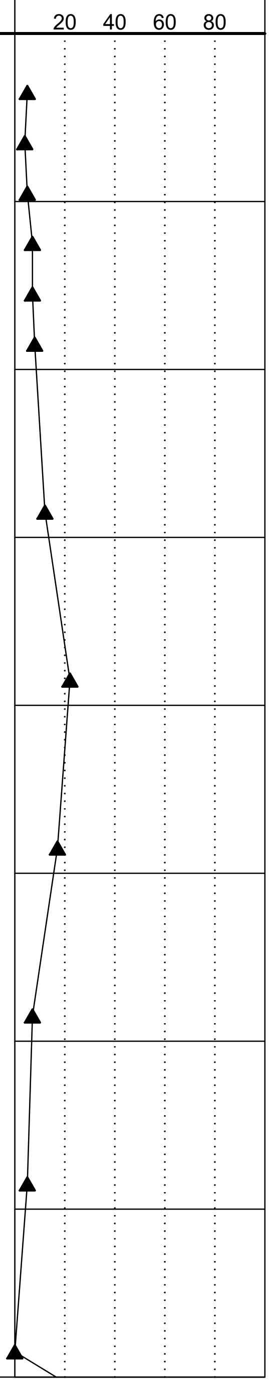
BORING NUMBER B-5

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/10/20 **COMPLETED** 6/10/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 26.5 ft, perched
NOTES
AFTER DRILLING NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Very loose to loose brown and gray SAND								
			SPT 1	3-2-3 (5)					
		4	SPT 2	2-2-2 (4)					
5	(SP) Loose to medium dense pale gray and brown SAND		SPT 3	2-2-3 (5)					
			SPT 4	3-2-5 (7)					
			SPT 5	3-3-4 (7)					
10			SPT 6	4-3-5 (8)					
15			SPT 7	5-6-6 (12)					
		18.5							
20	(SP-SC) Medium dense brown and orange SAND with clay		SPT 8	8-11-11 (22)					
25			SPT 9	9-10-7 (17)					
		27.5							
	(CL/CH) Firm gray and brown CLAY with sand								
30			SPT 10	2-3-4 (7)					
35			SPT 11	2-2-3 (5)				79	63
	Weight-of-rod from 38.5 to 40 ft bls								
	Loss of circulation at 38ft bls	38.5							
40	(CL/CH) Very soft gray and brown CLAY with sand and trace of limestone		SPT 12	0-0-0 (0)	82	27	55	78	77

▲ SPT N VALUE ▲



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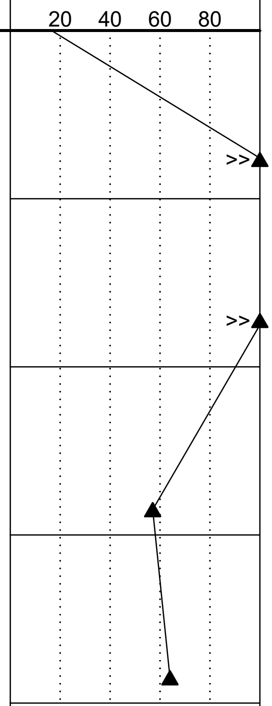
BORING NUMBER B-5

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
40		41							
	Very hard LIMESTONE								
45			SPT 13	20-50/2" 50/2"					
50			SPT 14	50/3"					
55			SPT 15	19-27-30 (57)					
60		60	SPT 16	20-26-38 (64)					
	Bottom of borehole at 60.0 feet.								

▲ SPT N VALUE ▲



BORING NUMBER B-6

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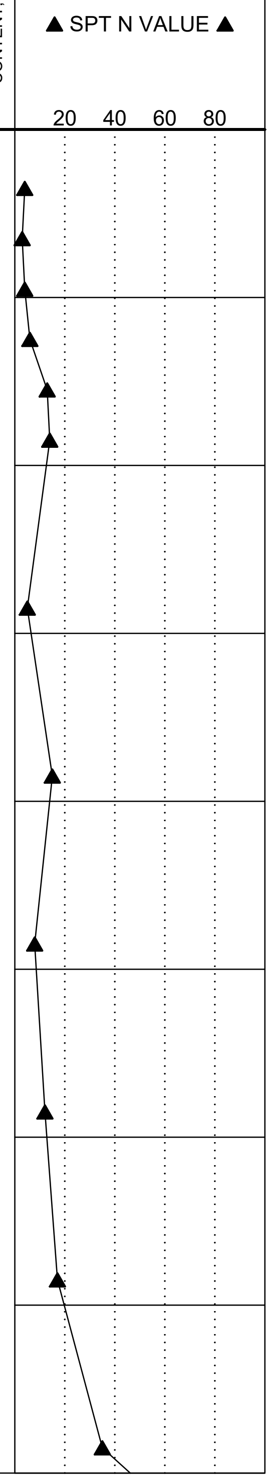
CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/8/20 **COMPLETED** 6/8/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 7.5 ft, perched
NOTES
AFTER DRILLING NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Very loose brown and gray SAND	4	SPT 1	2-2-2 (4)					
			SPT 2	2-1-2 (3)					
5	(SP) Very loose to medium dense pale gray and brown SAND	8.5	SPT 3	2-2-2 (4)					
			SPT 4	2-3-3 (6)					
			SPT 5	4-6-7 (13)					
10	(SC/CL) Medium dense brown and orange very clayey SAND with trace of limestone	9.5	SPT 6	6-6-8 (14)				35	19
	(CL/CH) Stiff CLAY with sand	13.5							
15	(CL/CH) Firm gray and brown CLAY	18	SPT 7	2-2-3 (5)					
20	Soft LIMESTONE *Loss of circulation at 18 ft bls*	21.5	SPT 8	4-7-8 (15)					
25	(CL/CH) Firm to stiff gray and brown CLAY	33	SPT 9	6-4-4 (8)					
30			SPT 10	5-6-6 (12)					
35	(CL/CH) Very stiff CLAY with limestone	34.5	SPT 11	4-5-12 (17)					
40	Hard to very hard LIMESTONE		SPT 12	16-16-19 (35)					



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BORING NUMBER B-6

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ (20 40 60 80)
40		Hard to very hard LIMESTONE *(continued)*									
				SPT 13	50/5"						>>▲
45											
			49.4	SPT 14	28-50/5" 50/5"						>>▲
		Bottom of borehole at 49.4 feet.									

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BORING NUMBER B-7

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 23.0 ft, perched
NOTES
AFTER DRILLING NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose brown and gray SAND with silt		SPT 1	2-1-1 (2)					
			SPT 2	1-1-2 (3)					
5		5.5	SPT 3	2-1-3 (4)					
	(SP) Loose pale gray and brown SAND		SPT 4	2-5-4 (9)					
			SPT 5	4-3-4 (7)					
10			SPT 6	6-5-4 (9)					
		13.5							
15	(SC) Medium dense brown, gray, orange clayey SAND		SPT 7	8-6-5 (11)					
20			SPT 8	7-9-9 (18)					
	▽ (estimated seasonal high, 23.0 ft)	24							
25	(CL/CH) Stiff brown, green, and orange CLAY with sand and trace limestone		SPT 9	5-5-6 (11)					
30			SPT 10	4-6-4 (10)					
		34							
35	(SC) Loose to medium dense brown and gray clayey SAND		SPT 11	5-6-8 (14)					
40			SPT 12	4-4-6 (10)					

▲ SPT N VALUE ▲ (scale: 20 40 60 80)

(Continued Next Page)

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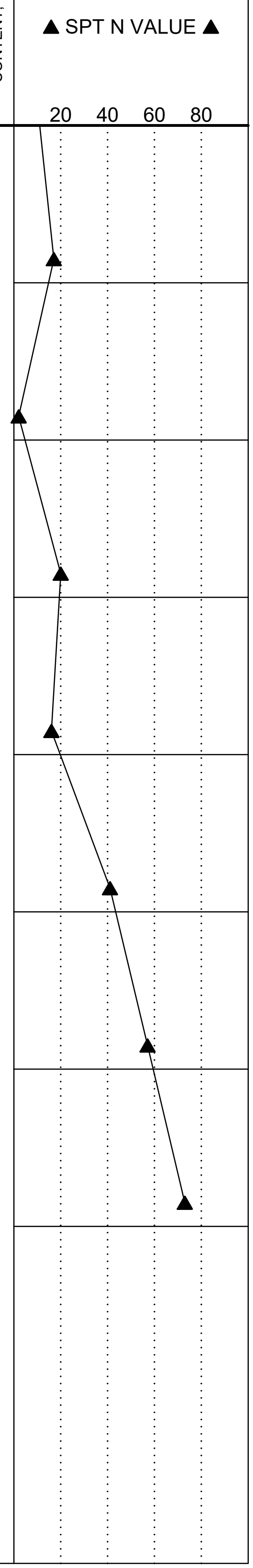
BORING NUMBER B-7

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
40	(SC) Loose to medium dense brown and gray clayey SAND *(continued)*	42							
	(CL/CH) Very stiff green and gray CLAY with sand								
45			SPT 13	9-9-8 (17)					
		48.5							
50	(SP) Very loose brown and orange SAND		SPT 14	2-1-1 (2)					
		53							
55	Soft to very hard LIMESTONE *Loss of circulation at 53 ft bls*		SPT 15	7-10-10 (20)					
60			SPT 16	9-7-9 (16)					
65			SPT 17	13-17-24 (41)					
70			SPT 18	19-26-31 (57)					
75		75	SPT 19	31-30-43 (73)					
	Bottom of borehole at 75.0 feet.								



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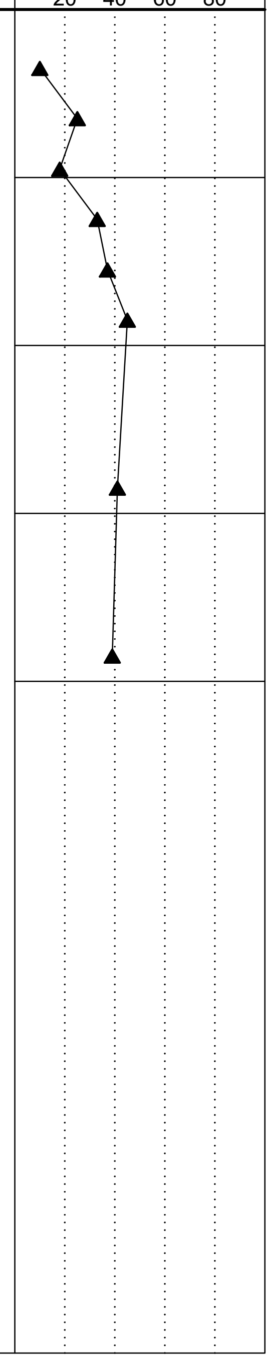
BORING NUMBER B-8

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/9/20 **COMPLETED** 6/9/20
GROUND ELEVATION ______ **HOLE SIZE** ______
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH >20 ft
NOTES
AFTER DRILLING 4.2 ft (Rain) (6/10/2020)

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0		(CL/CH) Stiff to very stiff brown and gray CLAY with trace of limestone		SPT 1	2-4-6 (10)					
			4	SPT 2	7-10-15 (25)					
5		Soft to hard LIMESTONE		SPT 3	12-9-9 (18)					
				SPT 4	11-18-15 (33)					
				SPT 5	9-15-22 (37)					
10				SPT 6	10-20-25 (45)					
15				SPT 7	18-22-19 (41)					
20			20	SPT 8	21-22-17 (39)					
		Bottom of borehole at 20.0 feet.								

▲ SPT N VALUE ▲



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BORING NUMBER B-9

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 28.0 ft, perched
NOTES
AFTER DRILLING 30.2 ft (6/10/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Very loose brown and gray SAND		SPT 1	2-1-1 (2)					
			SPT 2	3-1-2 (3)					
5	(SP) Loose to medium dense pale gray and brown SAND	4	SPT 3	2-2-3 (5)					
	(SC) Medium dense to dense gray, brown, and orange clayey SAND	6	SPT 4	4-5-6 (11)					
			SPT 5	6-9-14 (23)					
10			SPT 6	26-16-17 (33)					
15			SPT 7	14-18-22 (40)					
20			SPT 8	13-16-20 (36)					
25			SPT 9	14-18-14 (32)					
30	(CL/CH) Very stiff gray CLAY	29	SPT 10	10-8-10 (18)					
35	(CL/CH) Very stiff gray and brown sandy CLAY	33.5	SPT 11	9-10-10 (20)					
40		39	SPT 12	7-11-18 (29)					

▲ SPT N VALUE ▲ (20, 40, 60, 80)

(Continued Next Page)

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BORING NUMBER B-9

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ (20 40 60 80)
40		(SP-SC) Loose to medium dense brown and orange SAND with clay *(continued)*									
45				SPT 13	4-4-6 (10)						
			49	SPT 14	5-50/3" 50/3"						>>
50		Hard LIMESTONE									
			51.5								

Bottom of borehole at 51.5 feet.
Boring terminated due to drilling refusal

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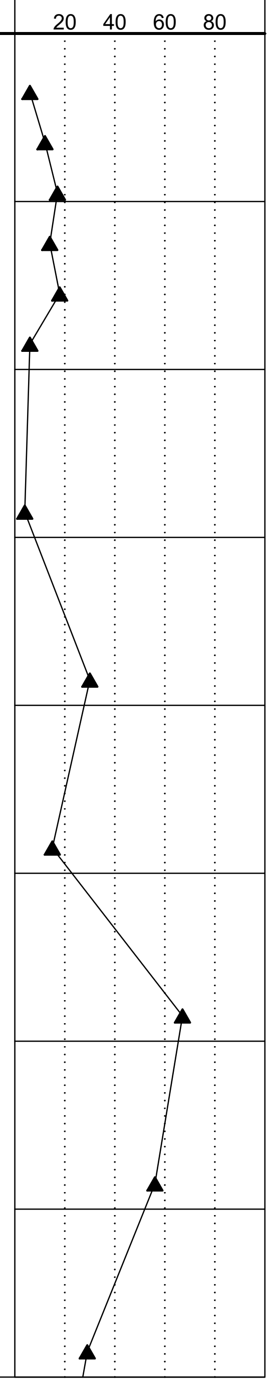
BORING NUMBER B-10

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 38.0 ft
NOTES
AFTER DRILLING 38.6 ft (6/10/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SC) Loose to medium dense orange and brown clayey SAND		SPT 1	2-2-4 (6)					
			SPT 2	5-6-6 (12)					
5			SPT 3	8-9-8 (17)					
		6	SPT 4	6-7-7 (14)					
	(SP-SC) Loose to medium dense brown, orange, and gray SAND with clay *Loss of circulation at 8 ft bls*		SPT 5	9-9-9 (18)					
		9	SPT 6	2-4-2 (6)					
10	(SP-SC) Loose to very loose gray SAND with clay								
		14.5	SPT 7	2-3-1 (4)					
15	Very soft to very hard LIMESTONE								
20			SPT 8	5-12-18 (30)					
25			SPT 9	6-8-7 (15)					
30			SPT 10	31-18-49 (67)					
35			SPT 11	21-28-28 (56)					
40			SPT 12	10-12-17 (29)					

▲ SPT N VALUE ▲



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BORING NUMBER B-10

CLIENT Gainesville Regional Utilities

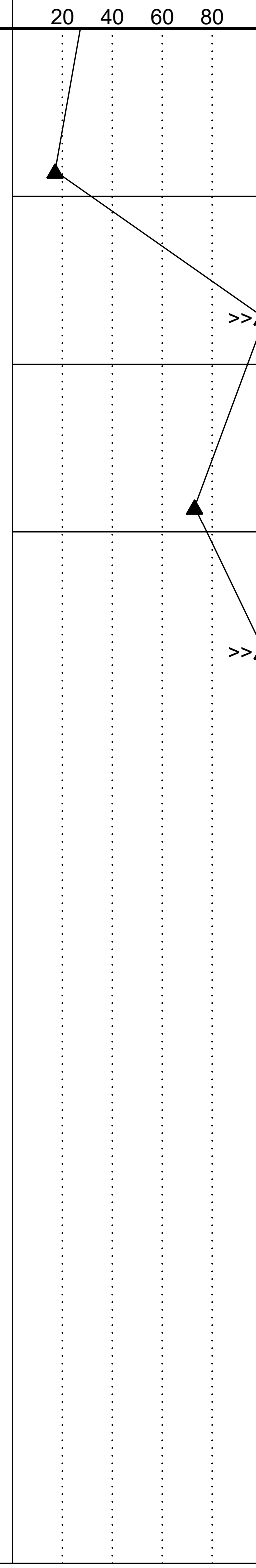
PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
40		Very soft to very hard LIMESTONE *(continued)*								
45				SPT 13	6-5-12 (17)					
50				SPT 14	50/3"					
55				SPT 15	24-28-45 (73)					
		Bottom of borehole at 58.7 feet.	58.7	SPT 16	50/2"					

▲ SPT N VALUE ▲



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BORING NUMBER B-11

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 1.5 ft, perched
NOTES
AFTER DRILLING 36.2 ft (6/5/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose brown and gray SAND with silt	2.5	SPT 1	2-1-1 (2)					
	(CL/CH) Soft to firm brown and gray CLAY with sand	5.5	SPT 2	2-2-2 (4)					
5			SPT 3	3-2-3 (5)					
	(SP) Loose pale gray SAND	6.5	SPT 4	7-4-5 (9)					
	(CL/CH) Firm to stiff brown and gray sandy CLAY	12.5	SPT 5	4-3-4 (7)					
10			SPT 6	6-5-5 (10)					
15	Hard to very hard LIMESTONE		SPT 7	21-19-23 (42)					
20			SPT 8	39-50/4" 50/4"					
25	*Loss of circulation at 23 ft bls*		SPT 9	29-48-49 (97)					
30			SPT 10	50-50/3" 50/3"					
35		38.9	SPT 11	30-21-50/1" 71/7"					
	Bottom of borehole at 38.9 feet.		SPT 12	50/5"					

▲ SPT N VALUE ▲

20 40 60 80

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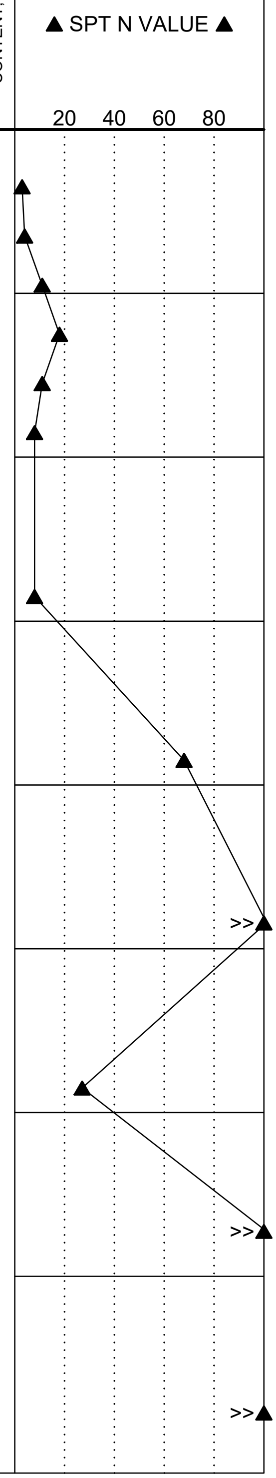
BORING NUMBER B-12

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION ______ **HOLE SIZE** ______
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 3.0 ft, perched
NOTES ______
AFTER DRILLING NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Very loose brown and gray SAND	4	SPT 1	2-1-2 (3)					
			SPT 2	2-1-3 (4)					
5	(CL/CH) Stiff gray and orange sandy CLAY with trace of limestone	5.5	SPT 3	2-3-8 (11)					
	Soft LIMESTONE	9	SPT 4	13-10-8 (18)					
			SPT 5	12-4-7 (11)					
10	(CL/CH) Firm gray and orange CLAY with SAND	12.5	SPT 6	6-5-3 (8)	54	16	38	72	36
15	Very soft to very hard LIMESTONE		SPT 7	6-3-5 (8)					
20			SPT 8	14-28-40 (68)					
25			SPT 9	26-30-50/5" 80/11"					
	Loss of circulation at 26 ft bls								
30			SPT 10	11-11-16 (27)					
35			SPT 11	50/3"					
		39.8	SPT 12	42-36-50/4" 86/10"					
	Bottom of borehole at 39.8 feet.								



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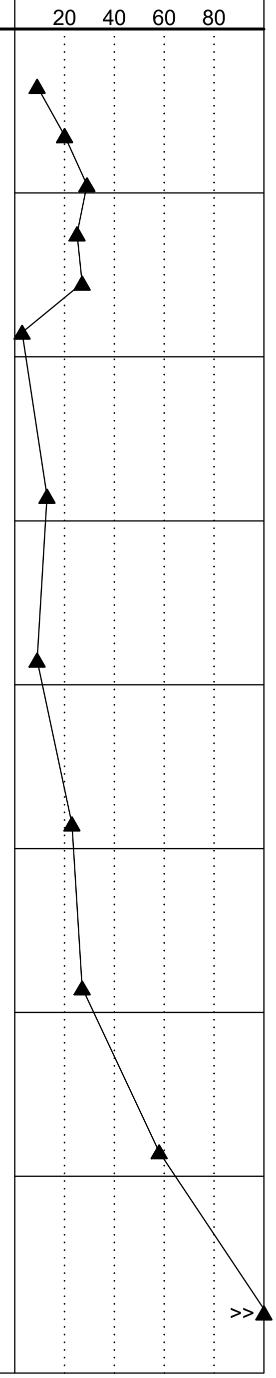
BORING NUMBER B-13

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/11/20 **COMPLETED** 6/11/20
GROUND ELEVATION ____ **HOLE SIZE** ____
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 40.0 ft
NOTES ____
AFTER DRILLING ____

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	Very soft to very hard LIMESTONE *Loss of circulation at ground surface*								
			SPT 1	5-6-3 (9)					
			SPT 2	3-5-15 (20)					
5			SPT 3	23-13-16 (29)					
			SPT 4	14-16-9 (25)					
			SPT 5	22-12-15 (27)					
10			SPT 6	13-1-2 (3)					
15			SPT 7	7-5-8 (13)					
20			SPT 8	4-4-5 (9)					
25			SPT 9	16-15-8 (23)					
30			SPT 10	13-10-17 (27)					
35			SPT 11	39-30-28 (58)					
		39.8	SPT 12	20-25-50/4" 75/10"					
	Bottom of borehole at 39.8 feet.								

▲ SPT N VALUE ▲



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BORING NUMBER B-14

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/10/20 **COMPLETED** 6/10/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 5.5 ft, perched
NOTES
AFTER DRILLING 31.5 ft (6/4/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)
0	(SP-SM) Very loose brown and gray SAND with silt	3
	(SP) Very loose to loose pale gray and brown SAND	4.5
5	(SC) Loose to medium dense brown and orange clayey SAND (estimated seasonal high water level)	6.5
	(CL/CH) Stiff to very stiff brown, gray, and orange sandy CLAY	9
10	(CL/CH) Very stiff brown, gray, and orange sandy CLAY with trace of limestone	13.5
15	Very soft to moderately hard LIMESTONE *Loss of circulation at 13.5 ft bls* *Return of circulation at 21 ft bls* *Loss of circulation at 27.5 ft bls* *Weight-of-rod from 30 to 38 ft bls* (after drilling water level)	38
	Soft to very hard LIMESTONE	
40		

SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)
SPT 1	2-2-1 (3)
SPT 2	1-1-2 (3)
SPT 3	2-2-3 (5)
SPT 4	4-5-7 (12)
SPT 5	6-9-10 (19)
SPT 6	8-10-10 (20)
SPT 7	3-2-7 (9)
SPT 8	6-6-5 (11)
SPT 9	24-14-6 (20)
SPT 10	4-3-2 (5)
SPT 11	0-0-0 (0)
SPT 12	0-0-0 (0)
SPT 13	0-0-0 (0)
SPT 14	0-0-0 (0)
SPT 15	0-0-0 (0)
SPT 16	3-8-4 (12)

LIQUID LIMIT, % | PLASTIC LIMIT, % | PLASTICITY INDEX | PERCENT PASS NO. 200 SIEVE | MOISTURE CONTENT, % | ▲ SPT N VALUE ▲ (20 40 60 80)

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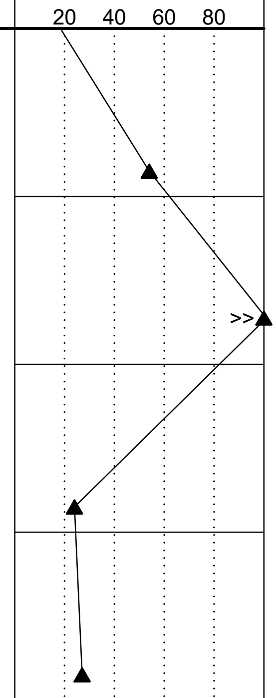
BORING NUMBER B-14

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ (20 40 60 80)
40		Soft to very hard LIMESTONE *(continued)*									
45				SPT 17	21-26-28 (54)						
50				SPT 18	50/3"						>>
55				SPT 19	4-2-22 (24)						
60			60	SPT 20	22-12-15 (27)						
		Bottom of borehole at 60.0 feet.									



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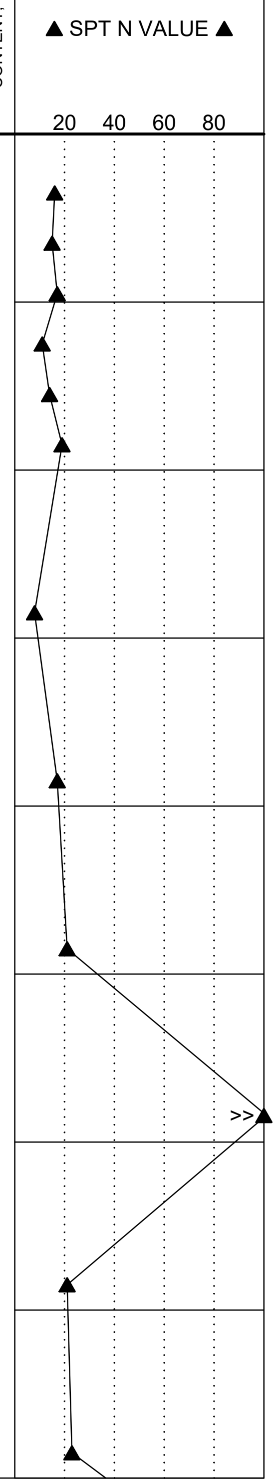
BORING NUMBER B-15

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING 32.0 ft
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 5.0 ft, perched
NOTES
AFTER DRILLING NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Medium dense brown and gray SAND								
			SPT 1	6-7-9 (16)					
		4	SPT 2	10-9-6 (15)					
5	(SP) Medium dense pale gray SAND		SPT 3	9-8-9 (17)					
		6	SPT 4	7-5-6 (11)					
	(CL/CH) Stiff to very stiff gray and orange sandy CLAY		SPT 5	5-6-8 (14)					
10			SPT 6	10-9-10 (19)					
		12							
	Very soft to very hard LIMESTONE								
15			SPT 7	3-2-6 (8)					
20			SPT 8	3-7-10 (17)					
25			SPT 9	22-10-11 (21)					
30			SPT 10	26-9-50/5" 59/11"					
35			SPT 11	8-9-12 (21)					
40			SPT 12	18-8-15 (23)					



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BORING NUMBER B-15

CLIENT Gainesville Regional Utilities

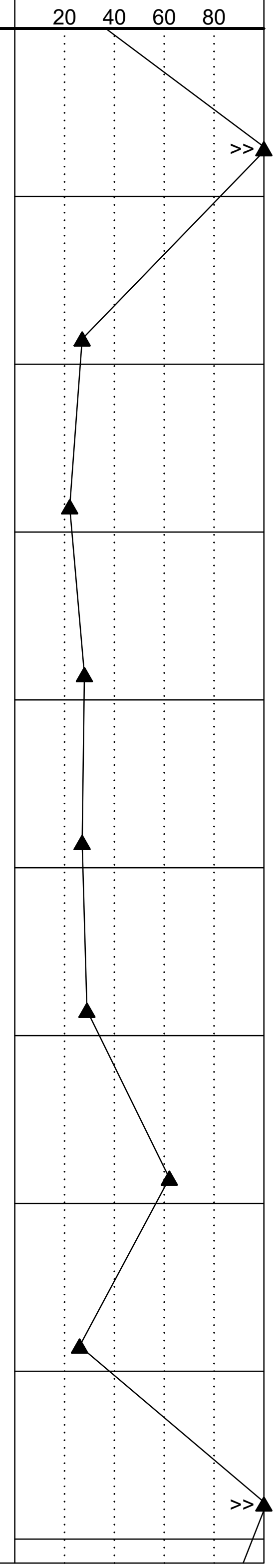
PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
40		Very soft to very hard LIMESTONE *(continued)*								
45				SPT 13	50/2"					
50				SPT 14	18-18-9 (27)					
55				SPT 15	9-10-12 (22)					
60				SPT 16	49-14-14 (28)					
65				SPT 17	18-18-9 (27)					
70		*Weight-of-hammer from 69 to 69.5 ft bls*		SPT 18	17-0-29 (29)					
75				SPT 19	15-22-40 (62)					
80				SPT 20	13-14-12 (26)					
85				SPT 21	30-50/5" 50/5"					

▲ SPT N VALUE ▲



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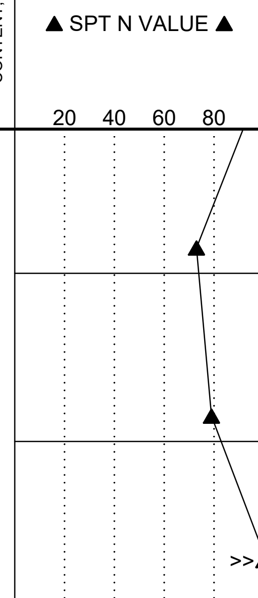
BORING NUMBER B-15

CLIENT Gainesville Regional Utilities
PROJECT NUMBER 14588
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
		Very soft to very hard LIMESTONE *(continued)*								
90				SPT 22	39-30-43 (73)					
95				SPT 23	25-31-48 (79)					
		Bottom of borehole at 98.6 feet.	98.6	SPT 24	50/1"					



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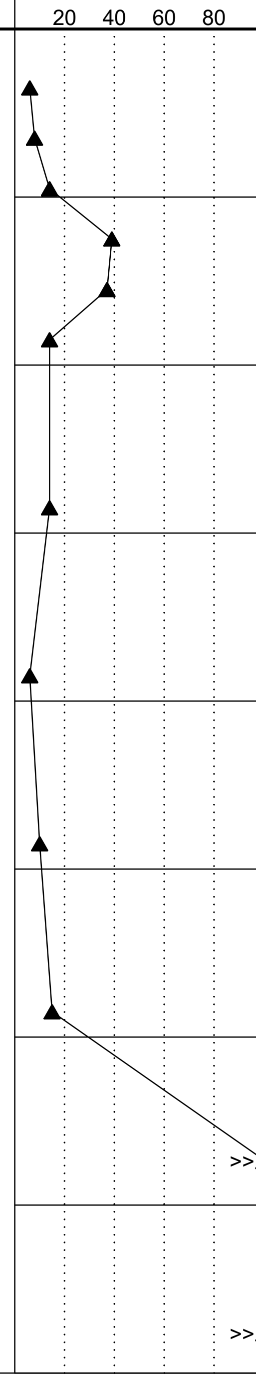
BORING NUMBER B-16

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 2.0 ft, perched
NOTES
AFTER DRILLING NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Loose brown and gray SAND	1.5							
	(SC) Loose brown, gray, and orange clayey SAND with trace rock	3	SPT 1	1-2-4 (6)					
	(CL/CH) Firm to hard brown and orange CLAY with sand and trace limestone	6	SPT 2	2-4-4 (8)					
5			SPT 3	5-5-9 (14)					
	Soft to hard LIMESTONE		SPT 4	15-20-19 (39)					
			SPT 5	21-20-17 (37)					
10			SPT 6	10-6-8 (14)					
	Loss of circulation at 11 ft bls								
15			SPT 7	4-4-10 (14)					
		18.5							
20	(SC) Loose brown, gray, and orange clayey SAND with trace of limestone	23	SPT 8	4-4-2 (6)					
25	Soft to hard LIMESTONE		SPT 9	3-6-4 (10)					
30			SPT 10	6-8-7 (15)					
35			SPT 11	50/5"					
40			SPT 12	39-50/2" 50/2"					

▲ SPT N VALUE ▲



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BORING NUMBER B-16

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ 20 40 60 80
40		Soft to hard LIMESTONE *(continued)*									
			44.4	SPT 13	45-50/5" 50/5"						>>▲
		Bottom of borehole at 44.4 feet.									

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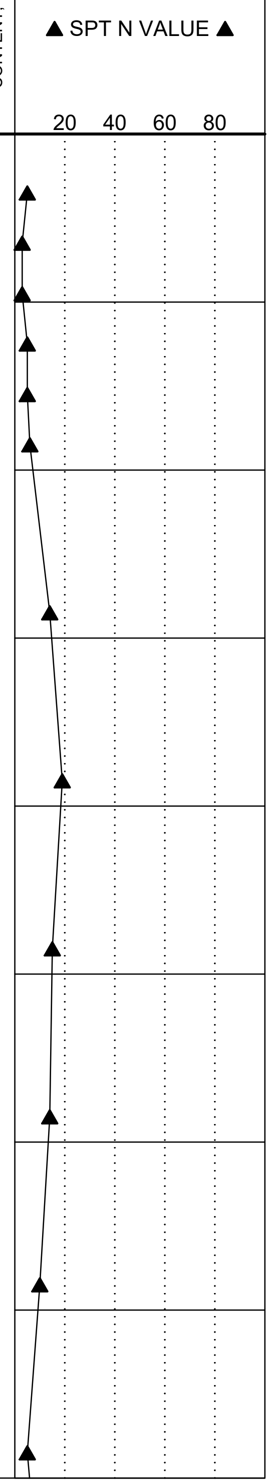
BORING NUMBER B-17

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NE
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 22.5 ft, perched
NOTES
AFTER DRILLING NR

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0		(SP) Very loose to loose gray and brown SAND		SPT 1	2-2-3 (5)					
			3.5	SPT 2	2-2-1 (3)					
5		(SP) Very loose to loose pale brown and gray SAND		SPT 3	2-2-1 (3)					
				SPT 4	2-2-3 (5)					
				SPT 5	4-2-3 (5)					
10				SPT 6	4-3-3 (6)					
		(SP) Medium dense brown and orange SAND	13.5	SPT 7	5-6-8 (14)					
20				SPT 8	9-9-10 (19)					
		(CL/CH) Stiff gray and brown CLAY with sand	23.5	SPT 9	5-7-8 (15)					
30				SPT 10	3-5-9 (14)					
35		(CL/CH) Firm to stiff brown and orange CLAY with sand	34.5	SPT 11	10-6-4 (10)				82	60
40				SPT 12	2-2-3 (5)					



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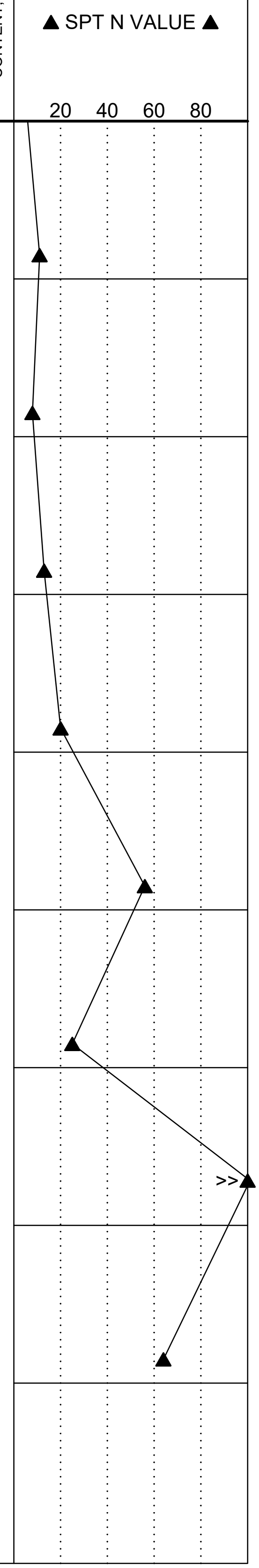
BORING NUMBER B-17

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲
40		(CL/CH) Firm to stiff brown and orange CLAY with sand *(continued)*	43.5								
45		(CL/CH) Stiff gray and brown CLAY with sand *Loss of circulation at 43.5 ft bls*	48	SPT 13	3-4-7 (11)						
50		(CL/CH) Firm gray CLAY with trace limestone	50	SPT 14	4-4-4 (8)						
55		Soft to very hard LIMESTONE		SPT 15	11-7-6 (13)						
60				SPT 16	5-7-13 (20)						
65				SPT 17	18-25-31 (56)						
70				SPT 18	6-15-10 (25)						
75				SPT 19	50/2"						>>
80			80	SPT 20	18-30-34 (64)						
		Bottom of borehole at 80.0 feet.									



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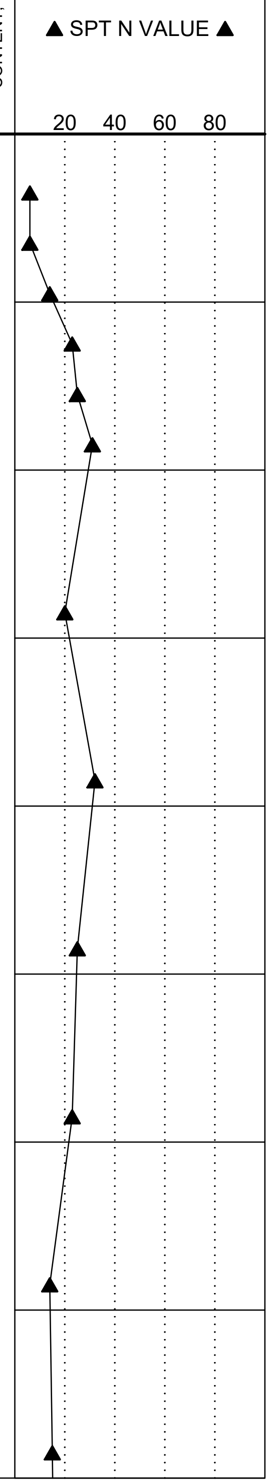
BORING NUMBER B-18

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/1/20 **COMPLETED** 6/1/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 31.0 ft, perched
NOTES
AFTER DRILLING 40.9 ft (6/16/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Loose brown SAND	3	SPT 1	3-3-3 (6)					
	(SC) Loose to medium dense brown and gray clayey SAND	5	SPT 2	2-2-4 (6)					
5	(SP-SC) Medium dense gray and brown SAND with clay	7.5	SPT 3	4-6-8 (14)					
			SPT 4	8-11-12 (23)					
	(SP) Medium dense to dense gray and brown SAND	13.5	SPT 5	11-11-14 (25)					
10			SPT 6	15-14-17 (31)					
15	(SP) Medium dense brown and orange SAND	18.5	SPT 7	6-9-11 (20)					
20	(SP) Medium dense to dense brown and gray SAND	28.5	SPT 8	12-15-17 (32)					
25			SPT 9	10-13-12 (25)					
30	(SM) Medium dense brown and gray silty SAND ∇	32	SPT 10	9-10-13 (23)					
35	(CL/CH) Stiff gray and orange sandy CLAY	38.5	SPT 11	7-8-6 (14)					
40	(SP) Medium dense gray and brown SAND		SPT 12	6-8-7 (15)					



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BORING NUMBER B-18

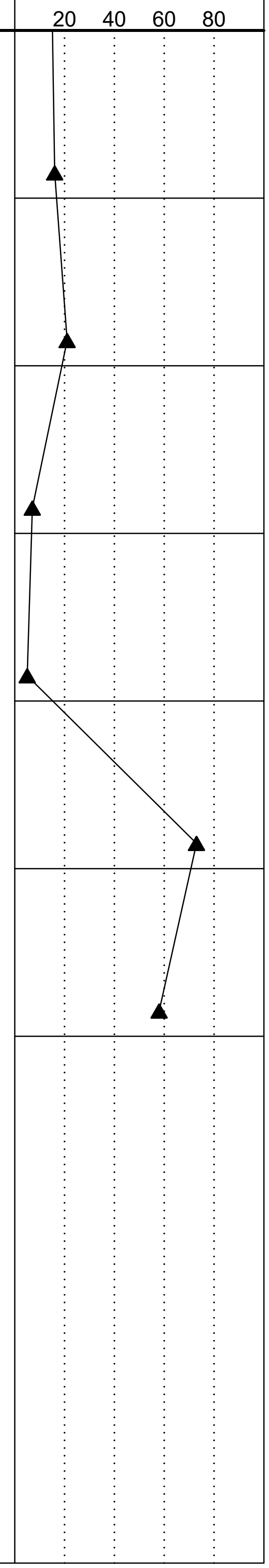
CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
40		(SP) Medium dense gray and brown SAND *(continued)*	43.5							
45		(SC) Medium dense gray and brown clayey SAND	48.5	SPT 13	10-8-8 (16)					
50		(SP-SC) Medium dense brown and orange SAND with clay *Loss of circulation at 48.5 ft bls*	53	SPT 14	7-9-12 (21)					
55		(SP-SC/SM) Loose brown SAND with clay and silt	56	SPT 15	4-2-5 (7)					
60		Very soft to very hard LIMESTONE	64.5	SPT 16	3-2-3 (5)					
65		Very hard gray LIMESTONE		SPT 17	10-28-45 (73)					
70			71	SPT 18	17-20-38 (58)					

Bottom of borehole at 71.0 feet.

Boring terminated due to drilling refusal

▲ SPT N VALUE ▲



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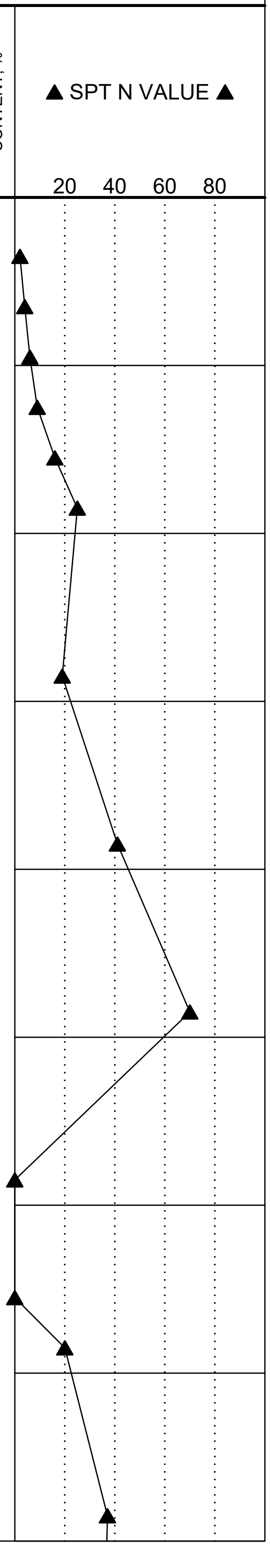
BORING NUMBER B-19

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/4/20 **COMPLETED** 6/4/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 27.5 ft, perched
NOTES
AFTER DRILLING NR

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose brown and gray SAND with silt	2.5	SPT 1	2-1-1 (2)					
	(SP) Very loose to loose pale brown SAND	4	SPT 2	1-2-2 (4)					
5	(SP) Loose pale gray SAND	6.5	SPT 3	2-3-3 (6)					
			SPT 4	3-4-5 (9)					
	(SC) Loose to medium dense brown and orange clayey SAND	7.5	SPT 5	5-7-9 (16)					
10	(SC) Medium dense gray, brown, and orange clayey SAND	14	SPT 6	10-12-13 (25)					
15	Moderately hard to very hard LIMESTONE		SPT 7	6-8-11 (19)					
20			SPT 8	16-22-19 (41)					
25			SPT 9	35-20-50 (70)					
	Loss of circulation at 27 ft bls	28.5							
30	(SC/CL) Very loose brown, gray, and orange very clayey SAND *Weight-of-rod from 28.5 to 34 ft bls*		SPT 10	0-0-0 (0)	31	14	17	31	32
		34	SPT 11	0-0-0 (0)					
35	Moderately hard to hard LIMESTONE		SPT 12	12-10-10 (20)					
40			SPT 13	37-16-21 (37)					



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BORING NUMBER B-19

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ 20 40 60 80
40		Moderately hard to hard LIMESTONE *(continued)*									
45				SPT 14	15-20-16 (36)						
50			50	SPT 15	12-10-12 (22)						
		Bottom of borehole at 50.0 feet.									

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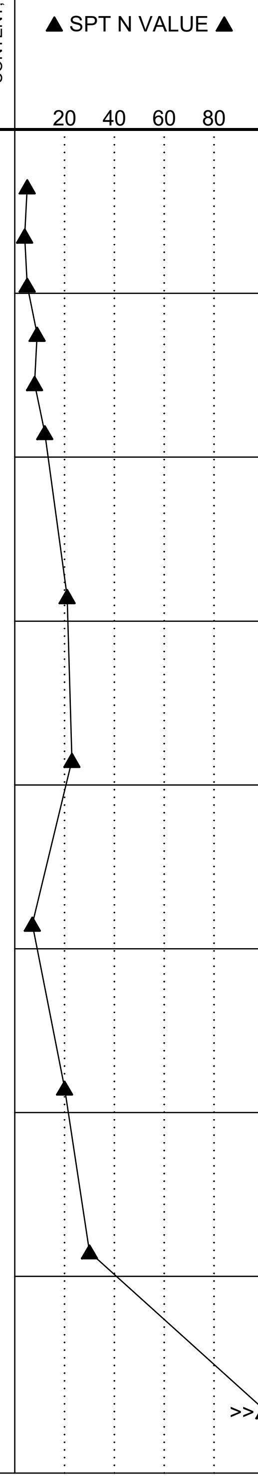
BORING NUMBER B-20

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 6/5/20 **COMPLETED** 6/5/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NR
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH 8.0 ft, perched
NOTES
AFTER DRILLING 29.9 ft (6/4/2020)

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose to loose brown and gray SAND with silt	3.5	SPT 1	2-3-2 (5)					
			SPT 2	2-2-2 (4)					
5	(SP) Very loose to loose pale gray and brown SAND	7.5	SPT 3	2-2-3 (5)					
			SPT 4	4-4-5 (9)					
	(SC/CL) Loose to medium dense gray and orange very clayey SAND	9	SPT 5	6-4-4 (8)					
10	(CL/CH) Stiff to very stiff gray, brown, and orange CLAY	18.5	SPT 6	3-5-7 (12)					
15			SPT 7	3-6-15 (21)					
20	(SP-SC) Medium dense gray, brown, and orange SAND with clay	23.5	SPT 8	8-11-12 (23)					
25	(SC/CL) Loose gray, brown, amd orange very clayey SAND		SPT 9	4-3-4 (7)	40	14	26	44	20
	Loss of circulation at 28.5 ft bls	29							
30	Moderately hard to very hard LIMESTONE	39.8	SPT 10	5-7-13 (20)					
35			SPT 11	24-15-15 (30)					
			SPT 12	8-27-50/3" 77/9"					
	Bottom of borehole at 39.8 feet.								



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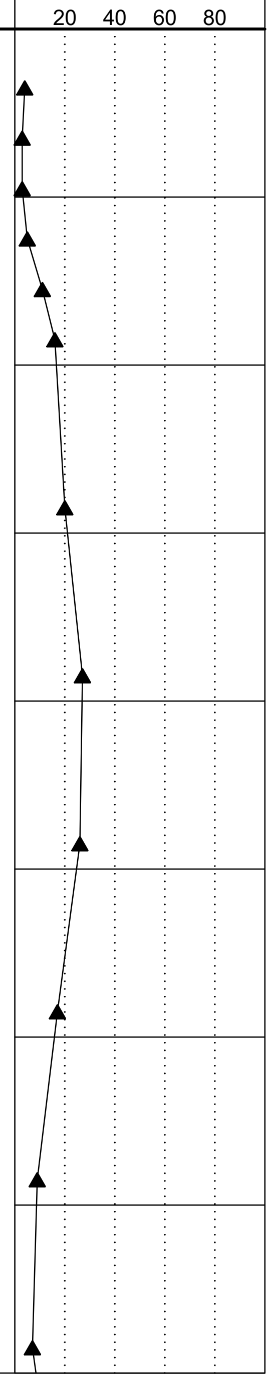
BORING NUMBER B-21

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site
PROJECT NUMBER 14588
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 7/22/20 **COMPLETED** 7/22/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NE
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH NA
NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP) Very loose brown SAND		SPT 1	3-2-2 (4)					
			SPT 2	2-1-2 (3)					
5		5	SPT 3	2-2-1 (3)					
	(SP) Very loose to medium dense pale gray and brown SAND		SPT 4	2-2-3 (5)					
		8	SPT 5	3-4-7 (11)					
10	(SP-SC) Medium dense brown and orange SAND with clay		SPT 6	8-8-8 (16)					
15			SPT 7	9-9-11 (20)					
20			SPT 8	10-13-14 (27)					
		23.5							
25	(SP-SC) Medium dense brown and gray SAND with clay		SPT 9	9-11-15 (26)					
		28.5							
30	(SC) Medium dense brown and gray clayey SAND		SPT 10	11-9-8 (17)					
		34							
35	(SC) Loose brown, gray and orange clayey SAND		SPT 11	5-5-4 (9)					
		39.5							
40			SPT 12	5-3-4 (7)					

▲ SPT N VALUE ▲



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BORING NUMBER B-21

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site

PROJECT NUMBER 14588

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ (20 40 60 80)
40		(CL/CH) Firm brown, gray, green and orange sandy CLAY *(continued)*	43.5								
45		(SC) Medium dense orange and brown clayey SAND		SPT 13	5-7-10 (17)						
			48.5								
50		(SP-SC) Medium dense brown and gray SAND with clay		SPT 14	7-7-6 (13)						
			52.5								
55		(SC/CL) Loose brown and gray very clayey SAND		SPT 15	4-3-3 (6)				42	34	
		Loss of circulation at 58 ft	58								
60		Hard to very hard LIMESTONE		SPT 16	9-15-19 (34)						
65				SPT 17	23-22-25 (47)						
70			70	SPT 18	22-31-40 (71)						

Bottom of borehole at 70.0 feet.

8.3 Laboratory Results

GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF LABORATORY TEST RESULTS

Project Number: 14588

Project Name: GRU 63 Acre Wetland Recharge Site

Boring Number	Depth (ft)	Soil Description	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Organic Content (%)	Hydraulic Conductivity (ft/day)	Unified Soil Classification
A-2	3-5	Pale gray and brown SAND with silt	6.0				8.7		16	SP-SM
A-2	7.5-8	Brown, gray, and orange sandy CLAY with trace limestone	27	69	19	50	56			CL/CH
A-3	12-14	Brown, gray, and orange clayey SAND	15				20		0.6	SC
A-4	8-10	Pale gray and brown SAND with silt	4.5				6.6		18	SP-SM
A-7	2.5-4	Brown and gray SAND with silt	4.6				8.3		8.3	SP-SM
A-9	2-3.5	Brown and gray silty SAND	7.5				12		11	SM
A-9	8.5-9	Brown and orange sandy CLAY	27	54	19	35	54			CL/CH
A-12	2-4	Brown and gray SAND with silt	4.9				8.1		13	SP-SM
A-15	0-2	Gray and brown SAND with silt	6.5				9.9		9.8	SP-SM
A-15	3.5-4	Brown, gray, and orange very clayey SAND	21				37			SC/CL
A-16	13-15	Gray, brown, and orange clayey SAND	11				17		11	SC
A-18	0-2	Brown and gray SAND with silt	5.6				8.7		9.4	SP-SM

GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF LABORATORY TEST RESULTS

Project Number: 14588

Project Name: GRU 63 Acre Wetland Recharge Site

Boring Number	Depth (ft)	Soil Description	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Organic Content (%)	Hydraulic Conductivity (ft/day)	Unified Soil Classification
A-19	3-5	Brown SAND with silt	4.3				5.1		18	SP-SM
A-22	2.5-5	Brown and orange clayey SAND	15				23		10	SC
A-24	13-15	Brown, gray, and orange clayey SAND	11				18		NF	SC
A-25	8-10	Pale gray and brown SAND with silt	3.7				5.3		20	SP-SM
A-25	11-11.5	Gray, green, and brown very clayey SAND	24	51	15	36	45			SC/CL
A-26	7-9	Pale brown and gray SAND with silt	8.7				6.9		11	SP-SM
A-29	0-2	Brown and gray SAND with silt	6.2				8.4		5.4	SP-SM
A-29	2.5-3	Brown and orange very clayey SAND	19				33			SC/CL

GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF LABORATORY TEST RESULTS

Project Number: 14588

Project Name: GRU 63 Acre Wetland Recharge Site

Boring Number	Depth (ft)	Soil Description	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Organic Content (%)	Hydraulic Conductivity (ft/day)	Unified Soil Classification
B-21	53.5-55	Loose brown and gray very clayey SAND	34				42			SC/CL

GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF LABORATORY TEST RESULTS

Project Number: 14588

Project Name: GRU 63 Acre Wetland Recharge Site

Boring Number	Depth (ft)	Soil Description	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Organic Content (%)	Hydraulic Conductivity (ft/day)	Unified Soil Classification
B-4	58.5-60	Loose dark green and gray clayey SAND	24				23			SC
B-4	68.5-70	Loose to medium dense dark brown and gray SAND with silt	23				7.2			SP-SM
B-5	33.5-35	Firm gray and brown CLAY with sand	63				79			CL/CH
B-5	38.5-40	Very soft gray and brown CLAY with sand and trace limestone	77	82	27	55	78			CL/CH
B-6	8.5-10	Medium dense brown and orange very clayey SAND with trace of limestone	19				35			SC/CL
B-12	8.5-10	Firm gray and orange CLAY with sand	36	54	16	38	72			CL/CH
B-17	33.5-35	Firm to stiff brown and orange CLAY with sand	60				82			CL/CH
B-19	28.5-30	Very loose brown, gray, and orange very clayey SAND	32	31	14	17	31			SC/CL
B-20	23.5-25	Loose gray, brown, and orange very clayey SAND	25	40	14	26	44			SC/CL

8.4 Key to Soil Classification

KEY TO SOIL CLASSIFICATION CHART

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests				SYMBOLS		GROUP NAME
				GRAPHIC	LETTER	
COARSE-GRAINED SOILS	Gravels	Clean Gravels	Cu ≥ 4 and 1 ≤ Cc ≤ 3		**GW**	Well graded GRAVEL
More than 50% retained on No. 200 sieve	More than 50% of coarse fraction retained on No. 4 sieve	Less than 5% fines	Cu < 4 and/or 1 > Cc > 3		**GP**	Poorly graded GRAVEL
		Gravels with fines	Fines classify as ML or MH		**GM**	Silty GRAVEL
		More than 12% fines	Fines classify as CL or CH		**GC**	Clayey GRAVEL
	Sands	Clean Sands	Cu ≥ 6 and 1 ≤ Cc ≤ 3		**SW**	Well graded SAND
	50% or more of coarse fraction passes No. 4 sieve	Less than 5% fines	Cu < 6 and/or 1 > Cc > 3		**SP**	Poorly graded SAND
		Sand with fines	Fines classify as ML or MH		**SP-SM**	SAND with silt
		5% ≤ fines < 12%	Fines classify as CL or CH		**SP-SC**	SAND with clay
		Sand with fines	Fines classify as ML or MH		**SM**	Silty SAND
		12% ≤ fines < 30%	Fines classify as CL or CH		**SC**	Clayey SAND
		Sand with fines	Fines classify as ML or MH		**SM**	Very silty SAND
		30% fines or more	Fines classify as CL or CH		**SC**	Very clayey SAND
FINE-GRAINED SOILS	Clays	inorganic	50% ≤ fines < 70%		**CL/CH**	Sandy CLAY
50% or more passes the No. 200 sieve			70% ≤ fines < 85%		**CL/CH**	CLAY with sand
			fines ≥ 85%		**CL/CH**	CLAY
	Silts and Clays	inorganic	PI > 7 and plots on/above "A" line		**CL**	Lean CLAY
	Liquid Limit less than 50		PI < 4 or plots below "A" line		**ML**	SILT
		organic	Liquid Limit - oven dried / Liquid Limit - not dried < 0.75		**OL**	Organic clay / Organic silt
	Silts and Clays	inorganic	PI plots on or above "A" line		**CH**	Fat CLAY
	Liquid Limit 50 or more		PI plots below "A" line		**MH**	Elastic SILT
		organic	Liquid Limit - oven dried / Liquid Limit - not dried < 0.75		**OH**	Organic clay / Organic silt
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor				**PT**	PEAT

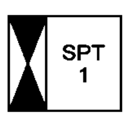
CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	No. OF BLOWS, N	RELATIVE DENSITY
SANDS:	0 - 4	Very Loose
	5 - 10	Loose
	11 - 30	Medium dense
	31 - 50	Dense
	OVER 50	Very Dense

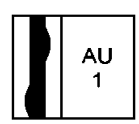
	No. OF BLOWS, N	RELATIVE DENSITY
LIMESTONE:	0 - 8	Very Soft
	9 - 18	Soft
	19 - 32	Moderately Hard
	33 - 50	Hard
	OVER 50	Very Hard

	No. OF BLOWS, N	CONSISTENCY
SILTS & CLAYS:	0 - 2	Very Soft
	3 - 4	Soft
	5 - 8	Firm
	9 - 15	Stiff
	16 - 30	Very Stiff
	31 - 50	Hard
	OVER 50	Very Hard

SAMPLE GRAPHIC TYPE LEGEND



Location of SPT Sample



Location of Auger Sample

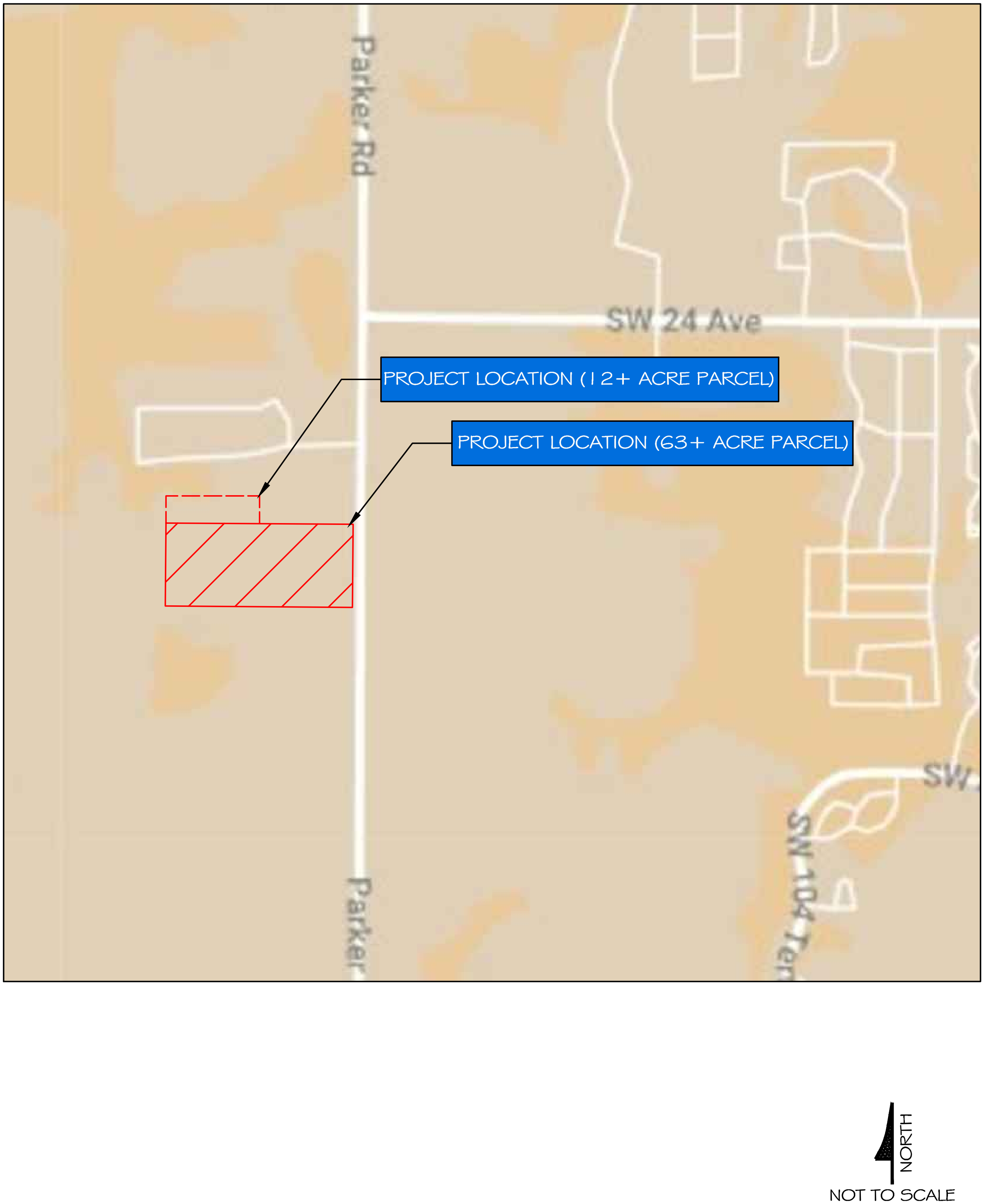
PARTICLE SIZE IDENTIFICATION

BOULDERS:		Greater than 300 mm
COBBLES:		75 mm to 300 mm
GRAVEL:	Coarse -	19.0 mm to 75 mm
	Fine -	4.75 mm to 19.0 mm
SANDS:	Coarse -	2.00 mm to 4.75 mm
	Medium -	0.425 mm to 2.00 mm
	Fine -	0.075 mm to 0.425 mm
SILTS & CLAYS:		Less than 0.075 mm

LABORATORY TEST LEGEND

LL	=	Liquid Limit, %
PL	=	Plastic Limit, %
PI	=	Plasticity Index, %
% PASS - 200	=	Percent Passing the No. 200 Sieve
MC	=	Moisture Content, %
ORG	=	Organic Content, %
k_h	=	Horizontal Hydraulic Conductivity, ft/day

FIGURES



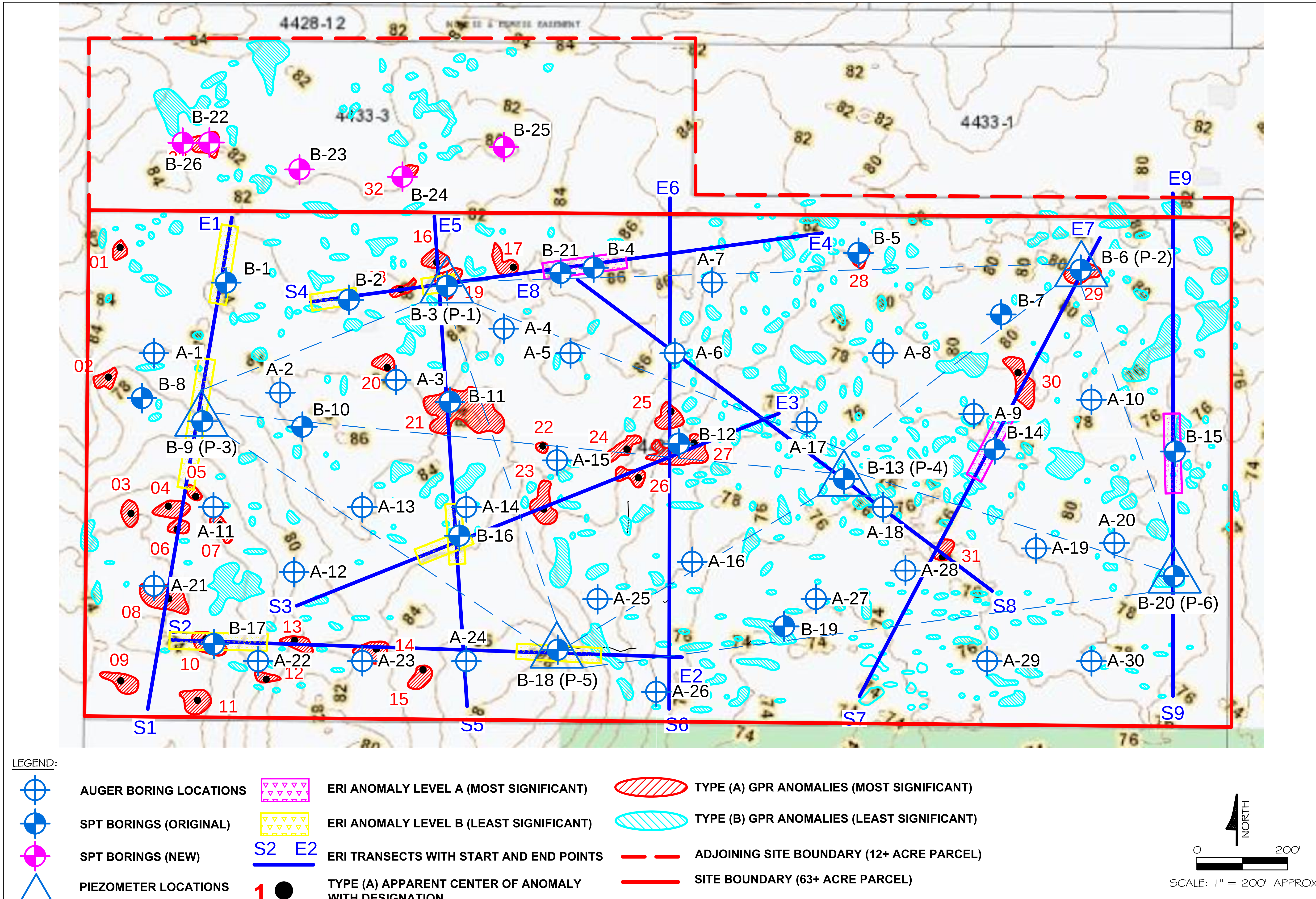
GRU 63 ACRE PARCEL- WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

PROJECT SITE LOCATION MAP

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GSE Engineering & Consulting, Inc.

FIGURE 1



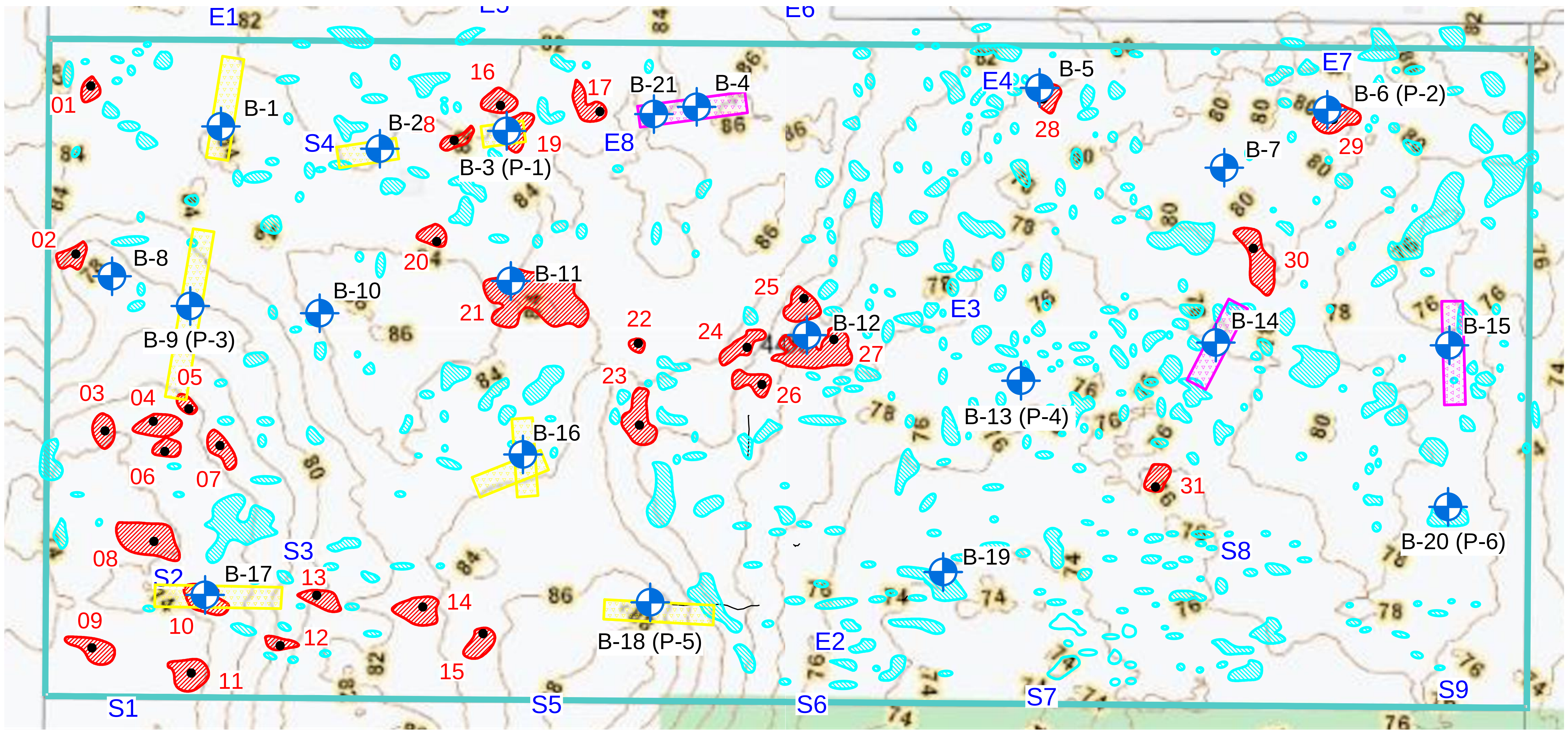
SITE PLAN SHOWING APPROXIMATE LOCATIONS OF FIELD TESTS AND GPR/ERI ANOMALIES

FIGURE 2

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GRU 63 ACRE PARCEL- WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588



LEGEND:

- SPT BORING LOCATIONS
- ERI ANOMALY LEVEL A (MOST SIGNIFICANT)
- ERI ANOMALY LEVEL B (LEAST SIGNIFICANT)
- TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)
- 1 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION
- TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)

NORTH

0 200'

SCALE: 1" = 200' APPROX.

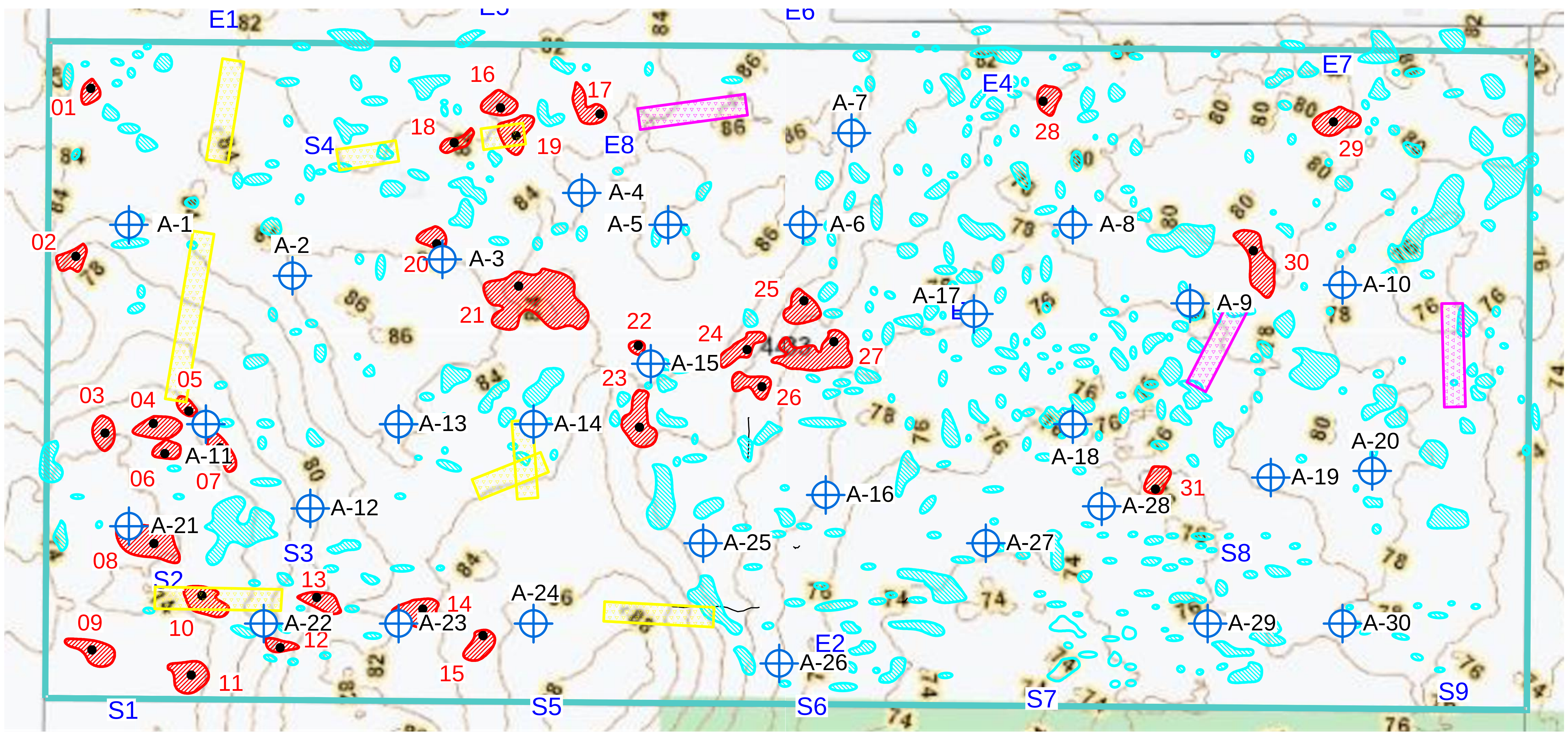
SITE PLAN SHOWING APPROXIMATE LOCATIONS OF SPT BORINGS AND GPR/ERI ANOMALIES

FIGURE 2A

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : KLH
DRAWN BY : SCL

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588



LEGEND:

AUGER BORING LOCATIONS

S2 E2 ERI TRANSECTS WITH START AND END POINTS

ERI ANOMALY LEVEL A (MOST SIGNIFICANT)

TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)

ERI ANOMALY LEVEL B (LEAST SIGNIFICANT)

TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)

1 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION

NORTH

0 200'

SCALE: 1" = 200' APPROX.

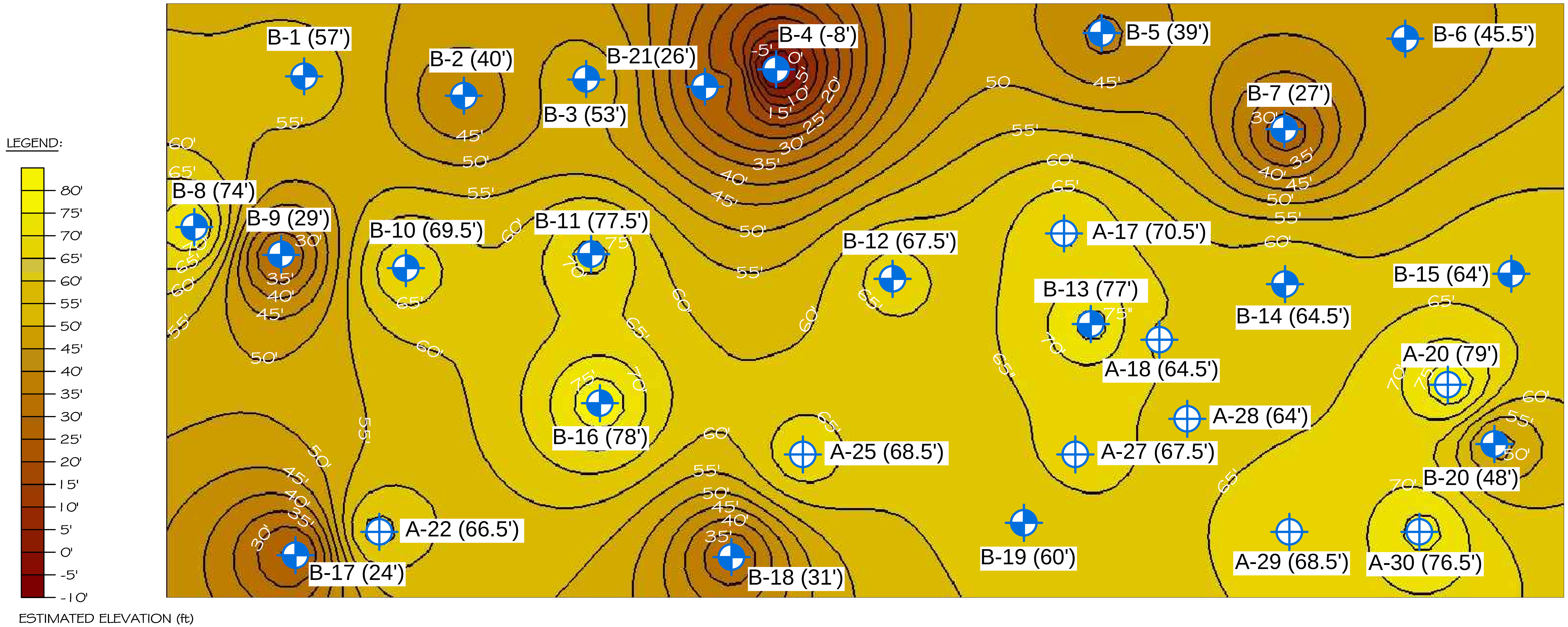
SITE PLAN SHOWING APPROXIMATE LOCATIONS OF AUGER BORINGS AND GPR/ERI ANOMALIES

FIGURE 2B

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : KLH
DRAWN BY : SCL

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588



LEGEND:

STANDARD PENETRATION TEST BORING (LIMESTONE ELEVATION)

AUGER BORING (LIMESTONE ELEVATION)

NORTH

0 200'

SCALE: 1" = 200' APPROX.

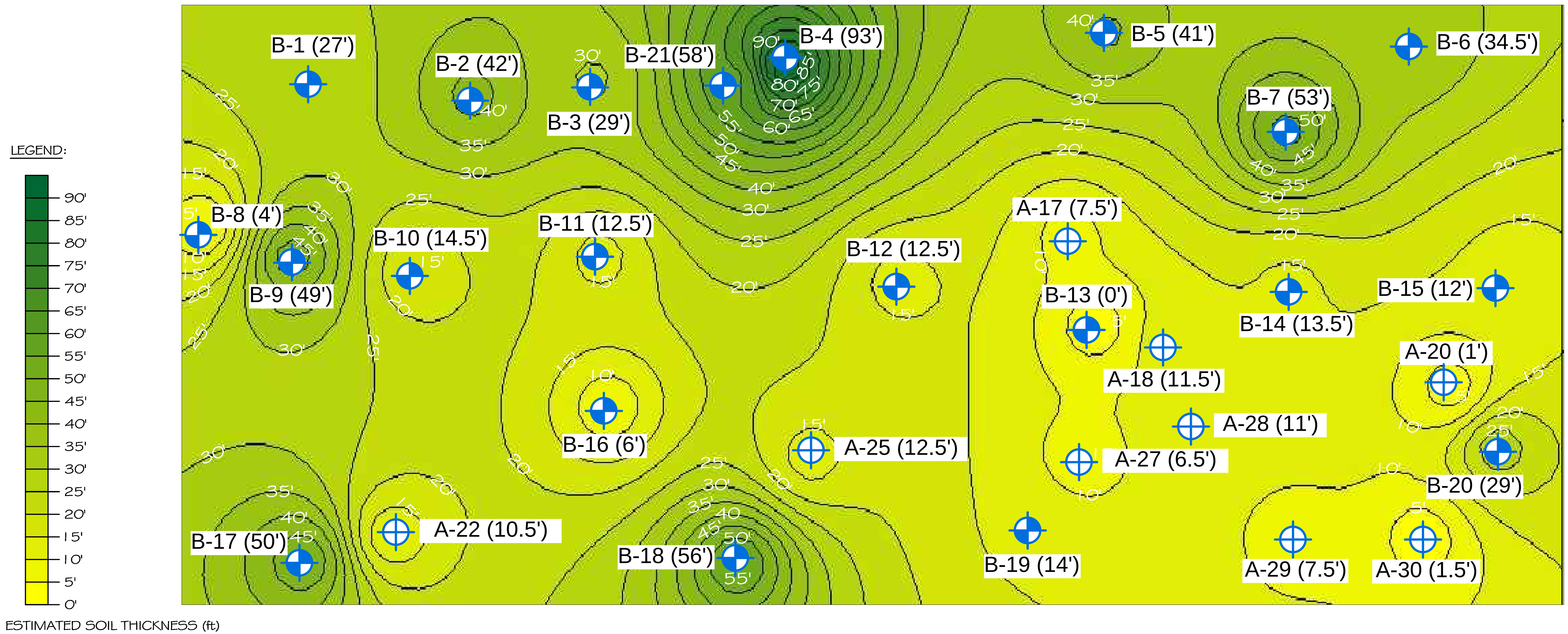
ESTIMATED LIMESTONE SURFACE ELEVATION

FIGURE 3A

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : KLH
DRAWN BY : SCL

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588



LEGEND:

STANDARD PENETRATION TEST BORING (SOIL THICKNESS)

AUGER BORING (SOIL THICKNESS)

NORTH

0 200'

SCALE: 1" = 200' APPROX.

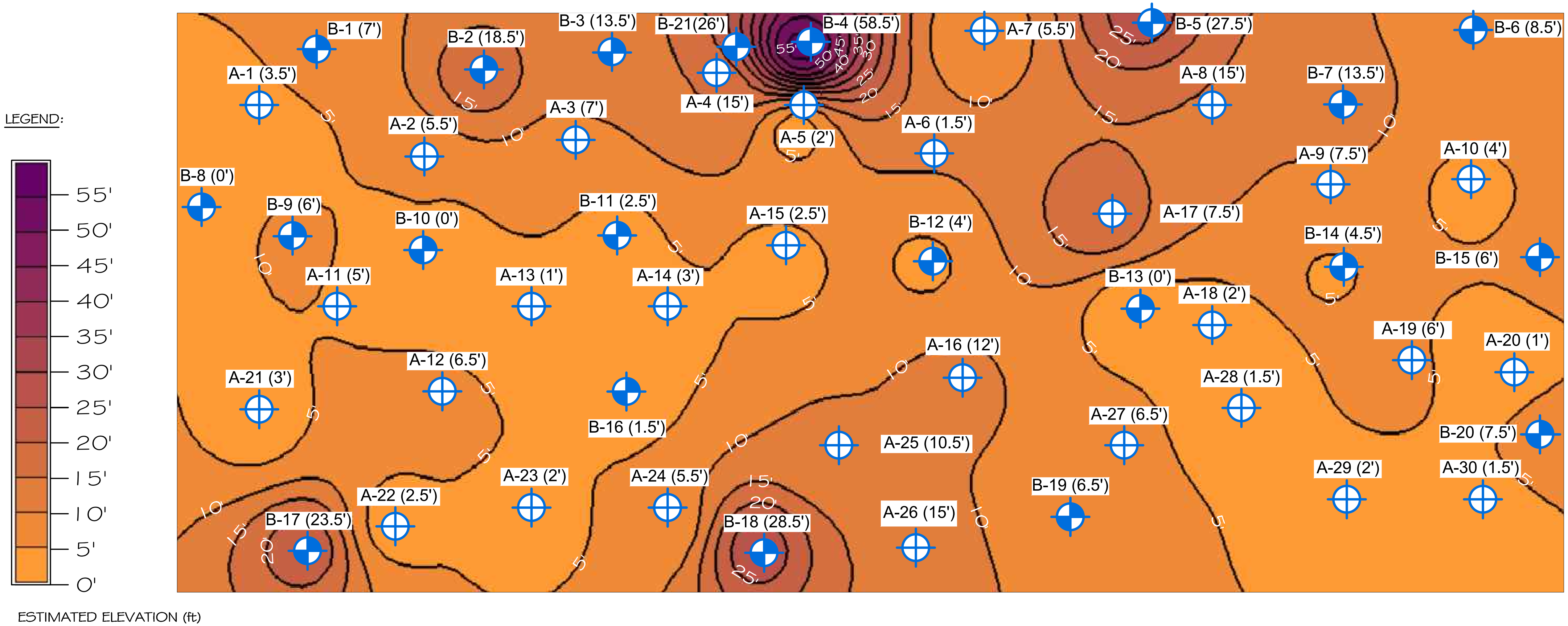
ESTIMATED THICKNESS OF UNCONSOLIDATED SOIL

FIGURE 3B

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : KLH
DRAWN BY : SCL

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588



LEGEND:

STANDARD PENETRATION TEST BORING (SANDY SOIL THICKNESS)

AUGER BORING (SANDY SOIL THICKNESS)

NORTH

0 200'

SCALE: 1" = 200' APPROX.

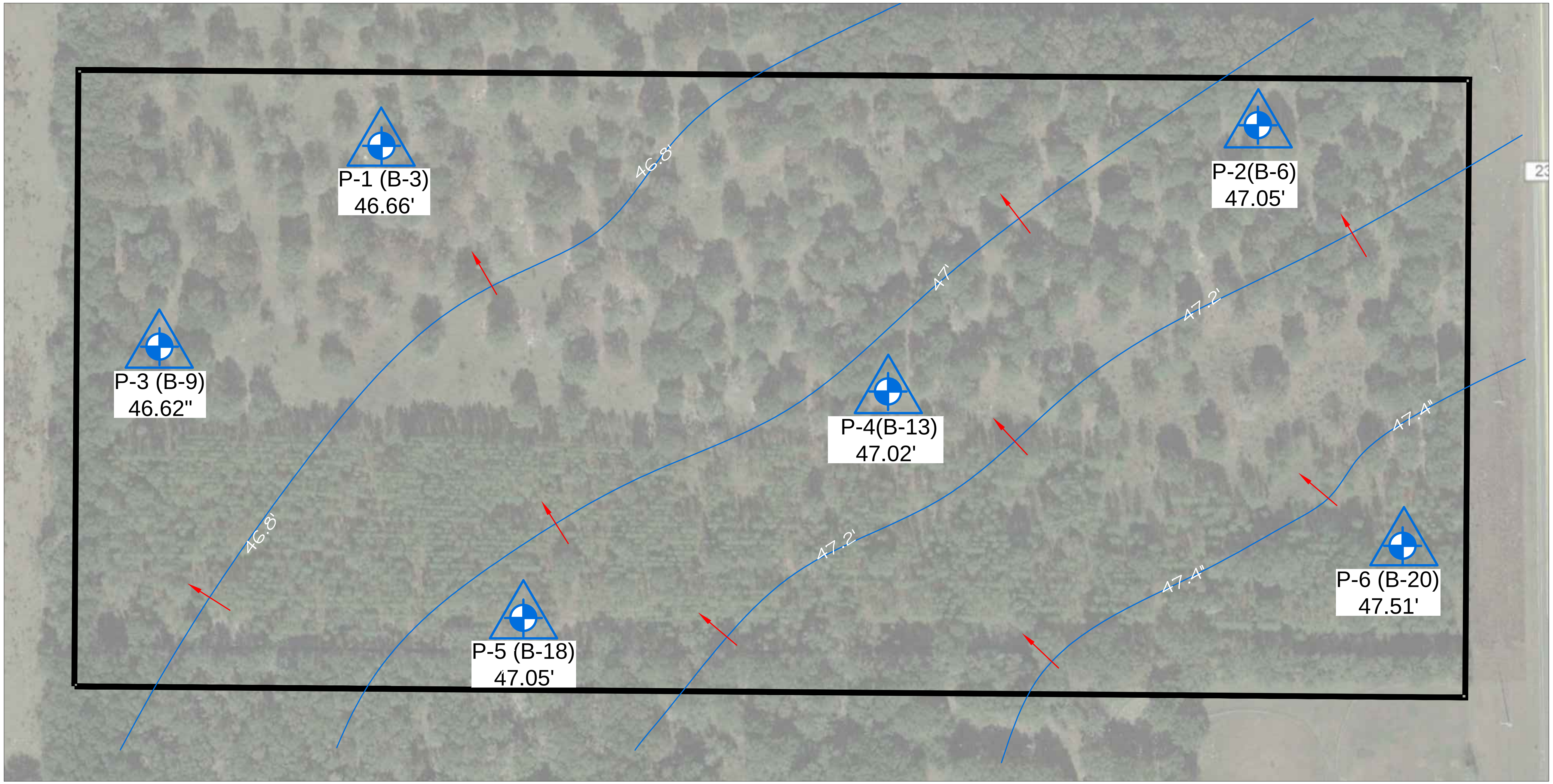
ESTIMATED THICKNESS OF SURFICIAL SANDY SOIL

FIGURE 3C

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : KLH
DRAWN BY : PJM

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588



LEGEND:

PROJECT BORDER

PROPOSED PIEZOMETER LOCATION WITH BORING LOCATION

NORTH

0 200'

SCALE: 1" = 200' APPROX.

ESTIMATED GROUNDWATER FLOW

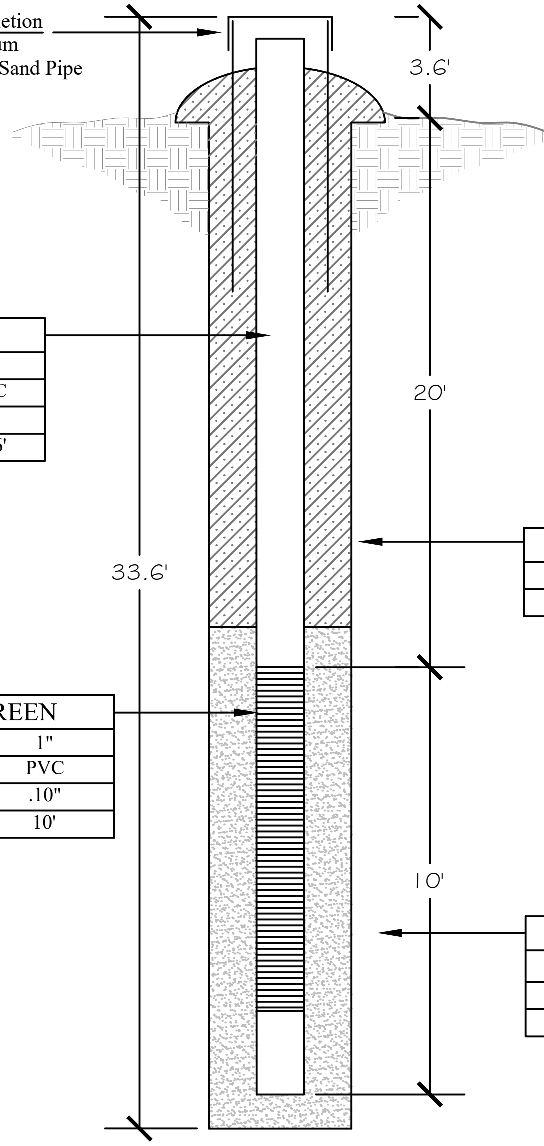
FIGURE 4

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : KLH
DRAWN BY : SCL

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

APPENDIX A



WELL CASING	
Diameter:	3"
Type:	PVC
Schedule:	40
Length:	23.6'

GROUT SEAL	
Type:	PORTLAND
Feet:	28'

WELL SCREEN	
Diameter:	1"
Type:	PVC
Slot:	.10"
Length:	10'

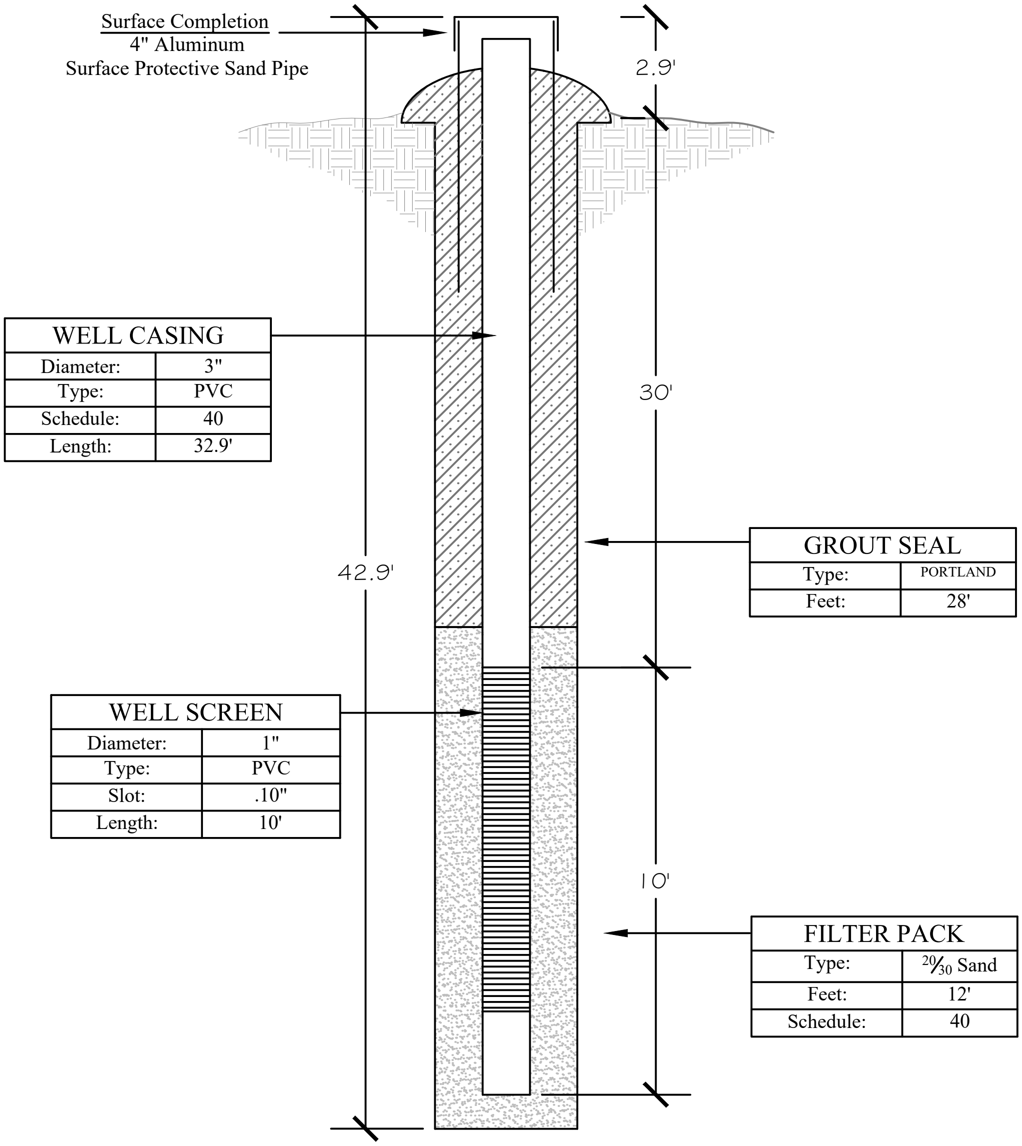
FILTER PACK	
Type:	20/30 Sand
Feet:	12'
Schedule:	40

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

PIEZOMETER/MONITORING WELL COMPLETION LOG P-1

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

Engineering & Consulting, Inc.

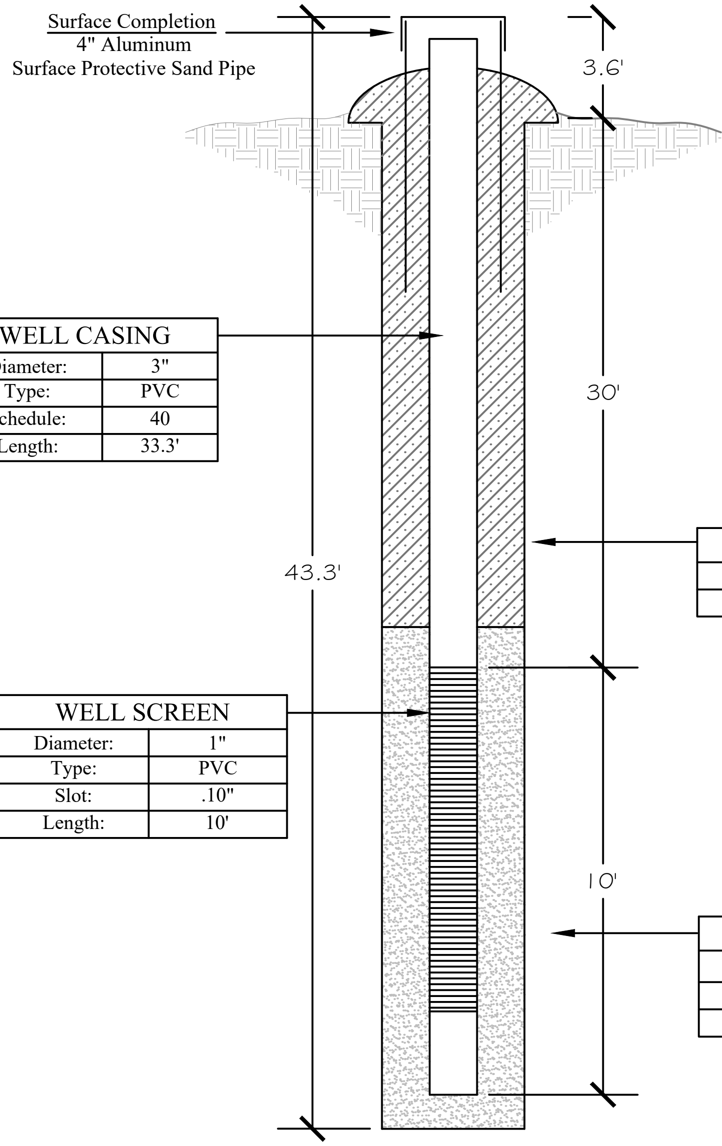


GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

PIEZOMETER/MONITORING WELL COMPLETION
LOG P-2

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GSE Engineering & Consulting, Inc.



WELL CASING	
Diameter:	3"
Type:	PVC
Schedule:	40
Length:	33.3'

GROUT SEAL	
Type:	PORTLAND
Feet:	28'

WELL SCREEN	
Diameter:	1"
Type:	PVC
Slot:	.10"
Length:	10'

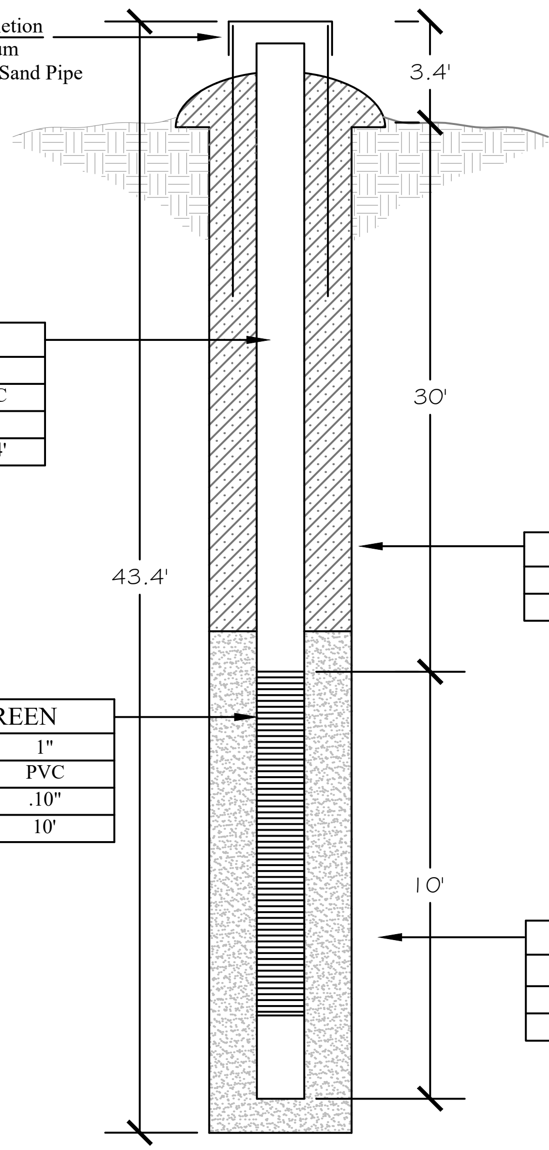
FILTER PACK	
Type:	20/30 Sand
Feet:	12'
Schedule:	40

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

PIEZOMETER/MONITORING WELL COMPLETION LOG P-3

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GSE Engineering & Consulting, Inc.



WELL CASING	
Diameter:	3"
Type:	PVC
Schedule:	40
Length:	33.4'

GROUT SEAL	
Type:	PORTLAND
Feet:	28'

WELL SCREEN	
Diameter:	1"
Type:	PVC
Slot:	.10"
Length:	10'

FILTER PACK	
Type:	$^{20}/_{30}$ Sand
Feet:	12'
Schedule:	40

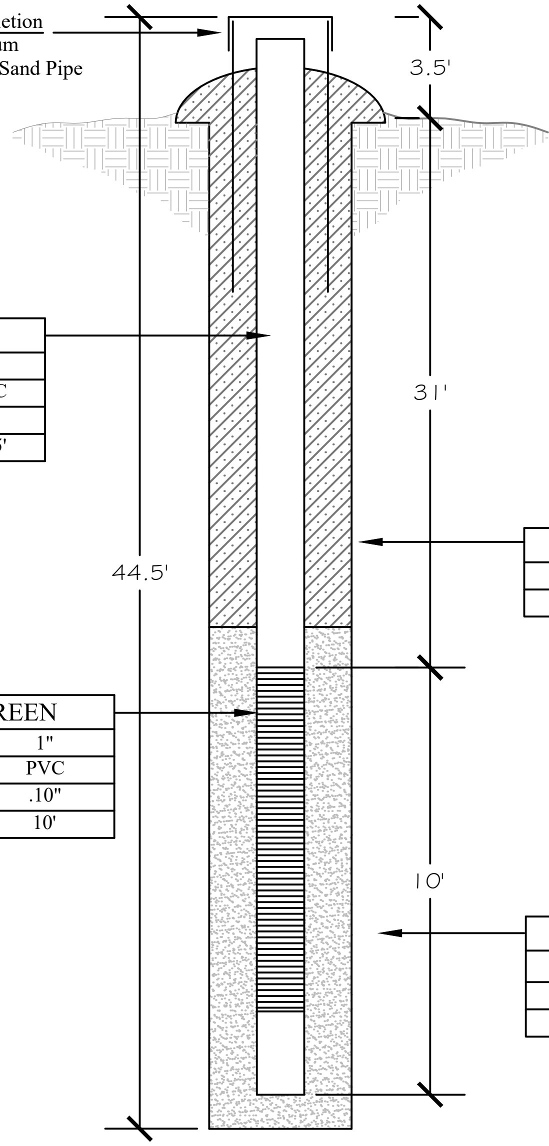
GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

PIEZOMETER/MONITORING WELL COMPLETION LOG P-4

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GSE Engineering & Consulting, Inc.

Surface Completion
4" Aluminum
Surface Protective Sand Pipe



WELL CASING	
Diameter:	3"
Type:	PVC
Schedule:	40
Length:	34.5'

GROUT SEAL	
Type:	PORTLAND
Feet:	28'

WELL SCREEN	
Diameter:	1"
Type:	PVC
Slot:	.10"
Length:	10'

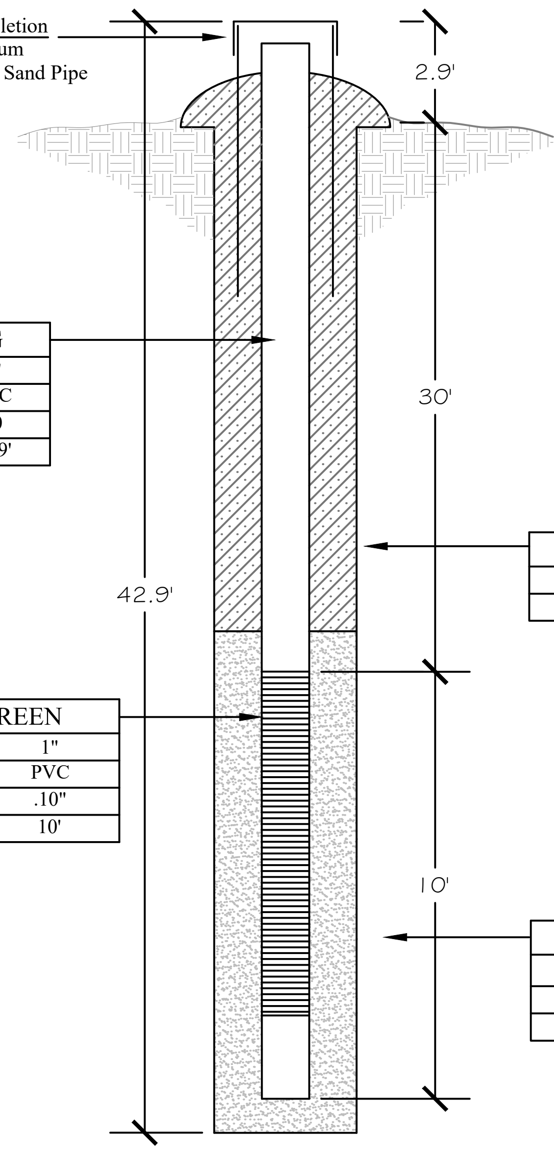
FILTER PACK	
Type:	20/30 Sand
Feet:	12'
Schedule:	40

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

PIEZOMETER/MONITORING WELL COMPLETION
LOG P-5

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GSE Engineering & Consulting, Inc.



WELL CASING	
Diameter:	3"
Type:	PVC
Schedule:	40
Length:	32.9'

GROUT SEAL	
Type:	PORTLAND
Feet:	28'

WELL SCREEN	
Diameter:	1"
Type:	PVC
Slot:	.10"
Length:	10'

FILTER PACK	
Type:	20/30 Sand
Feet:	12'
Schedule:	40

GRU 63 ACRE WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588

PIEZOMETER/MONITORING WELL COMPLETION LOG P-6

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GSE Engineering & Consulting, Inc.

APPENDIX B

FINAL REPORT
GEOPHYSICAL INVESTIGATION
GRU-PARKER ROAD RECHARGE WETLAND SITE
ALACHUA COUNTY, FL

Prepared for GSE Engineering & Consulting, Inc.
Gainesville, FL

Prepared by GeoView, Inc.
St. Petersburg, FL

May 27, 2020

Mr. Joakim (Jay) Nordqvist, P.E.
GSE Engineering & Consulting, Inc.
5590 SW 64th Street, Suite B
Gainesville, FL 32608

Subject: Transmittal of Final Report for Geophysical Investigation
GRU-Parker Road Recharge Wetland Site - Alachua County, FL
GeoView Project Number 31405

Dear Mr. Nordqvist,

GeoView, Inc. (GeoView) is pleased to submit the final report that summarizes and presents the results of the geophysical investigation conducted at the project site. GeoView appreciates the opportunity to have assisted you on this project. If you have any questions or comments about the report, please contact us.

GEOVIEW, INC.

Michael J. Wightman, P.G.
Principal Geophysicist, President
Florida Professional Geologist
Number 1423

Stephen Scruggs, P.G.
Senior Geophysicist
Florida Professional Geologist
Number 2470

4610 Central Avenue
St. Petersburg, FL 33711
Tel.: (727) 209-2334
Fax: (727) 328-2477

1.0 Introduction

A geophysical investigation was conducted at the proposed site for the GRU-Parker Road Recharge Wetland facility which is located west of Parker Road in Alachua County, Florida. The survey area was approximately 65-acres in size. The majority of the site was accessible to the geophysical instrumentation with the exception of large tree clusters and rows of pine trees in the southern portion. The investigation was conducted under the supervision of GSE Engineering and Consulting, Inc. (GSE).

The purpose of the geophysical investigation was to help characterize near-surface geological conditions in the survey area and to identify subsurface features that may be associated with karst (sinkhole) activity. The location of the geophysical survey area is provided on Figures 1-3 (Appendix 1). A discussion of the field methods used to generate the report figures is provided in Appendix A2.1.

Geotechnical investigations for a planned school were performed by GSE approximately 0.5 miles northeast of the site area. Based on the results from these investigations a description of near-surface geological conditions is as follows:

- Surficial Sand (SP) Stratum ranging in thickness from 2 to 3 feet (ft).
- Intermittent sandy clay (SC) to clay (CH) with a thickness typically ranging from 2 to 8 ft. Significant variations in the thickness surficial sand to clayey sediments were observed with one boring not encountering limestone to a depth of 42.5 ft below land surface (bls).
- Limestone. Top of limestone was frequently weathered with more competent limestone typically beginning at a depth range of 10 to 25 ft below land surface (bls).

The contact between the surficial sand stratum and underlying clayey sediments/limestone rock is referred to as an epikarst zone. In this zone the clayey sediments and near-surface limestone are highly weathered as a result of multiple periods of submersion, erosion and sub-aerial exposure which have occurred over 10's of millions of years. The surficial sands which overlie the clayey sediments and limestone were recently deposited (within the last 10 to 20 thousand years). Karst-related geological features are quite common within this type of geological setting.

2.0 Description of Geophysical Investigation

The geophysical investigation was performed using ground penetrating radar (GPR) and electrical resistivity imaging (GPR). The purpose of the GPR study was to evaluate shallow geological conditions with a focus on the epikarst zone between the surficial sand stratum and underlying limestone and clayey sediments to a depth range of 10 to 15 ft bls. The purpose of the ERI study was to evaluate geological conditions at depth with the primary purpose of identifying any large cavities or buried collapse zones within the limestone. The ERI method was able to provide an assessment of geological conditions to depths ranging from approximately 131 to 197 ft bls across the site.

The GPR portion of the investigation was conducted on April 27 to 30, 2020. The ERI field study was performed from May 18 to May 22, 2020. The GPR data was analyzed and results were presented in an interim report. The design of the ERI transect configuration was based on the results of the GPR investigation in consultation with GSE. The ERI transects were designed with the following objectives:

- Characterize geological conditions at depth in several of the areas with the most severe of the GPR anomalies.
- Characterize geological conditions on either side of the 80-foot elevation contour line.
- Provide a representative assessment of geological conditions at depth across the entire project site.

2.1 Ground Penetrating Radar Investigation

The GPR survey was conducted along a series of perpendicular transects spaced approximately 20 ft apart (Figures 1-3). The configuration of the GPR transects was modified as necessary to accommodate site conditions. Additional parallel transects were performed in accessible portions of the southern portion of the site along the tree rows.

The GPR data was collected with a Mala radar system using a 250 MHz antenna and a time range setting of 206 nano-seconds. This equipment configuration provided an average exploration depth of 10 to 15 ft bls.

2.2 Electrical Resistivity Imaging Survey

The ERI survey was conducted using the Advanced Geosciences, Inc. Sting R8 automatic electrode resistivity system. Nine ERI transects were performed using an electrode spacing of 10 ft. The transects ranged in length from 1080 to 1,110 ft with a total combined length of 9,930 ft.

A dipole-dipole combined with an inverse Schlumberger electrode configuration was used with a maximum “n value” of ten. The ERI data was analyzed using EarthImager 2D, a computer inversion program, which provides two-dimensional vertical cross-sectional resistivity model (pseudo-section) of the subsurface. A description of the ERI method and the methods employed for geotechnical characterization studies is provided in Appendix A2.2. A discussion of the modeling process used to create the ERI results is provided in Appendix A2.2.1.

The positions of the geophysical transect lines were recorded using a Trimble GeoXH Global Positioning System (GPS). A Wide Area Augmentation System (WAAS) was used to augment GPS with additional signals for increasing the reliability, integrity, accuracy and availability of the GPS signal. By using WAAS, an accuracy of less than 3 feet in the horizontal dimension was achieved. In areas near dense tree canopy, the accuracy of the GPS signal was typically reduced.

3.0 Identification of Possible Sinkhole Features Using GPR and ERI Methods

3.1 Identification of Possible Sinkhole Features Using GPR

The features observed on GPR data that are most commonly associated with sinkhole activity are:

- A downwarping of GPR reflector sets, that are associated with suspected lithological contacts, towards a common center. Such features typically have a bowl or funnel shaped configuration and can be associated with a deflection of overlying sediment horizons caused by the migration of sediments into voids in the underlying limestone. If the GPR reflector sets are sharply downwarping and intersect, they can create a “bow-tie” shaped GPR reflection feature, which often designates the apparent center of the GPR anomaly.
- A localized significant increase in the depth of the penetration and/or amplitude of the GPR signal response. The increase in GPR signal penetration depth or amplitude is often associated with either a localized increase in sand content at depth or decrease in soil density.
- An apparent discontinuity in GPR reflector sets, that are associated with suspected lithological contacts. The apparent discontinuities and/or disruption of the GPR reflector sets may be associated with the downward migration of sediments.

The greater the severity of these features or a combination of these features the greater the likelihood that the identified feature is a sinkhole. It is not possible based on the GPR data alone to determine if an identified feature is a sinkhole or, more important, whether that feature is an active sinkhole.

3.2 Identification of Possible Sinkhole Features Using ERI

Sinkhole features are typically characterized by one of the following conditions on the ERI profile:

1. The occurrence of highly resistive material that extends to depth in a columnar fashion towards the top of the limestone. Such a feature may indicate the presence of a sand-filled depression or raveling zone.
2. The localized presence of low-resistivity material extending below the interpreted depth to the top of limestone. Such a feature may indicate the presence of a clay-filled void or fracture with the limestone or the presence of highly weathered limestone rock.
3. Any significant localized increase in the depth to limestone. Such a feature may indicate the presence of an in-filled depression (paleo-sink).

When comparing the results of the ERI method, the following considerations should be given. The ERI method, for example, describes the transition from clay to limestone as a transition, rather than a discrete depth. This transition is due to several factors including: a) The vertical density of the resistivity data decreasing with depth and b) The possibility that the upper portion of the limestone is weathered which would create a physical transition zone in terms of resistivity between the clay and competent (non-weathered) limestone and c) The limitations in the modeling process.

4.0 Survey Results

4.1 Ground Penetrating Radar Survey

Results of the GPR survey indicated the presence of a well-defined, highly variable set of GPR reflectors at an approximate depth range of 1 to 8 ft bls. The reflector set is associated with the lithological contact between the surficial sand stratum and underlying clayey sediments or weathered limestone.

Description of GPR Anomalies

As previously mentioned, the GPR data observed a high degree of variability in the depth of the reflector set. This variability is characteristic of a highly weathered epi-karst terrain common to this area. The majority of the variability in epi-karst terrain can be attributed to surficial erosion of the limestone surface rather than settlement due to an underlying void or cavity. Accordingly, in order to focus on the areas with the greatest possibility for underlying sinkhole activity, the anomalies were identified based on two categories as described below:

- Type A – Type A anomalies are characterized by a downwarping of approximately 5 to 10 ft toward a common center. In addition, a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. The increase in GPR signal penetration depth or amplitude is often associated with either a localized increase in sand content at depth or decrease in soil density. Such features typically have a bowl or funnel shaped configuration and can be associated with a deflection of overlying sediment horizons caused by the migration of sediments into deeper voids. Based on the GPR data, Type A anomalies have a higher probability of being associated with potential underlying sinkhole activity than Type B anomalies. Accordingly, the Type A anomalies are numbered on Figures 1 through 3 for reference.
- Type B – Type B anomalies are characterized by a moderate downwarping of 1 to 5 ft toward a common center and/or a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. Type B anomalies were observed in the upper 5 to 10 ft of the soils and do not appear to continue with depth. These anomalies are more likely associated with surficial weathering or erosional activities characteristic of epi-karst terrain rather than sinkhole activity.

The GPR survey identified 31 Type A anomalies and 445 Type B anomalies as shown on Figures 1-3. Examples of the GPR data collected across Type A Anomaly 14 and several Type B anomalies are provided in Appendix 1.

A much higher concentration of Level B GPR anomalies is observed to the east (high side) of the 80 ft elevation contour line (Figures 1-3), while a higher concentration of Level A GPR anomalies are observed on the west (lower) side of the 80 ft contour line. A discussion of the limitations of the GPR technique in geological characterization studies is provided in Appendix 2.

It is not possible, based on the geophysical results to determine whether these identified anomalies have a potential for collapse or subsidence into an underlying void or are associated with surficial erosional processes. It is recommended that further geophysical testing be performed to gather more information regarding the deeper soil conditions below both types of GPR anomalies using appropriate geotechnical testing methods.

4.2 Discussion of ERI Survey Results

Results from the ERI surveys are presented as Figures 4-12 (Appendix 1). The ERI transects are of good to excellent quality. Accordingly, the ERI results do provide a reasonably accurate description of geological conditions. A discussion of the criteria used to determine the quality of an ERI inversion model is provided in Appendix A2.3.1

Analysis of the ERI transects indicate the presence of a mixture of high to low resistivity earth materials to an approximate depth range of 40 to 60 ft bls (represented in blue to red on the ERI transects). This mixed resistivity layer is most likely associated epikarst conditions where the relative percentages of sand, clays, weathered limestone and competent limestone are both vertically and horizontally highly variable. This mixed resistivity layer is underlain by a moderate to high resistivity layer (represented in yellow to red) to the maximum depth of the ERI results. This moderate to high resistivity layer is most likely associated with competent limestone.

Discussion of ERI Anomalies

Eleven ERI anomalies were identified across the project site (Figures 1-3). These anomaly areas are also annotated on the modeled ERI transects results (Figures 4-12). The ERI anomalies are characterized by two levels of apparent severity, where Level A anomalies are most severe and Level B are least severe. No ERI anomalies were observed across the 80-foot elevation contour line.

Level B anomalies are characterized by a localized intrusion of more than 20 to 30 ft of the surficial resistivity layer materials into the underlying suspected layer of competent limestone. Level A anomalies are characterized by the intrusion of these surficial layer materials throughout the entire identified depth of the competent limestone.

It is not possible based upon the resistance of the surficial materials intruding or breaching the lower moderate to high resistivity layer to determine whether these intruding materials are associated with clays, weathered limestone or possible voids. Such a determination will need to be made by geotechnical testing. Table 1 provides the coordinates for the recommended boring locations for selected ERI anomalies. These coordinates were developed using a Trimble GEO-XH global positioning system (GPS) with an accuracy of 1-3 ft.

4.3 Correlation of Geophysical Study Results

On each of the ERI transects the position of the center of any Type A GPR anomaly along a particular transect is provided (Figures 4-12). A comparison of the results from the two geophysical methods indicates that there is no well-defined correlation between the occurrence of the ERI and GPR anomalies. This would indicate that the GPR anomalies are most likely associated with near-surface geological activity within the epikarst zone and are not related to any large-scale potential karst feature at depth. This interpretation is supported by the occurrence of the GPR anomalies within the upper range of soils (10 to 15 ft bls) while the ERI anomalies begin at a depth range of 40 to 60 ft bls.

4.4 Recommendations for Future Geotechnical Testing.

A total of 20 recommended locations for future geotechnical testing were developed in consultation with GSE. Ten of the testing locations were within (or very close) to ERI anomalies. The remaining recommended locations were placed either within GPR anomalies or in areas where no anomalies were present in order to characterize background conditions across the site. For reference purposes any borings not directly related to ERI anomalies, but close an ERI transect are also indicated on the individual ERI transects (Figures 4-12).

Table 1 provides the purpose and coordinates for each of the boring locations. The coordinates for the borings associated with the ERI or GPR anomalies were developed using a Trimble GEO-XH global positioning system (GPS) with an accuracy of 1-3 ft.

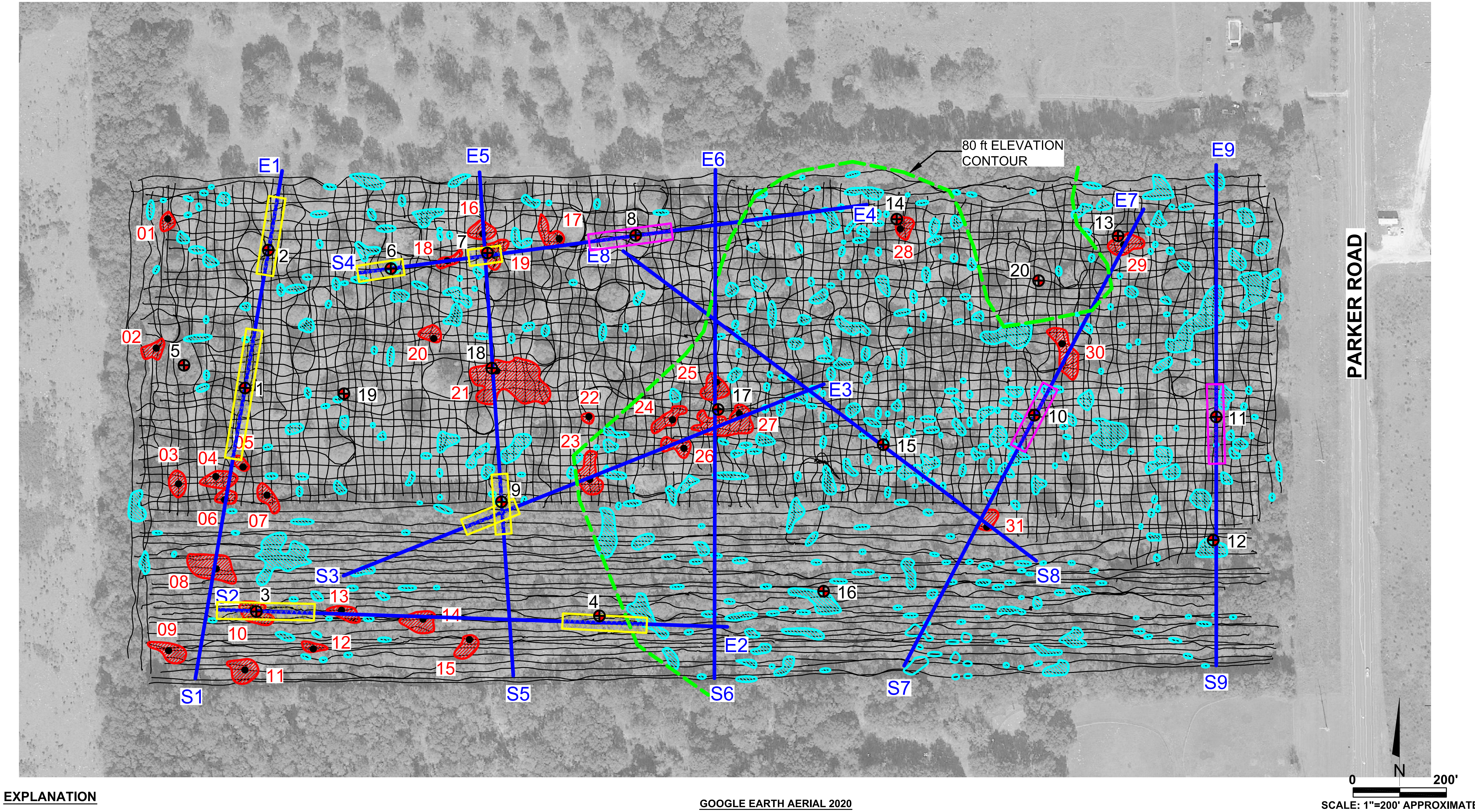
Table 1 – Recommended Geotechnical Boring Locations*

Boring	ERI Anomaly 1/	GPR Anomaly 2/	Background 3/	Northing	Easting	Latitude	Longitude
B1	X			231631.24	2610255	29.62128932	-82.48019869
B2	X			231927.09	2610304.69	29.62210029	-82.48002584
B3	X	X		231152.11	2610279.18	29.61997085	-82.48014931
B4	X			231142.4	2611014.93	29.61990829	-82.47783474
B5			X	231679.98	2610123.8	29.62142971	-82.48060881
B6	X			231887.36	2610567.27	29.62197827	-82.47920180
B7	X	X		231920.83	2610774.38	29.62206019	-82.47854822
B8	X			231958.72	2611092.35	29.62214886	-82.47754556
B9	X			231386.93	2610804.6	29.62059084	-82.47848292
B10	X			231572.83	2611947.17	29.6210462	-82.47487729
B11	X			231569.24	2612337.26	29.62101727	-82.47365002
B12		X		231305.01	2612330.82	29.62029112	-82.47368506
B13		X		231957.48	2612126.73	29.62209496	-82.47429077
B14		X		231993.64	2611652.21	29.62221755	-82.47578191
B15			X	231509.73	2611623.3	29.62088853	-82.47589992
B16		X		231195.43	2611495.2	29.62003066	-82.47632056
B17		X		231585.17	2611269.18	29.62111322	-82.47700999
B18		X		231673.86	2610783.69	29.62138073	-82.47853271
B19			X	231618.95	2610466.67	29.62124522	-82.47953332
B20			X	231861.56	2611956.2	29.62183957	-82.47483274

* US State Plane, Florida West, NAD83 (Conus), Feet
1/ Boring to Characterize ERI Anomaly
2/ Boring to Characterize GPR Anomaly
3/Boring to Characterize Background Conditions

APPENDIX 1

FIGURES AND EXAMPLES OF GPR ANOMALIES



EXPLANATION

- GPR TRANSECTS
- TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)
- 1 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION
- TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)
- S2 E2 ERI TRANSECTS WITH START AND END POINTS
- ERI ANOMALY LEVEL A (MOST SIGNIFICANT)
- ERI ANOMALY LEVEL B (LEAST SIGNIFICANT)
- 1 RECOMMENDED TESTING LOCATION WITH DESIGNATION (ERI)

GOOGLE EARTH AERIAL 2020

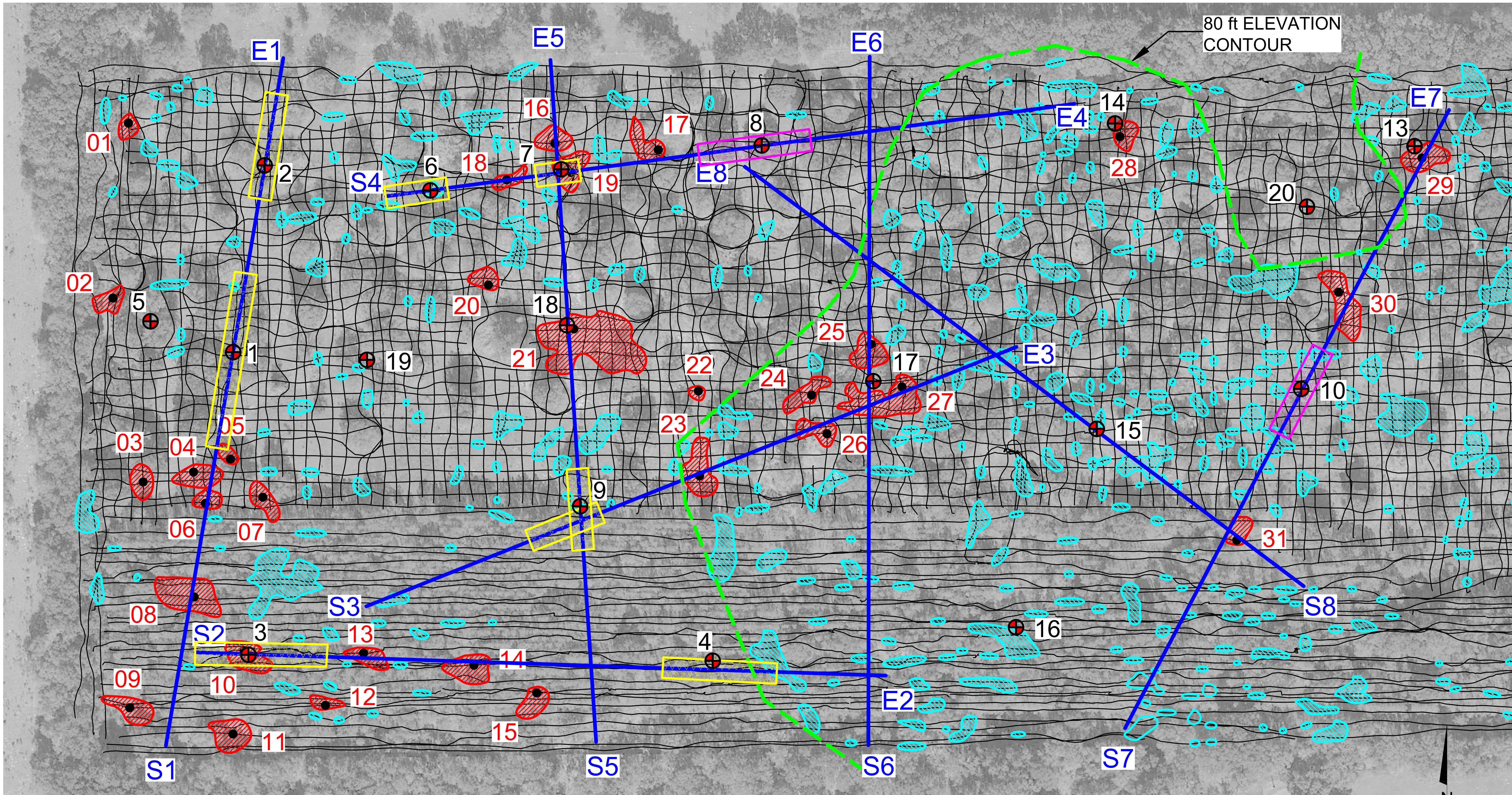
GeoView

FIGURE 1
OVERALL SITE MAP SHOWING RESULTS OF GEOPHYSICAL INVESTIGATION AND PROPOSED PHASE 1 ERI TRANSECTS

GRU-PARKER ROAD RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING & CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405
DATE: 07/02/20



EXPLANATION

- GPR TRANSECTS
- TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)
- 1 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION
- TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)
- S2 E2 ERI TRANSECTS WITH START AND END POINTS
- ERI ANOMALY LEVEL A (MOST SIGNIFICANT)
- ERI ANOMALY LEVEL B (LEAST SIGNIFICANT)
- 1 RECOMMENDED TESTING LOCATION WITH DESIGNATION (ERI)

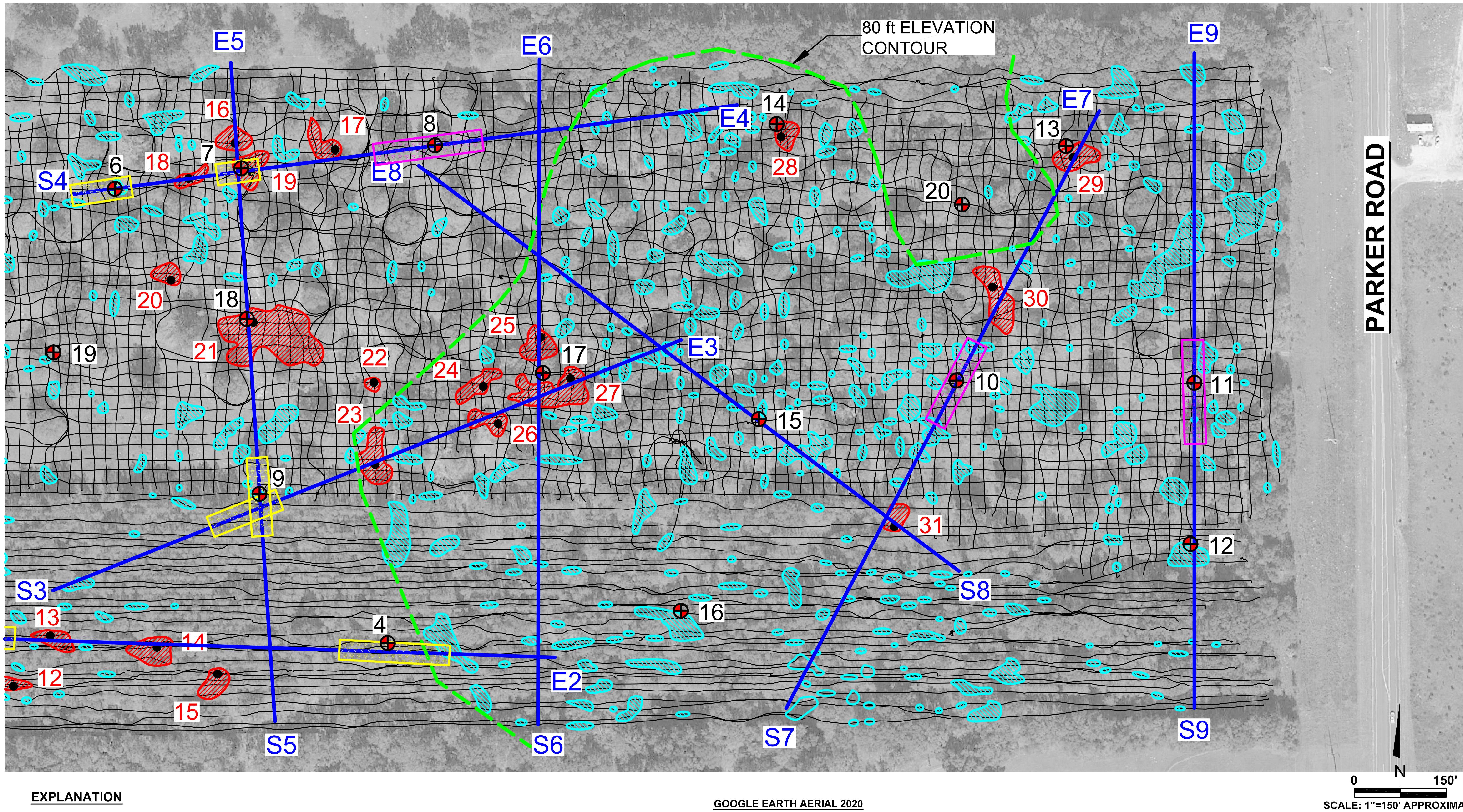
GeoView

FIGURE 2
WESTERN SITE MAP SHOWING RESULTS OF GEOPHYSICAL INVESTIGATION AND PROPOSED PHASE 1 ERI TRANSECTS

GRU-PARKER ROAD
RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING & CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405
DATE: 07/02/20



EXPLANATION

- GPR TRANSECTS
- TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)
- 1 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION
- TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)
- S2 E2 ERI TRANSECTS WITH START AND END POINTS
- ERI ANOMALY LEVEL A (MOST SIGNIFICANT)
- ERI ANOMALY LEVEL B (LEAST SIGNIFICANT)
- 1 RECOMMENDED TESTING LOCATION WITH DESIGNATION (ERI)

GOOGLE EARTH AERIAL 2020

GeoView

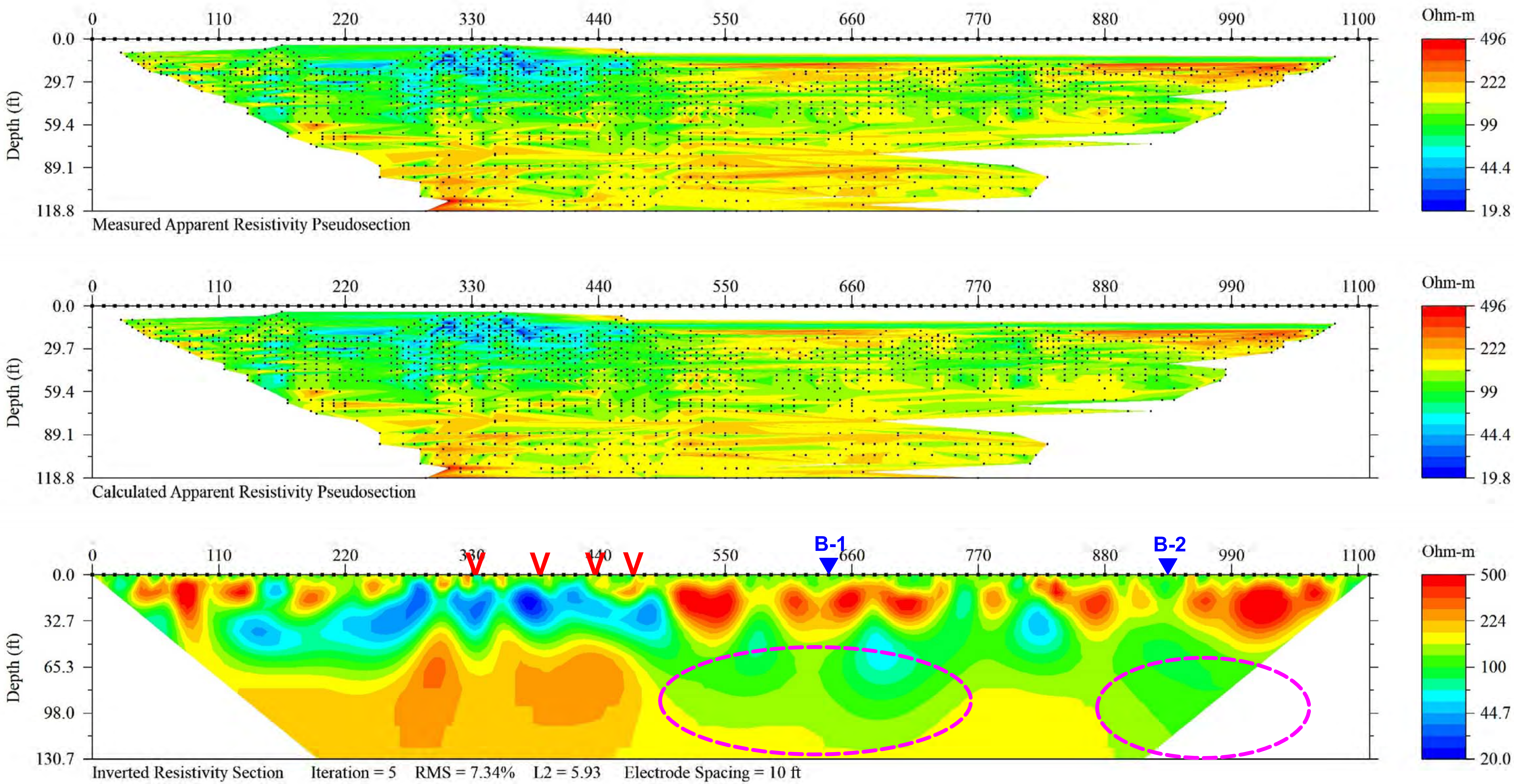
FIGURE 3
EASTERN SITE MAP SHOWING RESULTS OF GEOPHYSICAL INVESTIGATION AND PROPOSED PHASE 1 ERI TRANSECTS

GRU-PARKER ROAD RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING & CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405
DATE: 07/02/20

ERI TRANSECT 1



EXPLANATION

ERI ANOMALIES -LEVEL A

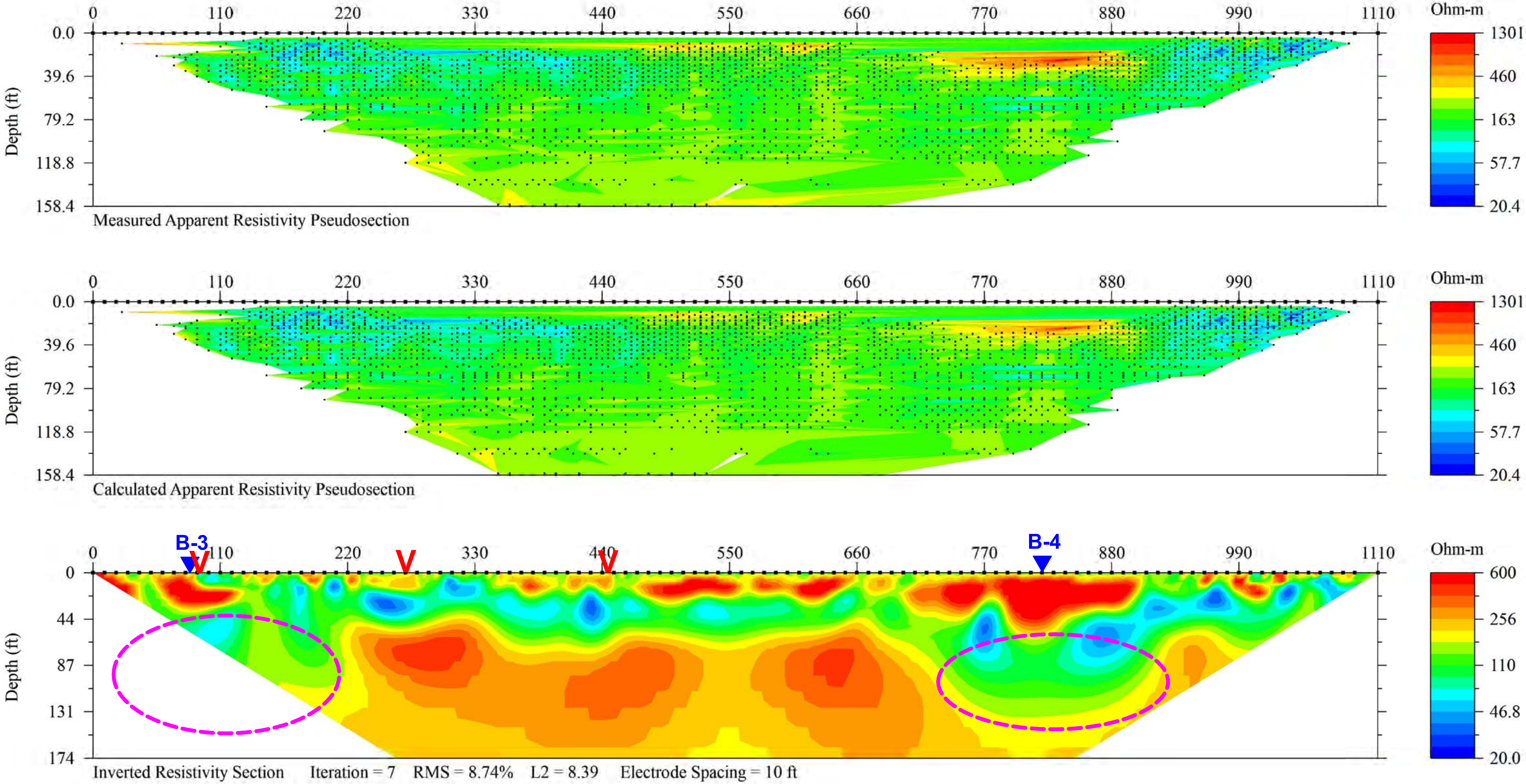
ERI ANOMALIES -LEVEL B

B-1 RECOMMENDED BORING LOCATIONS

V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

GeoView	**FIGURE 4** ERI TRANSECT 1	GRU-PARKER ROAD RECHARGE WETLAND SITE ALACHUA COUNTY, FLORIDA
		GSE ENGINEERING & CONSULTING, INC. GAINESVILLE, FLORIDA — PROJECT: 31405 DATE: 05/26/17

ERI TRANSECT 2



EXPLANATION

- ERI ANOMALIES -LEVEL A
- ERI ANOMALIES -LEVEL B
- B-1 RECOMMENDED BORING LOCATIONS
- V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

GeoView

FIGURE 5

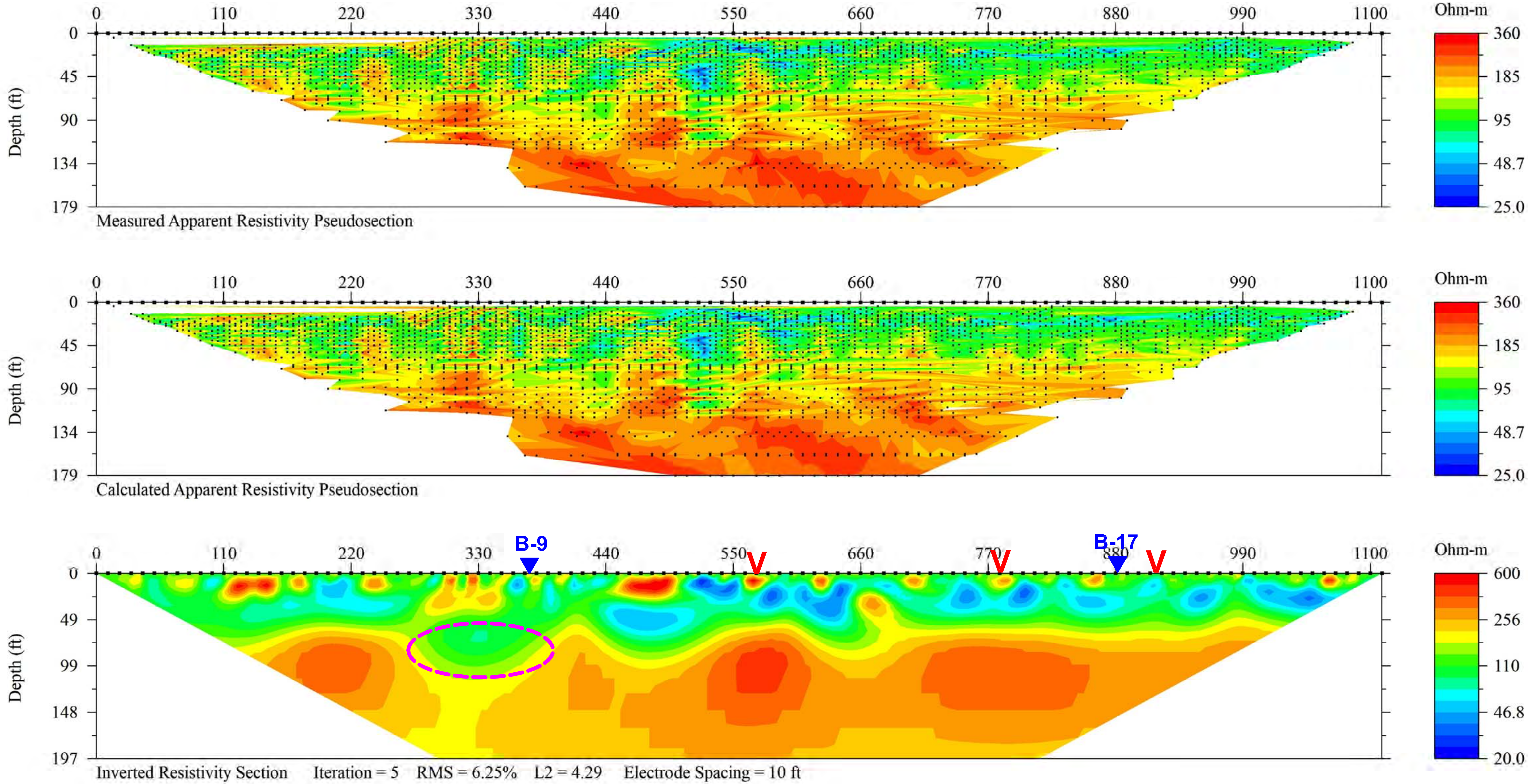
ERI TRANSECT 2

GRU-PARKER ROAD
RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING &
CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405
DATE: 05/26/17

ERI TRANSECT 3



EXPLANATION

ERI ANOMALIES -LEVEL A

ERI ANOMALIES -LEVEL B

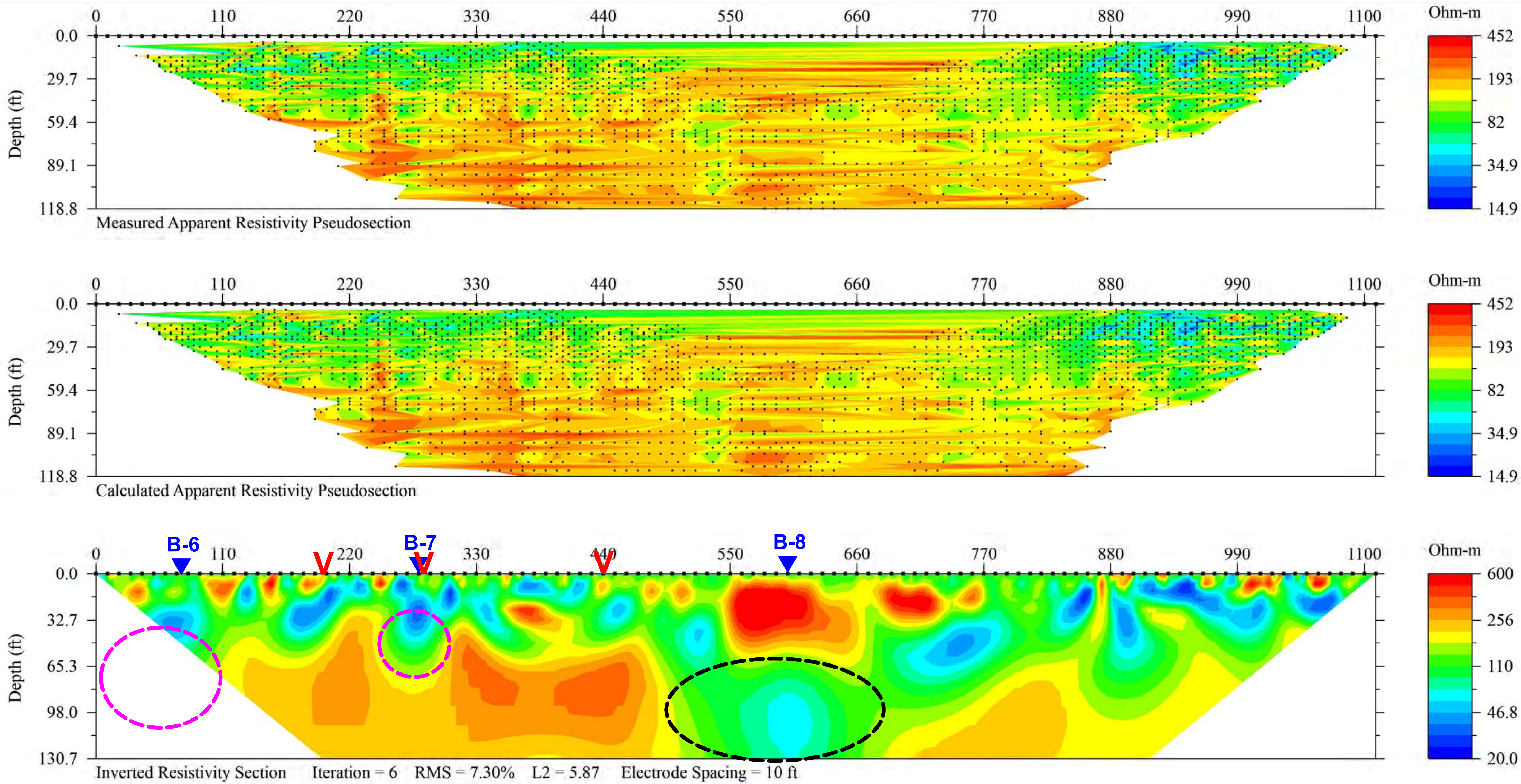
B-1 RECOMMENDED BORING LOCATIONS

V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

GeoView

FIGURE 6	GRU-PARKER ROAD RECHARGE WETLAND SITE ALACHUA COUNTY, FLORIDA	
ERI TRANSECT 3	GSE ENGINEERING & CONSULTING, INC. GAINESVILLE, FLORIDA	PROJECT: 31405 DATE: 05/26/17

ERI TRANSECT 4



EXPLANATION

ERI ANOMALIES -LEVEL A

ERI ANOMALIES -LEVEL B

B-1 RECOMMENDED BORING LOCATIONS

V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

GeoView

FIGURE 7

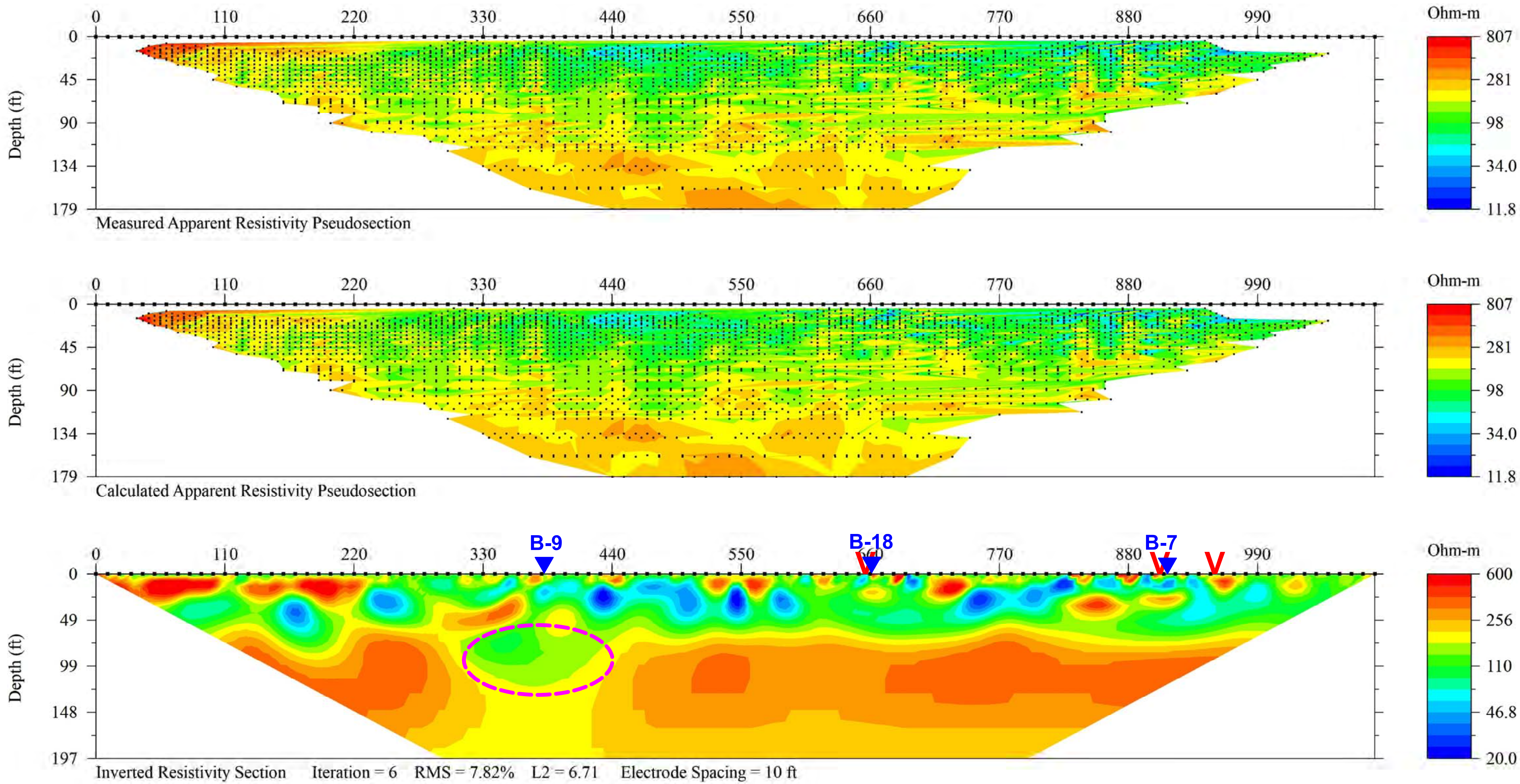
ERI TRANSECT 4

GRU-PARKER ROAD
RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING &
CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405
DATE: 05/26/17

ERI TRANSECT 5



EXPLANATION

ERI ANOMALIES -LEVEL A

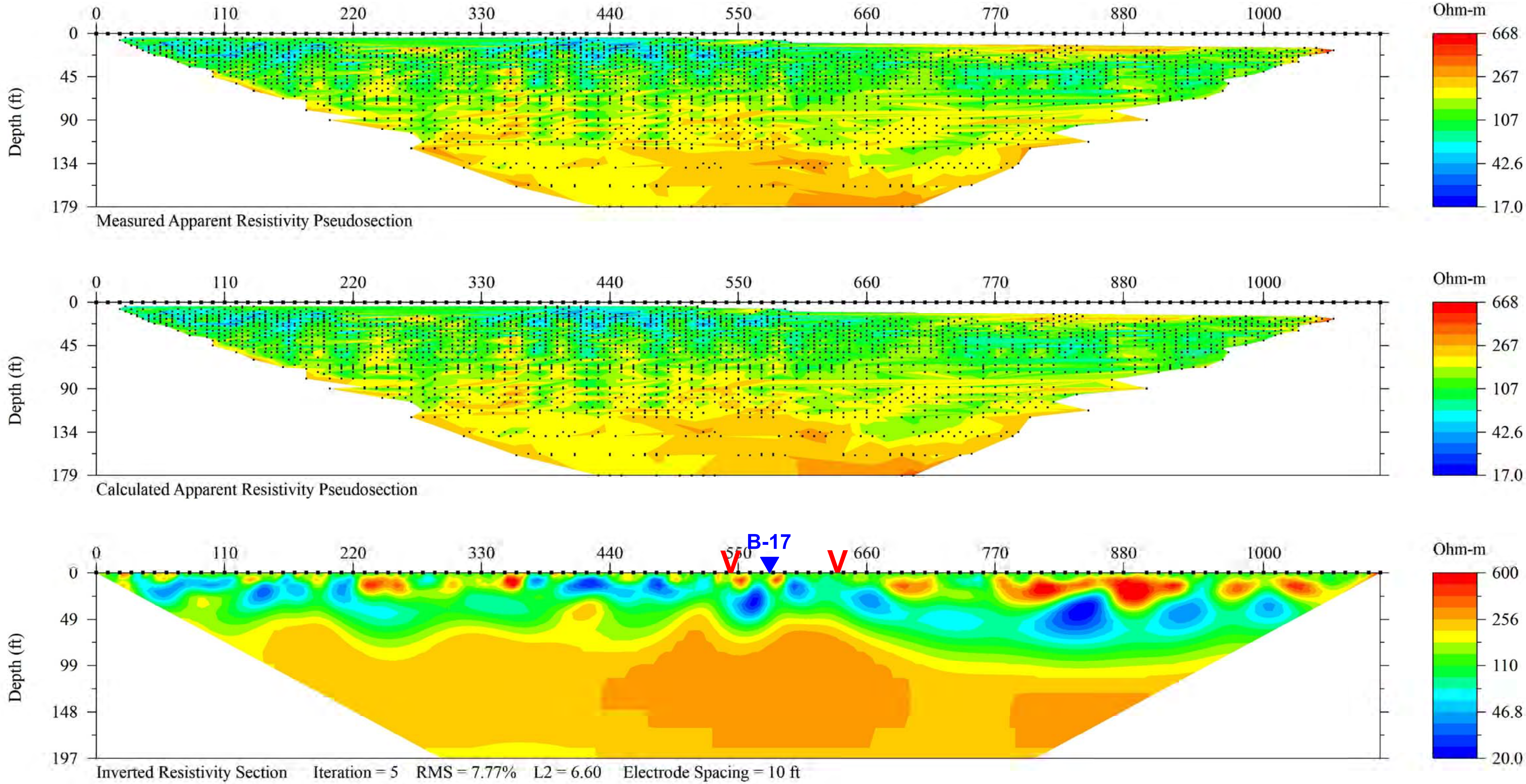
ERI ANOMALIES -LEVEL B

B-1 RECOMMENDED BORING LOCATIONS

V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

FIGURE 8	GRU-PARKER ROAD RECHARGE WETLAND SITE ALACHUA COUNTY, FLORIDA	
ERI TRANSECT 5	GSE ENGINEERING & CONSULTING, INC. GAINESVILLE, FLORIDA	PROJECT: 31405 DATE: 05/26/17

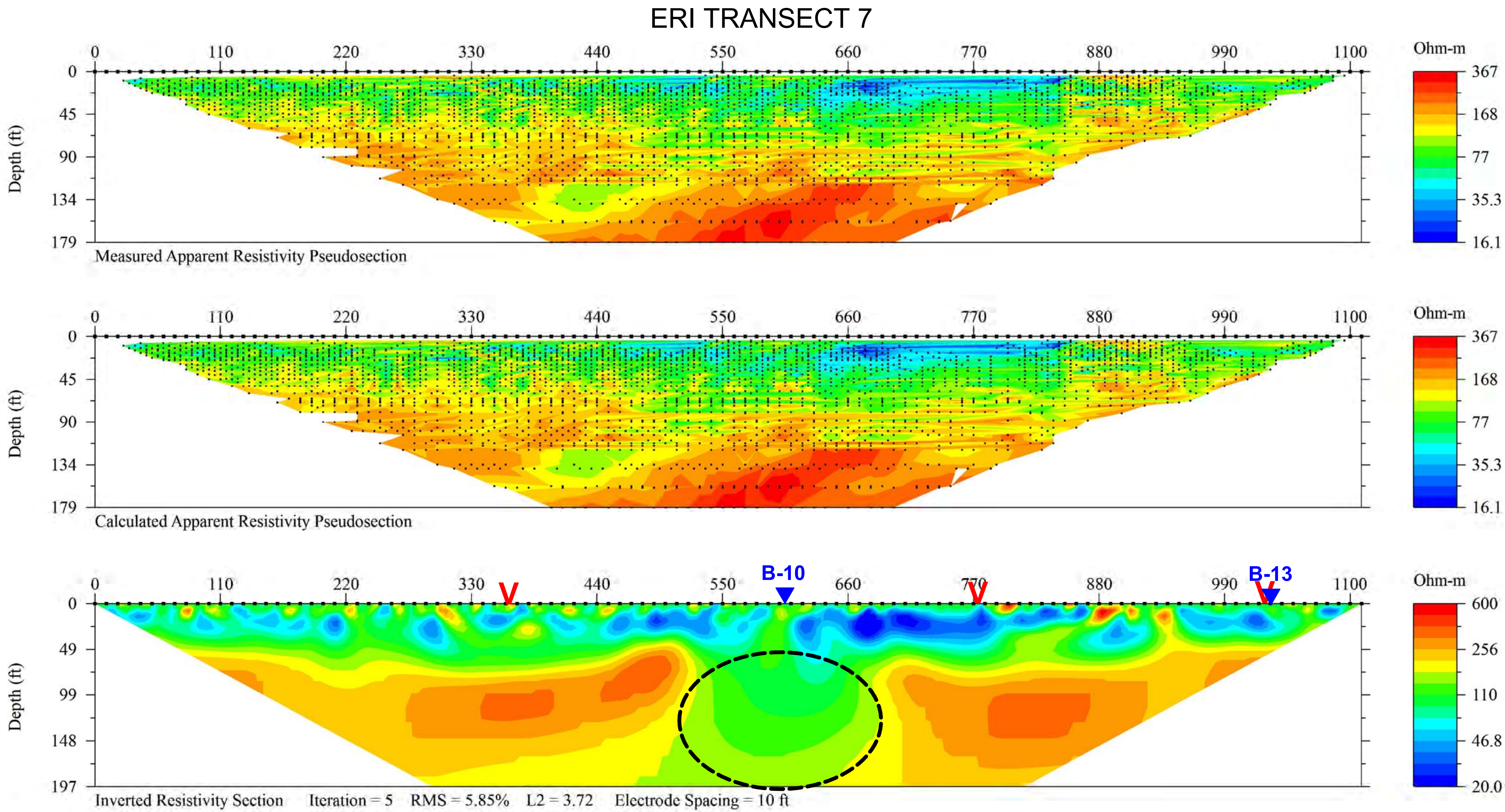
ERI TRANSECT 6



EXPLANATION

- ERI ANOMALIES -LEVEL A
- ERI ANOMALIES -LEVEL B
- B-1 RECOMMENDED BORING LOCATIONS
- V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

GeoView	**FIGURE 9** ERI TRANSECT 6	GRU-PARKER ROAD RECHARGE WETLAND SITE ALACHUA COUNTY, FLORIDA	
		GSE ENGINEERING & CONSULTING, INC. GAINESVILLE, FLORIDA	PROJECT: 31405 DATE: 05/26/17



EXPLANATION

ERI ANOMALIES -LEVEL A

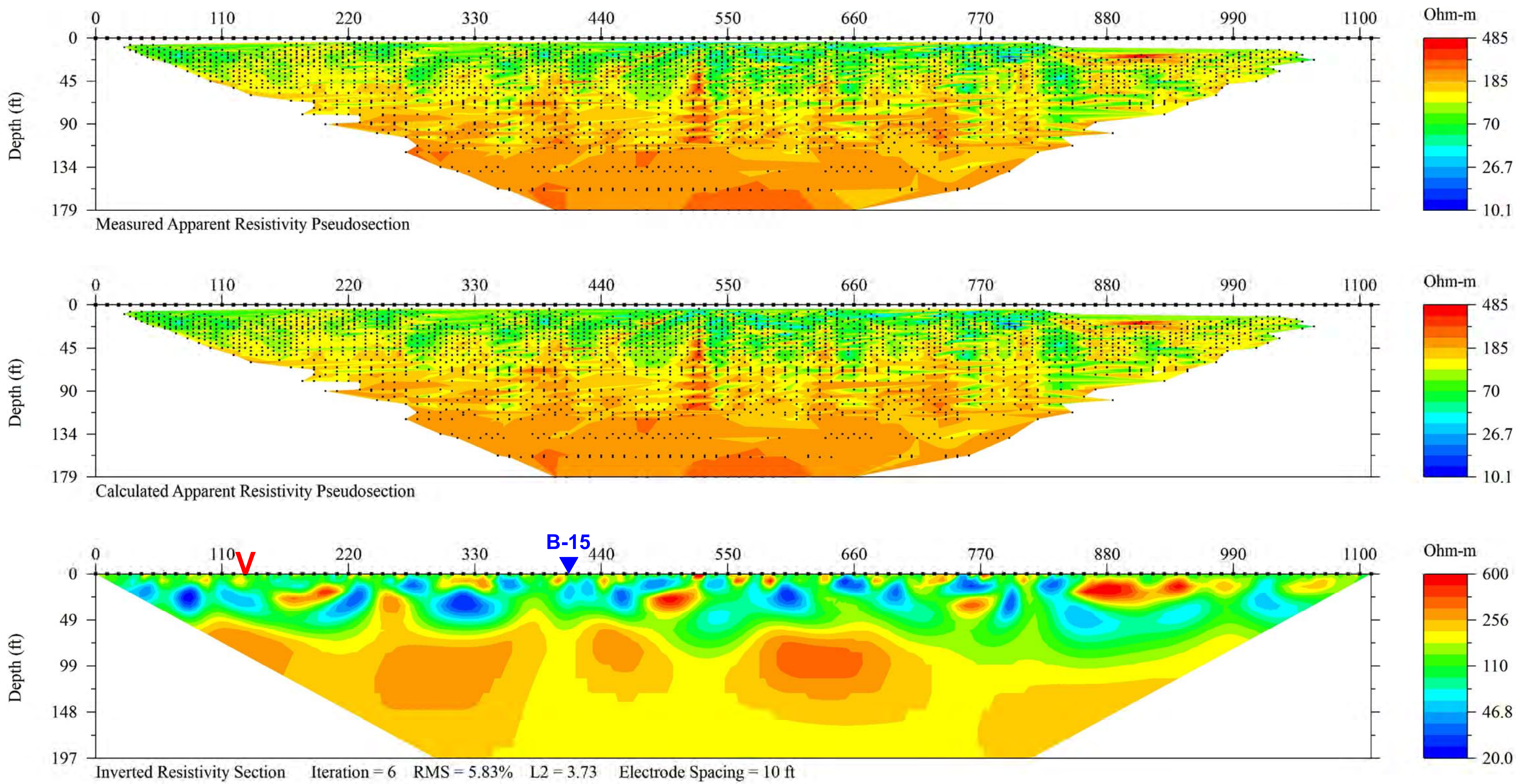
ERI ANOMALIES -LEVEL B

B-1 RECOMMENDED BORING LOCATIONS

V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

GeoView	FIGURE 10 ERI TRANSECT 7	GRU-PARKER ROAD RECHARGE WETLAND SITE ALACHUA COUNTY, FLORIDA	
		GSE ENGINEERING & CONSULTING, INC. GAINESVILLE, FLORIDA	PROJECT: 31405 DATE: 05/26/17

ERI TRANSECT 8



EXPLANATION

ERI ANOMALIES -LEVEL A

ERI ANOMALIES -LEVEL B

B-1 RECOMMENDED BORING LOCATIONS

V LOCATION OF TYPE A GPR ANOMALY CROSSED BY ERI TRANSECT

GeoView

FIGURE 11

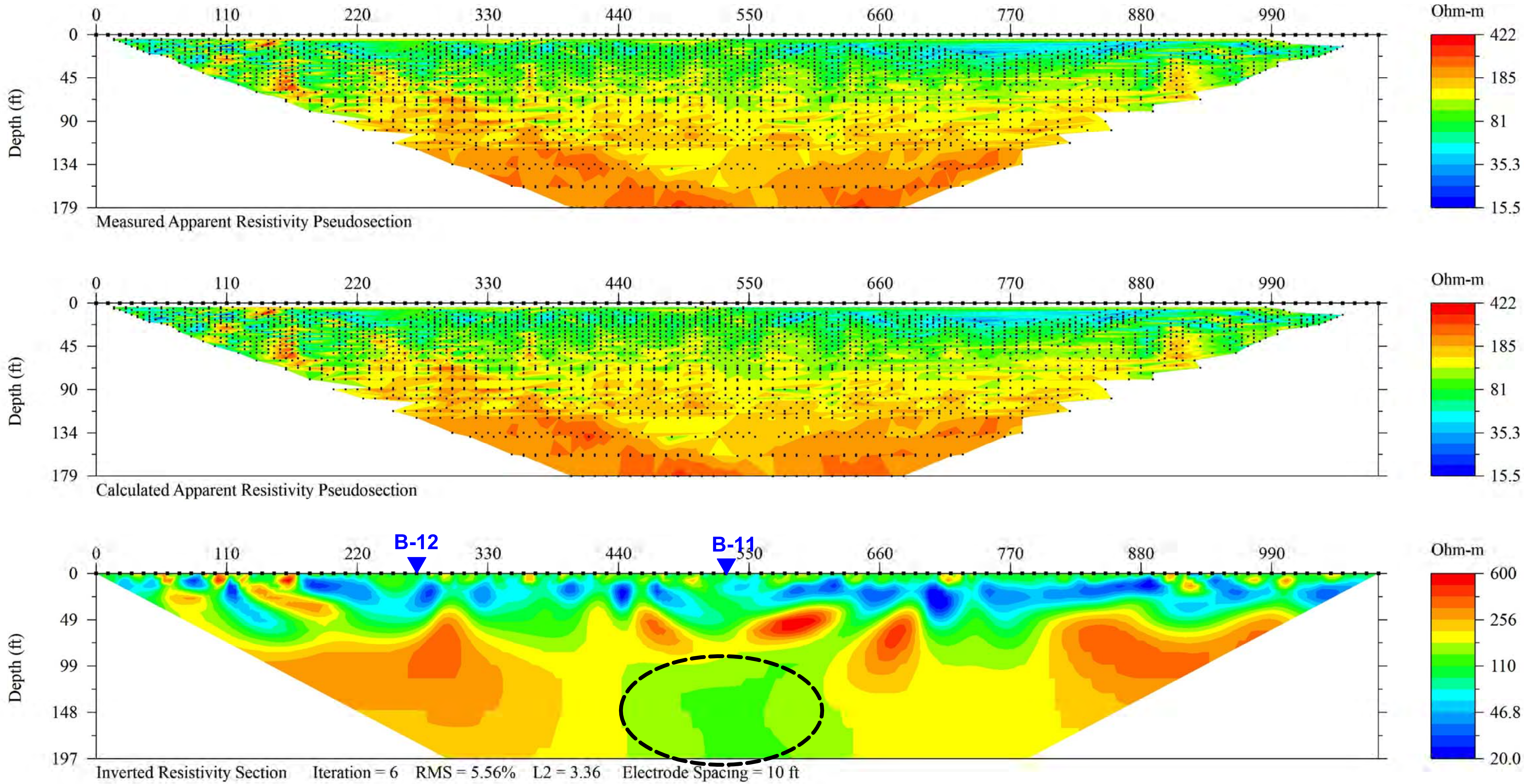
ERI TRANSECT 8

GRU-PARKER ROAD
RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING & CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405
DATE: 05/26/17

ERI TRANSECT 9



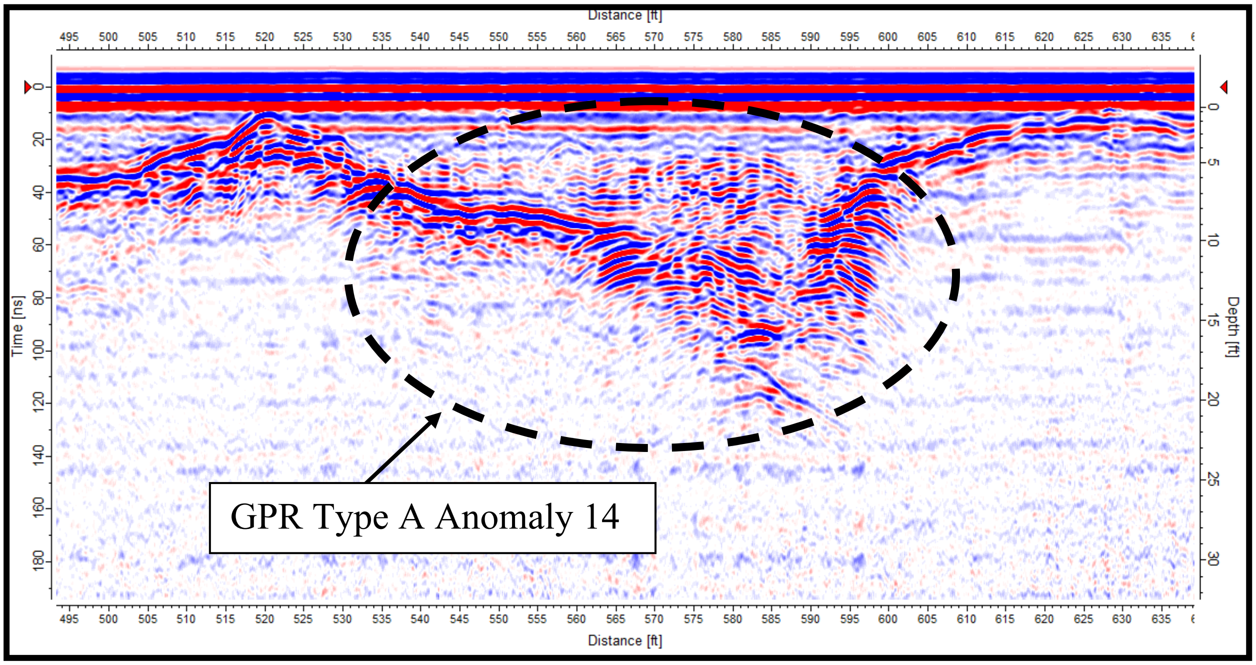
EXPLANATION

ERI ANOMALIES -LEVEL A

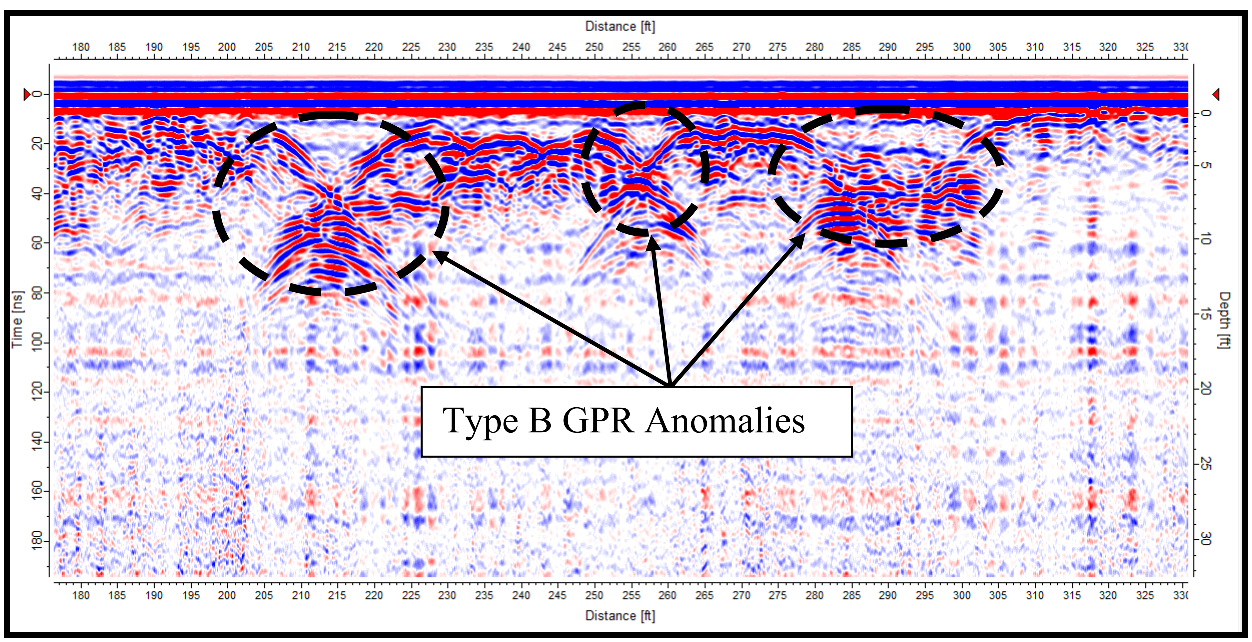
ERI ANOMALIES -LEVEL B

B-1 RECOMMENDED BORING LOCATIONS

GeoView	**FIGURE 12** ERI TRANSECT 9	GRU-PARKER ROAD RECHARGE WETLAND SITE ALACHUA COUNTY, FLORIDA	
		GSE ENGINEERING & CONSULTING, INC. GAINESVILLE, FLORIDA	PROJECT: 31405 DATE: 05/26/17



GPR Transect Showing Example of GPR Type A Anomaly 14



GPR Transect Showing Examples of GPR Type B Anomalies

APPENDIX 2
DESCRIPTION OF GEOPHYSICAL METHODS, SURVEY METHODOLOGIES AND LIMITATIONS

A2.1 On Site Measurements

The positions of the geophysical transect lines were recorded using a Trimble GeoXH Global Positioning System (GPS). These GPS systems typically have an accuracy of 1 to 3 ft.

A2.2 Ground Penetrating Radar

Ground Penetrating Radar (GPR) consists of a set of integrated electronic components that transmits high frequency (200 to 1500 megahertz [MHz]) electromagnetic waves into the ground and records the energy reflected back to the ground surface. The GPR system consists of an antenna, which serves as both a transmitter and receiver, and a profiling recorder that both processes the incoming signal and provides a graphic display of the data. The GPR data can be reviewed as both printed hard copy output or recorded on the profiling recorder's hard drive for later review. GeoView uses a Mala GPR system.

A GPR survey provides a graphic cross-sectional view of subsurface conditions. This cross-sectional view is created from the reflections of repetitive short-duration electromagnetic (EM) waves that are generated as the antenna is pulled across the ground surface. The reflections occur at the subsurface contacts between materials with differing electrical properties. The electrical property contrast that causes the reflections is the dielectric permittivity that is directly related to conductivity of a material. The GPR method is commonly used to identify such targets as underground utilities, underground storage tanks or drums, buried debris, voids or geological features.

The greater the electrical contrast between the surrounding earth materials and target of interest, the greater the amplitude of the reflected return signal. Unless the buried object is metal, only part of the signal energy will be reflected back to the antenna with the remaining portion of the signal continuing to propagate downward to be reflected by deeper features. If there is little or no electrical contrast between the target interest and surrounding earth materials it will be very difficult if not impossible to identify the object using GPR.

The depth of penetration of the GPR signal is very site specific and is controlled by two primary factors: subsurface soil conditions and selected antenna frequency. The GPR signal is attenuated (absorbed) as is passes through earth materials. As the energy of the GPR signal is diminished due to attenuation, the energy of the reflected waves is reduced, eventually to the level that the reflections can no longer be detected. As the conductivity of the earth materials increases, the attenuation of the GPR signal increases thereby reducing the signal penetration depth. In Florida, the typical soil conditions that severely limit GPR signal penetration are near-surface clays and/or organic materials.

The depth of penetration of the GPR signal is also reduced as the antenna frequency is increased. However, as antenna frequency is increased the resolution of the GPR data is improved. Therefore, when designing a GPR survey a tradeoff is made between the required depth of penetration and desired resolution of the data. As a rule, the highest frequency antenna that will still provide the desired maximum depth of penetration should be used. For outside areas, a low-frequency (250 MHz) antenna is used. This allows for maximum signal penetration and thereby maximum depth from which information will be obtained.

A GPR survey is conducted along survey lines (transects) that are measured paths along which the GPR antenna is moved. An integrated survey wheel electronically records the distance of the GPR system along the transect lines.

For geological characterization surveys, the GPR survey is conducted along a set of perpendicularly orientated transects. The survey is conducted in two directions because subsurface features such as sinkholes are often asymmetric. Spacing between the transects typically ranges from 10 to 50 ft. Closely spaced grids are used when the objective of the GPR survey is to identify all sinkhole features within a project site. Coarser grids are used when the objective is to provide a general overview of site conditions. After completion of a survey using a given grid spacing, additional more-closely spaced GPR transects are often performed to better characterize sinkhole features identified by the initial survey. This information can be used to provide recommended locations for geotechnical borings.

Depth estimates to the top of lithological contacts or sinkhole features are determined by dividing the time of travel of the GPR signal from the ground surface to the top of the feature by the velocity of the GPR signal. The velocity of the GPR signal is usually obtained from published tables of velocities for the type and condition (saturated vs. unsaturated) of soils underlying the site. The accuracy of GPR-derived depths typically ranges from 20 to 40 percent of the total depth.

<u>Interpretation and Limitations of GPR data</u>

The analysis and collection of GPR data is both a technical and interpretative skill. The technical aspects of the work are learned from both training and experience. Having the opportunity to compare GPR data collected in numerous settings to the results from geotechnical studies performed at the same locations develops interpretative skills for geological characterization studies.

The ability of GPR to collect interpretable information at a project site is limited by the attenuation (absorption) of the GPR signal by underlying soils. Once the GPR signal has been attenuated at a particular depth, information regarding deeper geological conditions will not be obtained. In addition, GPR data can only resolve subsurface features that have a sufficient electrical contrast between the feature in question and surrounding earth materials. If an insufficient contrast is present, the subsurface feature will not be identified. GeoView can make no warranties or representations of geological conditions that may be present beyond the depth of investigation or resolving capability of the GPR equipment or in areas that were not accessible to the geophysical investigation.

A2.3 Electrical Resistivity

Electrical resistivity surveying is a geophysical method in which an electrical current is injected into the earth; the subsequent response (potential) is measured at the ground surface to determine the resistance of the underlying earth materials. The resistivity survey is conducted by applying electrical current into the earth from two implanted electrodes (current electrodes C_1 and C_2) and measuring the associated potential between a second set of implanted electrodes (potential electrodes P_1 and P_2). Field readings are in volts. Field readings are then converted to resistivity values using Ohm's Law and a geometric correction factor for the spacing and configuration of the electrodes. The calculated resistivity values are known as "apparent" resistivity values. The values are referred to as "apparent" because the calculations for the values assume that the volume of earth material being measured is electrically homogeneous. Such field conditions are rarely present.

Resistivity of earth materials is controlled by several properties including composition, water content, pore fluid resistivity and effective permeability. For this study the properties that had the primary control on measured resistivity values are composition and effective permeability. The general geological setting of this project area is clay overlain by limestone.

For this study a dipole-dipole combined with an inverse Schlumberger resistivity array configuration was used. The dipole-dipole array is different that most other resistivity arrays in that the electrode and current electrodes are kept together using a constant spacing value referred to as an "a spacing". The current and potential electrode sets are moved away from each other using multiples of the "a spacing" value. The number of multiples is referred to as the "n value". For example, an array with an “a spacing” of 5 ft and a “n value” of 6 would have the current and potential electrode sets spaced 30 ft apart with a separation between the two electrodes in the set of 5 ft. By sampling at varying “n values”, greater depth measurements can be achieved. Inverse Schlumberger data is collected with the current set of electrodes being kept with a fixed separation (L spacing) and the potential electrodes a minimum distance of 5L from the inner current electrodes. Dipole-dipole resistivity data is usually presented in a two-dimensional pseudo-section format. Inverse Schlumberger data is usually presented as a vertical profile of resistivity distribution below the center point between the two current electrodes. The dipole-dipole and inverse Schlumberger data is combined and presented as either a contour of the individual data points (using the calculated apparent resistivity values) or as a geological model using least squares analysis. Such least squares analysis was used for this study using the computer software program (EarthImager 2D) developed for the equipment manufacturer. Apparent resistivity values are calculated using the following formula for a dipole-dipole configuration: $\gamma_a=\pi(b^3/a^2-b)\nabla V/I$:

Where:

γ_a=	apparent resistivity
π=	3.14
a=	“a spacing”
b=	“a spacing” x “n value”
∇V=	voltage between the two potential electrodes
I=	current (in amps)

For a Schlumberger configuration the apparent resistivity is calculated using: $\gamma_a=\pi([s^2-a^2]/4)\nabla V/aI$:

Where:

γ_a=	apparent resistivity
π=	3.14
a=	spacing between the inner set of electrodes”
s=	distance between the outer electrode and nearest inner electrode
∇V=	voltage between the two potential electrodes
I=	current (in amps)

A2.3.1 Inversion Modeling of ERI Data

The objective for inversion modeling of resistivity data is to create a description of the actual distribution of earth material resistivity based on the subsurface geology that closely matches the resistivity values that are measured by the instrumentation. This modeling is done through the use of EarthImager™, a proprietary computer program developed by the equipment manufacturer. When evaluating the validity of the inversion model several factors need to be considered. The RMS, or root mean square error, expresses the quality of fit between the actual and modeled resistivity values for the given set of points in the model. The lower the RMS error the higher the quality of fit between the actual and modeled data sets. In general, inversion models with an RMS error of less than 5 to 10 percent are acceptable. The size of the RMS error is dependent upon the number of bad data points within a data set and the magnitude of how bad the data points are. As part of the modeling process bad data points are typically removed, which decreases the RMS error and improves (with limitations) the quality of the model. The quality of fit between the actual and modeled resistivity values is also expressed as the L-2 norm. When the modeled and actual data sets have converged, the L-2 norm reduces to unity (1.0 or smaller).

However, as the number of data points is reduced, the validity of the inversion model is diminished. Accordingly, when interpreting a particular area of an inversion model the number of data points used to create that portion of the model must be taken into consideration. If very few points are within a particular area of the model, then the modeled solution in that area should be considered suspect and possibly rejected.

The entire ERI transect should be considered suspect if a model has a high RMS error and a large number of removed data points. It is likely that sources of interference have affected the field readings and rendered the modeled solution invalid. Such sources of interference can include buried metallic underground utilities, reinforced concrete slabs, septic leach fields or electrical grounding systems. Accordingly, all efforts need to be made in the field to locate, to the degree possible, the ERI transect lines away from such features. The locations of such features also need to be mapped in the field so their potential effects can be considered when interpreting the modeled results.

APPENDIX C

GSE Engineering & Consulting, Inc.

LIMITED SUBSURFACE SITE EVALUATION

GRU 12 ACRE PARCEL - WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA

GSE PROJECT NO. 14588A

Prepared For:

GAINESVILLE REGIONAL UTILITIES

NOVEMBER 2020

Certificate of Authorization No. 27430

GSE Engineering & Consulting, Inc.

November 2, 2020

Mr. Zach Tucker
Gainesville Regional Utilities
P.O. Box 147117, Station E3-F
Gainesville, Florida 32614-7117

Subject: Limited Subsurface Site Evaluation
GRU 12 Acre Parcel - Wetland Recharge Site
Gainesville, Alachua County, Florida
GSE Project No. 14588A

Dear Mr. Tucker:

GSE Engineering & Consulting, Inc. (GSE) is pleased to submit this limited subsurface site evaluation for the above referenced project.

Presented herein are a summary, findings, and conclusions of the field and laboratory services, related to sinkhole potential at the site. Our services were provided consistent with GSE Proposal No. 2020-131A dated July 10, 2020 authorized through GRU Purchase Order 4510049530 dated August 17, 2020.

We appreciate this opportunity to assist Gainesville Regional Utilities on this project. If you have any questions or comments concerning this report, please contact us.

Sincerely,

GSE Engineering & Consulting, Inc.

This item has been digitally signed and sealed by Joakim B Nordqvist
Digitally signed by Joakim B Nordqvist
Date: 2020.11.02 14:28:40 -05'00'
on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

JOAKIM B. NORDQVIST
LICENSE
No.42681
STATE OF FLORIDA
PROFESSIONAL ENGINEER

Jason E. Gowland
Senior Engineer
Florida Registration Number 66467

Joakim (Jay) B. Nordqvist, P.E.
Principal Engineer
Florida Registration Number 42681

JEG/JBN:maj
Z:Projects\14588A GRU 12 Acre Parcel - Wetland Recharge Site/14588A.doc

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Certificate of Authorization No. 27430

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APPENDIX A

1.0 INTRODUCTION

GSE Engineering & Consulting, Inc. (GSE) has completed this limited subsurface site evaluation for an additional parcel of land being considered for purchase for the proposed constructed wetland recharge site on an adjacent 63+ acre parcel. The site adjoins the northwest portion of the 63+ acre parcel and is located in western Alachua County, Florida (Figure 1). The services were performed in general accordance with Tasks 1, 2, and 3 of GSE Proposal No. 2020-131A dated July 10, 2020 authorized through GRU Purchase Order 4510049530 dated August 17, 2020.

1.1 Project Description

GRU is conducting due diligence related work in regards to purchasing the subject 12+ acre and adjoining 63+ acre parcel for the construction of a wetland and recharge area. GSE has completed a geotechnical exploration for the 63+ acre parcel summarized in a report titled *Sinkhole Susceptibility Study and Near Surface Geotechnical Exploration* dated August 27, 2020 (GSE Project No. 14588). That report incorporates and considers the findings of this investigation. Please refer to that report for additional background information and recommendations related to the findings presented herein.

The additional parcel is located just south of SW 24th Avenue along the west side of SW 122nd Street (Parker Road). The Alachua County Property Appraiser (ACPA) identifies the property as Parcel No. 04433-003-000. According to the ACPA, the property is approximately 12.64 acres.

As part of due diligence, GSE was requested to conduct a limited subsurface site evaluation. The scope of this study was developed considers the findings of a more comprehensive study of the adjoining 63+ acre site.

1.3 Purpose

The intent of this evaluation is to conduct a limited evaluation of subsurface conditions of this additional parcel. Comprehensive geophysical and geotechnical services provided for the adjoining to the south approximately 63+ acre site have been completed. The findings on that site were considered in developing the scope of this evaluation. The intent of this investigation is to evaluate if similar subsurface conditions are expected to be present on this adjoining parcel.

1.4 Scope of Services

The scope of services (Task 1, 2, & 3) outlined in GSE Proposal No. 2020-131A have been completed and are reported herein. Provided services are summarized below.

Task 1 – Ground Penetrating Radar (GPR) Survey

- Coordinated the GPR services with Geoview, Inc. (subconsultant).
- Conducted a GPR survey. The GPR data was collected by towing the GPR instrument array using an all-terrain vehicle. The GPR survey was performed in accessible areas to the all-terrain vehicle.
- Reviewed the findings of the GPR survey with GRU/consultants in a videoconference meeting.
- Prepared a site exploration plan for the standard penetration test (SPT) soil borings.

Task 2 – Standard Penetration Test (SPT) Boring Program

- Laid out the proposed SPT boring locations.
- Cleared utilities at the site through Sunshine One Call.
- Mobilized to the site with track mounted drilling equipment.
- Advanced SPT borings to the limestone formation at five (5) locations considering the findings of the GPR survey.
- The SPT soil borings were abandoned consistent with Water Management District guidelines.
- Performed visual classification of the soil samples obtained from the soil borings to confirm field classifications.
- Conducted laboratory tests to confirm and establish the engineering properties of near surface soils. This will include percent fines, full grain size, natural moisture content, and Atterberg limits tests.
- Prepared SPT boring logs.
- Reviewed the results of the geophysical survey and SPT boring findings with GRU/consultants in a videoconference meeting

Task 3 – Summary Limited Subsurface Site Evaluation Report

Prepared this summary report specifically addressing the following items:

- Existing site conditions.
- Exploration, testing and sampling methods.
- A discussion of the regional geological conditions and soil survey information.
- Subsurface soil conditions encountered and soil classifications.
- Depth to groundwater at the time of the exploration, if encountered.
- Summary of on-site sinkhole potential.
- A discussion of the SPT boring results and whether indicators of sinkhole activity or potential sinkhole activity are present and the potential for sinkhole development in the area.
- A comparison to the more comprehensive data collected and findings for the adjoining southern parcel.
- An opinion as to whether or not subsurface conditions on this parcel are expected to be similar to those encountered on the adjoining 63+ acre parcel.

2.0 FIELD AND LABORATORY TESTS

The procedures used for field sampling and testing are in general accordance with industry standards of care and established geotechnical engineering and geological practices for this geographic region. This section provides a summary of field and laboratory tests performed.

2.1 Ground Penetrating Radar Survey

The Ground Penetrating Radar (GPR) survey was performed at the site by GeoView, Inc. (GeoView) as a subconsultant to GSE on August 21, 2020. The survey was conducted over the approximately 12+ acre site. The findings are summarized in the GeoView (GeoView Project No. 31405) report in the Appendix dated August 31, 2020. A summary of the survey field and interpretation procedures is provided below.

The GPR survey was conducted along a series of perpendicular transects spaced approximately 40 feet apart. The configuration of the GPR transects was modified as necessary to accommodate site conditions.

The GPR data was collected with a Mala radar system using a 250 MHz antenna and a time range setting of 203 nano-seconds. This equipment configuration provided an average exploration depth of 7 to 15 feet below land surface (bls).

The positions of the geophysical transect lines were recorded using a Trimble GeoXH Global Positioning System (GPS). A Wide Area Augmentation System (WAAS) was used to augment GPS with additional signals for increasing the reliability, integrity, accuracy and availability of the GPS signal. By using WAAS, an accuracy of less than 3 feet in the horizontal dimension was achieved. In areas near dense tree canopy, the accuracy of the GPS signal was typically reduced.

The findings of the GPR survey is illustrated on Figure 2. A more detailed description of the GPR methods, survey and findings is included in the referenced GeoView report in the Appendix.

2.2 Standard Penetration Test (SPT) Borings

This exploration included five (5) Standard Penetration Test (SPT) borings advanced to depths of 30 to 97 feet bls. Three of the borings were performed in the areas of GPR anomalies identified through the geophysical survey. The borings were located at the site using the Geoview figures, GPS coordinates, and obvious site features as reference. The boring locations should be considered approximate. The soil borings were performed from September 10 through 14, 2020. The SPT and GPR anomaly locations, as well as the SPT, GPR, and ERI anomaly locations of the 63+ acre site, are shown on Figure 2.

The soil borings were performed with a drill rig employing mud rotary drilling techniques and SPT in accordance with ASTM D1586. The SPTs were performed continuously to 10 feet and at 5-foot intervals thereafter. Soil samples were obtained at the depths where the SPTs were performed. The soil samples were classified in the field, placed in sealed containers, and returned to our laboratory for further evaluation.

After drilling to the sampling depth and flushing the borehole, the standard two-inch O.D. split-barrel sampler was seated by driving it 6 inches into the undisturbed soil. Then the sampler was driven an additional 12 inches by blows of a 140-pound hammer falling 30 inches. The number of blows required to produce the next 12 inches of penetration were recorded as the penetration resistance (N-value). These values and the complete SPT boring logs are provided in Section 6.1.

Upon completion of the sampling, the boreholes were abandoned in accordance with Water Management District guidelines.

2.3 Soil Laboratory Tests

The soil samples recovered from the SPT borings were returned to our laboratory and examined to confirm the field descriptions. Representative samples were then selected for laboratory testing. The laboratory tests consisted of four (4) percent soil fines passing the No. 200 sieve determinations, four (4) natural moisture content determinations, and two (2) Atterberg Limits tests. These tests were performed in order to aid in classifying the soils and to further evaluate their engineering properties. The laboratory test results are provided in Section 6.2.

3.0 REVIEW OF PUBLISHED DATA

The following section provides a review of readily available published data.

3.1 Review of Published Topographic Data

The topography at the site is gently sloping and rolling. Alachua County Growth Management Lidar data indicates the ground surface elevations at the site range between elevations of 80 to 84 feet NGVD[1].

The Lidar data identified one well defined and pronounced closed depression on-site. This area corresponds to the area where SPT boring B-25 was performed. There are well defined closed depressions in relatively close proximity on adjacent sites to the east, west and south. Closed depressions can be but are not necessarily an indicator of sinkholes, and could represent other landforms.

3.2 Review of Published Hydrological Data

The Floridan aquifer in the vicinity of the site has an elevation on the order of 40 to 50 feet[2]. This elevation is below land surface, indicating a downward hydraulic gradient occurs at the site. The site appears to fall within the Rum Island/Gilchrist Blue Spring springshed[3].

The Floridan aquifer is generally unconfined in this area. A perched near surface groundwater can be present in some areas where confining soils are more uniform. Where present, the surficial groundwater is often a transient condition that occurs during prolonged wet periods and tends to recede and disappear during extended dry periods.

3.3 Review of Published Soil Survey Information

The site is mapped with two soil series by the Soil Conservation Service (SCS) Soil Survey for Alachua County[4]. The following soil descriptions are from the Soil Survey.

Arredondo fine sand, 0 to 5 percent slopes – This nearly level to gently sloping, well-drained soil is in both small and large areas of uplands. Slopes are smooth to convex. The areas are irregular in shape and range from about 10 to 160 acres in size.

Typically, the surface layer is dark grayish brown fine sand about 8 inches thick. The subsurface layer is fine sand to a depth of 49 inches. The upper 23 inches is yellowish brown, and the lower 18 inches is brownish yellow. The subsoil extends to a depth of 86 inches or more. The upper 5 inches is yellowish brown loamy sand; the next 10 inches is yellowish brown sandy clay loam, and the lower 22 inches is dark yellowish brown sandy clay and sandy clay loam.

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[1] Alachua County Growth Management Website. https://mapgenius.alachuacounty.us/

[2] Potentiometric Surface of the Upper Floridan Aquifer in the St. Johns River Water Management District and Vicinity, Florida, May 2009, U.S. Geological Survey.

[3] http://my.ees.ufl.edu/symposium2010/downloads/All_Presentations-PDF/Day_2-Thursday_2-25/Hydrologic1_830_2-25/Upchurch_Hydrologic1_830_2-25.pdf (Accessed on July 20, 2020)

[4] Soil Survey of Alachua County, Florida. Soil Conservation Service, U.S. Department of Agriculture.

Included with this soil in mapping are small depressional areas of soils that have a very dark gray or black surface layer 8 to 24 inches thick. This layer overlies gray sandy material. These areas are shown by wet spot symbols. Also included are small areas of Fort Meade, Gainesville, Kendrick, and Millhopper soils.

A few areas of this soil include Arredondo soils that have 5 to 8 percent slopes. Some areas of this soil in the western part of the county have small spots of strongly acid to medium acid soil material 40 to 70 inches deep to calcareous limestone. Limestone boulders, fragments of limestone, and sinkholes are in some areas of this soil, mainly in the limestone plain sections of the western part of the county. Most of these boulders are siliceous. The sinkholes and the boulders are shown by appropriate map symbols. Total included areas are about 15 percent.

In this Arredondo soil, the available water capacity is low in the sandy surface and subsurface layers and low to medium in the loamy subsoil. Permeability is rapid in the surface and subsurface layers and moderately slow to moderate in the loamy subsoil. Natural fertility is low in the sandy surface and subsurface layers and medium in the finer textured subsoil. Organic matter content is low. The water table in this soil is at a depth of more than 72 inches. Surface runoff is slow.

***Jonesville-Cadillac-Bonneau complex, 0 to 5 percent slopes* -** This complex consists of small areas of nearly level to gently sloping, well drained Jonesville and Cadillac soils and moderately well drained Bonneau soils. These soils are so intermixed that they cannot be separated at the scale of mapping. These soils are intermixed across the landscape. Individual areas of each soil range from about 1/10 of an acre to 5 acres. Mapped areas of this complex are irregular in shape and range from about 25 5o 125 acres.

Jonesville sand makes up about 45 to 55 percent of each mapped area. Typically, the soil has a dark gray sand surface layer about 7 inches thick. The subsurface layer is pale brown fine sand to a depth of 29 inches. The subsoil extends to a depth of 33 inches and is brownish yellow sandy clay loam. Below this is white limestone to a depth of 80 inches or more. This limestone is soft enough to be dug with light power equipment, such as a back hoe.

In the Jonesville soil, the available water capacity is low in the sandy surface layer, low to very low in the sandy subsurface layer, and medium in the loamy subsoil. Permeability is rapid in the sandy surface and subsurface layers and moderately slow to moderate in the loamy subsoil. Organic matter content is moderately low. Natural fertility is low to medium. Surface runoff is slow. The water table is at a depth of more than 72 inches.

Cadillac fine sand makes up about 25 to 35 percent of each mapped area. Typically, the surface layer is dark gray fine sand about 7 inches thick. The subsurface layer is fine sand to a depth of 52 inches. The upper 22 inches is light yellowish brown, and the lower 33 inches is very pale brown. The subsoil extends to a depth of 76 inches. The upper 7 inches is yellowish brown fine sandy loam, and the lower 17 inches is strong brown sandy clay loam. Between a depth of 76 and 118 inches, the underlying material is clay. The upper 22 inches is yellowish brown and has mottles, and the lower 20 inches is gray and has some limestone fragments.

In the Cadillac soil, the available water capacity is low in the sandy surface and subsurface layers and medium in the loamy subsoil. Permeability is rapid in the sandy layers and slow to moderate in the loamy subsoil. Organic matter content is low to moderately low. Natural fertility is low in the sandy surface and subsurface layers and medium in the loamy subsoil. The water table in this soil is at a depth of more than 72 inches. Surface runoff is slow.

Bonneau fine sand makes up about 5 to 10 percent of each mapped area. Typically, the surface layer is dark gray fine sand about 9 inches thick. The subsurface layer is brownish yellow fine sand to a depth of 29 inches. The subsoil is sandy clay loam that extends to a depth of 84 inches or more. The upper 9 inches is yellowish brown, and the lower 47 inches is gray and has yellowish and brownish mottles.

In the Bonneau soil, the water table is about 50 to 72 inches below the surface for 1 to 3 months during most years. During dry seasons, it is more than 72 inches below the surface. Permeability is moderately rapid to rapid in the sandy surface and subsurface layers. It is moderately slow to moderate in the upper part of the subsoil and very slow to slow in the lower part. The available water capacity and the natural fertility are low in the sandy surface and subsurface layers and medium in the subsoil. Organic matter content is low to moderately low.

Included with these soils in mapping are many areas of soils that have pedon characteristics similar to the Pedro soils. Also included are some soils that have a grayish brown, sandy surface layer; a pale brown, sandy subsurface layer that extends a depth of 20 to 40 inches; and a yellowish brown or strong brown sandy clay loam subsoil that reaches a depth of more than 60 inches. Some soils have sandy surface and subsurface layers 40 to 50 inches thick, a subsoil 4 to 10 inches thick that is yellowish brown or strong brown sandy loam or sandy clay loam, and soft, white limestone at a depth of about 45 to 60 inches. Included in some areas are soils that have fine sand surface and subsurface layers less than 20 inches thick, a yellowish brown or strong brown sandy clay subsoil, and soft limestone at a depth of about 30 to 50 inches. Some areas have included soils that have pedon characteristics similar to the Arredondo and Candler soils. Limestone boulders and sinkholes are common. About 12 acres mapped as this complex along the Santa Fe River is occasionally flooded. Total included areas are 5 to 15 percent of each mapped area.

The near surface soils encountered by the borings are generally consistent with the County Soil Survey mappings.

3.4 Review of Published Regional Geology

The site is located within the southwestern portion of Alachua County. Alachua County straddles two physiographic provinces: Northern Highlands and Coastal Lowlands[5]. A broad karst escarpment known as the Cody Scarp separates these two provinces. The subject site is located within the western Coastal Lowlands geological area of the County

The Northern Highlands, which lie north and east of the Cody Scarp, are underlain by a thick sequence of relatively impermeable Miocene to Pleistocene sediments. Because of this thick sequence of sediments, the Northern Highlands Province contains few karst features. This upland plateau is nearly level, sloping gently to the west, north and east. Elevation ranges from about 150 to 200 feet above sea level. The plateau, which originally extended completely across the county, has many swamps. Sinkholes are not common within the plateau, but a few are found near its margin.

[5] White, W.A., 1970. The Geomorphology of the Florida Peninsula. Florida Geological Survey, Bulletin 51.

Thin Plio-Pleistocene sediments overlying thin and discontinuous, residual Miocene strata and Eocene limestone characterize the Lowlands. Karst features are numerous in the Lowlands. The western plains region has low relief. Elevation ranges from about 50 to 80 feet above sea level. The plain is devoid of stream channels, but it is dotted with sinks and limestone mines. While the Ocala Limestone is essentially near the surface in this region, many of the old sinks have become filled (some to a depth of 250 feet) with sand, clayey sand, and sandy clay.

These soil materials come from marine submergence, soil creep and slumping, and stream transport from the Northern Highlands. This sinkhole fill tends to mask many of the karst irregularities of the Ocala surface.

The Cody Scarp, which separates the Northern Highlands from the Coastal Lowlands, contains large sinkholes, sinking streams, and other karst features. The bottoms of the karst features often penetrate to the Ocala Limestone and the depressions are usually filled with organic soils, fluvial and lacustrine sediments, and clay-rich soils. The hills within the scarp contain Miocene sediments similar to the Northern Highlands Province. Many of the large, flat-bottomed lakes and wet prairies are associated with the scarp and represent coalescent sinkholes known as poljes and uvalas. Many of these level prairies and lakes, most of which are near or below 60 feet NGVD, are associated with ground water levels.

Three major geologic formations occur at or near the surface within the county. These formations have influenced soil development. They are, in order of decreasing age, the Ocala Limestone of Eocene age, the Miocene to Pliocene Hawthorn Group, and the Plio-Pleistocene Terrace Deposits.

The Ocala Limestone underlies the entire county; exposures are common in the Coastal Lowlands in the southern and western parts of the county. Here a limestone plain is formed which is covered by a veneer of loose sand in most places. Thin and discontinuous beds of clay-rich soils may also occur in this region of the county. The Ocala Limestone consists of soft, white to cream colored, chalky, limestone that is approximately 98 percent calcium carbonate. Boulders and irregular masses of chert are common near the top. In many areas the Ocala is cavernous and fractured.

The Miocene Hawthorn Group includes at least three formations in Alachua County. These are, from bottom to top, the Penny Farms Formation, Marks Head Formation, and Coosawhatchie Formation[6]. All three formations consist of varying proportions of interbedded clay, sand, limestone, and dolostone, all of which are phosphatic. The Hawthorn Group crops out in isolated areas around the town of Micanopy and in an irregular pattern along the Cody Scarp from Lochloosa Lake northwestward through Gainesville and into the north-Northern and northwestern part of the county. Much of the outcrop area is hill and valley terrain created by the formation of karst features at the foot of the escarpment. A thin veneer of loose sands of the older Plio-Pleistocene Terrace deposits covers the Hawthorn Group of sediments in the Cody Scarp and Northern Highlands. The Hawthorn Group lies unconformably on the solution-pitted Ocala Limestone surface.

The most recent formation is a surface mantle of fine to medium sand, silt, and clay that formed as Pliocene and Pleistocene sea levels fluctuated and periodically inundated portions of the county. Primarily, the terrace deposits overlie the Hawthorn Group. They are exposed in the Northern and eastern parts of the county.

[6] Scott, T.M., 1988. The Lithostratigraphy of the Hawthorn Group (Miocene) of Florida. Florida Geological Survey, Bulletin No. 59.

3.5 Review of State Sinkhole Information and GSE In-House Geotechnical Information

GSE reviewed readily available published information on the Florida Map Direct[7] on-line system. Two database layers were queried as summarized below.

The *State of Florida Sinkhole Types* GIS layer is an assessment as part of a 1985 cooperative effort between the US geological survey and multiple State agency partners to summarize the types of sinkholes that occur within various areas of the State. The subject site is located within an area described as having Type I characteristics. The area as characterized as typically having a *"bare or thinly covered limestone"* where sinkholes *"are few, generally shallow and broad and develop gradually. Solution sinkholes dominate"*.

The *Florida Subsidence Incident Report* GIS layer represents reported subsidences. The database has been compiled by the Florida Department of Environmental Protection and Florida Geological Survey. These have not always been confirmed or verified as sinkholes and may represent other landforms. Furthermore, many of the incidents have not been field verified. There were not subsidence incidences reported within one-mile of the subject site. Multiple incidences were reported in excess of one-mile.

GSE reviewed in-house geotechnical information for the general area. GSE has extensive geotechnical experience in the western portion of Alachua County including for the Alachua County School Board and other private clients in the immediate area of the subject site. Area information and experience was considered and, in some cases, reviewed as part of this investigation.

[7] https://ca.dep.state.fl.us/mapdirect.

4.0 FINDINGS

This section presents our field and laboratory program findings. To provide context, the identified geophysical survey anomaly areas and SPT test locations on the adjoining 63+ acre site (in addition to the 12+ acre site) are included on Figure 2 referenced in the sections below.

4.1 Site Observations

Mr. Joakim (Jay) B. Nordqvist, P.E. initially visited the subject site on June 1, 2020. Mr. Nordqvist observed the site a second time accompanied by GRU and other consultants on July 7, 2020. Subsequent visits were made to the site by support GSE Staff to coordinate and conduct the field services described herein. In addition, a final site visit was conducted by Mr. Kevin Fisher, E.I. on October 1, 2020.

The site is currently undeveloped open and wooded land. The central portions of the site are mostly open field with wooded areas and ground cover including grass, shrubs, and cacti. The western and eastern portions of the site are more densely wooded. The site was mostly easily accessible by foot and vehicle. High grass, weeds and shrubs cover portions of the site making some areas less accessible.

Overall, site topography can be described as gently sloping and rolling. The broad depressional feature identified in the area of SPT boring B-25 was noted during our initial site visit. No compelling indications of active sinkholes on-site were identified during our site visits. No areas of standing water were observed on-site.

4.2 Ground Penetrating Radar (GPR)

The GPR survey was conducted across the 12+ acre site. The area of the survey was selected by GeoView and GSE. Figure 2 illustrates the identified GPR anomaly areas. A complete discussion of the GPR methods and findings are presented in the GeoView report in the Appendix. The geophysical results were discussed during a progress meeting with GRU and consultant representatives on September 1, 2020. The following has been taken directly from the GeoView report and slightly edited for the purpose of this discussion.

Results of the GPR survey indicated the presence of a well-defined, highly variable set of GPR reflectors at an approximate depth range of 2 to 12 feet bls. The reflector set is associated with the lithological contact between the surficial sand stratum and underlying clayey sediments or weathered limestone.

The GPR data observed a high degree of variability in the depth of the reflector set. This variability is characteristic of a highly weathered epi-karst terrain common to this area. The majority of the variability in epi-karst terrain can be attributed to surficial erosion of the limestone surface rather than settlement due to an underlying void or cavity.

Thirty-one (31) GPR suspected karst features were identified at the project site. Anomalies 32 and 33 were classified as "Level A" anomalies and the remainder were classified as "Level B" anomalies.

The Level A anomalies were characterized by a downwarping of approximately 5 to 10 feet toward a common center. In addition, a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. These represent the more pronounced GPR features identified.

The Level B anomalies were characterized by a moderate downwarping of 1 to 5 feet toward a common center and/or a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. Type B anomalies were observed in the upper 5 to 10 feet of the soils and do not appear to continue with depth. These anomalies are more likely associated with surficial weathering or erosional activities characteristic of epi-karst terrain rather than sinkhole activity.

It is noted that additional minor and small features may be present between the transects that would not be observed by the GPR data.

4.3 SPT Boring Results

Five (5) SPT borings were performed at the site. The SPT boring locations are illustrated on Figure 2. The boring locations were selected considering the findings of the GPR results, site topography, and to provide for a general spatial coverage across the site. The actual locations were selected by GeoView and GSE with input from GRU and consultant representatives. The intent of the borings was to further explore potential sinkhole activity identified by the GPR survey and provide for characterization of the site soils. The SPT borings logs summarizing the results are provided in Section 6.1.

The borings indicate the soil conditions across the site are variable. The borings generally encountered a sandy layer of poorly graded sand, sand with clay, sand with silt, and silty sand (SP, SP-SC, SP-SM, SM) to depths ranging from 7.5 to 53.5 feet bls. This was underlain by clayey to very clayey sand (SC, SC/CL) and interbedded strata of clay-rich soils consisting of sandy clay, clay with sand, and clay (CL/CH) to the limestone formation.

With one exception, the limestone formation was encountered starting at depths ranging from 17.5 to 57.5 feet bls. The exception was B-25, where the limestone was presumed to be encountered at a depth of 97 feet bls. Drilling and driving refusal conditions were encountered at this depth with no sample recover. The refusal material is expected to represent the limestone formation. This depth is relatively consistent with boring B-4 performed on the order of 300+ feet to the southeast on the adjoining 63+ acre site where limestone was encountered at 93 feet bls.

The poorly graded sand, sand with clay, sand with silt, and silty sand (SP, SP-SC, SP-SM, SM) ranged from very loose to dense conditions with N-values ranging from 0 to 43 blows per foot. The underlying clayey to very clayey sand (SC, SC/CL) are generally in a very loose to dense condition with N-values ranging from 4 to 38 blows per foot. The clay-rich soils (CL/CH) are generally in a very soft to very stiff condition with N-values ranging from 1 to 29 blows per foot. The limestone ranged from very soft to very hard with N-values ranging from 1 to 68 blows per foot.

Weight-of-rod (WOR) strength materials were encountered at boring location B-24 at depths ranging from approximately 8.5 to 23 feet bls. This was accompanied by loss of drilling fluid circulation during the entire boring advancement. Weight-of-hammer (WOH) strength materials were encountered at B-25 at depths ranging from approximately 64 to 65 feet bls. This was accompanied by loss of drilling fluid circulation at a depth of approximately 52 feet bls. The drilling fluid circulation loss occurred within the unconsolidated portion of the boring profile.

Losses of drilling fluid circulation occurred within B-22 at a depth of approximately17.5 feet bls, B-23 at a depth of approximately 58.5 feet bls, and B-26 at a depth of approximately 36 feet bls. These drilling fluid circulation losses occurred at the transition into or within the limestone formation.

The water table was encountered in two of the SPT borings at depths of 34 and 35 feet bls at the time of drilling. This is generally consistent with the water table depths recorded in the piezometers on the adjacent 63+ acre site. This groundwater level represents the Floridan Aquifer.

4.4 Laboratory Soil Analysis

Selected soil samples recovered from the soil borings were analyzed for natural moisture content, the percent fines passing the No. 200 sieve, and Atterberg Limits. Selected soil samples were collected from depths ranging from 13.5 to 65 feet bls. These tests were performed to confirm visual soil classification and evaluate their engineering properties. The complete laboratory report is provided in Section 6.2.

Laboratory tests were conducted on soil samples consisting of silty sand, very clayey sand, sandy clay, and clay. The tested silty sand (SM) contained 22 percent soil fines passing the No. 200 sieve with a natural moisture content of 26 percent.

The tested clay (CL/CH) contained 95 percent soil fines passing the No. 200 sieve with a natural moisture content of 52 percent.

The tested very clayey sand (SC/CL) contained 35 percent soil fines passing the No. 200 sieve with a natural moisture content of 42 percent. Atterberg Limits tests indicate the very clayey sand (SC/CL) has a Liquid Limit (LL) value of 44, Plastic Limit (PL) value of 18, and Plasticity Index (PI) value of 26. This corresponds to a material with low ($LL < 50$ and $PI < 25$) to marginal ($50 \leq LL \leq 60$ and $25 \leq PI \leq 35$) potential for expansive behavior[8]. The natural moisture content was 2 percent below the LL for this sample.

The tested sandy clay (CL/CH) contained 67 percent soil fines passing the No. 200 sieve with a natural moisture content of 44 percent. The sandy clay (CL/CH) has a LL value of 85, PL value of 26, and PI value of 59. This corresponds to a material with high ($LL > 60$ and $PI > 35$) potential for expansive behavior. The natural moisture content is well within the PL range.

[8] U.S. Department of the Army USA, 1983, Foundations in Expansive Soils, TM 5-818-7, p. 4-1.

5.0 SINKHOLE SUSCEPTIBILITY EVALUATION

5.1 General

The following evaluation considers the GPR geophysical survey, SPT soil borings and laboratory test data, and experience with similar sites and subsurface conditions. In this section of the report, we present our evaluations as it relates to sinkhole potential for the site.

5.2 Area Sinkhole Development Potential

Geologically, the site is located in the central-western portion of Alachua County within the Ocala Limestone regional geology. This area of Alachua County is referred to as the Coastal lowlands, which is typically highly karstic and has a higher risk for sinkhole activity compared to other areas of the County.

Site development and drainage improvement are the most common contributing causes of sinkholes in Alachua County. With that said, sinkholes also develop in undeveloped areas. Sinkholes most commonly occur in areas where large amounts of water are diverted, held, and allowed to infiltrate. Sinkholes generally result from the erosion of sandy soils through cracks in the clay and limestone as a result of surface water infiltration.

Sinkholes in this area develop with most frequency within storm water management facilities (SWMF). This can be attributed to the storage and infiltration of large volumes of water in concentrated areas, where historically, this condition did not exist. Furthermore, excavation of the soils as part of SWMF construction often exposes or approaches pinnacles within the underlying limestone formation, making them more prone to sinkhole development.

GSE has experience with sinkholes in western Alachua County including the adjacent subject area. This includes sinkholes that have occurred within +/- 1 mile of the site. GSE has evaluated and assisted with remediation of sinkholes.

Many of the sinkholes that have developed are chimney type features. These are typically 10 feet in diameter and less than 5 to 15 feet deep. These chimney features typically have a relatively small diameter solution channel (sockets) within the limestone formation that occurs within the upper 5 to 10 feet.

There are also cases of larger sinkholes having developed on the order of 30+ feet in diameter and 25+ feet deep. In these cases, pinnacled portions of the limestone formation are often observed near the ground surface but the openings and fissures that allowed the soil to collapse within the formation occur at the deeper depths.

5.3 Evaluation of GPR and SPT Soil Boring Findings

The GPR survey identified multiple anomaly areas. This is expected for the area of the subject site. The identified GPR anomalies are illustrated on Figure 2. For context, the identified geophysical survey anomaly areas and SPT boring locations on the adjoining 63+ acre site are also shown on Figure 2.

Two more pronounced and well-defined GPR anomalies were identified as Level A features. As previously described (Section 4.2), the Level A anomalies were characterized by a downwarping of approximately 5 to 10 feet toward a common center. In addition, a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed.

Two SPT borings were advanced in the center of these features (B-22 & B-24), and one SPT (B-26) was advanced in the same anomaly approximately 30 feet west of the center. The two borings (B-22 & B-26) in GPR Anomaly Area No. 33 (Figure 2) were advanced to investigate two independent apparent "downwarping" areas within this anomaly.

Multiple less pronounced Level B GPR anomalies were also identified across the site. The Level B anomalies were characterized by a moderate downwarping of 1 to 5 feet toward a common center and/or a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. Type B anomalies do not appear to continue with depth, and are more likely associated with surficial weathering or erosional activities characteristic of epi-karst terrain rather than sinkhole activity. SPT borings were not advanced within these less prominent features as part of this evaluation.

One soil boring (SPT-25) was performed within a topographic closed depressional area. This boring was selected to explore the depression. One boring (B-23) was advanced between the two Level A GPR anomalies. The intent of this boring placement was to characterize subsurface conditions outside of the Level A and depressional feature areas and for comparison purposes.

The SPT borings encountered soil and rock conditions consistent with this area of western Alachua County. The borings generally encountered a sandy layer of poorly graded sand, sand with clay, sand with silt, and silty sand (SP, SP-SC, SP-SM, SM) underlain by clayey to very clayey sand (SC, SC/CL) with interbedded strata of sandy clay, clay with sand, and clay (CL/CH) to the limestone formation. Conditions encountered by individual borings are summarized below.

SPT B-24 was performed within Level A GPR Anomaly No. 32 (Figure 2). Very loose sand with silt and sand with clay (SP-SM, SP-SC) was penetrated from the ground surface to 28.5 feet bls. This was underlain by medium dense very clayey sand (SC/CL) overlying very soft to soft sandy clay (CL/CH) to a depth of 39.5 feet bls. Very soft to very hard limestone was then penetrated to terminated at 58.8 feet bls in limestone. WOR events were recorded from 8.5 to 23 feet bls within the sand with silt. The depth to groundwater was not recorded. Drilling fluid circulation loss occurred at the ground surface and throughout advancement of the boring to the termination depth. The observed loss of soil strength with depth accompanied by a drilling fluid circulation loss is indicative of sinkhole activity.

Boring B-25 was conducted within a closed depressional area (Figure 2). The boring penetrated sand with silt (SP-SM) overlying interbedded strata of sand with clay, clayey to very clayey sand, and clay-rich soils (SP-SC, SC, SC/CL, CL/CH) to 63.5 feet bls. This was underlain by silty sand (SM) to the termination depth of 97 feet bls. The boring was terminated due to drilling and split spoon hammer refusal. A loss of drilling fluid circulation occurred at 52 feet bls. WOH strength soil was encountered from 64 to 65 feet bls within the silty sand (SM). The near Ocala limestone formation appeared absent at this location with underlying limestone formation being encountered at approximately 97 feet bls. The depth to groundwater was recorded at 34 feet bls.

The B-25 boring profile is indicative of a paleosink (ancient relic infilled feature). The overall strength pattern and loss of drilling fluid circulation in the unconsolidated portion of the soil profile suggests it may be an active feature. The presence of the surface depressional expression provides further evidence of the condition encountered is associated with sinkhole activity.

Boring B-22 was performed within another of the prominent Level A GPR Anomaly Area No 33 (Figure 2). Very loose to loose sand with silt (SP-SM) was penetrated to 13.5 feet underlain by clay (CL/CH) to 17.5 feet bls. This was underlain by limestone to 30 feet bls. A loss of drilling fluid circulation occurred within the limestone formation at 17.5 feet bls. No WOH or WOR events were recorded. The depth to groundwater was not recorded.

Boring B-26 was conducted within the same Level A GPR anomaly as B-22. Very loose to medium dense sand with silt and silty sand (SP-SM, SM) was penetrated to 34.5 feet underlain by firm clay with sand (CL/CH) to 36 feet bls. Limestone was then encountered to the 39.8 feet boring termination depth. Loss of drilling fluid circulation was recorded at 36 feet. The depth to groundwater was not recorded.

No indications of sinkhole activity were encountered within boring B-26. The loss of drilling fluid circulation is expected and associated with epikarst and porous nature of the limestone.

Boring B-23 was conducted in an area not within a Level A GPR anomaly. Very loose to loose sand with silt (SP-SM) was encountered to a depth of 7.5 feet bls overlying clayey sand (SC) to a depth of 13 feet bls. This was underlain by medium dense silty sand (SM) to a depth of 53.5 feet bls overlying firm clay with sand (CL/CH) to the top of limestone at 57.5 feet bls. Loss of drilling fluid circulation was recorded at 58.5 feet bls within the limestone. No WOR or WOH events were recorded. The depth to groundwater was recorded at 35 feet bls.

The overall soil strength patterns of B-22, B-23 and B-26 are not indicative of sinkhole activity. The losses of drilling fluid circulation is expected and associated with epikarst and porous nature of the limestone.

5.4 Groundwater

Groundwater table measurements in the borings at the time of our exploration identified groundwater at depths ranging between 34 to 35 feet bls. The measured groundwater is interpreted as the potentiometric surface of the Floridan Aquifer.

It is expected that groundwater will temporarily perch on top of the clay rich soils after periods of heavy prolonged and seasonal rainfall. The temporarily perched groundwater should be expected, especially if excavations are made into the clay rich soils that result in a “bowl” or “swimming pool” type effect. Construction of on-site wetlands could result in perched groundwater in some areas where underlining confining soils are more continuous on-site, and needs to be considered as part of the design.

5.5 Subject Site Sinkhole Development Potential

Overall, the limestone formation was encountered slightly deeper than expected for this area of the County. With this said, the depth to limestone is expected to vary abruptly within very short lateral distances. That is function of the pinnacle and erosional characteristics of the Ocala limestone formation in this area of the County. The SPT borings confirmed the limestone formation strength varies between very soft to very hard. This variability in strength is expected, and partially attributed to variability in limestone weathering and presence of voids within the formation.

Epikarst represents the geological transition from the unconsolidated to the underlying rock formation. This transition zone often displays weaker soil/rock conditions accompanied by drilling fluid circulation losses. Loss of drilling fluid circulation was recorded in each of the borings performed at this site. Loss of soil strength within the epikarst portion of the boring profiles was identified in borings B-22 and B-23. These represent expected and typical conditions at this transition, and in and of itself are not an indicator of sinkhole activity. The conditions encountered within the epikarst are evaluated and considered in overall boring material strength encountered above and below this section of the individual boring profiles.

Low strength materials (WOH or WOR) were encountered within the unconsolidated soils overlying the limestone formation in borings B-24 and B-25 from approximately 8.5 to 23 feet bls and 64 to 65 feet bls, respectively. These low strength materials were accompanied by drilling fluid circulation losses within the unconsolidated portion of the profile. Sinkhole activity was identified by boring B-24. A possibly active in-filled paleosink condition was identified at boring B-25.

Boring B-24 represents a location where a cover collapse or chimney type sinkhole could potentially occur. GSE revisited the site 2 to 3 weeks following the boring having been completed to observe the area. No surface expression (subsidence or depression) was readily apparent in the area before or after the boring having been completed.

Although ground cover collapse or an observable depression in the ground surface was not identified, the loss of sandy soil strength with depth and drilling fluid circulation loss in the unconsolidated portion of the profile indicates there remains potential for a future sinkhole collapse to occur. There is no way to predict if or when such collapse may occur, but rather that a potential exists that is considered more probable than other areas where such conditions are absent. Considering the depth to limestone, if a cover collapse or chimney sinkhole developed it would probably be on the order of 20 to 50 feet in diameter.

The sinkhole indicators in the profile of boring B-25 are present, but less prominent as compared to B-24. The boring profile is interpreted as an infilled paleosink feature similar to that encountered by the non-active paleosink identified by B-4 on the larger adjoining 63+ acre site. However, the overall reduction in soil strength with depth accompanied with the loss of drilling fluid circulation in B-25 suggests this feature may be active.

5.6 Comparison of the 12+ and 63+ Acre Sites

A more comprehensive study of the adjoining 63+ acre site was conducted (GSE Report No. 14588). The investigation included GPR and ERI surveys, SPT borings, auger borings, and installing piezometers. Twenty-one (21) SPT borings were spread out across the 63+ acre site. The majority of the SPT borings targeted Level A GPR and ERI anomalies, while several were performed in areas where no anomalies were encountered in order to compare findings and gain an understanding of general site conditions.

With exception of SPT borings B-24 and B-25, the SPT borings on the 12+ acre site encountered similar conditions to the 63+ acre site. Borings B-24 and B-25 were determined to have indications of sinkhole activity. No indications of sinkhole activity were identified on the 63+ acre site. Additionally, a closed depression with indications of sinkhole activity (B-25) was identified on the 12+ acre parcel.

With the noted exception of further evaluating and as needed addressing the identified sinkhole activity, the recommendations outlined for the 63+ acre site remain applicable to the 12+ acre parcel. The scope of the additional investigation of the 12+ acre site will need to be considered as part of and during the proposed constructed wetland design process.

It is expected that upon further subsurface characterization and evaluation of the conditions encountered in the areas of B-24 and B-25, that these can be incorporated into and addressed by the design to allow for construction of wetlands on the combined 75+ acre site. Prior to further characterization of the area of B-24, due to the potential for a perceived potential for a collapse to occur, access to this area should be restricted until such time that further characterization is conducted.

6.0 FIELD DATA

6.1 Standard Penetration Test (SPT) Boring Logs

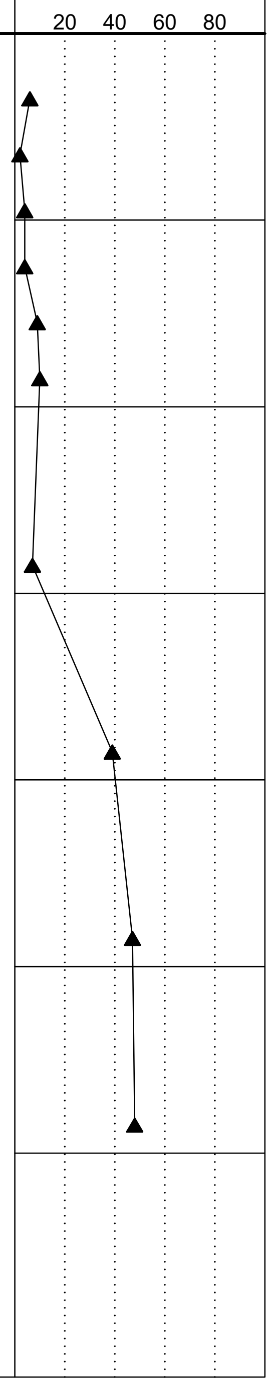
GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

BORING NUMBER B-22

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition
PROJECT NUMBER 14588A
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 9/10/02 **COMPLETED** 9/10/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NE
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH NA
NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Gray SAND with silt	0.5							
	(SP-SM) Very loose to loose brown SAND with silt		SPT 1	3-3-3 (6)					
			SPT 2	2-1-1 (2)					
5			SPT 3	1-2-2 (4)					
			SPT 4	2-2-2 (4)					
			SPT 5	4-4-5 (9)					
10			SPT 6	5-4-6 (10)					
		13.5							
15	(CL/CH) Firm brown and orange CLAY		SPT 7	3-3-4 (7)				95	52
		17.5							
	Hard LIMESTONE								
20	*Loss of circulation at 17'-6"*		SPT 8	11-15-24 (39)					
25			SPT 9	29-22-25 (47)					
	Circulation returned at 26'-0"								
30		30	SPT 10	23-20-28 (48)					
	Bottom of borehole at 30.0 feet.								

▲ SPT N VALUE ▲



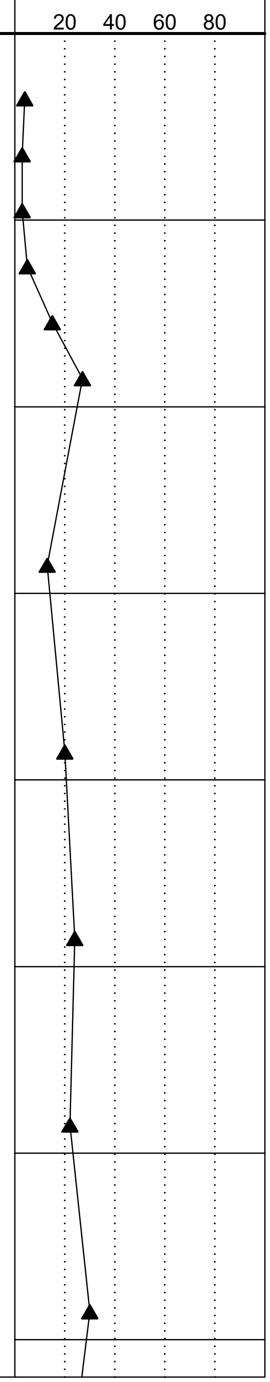
GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

BORING NUMBER B-23

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition
PROJECT NUMBER 14588A
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 9/10/02 **COMPLETED** 9/10/20
GROUND ELEVATION ______ **HOLE SIZE** ______
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING 35.0 ft
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH NA
NOTES ______

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose brown SAND with silt								
			SPT 1	3-2-2 (4)					
			SPT 2	2-2-1 (3)					
5		5	SPT 3	2-2-1 (3)					
	(SP-SM) Very loose to loose pale gray and brown SAND with silt		SPT 4	2-2-3 (5)					
		7.5	SPT 5	5-7-8 (15)					
	(SC) Medium dense brown, orange and gray clayey SAND		SPT 6	10-12-15 (27)					
10									
		13							
	(SM) Medium dense brown silty SAND		SPT 7	5-6-7 (13)					
15									
			SPT 8	7-8-12 (20)					
20									
			SPT 9	8-12-12 (24)					
25									
			SPT 10	8-11-11 (22)					
30									
		33.5							
	(SM) Loose to medium dense pale gray and brown silty SAND		SPT 11	13-13-17 (30)					
35									

▲ SPT N VALUE ▲



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GSE Engineering & Consulting, Inc.
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Telephone: (352)377-3233
Fax: (352)377-0335

BORING NUMBER B-23

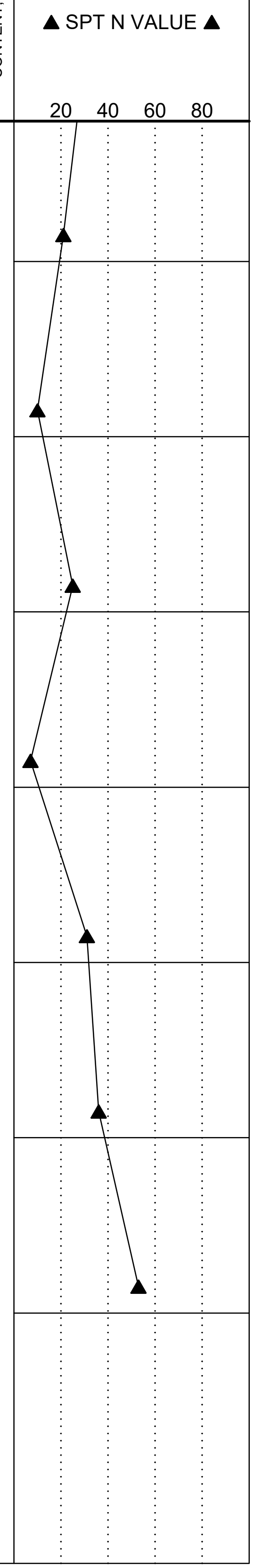
CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition

PROJECT NUMBER 14588A

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
		(SM) Loose to medium dense pale gray and brown silty SAND *(continued)*								
40				SPT 12	10-10-11 (21)					
45				SPT 13	8-5-5 (10)					
50				SPT 14	11-15-10 (25)					
		(CL/CH) Firm brown, gray and orange CLAY with sand	53.5	SPT 15	2-3-4 (7)					
55										
		Moderately hard to hard LIMESTONE *Loss of circulation at 58'-6"*	57.5							
60				SPT 16	19-14-17 (31)					
65				SPT 17	15-15-21 (36)					
70			70	SPT 18	18-23-30 (53)					
		Bottom of borehole at 70.0 feet.								



BORING NUMBER B-24

GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition
PROJECT NUMBER 14588A
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 9/11/20 **COMPLETED** 9/11/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING NE
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH NA
NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose brown and gray SAND with silt *Started drilling with no circulation*								
			SPT 1	2-2-2 (4)					
			SPT 2	2-2-2 (4)					
5			SPT 3	2-1-2 (3)					
			SPT 4	1-1-1 (2)					
			SPT 5	1-1-1 (2)					
	Weight of rod from 8'-6" to 23'-0"		SPT 6	0-0-0 (0)					
10									
15			SPT 7	0-0-0 (0)					
20	*No recovery*		SPT 8	0-0-0 (0)					
	(SP-SC) Very loose brown and orange SAND with clay *No recovery*	23							
25			SPT 9	1-1-1 (2)					
	(SC/CL) Medium dense brown and orange very clayey SAND	28.5							
30			SPT 10	3-6-6 (12)					
	(CL/CH) Very soft to soft brown and orange sandy CLAY	33.5							
35			SPT 11	2-2-2 (4)	85	26	59	67	44

▲ SPT N VALUE ▲ (20 40 60 80)

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GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

BORING NUMBER B-24

CLIENT Gainesville Regional Utilities

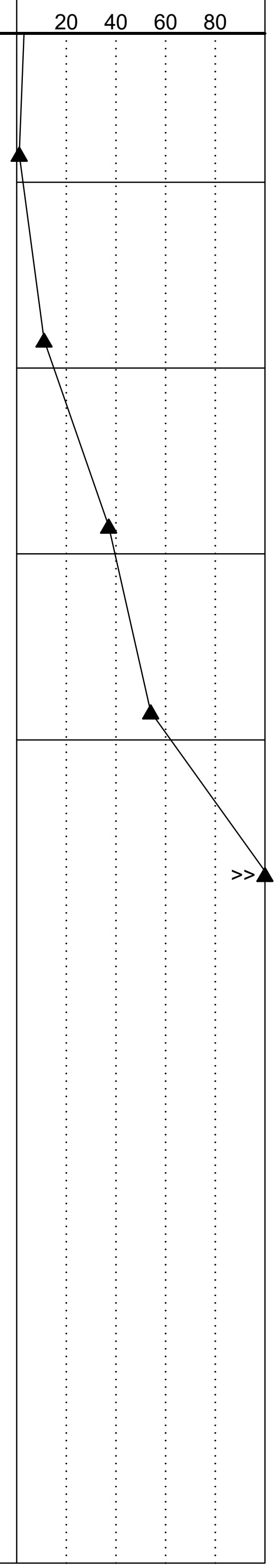
PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition

PROJECT NUMBER 14588A

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
		(CL/CH) Very soft to soft brown and orange sandy CLAY *(continued)*								
40			39.5	SPT 12	2-1-0 (1)					
		Very soft to very hard LIMESTONE								
45				SPT 13	5-5-6 (11)					
50				SPT 14	19-17-20 (37)					
55				SPT 15	21-29-25 (54)					
			58.75	SPT 16	50/3"					
		Bottom of borehole at 58.8 feet.								

▲ SPT N VALUE ▲

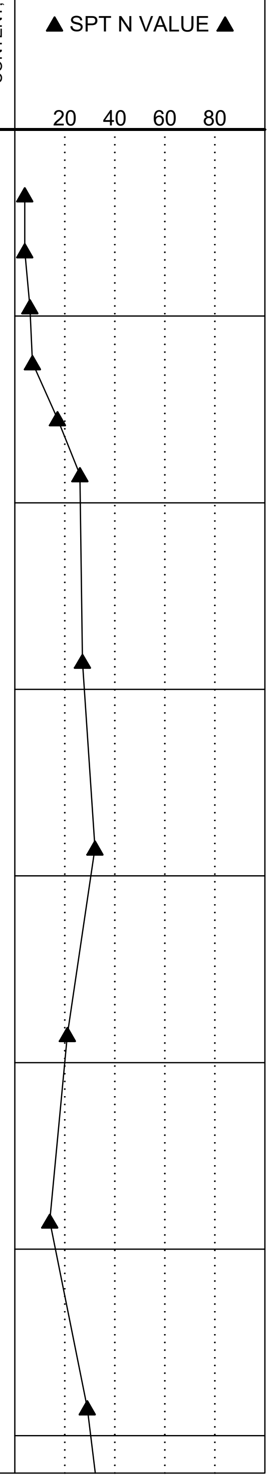


GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

BORING NUMBER B-25

CLIENT Gainesville Regional Utilities
PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition
PROJECT NUMBER 14588A
PROJECT LOCATION Gainesville, Alachua County, Florida
DATE STARTED 9/11/20 **COMPLETED** 9/11/20
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR Whitaker Drilling, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING 34.0 ft
LOGGED BY WDI **CHECKED BY** KPF
ESTIMATED SEASONAL HIGH NA
NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose to loose brown SAND with silt		SPT 1	2-2-2 (4)					
			SPT 2	2-2-2 (4)					
5	(SP-SM) Loose to medium dense pale brown SAND with silt	4.5	SPT 3	2-3-3 (6)					
			SPT 4	3-4-3 (7)					
	(SC) Medium dense brown, gray and orange clayey SAND	7.5	SPT 5	5-7-10 (17)					
10			SPT 6	10-11-15 (26)					
15	(SP-SC) Medium dense brown and gray SAND with clay	13.5	SPT 7	10-13-14 (27)					
20	(SC) Dense brown and orange clayey SAND	18.5	SPT 8	10-14-18 (32)					
25	(CL/CH) Stiff to very stiff gray, brown and green CLAY with sand	23.5	SPT 9	5-9-12 (21)					
30			SPT 10	3-5-9 (14)					
35			SPT 11	10-13-16 (29)					



(Continued Next Page)

GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

BORING NUMBER B-25

CLIENT Gainesville Regional Utilities

PROJECT NUMBER 14588A

PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
	(CL/CH) Stiff to very stiff gray, brown and green CLAY with sand *(continued)*	38.5							
40	(SC) Loose to dense brown and gray clayey SAND		SPT 12	11-19-19 (38)					
45			SPT 13	6-7-9 (16)					
50			SPT 14	4-5-5 (10)					
	Loss of circulation at 52'-0"	53.5							
55	(SC/CL) Very loose to loose brown and gray very clayey SAND		SPT 15	2-2-3 (5)					
60			SPT 16	2-2-2 (4)	44	18	26	35	42
		63.5							
65	(SM) Very loose gray silty SAND *Weight of hammer from 64 to 65 ft*		SPT 17	2-0-0 (0)				22	26
		68.5							
70	(SM) Loose brown and orange silty SAND		SPT 18	3-4-3 (7)					
75			SPT 19	3-3-3 (6)					

▲ SPT N VALUE ▲ (20, 40, 60, 80)

(Continued Next Page)

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Telephone: (352)377-3233
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BORING NUMBER B-25

CLIENT Gainesville Regional Utilities

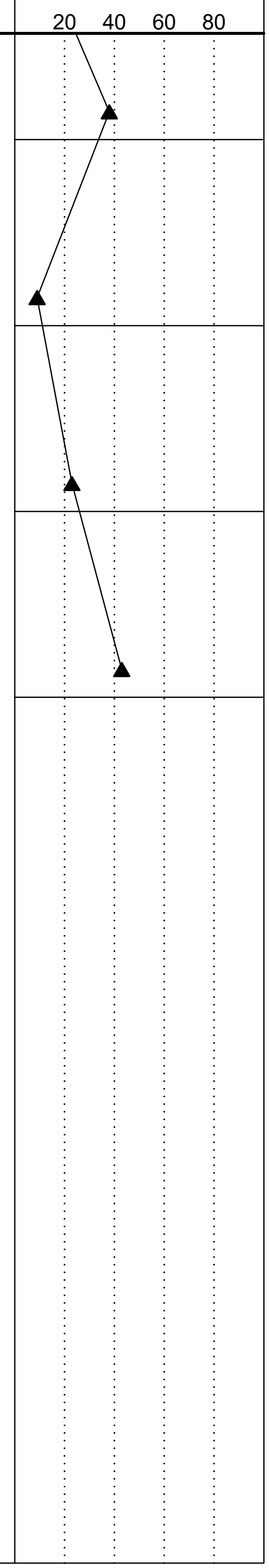
PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition

PROJECT NUMBER 14588A

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
		(SM) Loose brown and orange silty SAND *(continued)*	78.5							
80		(SM) Dense pale brown silty SAND		SPT 20	14-15-23 (38)					
			83.5							
85		(SM) Loose pale brown and orange silty SAND		SPT 21	3-5-4 (9)					
			88.5							
90		(SM) Medium dense gray silty SAND		SPT 22	4-6-17 (23)					
			93.5							
95		(SM) Dense dark gray silty SAND		SPT 23	11-20-23 (43)					
			97							

▲ SPT N VALUE ▲



Bottom of borehole at 97.0 feet.
Boring terminated due to drill and hammer refusal

GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

BORING NUMBER B-26

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition

PROJECT NUMBER 14588A

PROJECT LOCATION Gainesville, Alachua County, Florida

DATE STARTED 9/14/02 **COMPLETED** 9/14/02

GROUND ELEVATION **HOLE SIZE**

DRILLING CONTRACTOR Whitaker Drilling, Inc.

GROUND WATER LEVELS:

DRILLING METHOD Mud Rotary

AT TIME OF DRILLING NE

LOGGED BY WDI **CHECKED BY** KPF

ESTIMATED SEASONAL HIGH NA

NOTES

DEPTH (ft)	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %
0	(SP-SM) Very loose brown SAND with silt								
			SPT 1	3-2-2 (4)					
			SPT 2	2-2-2 (4)					
5	(SP-SM) Very loose to loose pale brown and gray SAND with silt	5	SPT 3	1-2-2 (4)					
			SPT 4	2-3-3 (6)					
	(SP-SM) Loose brown and orange SAND with silt	7.5	SPT 5	3-4-3 (7)					
10			SPT 6	3-4-3 (7)					
15	(SP-SM) Medium dense pale brown and gray SAND with silt	13.5	SPT 7	9-12-15 (27)					
20			SPT 8	10-12-14 (26)					
25	(SM) Loose to medium dense brown and orange silty SAND	23.5	SPT 9	8-11-11 (22)					
30			SPT 10	9-11-11 (22)					
35	(CL/CH) Firm gray and green CLAY with sand	34.5	SPT 11	2-2-3 (5)					

▲ SPT N VALUE ▲ (20, 40, 60, 80)

(Continued Next Page)

BORING NUMBER B-26

GSE Engineering & Consulting, Inc.
5590 SW 64th St.
Gainesville, FL 32608
Telephone: (352)377-3233
Fax: (352)377-0335

CLIENT Gainesville Regional Utilities

PROJECT NAME GRU 63 Acre Wetland Recharge Site - 12Acre Addition

PROJECT NUMBER 14588A

PROJECT LOCATION Gainesville, Alachua County, Florida

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	CONTACT DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	PERCENT PASS NO. 200 SIEVE	MOISTURE CONTENT, %	▲ SPT N VALUE ▲ (20 40 60 80)
		Very hard LIMESTONE *Loss of circulation at 36'-0"*	36								
			39.75	SPT 12	10-18-50/3" 68/9"						>>
		Bottom of borehole at 39.8 feet. *Boring terminated due to drill and hammer refusal*									

6.2 Laboratory Results

GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF LABORATORY TEST RESULTS

Project Number: 14588A

Project Name: GRU 12+ Acre Parcel Wetland Park

Boring Number	Depth (ft)	Soil Description	Natural Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Organic Content (%)	Hydraulic Conductivity (ft/day)	Unified Soil Classification
B-22	13.5-15	Firm brown and orange CLAY	52				95			CL/CH
B-24	33.5-35	Very soft to soft brown and orange sandy CLAY	44	85	26	59	67			CL/CH
B-25	58.5-60	Very loose to loose brown and gray very clayey SAND	42	44	18	26	35			SC/CL
B-25	63.5-65	Very loose gray silty SAND	26				22			SM

6.3 Key to Soil Classification

KEY TO SOIL CLASSIFICATION CHART

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests				SYMBOLS		GROUP NAME
				GRAPHIC	LETTER	
COARSE-GRAINED SOILS	Gravels	Clean Gravels	$Cu \geq 4$ and $1 \leq Cc \leq 3$		**GW**	Well graded GRAVEL
More than 50% retained on No. 200 sieve	More than 50% of coarse fraction retained on No. 4 sieve	Less than 5% fines	$Cu < 4$ and/or $1 > Cc > 3$		**GP**	Poorly graded GRAVEL
		Gravels with fines	Fines classify as ML or MH		**GM**	Silty GRAVEL
		More than 12% fines	Fines classify as CL or CH		**GC**	Clayey GRAVEL
	Sands	Clean Sands	$Cu \geq 6$ and $1 \leq Cc \leq 3$		**SW**	Well graded SAND
	50% or more of coarse fraction passes No. 4 sieve	Less than 5% fines	$Cu < 6$ and/or $1 > Cc > 3$		**SP**	Poorly graded SAND
		Sand with fines	Fines classify as ML or MH		**SP-SM**	SAND with silt
		$5\% \leq$ fines $< 12\%$	Fines classify as CL or CH		**SP-SC**	SAND with clay
		Sand with fines	Fines classify as ML or MH		**SM**	Silty SAND
		$12\% \leq$ fines $< 30\%$	Fines classify as CL or CH		**SC**	Clayey SAND
		Sand with fines	Fines classify as ML or MH		**SM**	Very silty SAND
		30% fines or more	Fines classify as CL or CH		**SC**	Very clayey SAND
FINE-GRAINED SOILS	Clays	inorganic	$50\% \leq$ fines $< 70\%$		**CL/CH**	Sandy CLAY
50% or more passes the No. 200 sieve			$70\% \leq$ fines $< 85\%$		**CL/CH**	CLAY with sand
			fines $\geq 85\%$		**CL/CH**	CLAY
	Silts and Clays	inorganic	$PI > 7$ and plots on/above "A" line		**CL**	Lean CLAY
	Liquid Limit less than 50		$PI < 4$ or plots below "A" line		**ML**	SILT
		organic	$\frac{\text{Liquid Limit - oven dried}}{\text{Liquid Limit - not dried}} < 0.75$		**OL**	Organic clay Organic silt
	Silts and Clays	inorganic	PI plots on or above "A" line		**CH**	Fat CLAY
	Liquid Limit 50 or more		PI plots below "A" line		**MH**	Elastic SILT
		organic	$\frac{\text{Liquid Limit - oven dried}}{\text{Liquid Limit - not dried}} < 0.75$		**OH**	Organic clay Organic silt
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor				**PT**	PEAT

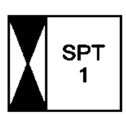
CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	No. OF BLOWS, N	RELATIVE DENSITY
SANDS:	0 - 4	Very Loose
	5 - 10	Loose
	11 - 30	Medium dense
	31 - 50	Dense
	OVER 50	Very Dense

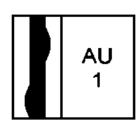
	No. OF BLOWS, N	CONSISTENCY
SILTS & CLAYS:	0 - 2	Very Soft
	3 - 4	Soft
	5 - 8	Firm
	9 - 15	Stiff
	16 - 30	Very Stiff
	31 - 50	Hard
	OVER 50	Very Hard

	No. OF BLOWS, N	RELATIVE DENSITY
LIMESTONE:	0 - 8	Very Soft
	9 - 18	Soft
	19 - 32	Moderately Hard
	33 - 50	Hard
	OVER 50	Very Hard

SAMPLE GRAPHIC TYPE LEGEND



Location of SPT Sample



Location of Auger Sample

PARTICLE SIZE IDENTIFICATION

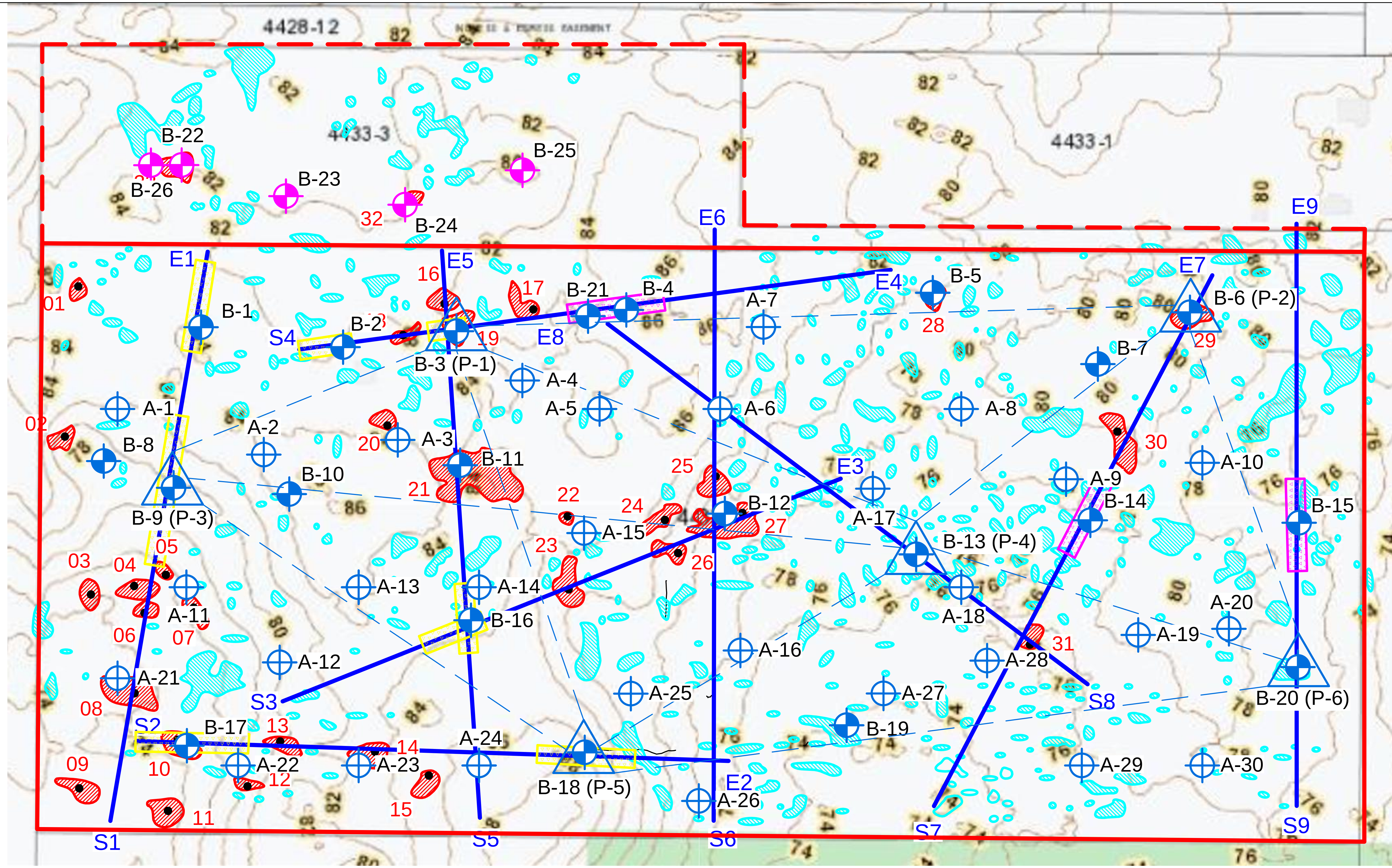
BOULDERS:		Greater than 300 mm
COBBLES:		75 mm to 300 mm
GRAVEL:	Coarse -	19.0 mm to 75 mm
	Fine -	4.75 mm to 19.0 mm
SANDS:	Coarse -	2.00 mm to 4.75 mm
	Medium -	0.425 mm to 2.00 mm
	Fine -	0.075 mm to 0.425 mm
SILTS & CLAYS:		Less than 0.075 mm

LABORATORY TEST LEGEND

LL	=	Liquid Limit, %
PL	=	Plastic Limit, %
PI	=	Plasticity Index, %
% PASS - 200	=	Percent Passing the No. 200 Sieve
MC	=	Moisture Content, %
ORG	=	Organic Content, %
k_h	=	Horizontal Hydraulic Conductivity, ft/day

FIGURES

GRU 12 ACRE PARCEL- WETLAND RECHARGE SITE GAINESVILLE, ALACHUA COUNTY, FLORIDA GSE PROJECT NO. 14588A	PROJECT SITE LOCATION MAP		
	DESIGNED BY: JEG CHECKED BY: KLH DRAWN BY: SCL	GSE Engineering & Consulting, Inc.	FIGURE 1



LEGEND:

- AUGER BORING LOCATIONS
- SPT BORINGS (ORIGINAL)
- SPT BORINGS (NEW)
- PIEZOMETER LOCATIONS
- ERI ANOMALY LEVEL A (MOST SIGNIFICANT)
- ERI ANOMALY LEVEL B (LEAST SIGNIFICANT)
- S2 E2 ERI TRANSECTS WITH START AND END POINTS
- 1 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION
- TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)
- TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)
- ADJOINING SITE BOUNDARY (12+ ACRE PARCEL)
- SITE BOUNDARY (63+ ACRE PARCEL)

NORTH

0 200'

SCALE: 1" = 200' APPROX.

SITE PLAN SHOWING APPROXIMATE LOCATIONS OF FIELD TESTS AND GPR/ERI ANOMALIES

FIGURE 2

GSE Engineering & Consulting, Inc.

DESIGNED BY : JEG
CHECKED BY : JBN
DRAWN BY : SCL

GRU 63 ACRE PARCEL- WETLAND RECHARGE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 14588A

APPENDIX A

DRAFT REPORT
GEOPHYSICAL INVESTIGATION
GRU-PARKER ROAD RECHARGE WETLAND SITE - PHASE 2
ALACHUA COUNTY, FL

Prepared for GSE Engineering & Consulting, Inc.
Gainesville, FL

Prepared by GeoView, Inc.
St. Petersburg, FL

August 31, 2020

Mr. Joakim (Jay) Nordqvist, P.E.
GSE Engineering & Consulting, Inc.
5590 SW 64th Street, Suite B
Gainesville, FL 32608

Subject: Transmittal of Draft Report for Geophysical Investigation
GRU-Parker Road Recharge Wetland Site – Phase 2
Alachua County, FL
GeoView Project Number 31405

Dear Mr. Nordqvist,

GeoView, Inc. (GeoView) is pleased to submit the final report that summarizes and presents the results of the geophysical investigation conducted at the project site. GeoView appreciates the opportunity to have assisted you on this project. If you have any questions or comments about the report, please contact us.

GEOVIEW, INC.

Michael J. Wightman, P.G.
Principal Geophysicist, President
Florida Professional Geologist Number 1423

1.0 Introduction

This study area is approximately 12.5 acres in size and is positioned along the northwest boundary of a previously investigated property for the same project (Figures 1 and 2, Appendix 1). Results from the previous investigation are presented in GeoView Final Report 31405, dated May 27, 2020. As with the previous investigation, this investigation was conducted under the supervision of GSE Engineering and Consulting, Inc. (GSE). A discussion of the field methods used to generate the report figure is provided in Appendix A2.1.

The purpose of the geophysical investigation was to help characterize near-surface geological conditions in the survey area and to identify subsurface features that may be associated with karst (sinkhole) activity. A generalized description of geological conditions underlying the project site are as follows:

- Surficial Sand (SP) Stratum ranging in thickness from 2 to 3 feet (ft).
- Intermittent sandy clay (SC) to clay (CH) with a thickness typically ranging from 2 to 8 ft with localized significant increases in the thickness of the clayey sediments.
- Limestone. Top of limestone is frequently weathered with more competent limestone typically beginning at a depth range of 10 to 25 ft below land surface (bls).

The contact between the surficial sand stratum and underlying clayey sediments/limestone rock is referred to as an epikarst zone. In this zone the clayey sediments and near-surface limestone are highly weathered as a result of multiple periods of submersion, erosion and sub-aerial exposure which have occurred over 10's of millions of years. The surficial sands which overlie the clayey sediments and limestone were recently deposited (within the last 10 to 20 thousand years). Karst-related geological features are quite common within this type of geological setting.

2.0 Description of Geophysical Investigation

The geophysical investigation was performed using ground penetrating radar (GPR). The purpose of the GPR study was to evaluate shallow geological conditions with a focus on the epikarst zone between the surficial sand stratum and underlying limestone and clayey sediments. The GPR investigation was conducted on August 21, 2020. The majority of the site was accessible to the geophysical instrumentation with the exception of large tree clusters and areas with a high concentration of high/dense brush.

The GPR survey was conducted along a series of perpendicular transects spaced approximately 40 ft apart (Figure 1). The configuration of the GPR transects was modified as necessary to accommodate site conditions. The GPR data was collected with a Mala radar system using a 250 MHz antenna and a time range setting of 203 nano-seconds. This equipment configuration provided an average exploration depth of 7 to 15 ft bls.

3.0 Identification of Possible Sinkhole Features Using GPR

The features observed on GPR data that are most commonly associated with sinkhole activity are:

- A downwarping of GPR reflector sets, that are associated with suspected lithological contacts, towards a common center. Such features typically have a bowl or funnel shaped configuration and can be associated with a deflection of overlying sediment horizons caused by the migration of sediments into voids in the underlying limestone. If the GPR reflector sets are sharply downwarping and intersect, they can create a “bow-tie” shaped GPR reflection feature, which often designates the apparent center of the GPR anomaly.
- A localized significant increase in the depth of the penetration and/or amplitude of the GPR signal response. The increase in GPR signal penetration depth or amplitude is often associated with either a localized increase in sand content at depth or decrease in soil density.
- An apparent discontinuity in GPR reflector sets, that are associated with suspected lithological contacts. The apparent discontinuities and/or disruption of the GPR reflector sets may be associated with the downward migration of sediments.

The greater the severity of these features or a combination of these features the greater the likelihood that the identified feature is a sinkhole. It is not possible based on the GPR data alone to determine if an identified feature is a sinkhole or, more important, whether that feature is an active sinkhole.

4.0 Survey Results

Results of the GPR survey indicated the presence of a well-defined, highly variable set of GPR reflectors at an approximate depth range of 2 to 12 ft bls. The reflector set is associated with the lithological contact between the surficial sand stratum and underlying clayey sediments or weathered limestone.

The GPR data observed a high degree of variability in the depth of the reflector set. This variability is characteristic of a highly weathered epi-karst terrain common to this area. The majority of the variability in epi-karst terrain can be attributed to surficial erosion of the limestone surface rather than settlement due to an underlying void or cavity. Accordingly, in order to focus on the areas with the greatest possibility for underlying sinkhole activity, the anomalies were identified based on two categories as described below:

- Type A – Type A anomalies are characterized by a downwarping of approximately 5 to 10 ft toward a common center. In addition, a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. The increase in GPR signal penetration depth or amplitude is often associated with either a localized increase in sand content at depth or decrease in soil density. Such features typically have a bowl or funnel shaped configuration and can be associated with a deflection of overlying sediment horizons caused by the migration of sediments into deeper voids. Based on the GPR data, Type A anomalies have a higher probability of being associated with potential underlying sinkhole activity than Type B anomalies.
- Type B – Type B anomalies are characterized by a moderate downwarping of 1 to 5 ft toward a common center and/or a localized increase in the depth of the penetration and/or amplitude of the GPR signal response is observed. Type B anomalies were observed in the upper 5 to 10 ft of the soils and do not appear to continue with depth. These anomalies are more likely associated with surficial weathering or erosional activities characteristic of epi-karst terrain rather than sinkhole activity.

The GPR survey identified two Type A anomalies and 29 Type B anomalies as shown on Figure 1. The numbering of the Type A GPR anomalies (32 and 33) is a continuation of the numbering from the previous investigation. The distribution of anomalies observed within the study area is comparable to the distribution of anomalies observed in the larger study area to the south (Figure 2). Examples of the GPR data collected across each of the Type A anomalies are provided in Appendix 1. A discussion of the limitations of the GPR technique in geological characterization studies is provided in Appendix 2.

It is not possible, based on the geophysical results to determine whether these identified anomalies have a potential for collapse or subsidence into an underlying void or are associated with surficial erosional processes. It is recommended that further geophysical testing be performed to gather more information regarding the potential for future karst-related geological activity. Table 1 provides the coordinates for the recommended boring locations for the two Type A GPR anomalies. These coordinates were developed using a Trimble GEO-XH global positioning system (GPS) with an accuracy of 1-3 ft. The numbering of the borings (21 and 22) is a continuation from the previous investigation.

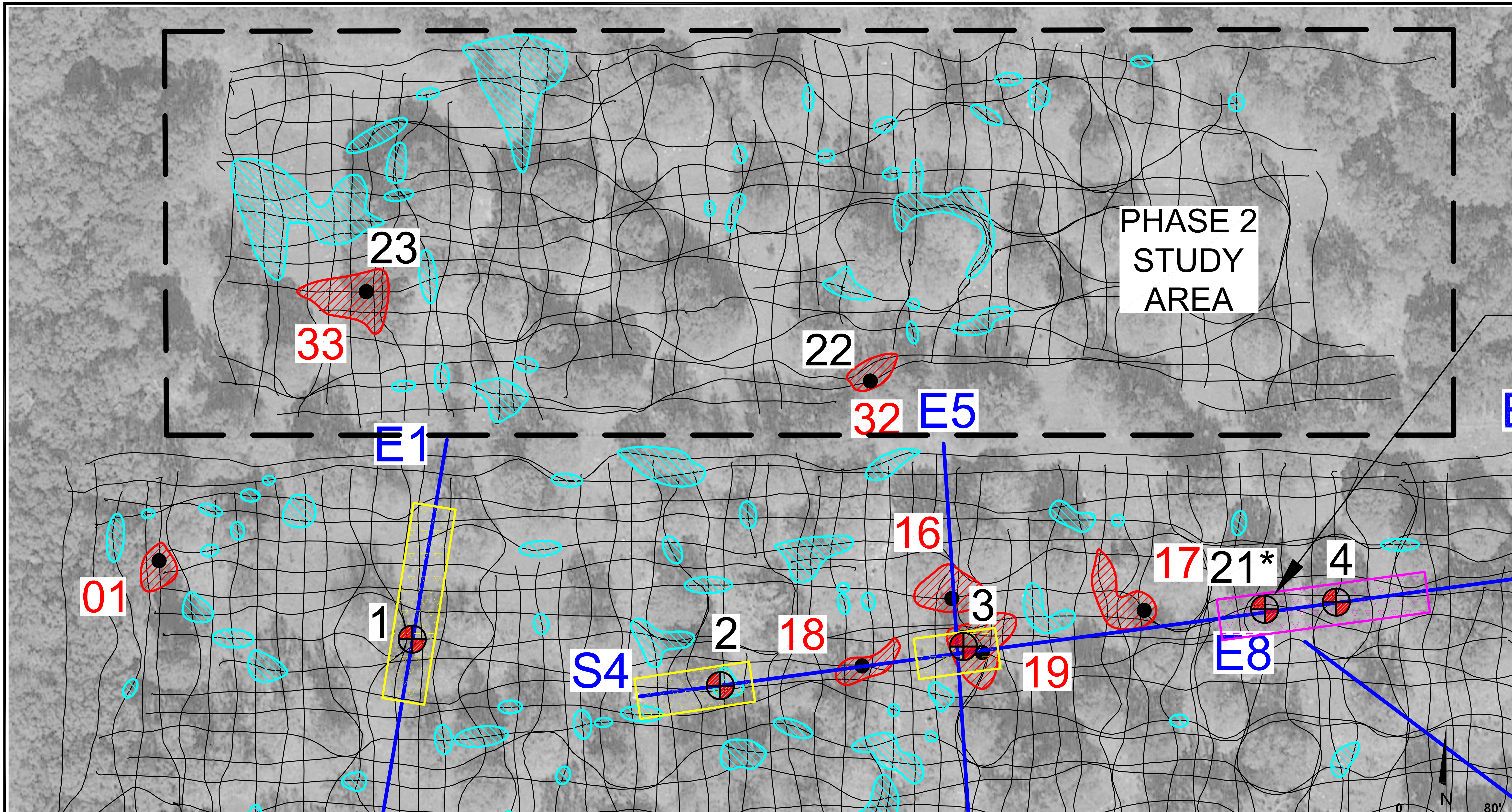
Table 1 – Recommended Geotechnical Boring Locations*

Boring	Northing	Easting	Latitude	Longitude
B22	232147.36	2610695.03	29.62268687	-82.47878527
B23	232223.11	2610265.42	29.62291607	-82.4801329

* US State Plane, Florida West, NAD83 (Conus), Feet

APPENDIX 1

FIGURES AND EXAMPLES OF GPR ANOMALIES



GOOGLE EARTH AERIAL 2020

EXPLANATION

GPR TRANSECTS

TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)

32 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION

TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)

S2 E2 ERI TRANSECTS WITH START AND END POINTS

ERI ANOMALY LEVEL A (MOST SIGNIFICANT)

ERI ANOMALY LEVEL B (MOST SIGNIFICANT)

22 RECOMMENDED TESTING LOCATION WITH DESIGNATION

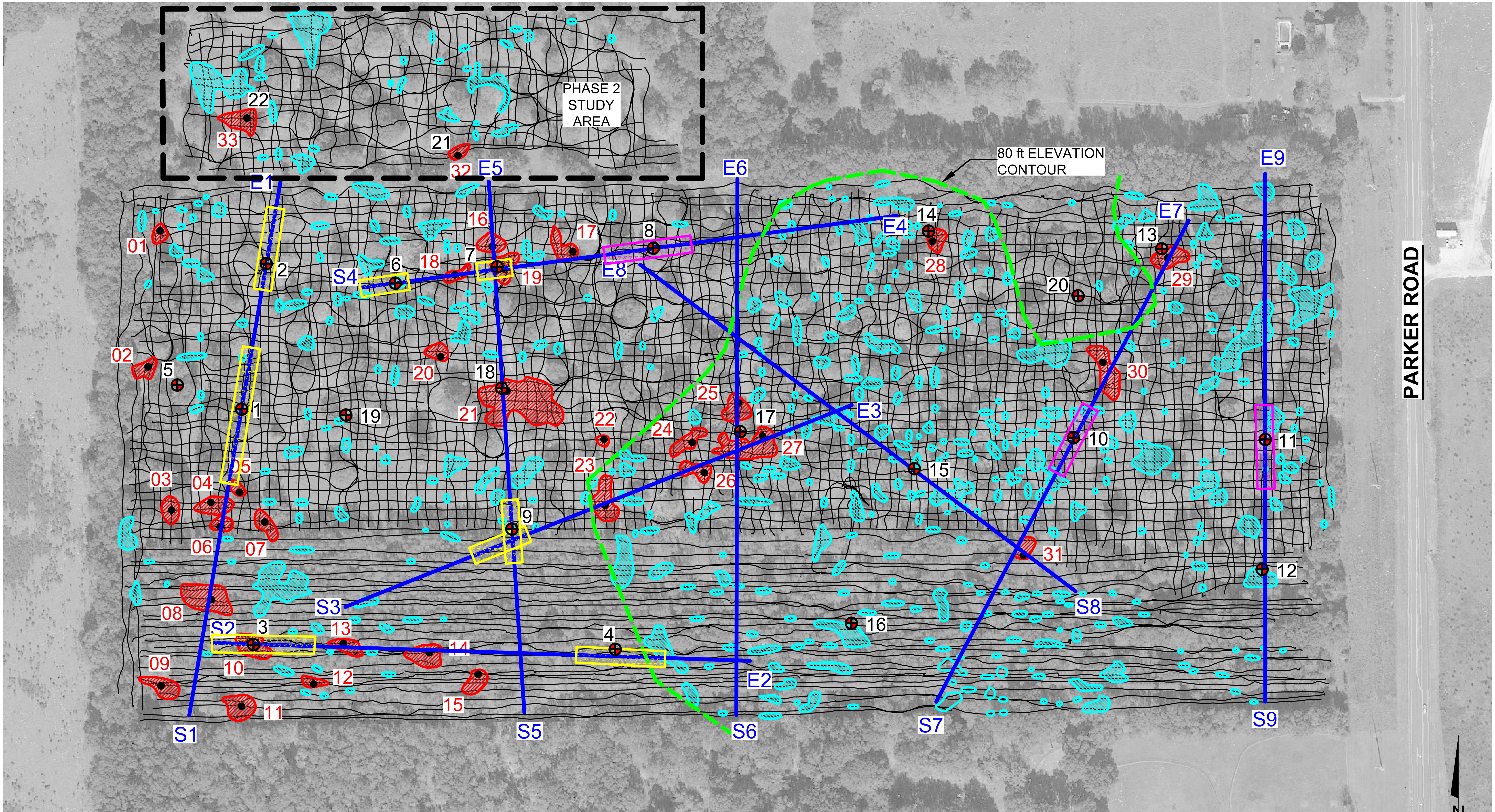
GeoView

FIGURE 1
PHASE 2 SITE MAP SHOWING RESULTS OF GEOPHYSICAL INVESTIGATION AND PROPOSED PHASE 1 ERI TRANSECTS

GRU-PARKER ROAD SITE PHASE 2
RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING & CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405.1
DATE: 08/31/20



GOOGLE EARTH AERIAL 2020

EXPLANATION

- GPR TRANSECTS
- TYPE (A) GPR ANOMALIES (MOST SIGNIFICANT)
- 32 ● TYPE (A) APPARENT CENTER OF ANOMALY WITH DESIGNATION
- TYPE (B) GPR ANOMALIES (LEAST SIGNIFICANT)
- S2 E2 ERI TRANSECTS WITH START AND END POINTS
- ERI ANOMALY LEVEL A (MOST SIGNIFICANT)
- ERI ANOMALY LEVEL B (MOST SIGNIFICANT)
- 21 ⊕ RECOMMENDED TESTING LOCATION WITH DESIGNATION

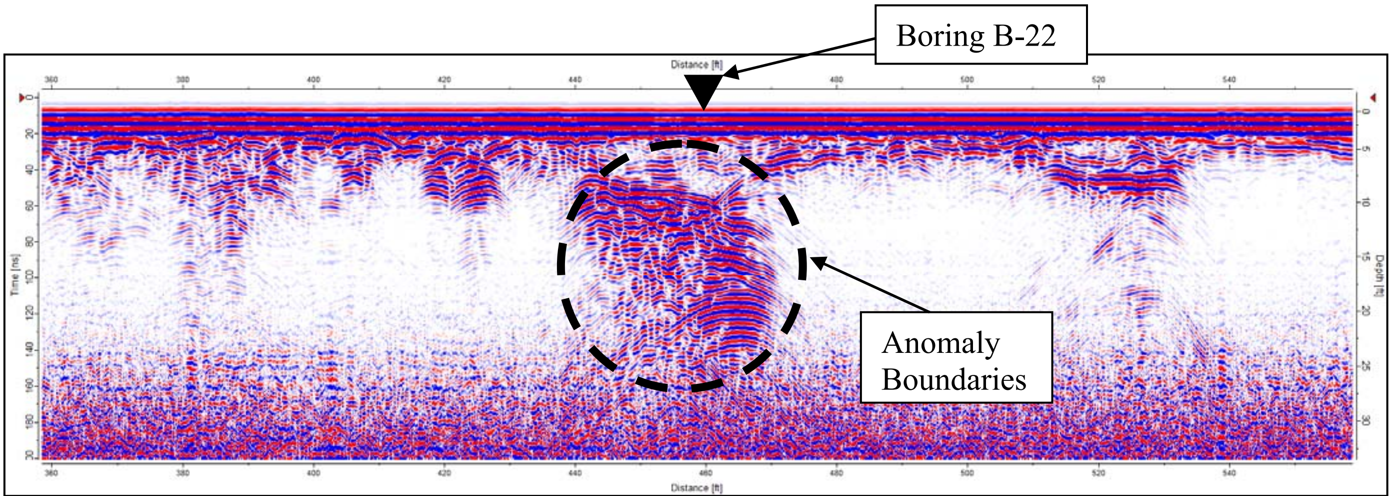
GeoView

FIGURE 2
OVERALL SITE MAP SHOWING RESULTS OF GEOPHYSICAL INVESTIGATION AND PROPOSED PHASE 1 ERI TRANSECTS

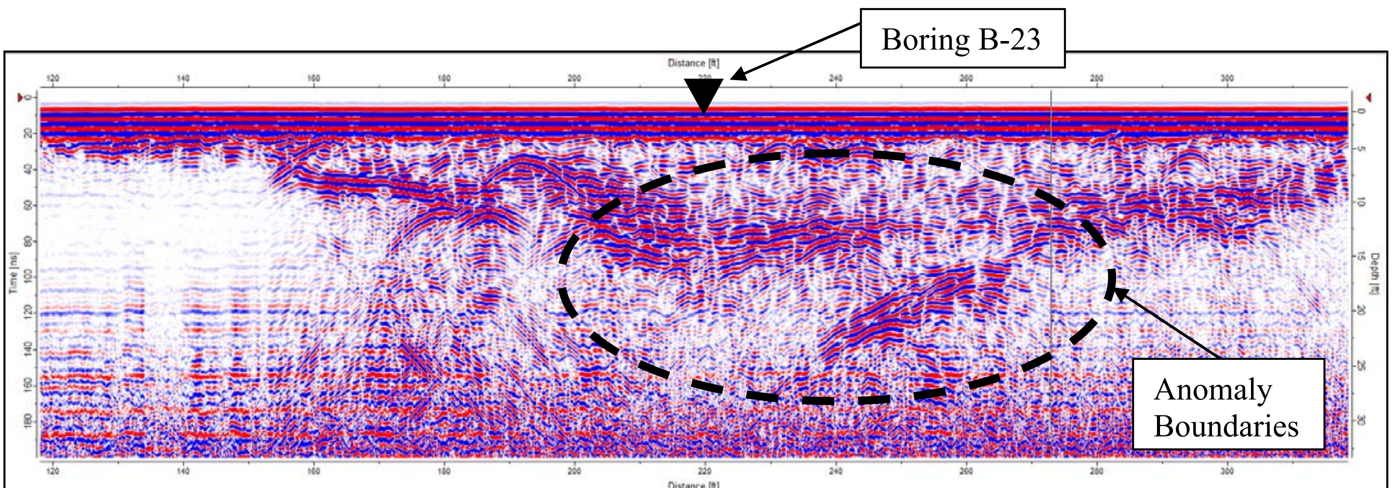
GRU-PARKER ROAD SITE PHASE 2
RECHARGE WETLAND SITE
ALACHUA COUNTY, FLORIDA

GSE ENGINEERING & CONSULTING, INC.
GAINESVILLE, FLORIDA

PROJECT: 31405.1
DATE: 08/31/20



GPR Transect 4 Showing Example of GPR Anomaly 32 (Type A) with Recommended Boring Location



GPR Transect 9 Showing Example of GPR Anomaly 33 (Type A) with Recommended Boring Location

APPENDIX 2
DESCRIPTION OF GEOPHYSICAL METHODS, SURVEY METHODOLOGIES AND LIMITATIONS

A2.1 On Site Measurements

The positions of the geophysical transect lines were recorded using a Trimble GeoXH Global Positioning System (GPS). These GPS systems typically have an accuracy of 1 to 3 ft.

A2.2 Ground Penetrating Radar

Ground Penetrating Radar (GPR) consists of a set of integrated electronic components that transmits high frequency (200 to 1500 megahertz [MHz]) electromagnetic waves into the ground and records the energy reflected back to the ground surface. The GPR system consists of an antenna, which serves as both a transmitter and receiver, and a profiling recorder that both processes the incoming signal and provides a graphic display of the data. The GPR data can be reviewed as both printed hard copy output or recorded on the profiling recorder's hard drive for later review. GeoView uses a Mala GPR system.

A GPR survey provides a graphic cross-sectional view of subsurface conditions. This cross-sectional view is created from the reflections of repetitive short-duration electromagnetic (EM) waves that are generated as the antenna is pulled across the ground surface. The reflections occur at the subsurface contacts between materials with differing electrical properties. The electrical property contrast that causes the reflections is the dielectric permittivity that is directly related to conductivity of a material. The GPR method is commonly used to identify such targets as underground utilities, underground storage tanks or drums, buried debris, voids or geological features.

The greater the electrical contrast between the surrounding earth materials and target of interest, the greater the amplitude of the reflected return signal. Unless the buried object is metal, only part of the signal energy will be reflected back to the antenna with the remaining portion of the signal continuing to propagate downward to be reflected by deeper features. If there is little or no electrical contrast between the target interest and surrounding earth materials it will be very difficult if not impossible to identify the object using GPR.

The depth of penetration of the GPR signal is very site specific and is controlled by two primary factors: subsurface soil conditions and selected antenna frequency. The GPR signal is attenuated (absorbed) as is passes through earth materials. As the energy of the GPR signal is diminished due to attenuation, the energy of the reflected waves is reduced, eventually to the level that the reflections can no longer be detected. As the conductivity of the earth materials increases, the attenuation of the GPR signal increases thereby reducing the signal penetration depth. In Florida, the typical soil conditions that severely limit GPR signal penetration are near-surface clays and/or organic materials.

The depth of penetration of the GPR signal is also reduced as the antenna frequency is increased. However, as antenna frequency is increased the resolution of the GPR data is improved. Therefore, when designing a GPR survey a tradeoff is made between the required depth of penetration and desired resolution of the data. As a rule, the highest frequency antenna that will still provide the desired maximum depth of penetration should be used. For outside areas, a low-frequency (250 MHz) antenna is used. This allows for maximum signal penetration and thereby maximum depth from which information will be obtained.

A GPR survey is conducted along survey lines (transects) that are measured paths along which the GPR antenna is moved. An integrated survey wheel electronically records the distance of the GPR system along the transect lines.

For geological characterization surveys, the GPR survey is conducted along a set of perpendicularly orientated transects. The survey is conducted in two directions because subsurface features such as sinkholes are often asymmetric. Spacing between the transects typically ranges from 10 to 50 ft. Closely spaced grids are used when the objective of the GPR survey is to identify all sinkhole features within a project site. Coarser grids are used when the objective is to provide a general overview of site conditions. After completion of a survey using a given grid spacing, additional more-closely spaced GPR transects are often performed to better characterize sinkhole features identified by the initial survey. This information can be used to provide recommended locations for geotechnical borings.

Depth estimates to the top of lithological contacts or sinkhole features are determined by dividing the time of travel of the GPR signal from the ground surface to the top of the feature by the velocity of the GPR signal. The velocity of the GPR signal is usually obtained from published tables of velocities for the type and condition (saturated vs. unsaturated) of soils underlying the site. The accuracy of GPR-derived depths typically ranges from 20 to 40 percent of the total depth.

Interpretation and Limitations of GPR data

The analysis and collection of GPR data is both a technical and interpretative skill. The technical aspects of the work are learned from both training and experience. Having the opportunity to compare GPR data collected in numerous settings to the results from geotechnical studies performed at the same locations develops interpretative skills for geological characterization studies.

The ability of GPR to collect interpretable information at a project site is limited by the attenuation (absorption) of the GPR signal by underlying soils. Once the GPR signal has been attenuated at a particular depth, information regarding deeper geological conditions will not be obtained. In addition, GPR data can only resolve subsurface features that have a sufficient electrical contrast between the feature in question and surrounding earth materials. If an insufficient contrast is present, the subsurface feature will not be identified. GeoView can make no warranties or representations of geological conditions that may be present beyond the depth of investigation or resolving capability of the GPR equipment or in areas that were not accessible to the geophysical investigation.