GSE Engineering & Consulting, Inc.

SUMMARY REPORT OF A KARST SITE EVALUATION OF STORMWATER MANAGEMENT FACILITY

FLETCHER EAST PHASES 1 & 2
JONESVILLE, ALACHUA COUNTY, FLORIDA

GSE PROJECT NO. 15545C

Prepared For:

FLETCHER DEVELOPMENT, LLC

JULY 2023

GSE Engineering & Consulting, Inc.

July 31, 2023

Blake Fletcher
Fletcher Development, LLC
4510 NW 6th Place, 3rd Floor
Gainesville, Florida 32607

Subject: Summary Report of a Karst Site Evaluation of Stormwater Management Facility
Fletcher East Phases 1 & 2
Jonesville, Alachua County, Florida
GSE Project No. 15545C

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

Presented herein are the findings and conclusions of our exploration, including our evaluation of any geological conditions within the proposed stormwater basin and if additional site preparation recommendations are warranted.

GSE appreciates this opportunity to have assisted you on this project. If you have any questions or comments concerning this report, please contact us.

Sincerely,

GSE Engineering & Consulting, Inc.

JASON E. GOWLAND
LICENSE
No.66467
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

This item has been digitally signed and sealed by Jason E Gowland
Digitally signed by Jason E Gowland
Date: 2023.07.31 10:09:34 -04'00'
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.

Kevin P. Fisher, E.I.
Staff Engineer

Jason E. Gowland, P.E.
Principal Engineer
Florida Registration No. 66467

KPF/JEG: hmp
Q:\Projects\15545C Fletcher East Phases 1 & 2\15545C.docx

Distribution: Addressee (1 - Electronic)
File (1)

GSE Engineering & Consulting, Inc.
5590 SW 64th Street, Suite B
Gainesville, Florida 32608
(352) 377-3233 Phone ◆ (352) 377-0335 Fax
www.gseengineering.com

TABLE OF CONTENTS

LIST OF FIGURES ii

1.0 INTRODUCTION 1-1
- 1.1 General 1-1
- 1.2 Project Description 1-1
- 1.3 Purpose 1-1

2.0 FIELD TESTS 2-1
- 2.1 Geophysical Survey 2-1
- 2.2 Standard Penetration Test Borings 2-1

3.0 REVIEW OF PUBLISHED DATA 3-1
- 3.1 Review of Published Topographic Data 3-1
- 3.2 Review of Published Hydrological Data 3-1
- 3.3 Review of Published Soil Survey Information 3-1
- 3.4 Review of Published Regional Geology 3-2
- 3.5 Review of State Sinkhole Information and GSE In-House Geotechnical Information 3-3

4.0 FINDINGS 4-1
- 4.1 Site Observations 4-1
- 4.2 Geophysical Survey Results 4-1
- 4.3 SPT Boring Results 4-2

5.0 EVALUATION AND RECOMMENDATIONS 5-1
- 5.1 General 5-1
- 5.2 Area Sinkhole Development Potential 5-1
- 5.3 Evaluation of Geophysical Survey and SPT Soil Boring Findings for Sinkhole Potential 5-1

6.0 FIELD DATA 6-1
- 6.1 Standard Penetration Test Soil Boring Logs 6-2
- 6.2 Key to Soil Classification 6-3

7.0 LIMITATIONS 7-1
- 7.1 Warranty 7-1
- 7.2 SPT Borings 7-1
- 7.3 Site Figures 7-1
- 7.4 Unanticipated Soil Conditions 7-1
- 7.5 Misinterpretation of Soil Engineering Report 7-1

LIST OF FIGURES

Figure

1. Project Site Location Map
2. Site Plan Showing Approximate Locations of Field Tests

APPENDIX

GeoView Report No. 39512 dated July 18, 2023

1.0 INTRODUCTION

1.1 General

GSE Engineering & Consulting, Inc. (GSE) has completed this karst site evaluation for the proposed Fletcher East Phases 1 & 2 located in Jonesville, Alachua County, Florida. This exploration was performed in accordance with GSE Proposal No. 2023-424 dated June 30, 2023. You authorized our services on June 30, 2023.

1.2 Project Description

This project will consist of commercial buildings, pavement, and associated retention pond area(s). The site is located on the south side of SR-26 just west of SW 138th Terrace in Jonesville, Alachua County, Florida.

GSE previously completed geotechnical site explorations at the site and issued our findings in our GSE Project No. 15545 dated May 26, 2022, GSE Project No. 15545A dated April 17, 2023, GSE Project No. 15545B dated April 17, 2023, and GSE Project No. 15545B Addendum No. 1 dated June 7, 2023. Please refer to these reports for additional background information. Alachua County Environmental Protection Department (ACEPD) has reviewed those documents and has requested additional geophysical services be performed for the proposed stormwater basin. Mr. Daniel Young, P.E., LEED AP with CHW relayed this request to GSE. This includes reported and documented review of karst features on adjacent properties and the concern of potential karst activity in the area of the proposed stormwater basins at the subject site.

GSE subcontracted GeoView Inc. to perform the geophysical survey. The geophysical services included an Electrical Resistivity Imaging (ERI) survey, a Ground Penetrating Radar (GPR) survey, and soil borings to explore the geological conditions within the proposed stormwater basin and to determine if additional site preparation recommendations are warranted.

A recent aerial photograph of the site was obtained. The site plan and aerial photograph were used in preparation of this exploration and report.

1.3 Purpose

The purpose of this karst stormwater management facility site evaluation was to explore the geological conditions within the proposed stormwater basin and to determine if additional site preparation recommendations are warranted.

2.0 FIELD 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.

2.1 Geophysical Survey

The geophysical survey was performed on July 10 and 11, 2023. The findings are summarized in the GeoView (GeoView Project No. 39512) report in the Appendix dated July 18, 2023. A summary of the surveys field and interpretation procedures is provided below.

The GPR data was collected with a Mala radar system with a 250 MHz antenna and a time range of 201 nanoseconds. This equipment configuration provided an estimated exploration depth of 15 to 23 feet below land surface (bls). The GPR data was digitally recorded for both analysis and archiving purposes. The positioning of the GPR transect lines was recorded using a Trimble Geo7x GPS system.

The ERI survey was conducted using an Advanced Geosciences, Inc. Sting R8 automatic electrode resistivity system. Three ERI transects were performed with an electrode spacing of 10 to 12.5 feet. The transects ranged in length from 450 feet to 600 ft and provided an estimated maximum exploration depth which ranged from 99 to 136 feet bls.

A dipole-dipole combined with an inverse Schlumberger electrode configuration was used for the investigation. The ERI data was analyzed using EarthImager 2D, a computer inversion program, which provides a two-dimensional vertical cross-sectional resistivity model (pseudo-section) of the subsurface. The positioning of the ERI transect lines were recorded using a Trimble Geo7x GPS system.

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

2.2 Standard Penetration Test Borings

This exploration included four (4) Standard Penetration Test (SPT) borings advanced to depths of 23.7 to 50 feet bls. The borings were performed in the areas of the ERI and 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 on July 28, 2023. The SPT boring locations 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 and placed in sealed containers.

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.

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 down toward the southwest from the north. Regional topography is gently rolling hills. The Alachua County Growth Management website indicates the ground surface elevations at the site are near elevations 86 to 88 feet[1].

3.2 Review of Published Hydrological Data

The Floridan aquifer in the vicinity of the site has an elevation on the order of 50 feet[2] NGVD 29. This elevation is below land surface, indicating a downward hydraulic gradient occurs at the site.

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 as one soil series by the Soil Conservation Service (SCS) Soil Survey for Alachua County[3]. The following soil description is 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.

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.

---

[1] Alachua County Growth Management website, http://mapgenius.alachuacounty.us/.

[2] Potentiometric Surface of the Upper Floridan Aquifer, September 2019, U.S. Geological Survey.

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

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.

3.4 Review of Published Regional Geology

The site is located within the western portion of Alachua County. This area of Alachua County maps as the transition from the Hawthorne Group Coosawhatchie Formation to Ocala Limestone[4]. The following descriptions are from the Geological Survey.

Hawthorne Group, Coosawhatchie Formation – The Coosawhatchie Formation[5] is sediments of the Miocene Series that is exposed or lies beneath a thin overburden on the eastern flank of the Ocala Platform from southern Columbia County to southern Marion County. Within the outcrop region, the Coosawhatchie Formation varies from a light gray to olive gray, poorly consolidated, variable clayey and phosphatic sand with few fossils, to an olive gray, poorly to moderately consolidated, slightly sandy, silty clay with few to no fossils. Occasionally, the sands will contain a dolomite component and, rarely, the dominant lithology will be dolostone or limestone. Silicified nodules are often present in the Coosawhatchie Formation sediments in the outcrop region. The sediment may contain 20 percent or more phosphate (Scott, 1988). Permeability of the Coosawhatchie Formation is generally low, forming part of the intermediate confining unit/ aquifer system.

The Miocene sediments consist of siliciclastics, carbonates and mixed siliciclastics-carbonate lithologies with numerous lateral and vertical facies changes. The importance of the Miocene sediments in Florida is twofold - first, these sediments contain valuable mineral resources, primarily phosphate and absorptive clays; and second, the Miocene sediments comprise the intermediate confining unit and aquifer system. Whereas the principal geological hazard associated with Paleogene carbonates is karst development, the hazards associated with the Miocene sediments are radon gas and swelling clays.

Ocala Limestone – Dall and Harris (1892) referred to the limestones exposed near Ocala, Marion County, in central peninsular Florida as the Ocala Limestone. Puri (1953, 1957) elevated the Ocala Limestone to group status recognizing its component formations on the basis of foraminiferal faunas (biozones). Scott (1991 reduced the Ocala Group to formational status in accordance with North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983).

---

[4] Open-File Report 80, Thomas M. Scott, P.G. No. 99, Text to Accompany the Geological Map of Florida, Florida Geological Survey, 2001.

[5] Scott, Thomas N., Geologic Map of the State of Florida – Northern Peninsula. Florida Geological Survey, Open-File Report No. 80, 2001.

The Ocala Limestone consists of nearly pure limestones and occasional dolostones. It can be subdivided into lower and upper facies on the basis of lithology. The lower member is composed of a white to cream-colored, fine to medium grained, poorly to moderately indurated, very fossiliferous limestone (grainstone and packstone). The lower facies may not be present throughout the areal extent of the Ocala Limestone and may be partially to completely dolomitized in some regions (Miller, 1986). The upper facies is a white, poorly to well indurated, poorly sorted, very fossiliferous limestone (grainstone, packstone and wackestone). Silicified, limestone (chert) is common in the upper facies. Fossils present in the Ocala Limestone include abundant large and smaller foraminifers, echinoids, bryozoans, and mollusks. The large foraminifera *Lepidocyclina* sp. is abundant in the upper facies and extremely limited in the lower facies. The presence of these large foraminifers in the upper facies is quite distinctive.

The Ocala Limestone is at or near the surface within the Ocala Karst District in the west-central to northwestern peninsula and within the Dougherty Plain District in the North-central panhandle (Scott, in preparation). In these areas, the Ocala Limestone exhibits extensive karstification. These karst features often have tens of feet (meters) of relief, dramatically influencing the topography of the Ocala Karst District and the Dougherty Plain District (Scott, in preparation). Numerous disappearing streams and springs occur within these areas.

The permeable, highly transmissive carbonates of the Ocala Limestone form an important part of the FAS. It is one of the most permeable rock units in the FAS (Miller, 1986).

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

GSE reviewed readily available published information on the Florida Map Direct[6] 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 is 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 in the immediate area of the subject site. Area information and experience was considered and reviewed as part of this investigation. GSE has documented numerous subsidence incidents in the Jonesville area. Most of these incidents occurred in stormwater management facilities and were remediated with surficial repairs. The county mentioned a significant geological feature was identified in preliminary evaluations located northeast of the stormwater basins on an adjacent property.

---

[6] Map Direct Gallery (state.fl.us)

4.0 FINDINGS

This section presents our field program findings.

4.1 Site Observations

The site is heavily wooded with large trees and thick underbrush. The site is bordered by State Road 26 to the north, SW 138th Terrace to the east, and SW 140th Terrace to the west. Residential homes along SW 138th Terrace are present east of the site while commercial buildings along SW 140th Terrace are present west of the site.

4.2 Geophysical Survey Results

The ERI and GPR surveys were conducted on three (3) transects spread across the stormwater basin. The transect locations were selected based on discussion between GSE and GeoView. Figure 2 illustrates the anomaly areas identified. A complete discussion of the ERI and GPR 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.

Results of the GPR survey indicated the presence of a well-defined, relatively continuous set of GPR reflectors at a depth range of 1 to 4 feet bls. This reflector set is most likely associated with the sand to sand with silt or silty sand interface identified in the auger borings.

Thirteen GPR anomaly areas were identified within the survey area. The anomalies were all characterized by a localized increase in the depth of penetration of the GPR signal. These anomalies do not appear to extend laterally and may be associated with vertically-walled chimney-type sinkhole features.

Analysis of the ERI transects indicate the presence of low to moderate resistivity near-surface soil materials across the majority of the project site to a depth range of 10 to 50 feet bls. This low to moderate resistivity layer corresponds to the sandy and clayey stratums identified in the auger borings. The surficial low to moderate resistivity layer is underlain by a moderate to high resistivity layer to the maximum depth of investigation of the ERI transects which ranged from approximately 99 to 136 feet bls. The moderate to high resistivity layer may correspond to the limestone stratum identified in the auger borings.

Five (5) ERI anomalies were identified at the project site. The ERI anomalies were characterized by a lateral discontinuity in the suspected limestone stratum with associated infilling with the overlying sediments. ERI anomalies were also considered to be present when there was a significant increase in the depth to the top of the suspected limestone stratum or increase in the surficial resistive layer.

The ERI anomalies occurred at depths well below the identified GPR anomalies. However, multiple GPR anomalies were identified in the overlying soils proximate to the ERI Anomalies. It is possible that these corresponding GPR anomalies may be associated with chimney-type sinkhole features possibly connected to the ERI anomalies at depth. Accordingly, GPR anomalies that have a corresponding ERI anomaly are considered to have the highest probability for being potentially active karst features.

However, based on the geophysical results it is not possible to determine whether these identified features have a potential for collapse or subsidence that could have an impact on the proposed stormwater basin development. The SPT boring program was conducted in order to further evaluate and characterize these findings.

4.3 SPT Boring Results

Four (4) 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 ERI and GPR results and the proposed construction in these areas. The actual locations were selected by GeoView and GSE. The intent of the borings was to further explore potential sinkhole activity identified by the ERI and GPR surveys 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 relatively consistent. The borings generally encountered 0.5 to 3.5 feet of poorly graded sand (SP) overlying interbedded strata of clay-rich soils (CL/CH) and limestone to the explored depths of 23.7 to 50 feet bls.

The surficial poorly graded sand (SP) ranged from very loose to loose conditions with N-values ranging from 3 to 6 blows per foot. The underlying clay-rich soils (CL/CH) are generally in a soft to hard condition with N-values ranging from 3 to 31 blows per foot. The limestone ranged from soft to very hard with N-values ranging from 14 to 87 blows per foot.

Loss of drilling fluid circulation occurred at boring location A-4 at a depth of approximately 28 feet bls within deposited material within the limestone formation. This is a common occurrence for this area of Alachua County and is not related to potential sinkhole activity. The moderately hard to hard limestone above bridges over the soft to stiff clay encountered within the limestone formation.

The water table was either not recorded or not encountered in the SPT borings at the time of our exploration. Due to the mud rotary method of advancing the boreholes, the groundwater depth was not apparent below a depth of 10 feet bls at the SPT boring locations.

5.0 EVALUATION AND RECOMMENDATIONS

5.1 General

The following evaluation and recommendations consider the geophysical survey, SPT soil borings, and experience with similar sites and subsurface conditions. In this section of the report, we present our evaluations as it relates to karst geological conditions at this site.

If plans or the location of proposed construction changes from those discussed previously, GSE requests the opportunity to review and possibly amend our recommendations with respect to those changes.

5.2 Area Sinkhole Development Potential

Geologically, the site is located in the central-western portion of Alachua County within or near the transition to the Ocala Limestone regional geology. This area of Alachua County 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 Alachua County. This includes sinkholes that have occurred within +/- 1 mile of the site. GSE has evaluated and assisted with remediation of sinkholes beneath buildings and within stormwater management facilities.

Many of the sinkholes that have developed in stormwater management facilities 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. Most repairs are surficial if shallow competent limestone can be observed; however, other deeper collapses may require subsurface grout injection where deeper remediation is necessary as discussed below.

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 Geophysical Survey and SPT Soil Boring Findings for Sinkhole Potential

The ERI and GPR surveys identified multiple anomaly areas. The identified ERI and GPR anomalies are illustrated on Figure 2. These anomalous features are expected for the heterogeneous soil conditions anticipated at the subject site.

These anomalous areas could represent area where sinkhole development is more likely to occur. Four (4) SPT borings were advanced in selected features to further evaluate the soil conditions in these identified areas.

The SPT borings encountered soil and rock conditions consistent with this area of Alachua County. The borings generally encountered 0.5 to 3.5 feet of poorly graded sand (SP) overlying interbedded strata of clay-rich soils (CL/CH) and limestone to the explored depths of 23.7 to 50 feet bls.

Overall, the limestone formation was encountered at variable depths at multiple locations across the site. With this said, for this area of Alachua County, the depth to limestone is expected to vary abruptly within very short lateral distances. That is the 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 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.

SPT borings A-1, A-2, and A-3 were performed in ERI anomalies as indicated on Figure 2. These borings generally encountered very loose to loose sand overlying firm to hard clay, when encountered, overlying soft to very hard limestone to the boring termination depths. No decline in soils strength or indicators of sinkhole activity were encountered in the borings. The soil conditions encountered in these borings do not suggest potential for sinkhole activity.

SPT boring A-4 was conducted within a combined ERI and GPR anomaly. The boring initially penetrated 3.5 feet of very loose to loose poorly graded sand (SP) overlying firm to stiff clay with trace limestone (CL/CH) to a depth of 8.5 feet bls. This was underlain by moderately hard to hard limestone to a depth of 21.5 feet bls. This was underlain by soft to stiff clay with trace limestone (CL/CH) to a depth of 37 feet bls where the moderately hard to very hard limestone formation was encountered to the explored depth of 50 feet bls.

Loss of drilling fluid circulation occurred at boring location A-4 at a depth of approximately 28 feet bls within deposited material within the limestone formation. This is a common occurrence for this area of Alachua County and is not related to potential sinkhole activity. The moderately hard to hard limestone above bridges over the soft to stiff clay encountered within the limestone formation.

It is GSE's opinion indicators of potential basin collapse are not indicated by this karst evaluation. No weight-of-hammer (WOH) or weight-of-rod (WOR) soil conditions were encountered by the borings performed. It is possible that there could be smaller features not identified by the SPT borings that have gone undetected by this exploration. This could include small in-filled voids in the limestone formation or fissures that are natural occurrences in karst areas. Some of these naturally occurring features may be exposed during over-excavation of the pond bottom. If encountered, these features will likely be remediated by the previously recommended backfilling operations which are standard best management practices for karst sensitive areas. If during construction, observations of site conditions suggest additional recommendations for these types of features are warranted, they should be addressed by the geotechnical engineer of record. However, it is GSE's opinion that additional site preparation recommendations for construction of the stormwater management facility are not warranted at this time.

6.0 FIELD DATA

6.1 Standard Penetration Test Soil Boring Logs

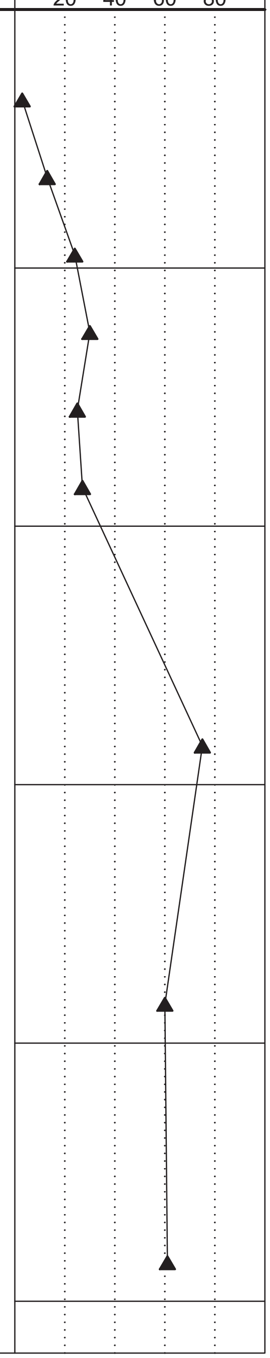
BORING NUMBER A-1

GSE Engineering
5590 SW 64th St
Gainesville, FL 32608
Telephone: 3523773233

CLIENT Fletcher Development, LLC
PROJECT NAME Fletcher East Phases 1 & 2
PROJECT NUMBER 15545C
PROJECT LOCATION Jonesville, Alachua County, Florida
DATE STARTED 7/28/23 **COMPLETED** 7/28/23
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								
	(CL/CH) Soft to very stiff gray, brown, and orange CLAY with trace of limestone	1.5	SPT 1	2-1-2 (3)					
			SPT 2	3-5-8 (13)					
5	Moderately hard to very hard LIMESTONE	4.5	SPT 3	13-11-13 (24)					
			SPT 4	24-14-16 (30)					
			SPT 5	7-9-16 (25)					
10			SPT 6	16-14-13 (27)					
15			SPT 7	19-28-47 (75)					
20			SPT 8	37-29-31 (60)					
25		25	SPT 9	24-24-37 (61)					
	Bottom of borehole at 25.0 feet.								

▲ SPT N VALUE ▲



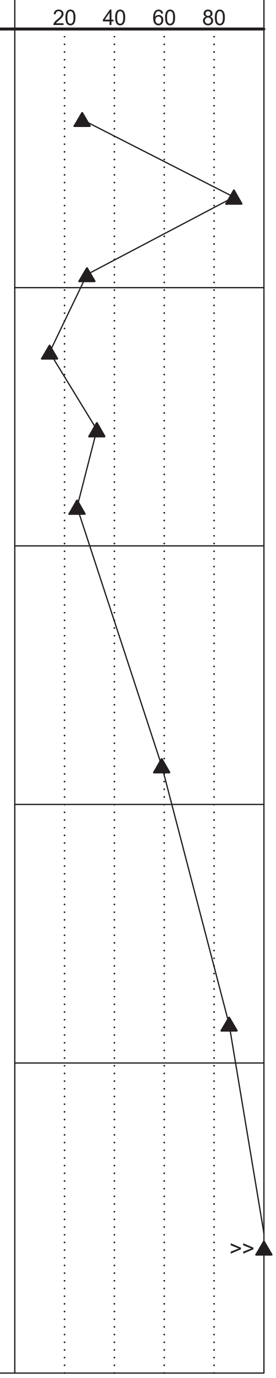
GSE Engineering & Consulting, Inc.
GSE Engineering
5590 SW 64th St
Gainesville, FL 32608
Telephone: 3523773233

BORING NUMBER A-2

CLIENT Fletcher Development, LLC
PROJECT NAME Fletcher East Phases 1 & 2
PROJECT NUMBER 15545C
PROJECT LOCATION Jonesville, Alachua County, Florida
DATE STARTED 7/28/23 **COMPLETED** 7/28/23
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) Brown SAND	0.5							
	Soft to very hard LIMESTONE								
			SPT 1	11-13-14 (27)					
			SPT 2	32-43-45 (88)					
5			SPT 3	33-15-14 (29)					
			SPT 4	17-8-6 (14)					
			SPT 5	19-18-15 (33)					
10			SPT 6	11-14-11 (25)					
15			SPT 7	23-26-33 (59)					
20			SPT 8	29-37-49 (86)					
		23.7	SPT 9	50/2"					
	Bottom of borehole at 23.7 feet.								

▲ SPT N VALUE ▲

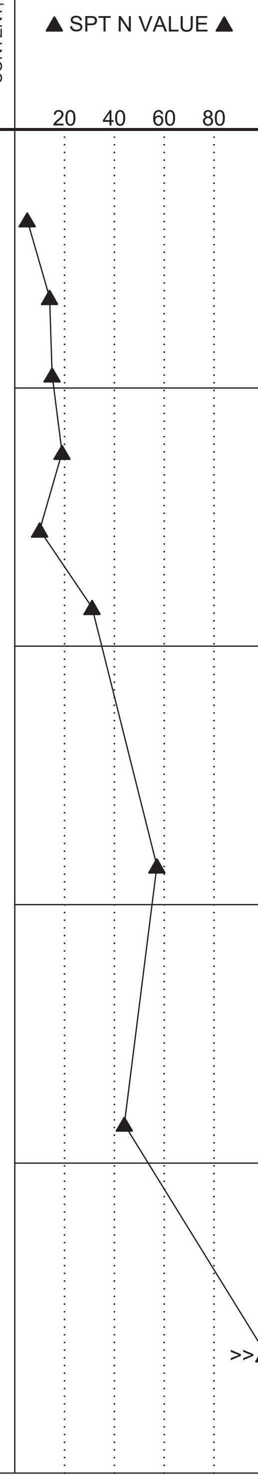


BORING NUMBER A-3

GSE Engineering & Consulting, Inc.
GSE Engineering
5590 SW 64th St
Gainesville, FL 32608
Telephone: 3523773233

CLIENT Fletcher Development, LLC
PROJECT NAME Fletcher East Phases 1 & 2
PROJECT NUMBER 15545C
PROJECT LOCATION Jonesville, Alachua County, Florida
DATE STARTED 7/28/23 **COMPLETED** 7/28/23
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) Loose brown SAND	2	SPT 1	3-2-3 (5)					
	(CL/CH) Firm to hard gray, brown, and orange CLAY with trace of limestone		SPT 2	5-6-8 (14)					
5			SPT 3	6-7-8 (15)					
			SPT 4	8-9-10 (19)					
			SPT 5	6-5-5 (10)					
10		10	SPT 6	6-11-20 (31)					
	Hard to very hard LIMESTONE								
15			SPT 7	12-21-36 (57)					
20			SPT 8	18-21-23 (44)					
		23.9	SPT 9	50/5"					
	Bottom of borehole at 23.9 feet.								



BORING NUMBER A-4

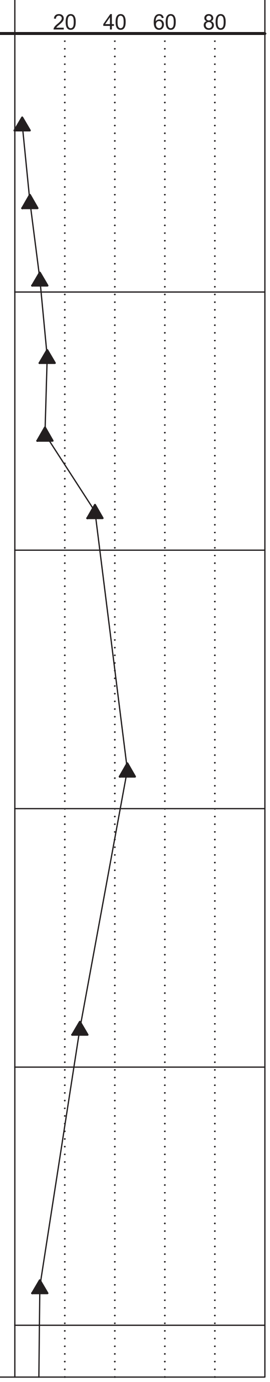
GSE Engineering
5590 SW 64th St
Gainesville, FL 32608
Telephone: 3523773233

CLIENT Fletcher Development, LLC
PROJECT NAME Fletcher East Phases 1 & 2
PROJECT NUMBER 15545C
PROJECT LOCATION Jonesville, Alachua County, Florida
DATE STARTED 7/28/23 **COMPLETED** 7/28/23
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)
0	(SP) Very loose to loose brown SAND	3.5
	(CL/CH) Firm to stiff brown CLAY with trace of limestone	7.5
	(CL/CH) Stiff gray and brown CLAY with trace of limestone	8.5
	Moderately hard to hard LIMESTONE	21.5
	(CL/CH) Soft to stiff brown, gray, and orange CLAY with trace of limestone	

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	2-2-4 (6)					
SPT 3	4-4-6 (10)					
SPT 4	6-7-6 (13)					
SPT 5	5-6-6 (12)					
SPT 6	10-13-19 (32)					
SPT 7	21-23-22 (45)					
SPT 8	10-12-14 (26)					
SPT 9	8-4-6 (10)					

▲ SPT N VALUE ▲



(Continued Next Page)

GSE Engineering
5590 SW 64th St
Gainesville, FL 32608
Telephone: 3523773233

BORING NUMBER A-4

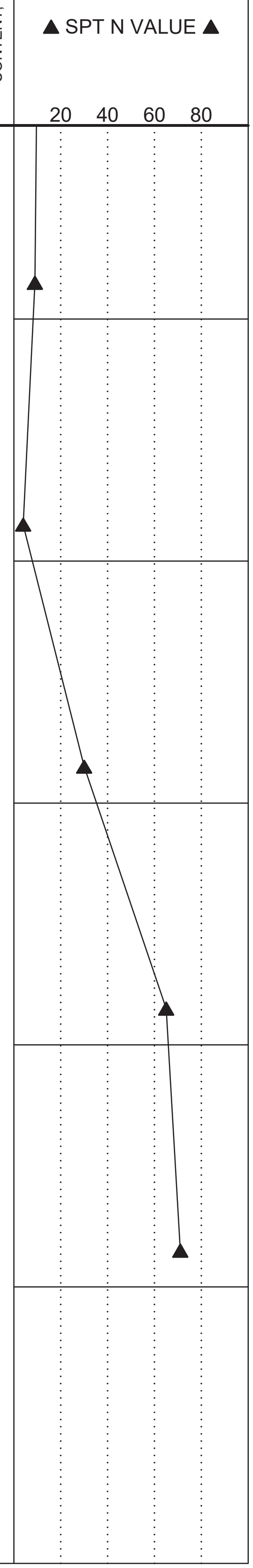
CLIENT Fletcher Development, LLC

PROJECT NAME Fletcher East Phases 1 & 2

PROJECT NUMBER 15545C

PROJECT LOCATION Jonesville, 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) Soft to stiff brown, gray, and orange CLAY with trace of limestone *(continued)*								
		Loss of Circulation at 28 ft								
30				SPT 10	4-4-5 (9)					
35				SPT 11	1-2-2 (4)					
		Moderately hard to very hard LIMESTONE	37							
40				SPT 12	20-14-16 (30)					
45				SPT 13	16-24-41 (65)					
50			50	SPT 14	23-24-47 (71)					
		Bottom of borehole at 50.0 feet.								



6.2 Key to Soil Classification

KEY TO SOIL CLASSIFICATION CHART

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests				SYMBOLS GRAPHIC	SYMBOLS LETTER	GROUP NAME
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	$\frac{\text{Liquid Limit - oven dried}}{\text{Liquid Limit - not dried}} < 0.75$		**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

7.0 LIMITATIONS

7.1 Warranty

This report has been prepared for our client for his exclusive use, in accordance with generally accepted soil and foundation engineering practices, and makes no other warranty either expressed or implied as to the professional advice provided in the report.

7.2 SPT Borings

The determination of soil type and conditions was performed from the ground surface to the maximum depth of the borings, only. Any changes in subsurface conditions that occur between or below the borings would not have been detected or reflected in this report.

Soil classifications that were made in the field are based upon identifiable textural changes, color changes, changes in composition or changes in resistance to penetration in the intervals from which the samples were collected. Abrupt changes in soil type, as reflected in boring logs and/or cross sections may not actually occur, but instead, be transitional.

Depth to the water table is based upon observations made during the performance of the SPT borings. This depth is an estimate and does not reflect the annual variations that would be expected in this area due to fluctuations in rainfall and rates of evapotranspiration.

7.3 Site Figures

The measurements used for the preparation of the figures in this report were made using the provided site plan and by estimating distances from existing structures and site features. Figures in this report were not prepared by a licensed land surveyor and should not be interpreted as such.

7.4 Unanticipated Soil Conditions

The analysis and recommendations submitted in this report are based upon the data obtained from soil borings performed at the locations indicated on Figure 2. This report does not reflect any variations that may occur between these borings.

The nature and extent of variations between borings may not become known until excavation begins. If variations appear, we may have to re-evaluate our recommendations after performing on-site observations and noting the characteristics of any variations.

7.5 Misinterpretation of Soil Engineering Report

GSE Engineering & Consulting, Inc. is responsible for the conclusions and opinions contained within this report based upon the data relating only to the specific project and location discussed herein. If others make the conclusions or recommendations based upon the data presented, those conclusions or recommendations are not the responsibility of GSE.

FIGURES

NORTH

NOT TO SCALE

FLETCHER EAST PHASES 1 & 2
JONESVILLE, ALACHUA COUNTY, FLORIDA
GSE PROJECT NO. 15545C

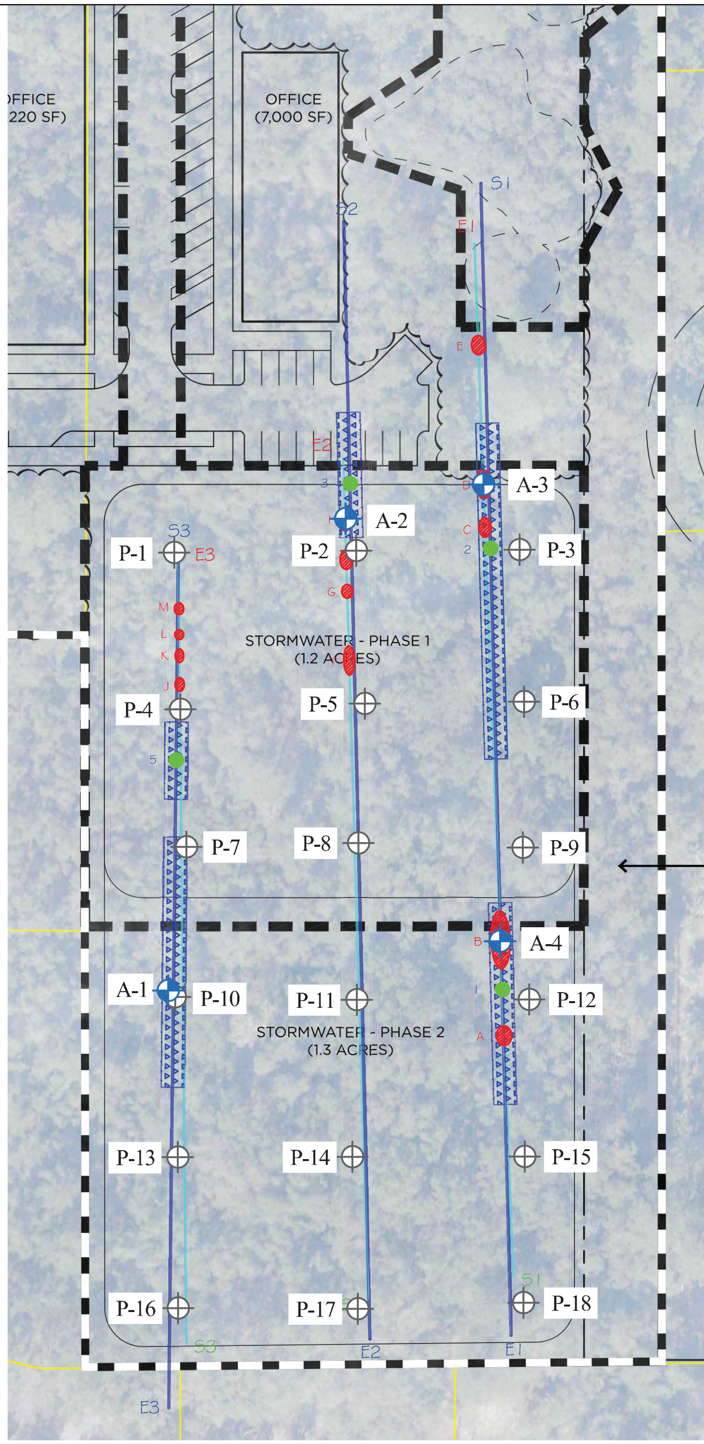
PROJECT SITE LOCATION MAP

DESIGNED BY : KPF
CHECKED BY : JEG
DRAWN BY : EEW

GSE Engineering & Consulting, Inc.

FIGURE

1



LEGEND:

SPT BORING

AUGER BORING - PREVIOUSLY PERFORMED (GSE PROJECT NO.15545B)

S1 E1 GPR TRANSECTS WITH START & END POINTS

S1 E1 ERI TRANSECTS WITH START & END POINTS

A GPR ANOMALIES & DESIGNATION

ERI ANOMALY & DESIGNATION

ERI ANOMALY CENTER

NORTH

0 100'

SCALE: 1" = 100' APPROX.

FLETCHER EAST PHASES 1 & 2 JONESVILLE, ALACHUA COUNTY, FLORIDA GSE PROJECT NO. 15545C	SITE PLAN SHOWING APPROXIMATE LOCATIONS OF FIELD TESTS		
	DESIGNED BY: KPF CHECKED BY: JEG DRAWN BY: EEW	GSE Engineering & Consulting, Inc.	FIGURE 2

APPENDIX

FINAL REPORT
GEOPHYSICAL INVESTIGATION
FLETCHER CENTER EAST SITE
GAINESVILLE, FLORIDA

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

Prepared by GeoView Associates, Inc.
St. Petersburg, FL

July 18, 2023

Mr. Jason Gowland
GSE Engineering & Consulting, Inc.
5590 SW 64th Steet Suite B
Gainesville, FL 32608

Subject: Transmittal of Final Report for Geophysical Investigation
Fletcher Center East Site
Gainesville, Florida
GeoView Project Number 39512

Mr. Gowland

GeoView, Inc. is pleased to submit the final report that summarizes and presents the results of the geophysical investigation performed at the above referenced site. Ground penetrating radar and electrical resistivity imaging were used to help determine the presence of possible karst (sinkhole) features that may be present 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.

Sincerely,

GEOVIEW ASSOCIATES, INC.

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

1.0 Introduction

A geophysical investigation was completed on July 10 and 11, 2023, at the Fletcher Center East Site site located at SW 138th Terrace in Gainesville, Florida. The project site is an undeveloped parcel of land that is being considered for development of a stormwater basin.

A geophysical investigation, using ground penetrating radar (GPR) and electrical resistivity imaging (ERI) was performed across the project site area. The purpose of the geophysical investigation was to help characterize near-surface geological conditions and to identify subsurface features that may be associated with karst (sinkhole) activity.

1.1 Discussion of Site Geological Conditions

Several soil auger borings were performed by GSE in and around the project site area prior to the geophysical investigation. Results from those borings indicated the presence of a surficial sand, sand with silt, and silty sand stratum to a minimum depth of 6 feet (ft) below land surface (bls), underlain by sand with clay to clayey sand to clay-rich soils to depths as deep as approximately 30 ft bls. The sediments are underlain by a limestone stratum at depths ranging from approximately 15 to 30 ft bls.

2.0 Description of Geophysical Investigation

The geophysical survey was conducted using Ground Penetrating Radar (GPR) and Electrical Resistivity Imaging (ERI). The location of the geophysical survey area is provided on Figure 1 (Appendix 1).

2.1 Ground Penetrating Radar Survey

The GPR survey was completed across accessible areas of the transects (Figure 1). The GPR data was collected with a Mala radar system with a 250 MHz antenna and a time range of 201 nanoseconds. This equipment configuration provided an estimated exploration depth of 15 to 23 ft below land surface (bls). The GPR data was digitally recorded for both analysis and archiving purposes.

The positioning of the GPR transect lines was recorded using a Trimble Geo7x GPS system. A discussion of the limitations of the establishment of the survey grid is provided in Appendix A2.1. A description of the GPR technique and the methods employed for geological characterization studies is provided in Appendix A2.2.

2.2 Electrical Resistivity Imaging Survey

The ERI survey was conducted using an Advanced Geosciences, Inc. Sting R8 automatic electrode resistivity system. Three ERI transects were performed with an electrode spacing of 10 to 12.5 ft. The transects ranged in length from 450 ft to 600 ft and provided an estimated maximum exploration depth which ranged from 99 to 136 ft bls.

A dipole-dipole combined with an inverse Schlumberger electrode configuration was used for the investigation. 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 positioning of the ERI transect lines were recorded using a Trimble Geo7x GPS system. A description of the ERI technique and the methods employed for geological characterization studies is provided in Appendix A2.3.

3.0 Identification of Possible Sinkhole Features Using GPR and ERI Methods

3.1 Identification of Possible Sinkhole (Karst) 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 an active karst-related geologic feature.

3.2 Identification of Possible Sinkhole Features Using ERI

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

- 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.
- 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.
- 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. The probability of an identified anomaly feature being associated with a potentially active sinkhole (karst) feature is the highest when both ERI and GPR anomalies are present.

4.0 Survey Results

4.1 Discussion of GPR Survey Results

Results of the GPR survey indicated the presence of a well-defined, relatively continuous set of GPR reflectors at a depth range of 1 to 4 ft bls. This reflector set is most likely associated with the sand to sand with silt or silty sand interface identified in the auger borings.

Description of GPR Anomalies

Thirteen GPR anomaly areas were identified within the survey area. The anomalies are labeled A through M on Figure 1. The anomalies were all characterized by a localized increase in the depth of penetration of the GPR signal. These anomalies do not appear to extend laterally and may be associated with vertically-walled chimney-type sinkhole features.

Examples of GPR Anomalies A through M are provided in Appendix 1. A discussion of the limitations of the GPR technique in geological characterization studies is provided in Appendix 2.

4.2 Discussion of ERI Survey Results

Results from the ERI surveys are presented in Appendix 1. The ERI transects are of good acceptable quality. 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 low to moderate resistivity near-surface soil materials across the majority of the project site to a depth range of 10 to 50 ft bls (represented in blue to green on the ERI transects). This low to moderate resistivity layer corresponds to the sandy and clayey stratums identified in the auger borings. The surficial low to moderate resistivity layer is underlain by a moderate to high resistivity layer (represented in green to red) to the maximum depth of investigation of the ERI transects which ranged from approximately 99 to 136 ft bls. The moderate to high resistivity layer may correspond to the limestone stratum identified in the auger borings.

Description of ERI Anomalies

Five ERI anomalies were identified at the project site (Figure 1). The ERI anomalies were characterized by a lateral discontinuity in the suspected limestone stratum with associated infilling with the overlying sediments. ERI anomalies were also considered to be present when there was a significant increase in the depth to the top of the suspected limestone stratum or increase in the surficial resistive layer. The anomaly areas are annotated on to the ERI modeling results provided in Appendix 1. The anomaly areas are designated in blue as Anomalies 1 through 5 on Figure 1. A discussion of the limitations of the ERI technique in karst studies is provided in Appendix 2.

4.3 Correlation of Geophysical Study Results

The ERI anomalies occurred at depths well below the identified GPR anomalies. However, multiple GPR anomalies were identified in the overlying soils proximate to the ERI Anomalies. It is possible that these corresponding GPR anomalies may be associated with chimney-type sinkhole features possibly connected to the ERI anomalies at depth. Accordingly, GPR anomalies that have a corresponding ERI anomaly are considered to have the highest probability for being potentially active karst features.

However, based on the geophysical results it is not possible to determine whether these identified features have a potential for collapse or subsidence that could have an impact on the proposed stormwater basin development. It is recommended that further testing be performed in order to ascertain the nature of the identified anomalies.

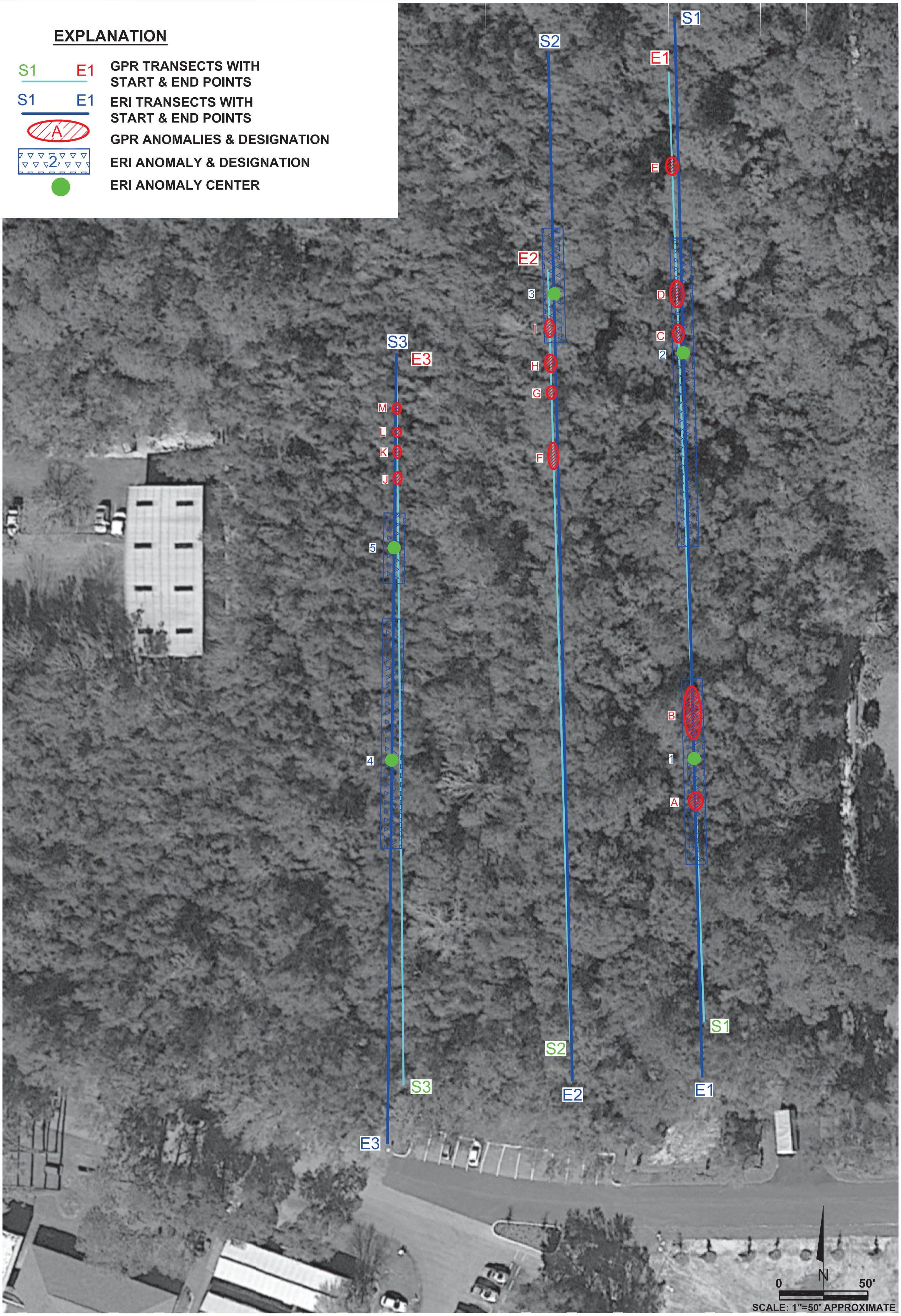
Recommended testing locations for each of the anomalies are provided on Table 2. These coordinates were developed using a Trimble Geo-7x global positioning system (GPS) with sub-foot accuracy.

Table 2 – Apparent Centers of GPR and ERI Anomalies
Coordinates for Recommended Testing Locations

GPR Anomaly	Northing*	Easting*	Latitude	Longitude
A	242259.32	2606791.61	29.65067794	-82.4905073
B	242309.42	2606790.07	29.65081576	-82.49050937
C	242524.32	2606781.88	29.65140699	-82.49052322
D	242547.35	2606781.1	29.65147035	-82.4905244
E	242619.27	2606778.33	29.65166821	-82.49052913
F	242454.37	2606710.97	29.65121811	-82.4907503
G	242491.02	2606710.07	29.65131892	-82.4907511
H	242507.47	2606709.59	29.65136417	-82.4907517
I	242527.57	2606708.99	29.65141946	-82.49075247
J	242442.41	2606622.8	29.6511895	-82.49102849
K	242457.59	2606622.62	29.65123124	-82.49102821
L	242468.57	2606622.5	29.65126144	-82.49102798
M	242481.87	2606622.45	29.651298	-82.4910274
ERI Anomaly				
1	242283.4	2606790.85	29.65074418	-82.49050836
2	242513.47	2606784.74	29.65137702	-82.49051482
3	242546.9	2606711.49	29.65147248	-82.49074353
4	242282.61	2606619.57	29.65075031	-82.49104752
5	242403.23	2606620.92	29.65108187	-82.49103658

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

APPENDIX 1
FIGURE, EXAMPLES OF GPR ANOMALIES AND ERI TRANSECTS



GeoView

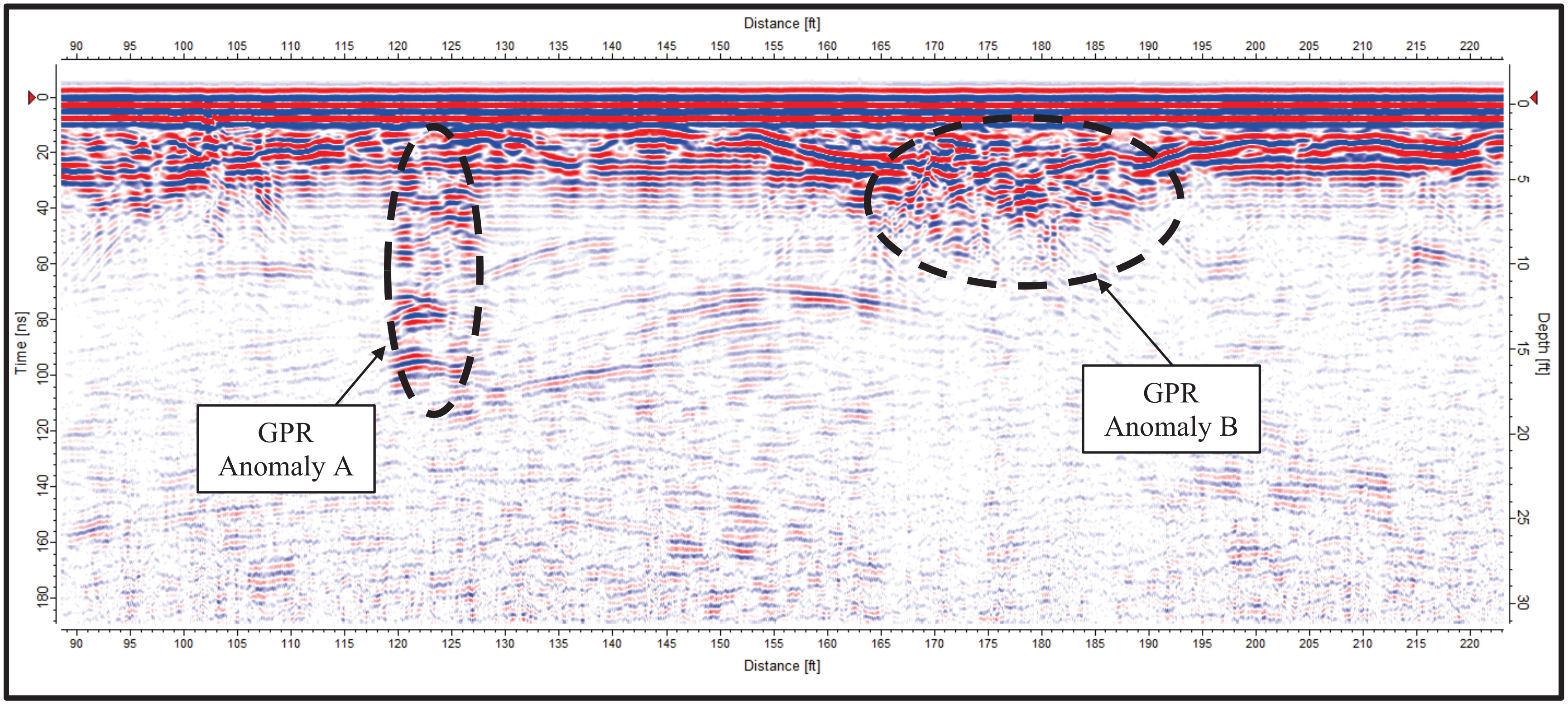
FIGURE 1

SITE MAP SHOWING RESULTS OF GEOPHYSICAL INVESTIGATION

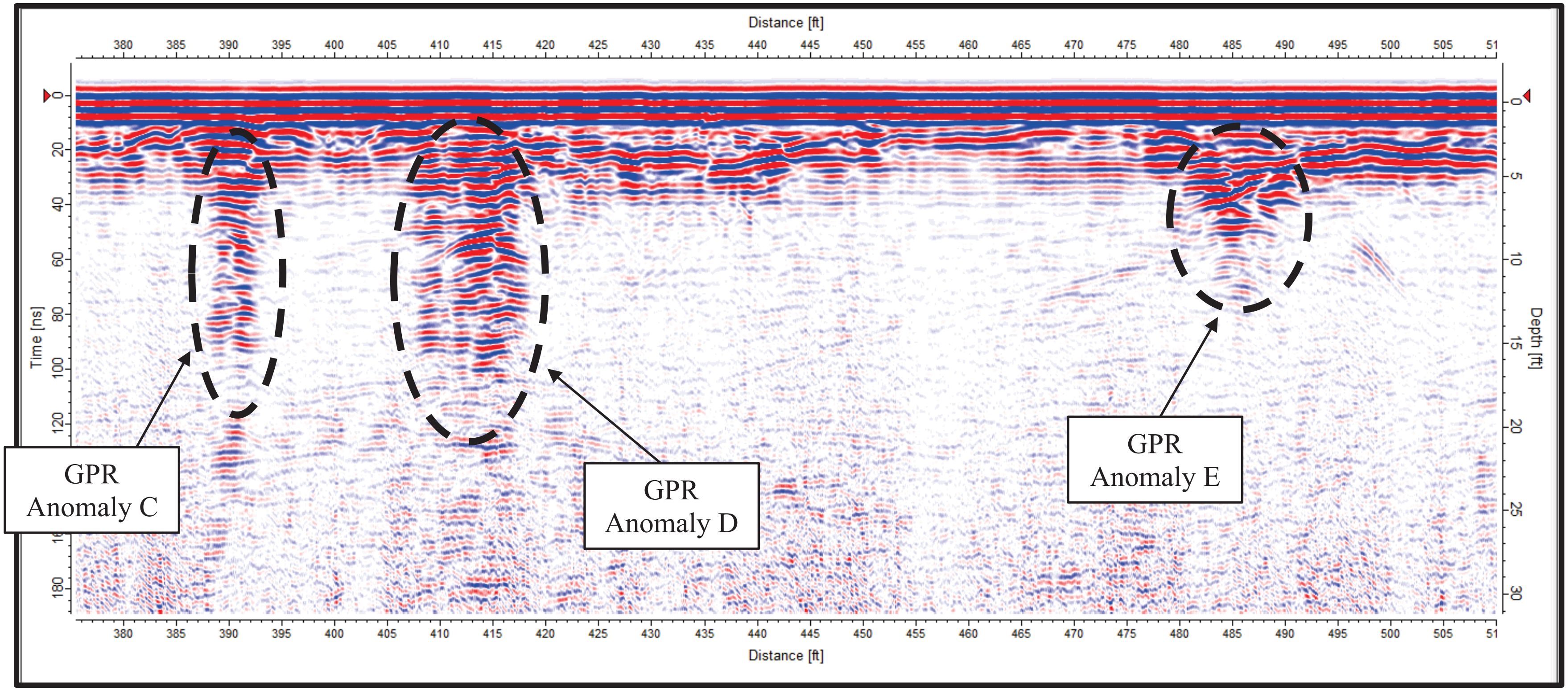
FLETCHER CENTER EAST SITE
SW 138th TERRACE
GAINESVILLE, FLORIDA

GSE ENGINEERING & CONSULTING, INC.
GAINESVILLE, FLORIDA

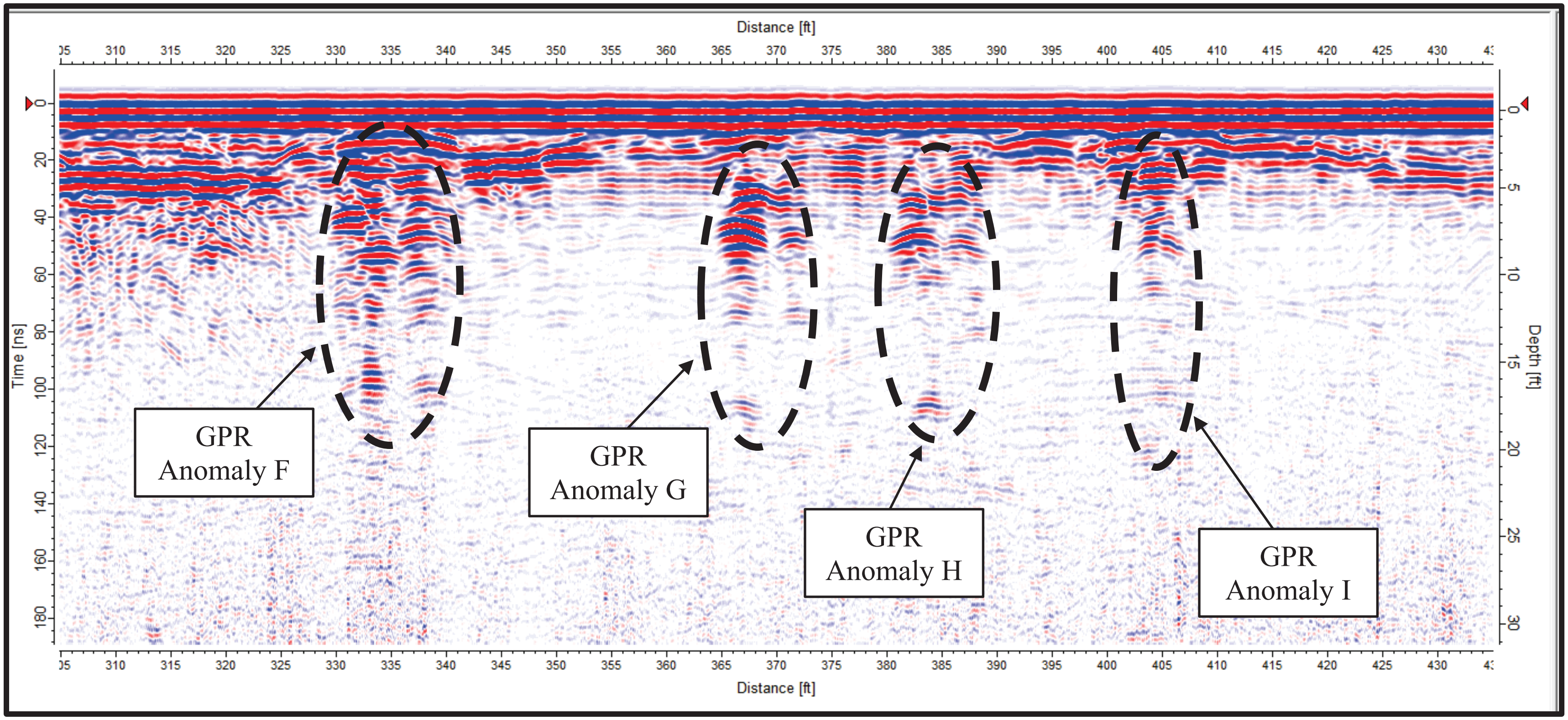
PROJECT: 39512
DATE: 07/18/23



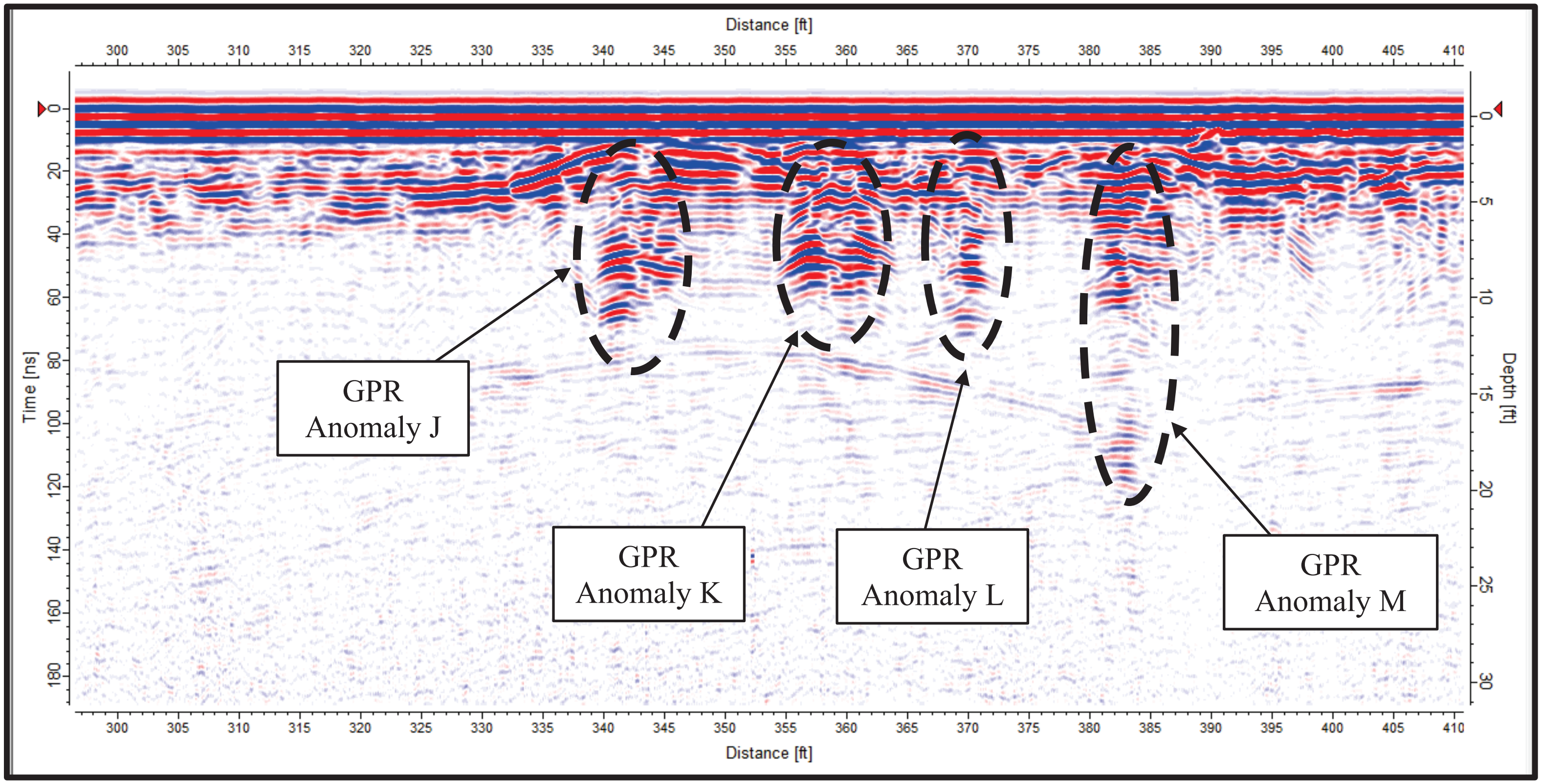
GPR TRANSECT 1 ACROSS GPR ANOMALIES A AND B



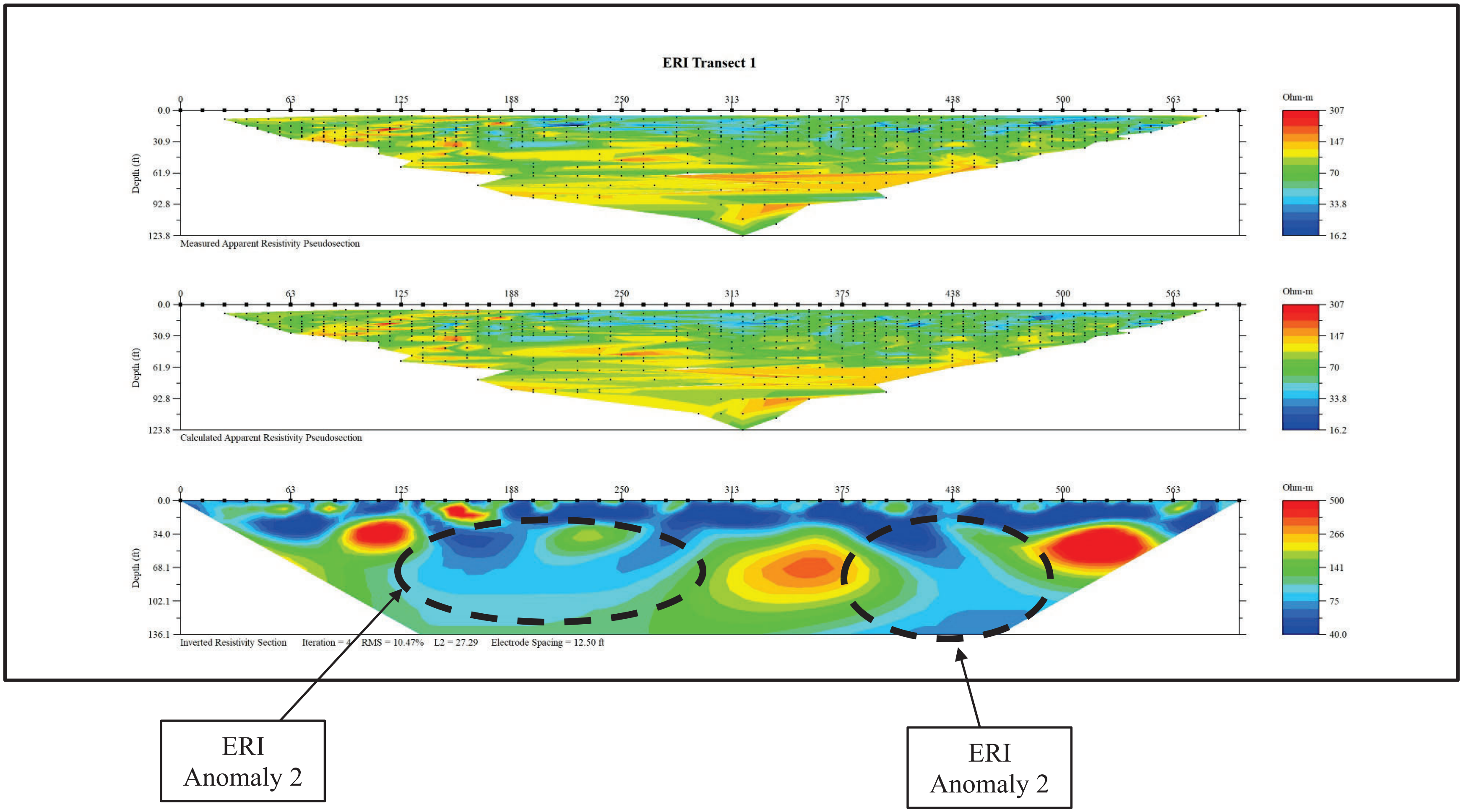
GPR TRANSECT 1 ACROSS GPR ANOMALIES C, D, AND E



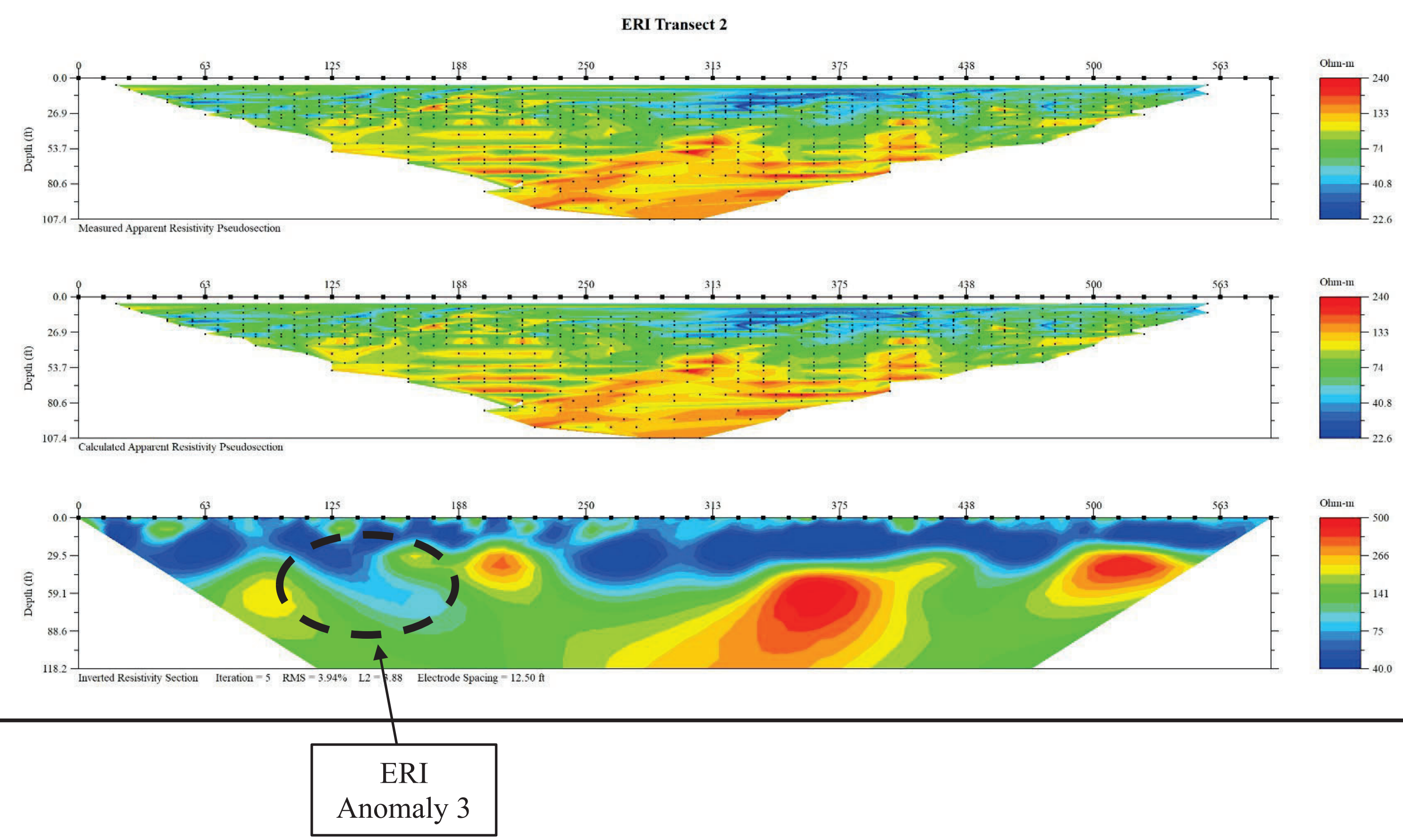
GPR TRANSECT 2 ACROSS GPR ANOMALIES F, G, H, AND I

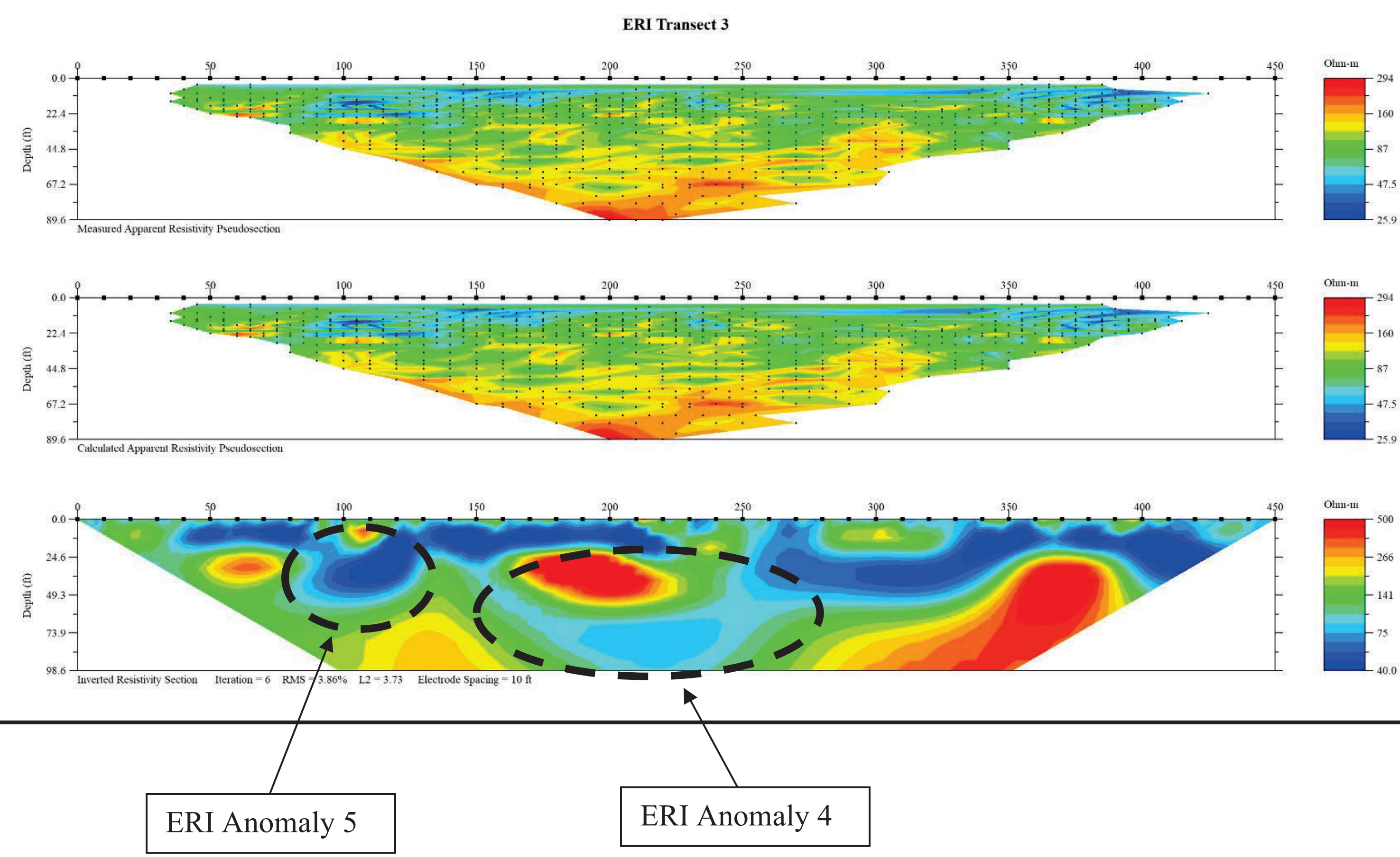


GPR TRANSECT 3 ACROSS GPR ANOMALIES J, K, L, AND M



ERI Transect 1
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section Iteration = 4 RMS = 10.47% L2 = 27.29 Electrode Spacing = 12.50 ft
Depth (ft)
0.0
30.9
61.9
92.8
123.8
34.0
68.1
102.1
136.1
0
63
125
188
250
313
375
438
500
563
Ohm-m
307
147
70
33.8
16.2
500
266
141
75
40.0
ERI Anomaly 2
ERI Anomaly 2


ERI Transect 2
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section
Iteration = 5
RMS = 3.94%
Electrode Spacing = 12.50 ft
Depth (ft)
Ohm-m
0
63
125
188
250
313
375
438
500
563
0.0
26.9
53.7
80.6
107.4
29.5
59.1
88.6
118.2
240
133
74
40.8
22.6
500
266
141
75
40.0
ERI
Anomaly 3



ERI Transect 3
Depth (ft)
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Inverted Resistivity Section Iteration = 6 RMS = 3.86% L2 = 3.73 Electrode Spacing = 10 ft
Ohm-m
294
160
87
47.5
25.9
500
266
141
75
40.0
ERI Anomaly 5
ERI Anomaly 4

APPENDIX 2
DESCRIPTION OF GEOPHYSICAL METHODS, SURVEY METHODOLOGIES AND LIMITATIONS

A2.1 On Site Measurements

Positioning information for the geophysical transect lines was established using a Trimble Geo7x GPS System. Positioning accuracy using this system is typically sub-foot.

A2.2 Ground Penetrating Radar

Ground Penetrating Radar (GPR) consists of a set of integrated electronic components which 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 and GSSI GPR systems. Geological studies are typically conducted using a 200 to 500 MHz antenna.

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, rebar or geological features.

The greater the electrical contrast between the surrounding materials (earth or concrete) 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.

A GPR survey is conducted along survey lines (transects), which are measured paths along which the GPR antenna is moved. Electronic marks are placed in the data by the operator at designated points along the GPR transects. These marks allow for a correlation between the GPR data and the position of the GPR antenna on the ground.

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.

A GPR survey is conducted along survey lines (transects) which are measured paths along which the GPR antenna is moved. Electronic marks are placed in the data by the operator at designated points along the GPR transects. These marks allow for a correlation between the GPR data and the position of the GPR antenna on the ground.

Depth estimates 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.

A2.3 Electrical Resistivity Imaging

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 sand and clay underlain 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 feet 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:

$\gamma_a=$	apparent resistivity
$\pi=$	3.14
a=	"a spacing"
b=	"a spacing" x "n value"
$\nabla V=$	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:

$\gamma_a=$	apparent resistivity
$\pi=$	3.14
a=	spacing between the inner set of electrodes"
s=	distance between the outer electrode and nearest inner electrode
$\nabla V=$	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.

A2.4 Limitations

The analysis and collection of geophysical 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 geophysical data collected in numerous settings to the results from geotechnical studies performed at the same locations develops interpretative skills for karst 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. 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.