CSIGeo
Geotechnical · CMT · CEI

Geotechnical Exploration and Evaluation Report
Phase 2

Rivertown Water Treatment Plant
St. Johns County, Florida

CSI Geo Project No.: 71-19-127-02
CDM Smith Project No.: 237938
Purchase Order: 91630
JEA Contract No.: 141-18

Prepared by:

CSI Geo, Inc.
2394 St. Johns Bluff Road S., Suite 200
Jacksonville, FL 32246
Tel: (904) 641-1993
Fax: (904) 641-0057

Prepared for:

CDM Smith, Inc.

July 30, 2020

Geotechnical · CMT · CEI

July 30, 2020

Mr. David J. Prah, P.E.
CDM Smith Inc.
4651 Salisbury Road, Suite 420
Jacksonville, Florida 32256

RE: Rivertown Water Treatment Plant
St. Johns County, Florida

Subject: Geotechnical Exploration and Evaluation Report (Phase 2)
CSI Geo Project No.: 71-19-127-02
CDM Smith Project No.: 237938, Purchase Order: 91630
JEA Contract No.: 141-18

Dear Mr. Prah:

CSI Geo, Inc. (CSI Geo) has performed the authorized geotechnical exploration and laboratory testing program at the proposed site of the Jacksonville Electric Authority (JEA) Rivertown Water Treatment Plant in St. Johns County, Florida. The overall design includes three wells (Well Nos. 1, 2, and 3), a ground storage tank (GST), a retention pond, new pipelines, an access road, and miscellaneous structures. The geotechnical investigation was conducted in two phases. The preliminary phase (Phase No. 1) was conducted for the 100-foot diameter Ground Storage Tank (GST No. 1), retention pond, and miscellaneous structures located within the area of Well No. 1. The findings of Phase No. 1 were presented in a Preliminary Geotechnical Exploration and Evaluation Report submitted on January 22, 2020. The second and final phase (Phase No. 2) was conducted for Well Nos. 2 & 3, the access road, and the new pipelines. This report presents our understanding of the subsurface conditions along with our geotechnical design and construction recommendations for Phases No. 1 & 2.

We have enjoyed working with you on this project and look forward to working with you on future projects. If you have any questions concerning this report, please contact our office.

Sincerely,

CSI Geo, Inc.

Nader Amer, Ph.D
Project Engineer

Digitally signed by Bruce B Khosrozadeh
Date: 2020.07.30 10:09:37-04'00'

Bruce Khosrozadeh, P.E.
Senior Geotechnical and Materials Engineer
Registered, Florida No. 45273

TABLE OF CONTENTS

TABLE OF CONTENTS

APPENDIX

Appendix A – Site Maps

- Site Location Map
- Field Exploration Plan

Appendix B – Field Exploration, Evaluation & Laboratory Testing

- Report of SPT Borings
- Report of Core Borings
- Recommended Soil Parameters for Horizontal Directional Drilling Design
- Recommended Soil Parameters for Sheet Pile Walls
- Tank Settlement Analysis Results
- Summary of Laboratory Test Results
- Grain Size Distribution Curves

Appendix C – General Information

- Key to Soil Classification
- Field and Laboratory Test Procedures

1.0 PROJECT INFORMATION

1.1 General Project Information

The purpose of this geotechnical exploration program was to develop information concerning the subsurface conditions in order to evaluate the site with respect to the proposed JEA Rivertown Water Treatment Plant (WTP) located along CR 244, just south of Greenbriar Road and west of Bartram Trail High School in St. Johns County, Florida. A Site Location Map is included in **Appendix A**.

The overall design includes three wells (Well Nos. 1, 2, and 3), a ground storage tank (GST), a retention pond, new pipelines, an access road, and miscellaneous structures. The geotechnical investigation was conducted in two phases. The preliminary phase (Phase No. 1) was conducted for the 100-foot diameter Ground Storage Tank (GST No. 1), retention pond, and miscellaneous structures located within the area of Well No. 1. The findings of Phase No. 1 were presented in a Preliminary Geotechnical Exploration and Evaluation Report submitted on January 22, 2020. The second and final phase (Phase No. 2) was conducted for Well Nos. 2 & 3, the access road, and the new pipelines. This report presents our understanding of the subsurface conditions along with our geotechnical design and construction recommendations for Phases No. 1 & 2.

1.2 Project Description and Existing Conditions

The overall proposed project features include Well Nos. 1, 2, and 3, concrete pads, a ground storage tank, chemical chlorine storage pad, high service pump station building, generator pad, fuel tank pad, a retention pond inside Well No. 1 area, the access road to Well No. 3, pipelines installed by Horizontal Directional Drilling (HDD) along the west side of Longleaf Pine Parkway, and open cut method of installation pipelines along the east side of Longleaf Pine Parkway.

The site in the gated area of Well No. 1 is relatively flat and cleared with scattered shrubs and small trees. An elevated pre-load embankment approximately two feet higher than the surrounding existing ground surface is situated at the northwest corner of the site. The pre-load embankment was constructed as part of previous plans to construct a ground storage tank, and the pre-load embankment was intended to reduce the anticipated total settlement. Also, an existing cell tower is located at the southeast corner of the site.

The sites at Wells Nos. 2 and 3 are heavily wooded and gently sloping. Well No. 2 area was partially wet during our geotechnical investigation. We understand that a new access road to Well No. 3 will be constructed, and that the eastern portion of the access road will be retained using permeant sheet pile walls at the intersection with Longleaf Pine Parkway.

The new pipelines consist of HDD pipelines to be installed along the western side of Longleaf Pine Parkway with the entry and exit pits located in front of Well No. 1 area from the south, and Well No. 3 area from the north. The new pipelines also consist of pipes to be constructed using open cut method of installation and to be installed across Longleaf Pine Parkway to connect with existing pipelines along the eastern side of Longleaf Pine Parkway. The site at the new pipeline corridors is generally flat along Longleaf Pine Parkway embankment and surrounded by wetlands and heavily wooded areas from the east and west outside the roadway embankment.

Information regarding this project was provided to CSI Geo, Inc. (CSI Geo) by Mr. David Prah, P.E. of CDM Smith, Inc. (CDM Smith).

2.0 GEOTECHNICAL EXPLORATION

2.1 Field Exploration

The locations of the test borings (Standard Penetration Test borings & Auger borings) were selected by CDM Smith and located in the field by personnel from CSI Geo using handheld GPS equipment. Therefore, the test locations should be considered approximate. The approximate geographical coordinates for each test location are presented on the Report of SPT Borings and Report of Core Borings included in **Appendix B**. All Standard Penetration Test (SPT) borings were grouted to full depth after boring completion. Soil samples collected were visually classified in the field and then transported to our laboratory for re-classification and testing. Representative soil samples obtained during our field exploration program were visually classified using the Unified Soil Classification System (USCS). The approximate locations of the SPT and auger borings are shown on the Field Exploration Plan sheet included in **Appendix A**. A brief discussion of the drilling, sampling, and field-testing techniques used during the field exploration program is provided in the Field and Laboratory Test Procedures sheet presented in **Appendix C**.

The Report of SPT Borings and Report of Core Borings sheets are included in **Appendix B** and present the descriptions of the subsurface soils encountered, the groundwater levels encountered and the penetration resistance, recorded at the time of drilling. The stratification lines and depth designations on the boring records represent the approximate boundary between the various soils encountered, and the transition from one stratum to the next should be considered approximate.

2.1.1 Ground Storage Tank

The ground storage tank was explored by means of four SPT borings (B-1 through B-4) located at equal distances along the perimeter of the tank and drilled to a depth of 50 feet below the existing ground surface. The center of the tank was explored by means of SPT boring B-5 drilled to a depth of 100 feet below the existing ground surface.

2.1.2 Pump Station Building, Wells, and Structures on Concrete Pads

The Well No. 1 concrete pad, the chemical chlorine storage pad, high service pump station building, generator pad, and fuel tank pad were explored by means of a total of six SPT borings

(B-6 through B-11) drilled to a depth of 20 feet below the existing ground surface. Wells Nos. 2 and 3 were explored by means of SPT borings B-18 and B-19, respectively, drilled to a depth of 20 feet below the existing surface. Boring B-19 was extended to 25 feet to extend beneath very loose soils encountered at a depth of 20 feet below the existing ground surface.

2.1.3 Horizontal Directional Drilling (HDD)

The HDD pipeline alignment was explored by means of a total of four SPT borings (B-12 through B-15). SPT boring B-12 was drilled to a depth of 40 feet and SPT borings B-13, B-14, and B-15 were drilled to a depth of 75 feet below the exiting ground surface.

2.1.4 Open Cut Method of Pipe Installation

The open cut pipelines were explored by means of SPT borings B-16 and B-17 drilled and extended to the depths of 25 and 30 feet, respectively, below the existing ground surface.

2.1.5 Access Road & Sheet Pile Walls

As instructed by CDM Smith, the area of the proposed access road was evaluated using SPT boring B-15 performed for the HDD pipeline due to its close proximity to the access road entrance and the sheet pile walls locations. SPT boring B-15 was drilled to a depth of 75 feet below the existing ground surface.

2.1.6 Retention Pond

The area of the proposed retention pond was explored by means of a total of two auger borings (A-1 and A-2) drilled to a depth of 15 feet below the existing ground surface.

2.2 Laboratory Testing

Quantitative laboratory testing was performed on representative samples of the soils collected during the field exploration program and were performed to better define the composition of the soils encountered. Representative samples for the laboratory testing program were selected and the laboratory tests were performed to determine moisture contents, fines content, organic content, grain size analyses, and Atterberg limits of the soils encountered. Results of the laboratory testing performed are included in **Appendix B**.

3.0 SUBSURFACE CONDITIONS

3.1 General

An illustrated representation of the subsurface conditions encountered in the proposed construction areas is shown on the Report of SPT Borings and Report of Core Borings sheets presented in **Appendix B**. The soil conditions outlined below highlight the major subsurface stratification. The Report of SPT Borings and Report of Core Borings in the **Appendix** should be consulted for a detailed description of the subsurface conditions encountered at each boring location. When reviewing the Report of SPT Borings and Report of Core Borings, it should be understood that soil conditions may vary between the borings and outside of the explored areas.

3.2 Soil Conditions

It should be cautioned that soil conditions at the site are highly erratic in nature and contain unsuitable material consisting of organic and highly organic soils and clays that are variable in thickness and depth throughout the site. It is emphasized that due to the erratic nature of these soils, the thickness and depth of the unsuitable material may vary from those noted herein, and that in some locations the unsuitable material may be deeper.

3.2.1 Ground Storage Tank

Unsuitable organic slightly silty sands (SP-SM/PT) were encountered in the upper 5 to 6 feet of depth below the existing ground surface in the areas of borings B-1 and B-2. However, the unsuitable organic soils appear to be erratic in nature and therefore, the presence of unsuitable organic soils should be expected at varying depths and thicknesses throughout the site. Removal of the unsuitable organic soils will be required, and it is strongly recommended that allowances are made for possible presence of such soils in other areas of the tank.

Below the organic soils, the area is generally underlain by very loose to medium dense sands (SP), slightly silty sands (SP-SM), and silty sands (SM) to the depths of 32 to 33.5 feet followed by dense silty sands and highly weathered limestone to the depths of 35.5 to 42 feet below the existing ground surface. Underlying the weathered limestone, medium dense to dense clayey sands (SC), silty sands (SM), and hard calcareous sandy silts (ML/MH), generally referred to as

Marl formation, were encountered until the boring termination depths of 50 and 100 feet below the existing ground surface.

3.2.2 Pump Station Building and Structures on Concrete Pads

Review of test borings (B-6 through B-11) indicates that these areas are generally underlain by unsuitable organic slightly silty sands (SP-SM/PT) and organic silty sands (SM/PT), generally in the upper 4 to 8 feet of depth below the existing ground surface. Wood was also encountered in boring B-6 between the depths of 8 and 9 feet below the existing ground surface. Generally, the unsuitable organic soils and wood pieces appear to be highly erratic in nature. It is emphasized that due to the erratic nature of these soils, the thickness and depth of the unsuitable material may vary from those noted herein, and that in some locations the unsuitable material may be deeper. It should be cautioned that over-excavation of the unsuitable organic soils will be required.

Beneath the unsuitable organic soils these areas are generally underlain by very loose to medium dense sands (SP), slightly silty sands (SP-SM), and silty sands (SM) until the boring termination depth of 20 feet below the existing ground surface.

3.2.3 Well No. 1

Unsuitable organic slightly silty sands (SP-SM/PT) were encountered in SPT boring B-9 in the upper 4 of depth below the existing ground surface. It should be noted that over-excavation of the unsuitable organic soils will be required. Beneath the unsuitable organic soils, loose to dense sands (SP) were encountered until the boring termination depth of 20 feet below the existing ground surface.

3.2.4 Well No. 2

Unsuitable highly organic silty sands (SM/PT) were encountered in the upper 2 of depth below the existing ground surface. It should be noted that over-excavation of the unsuitable organic soils will be required. Beneath the unsuitable organic soils, very loose to loose sands (SP) and slightly silty sands (SP-SM) were encountered to a depth of 12 feet, followed by very loose to medium dense clayey sands (SC) until the termination depth of 20 feet below the existing ground surface.

3.2.5 Well No. 3

The area of Well No. 3 is generally underlain by very loose to medium dense sands (SP), slightly silty sands (SP-SM), and clayey sands (SC) to a depth of 12 feet below the existing ground surface. Beneath these soils, firm sandy clays (CH) were encountered to a depth of 16 feet followed by loose silty sands (SM) until the boring termination depth of 25 feet below the existing ground surface.

3.2.6 Horizontal Directional Drilling (HDD)

Review of SPT borings B-12 through B-15 indicates that the HDD corridor is generally underlain by very loose to very dense sands (SP) and slightly silty sands (SP-SM) to a depth of 17 to 37 feet below the existing ground surface. It is noted that very soft sandy clays (CL) and silts (MH) were encountered between 17 and 32 feet of depth in borings B-12 and B-13. Beneath these soils, very loose to medium dense slightly silty sands (SP-SM), clayey sands (SC) and silty sands (SM) were encountered to depths ranging from 37 to 42 feet followed by very stiff to hard sandy clays (CH, CL / MARL) and medium dense to very dense clayey sands (SC / MARL) until the boring termination depths. It should be noted that soil conditions along the HDD corridor are erratic in nature and contain very soft clays with variable thicknesses and depths and may from those noted herein.

3.2.7 Open Cut Method of Pipe Installation

Review of SPT borings B-16 and B-17 indicates that the pipeline areas to be installed by open cut method of installation are generally underlain by very loose to medium dense sands (SP), slightly silty sands (SP-SM), and silty sands (SM) to a depth of 17 to 22 feet below the existing ground surface. Beneath these soils, very soft to firm sandy clays and clays (CH) were encountered to a depth of 22 feet, followed by slightly silty sands (SP-SM) until the deepest termination depth of 25 feet below the existing ground surface.

3.2.8 Access Road & Sheet Pile Walls

Due to its close proximity, SPT boring B-15 performed for the HDD alignment was utilized to evaluate the general subsurface conditions for the access road and sheet pile walls. Review of SPT boring B-15 indicates that the area of the access road and sheet pile walls is generally underlain by very loose to dense sands (SP) and slightly silty sands (SP-SM) to a depth of 37 feet below the existing ground surface. Beneath these soils, very stiff to hard sandy clays (CH / MARL) were encountered until the boring termination depth of 75 feet below the existing ground surface.

3.2.9 Retention Pond

Review of auger borings A-1 and A-2 indicates that the area of the retention pond is generally underlain by fine sands (SP), slightly silty fine sands (SP-SM), and silty fine sands (SM) until the borings termination depth of 15 feet below the existing ground surface. It should be cautioned that soil conditions within the proposed retention pond are highly erratic in nature and contain unsuitable material consisting of unsuitable organic and highly organic soils and clays that are variable in thickness and depth throughout the site. It is emphasized that due to the erratic nature of these soils, presence of unsuitable organic and clayey soils should be anticipated, and that the thickness and depth of the unsuitable material may vary from those noted herein, and that in some locations the unsuitable material may be deeper.

3.3 Groundwater Conditions

The groundwater levels were measured and recorded as encountered at the time of drilling. The depths of the groundwater level and estimated seasonal high water level at the test locations are marked on the Report of SPT Borings and Report of Core Borings sheets presented in the **Appendix B**.

3.3.1 Ground Storage Tank and Miscellaneous Structures

Review of the test borings B-1 through B-11 indicates that groundwater was encountered at depths ranging from 6 to 7 feet below the existing ground surface. The estimated seasonal high ground water table ranged from 5 to 6 feet below the existing ground surface.

3.3.2 Well No. 1

Review of the test boring B-9 indicates that groundwater was encountered at the depth of 6 feet below the existing ground surface. The estimated seasonal high ground water table is estimated to be at 5 feet below the existing ground surface.

3.3.3 Well No. 2

Review of the test boring B-18 indicates that groundwater was encountered at the depth of 3 feet below the existing ground surface. The estimated seasonal high ground water table is estimated at 1.5 feet below the existing `ground surface. Standing water was observed in the vicinity of the boring.

3.3.4 Well No. 3

Review of the test boring B-19 indicates that groundwater was encountered at the depth of 1.5 feet below the existing ground surface. The estimated seasonal high ground water table is estimated to be at ground surface. Standing water was not observed at the time of drilling.

3.3.5 Horizontal Directional Drilling (HDD) Pipelines

Review of the test borings B-12 through B-15 indicates that groundwater was encountered was encountered at depths ranging from 2 to 7 feet below the existing ground surface.

3.3.6 Open Cut Pipelines

Review of the test borings B-16 and B-17 indicates that groundwater was encountered was encountered at depths ranging from 4.5 to 6 feet below the existing ground surface. The estimated seasonal high ground water table ranged from 3.5 to 5 feet below the existing ground surface.

3.3.7 Access Road & Sheet Pile Walls

Review of the test boring B-15 indicates that groundwater was encountered at the depth of 5 feet below the existing ground surface.

3.3.8 Retention Pond

Review of the borings A-1 and A-2 indicates that groundwater was encountered at depths ranging from 1.5 to 4 feet below the existing ground surface. The estimated seasonal high ground water table ranged from 0.5 to 3 feet below the existing ground surface.

Determination of the estimated seasonal high groundwater table was made using the methodology described by the United States Department of Agriculture (USDA) Soil

Conservation Service (SCS). In sandy soils the method involves examining soil cuttings from the borings for subtle changes in root content and soil coloration. These subtle changes are indicators of the highest level the groundwater level has been for a prolonged period.

Fluctuations of the groundwater level should be anticipated as a result of fluctuations of the nearby creeks and tributaries, seasonal climatic variations, surface water runoff patterns, construction activities, and other related factors. During seasonal high precipitation periods, groundwater levels can be expected to vary from the levels recorded during this exploration. Therefore, design drawings and specifications should account for the possibility of groundwater level variations, and construction planning should be based on the assumption that such variations will occur.

4.0 GEOTECHNICAL ENGINEERING EVALUATION AND RECOMMENDATIONS

4.1 Basis of Evaluation & Recommendations

The following recommendations are based on the previously presented project information and the data provided to us. The discovery of site and/or subsurface conditions during construction that deviate from the data obtained in this exploration should be reported to us for our review.

4.2 Foundation Design & Construction Recommendations

Based on the results of our evaluation, the storage tank, the buildings, and miscellaneous structures can be founded on shallow bearing footings proportioned for a maximum gross allowable soil bearing capacity of 2,400 psf, provided that the unsuitable organic soils and very loose soils encountered in the upper 8 feet of depth are removed in their entirety and replaced with suitable compacted material in the dry.

Upon satisfactory removal of all unsuitable soils, we recommend that the exposed soils must first be compacted in the dry. This compactive effort should help improve the overall uniformity and bearing conditions of the near surface and underlying soils. Site work and construction techniques in general should be performed in accordance with our subsequent recommendations. The foundations may be constructed directly on compacted sands or natural soils, #57 stone, lean concrete, or structural fill. The granular free-draining soils should be compacted to a density of at least 95 percent of the Modified Proctor maximum dry density (ASTM D 1557). Extensive dewatering will be required to backfill and compact in the dry. If #57 stone is recommended as backfill of the over excavation, it is recommended that it should be wrapped around with filter fabric or geotextile as a separation layer to prevent settlement due to migration of fine soil particles into the aggregate layer.

Additionally, we recommend that techniques in **Section 4.4** be implemented to reduce the effects of settlement of ground storage tank and pipe connections.

4.3 Bearing Capacity and Anticipated Settlement

4.3.1 Ground Storage Tank

We understand that the GST will be supported on foundations placed at or near existing grade with some fill added. Using a 2,400 psf bearing capacity, we anticipate the total settlement of the tank to be on the order of 4.9 inches or less. Settlement was calculated using GeoStudio SIGMA/W model. We expect the majority of the settlement to be elastic (short-term) settlement. Based on the tank dimensions provided, we estimate the differential settlement between the center and edge of the tank to be on the order of 2.4 inches or less. A summary of the settlement analysis results is presented in **Appendix B**. These settlement values are below what is typically allowed by designers and tank manufacturers. However, we recommend that settlement mitigation techniques presented in **Section 4.4** of this report be considered.

4.3.2 Pump Station Building, Well Areas, and Structures on Concrete Pads

Bearing capacity was estimated using both the Terzaghi and Vesic methods. We recommend that shallow foundations should have a minimum footing width of 2 feet with an embedment depth of 2 feet. The maximum allowable soil bearing pressure for use in shallow foundation design should not exceed 2,100 psf. We recommend maximum footing sizes should be limited to 8-feet for isolated column footings and 4-feet for continuous wall footings. Using a maximum bearing pressure of 2,100 psf, we anticipate the total settlement will be on the order of 1-inch or and the differential settlement to be on the order of 0.25 inches less. Settlement was calculated using GeoStudio SIGMA/W model. This settlement is the result of elastic compression of the upper sandy soils. The elastic compression of the sandy soils should occur almost immediately upon the application of the structural dead load during construction. In general, the existing subgrade exhibits a soil unit weight of 105 pcf and friction angle of 29 degrees.

4.4 Settlement Mitigation Techniques for the Ground Storage Tank

4.4.1 Preloading

Based on the estimated total settlement and differential settlement results, it is our opinion that that the settlements are below, but close, to what is typically allowed by designers and tank manufacturers. Therefore, settlement mitigation measures may not be required during construction. If required, preloading is considered as a feasible settlement mitigation technique for the proposed tank. Preloading involves loading of the tank area prior to permanent construction in order to induce settlement that would otherwise take place during and after construction. Preloading options include (1) filling the tank with water prior to putting it in operation or (2) placing and removing an earthen fill embankment prior to tank construction.

If required, preloading can be done by first constructing the storage tank without making pipe connections, followed by filling the storage tank with water in 25% increments. Settlement should be monitored during the preload operation and at the end of each increment by monitoring/ surveying the tank itself. This would allow the geotechnical engineer or his/her representative to determine how the soils are responding and when the preload can be terminated. After the preload is completed, the pipe connections can be made and the tank can be placed in operation. This technique is a viable option assuming accommodations are made to acquire and discharge the water.

4.4.2 Pipe Connections

If the estimated differential settlement of 2.4 inches is considered to be over the threshold allowed between the tank and pipe connections, we recommend moving the connections or fittings outward away from the tank, if feasible, so that the distortion caused by differential settlement is lessened compared to being closer to the tank. Flexible piping connections are another option, which are able to bend and compensate for any settlement between the tank and pipe connections.

4.5 Floor Slab Design & Construction Recommendations

The floor slab may be constructed directly on compacted fine sands, natural soils, or structural fill. The granular free-draining soils should be compacted to a density of at least 95 percent of the Modified Proctor maximum dry density to a depth of at least 12 inches. A gravel frost protection layer is not considered necessary, although a vapor barrier should be installed to help reduce dampness of the surface of the slab. In addition, a thin lift of approximately 3 inches of sand may be placed above the vapor barrier to minimize curling of the slab, which occurs due to the difference in curing rates between the top and bottom of the slab.

Based on our review and evaluation of the test data and site conditions, we recommend that a modulus of subgrade reaction “k” value of 100 pci to be used for concrete slab design.

4.6 Recommended Design Soil Parameters for Horizontal Directional Drilling (HDD)

Pipes installed using HDD should follow the latest JEA Water & Wastewater Standards Manual. We recommend that soil parameters assumptions and interpretations for the horizontal directional drilling design follow the information provided in the Recommended Design Soil Parameters for Horizontal Directional Drilling tables included in **Appendix B**. Soil parameters provided in the tables are representative of the soil conditions at the variable depths and have been generated based on N-values that were corrected for hammer efficiency and overburden pressure.

4.7 Open Cut Excavations for Pipes

In general, we consider the subsurface soil conditions at the site to be favorable for support of the proposed pipes over a properly prepared and compacted subgrade, provided that the site preparation and earthwork construction recommendations in this report are followed.

It should be noted that over-excavation will be required in several areas due to the presence of large roots and unsuitable organic soils. Depending on the design pipe invert elevations, it is likely that some excavated suitable soils will get mixed with unsuitable organic and/or plastic soils during construction and should be regarded as unsuitable for backfill purposes. We recommend that allowances be made for possible overruns in quantities of subsoil removal and replacement with select backfill.

Outside the limits of the unsuitable soils, the area generally consists of sands (SP & SP-SM) which should be considered suitable for use in construction. We anticipate that the buried pipelines will exert little downward pressure on the subgrade soils. In areas where the surrounding groundwater level is above the pipe invert elevation, the lines should be designed to resist lateral earth pressures and hydrostatic uplift pressures appropriate to their depth below the existing grade and the seasonal high-water level.

4.8 Access Road

Generally, the near surface subgrade soils along the access road consist of sands (SP & SP-SM) material, which should be considered suitable for use in construction. However, it is anticipated the majority of the near surface subgrade soils are underlain by large roots. Therefore, site preparation consisting of the removal of large trees, vegetation, surficial topsoil, and any unsuitable organic soils will be necessary. This should be followed by placement of the select backfill or structural fill as needed to achieve the design finished pavement grades. Following the removal of unsuitable organic soils and backfilling with suitable soils, we consider the subsurface conditions at the site to be favorable for support of the access road, if a properly prepared subgrade is provided.

4.9 Sheet Pile Wall Design Recommendations

We understand that the proposed access road embankment to Well No. 3 will require permanent sheet pile retaining wall to support the embankment. Therefore, we recommend that the soil parameters included in **Appendix B** of this report be used for the sheet pile wall design.

4.10 Suitability of Borrow Materials for Construction

It should be cautioned that soil conditions at the site are highly erratic in nature and contain unsuitable material consisting of organic and highly organic soils and clays that are variable in thickness and depth throughout the site. It is emphasized that due to the erratic nature of these soils, the thickness and depth of the unsuitable material may vary from those noted herein, and that in some locations the unsuitable material may be deeper.

The near surface soil in the areas of Well Nos. 1 & 2 are generally underlain by unsuitable organic slightly silty sands (SP-SM/PT) and highly organic silty sands (PT) encountered in the upper 2 to 8 feet of depth below the existing ground surface, which are considered unsuitable for backfilling and construction. It should be noted that over-excavation of the unsuitable organic soils will be required. The near surface soils in the remaining areas outside Wells No. 1 & 2, and at the retention pond, are generally underlain by fine sands (SP: USCS), slightly silty sands (SP-SM), silty sands (SM), and clayey sands (SC) in the upper 22 to 35 feet of depth below the existing grades, followed by sandy clays (CH/CL) to the termination depths of the borings.

Fine sands (SP) and slightly silty fine sands (SP-SM) are considered as select material. Silty fine sands (SM) may contain excess moisture and will be difficult to dry and to compact. Therefore, silty fine sands should not be used at this site under the tank or the building foundations. Plastic clayey sands (SC), highly plastic sandy clays (CL/CH), and unsuitable organic soils should be considered unsuitable for backfilling and compaction purposes.

We recommend that allowance be made for overruns in quantities of subsoil removal and replacement with select backfill. It should be noted that unsuitable organic soils boundaries and limits are approximate and represent soils encountered at each boring location. Subsurface variance between borings may occur and should be anticipated.

Unsuitable organic soils, silty soils, and plastic soils should be stockpiled separately from the select soils in order to avoid contaminating the select material. In addition, an extensive dewatering system will be required in order to lower the groundwater level prior to excavation. This practice should allow the select SP and SP-SM soils to drain adequately prior to being excavated and stockpiled. Without a dewatering system, the stockpiled material will stay saturated, thus being difficult to dry and to compact for backfilling purposes.

5.0 PAVEMENT DESIGN GUIDELINES & RECOMMENDATIONS

5.1 Site Preparation

If needed, a certain degree of site preparation consisting of the removal of large trees and their roots, unsuitable organic soils, sands with many roots, vegetation, surficial topsoil may be required. This should be followed by placement of the select backfill or structural fill as needed to achieve the design finished pavement grades.

5.2 Stabilized Subgrade

For new pavement construction, the areas to be paved should be stripped and grubbed, filled and compacted. The top 12 inches of soils beneath the base course material shall be a stabilized subgrade with a minimum LBR value of 40 and it shall be compacted to at least 98 percent of its Modified Proctor maximum dry density.

5.3 Limerock Base

The base course could consist of Limerock with a Limerock Bearing Ratio of 100. We recommend a base course at least six inches thick under standard pavements, i.e. under automobiles and lightweight truck; and eight inches for heavy equipment areas. The base course may be placed and compacted in one single layer. All base course materials should be placed and compacted to at least 98 percent of its modified proctor maximum dry density.

5.4 Wearing Surface

A 1-1/2 (minimum) inch layer of type III (or FDOT Type S-1) asphalt concrete having a minimum Marshall stability of 1,000 pounds is recommended for wearing surface in automobile parking areas. For heavy equipment areas, 2 inches of Type III or Type S-1 asphalt concrete is recommended. The asphalt concrete layer should be compacted to at least 98 percent of laboratory density.

6.0 SITE PREPARATION & CONSTRUCTION RECOMMENDATIONS

6.1 Existing Utilities

The locations of existing utilities should be established prior to construction. Provisions should be made to relocate utilities interfering with the proposed alignments and construction, as needed. Underground pipes that are not operational should be either removed, plugged, or grouted in place otherwise they may become conduits for subsurface erosion and cause settlements.

6.2 Initial Site Preparations

All vegetation, topsoil, gravel, roots and organic zones should be removed from the construction area for a distance of at least (5) feet beyond the construction area limits and structures footprint. The depth to which stripping will be required will vary to some degree. Some localized areas may require more than 12 inches of stripping to remove significant root zones.

6.3 Groundwater Control

Groundwater level was encountered at depths ranging from ground surface to 7.0 feet beneath the existing ground surface at the time of drilling. Generally, dewatering may be achieved by conventional open pumping using ditches graded to a sump or by using a deep well point system. However, it is anticipated that extensive dewatering will be required to backfill and compact in the dry. The groundwater level should be maintained at least 2 feet below the bottom of any excavations made during construction and below the surface of any vibratory compaction operations.

6.4 Surface Water Control

The need for surface water runoff control should be anticipated during the site preparation and foundation construction process. Lack of proper controls could result in ponding of surface water in shallow foundation bearing areas and on compacted surfaces. Ponded water, combined with machine or foot traffic during construction operations or other activities, could disturb otherwise acceptable soils or previously compacted existing soils, causing instability, "pumping", and generally unacceptable conditions. The ponded water will also impede or prevent necessary soil compaction operations and make construction trafficability difficult.

Surface water can be controlled by proper grading of the site and by the use of temporary drainage ditches, diversion berms, and/or pumping from drainage controlled collection points.

6.5 Removal of Unsuitable Materials & Excavation Backfill Recommendations

Unsuitable organic soils were encountered in the areas of Well Nos. 1 and 2 in the upper 2 to 8 feet below the existing grades. These unsuitable organic soils are considered unsuitable material and should be completely removed/excavated in their entirety and backfilled with suitable material. It should be cautioned that soil conditions at the site are highly erratic in nature and contain unsuitable material consisting of organic and highly organic soils and clays that are variable in thickness and depth throughout the site. It is emphasized that due to the erratic nature of these soils, the thickness and depth of the unsuitable material may vary from those noted herein, and that in some locations the unsuitable material may be deeper. The approximate limits of unsuitable organic limits are summarized in the table below:

APPROXIMATE OVER-EXCAVATION LIMITS OF REMOVAL OF UNSUITABLE SOILS

Location	Reference Boring(s)	Approximate Over-Excavation Depth*
Ground Storage Tank (GST)	B-1 & B-2	8 feet
Well No. 1 Pad	B-9	4 feet
Well No. 2 Pad	B-18	2 feet
Chemical Chlorine Storage	B-6	9 feet
High Service Pump Station Building	B-7 & B-8	8 feet
Fuel Tank	B-10	6 feet
Generator	B-11	5 feet

* Depth below existing ground surface

Excavated unsuitable soils should be replaced with No. 57 stone or clean sands placed in maximum 1-foot loose lifts and compacted in the dry to densities equivalent to 95 percent of the Modified Proctor maximum dry density. When #57 stone is recommended as backfill of the over excavation, it is recommended that it should be wrapped around with filter fabric or geotextile as a separation layer to prevent settlement due to migration of fine soil particles into the aggregate layer. When excavating to remove unsuitable materials, it is very likely that the excavated suitable soils will get mixed with unsuitable organic soils during construction. Therefore, it is our opinion that some of the excavated material should be regarded as unsuitable for backfill purposes. We recommend that allowance be made for overruns in quantities of subsoil removal and replacement with select backfill. It should be noted that unsuitable organic soils boundaries and limits are approximate and represent soils encountered at each boring location. Subsurface variance between borings may occur and should be anticipated.

Due to the wooded nature of the site in some areas, extensive root zones should be expected. If left in place the root zones may contribute to some long-term decay related settlements. In the heavily wooded areas, and depending on design finished grades, it may be desirable to remove large root systems by using a root rake on track-mounted equipment to uproot and remove large root mat sections. It is recommended that the upper 12 to 18 inches of surficial soils be root raked. Insufficient removal in the surficial soils can result in low density results due to higher concentrations of low density material and high moisture contents.

6.6 Excavation Protection

All excavations should meet OSHA Excavation Standard Subpart P regulations for Type C soils. A trench box or braced sheet pile structures may be considered to support open excavations. The soil support system shall be designed according to OSHA by a Florida registered Professional Engineer.

6.7 Site & Fill Compaction

After initial clearing and stripping operations have been completed, and upon satisfactory removal of unsuitable organic soils, the exposed soils in the proposed construction areas should be compacted to densities equivalent to 95 percent of the Modified Proctor maximum dry density (ASTM D1557). This compactive effort should help improve the overall uniformity and bearing conditions of the near-surface and underlying soils.

Structural fill may be placed in loose lifts not exceeding 12 inches. Each lift of fill should be compacted until densities equivalent to at least 95 percent of the Modified Proctor maximum dry density are uniformly obtained. Structural fill should consist of an inorganic, non-plastic, granular soil containing less than 12 percent material passing through the No. 200 mesh sieve (relatively clean sand with a Unified Soil Classification of SP or SP-SM). Areas not supporting foundations, pavements, or any structures, and not receiving structural fill, can be compacted in the dry to at least 90 percent of the Modified Proctor maximum dry density provided the soils consist of relatively clean soils with no unsuitable soils.

6.8 Disturbed Soil Conditions

Should the soils experience "pumping" and subsequent soil strength loss during compaction operations, compaction work should be terminated and: (1) the disturbed soils removed and backfilled with "dry" structural fill soils, which are then compacted; or (2) the excess moisture content within the disturbed soils allowed to dissipate before re-compaction. Furthermore, the groundwater level should be checked and controlled as necessary in order to help ensure proper drawdown of any high groundwater conditions that may be causing the "pumping" conditions during compaction or construction activity upon these soils.

6.9 Pipe Backfill and Compaction of Pipe Backfill

The SP and SP-SM type soils are considered select material and suitable for use as backfill. Silty sands (SM) can be treated as select material, however, they may contain excess moisture and may be difficult to dry and to compact. Clayey sands (SC) and sandy clays (CL/CH) should be considered as plastic and highly plastic materials, respectively, and should be excavated to a minimum depth of one foot below the design invert elevations and replaced with suitable SP and SP-SM fill material. If encountered, organic soils should be removed in their entirety. Plastic clayey sands (SC), highly plastic sandy clays (CL/CH), and all organic soils should be considered unsuitable for backfilling and compaction purposes.

It should be cautioned that soil conditions at the site are highly erratic in nature and contain unsuitable material consisting of organic and highly organic soils and clays that are variable in thickness and depth throughout the site. It is emphasized that due to the erratic nature of these soils, the thickness and depth of the unsuitable material may vary from those noted herein, and that in some locations the unsuitable material may be deeper. As mentioned earlier, some of the excavated suitable soils will likely get mixed with unsuitable soils and/or plastic soils during construction. Therefore, some or all the excavated material may become unsuitable for backfill purposes. We recommend that allowance be made for overruns in quantities of subsoil removal and replacement with select backfill.

The backfill material within the excavation should be placed in thin loose lifts not exceeding 6 inches in thickness. The backfill material should be compacted by the use of hand-operated equipment. The backfill material should be granular (SP & SP-SM) fill with less than 10 percent material passing the no. 200 mesh sieve and containing less than 3 percent organic matter. The backfill material should be compacted to a minimum density of 98% or 95% of maximum dry density obtained from the Modified Proctor compaction test (ASTM D1557), as required by JEA. The moisture content during compaction should be maintained within $\pm$ 3 percent of the optimum moisture content as obtained from the Modified Proctor compaction test. Handheld compaction equipment should be used for the backfill placed around the pipes and to a height of 2 feet above the pipes. Heavier equipment may be used on the remaining backfill lifts placed above 2 feet. However, care should be taken not to damage the pipe below. The pipe should be designed to withstand the anticipated dead (overburden) and live loads.

6.10 Roadway Subgrade Stabilization and Compaction

The upper one foot of the subgrade soil should be stabilized to achieve an LBR Value of 40 with a maximum plasticity index of 6. The stabilization procedures and the stabilizing materials should be as presented in the Standard Specifications.

6.11 Foundation Bearing Surface Preparation

The upper 24 inches of bearing soils should be compacted to densities equivalent to at least 95 percent of the material's maximum dry density as determined by the Modified Proctor test. Concentrated root zones or other unsuitable matter encountered at the bearing level should be completely removed and replaced with compacted structural fill material. If plastic soils are encountered at the bottom of the foundation they should be regarded as unsuitable soils and should be removed to a depth of at least 2 feet beneath the bottom of the foundation. Excavated unsuitable soils should be replaced with clean sands placed in maximum 1-foot loose lifts and compacted to densities equivalent to 95 percent of the Modified Proctor maximum dry density. As noted earlier, silty fine sands may contain excess moisture and will be difficult to dry and to compact. Therefore, silty fine sands should not be used at this site under the tank or the building foundations.

7.0 QUALITY CONTROL & TESTING GUIDELINES

Prior to initiating compaction operations, we recommend that representative samples of the structural fill material to be used and acceptable exposed in-place soils be collected and tested to determine their compaction and classification characteristics. The maximum dry density, optimum moisture content, gradation and plasticity characteristics should be determined. These tests are needed for compaction quality control of the structural fill and existing soils and to determine if the fill material is acceptable.

A representative number of in-place field density tests should be performed in the compacted existing soils and in each lift of structural fill or backfill to confirm that the required degree of compaction has been obtained. At least one test per lift should be made for every 1,000 square feet of structure area and every 25 feet for the tank's foundation perimeter. The bearing level soils should be inspected and tested by an engineering technician acting under the direction and supervision of the geotechnical engineer in order to evaluate the density and acceptability of the bearing material prior to steel placement and foundation construction.

8.0 REPORT LIMITATIONS

The subsurface exploration program including our evaluation and recommendations was performed in general accordance with accepted geotechnical engineering principles and standard practices. CSI Geo is not responsible for any independent conclusions, opinions, or interpretations made by others based on the data presented in this report.

This report does not reflect any variations that may occur adjacent or between soil borings. The discovery of any site or subsurface condition during construction that deviates from the findings and data as presented in this report should be reported to CSI Geo for evaluation. If the location of the proposed project features is changed, our office should be contacted so our recommendations can be re-evaluated. We recommend that CSI Geo be given the opportunity to review the final design drawings and specifications to ensure that our recommendations are properly included and implemented.

Appendix A – Maps

- Site Location Map
- Field Exploration Plan

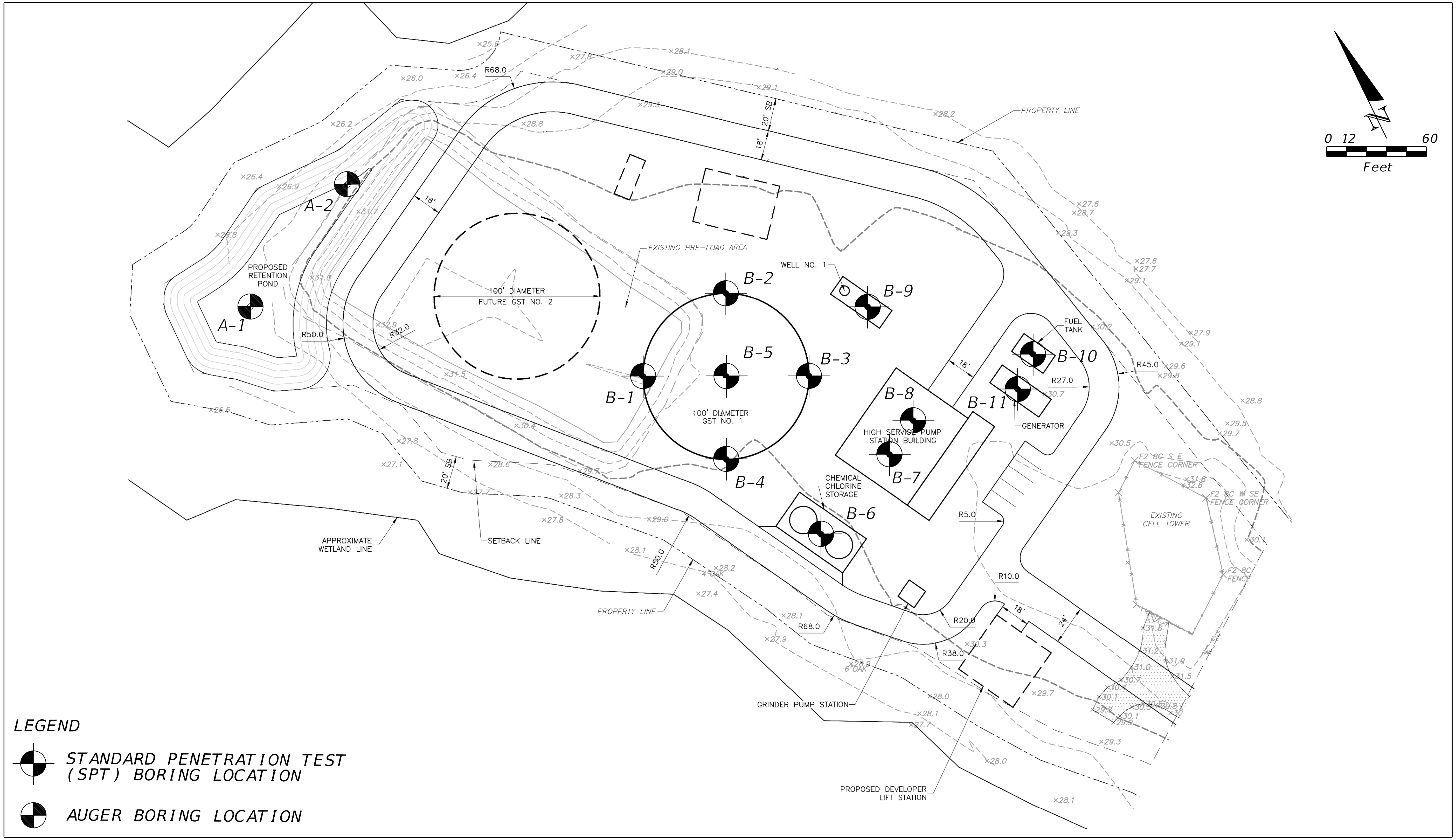
Site Location Map

CSI GEO, INC.
2394 ST. JOHNS BLUFF ROAD S., SUITE 200
JACKSONVILLE, FLORIDA 32246

SITE LOCATION MAP

RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA

Field Exploration Plan

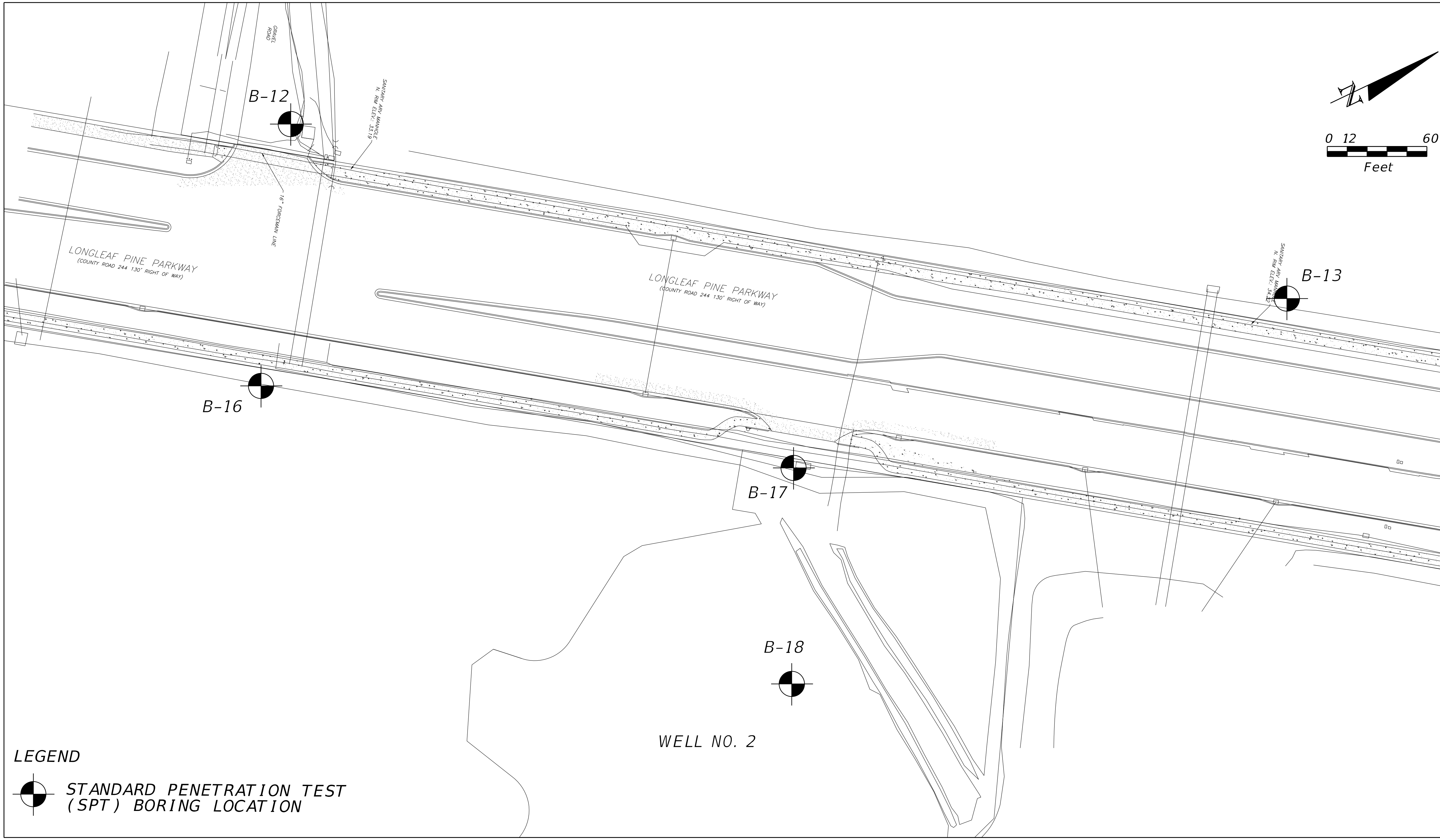


CSIGeo
GEOTECHNICAL·CMT·CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

FIELD EXPLORATION PLAN

RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA

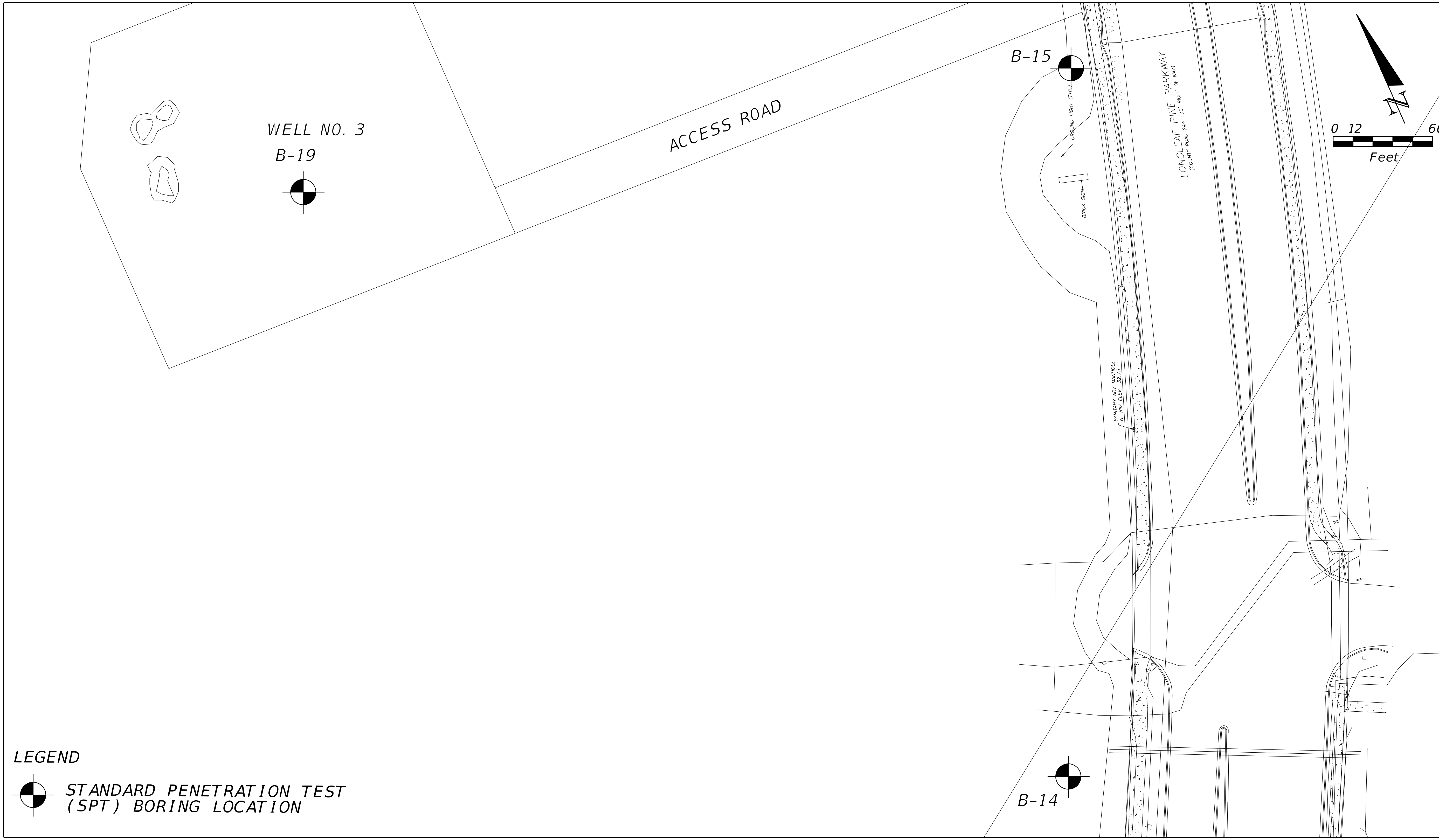


CSIGeo
GEOTECHNICAL·CMT·CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

FIELD EXPLORATION PLAN

RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



CSIGeo
GEOTECHNICAL·CMT·CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

FIELD EXPLORATION PLAN

RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA

Appendix B – Field Exploration, Evaluation & Laboratory Testing

- Report of SPT Borings
- Report of Core Borings (Retention Pond)
- Recommended Soil Parameters for Horizontal Directional Drilling Design
- Recommended Soil Parameters for Sheet Pile Walls
- Tank Settlement Analysis Results
- Summary of Laboratory Test Results
- Grain Size Distribution Curves

Report of SPT Borings

LEGEND

FINE SAND (SP); SLIGHTLY SILTY FINE SAND (SP–SM); SLIGHTLY CLAYEY FINE SAND (SP–SC)

SILTY FINE SAND (SM)

CLAYEY FINE SAND (SC)

SANDY CLAY (CL/CH)

CLAY (CH)

SANDY SILT (MH)

ORGANIC SLIGHTLY SITLY SAND (SP–SM/PT); ORGANIC SILTY SAND (SM/PT); WOOD PIECES; HIGHLY ORGANIC SILTY SAND (PT)

LIMESTONE

SHELLS

GRAVEL

(SP)	USCS SOIL CLASSIFICATION SYSTEM
▽	ESTIMATED SEASONAL HIGH GROUND WATER LEVEL
▼	GROUND WATER LEVEL AT TIME OF DRILLING
B.T.	SPT BORING TERMINATION
50/X"	BLOWS PER X INCREMENTS IN INCHES
WOH	WEIGHT OF HAMMER
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT. NUMBERS TO THE LEFT OF BORING INDICATE N–VALUES

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N–VALUE (BLOWS/FT)
VERY LOOSE	LESS THAN 3
LOOSE	3–8
MEDIUM DENSE	8–24
DENSE	24–40
VERY DENSE	GREATER THAN 40

SILTS AND CLAYS

CONSISTENCY	AUTOMATIC HAMMER SPT N–VALUE (BLOWS/FT)
VERY SOFT	LESS THAN 1
SOFT	1–3
FIRM	3–6
STIFF	6–12
VERY STIFF	12–24
HARD	GREATER THAN 24

STANDARD PENETRATION TEST DATA

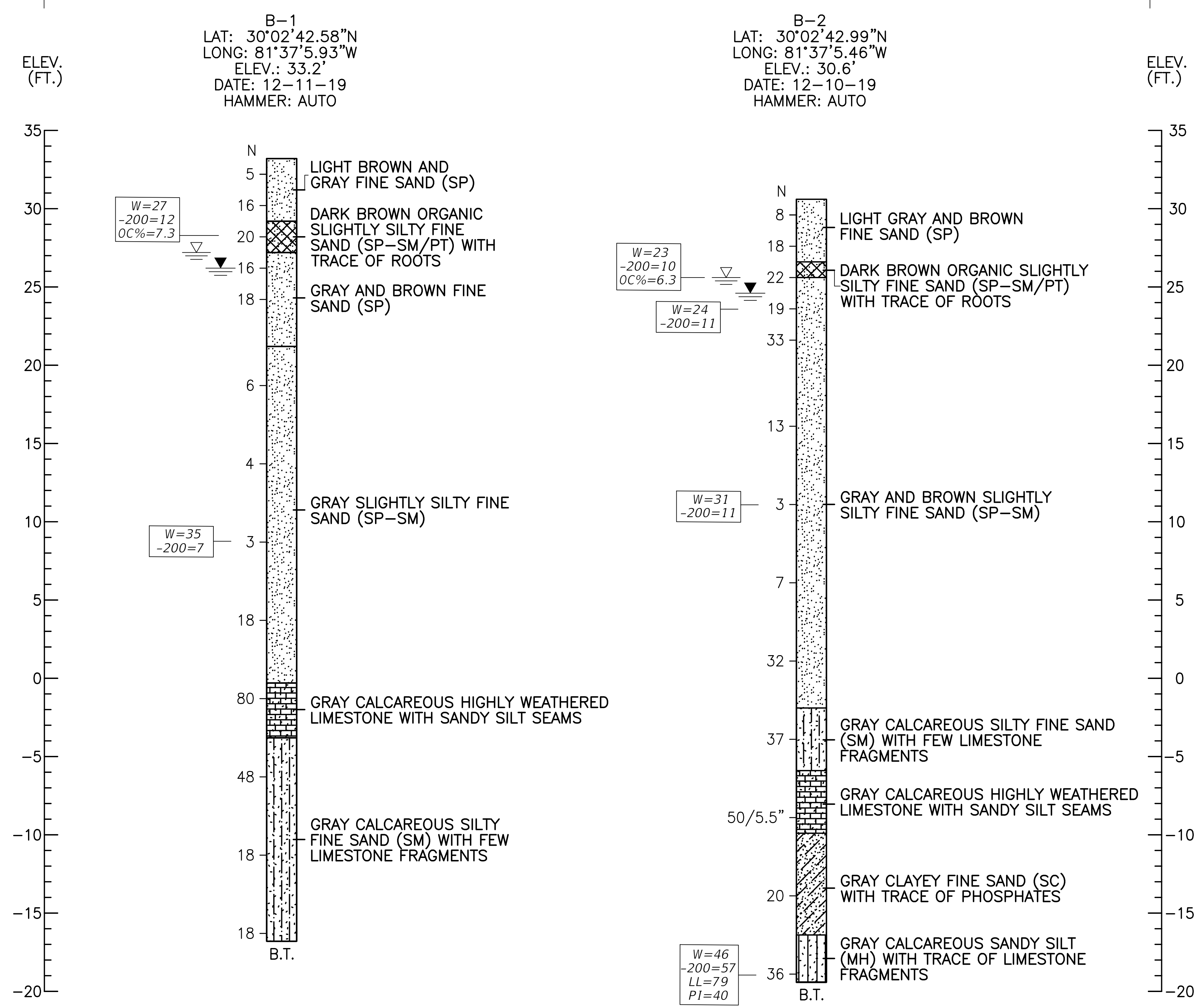
SPOON INSIDE DIA.	1.44 INCHES
SPOON OUTSIDE DIA.	2.0 INCHES
ASTM STANDARD DROP HAMMER	
AVG. HAMMER DROP	30.0 INCHES
HAMMER WEIGHT	140.0 LBS

NOTES:

1) DRILL AND PENETRATION TESTING WAS PERFORMED IN ACCORDANCE WITH ASTM D–1586.

2) LAYER BOUNDARIES ARE APPROXIMATE AND MAY VARY BETWEEN OR AWAY FROM BORING LOCATIONS.

GROUND STORAGE TANK (GST)

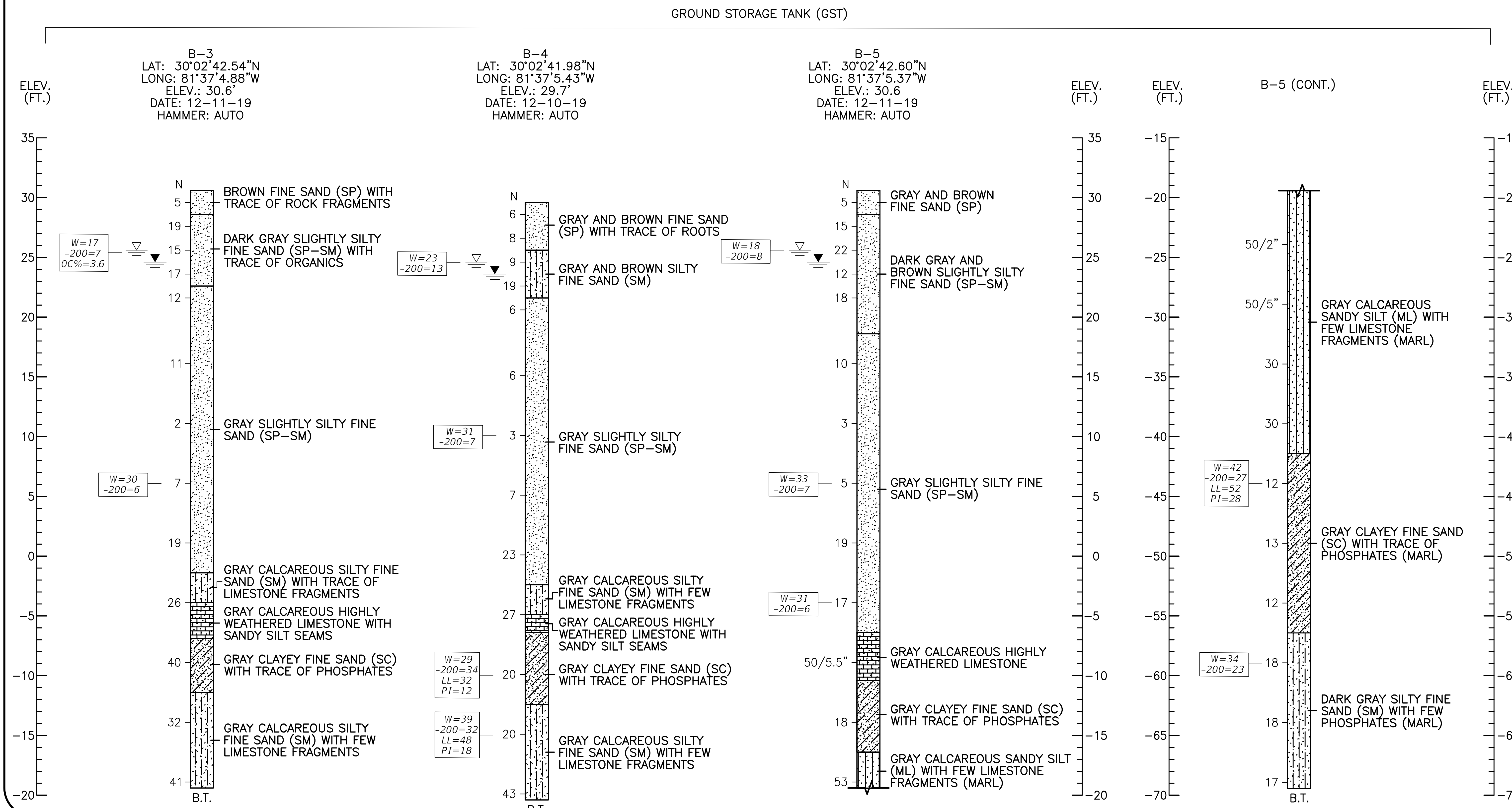


CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

REPORT OF SPT BORINGS

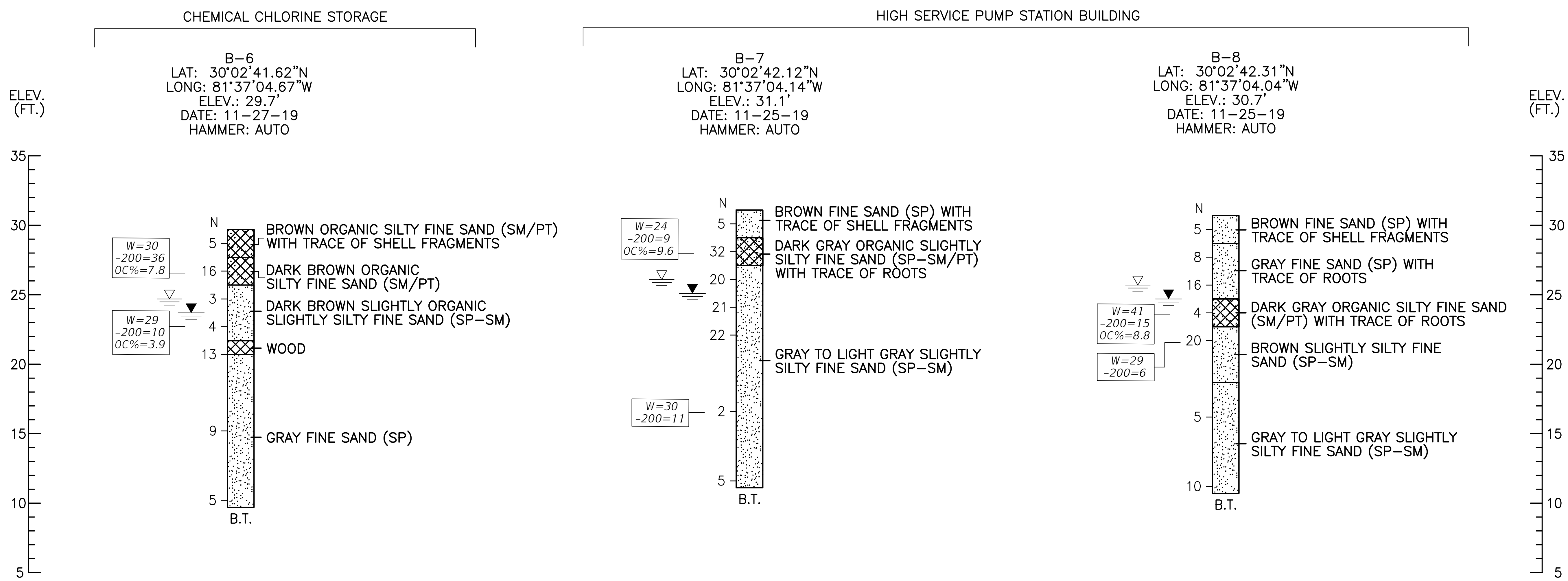
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

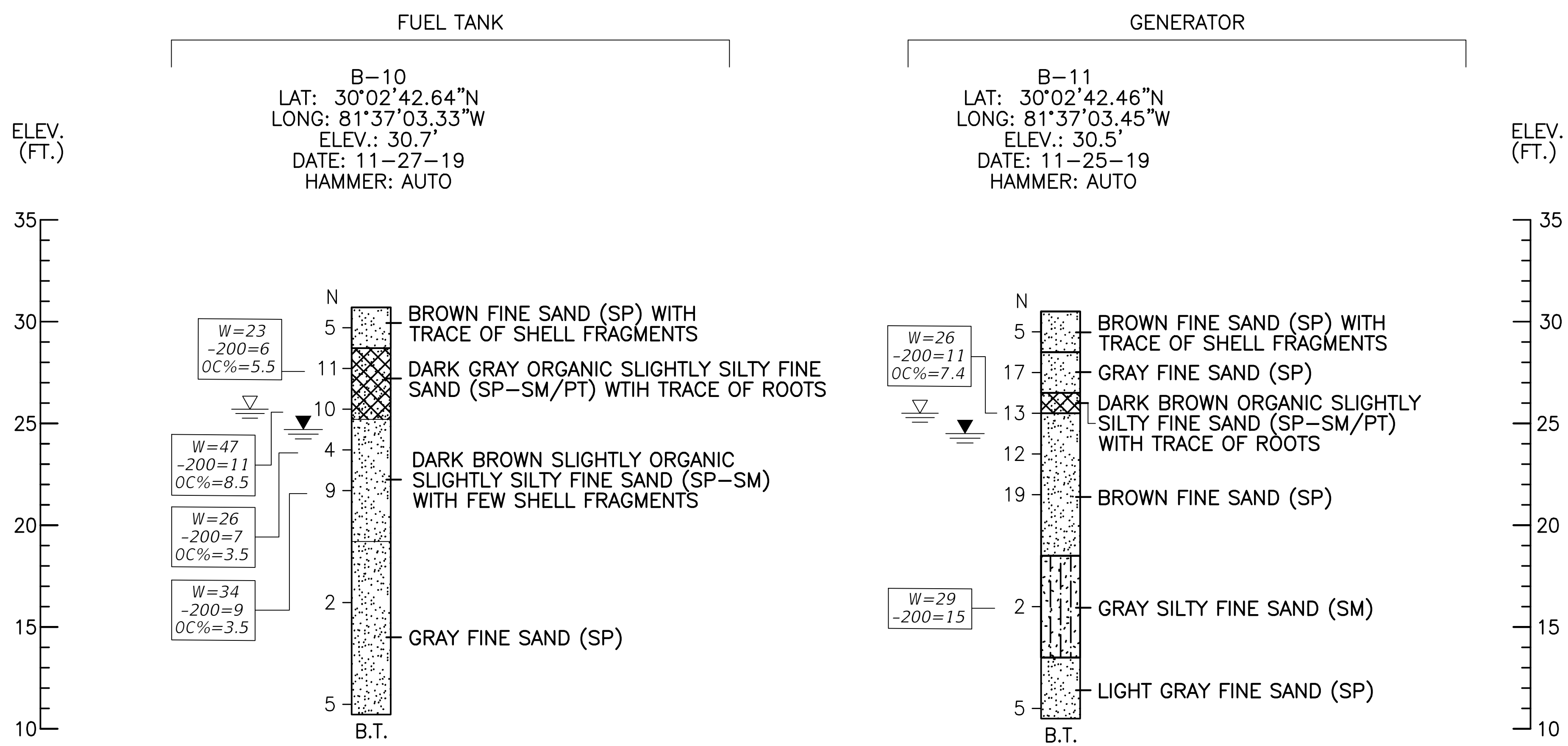
REPORT OF SPT BORINGS
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

REPORT OF SPT BORINGS
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA

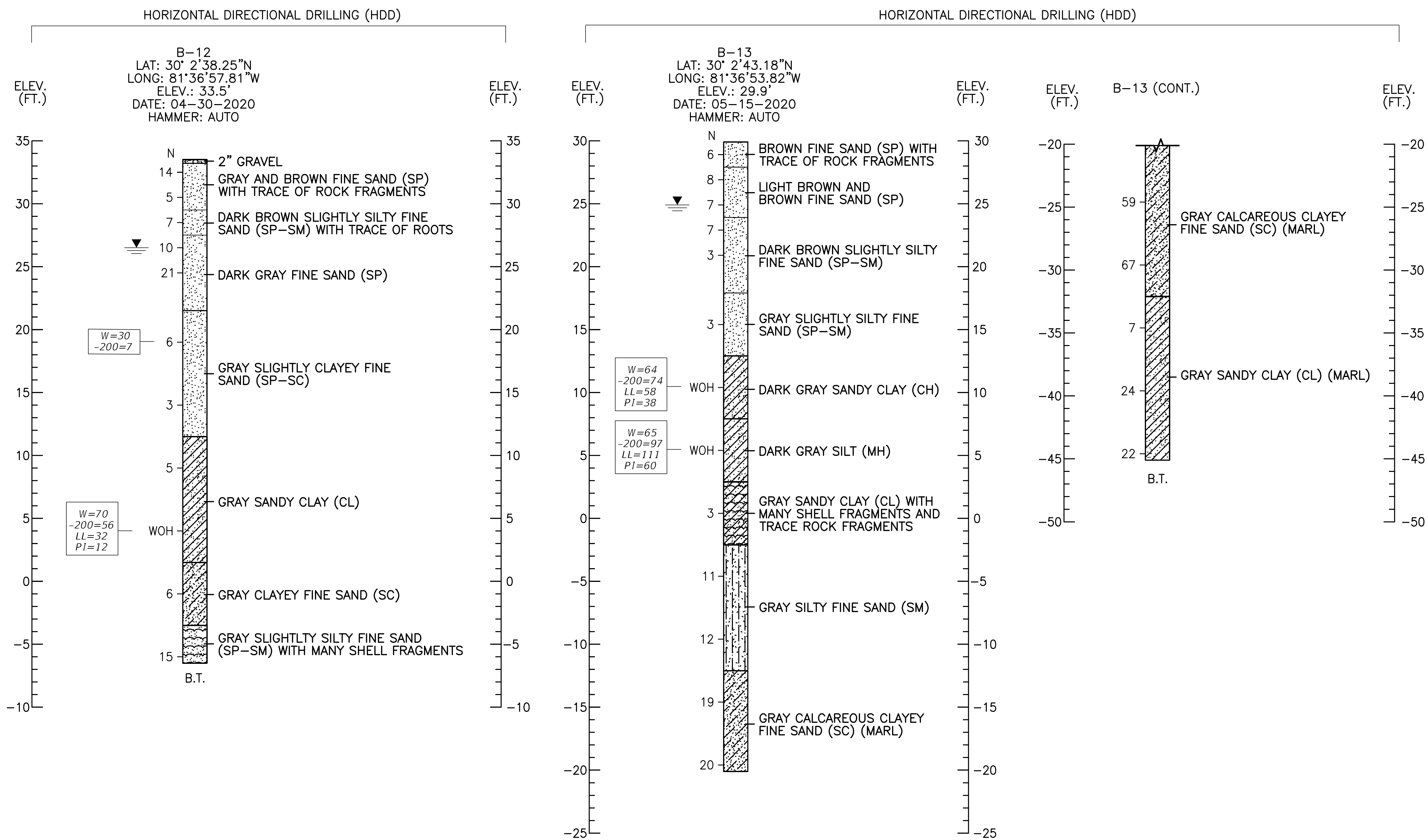


CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

REPORT OF SPT BORINGS

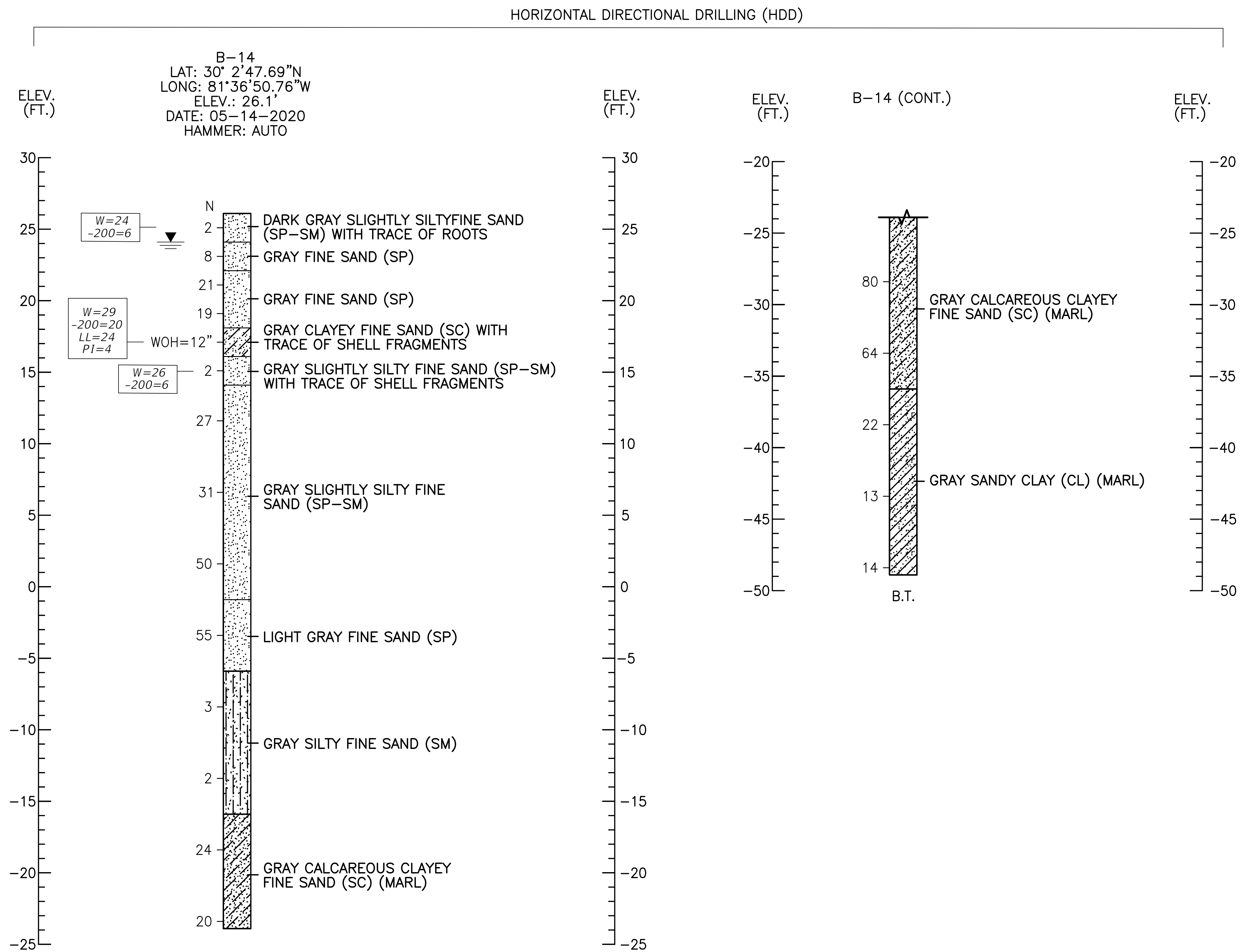
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

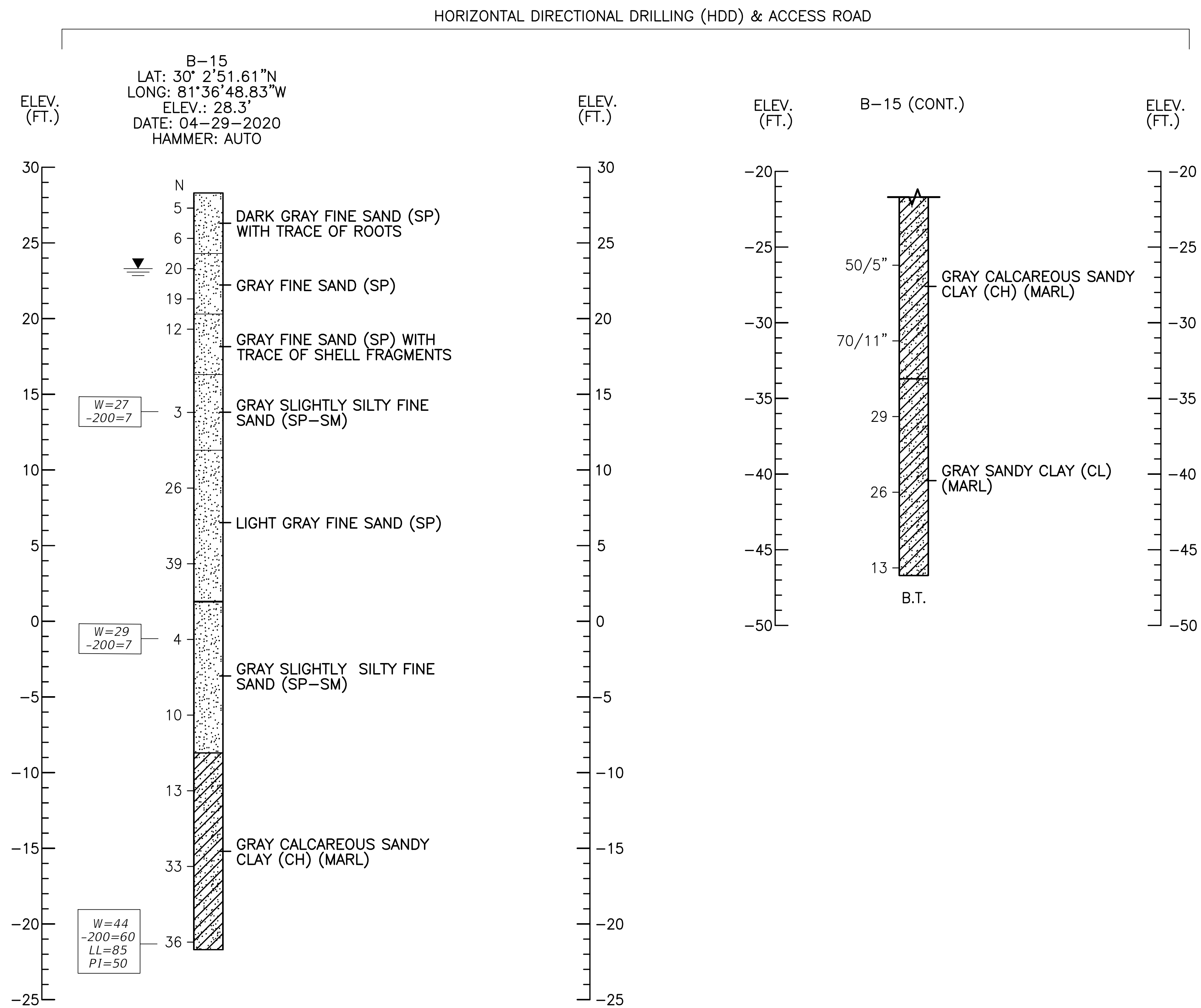
REPORT OF SPT BORINGS
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

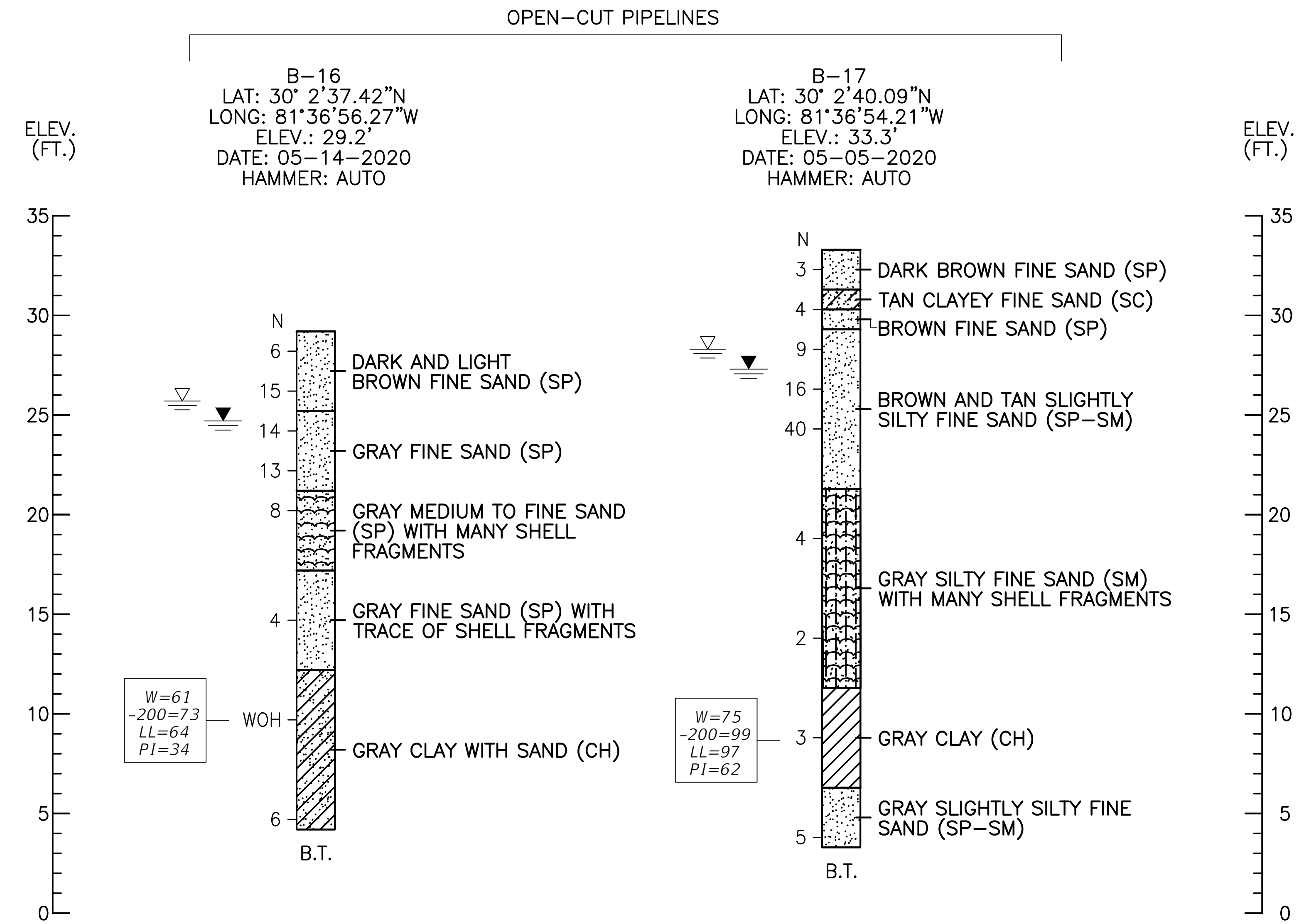
REPORT OF SPT BORINGS
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

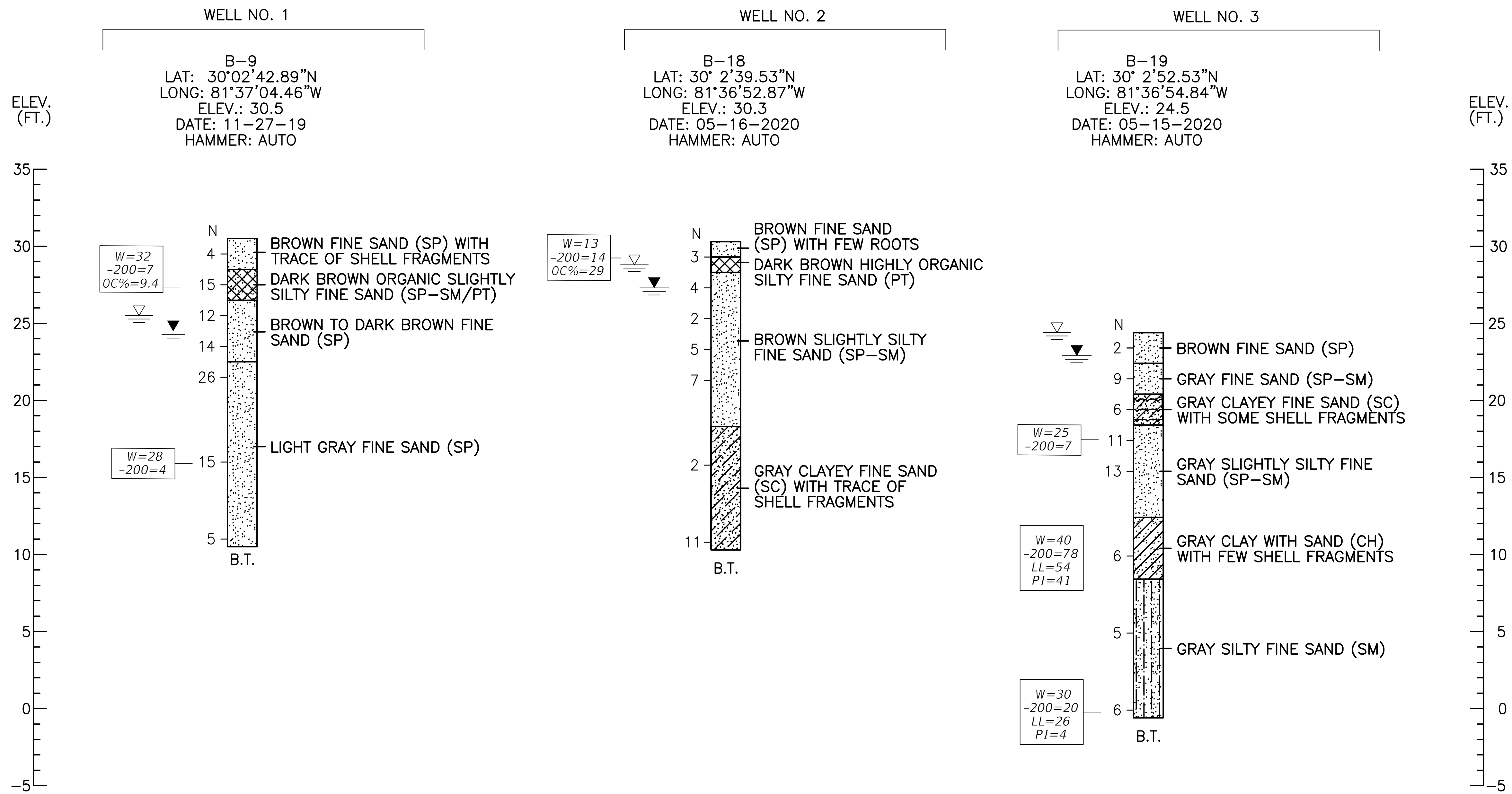
REPORT OF SPT BORINGS
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

REPORT OF SPT BORINGS
RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA



CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

REPORT OF SPT BORINGS

RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA

Report of Core Borings

LEGEND

FINE SAND (SP);
SLIGHTLY SILTY FINE SAND (SP–SM)

SILTY FINE SAND (SM)

(SP) USCS SOIL CLASSIFICATION SYSTEM

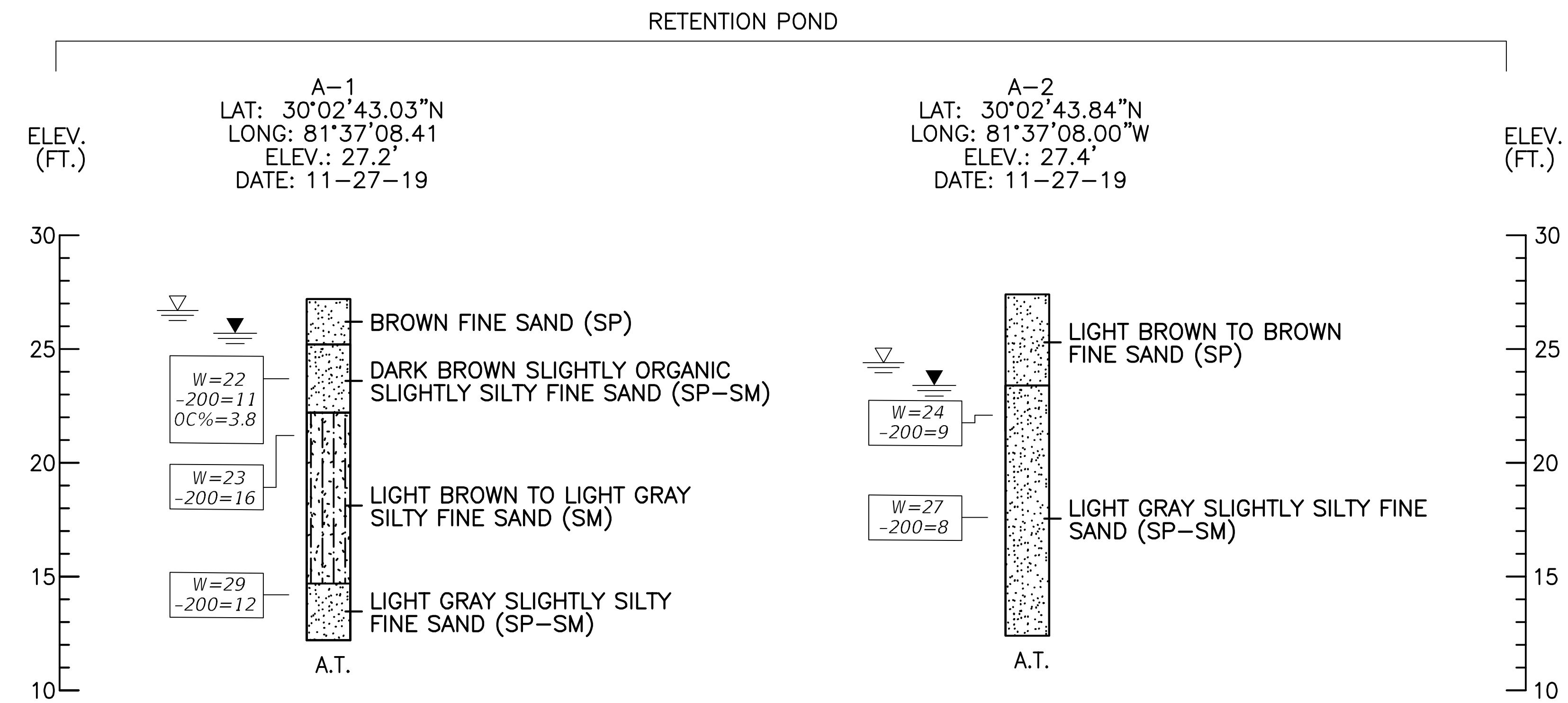
ESTIMATED SEASONAL HIGH GROUND WATER LEVEL

GROUND WATER LEVEL AT TIME OF DRILLING

A.T. AUGER BORING TERMINATION

NOTES:

LAYER BOUNDARIES ARE APPROXIMATE AND MAY VARY BETWEEN OR AWAY FROM BORING LOCATIONS.



CSIGeo
GEOTECHNICAL · CMT · CEI
2394 ST. JOHNS BLUFF ROAD, S. SUITE 200
JACKSONVILLE, FLORIDA 32246

GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

REPORT OF CORE BORINGS

RIVERTOWN WATER TREATMENT PLANT
ST. JOHNS COUNTY, FLORIDA

Recommended Soil Parameters for Horizontal Directional Drilling Design

<u>RECOMMENDED SOIL PARAMETERS FOR HORIZONTAL DIRECTIONAL DRILLING DESIGN</u>

Boring B-12

Soil Parameter	Loose to Medium Dense Sands	Loose Sands	Firm Clays	Very Soft Clays	Loose to Medium Dense Clayey Sands and Sands
Depth (ft)	0.0’- 12.0’	12.0’- 22.0’	22.0’- 27.0’	27.0’- 32.0’	32.0’- 40.0’
Saturated unit weight (pcf)	115	100	95	90	105
Effective unit weight for input purposes (pcf)	53	38	33	28	43
Estimated friction angle ϕ (degrees)	33	27	-	-	29
Cohesion (psf)	-	-	900	200	29
At Rest Pressure Coefficient (K_o)	0.46	0.55	1.0	1.0	0.52
Active Pressure Coefficient (K_a)	0.29	0.38	1.0	1.0	0.35
Passive Pressure Coefficient (K_p)	3.39	2.66	1.0	1.0	2.88

Soil parameters provided in the tables are representative of the soil conditions at the variable depths and have been generated based on N-values that were corrected for hammer efficiency and overburden pressure.

Boring B-13

Soil Parameter	Loose Sands	Very Soft Clays	Medium Dense Silty and Clayey Sands	Very Dense Clayey Sands	Stiff to Very Stiff Clays
Depth (ft)	0.0’- 17.0’	17.0’- 32.0’	32.0’- 52.0’	52.0’- 62.0’	62.0’- 75.0’
Saturated unit weight (pcf)	105	90	115	120	105
Effective unit weight for input purposes (pcf)	43	28	53	58	43
Estimated friction angle ϕ (degrees)	30	-	30	35	-
Cohesion (psf)	-	200	-	-	2,000
At Rest Pressure Coefficient (K_o)	0.50	1.0	0.50	0.43	1.0
Active Pressure Coefficient (K_a)	0.33	1.0	0.33	0.27	1.0
Passive Pressure Coefficient (K_p)	3.00	1.0	3.00	3.69	1.0

Soil parameters provided in the tables are representative of the soil conditions at the variable depths and have been generated based on N-values that were corrected for hammer efficiency and overburden pressure.

RECOMMENDED SOIL PARAMETERS FOR HORIZONTAL DIRECTIONAL DRILLING DESIGN

Boring B-14

Soil Parameter	Medium Dense to Dense Sands	Very Loose Sands	Dense to Very Dense Sands	Very Loose Silty Sands	Medium Dense Clayey Sands	Very Dense Clayey Sands (Marl)	Very Stiff Clays (Marl)
Depth (ft)	0.0’- 8.0’	8.0’- 12.0’	12.0’- 32.0’	32.0’- 42.0’	42.0’- 52.0’	52.0’- 62.0’	62.0’- 75.0’
Saturated unit weight (pcf)	115	95	120	100	120	120	105
Effective unit weight for input purposes (pcf)	53	33	58	38	58	58	43
Estimated friction angle ϕ (degrees)	33	27	36	26	32	35	-
Cohesion (psf)	-	-	-	-	-	-	2,000
At Rest Pressure Coefficient (K_o)	0.46	0.55	0.41	0.56	0.47	0.43	1.0
Active Pressure Coefficient (K_a)	0.29	0.38	0.26	0.39	0.31	0.27	1.0
Passive Pressure Coefficient (K_p)	3.39	2.66	3.85	2.56	3.25	3.69	1.0

Soil parameters provided in the tables are representative of the soil conditions at the variable depths and have been generated based on N-values that were corrected for hammer efficiency and overburden pressure.

Boring B-15

Soil Parameter	Medium Dense Sands	Very Loose Sands	Dense Sands	Loose Sands	Dense Clayey Sands	Hard Clays
Depth (ft)	0.0’- 12.0’	12.0’- 17.0’	17.0’- 27.0’	27.0’- 37.0’	37.0’- 62.0’	62.0’- 75.0’
Saturated unit weight (pcf)	115	100	120	105	120	115
Effective unit weight for input purposes (pcf)	53	38	58	43	58	53
Estimated friction angle ϕ (degrees)	33	28	36	28	33	-
Cohesion (psf)	-	-	-	-	-	2,000
At Rest Pressure Coefficient (K_o)	0.46	0.53	0.41	0.53	0.46	1.0
Active Pressure Coefficient (K_a)	0.29	0.36	0.26	0.36	0.29	1.0
Passive Pressure Coefficient (K_p)	3.39	2.77	3.85	2.77	3.39	1.0

Soil parameters provided in the tables are representative of the soil conditions at the variable depths and have been generated based on N-values that were corrected for hammer efficiency and overburden pressure.

Recommended Soil Parameters for Sheet Pile Walls

RECOMMENDED SOIL PARAMETERS FOR SHEET PILE WALLS

Boring B-15

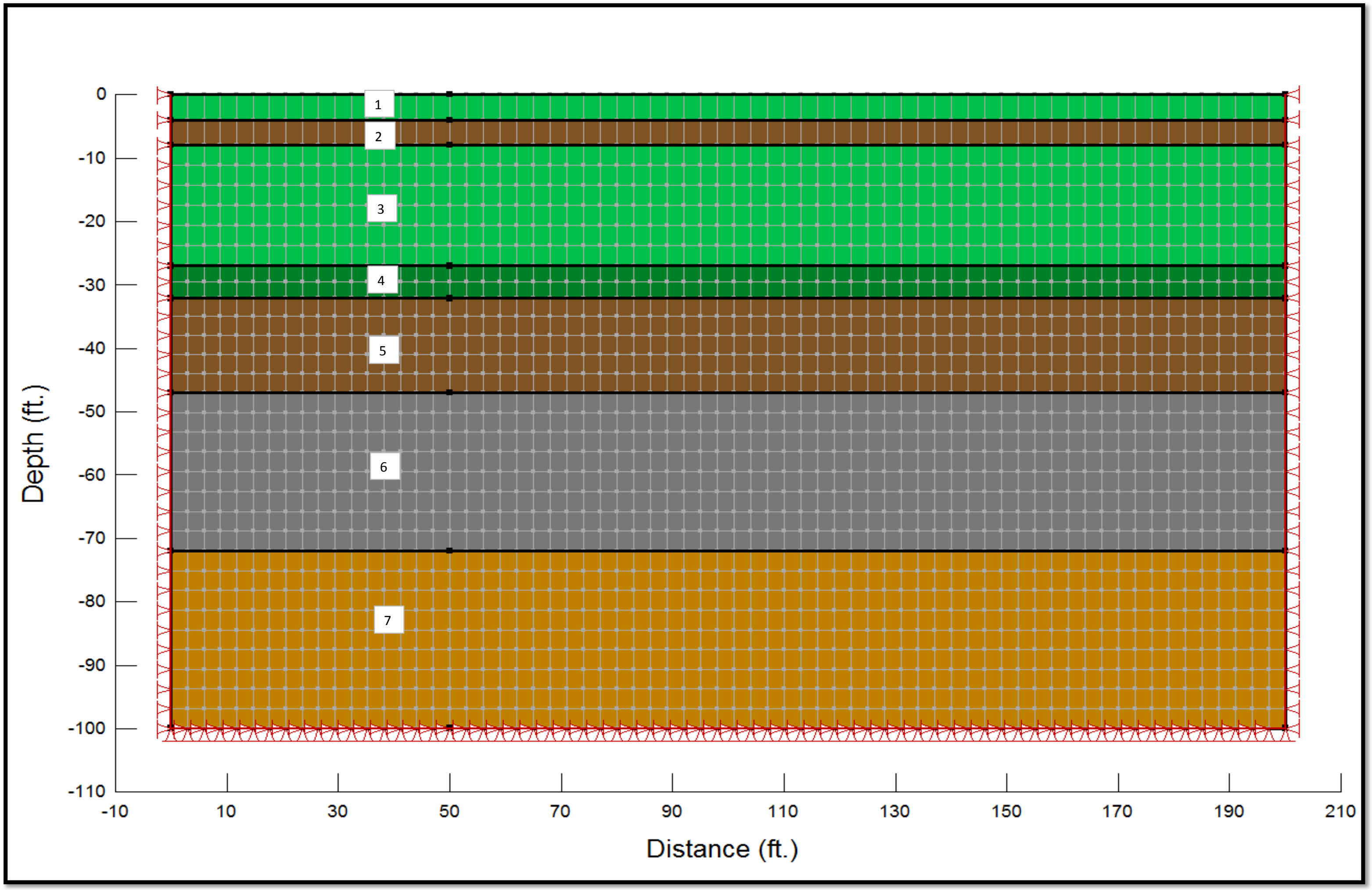
Soil Parameter	Medium Dense Sands	Very Loose Sands	Dense Sands	Loose Silty Sands
Depth (ft)	0.0’- 12.0’	12.0’- 17.0’	17.0’- 27.0’	27.0’- 37.0’
Saturated unit weight (pcf)	115	100	120	105
Effective unit weight for input purposes (pcf)	53	38	58	43
Estimated friction angle ϕ (degrees)	33	28	36	27
Estimated Wall Friction (degrees)	17	14	18	14
Cohesion (psf)	-	-	-	-
At Rest Pressure Coefficient (K_o)	0.46	0.53	0.41	0.55
Active Pressure Coefficient (K_a)	0.29	0.36	0.26	0.38
Passive Pressure Coefficient (K_p)	3.39	2.77	3.85	2.66

Tank Settlement Analysis Results

Settlement Analysis Results

Analysis Information	
Project:	Rivertown WTP
Location:	B-5
Bearing Pressure	2,400 psf
GWT:	5' in depth

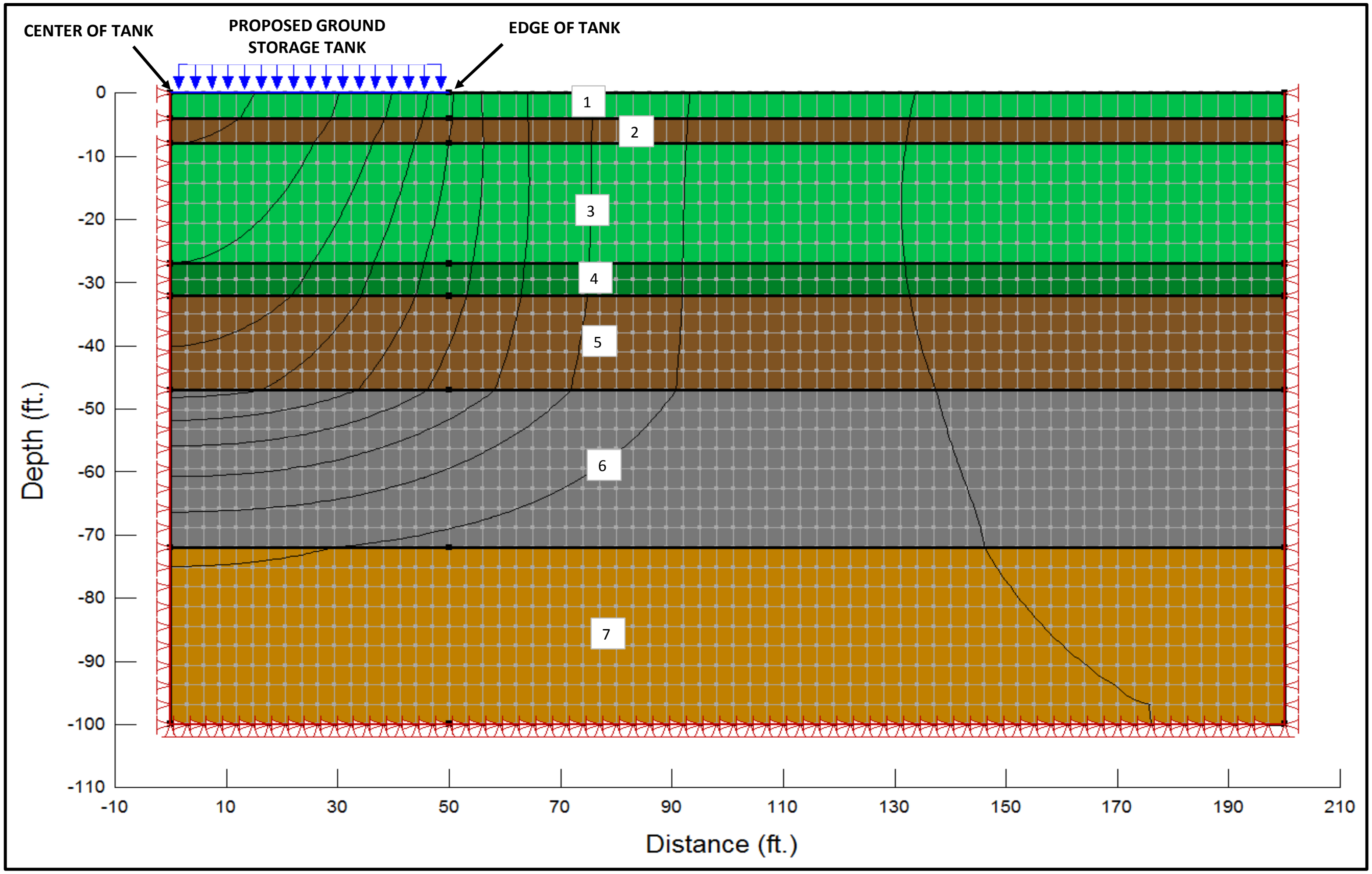
Soil Information									
Stratum	Color	Description	Unit Weight (pcf)	Elastic	Consolidation				
				E (ksf)	OCR	e_o	C_c	C_v (ft^2/day)	C_α
1		Medium Dense SP < 20	110	500	-	-	-	-	-
2		Medium Dense SM > 20	115	350	-	-	-	-	-
3		Medium Dense SP < 20	110	500	-	-	-	-	-
4		Medium Dense SP >20	115	700	-	-	-	-	-
5		Medium Dense SM > 20	115	350	-	-	-	-	-
6		Very Hard SILT	120	-	2.0	0.6	0.4	-	-
7		Medium Dense SC/SM < 20	110	250	-	-	-	-	-



Settlement Analysis Results

Settlement Results							
Section	Color	Description	Depth to Bottom	Elastic Settlement (in)	Primary Consolidation (in)	Total Settlement (in)	*Differential Settlement (in.)
1		Medium Dense SP < 20	4	0.1	---	0.1	0.0
2		Medium Dense SM > 20	8	0.1	---	0.2	0.1
3		Medium Dense SP < 20	27	0.6	---	0.7	0.4
4		Medium Dense SP >20	32	0.2	---	0.2	0.1
5		Medium Dense SM > 20	47	0.8	---	0.9	0.5
6		Very Hard SILT	72	---	3.1	2.1	1.1
7		Medium Dense SC/SM < 20	100	0.7	---	0.8	0.2
					Total	**4.9**	**2.4**

*Differential Settlement is Estimated between Center and Edge of Tank



Summary of Laboratory Test Results

SUMMARY OF LABORATORY TEST RESULTS

Rivertown Water Treatment Plant
St. Johns County, Florida
Water Treatment Plant - Structures

Boring No.	Sample No.	Approximate Depth (ft)			Natural Moisture Content (%)	Organic Content (%)	Percent Passing Sieve Size (%)						Atterberg Limits		Soil Classification Symbol
							#4	#10	#40	#60	#100	#200	LL	PI	
B-1	3	4.0	-	6.0	27	7.3						12			SP-SM/PT
B-1	8	23.5	-	25.0	35							7			SP-SM
B-2	3	4.0	-	5.0	23	6.3						10			SP-SM/PT
B-2	4	6.0	-	8.0	24							11			SP-SM
B-2	7	18.5	-	20.0	31							11			SP-SM
B-2	13	48.5	-	50.0	46							57	79	40	MH
B-3	3	4.0	-	6.0	17	3.6						7			SP-SM
B-3	8	23.5	-	25.0	30							6			SP-SM
B-4	3	4.0	-	6.0	23							13			SM
B-4	7	18.5	-	20.0	31							7			SP-SM
B-4	11	38.5	-	40.0	29							34	32	12	SC
B-4	12	43.5	-	45.0	39							32	48	18	SM
B-5	3	4.0	-	6.0	18							8			SP-SM
B-5	8	23.5	-	25.0	33							7			SP-SM
B-5	10	33.5	-	35.0	31							6			SP-SM
B-5	18	73.5	-	75.0	42							27	52	28	SC
B-5	21	88.5	-	90.0	34							23			SM
B-6	2	2.0	-	4.0	30	7.8						36			SM/PT
B-6	4	6.0	-	8.0	29	3.9	99	98	97	94	48	10			SP-SM
B-7	2	2.0	-	4.0	24	9.6						9			SP-SM/PT
B-7	6	13.5	-	15.0	30							11			SP-SM
B-8	4	6.0	-	8.0	41	8.8						15			SM/PT
B-8	5	8.0	-	10.0	29		100	100	100	97	44	6			SP-SM
B-9	2	2.0	-	4.0	32	9.4						7			SP-SM/PT
B-9	6	13.5	-	15.0	28							4			SP
B-10	2	2.0	-	4.0	23	5.5						6			SP-SM/PT
B-10	3	4.0	-	5.5	47	8.5						11			SP-SM/PT
B-10	4	6.0	-	8.0	26	3.5	100	98	91	86	37	7			SP-SM
B-10	5	8.0	-	10.0	34	3.5						9			SP-SM

SUMMARY OF LABORATORY TEST RESULTS

Rivertown Water Treatment Plant
St. Johns County, Florida
Water Treatment Plant - Structures

Boring No.	Sample No.	Approximate Depth (ft)	Natural Moisture Content (%)	Organic Content (%)	Percent Passing Sieve Size (%)						Atterberg Limits		Soil Classification Symbol
					#4	#10	#40	#60	#100	#200	LL	PI	
B-11	3	4.0 - 5.0	26	7.4						11			SP-SM/PT
B-11	6	13.5 - 15.0	29							15			SM
B-12	6	13.5 - 15.0	30							7			SP-SC
B-12	9	28.5 - 30.0	70							56	32	12	CL
B-13	7	18.5 - 20.0	64							74	58	38	CH
B-13	8	23.5 - 25.0	65							97	111	60	MH
B-14	1	0.0 - 2.0	24							6			SP-SM
B-14	5	8.0 - 10.0	29							20	24	4	SC
B-14	6	13.5 - 15.0	26							6			SP-SM
B-15	6	13.5 - 15.0	27		100	100	99	96	35	7			SP-SM
B-15	9	28.5 - 30.0	29							7			SP-SM
B-15	13	48.5 - 50.0	44							60	85	50	CH
B-16	7	18.5 - 20.0	61							73	64	34	CH
B-17	8	23.5 - 25.0	75							99	97	62	CH
B-18	1	1.0 - 2.0	13	28.9						14			PT
B-19	4	6.0 - 8.0	25							7			SP-SM
B-19	6	13.5 - 15.0	40							78	54	41	CH
B-19	8	23.5 - 25.0	30							20	26	4	SM

SUMMARY OF LABORATORY TEST RESULTS

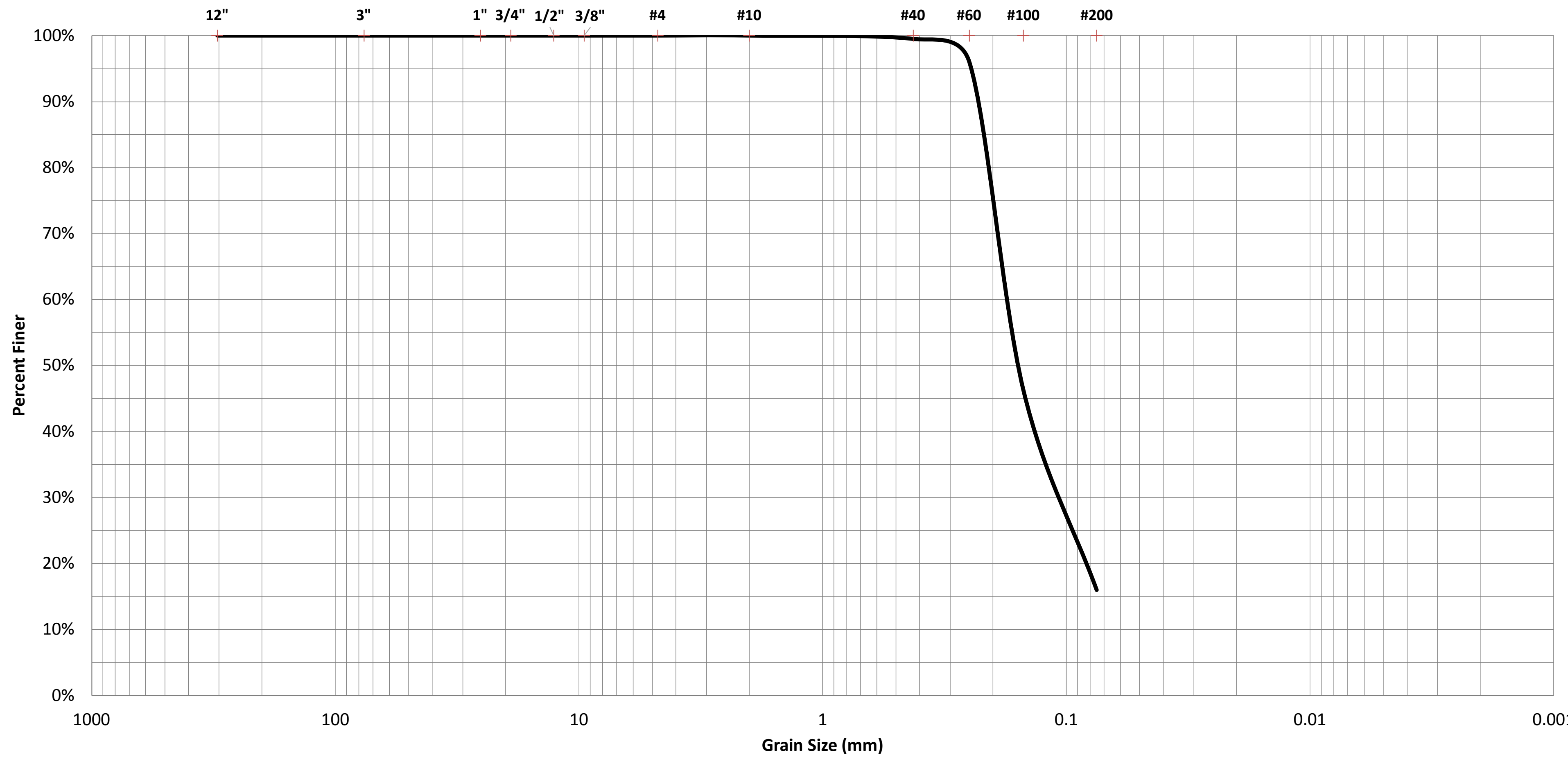
Rivertown Water Treatment Plant
St. Johns County, Florida
Retention Pond

Boring No.	Sample No.	Approximate Depth (ft)	Natural Moisture Content (%)	Organic Content (%)	Percent Passing Sieve Size (%)						Atterberg Limits		Soil Classification Symbol
					#4	#10	#40	#60	#100	#200	LL	PI	
A-1	2	2.0 - 5.0	22	3.8						11			SP-SM
A-1	3	5.0 - 7.0	23		100	100	99	96	46	16			SM
A-1	5	12.5 - 15.0	29							12			SP-SM
A-2	2	3.5 - 5.0	24		100	100	99	96	45	9			SP-SM
A-2	4	8.0 - 11.5	27							8			SP-SM

Grain Size Distribution Curves

GRAIN SIZE DISTRIBUTION GRAPH

US STANDARD SIEVE SIZES



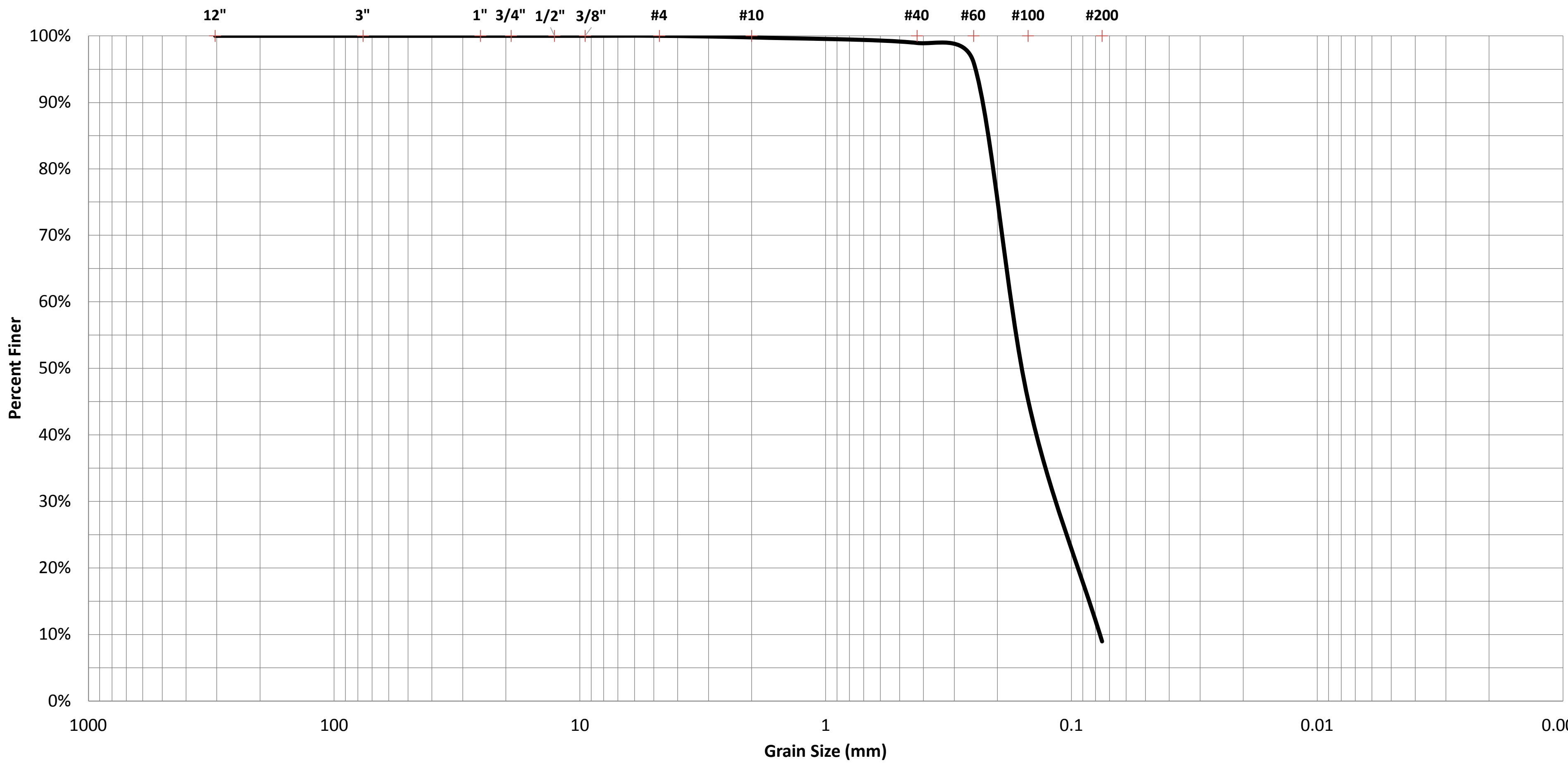
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY

PROJECT NAME:	Rivertown Water Treatment Plant	**BORING NO. / SAMPLE NO.:**	A-1 (3)
CSI GEO PROJECT NUMBER:	71-19-127-02	**DEPTH (FT.) :**	5-7

W%	LL	PL	PI	DESCRIPTION / CLASSIFICATION		CSI Geo, Inc.
23	-	-	-	Light Brown to Light Gray Silty Fine SAND	SM	

GRAIN SIZE DISTRIBUTION GRAPH

US STANDARD SIEVE SIZES



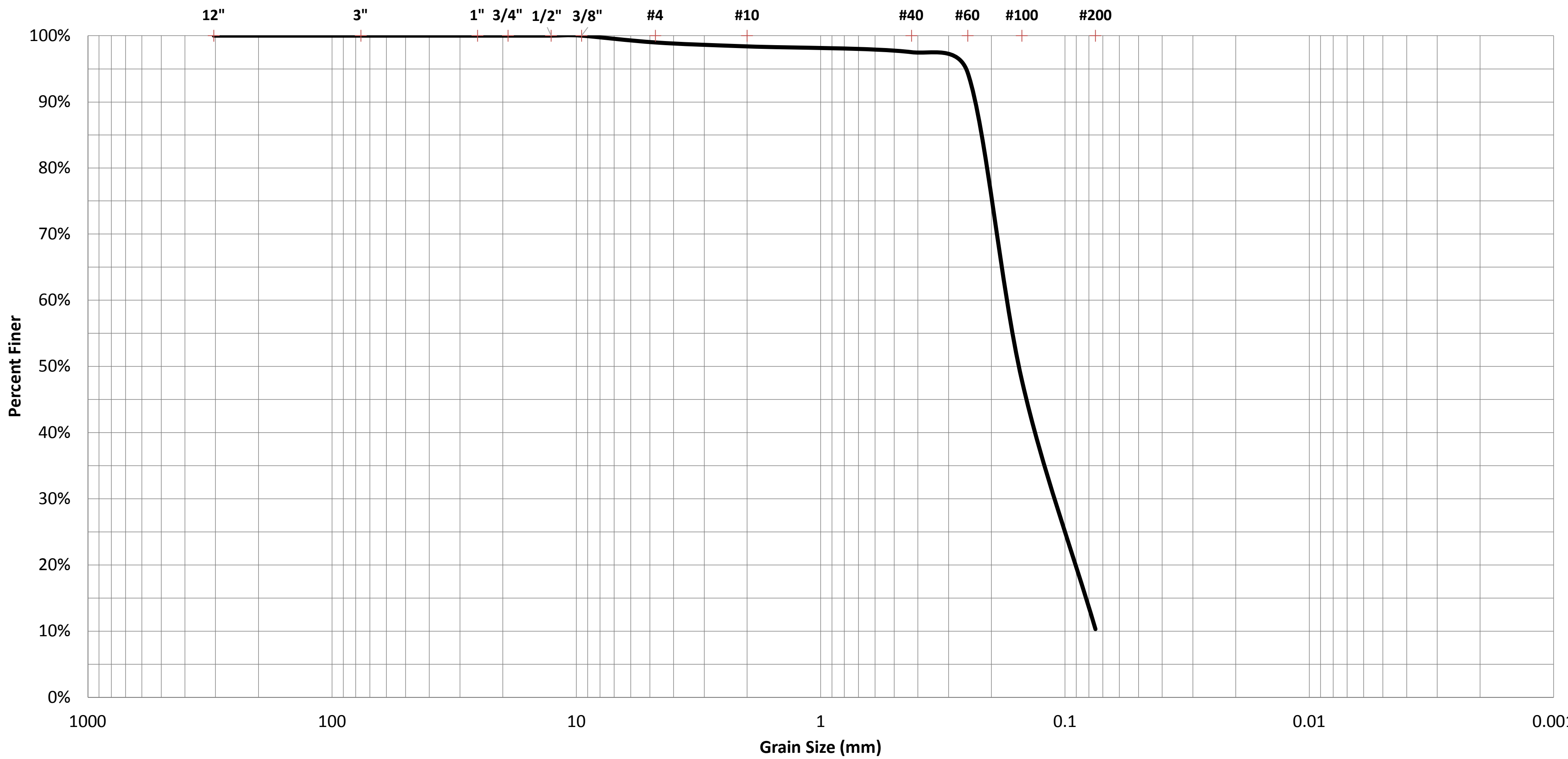
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY

PROJECT NAME:	Rivertown Water Treatment Plant	**BORING NO. / SAMPLE NO.:**	A-2 (2)
CSI GEO PROJECT NUMBER:	71-19-127-02	**DEPTH (FT.) :**	3.5-5

W%	**LL**	**PL**	**PI**	**DESCRIPTION / CLASSIFICATION**		**CSI Geo, Inc.**
24	-	-	-	Light Gray Slightly Silty Fine SAND	SP-SM	

GRAIN SIZE DISTRIBUTION GRAPH

US STANDARD SIEVE SIZES



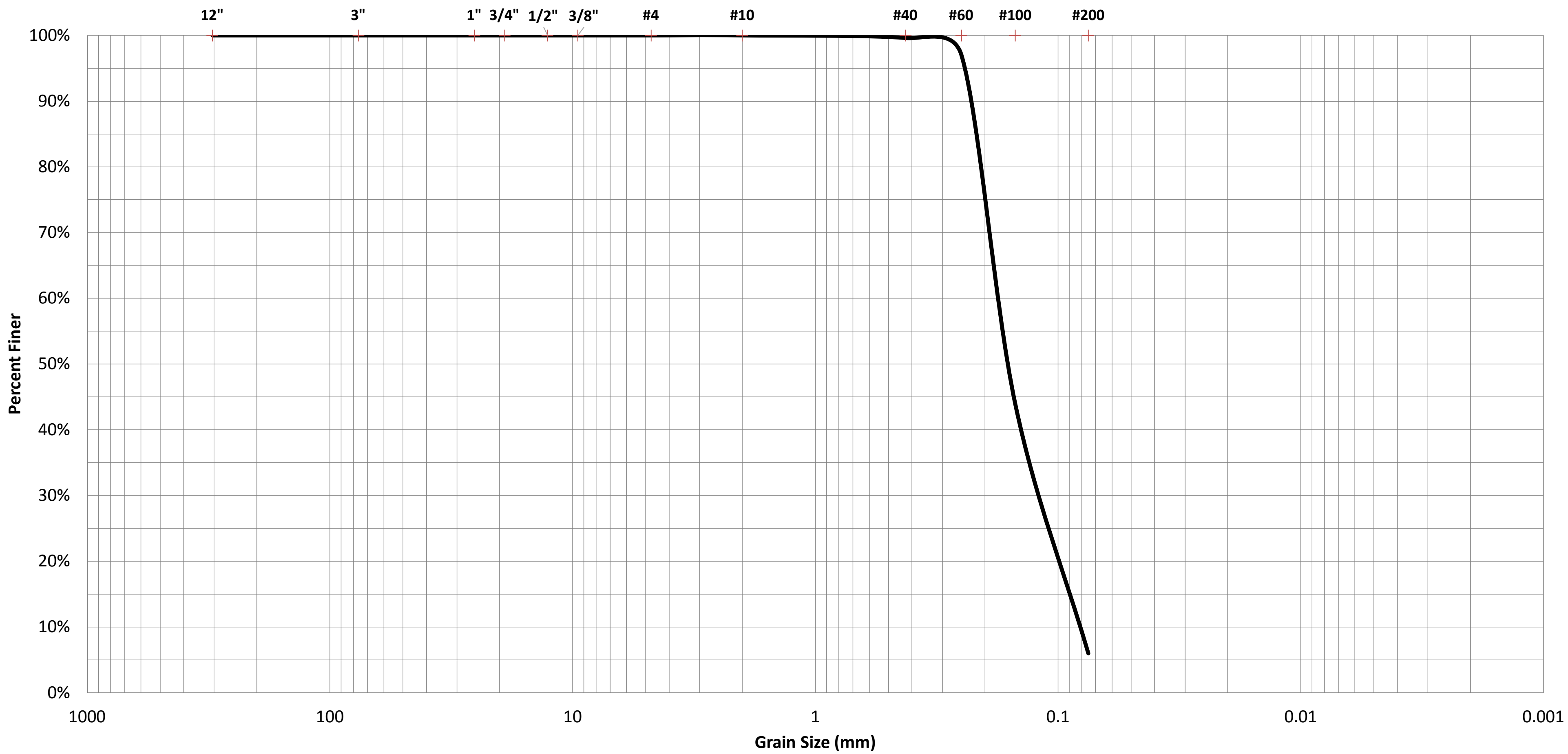
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY

PROJECT NAME:	Rivertown Water Treatment Plant	**BORING NO. / SAMPLE NO.:**	B-6 (4)
CSI GEO PROJECT NUMBER:	71-19-127-02	**DEPTH (FT.) :**	6-8

W%	LL	PL	PI	DESCRIPTION / CLASSIFICATION		
29	-	-	-	Dark Brown Slightly Organic Slightly Silty Fine SAND	SP-SM	CSI Geo, Inc.

GRAIN SIZE DISTRIBUTION GRAPH

US STANDARD SIEVE SIZES



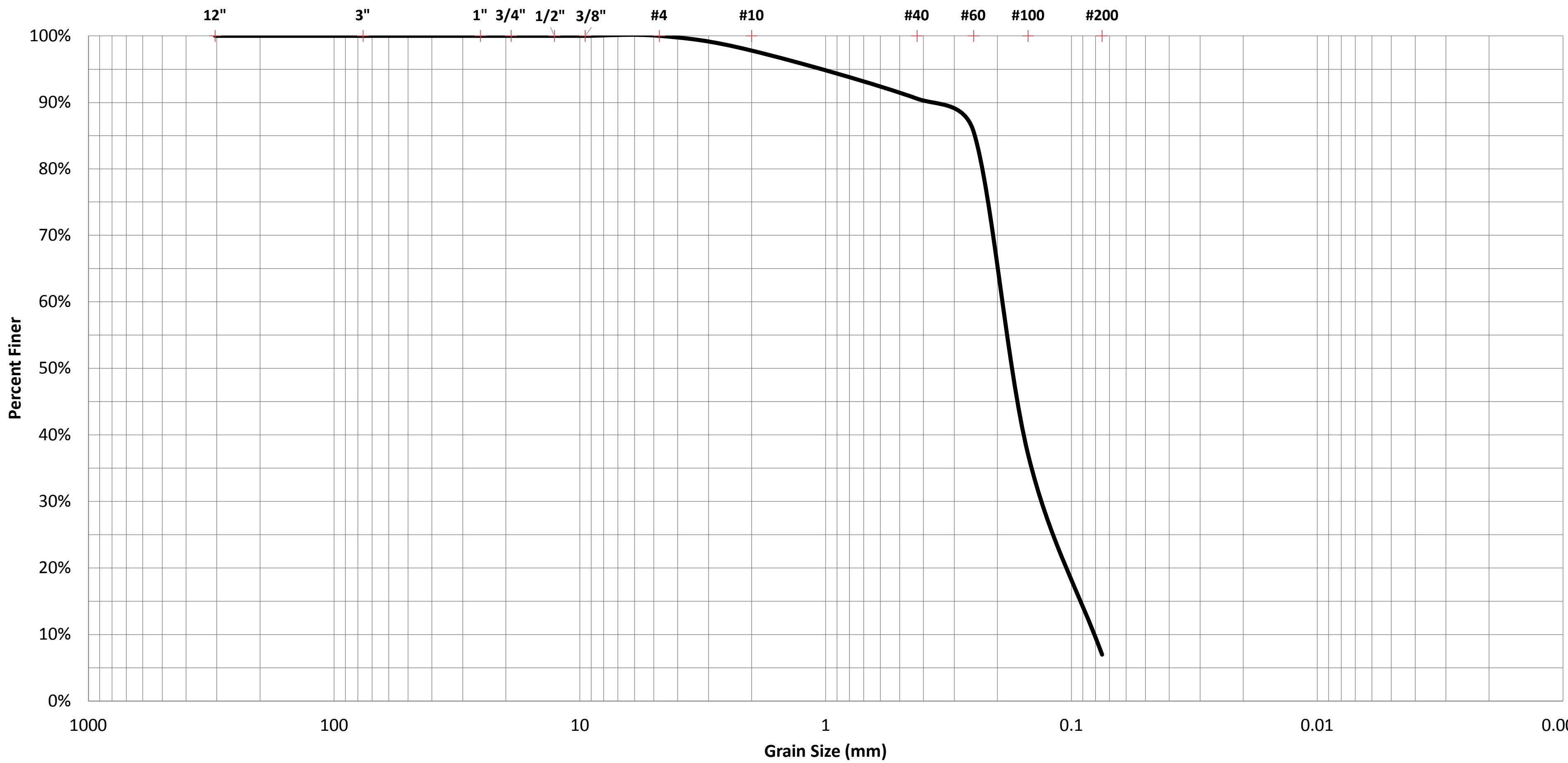
<table>
<tr><td rowspan="2">BOULDERS</td><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td colspan="2">FINES</td></tr>
<tr><td>COARSE</td><td>FINE</td><td>COARSE</td><td>MEDIUM</td><td>FINE</td><td>SILT</td><td>CLAY</td></tr>
</table>

PROJECT NAME:	Rivertown Water Treatment Plant	**BORING NO. / SAMPLE NO.:**	B-8 (5)
CSI GEO PROJECT NUMBER:	71-19-127-02	**DEPTH (FT.) :**	8-10

W%	LL	PL	PI	DESCRIPTION / CLASSIFICATION		
29	-	-	-	Brown Slightly Silty Fine SAND	SP-SM	**CSI Geo, Inc.**

GRAIN SIZE DISTRIBUTION GRAPH

US STANDARD SIEVE SIZES



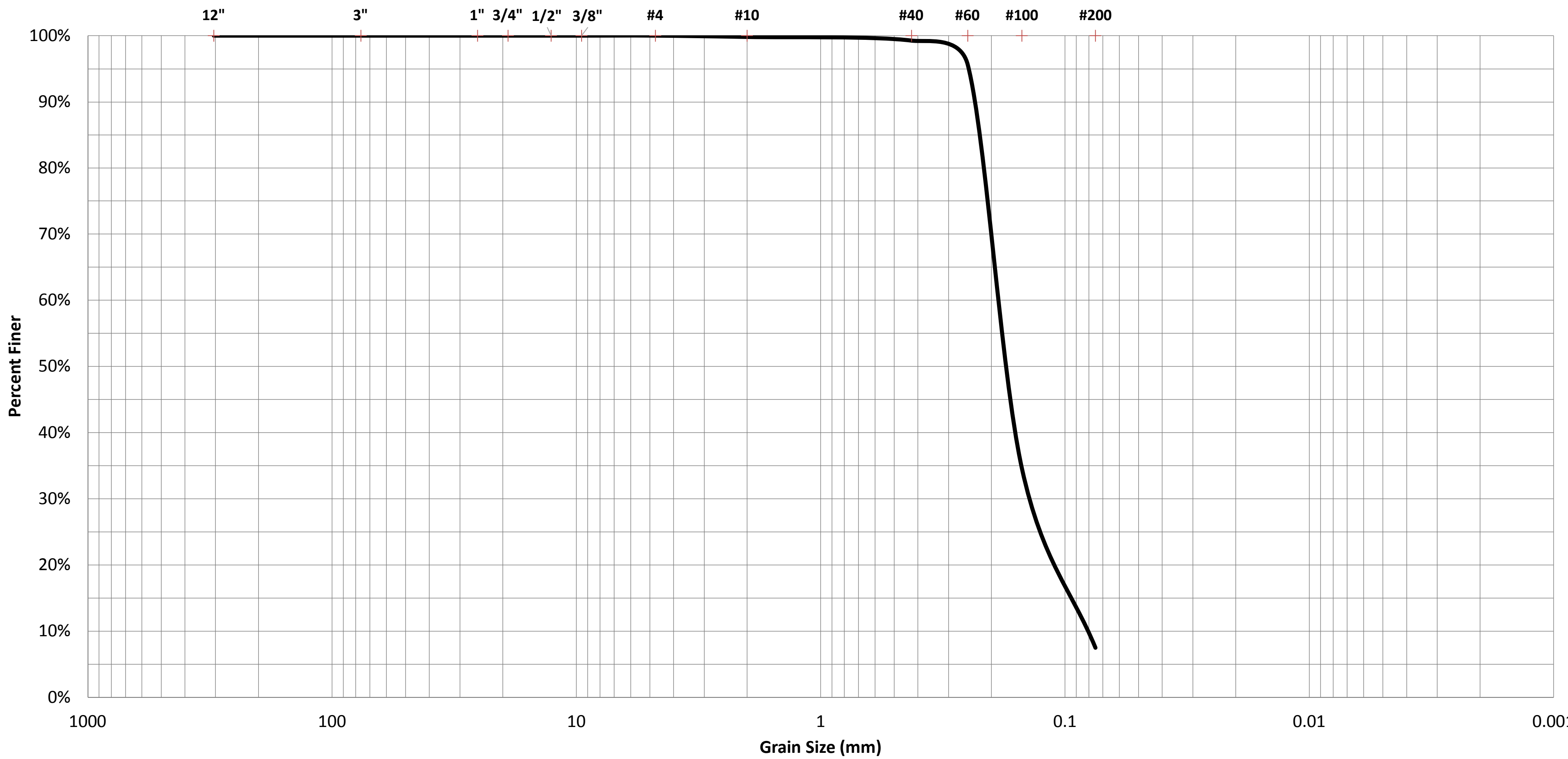
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY

PROJECT NAME:	Rivertown Water Treatment Plant	**BORING NO. / SAMPLE NO.:**	B-10 (4)
CSI GEO PROJECT NUMBER:	71-19-127-02	**DEPTH (FT.) :**	6-8

W%	LL	PL	PI	DESCRIPTION / CLASSIFICATION		
26	-	-	-	Dark Brown Slightly Organic Slightly Silty Fine SAND with few shell fragments	SP-SM	**CSI Geo, Inc.**

GRAIN SIZE DISTRIBUTION GRAPH

US STANDARD SIEVE SIZES



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY

PROJECT NAME:	Rivertown	**BORING NO. / SAMPLE NO.:**	B-15 (6)
CSI GEO PROJECT NUMBER:	71-19-127-02	**DEPTH (FT.) :**	13.5-15

W%	LL	PL	PI	DESCRIPTION / CLASSIFICATION		
27	-	-	-	Gray Slightly Silty Fine Sand	SP-SM	**CSI Geo, Inc.**

Appendix C – General Information

- Key to Soil Classification
- Field and Laboratory Test Procedures

Key to Soil Classification

KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

Granular Materials

Relative Density	**Auto Hammer SPT N-Value (Blows/foot)**
Very Loose	Less than 3
Loose	3 – 8
Medium Dense	8 - 24
Dense	24 - 40
Very Dense	Greater than 40

Silts and Clays

Consistency	**Auto Hammer SPT N-Value (Blows/foot)**
Very Soft	Less than 1
Soft	1 – 3
Firm	3 - 6
Stiff	6 - 12
Very Stiff	12 - 24
Hard	Greater than 24

Particle Size Identification (Unified Soil Classification System)

Boulders:	Diameter exceeds 8 inches
Cobbles:	3 to 8 inches diameter
Gravel:	Coarse - 3/4 to 3 inches in diameter
	Fine - 4.76 mm to 3/4 inch in diameter
Sand:	Coarse - 2.0 mm to 4.76 mm in diameter
	Medium - 0.42 mm to 2.0 mm in diameter
	Fine - 0.074 mm to 0.42 mm in diameter

Modifiers

These modifiers provide our estimate of the amount of fines (silt or clay size particles) in soil samples.

Approximate Fines Content	Modifiers
5% Fines 12%	Slightly silty or slightly clayey
12% Fines 30%	Silty or clayey
30% Fines 50%	Very silty or very clayey

These modifiers provide our estimate of shell, rock fragments, or roots in the soil sample.

Approximate Content, By Weight	Modifiers
< 5%	Trace
5% to 10%	Few
15% to 25%	Little
30% to 45%	Some
50% to 100%	Mostly

These modifiers provide our estimate of organic content in the soil sample.

Organic Content	Modifiers
1% to 3%	Trace
3% to 5%	Slightly Organic
5% to 20%	Organic
20% to 75%	Highly Organic (Muck)
> 75%	Peat

Field and Laboratory Test Procedures

FIELD AND LABORATORY TEST PROCEDURES

FIELD TEST PROCEDURES

Standard Penetration Test (SPT) Borings – The soil penetration test borings were made in general accordance with ASTM D-1586, "Penetration Test and Split-Barrel Sampling of Soils". The borings were advanced by continuous driving the split spoon sampler to a depth of 10 feet below the existing ground surface. Below 10 feet and until boring termination depths, split spoon sampling was performed at a spacing of 5 feet. Bentonite drilling fluid was used below the ground water level to stabilize the sides and to flush the cuttings. At the sampling intervals, the drilling tools were removed and soil samples were obtained with a standard 1.4 inch I.D., 2.0 inch O.D., split-tube sampler. The sampler was first seated six inches and then driven an additional foot with blows of a 140 pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot is designated the "Penetration Resistance". The penetration resistance, when properly interpreted, is an index to the soil strength and density. Representative portions of the soil samples, obtained from the sampler, were containerized and transported to our laboratory. The samples were then examined by a geotechnical engineer to confirm the field classifications.

Auger Borings – The auger borings were advanced by the use of a truck mounted auger drill rig. The soils encountered were identified in the field from the cuttings brought to the surface by the augering process. Representative soil samples were placed in glass jars and transported to our laboratory where they were examined by a geotechnical engineer to confirm field classifications.

LABORATORY TEST PROCEDURES

Natural Moisture Content – The water content is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the solid particles. This test was conducted in the general accordance with ASTM D2216.

Percent Fine Content – To determine the percentage of soils finer than No. 200 sieve, the dried samples were washed over a 200 mesh sieve. The material retained on the sieve was oven dried and then weighed and compared with the unwashed dry weight in order to determine the weight of the fines. The percentage of fines in the soil sample was then determined as the percent of weight of fines in the sample to the weight of the unwashed sample. This test was conducted in accordance with ASTM D1140.

Percent Organic Content – This test is based on the percent of organics by weight of the total sample. This test was conducted in accordance with FM I - T 267.

Grain Size Distribution - The grain size tests were performed to determine the particle size and distribution of the samples tested. Each sample was dried, weighed, and washed over a No. 200 mesh sieve. The dried sample was then passed through a standard set of nested sieves to determine the grain size distribution of the soil particles coarser than the No. 200 sieve. This test was conducted in accordance with ASTM D1140.

Plasticity (Atterberg Limits) – The soil's Plastic Index (PI) is bracketed by the Liquid Limit (LL) and Plastic Limit (PL). The LL is the moisture content at which the soil flows as a heavy viscous fluid and is determined in general accordance with FM 1-T 089. The PL is the moisture content at which the soil begins to crumble when rolled into a small thread and is also determined in general accordance with ASTM D4318. The water-plasticity ratio is computed from the above test data. This ratio is an expression comparing the relative natural state of soil with its liquid and plastic consolidation characteristics.