SUBSURFACE SOIL EXPLORATION
FORCE MAIN IMPROVEMENTS
AT BEN HILL GRIFFIN PARKWAY
LEE COUNTY, FLORIDA

Ardaman & Associates, Inc.

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Florida: Bartow, Cocoa, Fort Myers, Miami, Orlando, Port St. Lucie, Sarasota, Tallahassee, Tampa, West Palm Beach
Louisiana: Baton Rouge, Monroe, New Orleans, Shreveport

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

Ardaman Project No. 21-33-4517
June 2, 2022

Tetra Tech
10600 Chevrolet Way, Suite 300
Estero, Florida 33928

Attention: Mr. Tyler Wainwright, P.E.

SUBJECT: Subsurface Soil Exploration
Force Main Improvements
At Ben Hill Griffin Pkwy.
Lee County, Florida

Dear Mr. Wainwright:

As requested and authorized by **Tetra Tech**, Ardaman & Associates, Inc. (Ardaman) has completed the subsurface soil exploration program for the subject project in Lee County, Florida. The purpose of this program was to evaluate the general subsurface conditions along the approximate routes of the proposed utility improvements.

This report documents our findings and conclusions. It has been prepared for the exclusive use of **Tetra Tech** for specific application to the subject project in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

SCOPE

The scope of our services was limited to the following items:

1. Conducting twenty-one (21) Standard Penetration Test (SPT) borings to evaluate the nature and conditions of the subsurface soils.
2. Reviewing each soil sample obtained in our field exploration program by a geotechnical engineer in our laboratory for further identification and assignment of laboratory tests.
3. Preparing this report to document the results of our field exploration and laboratory programs.

SITE LOCATION AND PROJECT DESCRIPTION

We understand that Tetra Tech is working with Lee County to develop and implement infrastructure improvements to the force main utility lines along Ben Hill Griffin Pkwy. in south Lee County. The proposed improvements include the addition of a modulating valve and a concentrate line, as well as a new 16-inch force main from the intersection of Corkscrew Rd. to Grand Oaks Blvd. and a 12-inch force main from Grand Oaks Blvd. to FGCU Lake Pkwy. A **Site Location Map** showing the approximate project location is presented as **Figure 1**.

FIELD EXPLORATION PROGRAM

Our planned field exploration program consisted of performing twenty-one (21) SPT borings to a depth of 20 feet below the existing ground surface along the proposed utility improvement routes. The SPT borings were conducted using methods consistent with ASTM D-1586. The equipment and procedures used in the SPT borings are described in detail in **Appendix 2**. Due to high concentration of existing utility lines along the proposed utility routes, one boring that was planned for the intersection of Ben Hill Griffin Pkwy. and FGCU Blvd. could not be performed. Additionally, to avoid damaging existing utilities, some borings were partially drilled with a hand auger and some borings were re-located into the grassy median of the roadway. One boring, B-08, was also terminated at a shallower depth of approximately 17 ¼ feet because of close utility spacing preventing the ability to auger through rock. A description of the hand auger boring procedure is outlined in **Appendix 2**.

The locations of the borings are shown on the attached **Figure 2–Boring Location Map**. These locations were determined in the field by a hand-held Global Positioning System (GPS) device and should be considered accurate only to the degree implied by the method of measurement used. If more precise locations of the borings are desired, then we recommend that a registered land surveyor be employed to locate the borings on site. GPS coordinates of each boring location are provided on the attached soil boring profiles.

LABORATORY TESTING PROGRAM

Representative soil samples obtained during our field sampling operation were packaged and transferred to our office for a geotechnical engineer to confirm soil classifications. The soil descriptions shown on the soil boring profiles are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures. Results from the laboratory testing are included in the attached soil boring profiles as well as in the **Grain Size Distribution Curves** displayed in **Appendix 1**.

GENERAL SUBSURFACE CONDITIONS

The general subsurface conditions encountered during the field exploration are shown on the attached **Figures 3 - 5 - Soil Boring Profiles**. Soil stratification is based on evaluation of recovered soil samples and interpretation of the field boring logs. The stratification lines represent the approximate boundaries

between the soil types, the actual transitions may be gradual. Because of the large area of study, only broad generalities may be stated about the subsurface conditions. The soil boring profiles should be reviewed for more in-depth descriptions and information regarding the subsurface conditions.

In general, the borings encountered a range of very loose to very dense sandy soils from the existing ground surface to the boring termination depth of 20 feet, consisting of fine SAND (SP), slightly silty fine SAND (SP-SM), slightly clayey fine SAND (SP-SC), and silty fine SAND (SM), all with varying concentrations of gravel (rock fragments, shell, and/or cemented sand). Hard LIMESTONE (N-value > 50 blows per foot) was encountered in nine of the borings at varying thicknesses and depths, ranging from approximately 1 foot thick to 6 ½ feet thick. Soft LIMESTONE (N-value $\leq$ 50 blows per foot) was also encountered in five borings at varying thicknesses and depths, ranging from approximately 3 feet thick to 7 feet thick. Additionally, CONCRETE approximately 1 foot thick was encountered in one boring, B-19, at a depth of approximately 9 ½ to 10 ½ feet.

Groundwater was encountered within the boreholes at depths ranging from approximately 3 feet to 8 feet below the existing ground surface at the time of our field exploration. The groundwater depths are shown on the attached soil boring profiles and each individual groundwater depth represents the groundwater surface encountered on the date shown. Fluctuations in groundwater level should be anticipated throughout the year due to seasonal variations in rainfall, and other factors.

RECOMMENDATIONS & ON-SITE SOIL SUITABILITY

The fine sands with varying concentrations of gravel (SP, SP-SM, SP-SC) encountered in the borings are suitable for use as backfill and suitable for pipe bedding material. Roots as well as other organic material should be removed prior to placement of any fill. Unsuitable silty soils encountered in the borings (SM) as well as any limestone or concrete encountered at pipe bedding elevation should be over excavated a minimum of 12 inches below the pipe bedding elevation and replaced with gravel such as FDOT No. 89 Stone.

Typically, heavy excavators can remove soft limestone and boulders; however, dynamic methods using hydraulic hammers or hoes will be needed to remove the hard limestone strata or concrete, as well as any other very dense soil strata. Use of excavated rock as fill material will require further processing (crushing and screening) to reduce particle size to mostly sand and gravel size.

If soils extend below the water table, the soils should be allowed to dry prior to compaction. To accomplish this, we recommend stockpiling the material and allowing it to drain or spreading it in relatively thin lifts on the surface to be filled and allowing it to dry prior to compaction.

SITE PREPARATION PROCEDURES

Based on the proposed construction and existing soil conditions, the soils encountered at the subject site should be prepared in the following manner:

1. Excavation for pipe installation should be performed with appropriate equipment. Limestone and boulders should be expected, and excavation will require specialized equipment as mentioned above.

2. Trench bottoms should be proof-rolled using the appropriate compaction equipment for site and soil conditions. Adjust the moisture content of the soil, as necessary, to aid compaction. Sufficient passes should be made to develop a minimum dry density of 100 percent of the Standard Proctor Maximum Dry Density (ASTM D-698) to a depth of 12 inches below the compacted surface. Density requirements around drainage structures should have a minimum of 100 percent of the Standard Proctor Maximum Dry Density (ASTM D-698) for a distance of one pipe diameter but not less than 3 feet from the outside face of the structure. Replace all material, if determined to be deleterious, in areas that are loose or "yield" during the proof-rolling operation and replace with suitable fill material conforming to that stated in Item 4.

3. After satisfactory proof-rolling of the trench bottom in accordance with the above, filling with suitable material may proceed. Fill material should conform to that stated in Item 4 below. The fill should be placed in level lifts not exceeding 12 inches in uncompacted thickness. Each lift should be compacted by repeated passes with appropriate compaction equipment to achieve at least 95 percent of the Standard Proctor Maximum Dry Density (ASTM D-698). The filling and compaction operations should continue until the desired elevation(s) is achieved.

4. Fill material should preferably consist of clean to slightly silty fine sands (SP or SP-SM), free of organic or other deleterious materials, with less than 12 percent passing the U.S. Sieve No. 200. Bedding stone, such as FDOT No. 89 stone, may be used in place of structural fill.

5. Ardaman should be employed by the Owner to observe and test all prepared and compacted areas to document that all unsuitable soils are removed and that the structural fill soils are prepared and compacted in accordance with the above recommendations.

GENERAL COMMENTS

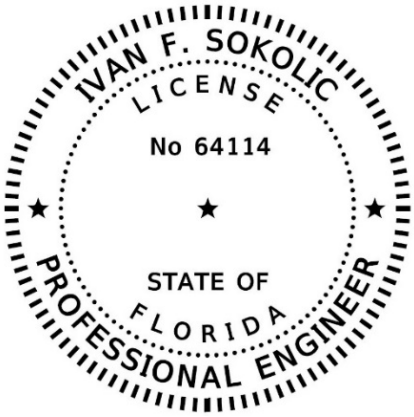
While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local variations characteristic of the subsurface materials of the region are anticipated and may not become evident until during construction. This study is based on a relatively shallow exploration. Additionally, this study does not include an evaluation of the environmental (ecological or hazardous/toxic material related) condition of the site and subsurface. The boring profiles and related information are based on the driller's logs and visual evaluation of selected samples in the laboratory. The delineation between soil types shown on the profiles is approximate and the descriptions represent our interpretation of subsurface conditions at the designated boring locations and on the particular date drilled.

If you have any questions about this report, please contact this office.

Very truly yours,

Ardaman & Associates, Inc.

Cory C. Schulte, E.I.
Staff Engineer



Ivan F. Sokolic, P.E. No.64114
Senior Engineer / Branch Manager

This document has been digitally signed and sealed by

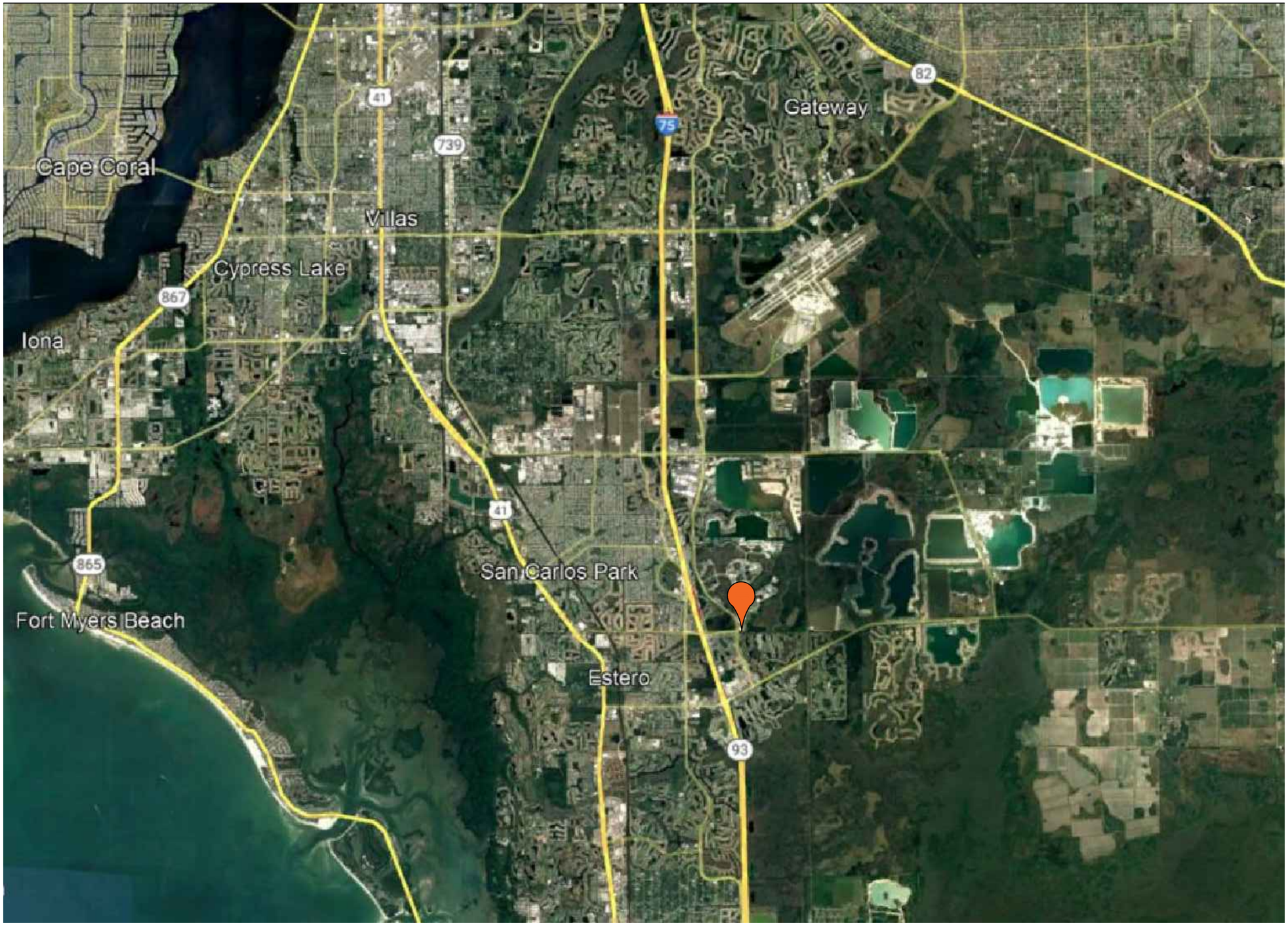
Ivan Sokolic Digitally signed by Ivan Sokolic
Date: 2022.06.02 12:15:35 -04'00'

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.

ATTACHMENTS

- **SITE LOCATION MAP (FIGURE 1)**
- **BORING LOCATION MAP (FIGURE 2)**
- **SOIL BORING PROFILES (FIGURES 3 – 5)**



REFERENCE: GOOGLE EARTH PRO 2021, IMAGERY DATED 1/2021

LEGEND

APPROXIMATE SITE LOCATION

APPROXIMATE SCALE

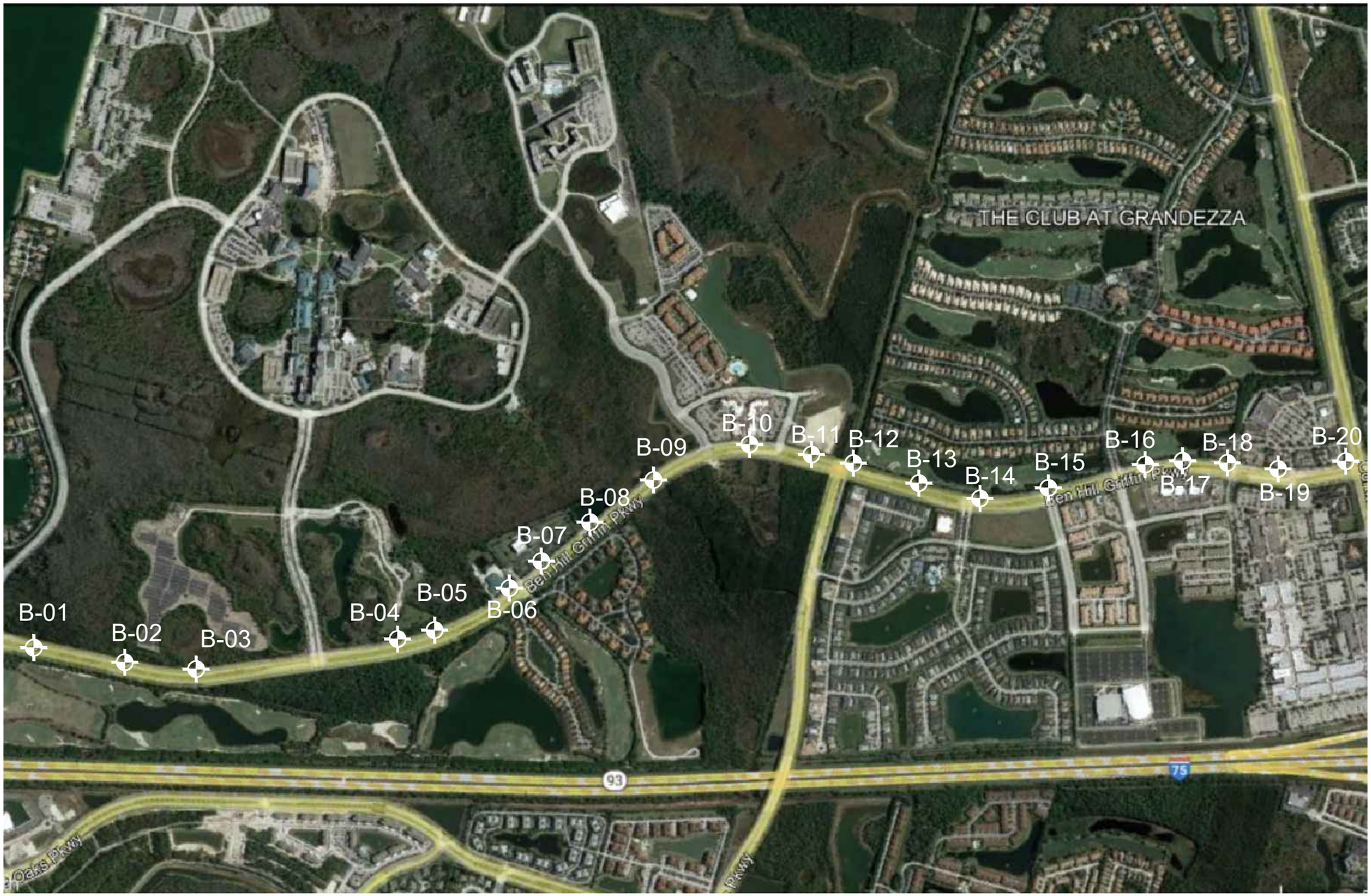
0mi 1.25 2.5

SITE LOCATION MAP

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

BEN HILL GRIFFIN PKWY.
FORCE MAIN IMPROVEMENTS
LEE COUNTY, FLORIDA

DRAWN BY:	CHECKED BY:	DATE:
CS	IS	5/31/2022
FILE NO.	APPROVED BY:	FIGURE:
21-33-4517	IS	1



LEGEND

APPROXIMATE LOCATION OF SOIL BORINGS

APPROXIMATE SCALE

0ft 1000 2000

REFERENCE: GOOGLE EARTH PRO 2021, IMAGERY DATED 1/2021

BORING LOCATION MAP

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Geotechnical, Environmental and Materials Consultants

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FORCE MAIN IMPROVEMENTS
LEE COUNTY, FLORIDA

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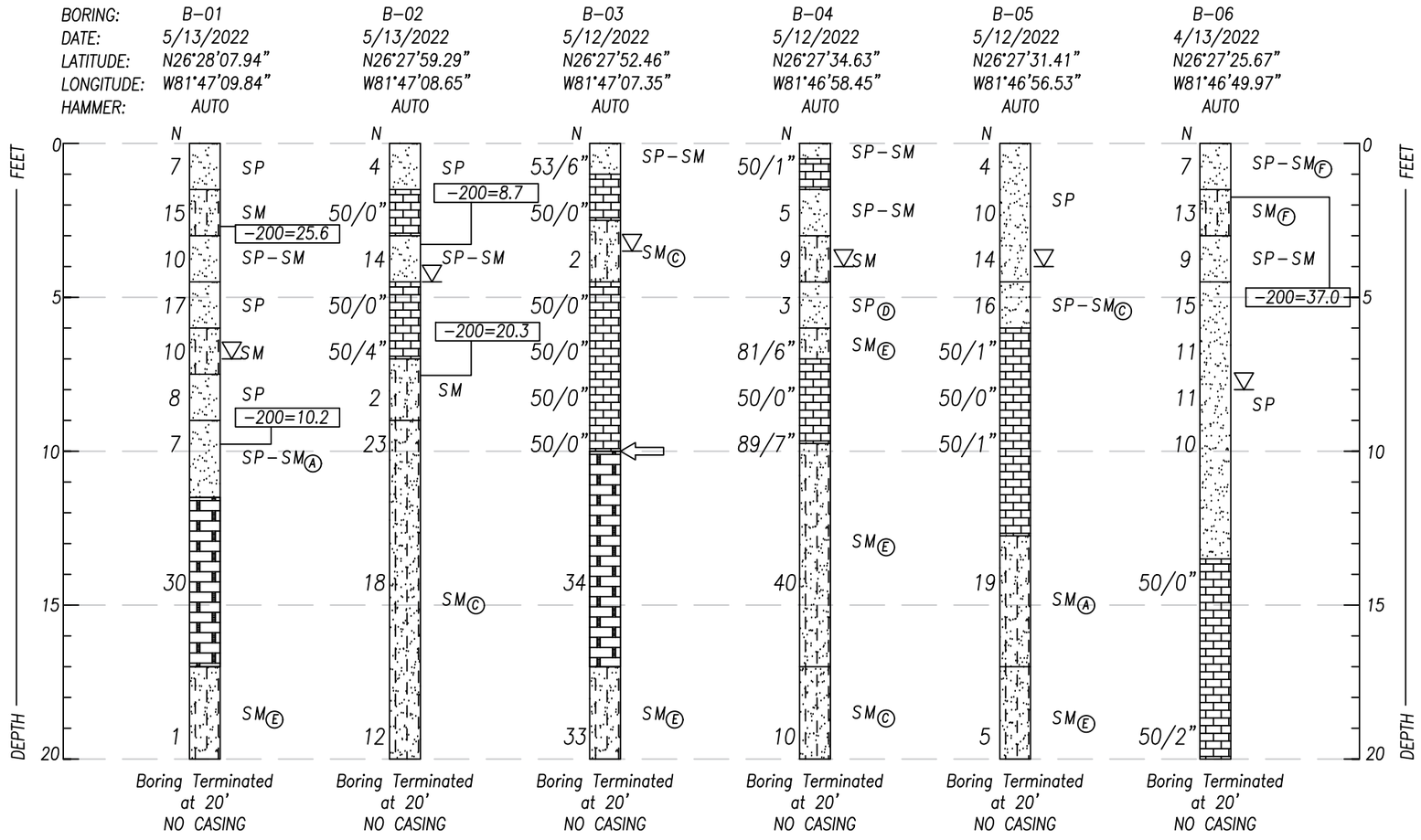
FILE NO.	APPROVED BY:	FIGURE:
21-33-4517	IS	2



LEGEND

- SAND: Sand with ≤ 12% fines
- Silty SAND: Sand with 12% to 50% Silt
- CONCRETE
- SOFT LIMESTONE: Limestone with N ≤ 50
- HARD LIMESTONE: Limestone with N > 50

ADDITIONAL SOIL COMPONENTS

- (A) Trace of Rock
- (B) Trace of Shell
- (C) Some Rock
- (D) Some Shell
- (E) Gravelly
- (F) Trace of Cemented Sand

SM	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP SYMBOL
(A)	SUBSCRIPT INDICATING ADDITIONAL COMPONENTS OF SOIL SAMPLE
N	SPT N-VALUE IN BLOWS PER FOOT
50/4"	NUMBER OF BLOWS FOR GIVEN PENETRATION (I.E. 50 BLOWS FOR 4 INCHES)
▽	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
HA	HAND AUGER
OC	ORGANIC CONTENT (%)
-200 %	PASSING #200 SIEVE
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
⇦	LOSS OF DRILLING FLUID CIRCULATION

SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

BEN HILL GRIFFIN PKWY.
FORCE MAIN IMPROVEMENTS
LEE COUNTY, FLORIDA

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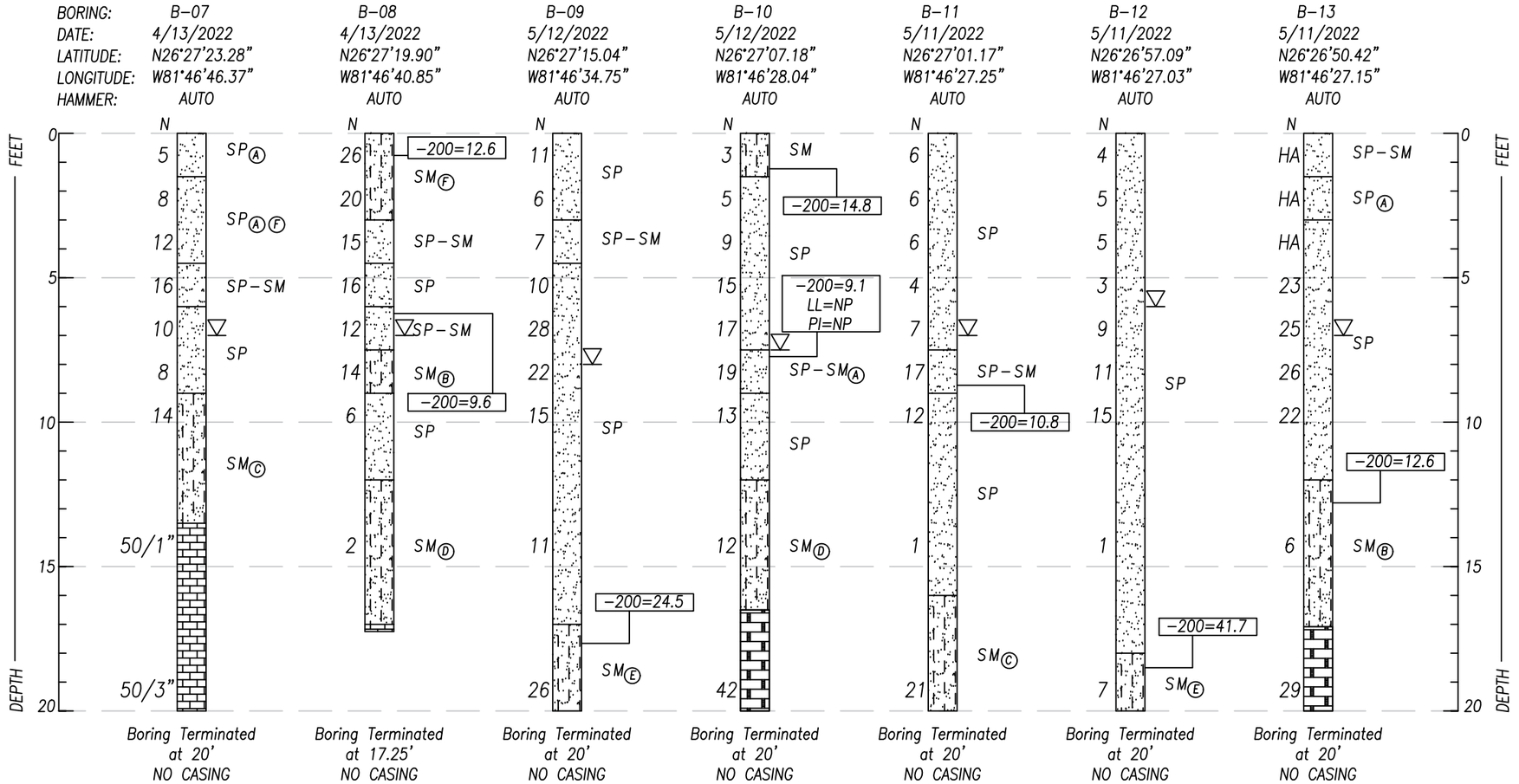
FILE NO. 21-33-4517	APPROVED BY: IS	FIGURE: 3



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HA	HAND AUGER
OC	ORGANIC CONTENT (%)
-200 %	PASSING #200 SIEVE
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
⇦	LOSS OF DRILLING FLUID CIRCULATION

SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

BEN HILL GRIFFIN PKWY.
FORCE MAIN IMPROVEMENTS
LEE COUNTY, FLORIDA

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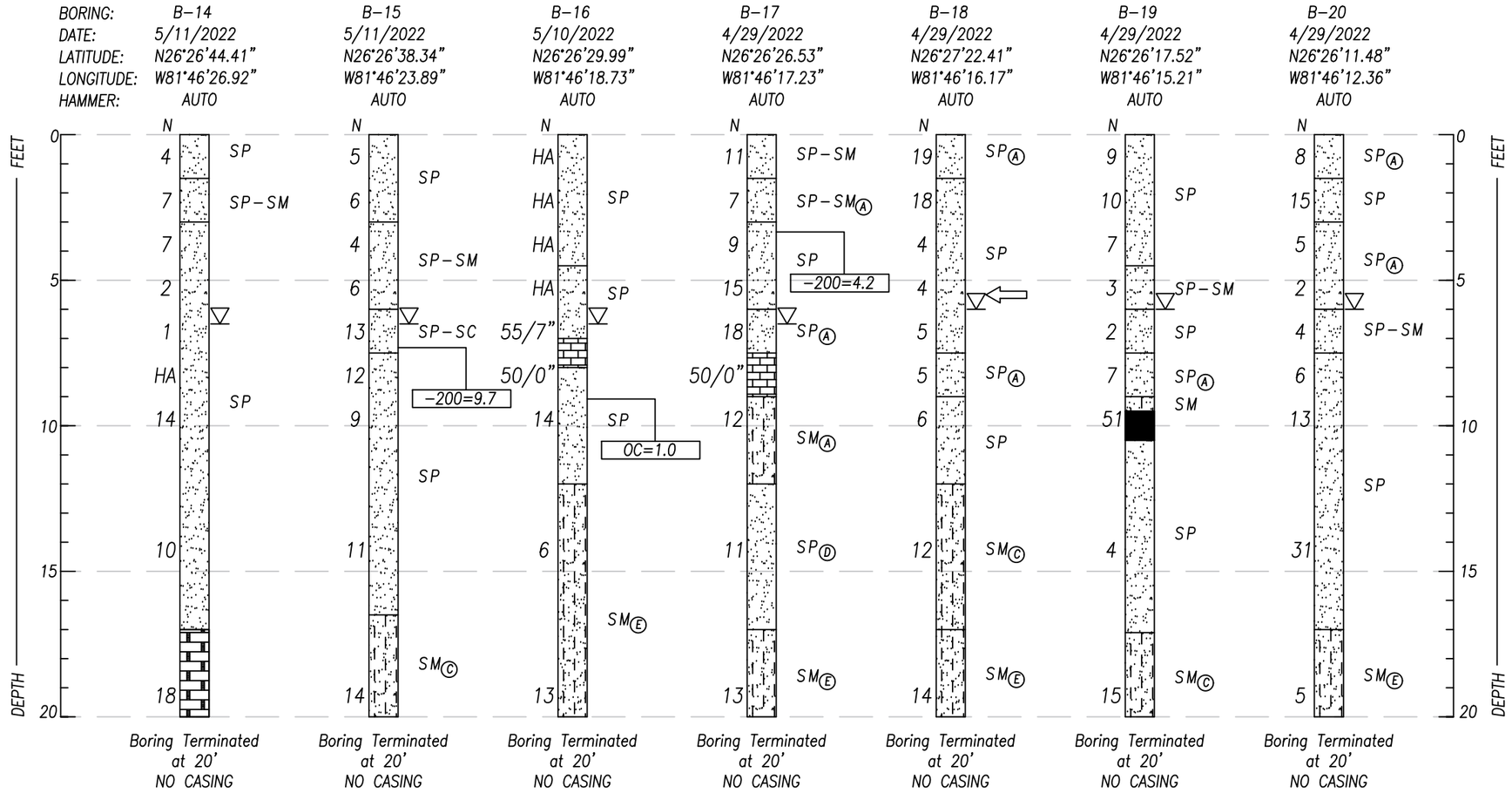

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SM	UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP SYMBOL
Ⓐ	SUBSCRIPT INDICATING ADDITIONAL COMPONENTS OF SOIL SAMPLE
N	SPT N-VALUE IN BLOWS PER FOOT
50/4"	NUMBER OF BLOWS FOR GIVEN PENETRATION (I.E. 50 BLOWS FOR 4 INCHES)
▽	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
HA	HAND AUGER
OC	ORGANIC CONTENT (%)
−200	% PASSING #200 SIEVE
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
⇦	LOSS OF DRILLING FLUID CIRCULATION

SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

BEN HILL GRIFFIN PKWY.
FORCE MAIN IMPROVEMENTS
LEE COUNTY, FLORIDA

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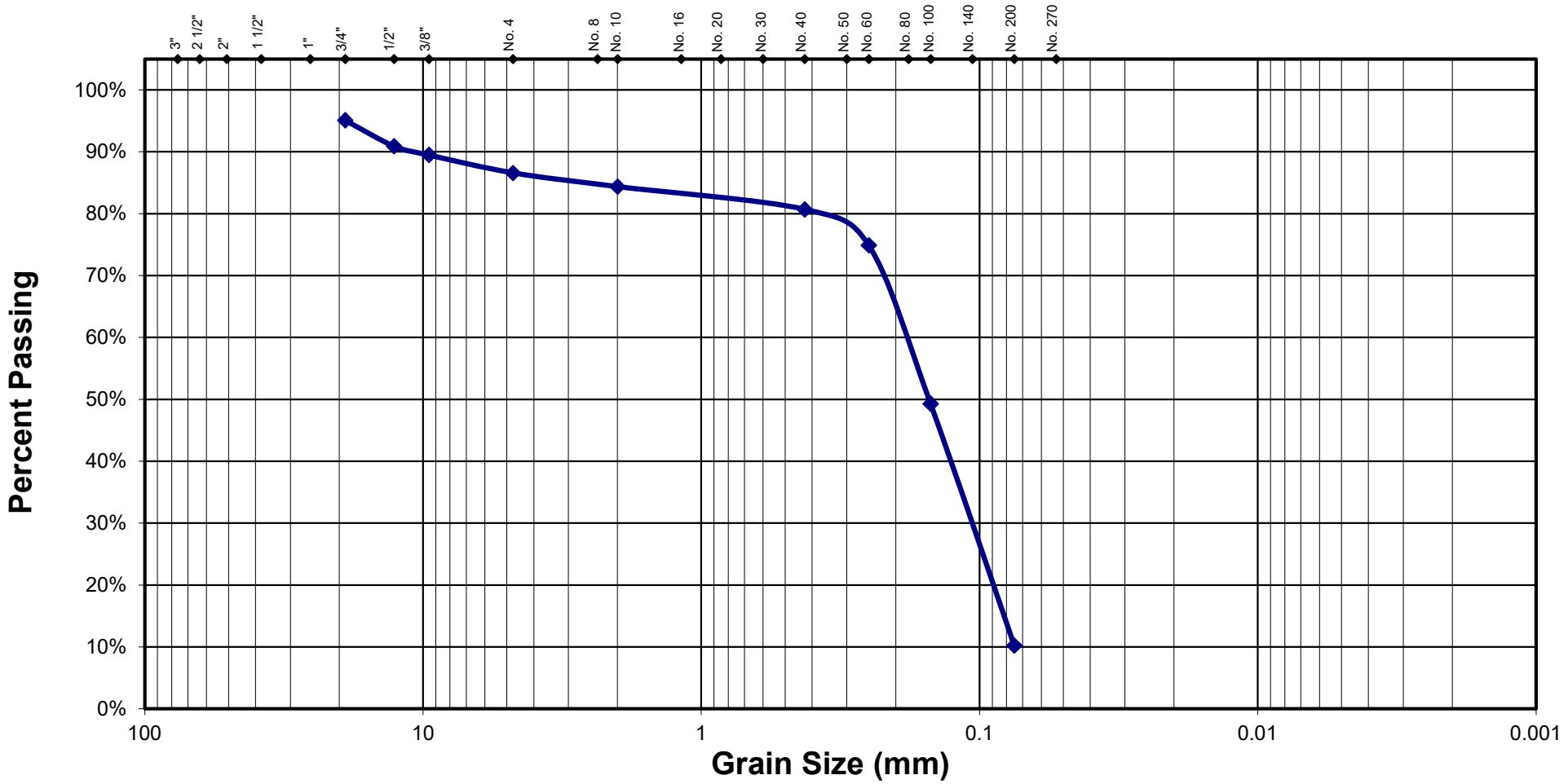
FILE NO. 21-33-4517	APPROVED BY: IS	FIGURE: 5

APPENDIX 1:

- **GRAIN SIZE DISTRIBUTION CURVES**

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL	SAND		SILT	CLAY
	Coarse to Medium	Fine		

Project Name: Ben Hill Griffin Pkwy. Force Main Improvements

Project Location: Lee County, Florida

Client Name: Tetra Tech

Sample Depth: 9 - 10.5 Boring Number: B-01

Sample Description: Slightly silty fine SAND with trace of rock fragments (SP-SM)

Percent Passing No. 200 Sieve = 10.2%

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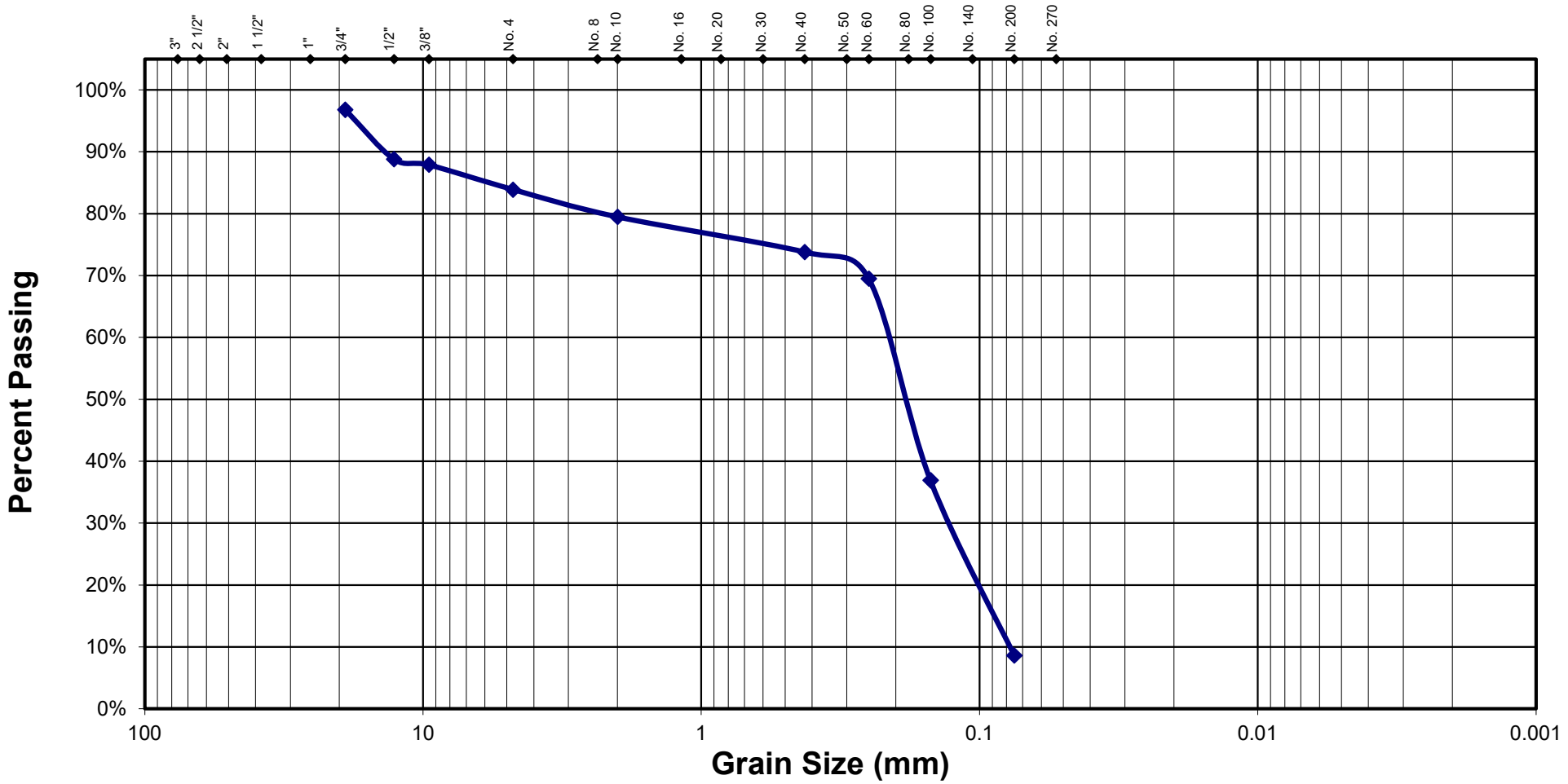
GRAIN SIZE DISTRIBUTION CURVE



GRAVEL	SAND		SILT	CLAY
	Coarse to Medium	Fine		

Project Name: Ben Hill Griffin Pkwy. Force Main Improvements

Project Location: Lee County, Florida

Client Name: Tetra Tech

Sample Depth: 4.5 - 6 Boring Number: B-05

Sample Description: Slightly silty fine SAND with some rock fragments (SP-SM)

Percent Passing No. 200 Sieve = 8.6%

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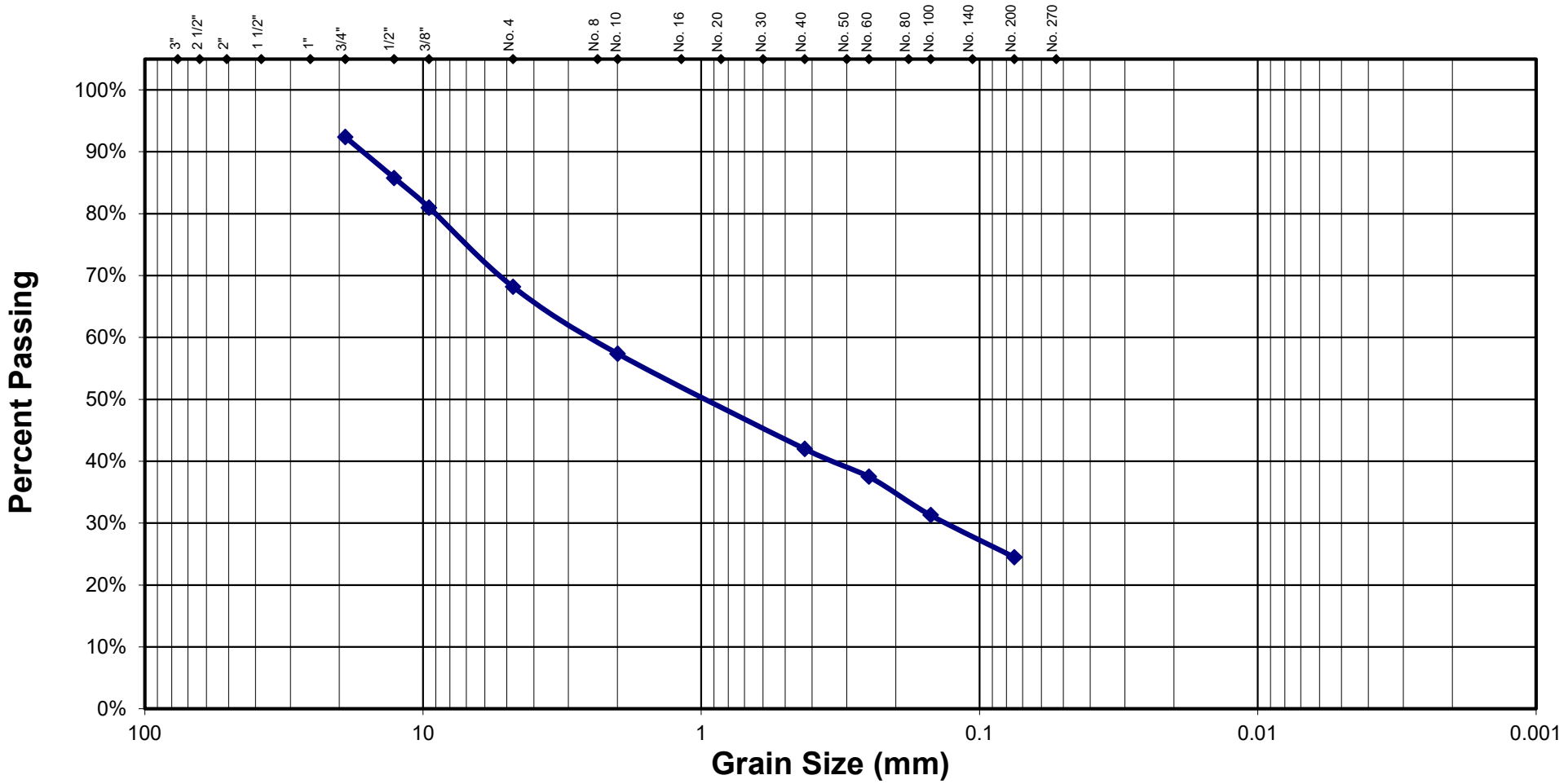
GRAIN SIZE DISTRIBUTION CURVE



GRAVEL	SAND		SILT	CLAY
	Coarse to Medium	Fine		

Project Name: Ben Hill Griffin Pkwy. Force Main Improvements

Project Location: Lee County, Florida

Client Name: Tetra Tech

Sample Depth: 18.5 - 20 Boring Number: B-09

Sample Description: Gravelly silty fine SAND (SM)

Percent Passing No. 200 Sieve = 24.5%

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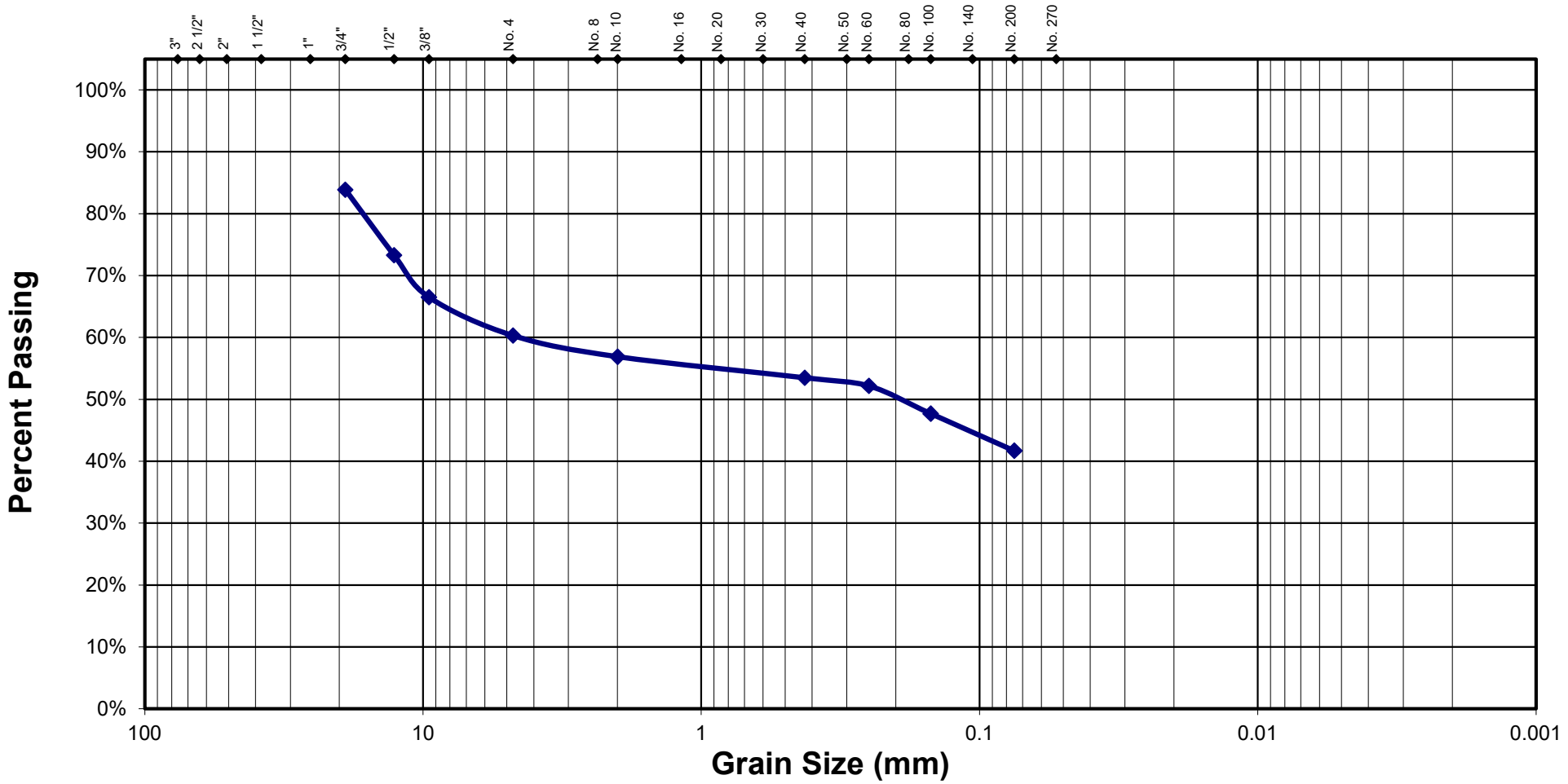
GRAIN SIZE DISTRIBUTION CURVE



GRAVEL	SAND		SILT	CLAY
	Coarse to Medium	Fine		

Project Name: Ben Hill Griffin Pkwy. Force Main Improvements

Project Location: Lee County, Florida

Client Name: Tetra Tech

Sample Depth: 18.5 - 20 Boring Number: B-12

Sample Description: Gravelly silty fine SAND (SM)

Percent Passing No. 200 Sieve = 41.7%

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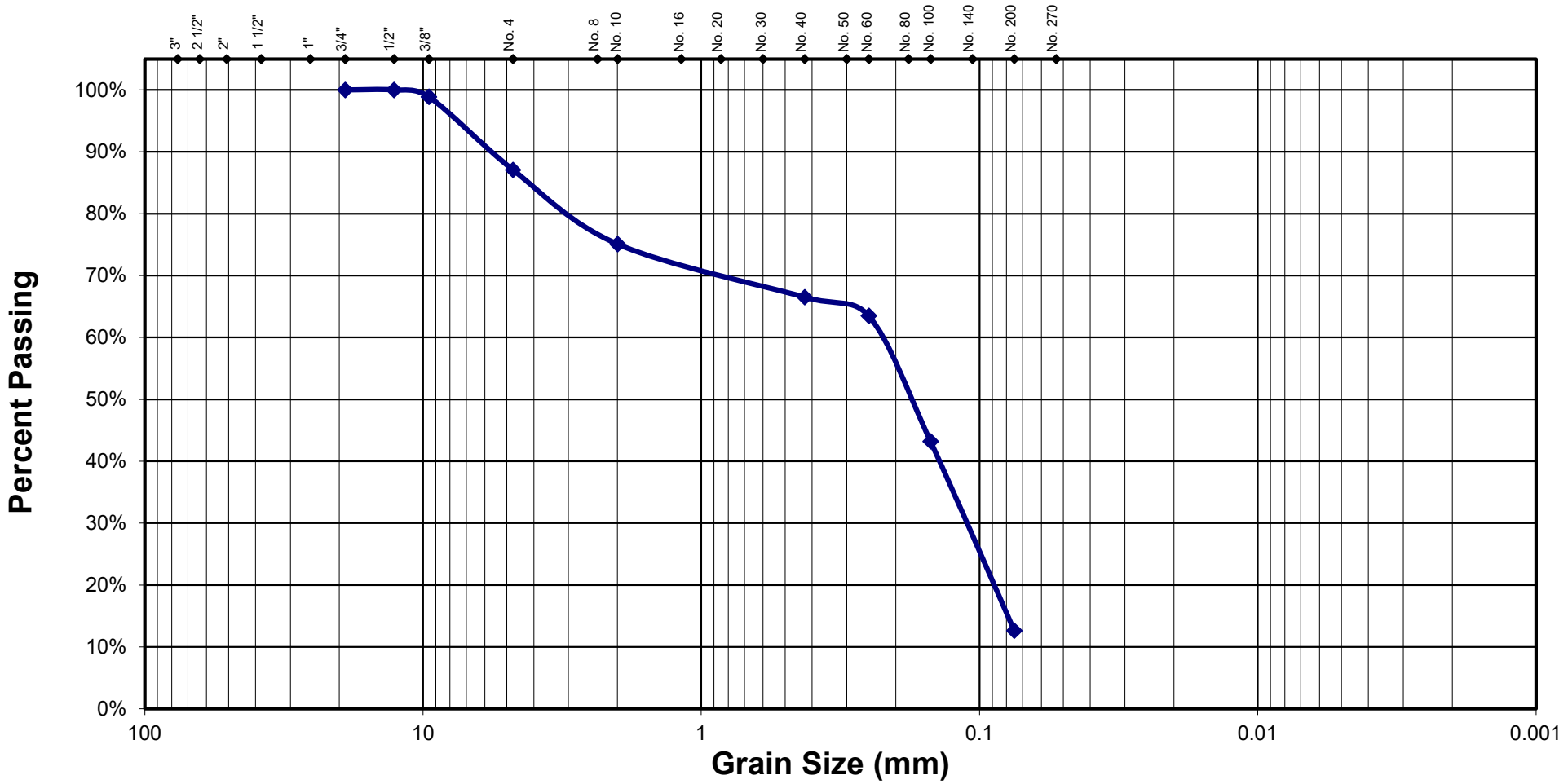
GRAIN SIZE DISTRIBUTION CURVE



GRAVEL	SAND		SILT	CLAY
	Coarse to Medium	Fine		

Project Name: Ben Hill Griffin Pkwy. Force Main Improvements

Project Location: Lee County, Florida

Client Name: Tetra Tech

Sample Depth: 13.5 - 15 Boring Number: B-13

Sample Description: Silty fine SAND with trace of shell (SM)

Percent Passing No. 200 Sieve = 12.6%

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APPENDIX 2:

- **SOIL BORING, SAMPLING AND TESTING METHODS**
  PROJECT SOIL DESCRIPTION PROCEDURE –
  UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

SOIL BORING, SAMPLING AND TESTING METHODS

STANDARD PENETRATION TEST

The Standard Penetration Test (SPT) is a widely accepted method of in-situ testing of foundation soils (ASTM D-1586). A 2 ft (0.6 m) long, 2 in (50 mm) O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 in (0.45 m) into the ground by successive blows of a 140 lb (63.5 Kg) hammer freely dropping 30 in (0.76 m). The number of blows needed for each 6 in (0.15 m) of penetration is recorded. The sum of the blows required for penetration of the second and third 6 in (0.15 m) increments penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual description of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load. The following tables relate N-values to a qualitative description of soil density and, for cohesive soils, an approximate unconfined compressive strength (Q_u):

Cohesionless Soils: N-Value Safety Hammer	N-Value Auto Hammer	Description	Relative Density
< 4	< 3	Very loose	0 - 15%
4 - 10	3 - 8	Loose	>15% - 35%
11 - 30	9 - 24	Medium dense	>35% - 65%
31 - 50	25 - 40	Dense	>65% - 85%
> 50	> 40	Very dense	>85% - 100%

Cohesive Soils: N-Value Safety Hammer	N-Value Auto Hammer	Description	Unconfined Compressive Strength, Q_u
< 2	< 1	Very soft	< 0.25 tsf (25 kPa)
2 - 4	1 - 3	Soft	0.25 - 0.50 tsf (25 - 50 kPa)
5 - 8	4 - 6	Firm	>0.50 - 1.0 tsf (50 - 100 kPa)
9 - 15	7 - 12	Stiff	>1.0 - 2.0 tsf (100 - 200 kPa)
16 - 30	13 - 24	Very stiff	>2.0 - 4.0 tsf (200 - 400 kPa)
> 30	> 24	Hard	> 4.0 tsf (400 kPa)

The tests are usually performed at 5 ft (1.5 m) intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed by backfilling with neat cement.

Representative split-spoon samples from each sampling interval and from different strata are brought to our laboratory in air-tight jars for classification and testing, if necessary. Afterwards, the samples are discarded unless prior arrangements have been made.

HAND AUGER BORINGS

Hand auger borings are used, if soil conditions are favorable, when the soil strata are to be determined within a shallow (approximately 5 ft [1.5 m]) depth or when access is not available to power drilling equipment. A 3 in (75 mm) diameter hand bucket auger with a cutting head is simultaneously turned and pressed into the ground. The bucket auger is retrieved at approximately 6 in (0.15 m) intervals and its contents emptied for inspection. Sometimes post-hole diggers are used, especially in the upper 3 ft (1 m) or so. The soil sample obtained is described and representative samples put in bags or jars and transported to the laboratory for classification and testing, if necessary.

POWER AUGER BORINGS

Auger borings are used when a relatively large, continuous sampling of soil strata close to the ground surface is desired. A 4 in (100 mm) diameter, continuous flight, helical auger with a cutting head at its end is screwed into the ground in 5 ft (1.5 m) sections. It is powered by the rotary drill rig. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is described and representative samples put in bags or jars and returned to the laboratory for classification and testing, if necessary.

LABORATORY TEST METHODS

Soil samples returned to our laboratory are looked at again by a geotechnical engineer or geotechnician to obtain more accurate descriptions of the soil strata. Laboratory testing is performed on selected samples as deemed necessary to aid in soil classification and to help define engineering properties of the soils. The test results are presented on the soil boring logs at the depths at which the respective sample was recovered, except that grain-size distributions or selected other test results may be presented on separate tables, figures or plates as discussed in this report, the results of which will be located in an Appendix. The soil descriptions shown on the logs are based upon visual-manual procedures in accordance with local practice. Soil classification is in general accordance with the Unified Soil Classification System (ASTM D-2487) and is also based on visual-manual procedures.

THE PROJECT SOIL DESCRIPTION PROCEDURE FOR SOUTHWEST FLORIDA [1]

For use with the ASTM D-2487 Unified Soil Classification System

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

BOULDERS (>12 in [300 mm]) and COBBLES (3 in [75 mm] to 12 in [300 mm]):

GRAVEL:
- Coarse Gravel: ¾ in (19 mm) to 3 in (75 mm)
- Fine Gravel: No. 4 (4.75 mm) Sieve to ¾ in (19 mm)

Descriptive Adjectives:

0 – 5%	---	no mention of gravel in description
>5% – 15%	---	trace
>15% – 30%	---	some
>30% – 50%	---	gravelly (shell, limerock, cemented sands)

SANDS:
- Coarse Sand: No. 10 (2 mm) Sieve to No. 4 (4.75 mm) Sieve
- Medium sand: No. 40 (425 μm) Sieve to No. 10 (2 mm) Sieve
- Fine sand: No. 200 (75 μm) Sieve to No. 40 (425 μm) Sieve

Descriptive Adjectives:

0 – 5%	---	no mention of sand in description
>5% – 15%	---	trace
>15% – 30%	---	some
>30% – 50%	---	sandy

SILT/CLAY: <#200 (75 μm) Sieve

Silty or Silt: PI < 4
Silty Clayey or Silty Clay: 4 ≤ PI ≤ 7
Clayey or Clay: PI > 7

Descriptive Adjectives:

0 – 5%	---	clean (no mention of silt or clay in description)
>5% – 12%	---	slightly
>12% – 30%	---	clayey, silty, or silty clayey
>30% – 50%	---	very

ORGANIC SOILS:

Organic Content	Descriptive Adjectives:	Classification:
0 – 2.5%	no mention of organics in description	see above
2.6 – 5%	slightly organic	see above
>5 – 20%	organic	add "with organic fines" to group name
>20-75%	highly organic sand or muck sandy peat	Peat (PT)
>75%	fibrous peat	Peat (PT)

STRATIFICATION AND STRUCTURE:

Descriptive Term:	Thickness:
seam:	less than ½ in (13 mm) thick
layer:	½ to 12 in (13 to 300 mm) thick
stratum:	more than 12 in (300 mm) thick
pocket:	small, erratic deposit, usually less than 1 ft
occasional:	1 or less per ft of thickness

Descriptive Term:	Thickness:
frequent:	more than 1 per ft of thickness
calcareous:	containing calcium carbonate (reaction to diluted HCL)
hardpan:	spodic horizon usually medium dense
marl:	mixture of carbonate clays, silts, shells and sands.

ROCK CLASSIFICATION:

Description:
Hard Limestone or Caprock: N-values >50 bpf
Soft Weathered Limestone: N-values ≤ 50 bpf

(1) This soil description procedure was developed specifically for projects in southwest Florida because it is believed that the terminology will be better understood as a result of local practice. It is not intended to supplant other visual-manual classification procedures for description and identification of soils such as ASTM D-2488.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines[C]	$C_u > 4$ and $1 < C_c < 3$[E]	GW	Well graded gravel[F]
			$C_u < 4$ and/or $1 > C_c > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines: More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines[D]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[E]	SW	Well graded sand[I]
			$C_u < 6$ and/or $1 > C_c > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines: More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		Organic:	Liquid limit - oven dried (< 0.75)	OL	Organic clay[K,L,M,N]
			Liquid limit - not dried (< 0.75)	OL	Organic silt[K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		Organic:	Liquid limit - oven dried (< 0.75)	OH	Organic clay[K,L,M,P]
			Liquid limit - not dried (< 0.75)	OH	Organic clay[K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well graded gravel with silt, GW-GC well graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well graded sand with silt, SW-SC well graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.