HILLIS-CARNES
ENGINEERING ASSOCIATES

Geotechnical Engineering Study
College of Southern Maryland
Gym Wall Slope
La Plata, Maryland
HCEA Job No. 19177A

Prepared for:

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April 26, 2019

College of Southern Maryland
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Re: Geotechnical Engineering Study
College of Southern Maryland
Gym Wall Slope Evaluation
PE Building, S. Campus Dr.
La Plata, Maryland
HCEA Project No. 19177A

Ms. Lisa M. Kreiser and,
Mr. Lawrence Abell:

Hillis-Carnes Engineering Associates, Inc. (HCEA) is pleased to submit this report conveying the results of subsurface exploration and subsequent geotechnical evaluation for the existing slope at the PE Building on the College of Southern Maryland campus, in La Plata, Maryland.

We wish to advise you that the boring samples will be stored at our Annapolis Junction, Maryland office for a period of 30 days from the date of this letter. Should you wish the samples to be stored for a longer period of time or to be delivered to you or another party, please advise us in writing prior to the end of the 30-day period. Otherwise, the samples will be discarded at the end of the 30-day storage period.

HCEA appreciates having had the opportunity to provide the geotechnical consultation for this project, and we will remain available for further consultation during the various design stages. Should you have any questions concerning the contents of this report, or require additional consultation, design, inspection, or testing services, please contact our Office.

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.

STATE OF MARYLAND
WILLIAM S. HARRIS
No. 39819
PROFESSIONAL ENGINEER

William Harris, PE
Project Engineer

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1.0 PURPOSE AND SCOPE

The purpose of this study was to determine the general subsurface conditions at the boring locations and to evaluate those conditions with respect to the overall stability of the slope descending from the upper level of the College of Southern Maryland P.E. building in La Plata, Maryland. Stability analyses were developed in order to provide an evaluation of the potential impacts of the below-grade oil tank at the site.

The evaluations and recommendations presented in this report were developed from an analysis of project characteristics and an interpretation of the general subsurface conditions at the site based on the boring information. The stratification lines indicated on the Records of Soil Exploration (boring logs) represent the approximate boundaries between soil types. In-situ, however, the transitions may be gradual. Such variations can best be evaluated during construction and, if necessary, any minor design changes can be made at that time.

An evaluation of the site with respect to potential construction problems and recommendations dealing with the earthwork and inspection during construction are also included, should the Client decide to stabilize the site. The inspection is considered necessary to verify the subsurface conditions and to verify that the soils-related construction phases are performed properly. The Appendix contains a summary of the field and laboratory work on which this report is based.

2.0 PROJECT CHARACTERISTICS

The project site is located at the northwest corner of the PE Building at the College of Southern Maryland in La Plata, Maryland as shown on the Project Location Map (Figure 1) in the Appendix.

The area of study consists of a grassy hill descending from the upper level of the College of Southern Maryland P.E. Building. Based on the available topographic data provided by the Client (College of Southern Maryland, Abell Associates), the crest of the hill is at the approximate elevation El. 200± ft and the lowest lying areas of the hill range in elevation between El. 184± ft and 186± ft. The buried oil tank is located at the lowest lying area of the site (Ref. Photo-2.0.1).

Available historic data and construction bid documents indicate that the built-up hill was constructed at some time after 2003, as part of an addition of the original College of Southern Maryland PE Building.



Photo 2.0.1 – Area of Study, including buried oil tank and soil mass.

Additional details concerning the construction of existing slope and structures were not available at the time that this report was being prepared.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 Site Reconnaissance

Prior to beginning the subsurface exploration program, HCEA performed site reconnaissance of the College of Southern Maryland PE Building slope. The slope being considered is currently open and grassy. The slope is bound by a flight of stairs to the east and the PE Building wall and retaining wall to the south.

Based on available utility plans and the result of a utility location service, it appears that several utilities run through this area. Utilities running through or about this area include sanitary sewer, electric, telecommunications and the connection to the underground oil tank.

Some evidence of soil movement was noted at the Gym Wall slope (See suspected Migrating Soil Mass (1&2), Photo 3.1.1). It is suspected that most of the displaced material is represented within the Suspected Migrating Soil Mass (1) area, delineated below. This region makes up the main body of the failure.

A small soil bulge was noted along the toe of the slope (See Suspected Migrating Soil Mass (2)). This soil mass appears to flank about the main body of the failure (Suspected Migrating Soil Mass (1)) and is further bound by S. Campus Drive to the north.

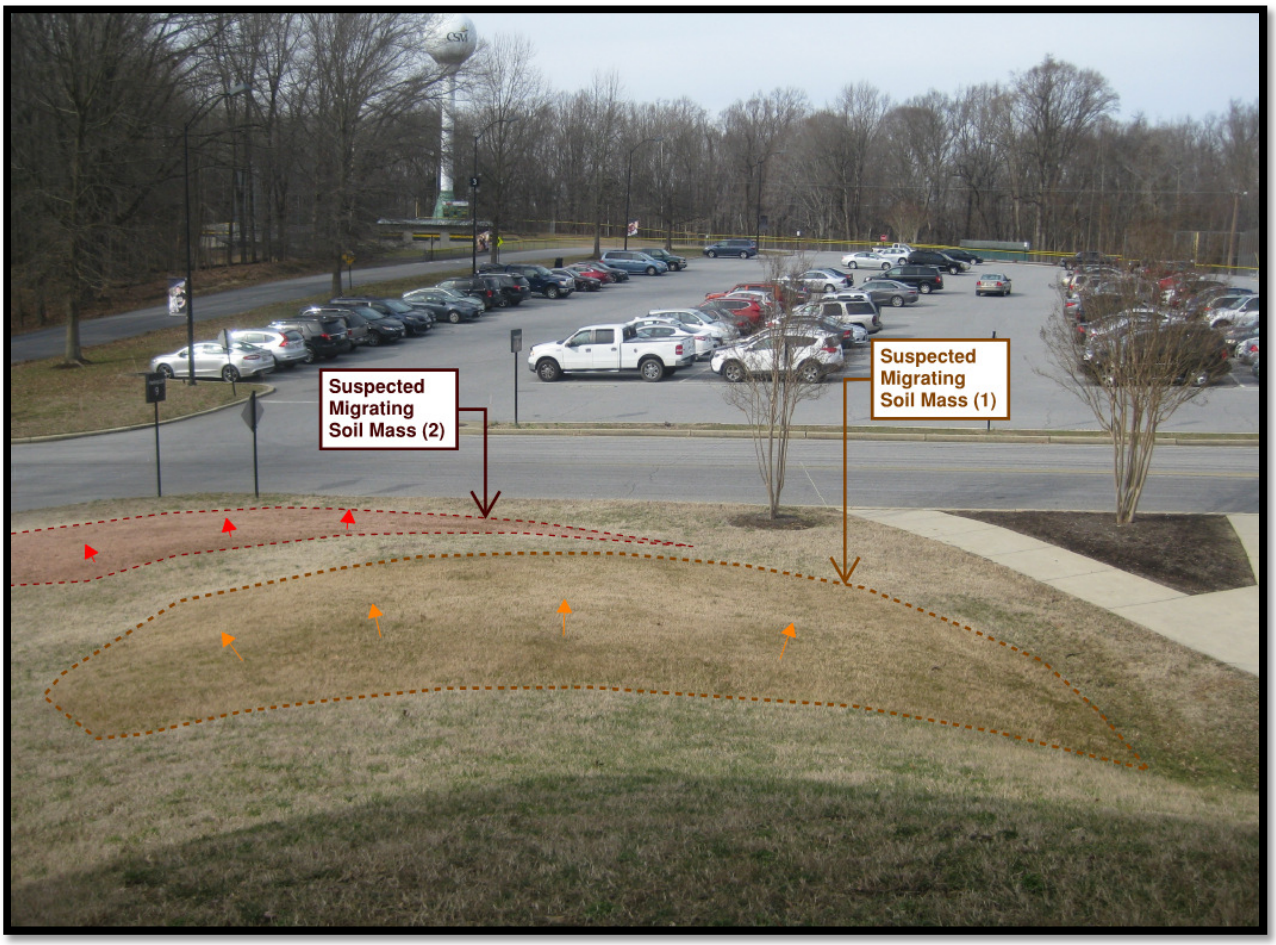


Photo 3.1.1 – Soil Mass movement delineation & annotation

A cursory evaluation of those existing structures related to our geotechnical analysis was done during HCEA's site reconnaissance – note however that the stability of the building or the associated structures (walls, stairs, etc.) was not evaluated during this study. The stairway leading from the upper level of the PE building, downslope to S. Campus Drive, shows evidence of settlement (Ref. Photo 3.1.2). The sidewalk at the crest of the slope appears to be bowing and

settling, with an approximate discernable settlement at least 4 inches. The sidewalk at the top of the slope has separated from the two doorways.



Photo 3.1.2 – Stairway movement and deflection

Sealant has been installed along the stairway and building interface as shown in photo 3.1.2. Over time, this sealant has given way as the stairs have continued to settle. Coloration along the stair structure and the exterior wall suggest considerable water runoff is present during precipitation events.

3.2 Subsurface Exploration Program

In order to determine the general foundation soil types and to develop design parameters, two (2) Standard Penetration Test (SPT) soil borings were drilled in accessible areas of the site in order to define the site stratigraphy. Boring locations were staked in the field by HCEA. Approximate boring locations are shown on the Boring Location Plan (Figure 2) in the Appendix.

Borings were advanced with hollow-stem augers and subsurface soils were typically sampled at 2.5 ft and 5.0 ft intervals. Samples were taken by driving a

1-3/8-inch I.D. (2-inch O.D.) split-spoon sampler in accordance with ASTM D-1586 specifications. The sampler was first seated 6 inches to penetrate any loose cuttings and then was 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 as the "Penetration Resistance" or "N" value. The penetration resistance, when properly evaluated, is an index to the soil strength and compression characteristics. A thin-wall Shelby tube was also pushed at two depths (22.5 ft and 32.5 ft below existing grade) within boring B-1, in order to recover a relatively undisturbed sample of the underlying material.

Representative portions of each soil sample were placed in glass jars and transported to HCEA's laboratory. In the laboratory, the samples were visually examined by the Geotechnical Engineer to verify the driller's field classifications. The samples were visually classified in general accordance with the Unified Soil Classification System and the field classifications were revised where necessary. The Unified Soil Classification Symbols appear on the boring logs and the system nomenclature is briefly described in the Appendix.

Laboratory testing was performed on representative samples, which consisted of Atterberg limits, sieve analysis, and moisture content tests. The results of the laboratory testing were used in general accordance with ASTM D-2487 to obtain the USCS classification of the soils tested. The results of the laboratory testing are presented in the Appendix and the USCS classifications presented on the Records of Soil Exploration were reviewed based on the laboratory testing results.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered at the site are shown on the Records of Soil Exploration. A brief description of the subsurface conditions and pertinent engineering characteristics of the soils are given below.

Strata divisions shown on the Records of Soil Exploration and boring profiles have been estimated based on visual examinations of the recovered boring samples. In the field, strata changes could occur gradually and/or at slightly different levels than indicated. Also, groundwater conditions indicated on the Records of Soil Exploration are those observed during the period of the subsurface exploration. Fluctuations in groundwater levels could occur seasonally and might also be influenced by changes in grading, runoff and infiltration rates, and other influencing factors.

Generalized subsurface conditions based on the results of the borings are discussed below:

4.1 Site Geology

The Geologic Map of Maryland (1968) shows that the project site is located within the physiographic province identified as the Atlantic Coastal Plain. According to the USGS 1968, the College of Southern Maryland Gym Wall Slope site is underlain by the Upland Deposits geology, generally characterized by "Gravel and sand, commonly orange-brown, locally limonite-cemented; minor silt and red, white, or gray clay." As stated previously, the materials that comprise the existing slope appear to be artificial fill materials placed during previous construction at the site.

4.2 Existing Surficial Materials and Fill Material

4.2.1 Surficial Materials

Both of the borings advanced during this geotechnical study occurred within the existing Gym hill slope. Surficial materials therefore consisted primarily of topsoil material. Topsoil noted onsite varied in thickness between 2-inches and 3-inches at the specific boring locations.

4.2.2 Fill Material

Fill materials are those materials showing evidence of having been worked or man-placed in the past. Fill noted by HCEA may be either controlled, engineering structural fill or uncontrolled fill potentially containing rubble, debris, organics, etc. Materials specifically identified as man-placed fill materials or possible man-placed fill materials were noted to depths of between 8 ft and 17.5 ft below existing site grades.

Fill material noted on site consisted primarily of clayey sand (SC) with varying amount of gravel. Silty sand (SM), silty-clayey sand (SC-SM), clayey gravel and sand (GC-SC). Poorly-graded sand (SP) fill materials were also noted within boring B-2. These coarse-grained fill materials had relative densities ranging from very loose to loose.

It should be noted that HCEA encountered material offering no penetration resistance over 18 inches at a depth of 2.5 ft below existing grade within boring B-1 and this may be indicative of a void, muck or very loose material below the stairs and the sidewalk.

Since the size of the samples obtained is relatively small in comparison to the areal extent of the site and since the fill materials could be of similar composition to the natural soils encountered at the site, it is often difficult to determine the presence and composition of fill materials from the SPT samples. It should be anticipated that man-placed fill materials may be encountered at other locations and to different depths across the site due

to the previous construction that has occurred on and around the project site.

4.3 Natural Soils

The natural soils encountered at the site were visually classified in general accordance with the Unified Soil Classification System as being clayey gravel and sand (GC-SC), poorly-graded sand (SP), silty-clayey sand (SC-SM), clayey sand (SC), lean clay (CL) and combinations thereof. Fat marine clay (CH) was noted at a depth of 30 ft in boring B-1.

Relative densities indicated by the SPT N-values ranged from very loose to dense for the more granular natural materials encountered. It should be noted that natural gravelly stratum encountered within boring B-1 had medium dense to dense relative densities while the rest of natural sandy materials had very loose to loose relative densities. The consistencies indicated by SPT N-values of the more fine-grained natural materials encountered ranged from very soft to soft.

4.4 Groundwater

Groundwater was observed during drilling operations and at boring completion. Each boring was backfilled at completion due to safety concerns. Groundwater was not noted within the depths of those borings advanced during this subsurface exploration program.

A more accurate determination of the hydrostatic water table would require the installation of perforated pipes or piezometers which could be monitored over an extended period of time. The actual level of the hydrostatic water table and the amount and level of perched water should be anticipated to fluctuate throughout the year, depending on variations in precipitation, surface run off, infiltration, site topography, and drainage.

5.0 SITE EVALUATION: POTENTIAL CAUSES OF SLOPE FAILURE

Our findings from the exploration of the subsurface conditions at the College of Southern Maryland Gym Wall Slope suggest that the failure of the gym wall slope, e.g. the settlement of the stairs and soil migration, is due primarily to existing water conditions and the soft/loose underlying soils within the slope. Possible failure due to water flow within the soil mass is briefly discussed in the following section.

5.1 Slope Stability Analyses

Slope stability analyses were performed using the GSTABL7 computer program based on the Generalized Limit Equilibrium (Morgenstern-Price) Method of critical failures in order to evaluate the stability of the slopes at the College of

Southern Maryland Gym Wall Slope. Slope stability analyses were performed in two representative sections, one parallel to the stairs (Section A) and the other towards the oil tank (Section B). Approximate section locations are shown on the Boring Location Plan (Figure 2) in the Appendix. As previously discussed, the underlying site stratigraphy is a rough approximation based on our subsurface exploration and should therefore be considered approximate. Results of the stability analyses are included in the Appendix.

5.1.1 Soil Parameters

The soil parameters utilized for the slope stability analyses were estimated based on correlations between the boring results, lab results and published literature. Soil parameters used to model the slope stability are summarized below:

SOIL	USCS CLASSIFICATION	UNIT WEIGHT (PCF)	SAT. WEIGHT (PCF)	COHESION (PSF)	PHI ANGLE
1	SC, SM, SC/CL; FILL	105	115	40	20°
2	GC/SC	118	128	0	33°
3	SC, SP, SC-SM	100	110	0	28°
4	CL, CH	103	113	400	12°

It should be noted that low recovery of the samples and suspected void encountered within fill stratum of boring B-1 caused some uncertainty of soil strength at this depth. Conservative soil properties were therefore assumed for this fill stratum. Strength of slope backfill material estimated above should be considered approximate.

5.1.2 Slope Geometry and Site Conditions

The geometry of the slopes and the boring elevations were determined using the grading plans provided by the Client. The subsurface stratigraphy was interpolated between two borings advanced at the site. Weight of the concrete slab (sidewalk) was applied at the top of slope backfill and the water table is conservatively assumed to be located at the slope surface to examine failures associated with precipitation and water intrusion. Utility lines and miscellaneous features at the site were not modeled in the stability analysis but may also contribute to water intrusion.

5.1.3 Results of Stability Analyses

Limit equilibrium analysis of slope stability typically results in a factor of safety (FOS) value. This value is a ratio of resisting force/moment to driving force/moment and is used to quantify the global stability of a slope. A FOS

ranging from 1.3 to 1.5 is conventionally accepted as a stable condition while a FOS less than 1.0 generally indicates a failing or unstable slope.

The details of the stability analyses of the College of Southern Maryland Gym Wall Slope are included in the Appendix and the results are summarized below:

SECTION	DIRECTION OF SECTION	FACTOR OF SAFETY (FOS)
A	parallel to stairway	1.192
B	towards oil tank	1.104

The critical surface from Section A analysis reflects the small bulge noted at the toe, which is the evidence of the slope failure previously discussed in Section 3.1. The oil tank area appears to be unimpacted by slope failure as the most critical potential sliding surface would toe at a higher elevation than the existing top of tank elevation. While slope stability was considered at the site, the integrity of the tank structure with relation to the movement tolerable by this structure was not part of our evaluation. We recommend that the tank and tank fitting manufacturer be consulted to determine the movement tolerable by the tank.

Each slope stability analysis resulted in FOS greater than 1.0 but less than 1.3. It should be noted that the slope fill did not immediately slide or fail at the time of construction, indicating some initial acceptable slope stability. Nonetheless, slope failures were observed on site over time. It is therefore suspected that there are likely to have been some external factors which triggered soil migration and settlement.

5.2 Water Seepage

Ideally stormwater should be managed in such a manner that it runs off the slope. Once water percolates below the concrete slab (sidewalk) and flows downward within the slope soil mass, seepage forces parallel to the flow direction may be generated. This additional driving force along with the weight of water would have adverse effects on stability of slope system. Water stains at the opposite side of brick wall behind the stairs could serve as possible evidence of subsurface water seepage. It is also possible that this area is receiving runoff from the roof of the existing building.

In addition, water flow within the soil mass has potential to wash out the underlying subsurface material, especially those fine soils which are light enough to migrate. As shown on the Records of Soil Exploration, surficial fill material, predominantly clayey sand (SC) containing 25% to 40% fine content, would have been subject to such migration over time. Washout near the sidewalk and the

suspected void (or very loose material) encountered within boring B-1 could be evidence of this migration of fines/material within the soil mass. Migration of subsurface fines/material could lead to the subsidence of fill, which may cause settlement of the slab and the stairs over time.

5.3 Condition of Slope Backfill

As shown on the Records of Soil Exploration, relative densities of fill material indicated by the SPT N-values ranged from very loose to loose. Despite the existing fill material being predominantly granular soil, e.g. clayey sand and silty sand with gravel, the very loose to loose relative densities noted onsite indicate that the strength of these fill material could be lower than the strength that typically characterizes granular soils. Poorly compacted soil would also be more susceptible to soil washout, generating more voids in soil mass and higher chance of water-related issues discussed in Section 5.1.

6.0 RECOMMENDATIONS: REMEDIATION OPTIONS

As a result of the slope failure and settlement, the soil mass has migrated downslope, likely relieving excess stress within slope. Ongoing water-related problems could continue to exacerbate site conditions. Furthermore, the potential void under the concrete slab (sidewalk) and stairway should be backfilled or remediated to avoid any subsequent structural failure or damage to the existing building or pedestrian walkway. It is also our understanding that several utility lines/pipes are existing within the slope and these subsurface utility features could possibly be damaged if the slope soil mass continues to migrate.

Thus, it is highly recommended that the existing slope be remediated to avoid additional failure or any potential damage. Considering the current condition of the site, possible remediation methods and risk management options are discussed in the following sections. Remediation processes should be done cautiously with respect to underlying existing utility features. Existing utilities should be identified and checked for leaks prior to any subsurface construction. During construction, contractors should be aware of subsurface utilities and properly protect them. Furthermore, it is recommended that the slope be monitored for movement over time utilizing optical surveying monitoring equipment.

6.1 Drainage System

As discussed in Section 5.2, water seeping through the soil mass may cause unfavorable conditions with respect to slope stability. To reduce water-related problems within the soil mass, water from external sources, e.g. rain and pipe leakage, should not be allowed to percolate into the soil mass, and should quickly be drained if infiltration occurs. If properly installed, drainage system will

minimize excess pore water pressure which could build up in the soil mass and weaken the underlying soils.

A subdrainage system is also recommended to capture water infiltration and to drain out of the soil mass. Subdrainage systems, such as horizontal drains, geotextile drainage, and geocomposite drainage (geonet with geotextiles) are ideal solutions. When installing horizontal drains by drilling through the slope, pipe lengths and locations should be carefully designed so that there is no conflict with existing utilities and building features. The use of geosynthetics will also help separate fines during drainage.

Once slope remediation measures are completed, steps should be taken to minimize surface water infiltrating into soil mass, joints of wall and stairs. If there is runoff from the roof, it should be redirected so the slope does not receive excessive runoff. A civil engineer should be consulted to evaluate the management of surface (sheet) water and stormwater at the site.

6.2 Removal/Remediation of Weak Soil

The weak fill stratum should be removed and replaced with engineered free-draining fill. It should be noted that the stability analyses show that the potential failures tend to occur within the weak fill stratum with very loose to loose relative density. Once the weak fill material is replaced with imported free-draining material and is properly compacted, the slope stability would increase significantly when accompanied with suitable drainage plan.

Extreme caution should be exercised during the removal of fill due to existing subsurface utility features within the slope. Abnormal changes of pipe pressure during the excavation and backfilling process would be a good indicator of pipe damage or leakage. If necessary, temporary support should be utilized to keep utility lines/pipes in place. It is also recommended that utilities be inspected for potential damage due to previous soil migration and settlement.

After the removal of weak fill material, engineered backfill should be placed in proper manner so that a stable slope condition is maintained. All fill should be placed in relatively horizontal 8 inch (maximum) loose lifts. Structural fill should be compacted to a minimum of 95 percent of the Modified Proctor (ASTM D-1557) maximum dry density. Fill materials in landscape and other non-structural areas should be compacted to at least 90 percent of the Modified Proctor maximum dry density if significant subsidence of the fill under its own weight is to be avoided. Field moisture contents should be maintained within 2 percentage points of the optimum moisture content in order to provide adequate compaction.

All material to be used as engineered fill should be inspected, tested and approved by the Geotechnical Engineer. In general, the on-site soils which are free from

organic and other deleterious components can be re-used as general site fill. New fills should be properly benched into existing slopes. To the extent possible, new slopes should be graded to a less steep angle to minimize the risk of future slope failures.

The mechanical reinforcement of soil using geogrid reinforcement can be utilized to further stabilize the slope. Geogrid can be placed during the backfill process with minimal impact to existing utilities.

Soil improvement options, such as soil mixing and grouting, or a new retaining wall option are not considered due to the complexity of utility lines within the slope, as well as likely cost constraints.

6.3 Chemical Grouting Injection

Based on subsurface exploration of the slope, it was suspected that water-related soil loss or migration may have created a void beneath the concrete slab and the stairway. In order to fill the potential void without sacrificing stability of the slope, chemical grouting (polymer) injection could be a good option to employ. A liquid form of polymer, when injected through the soil, will move throughout the soil mass, especially around the void. It will soon react and expand extensively in the void while densifying and binding surrounding soil media.

The seepage issue could also be treated as expanded polymers (foams) are typically impermeable and unaffected by water. While it is capable of bearing overburden pressure, expanded polymers are light-weight so that its weight does not significantly increase the driving force/moment of slope system. When accompanied with weak soil removal and a proper drainage system, this option could be applicable for slope remediation.

Like other remediation methods, care should be taken to apply chemical grouting injection with regard to utility protection.

7.0 RECOMMENDED ADDITIONAL SERVICES

Additional soil and foundation engineering, testing, and consulting services recommended for this project are summarized below:

Site Preparation and Proofrolling: A Geotechnical Engineer or experienced Soils Inspector should inspect the site after it has been stripped and excavated. The inspector should determine if any undercutting or in-place densification is necessary to prepare a subgrade for fill placement or for slab/stairway support.

Fill Placement and Compaction: A Geotechnical Engineer or experienced Soils Inspector should witness any required filling operations and should take sufficient in-place density tests to verify that the specified degree of fill compaction is achieved. He should observe and approve borrow materials used and should determine if their existing moisture contents are suitable.

Slope Remediation Inspection: A Geotechnical Engineer or the Geotechnical Engineer's representative should be onsite during all remediation phases, to observe and provide additional recommendations as required.

Optical Surveying Methods: We recommend that surveying monitoring points along the slope be monitored over time, utilizing Optical Surveying equipment capable of measuring movement of the soil mass and slope generally. Monitoring of the slope is recommended to determine if slope movement is ongoing, if slope movement corresponds to particular events (precipitation events, heavy pedestrian traffic events, etc.) and finally to gauge the effectiveness of remediation measures once they are undertaken.

8.0 REMARKS

This report has been prepared to aid in the evaluation of subsurface condition at the site. Additional consultations and services can be provided as needed.

These analyses and recommendations are, of necessity, based on the information made available to us at the time of the actual writing of the report and the on-site conditions, surface and subsurface that existed at the time the exploratory borings were drilled. Further assumption has been made that the limited exploratory borings, in relation both to the areal extent of the site and to depth, are representative of conditions across the site. The recommendations contained herein have been based on a series of widely spaced soil borings. Actual subsurface conditions encountered could vary from those outlined in this report.

If subsurface conditions are encountered which differ from those reported herein, this Office should be notified immediately so that the analyses and recommendations can be reviewed and/or revised as necessary. It is also recommended that:

1. We are given the opportunity to review any plans and specifications prepared subsequent to the final geotechnical study in order to comment on the interaction of the soil conditions as described herein and the design requirements.

2. A Geotechnical Engineer or experienced Soils Inspector are present at the site during the construction phase to verify installation according to the approved plans and specifications. This is particularly important during excavation, placement, and compaction of fill materials.

Please note that successful completion of the project is dependent on your compliance with all of the recommendations provided in this report. While represented separately, the recommendations represent work that is intertwined. The successful completion of the project is specifically conditioned on your complying with all recommendations.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties either implied or expressed. Hillis-Carnes Engineering Associates, Inc. assumes no responsibility for interpretations made by others based on work or recommendations made by HCEA.

APPENDIX

Site Location Map

Boring Location Plan

Records of Soil Exploration (Boring Logs)

Field Classification Sheet

Particle Size Distribution

Slope Stability Analyses (GSTABL7)



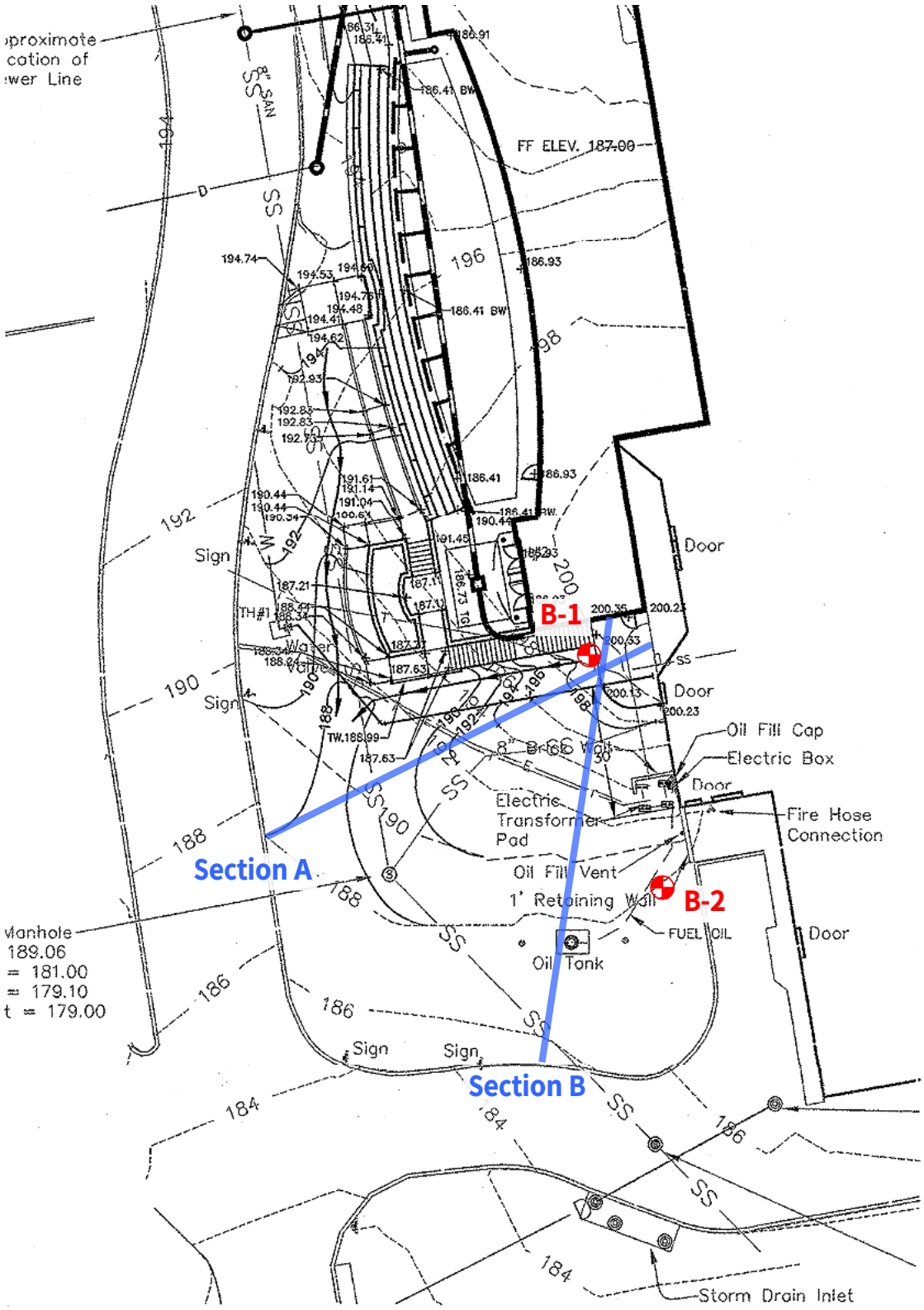
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PROJECT LOCATION MAP

Project: CSM Gym Wall Slope Evaluation

Project No.: 19177A

Scale: Reduced	Figure 1



HILLIS-CARNES
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BORING LOCATION PLAN

Project: CSM Gym Wall Slope Evaluation

Project No.: 19177A

Scale: Reduced | **Figure 2**

HILLIS - CARNES ENGINEERING ASSOCIATES, INC.

RECORD OF SOIL EXPLORATION

Project Name: **College of Southern Maryland Wall Slope** | Boring No.: B-1

Location: La Plata, MD | Job #: 19177A

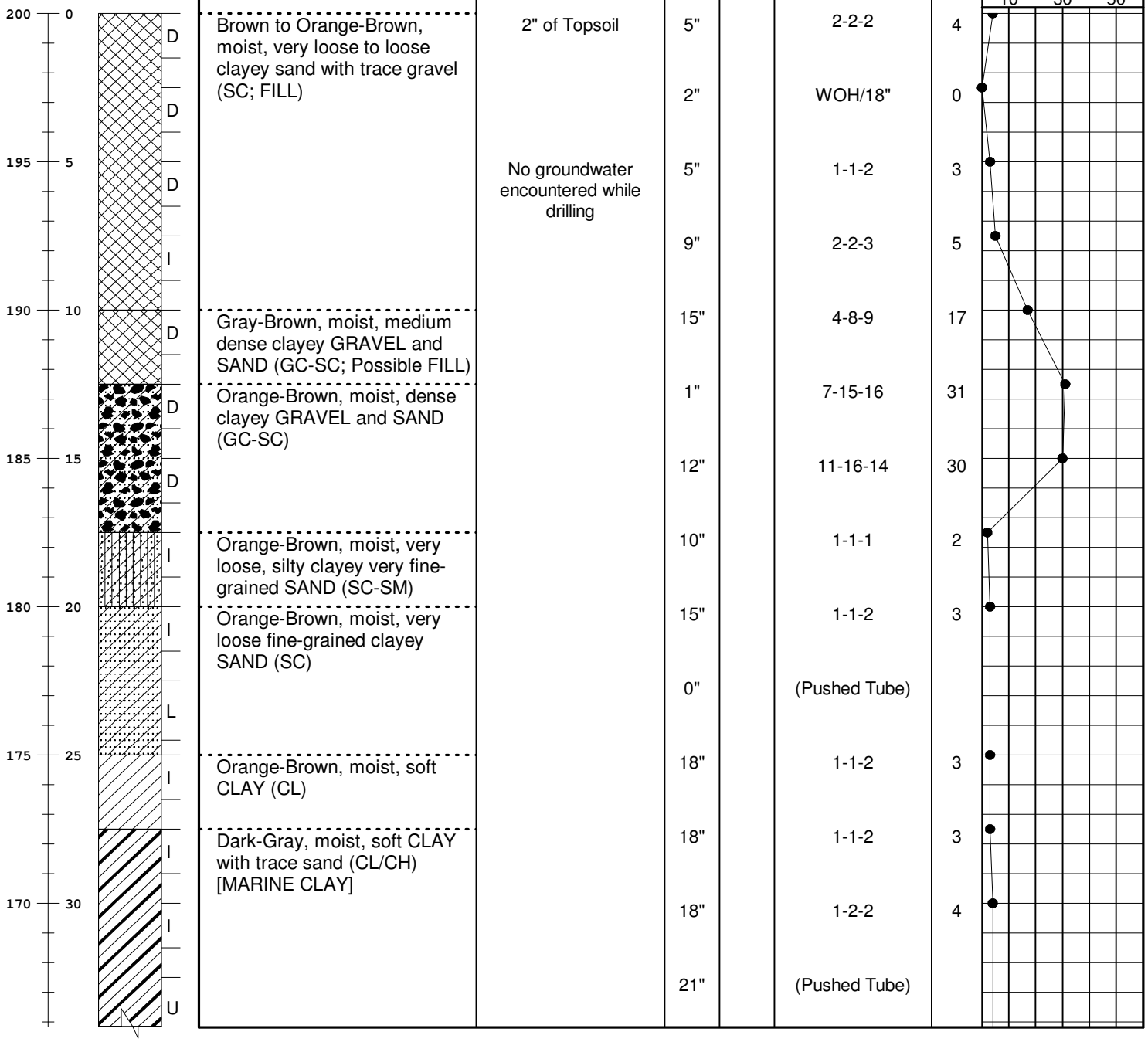
SAMPLER

Datum: | Hammer Wt.: 140 lbs. | Hole Diameter: 6" | Foreman: M. Stawas

Surf. Elev.: 200 ft | Hammer Drop: 30 in. | Rock Core Diameter: N/A | Inspector:

Date Started: 4/8/19 | Pipe Size: 2.0 in. | Boring Method: HSA | Date Completed: 4/9/19

Elevation/ Depth	SOIL SYMBOLS/ SAMPLE CONDITIONS	Description	Boring and Sampling Notes	Rec.	NM%	SPT Blows	SPT Blows/Foot N
200 / 0	D	Brown to Orange-Brown, moist, very loose to loose clayey sand with trace gravel (SC; FILL)	2" of Topsoil	5"		2-2-2	4
	D			2"		WOH/18"	0
195 / 5	D		No groundwater encountered while drilling	5"		1-1-2	3
	I			9"		2-2-3	5
190 / 10	D	Gray-Brown, moist, medium dense clayey GRAVEL and SAND (GC-SC; Possible FILL)		15"		4-8-9	17
	D	Orange-Brown, moist, dense clayey GRAVEL and SAND (GC-SC)		1"		7-15-16	31
185 / 15	D			12"		11-16-14	30
	I	Orange-Brown, moist, very loose, silty clayey very fine-grained SAND (SC-SM)		10"		1-1-1	2
180 / 20	I	Orange-Brown, moist, very loose fine-grained clayey SAND (SC)		15"		1-1-2	3
	L			0"		(Pushed Tube)	
175 / 25	I	Orange-Brown, moist, soft CLAY (CL)		18"		1-1-2	3
	I	Dark-Gray, moist, soft CLAY with trace sand (CL/CH) [MARINE CLAY]		18"		1-1-2	3
170 / 30	I			18"		1-2-2	4
	U			21"		(Pushed Tube)	



SAMPLER TYPE
DRIVEN SPLIT SPOON UNLESS OTHERWISE
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

	GROUND WATER	CAVE IN DEPTH
AT COMPLETION	Dry ft.	34.2 ft.
AFTER 24 HRS.	ft.	ft.
AFTER ___ HRS.	ft.	ft.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS - CARNES
ENGINEERING ASSOCIATES, INC.
RECORD OF SOIL EXPLORATION

Project Name: **College of Southern Maryland Wall Slope** Boring No.: B-1

Location: La Plata, MD Job #: 19177A

SAMPLER

Datum: _____ Hammer Wt.: 140 lbs. Hole Diameter: 6" Foreman: M. Stawas

Surf. Elev.: 200 ft Hammer Drop: 30 in. Rock Core Diameter: N/A Inspector: _____

Date Started: 4/8/19 Pipe Size: 2.0 in. Boring Method: HSA Date Completed: 4/9/19

Elevation/ Depth	SOIL SYMBOLS/ SAMPLE CONDITIONS	Description	Boring and Sampling Notes	Rec.	NM%	SPT Blows	SPT Blows/Foot N	SPT Blows/Foot Curve (10 30 50)
165 — 35	I			18"		1-2-2	4	
	I			18"		1-2-2	4	
160 — 40		Bottom of boring at 40 ft	Boring backfilled at completion					
155 — 45								
150 — 50								
145 — 55								
140 — 60								
135 — 65								

SAMPLER TYPE
DRIVEN SPLIT SPOON UNLESS OTHERWISE
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

	GROUND WATER	CAVE IN DEPTH
AT COMPLETION	Dry ft.	34.2 ft.
AFTER 24 HRS.	_____ ft.	_____ ft.
AFTER ___ HRS.	_____ ft.	_____ ft.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS - CARNES
ENGINEERING ASSOCIATES, INC.
RECORD OF SOIL EXPLORATION

Project Name: **College of Southern Maryland Wall Slope** | Boring No.: B-2

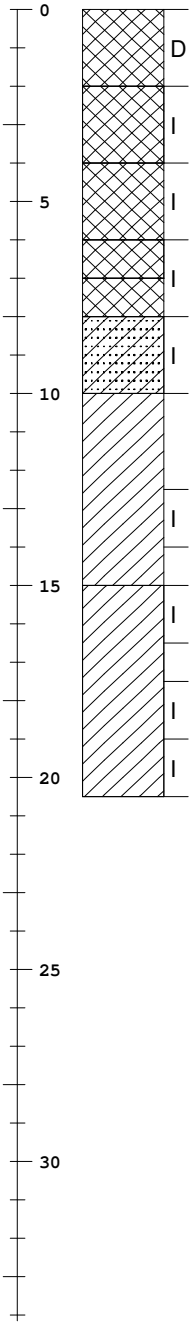
Location: La Plata, MD | Job #: 19177A

SAMPLER

Datum: | Hammer Wt.: 140 lbs. | Hole Diameter: 6" | Foreman: M. Stawas

Surf. Elev.: 188 ft | Hammer Drop: 30 in. | Rock Core Diameter: N/A | Inspector:

Date Started: 4/8/19 | Pipe Size: 2.0 in. | Boring Method: HSA | Date Completed: 4/8/19



Elevation/ Depth	Description	Boring and Sampling Notes	Rec.	NM%	SPT Blows	SPT Blows/Foot N
188	Brown, moist, loose silty SAND with trace gravel and roots (SM; FILL)	3" of Topsoil	10"		3-5-4-3	7
185	Orange-Brown, moist, very loose silty, clayey SAND with gravel (SC-SM; FILL)		11"		2-1-2-2	3
183	Brown, moist, very loose clayey SAND with trace pebbly gravel (SC; FILL)	No groundwater encountered while drilling	9"		3-2-1-2	3
180	Brown, moist, very loose clayey SAND with trace pebbly gravel (SC; FILL)		10"		2-2-1-2	3
178	Yellow-Brown, moist, very loose poorly-graded SAND (SP; FILL)		12"		2-3-3-4	6
175	Orange-Brown, moist, medium stiff very fine-graded clayey SAND (SC)		16"		2-1-2	3
173	Red-Brown/Light Gray, moist, soft CLAY with trace sand (CL)		18"		1-2-1	3
170	Yellow-Brown/Light Gray, moist, soft CLAY (CL)		18"		1-1-2	3
168			16"		1-1-1	2
167.5	Bottom of boring at 20.5 ft	Boring backfilled at completion				

SPT Blows/Foot Curve: 10 30 50

SAMPLER TYPE
DRIVEN SPLIT SPOON UNLESS OTHERWISE
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

	GROUND WATER	CAVE IN DEPTH
AT COMPLETION	Dry ft.	18.3 ft.
AFTER 24 HRS.	ft.	ft.
AFTER ___ HRS.	ft.	ft.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS-CARNES ENGINEERING ASSOCIATES, Inc.

10975 Guilford Road, Suite A • Annapolis Junction, Maryland 20701
Phone: (410)880-4788 • Fax: (410)880-4098

Description of Soils – per ASTM D2487

Major Component	Component Type	Component Description	Symbol	Group Name
Coarse-Grained Soils, More than 50% is retained on the No. 200 sieve	**Gravels** – More than 50% of the coarse fraction is retained on the No. 4 sieve. Coarse = 1" to 3" Medium = ½" to 1" Fine = ¼" to ½"	Clean Gravels <5% Passing No. 200 sieve	**GW**	Well Graded Gravel
			GP	Poorly Graded Gravel
		Gravels with fines, >12% Passing the No. 200 sieve	**GM**	Silty Gravel
			GC	Clayey Gravel
	Sands – More than 50% of the coarse fraction passes the No. 4 sieve. Coarse = No.10 to No.4 Medium = No. 10 to No. 40 Fine = No. 40 to No. 200	Clean Sands <5% Passing No. 200 sieve	**SW**	Well Graded Sand
			SP	Poorly Graded Sand
		Sands with fines, >12% Passing the No. 200 sieve	**SM**	Silty Sand
			SC	Clayey Sand
Fine Grained Soils, More than 50% passes the No. 200 sieve	Silts and Clays Liquid Limit is less than 50 Low to medium plasticity	Inorganic	**ML**	Silt
			CL	Lean Clay
		Organic	**OL**	Organic silt
				Organic Clay
	Silts and Clays Liquid Limit of 50 or greater Medium to high plasticity	Inorganic	**MH**	Elastic Silt
			CH	Fat Clay
		Organic	**OH**	Organic Silt
				Organic Clay
Highly Organic Soils	Primarily Organic matter, dark color, organic odor		**PT**	Peat

Proportions of Soil Components

Component Form	Description	Approximate percent by weight
Noun	Sand, Gravel, Silt, Clay, etc.	50% or more
Adjective	Sandy, silty, clayey, etc.	35% to 49%
Some	Some sand, some silt, etc.	12% to 34%
Trace	Trace sand, trace mica, etc.	1% to 11%
With	With sand, with mica, etc.	Presence only

Particle Size Identification

Particle Size	Particle dimension
Boulder	12" diameter or more
Cobble	3" to 12" diameter
Gravel	¼" to 3" diameter
Sand	0.005" to ¼" diameter
Silt/Clay (fines)	Cannot see particle

Cohesive Soils

Field Description	No. of SPT Blows/ft	Consistency
Easily Molded in Hands	0 – 3	Very Soft
Easily penetrated several inches by thumb	4 – 5	Soft
Penetrated by thumb with moderate effort	6 – 10	Medium
Penetrated by thumb with great effort	11 – 30	Stiff
Indented by thumb only with great effort	Greater than 30	Hard

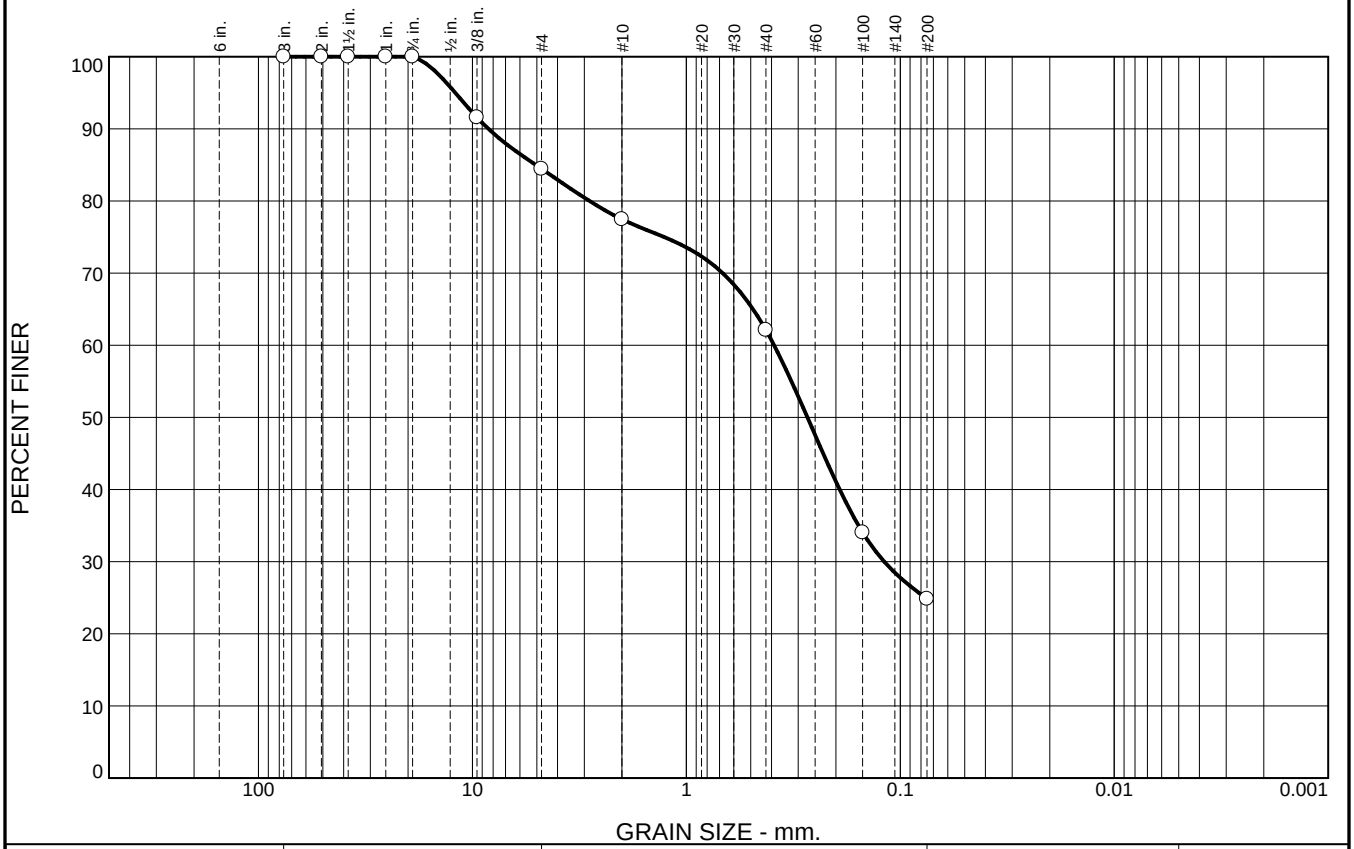
Granular Soils

No. of SPT Blows/ft	Relative Density
0 – 4	Very Loose
5 – 10	Loose
11 – 30	Medium Dense
31 – 50	Dense
Greater than 50	Very Dense

Other Definitions:

- **Fill:** Encountered soils that were placed by man. Fill soils may be controlled (engineered structural fill) or uncontrolled fills that may contain rubble and/or debris.
- **Saprolite**: Soil material derived from the in-place chemical and physical weathering of the parent rock material. May contain relic structure. Also called residual soils. Occurs in Piedmont soils, found west of the fall line.
- **Disintegrated Rock**: Residual soil material with rock-like properties, very dense, N = 60 to 51/0".
- **Karst:** Descriptive term which denotes the potential for solutioning of the limestone rock and the development of sinkholes.
- **Alluvium:** Recently deposited soils placed by water action, typically stream or river floodplain soils.
- **Groundwater Level**: Depth within borehole where water is encountered either during drilling, or after a set period of time to allow groundwater conditions to reach equilibrium.
- **Caved Depth:** Depth at which borehole collapsed after removal of augers/casing. Indicative of loose soils and/or groundwater conditions.

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	15.5	59.7	24.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1 - 1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	91.6		
#4	84.5		
#10	77.5		
#40	62.1		
#100	34.0		
#200	24.8		

* (no specification provided)

Material Description

Brown & yellow clayey sand with gravel

Atterberg Limits

PL= 14 LL= 26 PI= 12

Coefficients

D_{90}= 8.4190 D_{85}= 5.0586 D_{60}= 0.3889
D_{50}= 0.2717 D_{30}= 0.1189 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

Moisture content: 13.5%

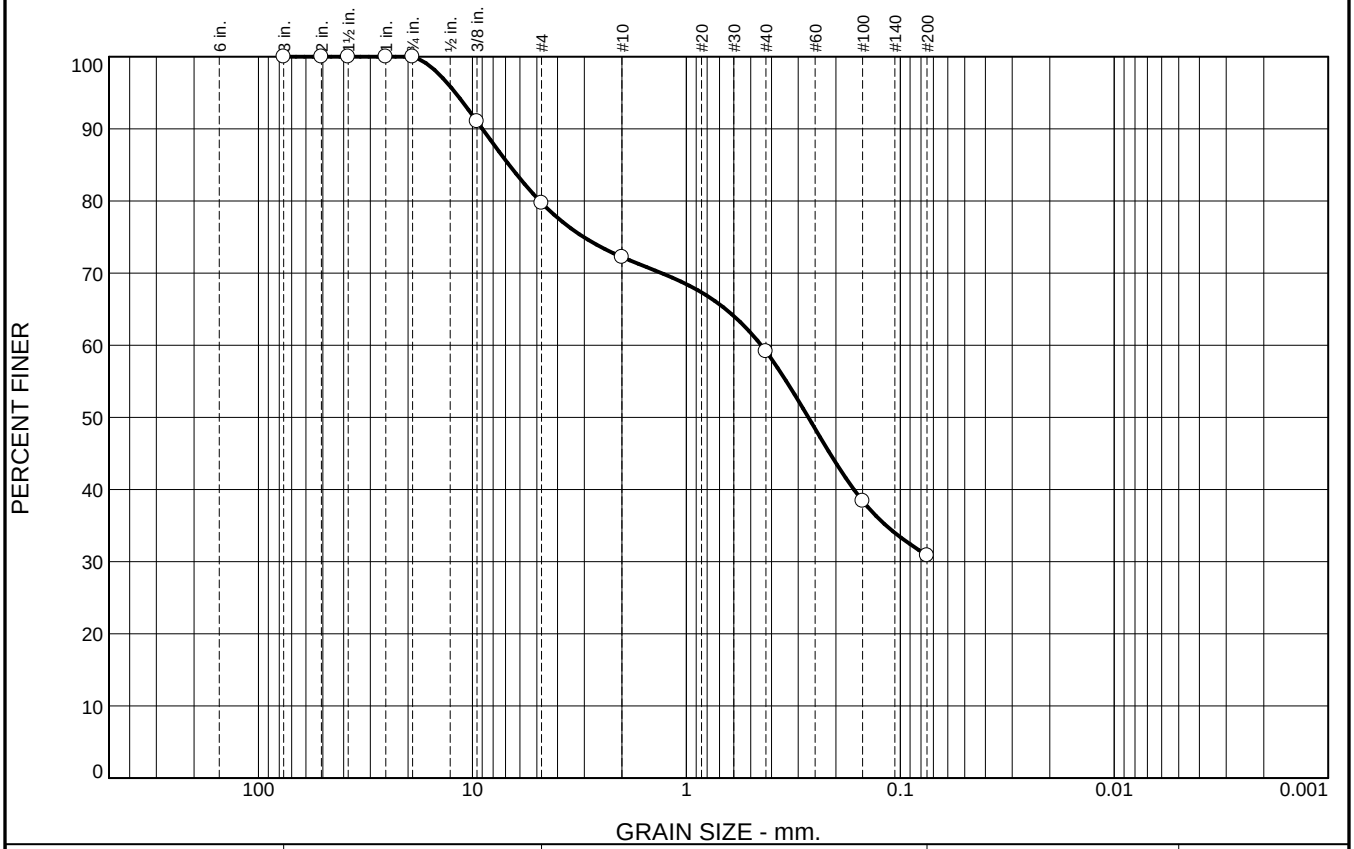
Location: B-1, S-1
Sample Number: 1 **Depth:** 0.0'-1.5' **Date:** 04/12/19

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

Client: Abell Associates
Project: CSM Gym Wall Slope

Project No: 19177A **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	20.3	48.8	30.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1 - 1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	91.0		
#4	79.7		
#10	72.2		
#40	59.2		
#100	38.4		
#200	30.9		

* (no specification provided)

Material Description

Dark brown clayey sand with gravel

Atterberg Limits

PL= 15 LL= 28 PI= 13

Coefficients

D_{90}= 8.9863 D_{85}= 6.7327 D_{60}= 0.4467
D_{50}= 0.2691 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

Moisture content: 14.2%

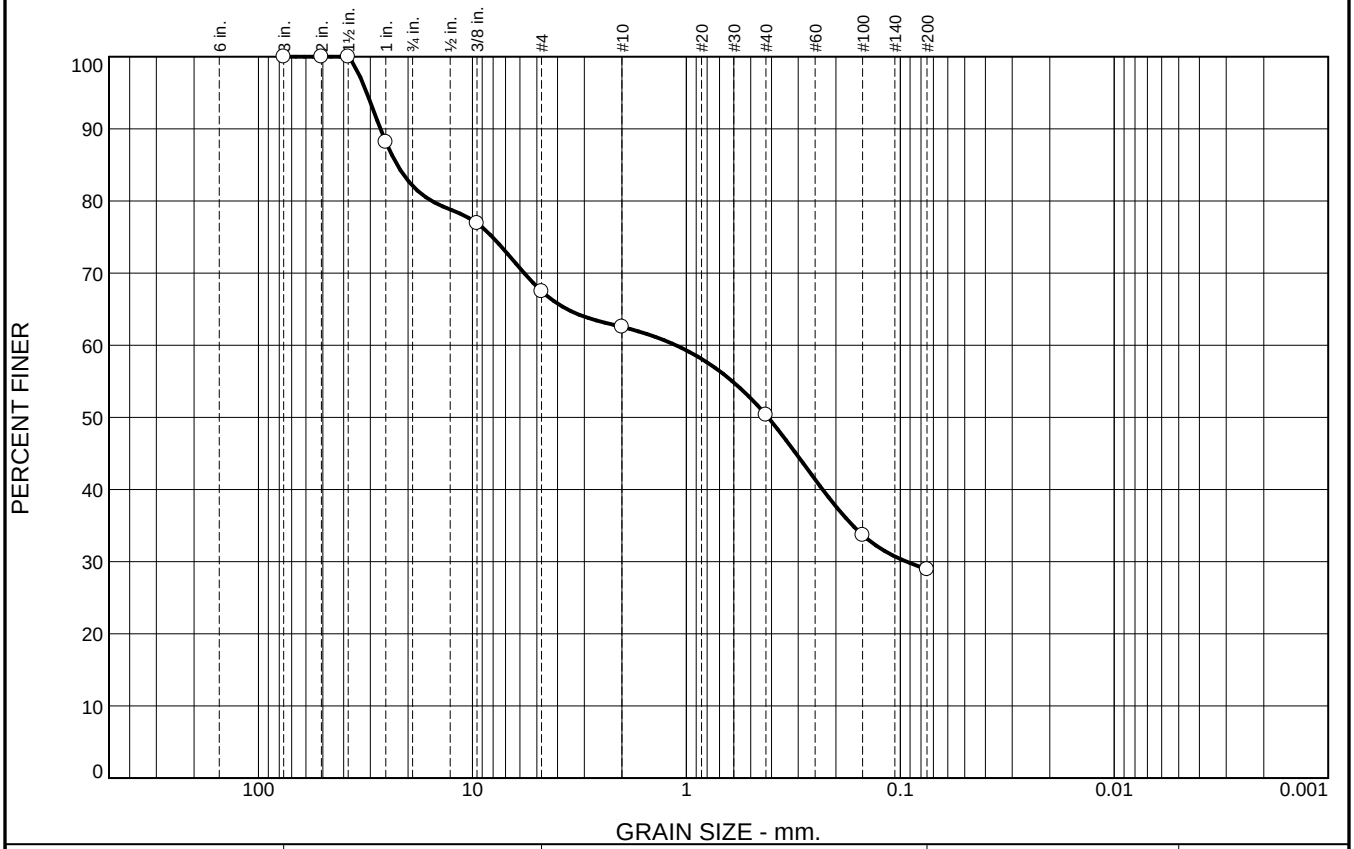
Location: B-1, S-3
Sample Number: 2 **Depth:** 5.0'-6.5' **Date:** 04/12/19

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

Client: Abell Associates
Project: CSM Gym Wall Slope

Project No: 19177A **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	32.5	38.6	28.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1 - 1/2"	100.0		
1"	88.2		
3/8"	76.9		
#4	67.5		
#10	62.5		
#40	50.4		
#100	33.7		
#200	28.9		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 17 LL= 33 PI= 16

Coefficients

D_{90}= 26.9045 D_{85}= 22.4590 D_{60}= 1.1192
D_{50}= 0.4152 D_{30}= 0.0934 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

Moisture content: 12.8%

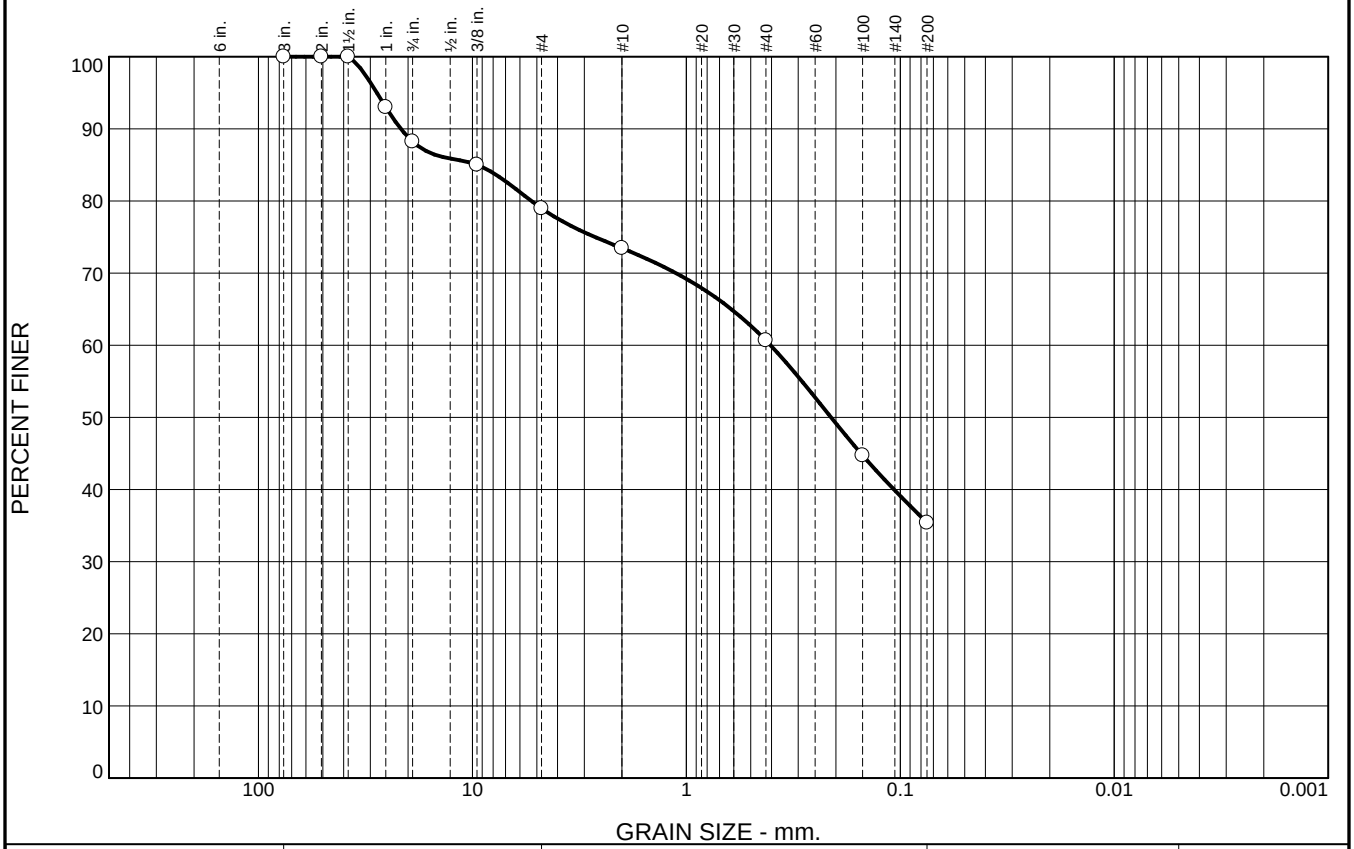
Location: B-1, S-4
Sample Number: 3 **Depth:** 7.5'-9.0' **Date:** 04/12/19

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

Client: Abell Associates
Project: CSM Gym Wall Slope

Project No: 19177A **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	21.0	43.6	35.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1 - 1/2"	100.0		
1"	93.0		
3/4"	88.2		
3/8"	85.0		
#4	79.0		
#10	73.5		
#40	60.7		
#100	44.7		
#200	35.4		

* (no specification provided)

Material Description

Brownish orange silty, clayey sand with gravel

Atterberg Limits

PL= 19 LL= 23 PI= 4

Coefficients

D_{90}= 21.5992 D_{85}= 9.4990 D_{60}= 0.4044
D_{50}= 0.2105 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC-SM AASHTO= A-2-4(0)

Remarks

Moisture content: 15.3%

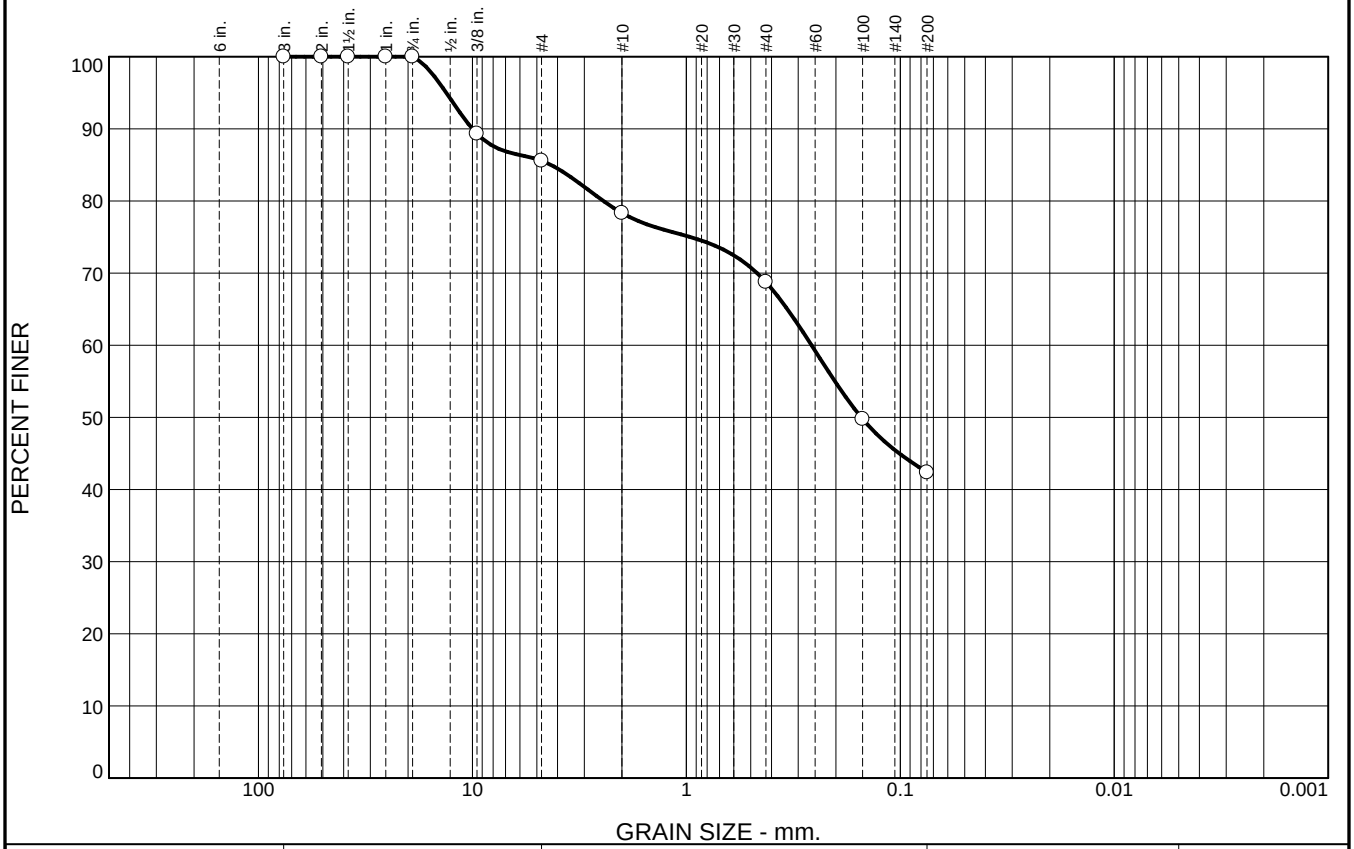
Location: B-2, S-2
Sample Number: 4 **Depth:** 2.0'-4.0' **Date:** 04/12/19

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

Client: Abell Associates
Project: CSM Gym Wall Slope

Project No: 19177A **Figure**

Particle Size Distribution Report



% +3"	% Gravel	% Sand	% Silt	% Clay
0.0	14.4	43.2	42.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1 - 1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	89.3		
#4	85.6		
#10	78.3		
#40	68.8		
#100	49.8		
#200	42.4		

* (no specification provided)

Material Description

Dark brown clayey sand

Atterberg Limits

PL= 14 LL= 23 PI= 9

Coefficients

D_{90}= 10.0055 D_{85}= 4.2949 D_{60}= 0.2599
D_{50}= 0.1522 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-4(1)

Remarks

Moisture content: 12.6%

Location: B-2, S-3
Sample Number: 5 **Depth:** 4.0'-6.0' **Date:** 04/12/19

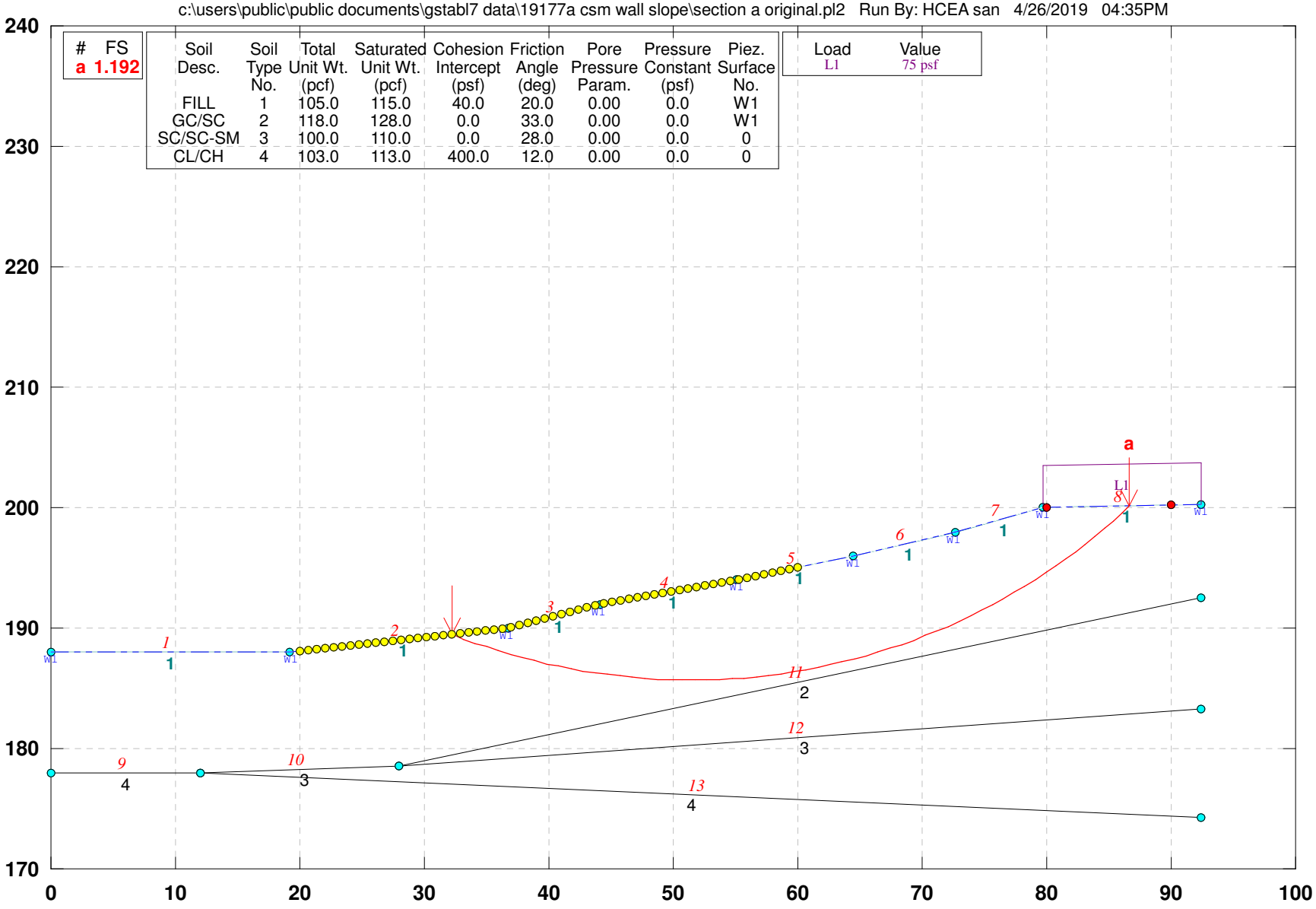
HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

Client: Abell Associates
Project: CSM Gym Wall Slope

Project No: 19177A **Figure**

19177A CSM gym wall slope section a original

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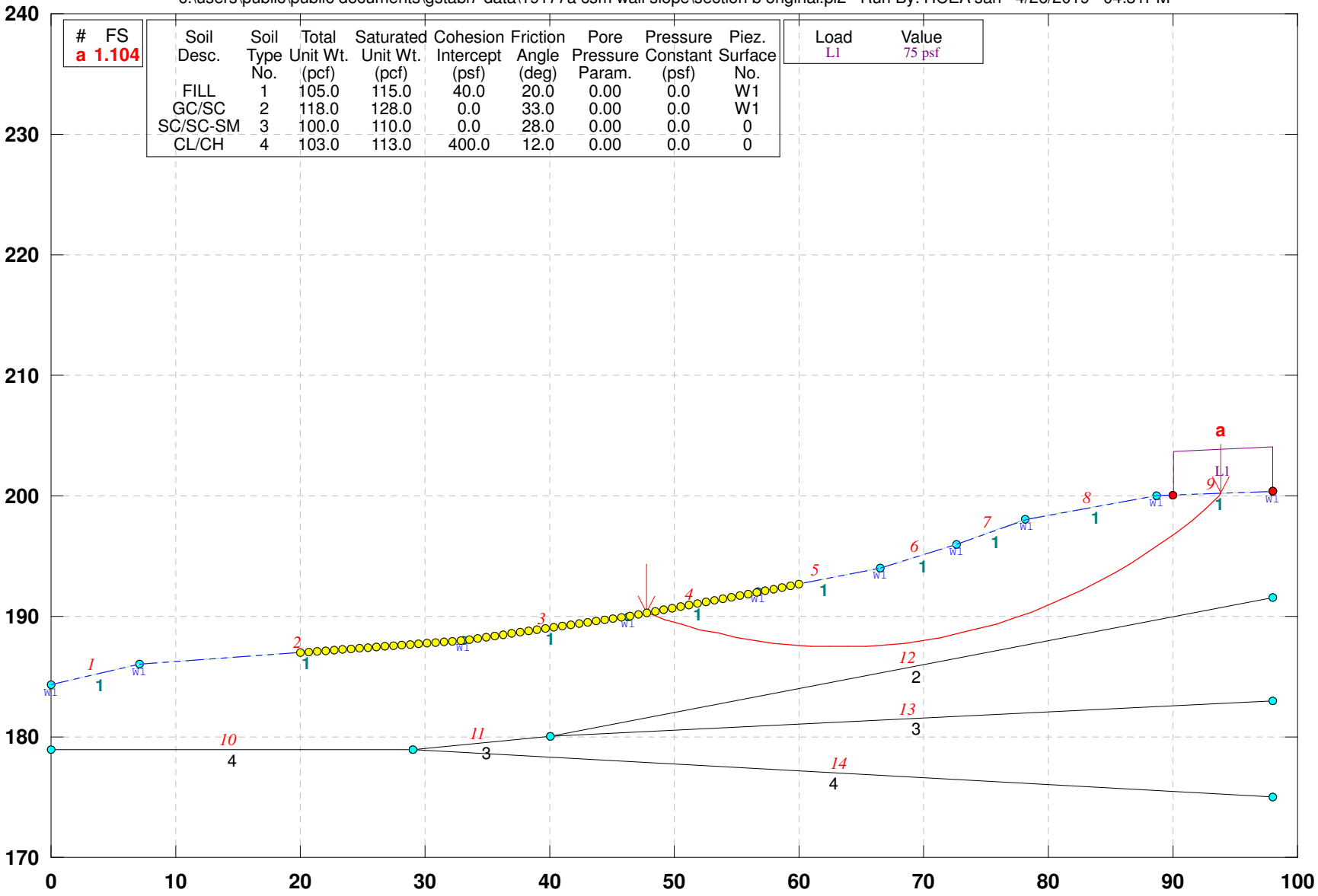


GSTABL7 v.2 FSmin=1.192

Safety Factors Are Calculated by GLE (Morgenstern-Price) Method (0-1)

19177A CSM gym wall slope section b original

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GSTABL7 v.2 FSmin=1.104

Safety Factors Are Calculated by GLE (Morgenstern-Price) Method (0-1)