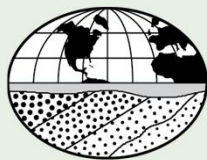


# Geotechnical Engineering Report

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**G**oose Creek Reservoir  
Hearford Lane  
Ashburn, Virginia

**O**ctober 5, 2018



**GeoConcepts  
Engineering, Inc.**

A **Terracon** COMPANY

19955 Highland Vista Drive, Suite 170 w Ashburn, Virginia 20147 w 703-726-8030



# GeoConcepts Engineering, Inc.

A **Terracon** COMPANY

19955 Highland Vista Dr., Suite 170  
Ashburn, Virginia 20147  
(703) 726-8030  
[www.geoconcepts-eng.com](http://www.geoconcepts-eng.com)

October 5, 2018

Mr. Christopher Ramo  
Hazen and Sawyer  
4035 Ridge Top Road, Suite 400  
Fairfax, Virginia 22030

**Subject:                    Geotechnical Engineering Report  
                                 Goose Creek Reservoir Pipeline (Our JD185123)  
                                 Hearford Lane, Ashburn, Loudoun County, Virginia**

Dear Mr. Ramo:

GeoConcepts Engineering, Inc. (GeoConcepts) A Terracon Company is pleased to present the following geotechnical engineering report prepared for Goose Creek Reservoir Pipeline near Hearford Lane in Ashburn, Loudoun County, Virginia.

We appreciate the opportunity to serve as your geotechnical consultant on this project. Please do not hesitate to contact me if you have any questions or want to meet to discuss the findings and recommendations contained in the report.

Sincerely,

**GEOCONCEPTS ENGINEERING, INC.**

Eric Miquelon  
Project Manager  
[emiquelon@geoconcepts-eng.com](mailto:emiquelon@geoconcepts-eng.com)

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Figure 1: Project Work Zones

Appendix A: Subsurface Investigation

Appendix B: Soil Laboratory Test Results

## 1.0 Scope of Services

This geotechnical engineering report presents the results of the field investigation, soil laboratory testing, and engineering analysis of the geotechnical data. This report specifically addresses the following:

- An evaluation of subsurface conditions within the area of the proposed pipeline crossing and boat ramp, including a seismic site classification per the International Building Code.
- Comments on corrosion potential of the on-site soils based on lab test data.
- Recommended soil design parameters based on the field investigation data.
- Recommendations regarding rock excavation for the proposed site development.

Services not specifically identified in the contract for this project are not included in the scope of services.

## 2.0 Site Description and Proposed Construction

The site is located near the north end of the Goose Creek Reservoir, northwest of Hearford Lane in Ashburn, Loudoun County, Virginia. A site vicinity map is provided as Figure 1 at the end of this report. The portion of the reservoir proposed for a submerged pipeline crossing is approximately 300 feet wide including the immediate flood plain, and it is surrounded by woodland with several dirt/gravel roads nearby. The elevation (EL) of the water surface is approximately EL 240 feet, and the banks on each side of the creek rise to approximately EL 290 feet within the project limits shown below.



Aerial Photograph provided courtesy of Google Maps accessed 5/2/18

Based on preliminary plans and a geotechnical scope provided to us by Arc Surveying and Mapping, Inc. dated April 25, 2018, it is our understanding that the proposed construction includes a submerged pipeline crossing, of which the alignment is shown in the plan above. ~~This pipeline will be used to transport municipal water supply between water treatment plants on either side of the reservoir.~~ This will allow both treatment plants to pull from the Goose Creek Reservoir without the addition of a new intake. It is our understanding that the pipe will be constructed from either high-density polyethylene (HDPE) ~~or ductile iron~~. The installation of a new boat ramp has also been proposed at a location further south on the western bank of the reservoir, just north of the Dulles Toll Road overpass. The intent of this investigation was to provide information regarding subsurface conditions present at the proposed pipeline crossing and boat ramp through field sampling and laboratory testing.

## 3.0 Subsurface Conditions

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Subsurface conditions were investigated by drilling a total of nine Standard Penetration Test (SPT) borings in the proposed pipeline crossing area, and two SPT borings in the proposed boat ramp area. The SPT borings were completed by Connelly and Associates, Inc. of Frederick, Maryland under our observation between July 31 and August 6, 2018, utilizing 3-¼ inch inside diameter hollow stem auger with automatic hammer. The sampler was advanced by driving the spoon into undisturbed soil under the impact of a 140-lbf hammer free-falling from 30 inches height per ASTM D1586-11. The boring locations were estimated in the field based off site features. The coordinates were in WGS 1984 taken by a hand-held GPS by GeoConcepts field personnel. Boring elevations were determined by GeoConcepts by linear interpolation between mapped ground surface elevation contour lines. Test boring logs and boring location plans are presented in Appendix A of this report.

### 3.1 Geology

The site lies within the Piedmont Physiographic Province of Virginia. The Piedmont is bordered to the east by the Coastal Plain Physiographic Province and to the west by the Blue Ridge Physiographic Province and contains several fault bordered basins. Bedrock in the Piedmont typically consists of highly weathered metamorphic and igneous bedrock. Surface topography in the Piedmont is the result of millions of years of erosion.

The site is mapped within the Newark Supergroup Section of the western Piedmont Physiographic Province of Virginia. Specifically, the site is located in the Culpeper Basin, a fault bounded basin, or graben (dropped block), that is one of a series of rift basins that comprise the Newark Supergroup rocks. Regionally, the various basins of the Newark Supergroup run from northeast to southwest, parallel with the eastern edge of the Appalachian Mountains, and are the result of tectonic activity associated with the break-up (rifting) of the super-continent of Pangaea during the Triassic and Early Jurassic Geologic Periods. Over time, the Culpeper Basin filled with lacustrine (lake bed) and alluvial fan deposits, a result of the erosion of the Appalachian Mountains to the west. These deposits left behind a sequence of non-durable siltstones and shales in the central portion of the basin and conglomerates and sandstones along the margins. These sedimentary deposits were periodically intruded by igneous magma forming sills and dikes of diabase. Surrounding these intrusions are zones of contact metamorphism, or aureoles, where the heat and pressure from the intruding igneous body recrystallized the host material into more durable rock types (e.g. quartzite, metasiltstone, greywacke, etc.), usually referred to as hornfels. In general, the hornfels are more durable than their parent material. The final episode of igneous activity occurred during the Early Jurassic Period, when flows of basalt were extruded onto the surface. Thermally altered rocks are also associated with the basalt flows, but are not as extensive as the intrusion associated hornfels.

The bedrock beneath the site consists of a diabase rock resulting from igneous intrusions of the Culpeper Basin in the early Jurassic Geologic Period. The residual materials derived from the physical and chemical weathering of the parent bedrock generally consists of clay and sand, with increasing amounts of weathered rock fragments at depth.

Based on our subsurface investigation, the sediments and strata correspond favorably to geologic publications.

### 3.2 Published Soils

A review of the Loudoun County soils maps indicates a portion of the site development will be built on Class IV soils. Specifically, Soil Mapping Units 60E, 68B, and 68C located on the site are Class IV for general development. According to the Loudoun County Interpretive Guide to the Use of Soils Maps, the soils may have very poor development potential due to shallow rock, steep slopes, seasonal high water tables, and high shrink/swell characteristics. However, soil laboratory testing completed for the on-site soils did not indicate a large amount of high plasticity soils. The groundwater conditions are discussed in Section 3.4 of

this report. The Loudoun County soils mapping is shown on Figures 2 and 3 in Appendix A of this report, and is presented below in Table 3.2-1.

Table 3.2-1: Soil Type Characteristics by Mapping Unit

Mapping Unit	Soil Group	Slope (percent)	Hydrologic Soil Class	Drainage	Published Depth to Water Table	Published Depth to Restrictive Feature
60E	Catlett-Rock outcrop complex	25 to 45	D	Well-drained	> 80 inches	17 inches
64D	Oakhill gravelly silt loam	15 to 25	C	Well-drained	> 80 inches	34 inches
68B	Jackland and Haymarket soils	2 to 7	C	Well-drained	> 80 inches	> 80 inches
68C	Jackland and Haymarket soils	7 to 15	C	Well-drained	> 80 inches	> 80 inches

### 3.3 Stratification

The subsurface materials encountered have been stratified for purposes of our discussions herein. These stratum designations do not imply that the materials encountered are continuous across the site. Stratum designations have been established to characterize similar subsurface conditions based on material gradations and parent geology. Per GeoConcepts' convention, Stratum A is reserved for existing fill soils. Existing fill soils were not encountered in the soil borings completed at the site. Accordingly, Stratum A was not used in this report. The generalized subsurface materials encountered in the test borings completed at the site have been assigned to the following strata:

Stratum B1 (Alluvial)	very soft to soft, SILT (ML) and LEAN CLAY (CL) WITH SAND, moist to wet, brown, gray, and gray-brown
Stratum B2 (Alluvial)	very loose to loose, SILTY SAND (SM), CLAYEY SAND (SC), WELL GRADED SAND (SW), and POORLY GRADED SAND (SP), wet, brown and gray-brown
Stratum C1 (Residual)	loose to very dense, POORLY GRADED GRAVEL (GP), SANDY SILTY CLAY (CL-ML), and CLAYEY SAND (SC) WITH ROCK FRAGMENTS, moist to wet, red-brown
Stratum C2 (Weathered Diabase Rock)	very dense, CLAYEY SAND (SC), POORLY GRADED SAND (SP), POORLY GRADED GRAVEL (GP), and WELL GRADED GRAVEL (GW) WITH CLAY AND SAND (GW-GC), moist to wet, brown, red-brown, gray-brown

The two letter designations included in the strata descriptions presented above and on the test boring logs represent the Unified Soil Classification System (USCS) group symbol and group name for the samples based on laboratory testing per ASTM D2487 and visual classifications per ASTM D2488. It should be noted that visual classifications per ASTM D2488 may not match classifications determined by laboratory testing per ASTM D2487.

### 3.4 Groundwater

Groundwater level observations were made in the field during drilling of the test borings. A summary of the water level readings rounded off to the nearest 0.5 feet elevation is presented below in Table 3.4-1. This table only includes water levels encountered for land based borings.

Table 3.4-1: Groundwater Readings

Test Boring No.	Depth to Groundwater (ft)	Groundwater Elevation (ft)
PC - 1	1.5	240.5
PC - 8	Not Encountered	--
PC - 9	Not Encountered	--

The groundwater observations presented herein are considered to be an indication of the groundwater levels at the dates and times indicated. Where more impervious Stratum C1 silt and clay soils are encountered, the amount of water seepage into the borings is limited, and it is generally not possible to establish the location of the groundwater table through short term water level observations. Accordingly, the groundwater information presented herein should be used with caution. Also, fluctuations in groundwater levels should be expected with seasons of the year, construction activity, changes to surface grades, precipitation, or other similar factors.

### 3.5 Soil Laboratory Test Results

Selected soil samples obtained from the field investigation were tested for grain size distribution, Atterberg limits, shear strength, compressibility, corrosivity, and natural moisture contents. A summary of soil laboratory test results is presented below in Table 3.5-1, and the results of natural moisture content tests are presented on the test boring logs in Appendix A.

There are two samples that have been submitted for direct shear testing which we have not received the results for at this time, and this information will be included in a future transmittal.

Table 3.5-1: Summary of Soil Laboratory Test Results

Test Boring No.	Depth (ft)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)
					Percent Retained #4 Sieve	Percent Passing #200 Sieve	LL	PL	PI	
BR-1	13.5	Jar	B1	SILT (ML) WITH SAND	0.0	79.8	43	30	13	51.8
BR-2	2.5	Jar	B1	SANDY SILT (ML)	0.0	58.2	34	25	9	48.9
PC-1	2.0	Jar	B1	SILT (ML)	0.0	87.5	42	30	12	52.0
PC-1	5.0	Shelby Tube	B1	SILT (ML)	0.0	95.3	48	30	18	59.7
PC-2	16.0	Jar	B1	SILT (ML)	0.0	87.0	47	30	17	65.5
PC-3	17.5	Jar	B1	SANDY SILT (ML)	0.0	58.0	36	27	9	65.3
PC-4	21.0	Jar	B2	SILTY SAND (SM)	0.0	16.6	NP	NP	NP	70.8

Test Boring No.	Depth (ft)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)
					Percent Retained #4 Sieve	Percent Passing #200 Sieve	LL	PL	PI	
PC-6	9.5	Jar	B1	SILT (ML)	0.0	93.1	47	33	14	93.1
PC-6	15.5	Shelby Tube	C1	SANDY SILTY CLAY (CL-ML)	0.0	55.4	24	19	5	22.0
PC-7	7.5	Jar	B1	LEAN CLAY (CL) WITH SAND	0.0	71.8	26	18	8	28.7
PC-7	17.5	Jar	C1	WELL GRADED GRAVEL (GW-GC) WITH CLAY AND SAND	52.8	8.9	20	15	5	6.3
PC-8	12.0	Jar	C1	CLAYEY SAND (SC)	0.5	38.1	39	22	17	23.6
PC-9	2.0	Jar	C1	SANDY LEAN CLAY (CL)	0.0	55.8	46	24	22	25.6

Notes:

1. Soil tests are in accordance with applicable ASTM standards
2. Soil classification symbols are in accordance with Unified Soil Classification System
3. Visual identification of samples is in accordance with ASTM D2488
4. Key to abbreviations: LL = liquid limit; PL = plastic limit; PI = plasticity index; NP = nonplastic

Unconfined compression tests were performed on two undisturbed tube samples of the Stratum B1 soils. Test results indicate unconfined compressive strengths ( $q_u$ ) varying between 265 and 306 psf for the samples tested.

A total of two direct shear tests were performed on undisturbed tube samples of the Stratum B1 soils. The results of the direct shear tests are presented below in Table 3.5-2.

Table 3.5-2: Direct Shear Tests Results

Test Boring No.	Sample Depth (ft)	USCS Symbol	Effective Angle of Internal Friction (degrees)	Approximate Effective Cohesion (psf)
PC-1	5 - 7	ML	35	50
PC-6	15.5 – 17.5	CL-ML	37	200

### 3.6 Seismic Site Classification

Based on the results of the subsurface investigation and our knowledge of local geologic conditions, the site soils have been assigned to a site class C per the International Building Code (IBC).

### 3.7 Metal Corrosion/Concrete Attack Test Results

In addition to standard geotechnical soil laboratory testing, three samples were submitted to an analytical laboratory for metal corrosion and concrete attack testing. Corrosion testing consisted of analysis for moisture content (ASTM D2216), pH (CA 643), resistivity (ASTM G187), sulfides (EPA 376.2), and reduction-oxidation potential (ASTM D1498 mod.). The results of these tests are presented below in Table 3.7-1:

Table 3.7-1: Analytical Laboratory Test Results

Test Boring No.	Sample Depth (ft)	Moisture Content (%)	pH	Resistivity (ohm – cm)	Sulfides (ppm)	Red-ox Potential (mV)	Point Total
PC-1	5 – 10	60	6.5	3400	<1.2	+311	4
PC-4	20 – 25	46	6.6	3600	<1.2	+291	7
PC-8	9 - 15	36	4.9	2100	<1.2	+279	8

Sulfate tests (EPA 375.4) and Chloride (CA 422) were performed on selected soil samples to determine the severity of sulfate attack on concrete structures. The results of sulfate testing are presented below in Table 3.7-2.

Table 3.7-2: Sulfate Test Results

Test Boring No.	Sample Depth (ft)	Sulfate Concentration (ppm)
PC-1	5 – 10	30
PC-4	20 – 25	130
PC-8	9 – 15	120

## 4.0 Engineering Analysis

Recommendations regarding soil corrosivity, soil design parameters, and rock excavation at the site are presented herein.

### 4.1 Corrosion Considerations

For each test presented in Section 3.7, points are assigned based on the range of the test results. If the total points from the five tests completed for a particular sample are 10 or more, the soil is considered to be corrosive. The methods described herein are based on information from the American Water Works Association (AWWA). Using the methods described by AWWA, the point total for the samples tested averaged 6. Accordingly, the site soils are considered non-corrosive.

Based on correlations between sulfate concentrations and severity of sulfate attack as presented in American Concrete Institute (ACI) 318, the above sulfate concentrations are considered to pose a negligible threat of sulfate attack on concrete.

### 4.2 Soil Design Parameters

Recommended soil design parameters for the in-situ soils are presented below in Table 4.2-1. These parameters have been developed based on our interpretation of subsurface conditions revealed in the test borings.

Table 4.2-1: Summary of Soil Design Parameters

Material Description	Unit Weight, <b>g</b> (pcf)	Long-Term (Drained) Strength		Short-Term (Undrained) Strength	
		Cohesion, <b>c'</b> (psf)	Friction Angle, <b>f'</b> (degrees)	Cohesion, <b>c</b> (psf)	Friction Angle, <b>f</b> (degrees)
Alluvial - CL, ML	115	0	28	150	0

Material Description	Unit Weight, g (pcf)	Long-Term (Drained) Strength		Short-Term (Undrained) Strength	
		Cohesion, c' (psf)	Friction Angle, f' (degrees)	Cohesion, c (psf)	Friction Angle, f (degrees)
Residual - SC, SM, SP, SW, GC, GP, GW	120	0	30	0	30
Weathered Rock	130	0	35	0	35

A summary of design earth pressure recommendations is presented below in Table 4.2-2.

Table 4.2-2: Lateral Earth Pressure Coefficients and Equivalent Fluid Pressure

Material Description	Unit Weight (g) pcf	Angle of Internal Friction (f) degrees	Lateral Earth Pressure (LEP) Coefficients*			Equivalent Fluid Pressure (EFP) <sup>+</sup>		
			At-Rest (K <sub>o</sub> )	Active (K <sub>a</sub> )	Passive (K <sub>p</sub> )	At-Rest (K <sub>o</sub> )	Active (K <sub>a</sub> )	Passive (K <sub>p</sub> )
CL, ML	115	28	0.53	0.36	2.77	61H	42H	319D
SC, SM, SP, SW, GC, GP, GW	120	30	0.50	0.33	3.00	60H	40H	360D

\* K<sub>o</sub> = 1 - sin (f); K<sub>a</sub> = 1 - sin (f) / 1 + sin (f); K<sub>p</sub> = 1 + sin (f) / 1 - sin (f); <sup>+</sup> EFP = g x LEP, H = height of the wall; D = depth of foundation below frost depth.

### 4.3 Rock Excavation

Rock excavation methods such as hoe-ramming or blasting may be required for some of the site development. The elevations where rock excavation methods may be required for removal of bedrock at the test boring locations are estimated below in Table 4.3-1, and are based on materials equal to or harder than an SPT resistance of 50/3":

Table 4.3-1: Estimated Elevation Where Rock Excavation Methods May be Required

Test Boring No.	Estimated Elevation Where Rock Excavation Methods May be Required
BR-1	EL 222
BR-2	EL 222
PC-1	EL 232
PC-2	EL 216
PC-3	EL 216
PC-4	EL 216
PC-5	EL 216
PC-6	EL 218
PC-7	EL 220
PC-8	EL 247
PC-9	EL 272

The elevations given above are based upon the use of normal earth excavation equipment including up to a Caterpillar 330 hydraulic backhoe or equivalent, for mass excavation. Project specifications should include the following as a definition of rock excavation for mass excavation: "Rock is defined as any material which cannot be dislodged by a Caterpillar 330 hydraulic backhoe without the use of hoe-ramming or blasting. This classification does not include material such as loose rock, concrete or other materials that can be removed by means other than hoe-ramming or blasting, but which for reasons of economy in excavating, the contractor chooses to remove by hoe-ramming or blasting." Variations in rock conditions should be expected from the elevations presented in the table above, since the rock surface can vary over the site. Also, the extent of rock excavation will depend on Contractor's methods, rock jointing, and rock foliation/bedding.

Any pre-blasting of utility lines should be carefully planned and executed to avoid over shooting of the diabase rock. Over shooting may result in separation and uplift of the rock. Over time, the blast loosened rock may collapse resulting in possible localized settlements. Additionally, water that penetrates the overblasted zone will cause the rock to slake and degrade over time, creating the potential for additional localized settlement. All overblasted material should be completely removed.

Requirements for blasting rock should be determined by a contractor with demonstrated experience in this work. Consideration must be given to vibrations transmitted to nearby buildings in determining the size of charges that may be detonated at one time. The specifications should require the taking of seismograph readings at adjacent structures to develop a blast plan that produces an acceptable level of vibrations. Each blast should be contained or covered to minimize air blast and flyrock. A precondition survey of nearby structures should be made prior to the start of construction to document the existing conditions. Also, line drilling should be performed adjacent to existing structures to reduce spalling of bedrock adjacent to these buildings.

## 5.0 General Limitations

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Recommendations contained in this report are based upon the data obtained from the relatively limited number of test borings. This report does not reflect conditions that may occur between the points investigated, or between sampling intervals in test borings. The nature and extent of variations between test borings and sampling intervals may not become evident until the course of pipeline installation. Therefore, it is essential that on-site observations of subgrade conditions be performed during the construction period to determine if re-evaluation of the recommendations in this report must be made. It is critical to the successful completion of this project that GeoConcepts be retained during construction to observe the implementation of the recommendations provided herein.

This report has been prepared to aid in the evaluation of the site and to assist your office and the design professionals in the design of this project. It is intended for use with regard to the specific project as described herein. Changes in proposed construction should be brought to our attention so that we may determine any effect on the recommendations presented herein.

This report should be made available to bidders prior to submitting their proposals to supply them with facts relative to the subsurface conditions revealed by our investigation and the results of analyses and studies that have been performed for this project. In addition, this report should be given to the successful contractor and subcontractors for their information only.

We recommend the project specifications contain the following statement: "A geotechnical engineering report has been prepared for this project by GeoConcepts Engineering, Inc. This report is for informational purposes only and should not be considered part of the contract documents. The opinions expressed in this report are those of the geotechnical engineer and represent their interpretation of the subsoil conditions, tests and results of analyses that they performed. Should the data contained in this report not be adequate for the contractor's purposes, the contractor may make their own investigations, tests and analyses prior to bidding."

This report was prepared in accordance with generally accepted geotechnical engineering practices. No warranties, expressed or implied, are made as to the professional services included in this report.

We appreciate the opportunity to be of service for this project. Please contact the undersigned if you require clarification of any aspect of this report.

Sincerely,

**GEOCONCEPTS ENGINEERING, INC.**



Eric Miquelon  
Project Manager

Paul Burkart, PE  
Senior Principal

EM/RSZ/PEB/shm  
N:\Projects\2018\JD185123\Working Files\Proposal folder\Final\Geotechnical Report Template.docx



AERIAL PHOTO PROVIDED COURTESY OF GOOGLE MAPS, ACCESSED 5/2/2018



**GeoConcepts  
Engineering, Inc.**

A **Terracon** COMPANY

19955 Highland Vista Dr., Suite 170 (703) 726-8030  
Ashburn, Virginia 20147 (703) 726-8032 fax

GOOSE CREEK RESERVOIR PIPELINE  
HEARFORD LANE, ASHBURN, LOUDOUN COUNTY, VIRGINIA

PROJECT WORK ZONES			Scale: N.T.S.	Fig. 1
Date: SEPT 2018	Drawn By: E.M.	Checked By: P.E.B.	Project No.: JD185123	

# Appendix A

## Subsurface Investigation

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Subsurface Investigation Procedures (1 page)

Identification of Soil (1 page)

Figure 2, Pipeline Crossing Boring Location Plan (1 page)

Figure 3, Boat Ramp Boring Location Plan (1 page)

Test Boring Notes (1 page)

Test Boring Logs (12 pages)

## Subsurface Investigation Procedures

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### 1. Test Borings – Hollow Stem Augers

The borings are advanced by turning an auger with a center opening of 3- $\frac{1}{4}$  inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

### 2. Standard Penetration Tests

Standard penetration tests are performed by driving a 2-inch O.D., 1- $\frac{3}{8}$  inch I.D. sampling spoon with a 140-pound hammer falling 30 inches, according to ASTM D1586. After an initial 6 inches penetration to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value. In the event 30 or more blows are required to drive the sampling spoon the initial 6-inch interval, the sampling spoon is driven to a total penetration resistance of 50 blows or 18 inches, whichever occurs first.

### 3. Undisturbed Tube Samples

Undisturbed tube sampling is accomplished by inserting 3-inch I.D. thin walled steel tubes into the soil through the hollow stem of the augers with hydraulically actuated rams.

### 4. Test Boring Stakeout

The test boring stakeout was provided by GeoConcepts personnel using available site plans, therefore the actual drilled locations may vary slightly from those locations shown on the Proposed Boring Location Plan submitted with our proposal. Actual drilled locations were recorded using a handheld GPS unit, and coordinates are provided on the boring logs.

# Identification of Soil

I. DEFINITION OF SOIL GROUP NAMES		ASTM D2487	Symbol	Group Name
Coarse-Grained Soils More than 50% retained on No. 200 sieve	<b>Gravels</b> More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	<i>GW</i>	WELL GRADED GRAVEL
			<i>GP</i>	POORLY GRADED GRAVEL
		Gravels with Fines More than 12% fines	<i>GM</i>	SILTY GRAVEL
			<i>GC</i>	CLAYEY GRAVEL
	<b>Sands</b> 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	<i>SW</i>	WELL GRADED SAND
			<i>SP</i>	POORLY GRADED SAND
		Sands with fines More than 12% fines	<i>SM</i>	SILTY SAND
			<i>SC</i>	CLAYEY SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	<b>Silts and Clays</b> Liquid Limit less than 50	Inorganic	<i>CL</i>	LEAN CLAY
			<i>ML</i>	SILT
		Organic	<i>OL</i>	ORGANIC CLAY
				ORGANIC SILT
	<b>Silts and Clays</b> Liquid Limit 50 or more	Inorganic	<i>CH</i>	FAT CLAY
			<i>MH</i>	ELASTIC SILT
		Organic	<i>OH</i>	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor	<i>PT</i>	PEAT	

## II. DEFINITION OF MINOR COMPONENT PROPORTIONS

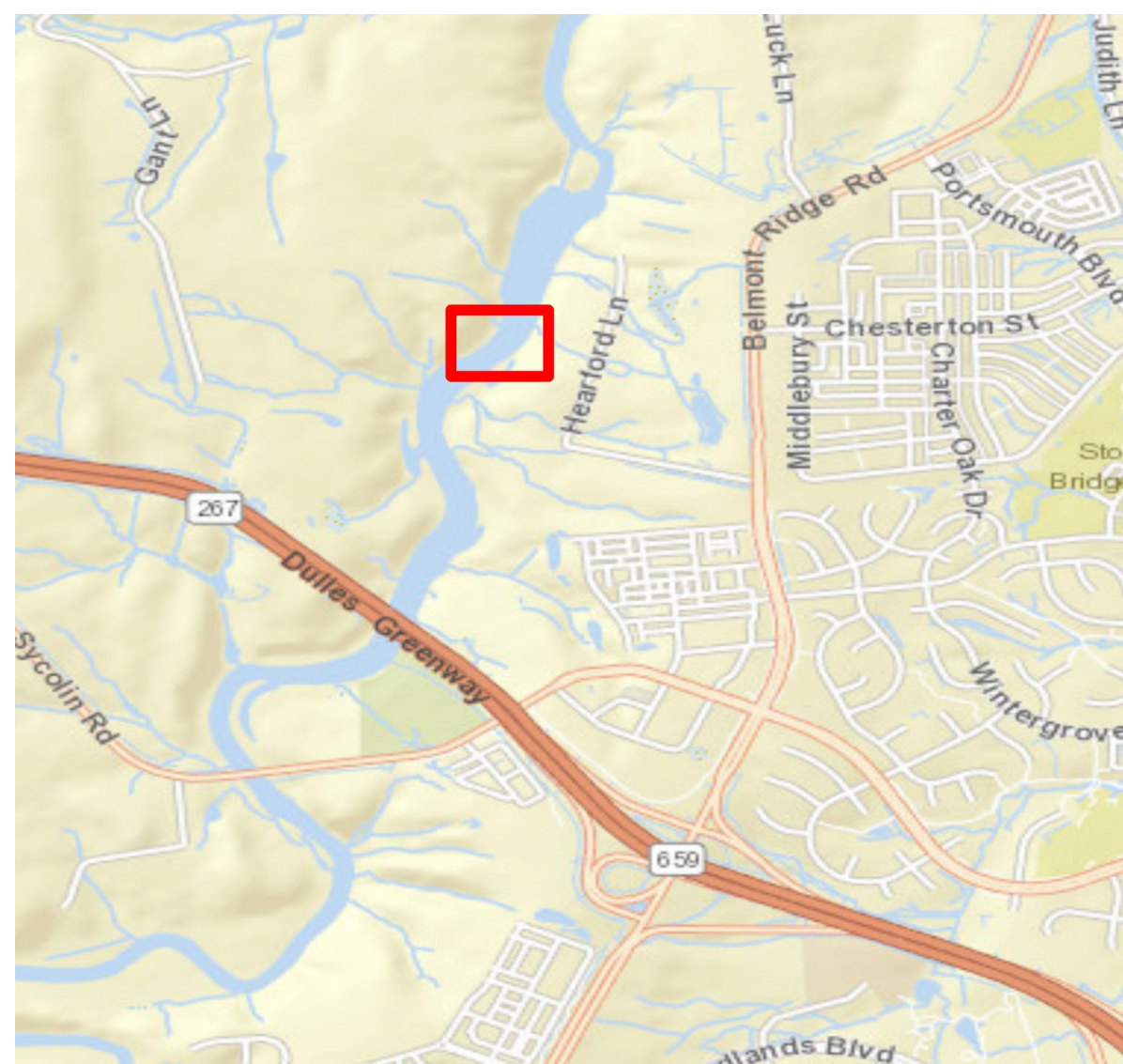
<u>Minor Component</u>	<u>Approximate Percentage of Fraction by Weight</u>
Gravelly, Sandy (adjective)	30% or more coarse grained
Sand, Gravel	15% to 29% coarse grained
Silt, Clay	5% to 12% fine grained

## III. GLOSSARY OF MISCELLANEOUS TERMS

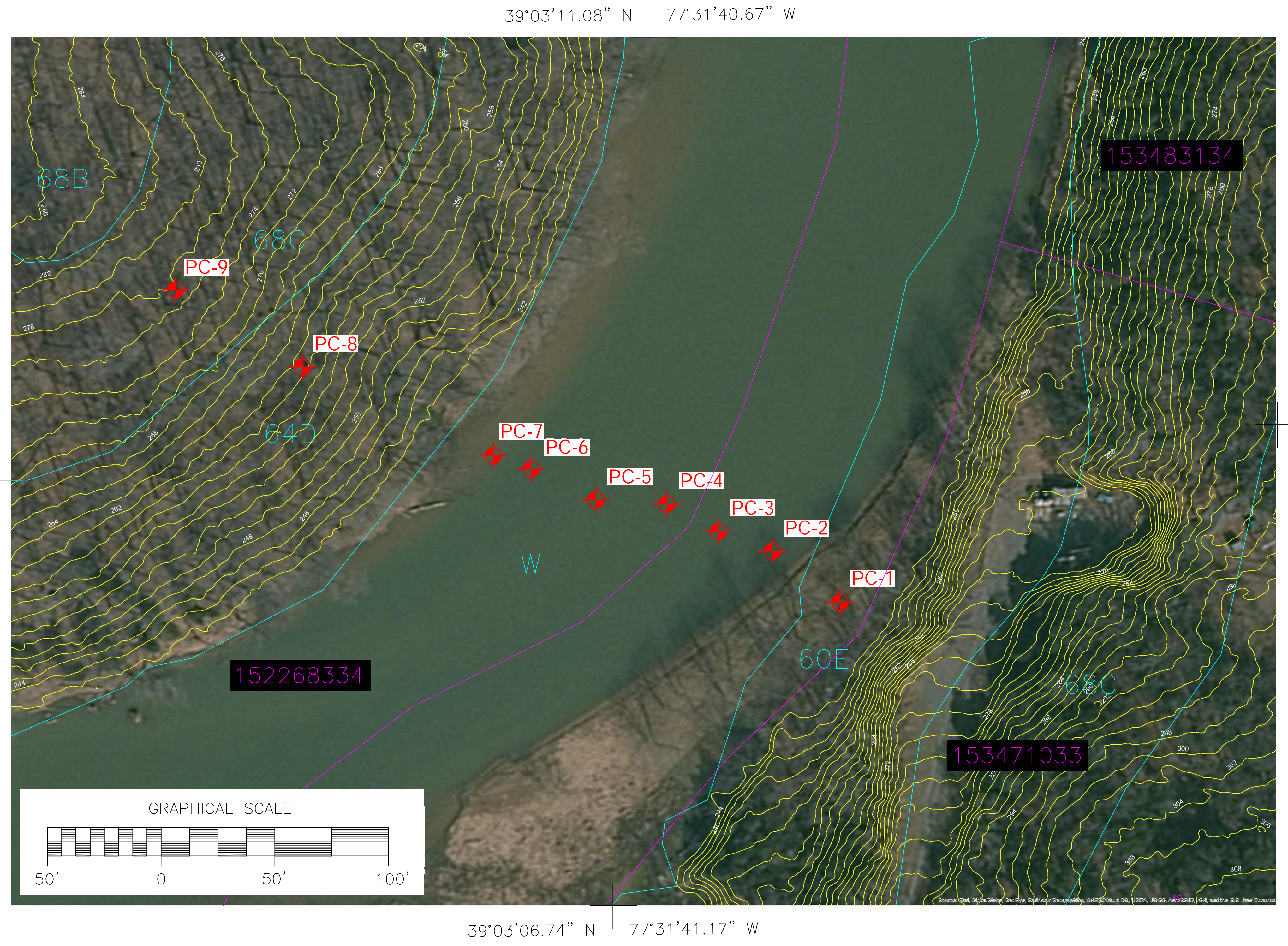
<b>SYMBOLS</b>	Unified Soil Classification Symbols are shown above as group symbols. Use "A" Line Chart for laboratory identification. Dual symbols are used for borderline classification.
<b>BOULDERS &amp; COBBLES WEATHERED ROCK</b>	Boulders are considered pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inches. Residual rock material with a standard penetration test (SPT) resistance of at least 50 blows per 6 inches.
<b>ROCK/SPOON REFUSAL ROCK FRAGMENTS</b>	Rock material with a standard penetration test (SPT) resistance of 50 blows for 1 inch. Angular pieces of rock which have separated from original vein or strata and are present in a soil matrix. Only used in residual soils
<b>QUARTZ CEMENTED SAND</b>	A hard silicate mineral often found in residual soils. Only used when describing residual soils. Usually localized rock-like deposits within a soil stratum composed of sand grains cemented by calcium carbonate, iron oxide, or other minerals. Commonly encountered in Coastal Plain sediments, primarily in the Potomac Group sands (Kps).
<b>MICACEOUS</b>	A term used to describe soil that "glitters" or is shiny. Most commonly encountered in fine-grained soils.
<b>ORGANIC MATERIALS (Excluding Peat)</b>	Topsoil - Surface soils that support plant life and contain organic matter.
<b>FILL</b>	Lignite - Hard, brittle decomposed organic matter with low fixed carbon content (a low grade of coal).
<b>CONTAINS WITH</b>	Man-made deposit containing soil, rock, and other foreign matter. This is used when a soil contains a secondary component that does not apply to a USCS classification. This is used when a residual soil contains a secondary component that is included in the USCS classification.
<b>PROBABLE FILL LAYERS</b>	Soils which contain no visually detected foreign matter but which are suspect with regard to origin. ½ to 12 inch seam of minor soil component.
<b>COLOR</b>	Two most predominant colors present should be described.
<b>MOISTURE CONDITIONS</b>	Wet, moist, or dry to indicate visual appearance of specimen.
<b>GRAIN SIZE</b>	Fine-medium-coarse



Mapping Unit Number, Name, Slope, Flooding Potential and Hydrologic Group	Soil Characteristics	Mapping Unit Potential Subclasses for Selected Parameters		
		General Development Central Water and Sewer/Depth to Rock	Conventional Septic Tank Drain Fields	Agricultural Forestry and Horticultural/ USDA Land
60E, Catlett-Rock outcrop complex, (25-45%), (D)	moderately deep to shallow well drained grayish-brown silty skeletal soils with many rock outcrops, stones, gravels and boulders on steep to very steep side slopes; developed from hornfels and granules	IV S - very poor potential; shallow to rock and steep slopes  depth to hard bedrock generally ranges between 10 to 30"	IV - very poor or no potential; shallow to rock and steep slopes	V - forestry and wildlife  7S, 8
64D, oakhill gravelly silt loam, very stony, (15-25%), ©	well to excessively drained moderately deep brown to yellowish-red loam skeletal soils with many rock outcrop and stones on moderately steep side slopes; developed from diabase or basalt	III RS - poor potential; rock outcrops and steep slopes  depth to hard bedrock generally ranges between 20 to 40"	III - poor potential; steep slopes and shallow to rock	IV - grassland agriculture  7S
68B, Jackland and Haymarket soils, (3-8%), none, (D)	complex of very deep stony moderately well drained yellowish-brown to olive-brown (Jackland) and strong brown (Haymarket) claypan soils with perched water tables on convex uplands; developed in diabase	IV P - very poor potential; wetness and high shrink-swell clays  depth to hard bedrock is generally greater than 5'	IV - very poor potential; wetness and high shrink-swell clays	V - forestry and wildlife  5S, 5S
68C, Jackland and Haymarket soils, (8-15%), (D)	complex of very deep stony moderately well drained yellowish-brown to olive-brown (Jackland) and strong brown (Haymarket) claypan soils with perched water tables on convex sloping side slopes; developed from diabase	IV P - very poor potential; wetness and high shrink-swell clays  depth to hard bedrock is generally greater than 5'	IV - very poor potential; wetness and high shrink-swell clays	V - forestry and wildlife  5S, 5S



SCALE: 1" = 2000'

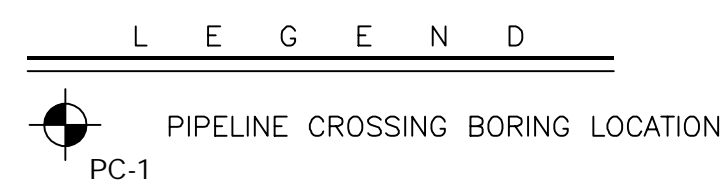


MAP COORDINATE SYSTEM  
US STATE PLANE  
VA NORTH  
DATUM = NAD27



A Terracon COMPANY

19955 Highland Vista Dr., Suite 170 (703) 726-8030  
Ashburn, Virginia 20147 (703) 726-8032 fax



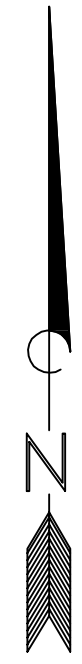
NO.	DATE	REVISION

**GOOSE CREEK RESERVOIR PIPELINE**  
HEARFORD LANE, ASHBURN, LOUDOUN COUNTY, VIRGINIA

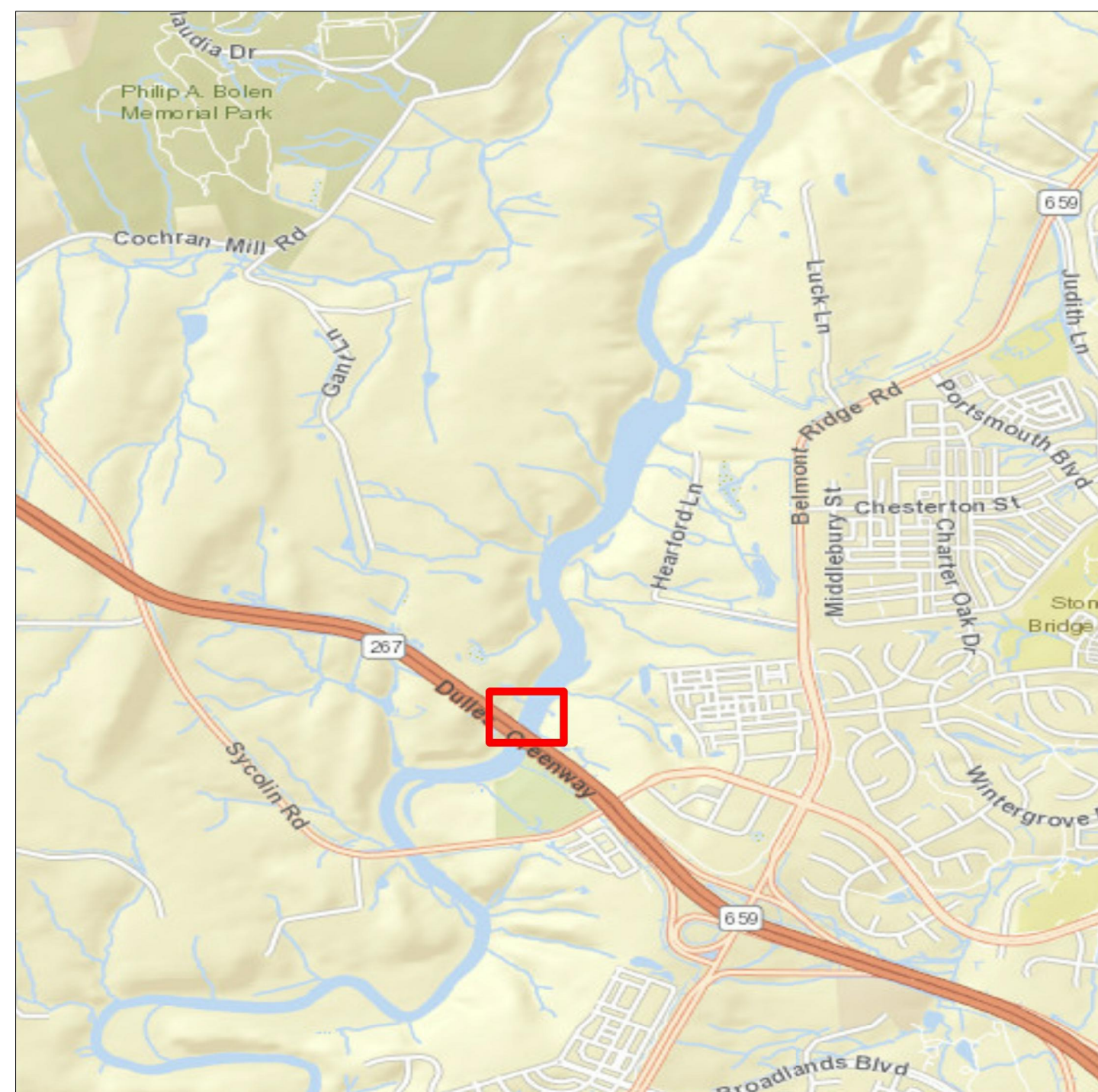
**PIPELINE CROSSING BORING LOCATION PLAN**

PROJECT NO.: JD185123  
SCALE: AS SHOWN  
DATE: SEPTEMBER 2018  
DRAWN BY: E.J.M.  
CHECKED BY: P.E.B.

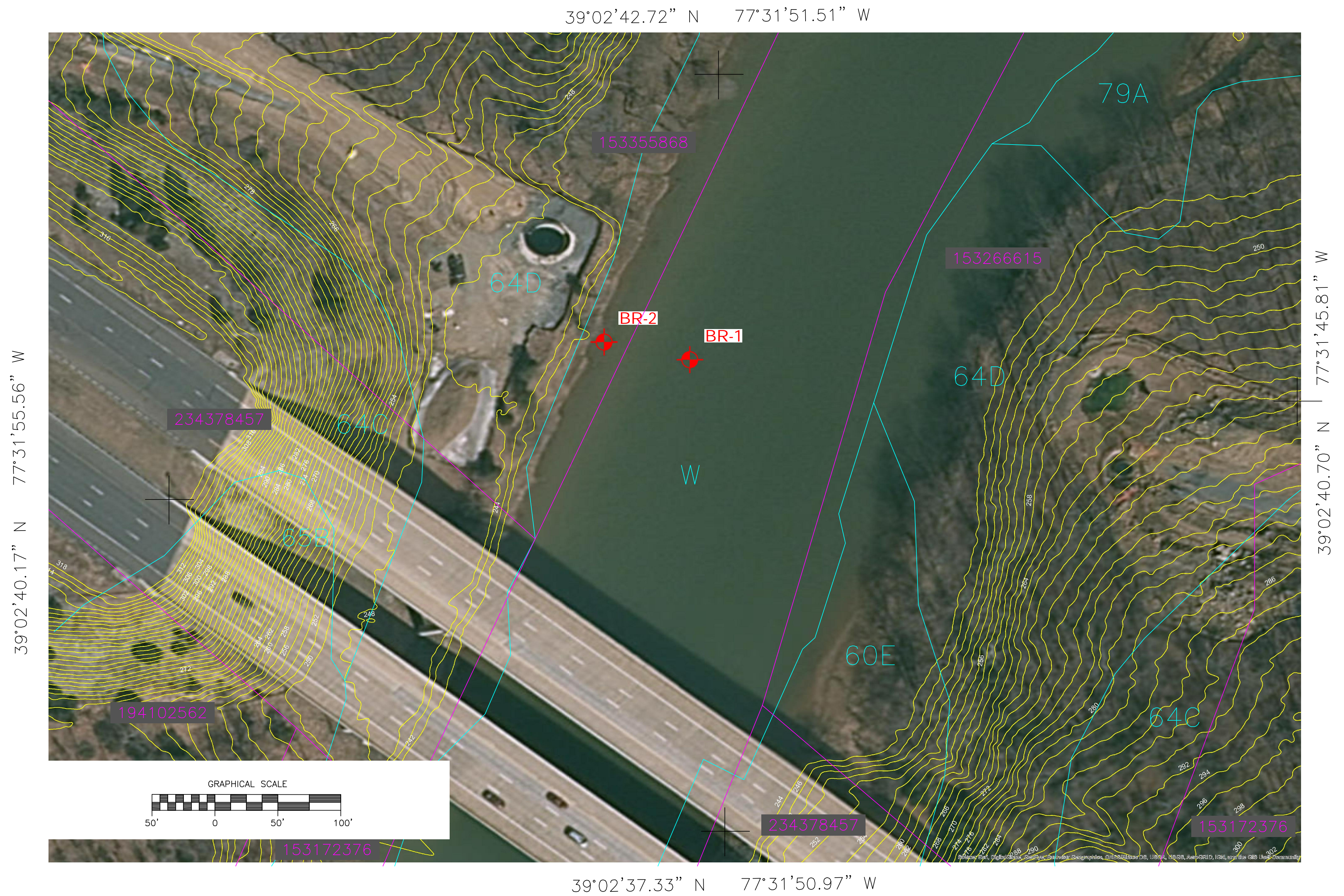
Fig. **2**



Mapping Unit Number, Name, Slope, Flooding Potential and Hydrologic Group	Soil Characteristics	Mapping Unit Potential Subclasses for Selected Parameters		
		General Development Central Water and Sewer/Depth to Rock	Conventional Septic Tank Drain Fields	Agricultural Forestry and Horticultural/USDA Land
60E, Catlett-Rock outcrop complex, (25-45%), (D)	moderately deep to shallow well drained grayish-brown silty skeletal soils with many rock outcrops, stones, gravels and boulders on steep to very steep side slopes; developed from hornfels and granules	IV S - very poor potential; shallow to rock and steep slopes	IV - very poor or no potential; shallow to rock and steep slopes	V - forestry and wildlife
		depth to hard bedrock generally ranges between 10 to 30"		
64D, oakhill gravelly silt loam, very stony, (15-25%), (C)	well to excessively drained moderately deep brown to yellowish-red loam skeletal soils with many rock outcrop and stones on moderately steep side slopes; developed from diabase or basalt	III RS - poor potential; rock outcrops and steep slopes	III - poor potential; steep slopes and shallow to rock	IV - grassland agriculture
		depth to hard bedrock generally ranges between 20 to 40"		



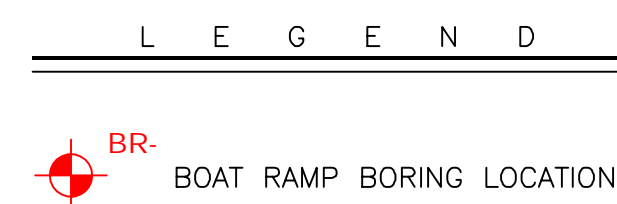
SCALE: 1" = 2000'



MAP COORDINATE SYSTEM  
US STATE PLANE  
VA NORTH  
DATUM = NAD27



A Terracon COMPANY  
19955 Highland Vista Dr., Suite 170 (703) 726-8030  
Ashburn, Virginia 20147 (703) 726-8032 fax



NO.	DATE	REVISION

**GOOSE CREEK RESERVOIR PIPELINE**  
HEARFORD LANE, ASHBURN, LOUDOUN COUNTY, VIRGINIA

**BOAT RAMP BORING LOCATION PLAN**

PROJECT NO.: JD185123  
SCALE: AS SHOWN  
DATE: SEPT. 2018  
DRAWN BY: RKS  
CHECKED BY: PEB

Fig. **3**

## Test Boring Notes

---

1. Classification of soil is by visual inspection and is in accordance with the Unified Soil Classification System.
2. Estimated groundwater levels are indicated on the logs. These are only estimates from available data and may vary with precipitation, porosity of soil, site topography, etc.
3. Sampling data presents standard penetrations for 6-inch intervals or as indicated with graphic representations adjacent to the sampling data. Where undisturbed tube samples are taken, they are designated "Shelby Tube" on the test boring log.
4. The energy applied to the split-spoon sampler using the automatic hammer is about 33 percent greater than the applied energy using the standard safety hammer. The hammer blows shown on the boring logs are uncorrected for the higher energy.
5. The logs and related information depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at the test locations. Also, the passage of time may result in a change in the subsurface conditions at the test locations.
6. The stratification lines represent the approximate boundary between soil types as determined in the sampling operation. Some variation may be expected vertically between samples taken. The soil profile, groundwater level observations and penetration resistances presented on the logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.
7. Weathered rock is defined as residual earth material with a penetration resistance between 50 blows per 6 inches and refusal. Spoon refusal at the surface of rock, boulders, or obstructions is defined as a penetration resistance of 50 blows for 1-inch penetration or less. Auger refusal is taken as the depth at which further penetration of the auger is not possible without risking significant damage to the drilling equipment.

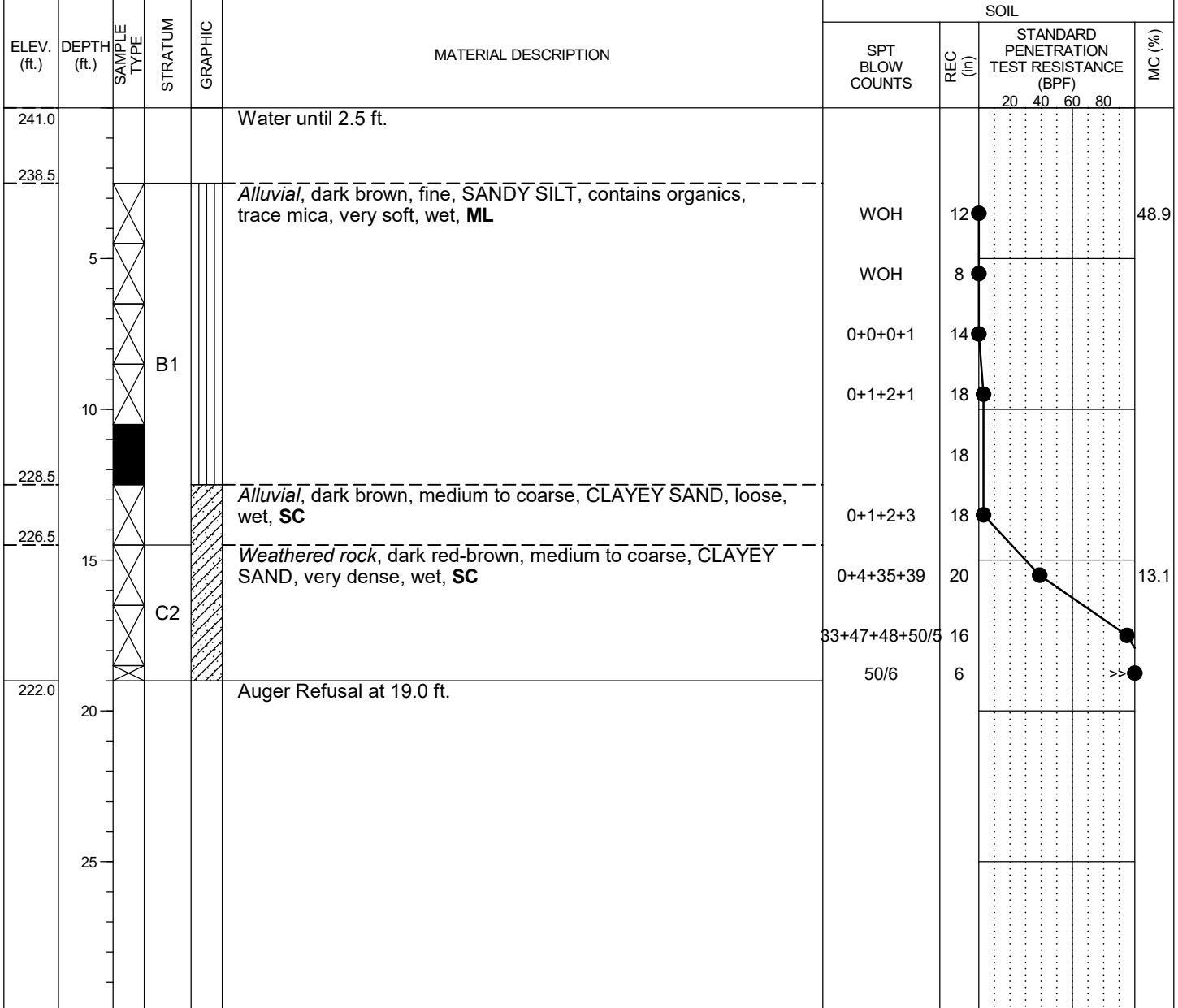


PROJECT: <b>Goose Creek Reservoir Pipeline</b>					LOGGED BY: <b>E. Miquelon</b>					BORING NUMBER: <b>BR-1</b>				
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>					DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>					SHEET 1 OF 1				
OWNER/CLIENT: <b>Hazen and Sawyer</b>					DRILLER: <b>J. Leatherman</b>					DATES DRILLED: <b>8/2/18 - 8/2/18</b>				
PROJECT NUMBER: <b>JD185123</b>			GROUND SURFACE ELEVATION (ft.): <b>241.0 ±</b>		DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>					DRILL RIG: <b>CME 55</b>				
ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SPT BLOW COUNTS	REC (ft)	SOIL				MC (%)		
								STANDARD PENETRATION TEST RESISTANCE (BPF) 20 40 60 80						
241.0					Water until 7.5 ft.									
233.5														
232.5			B1		<i>Alluvial</i> , dark brown, fine, SILT WITH SAND, contains organics, very soft, wet, <b>ML</b>	WOH	6					76.9		
231.5			B2		<i>Alluvial</i> , dark gray-brown, fine, SILTY SAND, trace mica, very loose, wet, <b>SM</b>	WOH	8							
	10				<i>Alluvial</i> , dark gray-brown, coarse, SILT WITH SAND, trace mica, very soft, wet, <b>ML</b>	WOH	0							
	15		B1			WOH	16					51.8		
223.5						0+0+2+12	6							
			C1		<i>Residual</i> , dark red-brown, POORLY GRADED GRAVEL, contains rock fragments, very dense, wet, <b>GP</b>	2+12+25+33	16							
221.5	20				Auger and Spoon Refusal at 19.5 ft.	50/0	0							
	25													
GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION							SAMPLE TYPES: SPT							
REMARKS: THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.														

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>BR-2</b>	
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		SHEET 1 OF 1	
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>		DATES DRILLED: <b>8/2/18 - 8/2/18</b>	
PROJECT NUMBER: <b>JD185123</b>		GROUND SURFACE ELEVATION (ft.): <b>241.0 ±</b>		DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	
				DRILL RIG: <b>CME 55</b>	



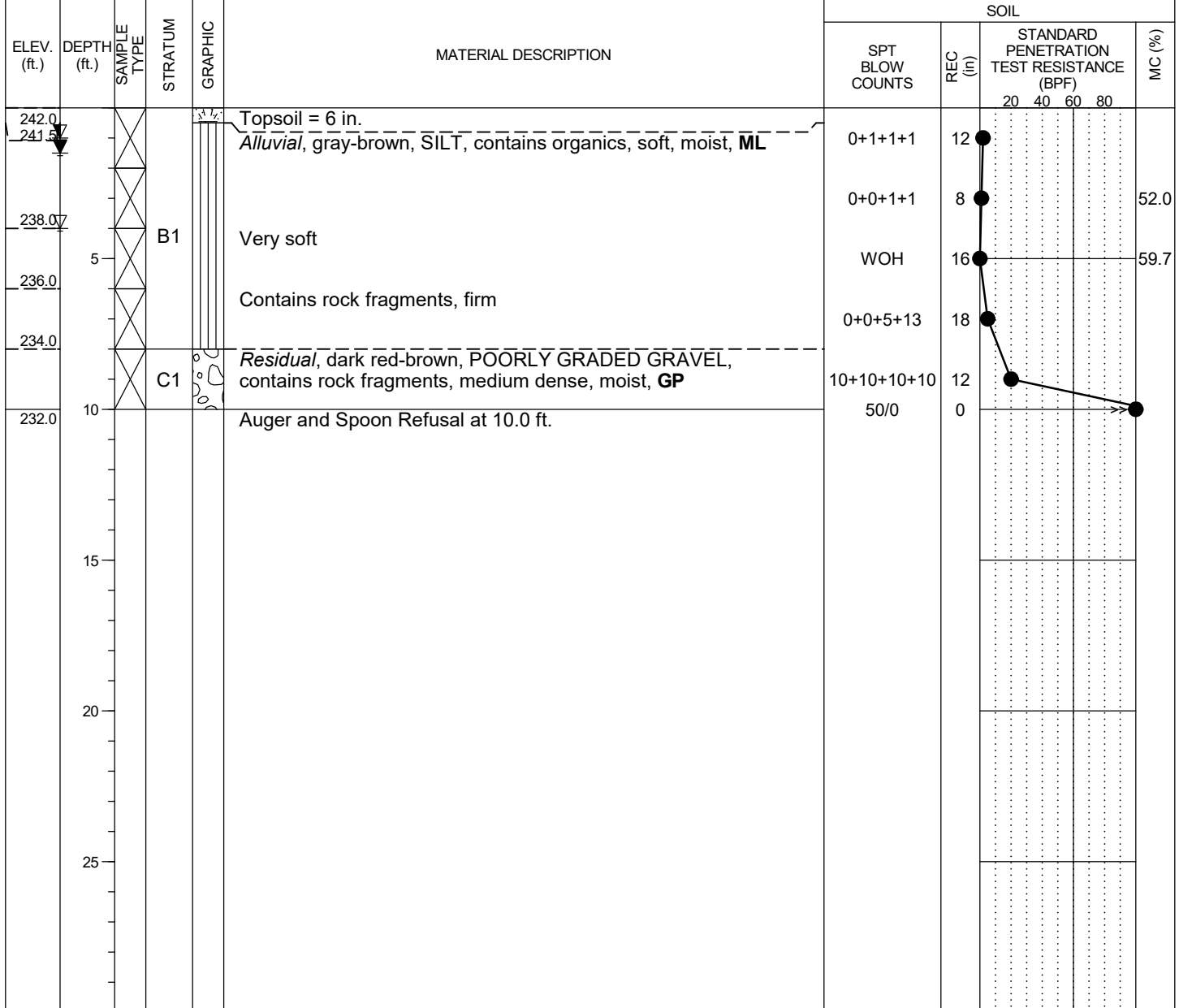
GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	SAMPLE TYPES: SPT Undisturbed Sample
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REMARKS:  
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-1</b>	
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		SHEET 1 OF 1	
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>		DATES DRILLED: <b>8/3/18 - 8/3/18</b>	
PROJECT NUMBER: <b>JD185123</b>		GROUND SURFACE ELEVATION (ft.): <b>242.0 ±</b>		DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	
				DRILL RIG: <b>CME 55</b>	



GROUND WATER LEVELS:		SAMPLE TYPES:	
▽ ENCOUNTERED:	4.0 ft. ELEV. 238.0	<input checked="" type="checkbox"/> SPT	
▼ UPON COMPLETION:	1.0 ft. ELEV. 241.0		
▼ 8/3/2018 3:09:00 PM	1.5 ft. ELEV. 240.5		

REMARKS: Offset 3.0 ft. south from PC-1 to collect Shelby tube at 5.0 ft.

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18



PROJECT: <b>Goose Creek Reservoir Pipeline</b>					LOGGED BY: <b>E. Miquelon</b>					BORING NUMBER: <b>PC-1A</b>					
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>					DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>					SHEET 1 OF 1					
OWNER/CLIENT: <b>Hazen and Sawyer</b>					DRILLER: <b>J. Leatherman</b>					DATES DRILLED: <b>8/3/18 - 8/3/18</b>					
PROJECT NUMBER: <b>JD185123</b>			GROUND SURFACE ELEVATION (ft.): <b>242.0 ±</b>			DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>					DRILL RIG: <b>CME 55</b>				
ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL									
						SPT BLOW COUNTS	REC (ft)	STANDARD PENETRATION TEST RESISTANCE (BPF)							
									20	40	60	80			
242.0			B1		<i>Alluvial</i> , gray-black, SILT, contains organics, soft, moist, <b>ML</b>										
	5														
234.0			C1		<i>Residual</i> , dark red-brown, <b>POORLY GRADED GRAVEL</b> , contains rock fragments, very dense, moist, <b>GP</b>	50/0	0								
232.5	10				Auger Refusal at 9.5 ft.										
	15														
	20														
	25														
GROUND WATER LEVELS:  NOT ENCOUNTERED DURING DRILLING  NOT ENCOUNTERED UPON COMPLETION						SAMPLE TYPES:  Undisturbed Sample									
REMARKS: Offset 3.0 ft. south from PC-1 to collect shelly tube.															

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-2</b>	
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		SHEET 1 OF 1	
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>		DATES DRILLED: <b>7/31/18 - 7/31/18</b>	
PROJECT NUMBER: <b>JD185123</b>		GROUND SURFACE ELEVATION (ft.): <b>240.0 ±</b>		DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	
				DRILL RIG: <b>CME 55</b>	

ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL				
						SPT BLOW COUNTS	REC (ft)	STANDARD PENETRATION TEST RESISTANCE (BPF) 20 40 60 80		MC (%)
240.0					Water until 6.0 ft.					
234.0	5				<i>Alluvial</i> , dark brown, fine, SILT WITH SAND, contains organics, micaceous, very soft, wet, <b>ML</b>	WOH	6			68.1
						WOH	6			
						WOH	16			
						WOH	14			
224.0	15		B1		<i>Alluvial</i> , brown, fine, SILT, contains organics, micaceous, very soft, wet, <b>ML</b>	WOH	18			65.5
						WOH	24			
						WOH	24			
						WOH	24			
217.0	20				<i>Weathered rock</i> , brown, POORLY GRADED GRAVEL, very dense, wet, <b>GP</b>					
216.1	25		C2			0+0+50 50/0	16			
					Auger and Spoon Refusal at 23.9 ft.		0			

GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	SAMPLE TYPES: <input checked="" type="checkbox"/> SPT
--	--

REMARKS:

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-3</b>
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>	DATES DRILLED: <b>7/31/18 - 7/31/18</b>	
PROJECT NUMBER: <b>JD185123</b>	GROUND SURFACE ELEVATION (ft.): <b>240.0 ±</b>	DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	DRILL RIG: <b>CME 55</b>	

ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL						
						SPT BLOW COUNTS	REC (ft)	STANDARD PENETRATION TEST RESISTANCE (BPF)		MC (%)		
								20	40	60	80	
240.0					Water until 13.5 ft.							
226.5	15		B1		<i>Alluvial</i> , dark brown, fine, SANDY SILT, contains organics, micaceous, very soft, wet, <b>ML</b>	WOH	6					
218.5	20		B2		<i>Alluvial</i> , dark gray-brown, medium, WELL GRADED SAND, very loose, wet, <b>SW</b>	WOH	6					
216.5	22		C2		<i>Weathered rock</i> , dark gray-brown, POORLY GRADED SAND, very dense, wet, <b>SP</b>	0+0+0+2	24					65.3
215.7	25				Auger and Spoon Refusal at 24.3 ft.	WOH	4					
						0+0+0+2	6					45.5
						35+50/4 50/0	10 0					

GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	SAMPLE TYPES: SPT
--	----------------------

REMARKS:  
THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-4</b>
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>	DATES DRILLED: <b>7/31/18 - 7/31/18</b>	
PROJECT NUMBER: <b>JD185123</b>	GROUND SURFACE ELEVATION (ft.): <b>240.0 ±</b>	DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	DRILL RIG: <b>CME 55</b>	

ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL						
						SPT BLOW COUNTS	REC (ft)	STANDARD PENETRATION TEST RESISTANCE (BPF)		MC (%)		
								20	40	60	80	
240.0					Water until 16.0 ft.							
224.0	5											
219.0	10											
217.0	15											
215.5	20	B1			<i>Alluvial</i> , dark brown, SILT, contains organics, very soft, wet, <b>ML</b>	WOH	0					
	21					WOH	2					
	22	B2			<i>Alluvial</i> , dark brown, fine to medium, SILTY SAND, contains organics, very loose, wet, <b>SM</b>	WOH	6					
	23											
	24	C2			<i>Weathered rock</i> , dark gray-brown, POORLY GRADED GRAVEL WITH SAND, very dense, wet, <b>GP</b>	19+16+50/4	12					70.8
	25				Auger and Spoon Refusal at 24.5 ft.	50/0	0					

GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	SAMPLE TYPES: <input checked="" type="checkbox"/> SPT
--	--

REMARKS: Shelby tube attempt at 21.0 ft. No recovery.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-5</b>
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>	DATES DRILLED: <b>8/1/18 - 8/1/18</b>	
PROJECT NUMBER: <b>JD185123</b>	GROUND SURFACE ELEVATION (ft.): <b>240.0 ±</b>	DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	DRILL RIG: <b>CME 55</b>	

ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL					
						SPT BLOW COUNTS	REC (ft)	STANDARD PENETRATION TEST RESISTANCE (BPF)			
								20	40	60	80
240.0					Water until 16.5 ft.						
223.5	5										
221.5			B1		<i>Alluvial</i> , dark brown, fine, SILT, contains organics, trace mica, very soft, wet, <b>ML</b>	WOH	6				
219.5			B2		<i>Alluvial</i> , dark brown, coarse, POORLY GRADED SAND WITH SILT, contains organics, very loose, wet, <b>SP-SM</b>	WOH	6				
217.5			C2		<i>Weathered rock</i> , dark red-brown, coarse, POORLY GRADED SAND WITH SILT, very dense, wet, <b>SP-SM</b>	0+0+3+13	8				
215.5	25				Auger Refusal at 24.5 ft.	0+0+38+50/2	6				

GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	SAMPLE TYPES: <input checked="" type="checkbox"/> SPT
--	--

REMARKS: Shelby tube attempt at 20.5 ft. No recovery.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-6</b>
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>	DATES DRILLED: <b>8/1/18 - 8/1/18</b>	
PROJECT NUMBER: <b>JD185123</b>	GROUND SURFACE ELEVATION (ft.): <b>240.0 ±</b>	DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	DRILL RIG: <b>CME 55</b>	

ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL				
						SPT BLOW COUNTS	REC (ft)	STANDARD PENETRATION TEST RESISTANCE (BPF) 20 40 60 80		MC (%)
240.0					Water until 7.5 ft.					
232.5	5				<i>Alluvial</i> , dark brown, SILT, contains organics, trace mica, very soft, wet, <b>ML</b>	WOH	6			93.1
	10		B1	WOH		12				
	15			WOH		12				
224.5	15			WOH		3				
222.5	20		C1		<i>Residual</i> , red-brown, fine, SANDY SILTY CLAY, loose, wet, <b>CL-ML</b> Contains rock fragments, very dense	1+2+2+3	14			22.0
218.5	20				<i>Weathered rock</i> , red-brown, medium to coarse, CLAYEY SAND, very dense, wet, <b>SC</b> Auger Refusal at 22.7 ft.	15+25+38+29	12			9.3
217.3	25		C2			17+20+35+42	14			
						50/4	4			>>

GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	SAMPLE TYPES: <input checked="" type="checkbox"/> SPT
--	--

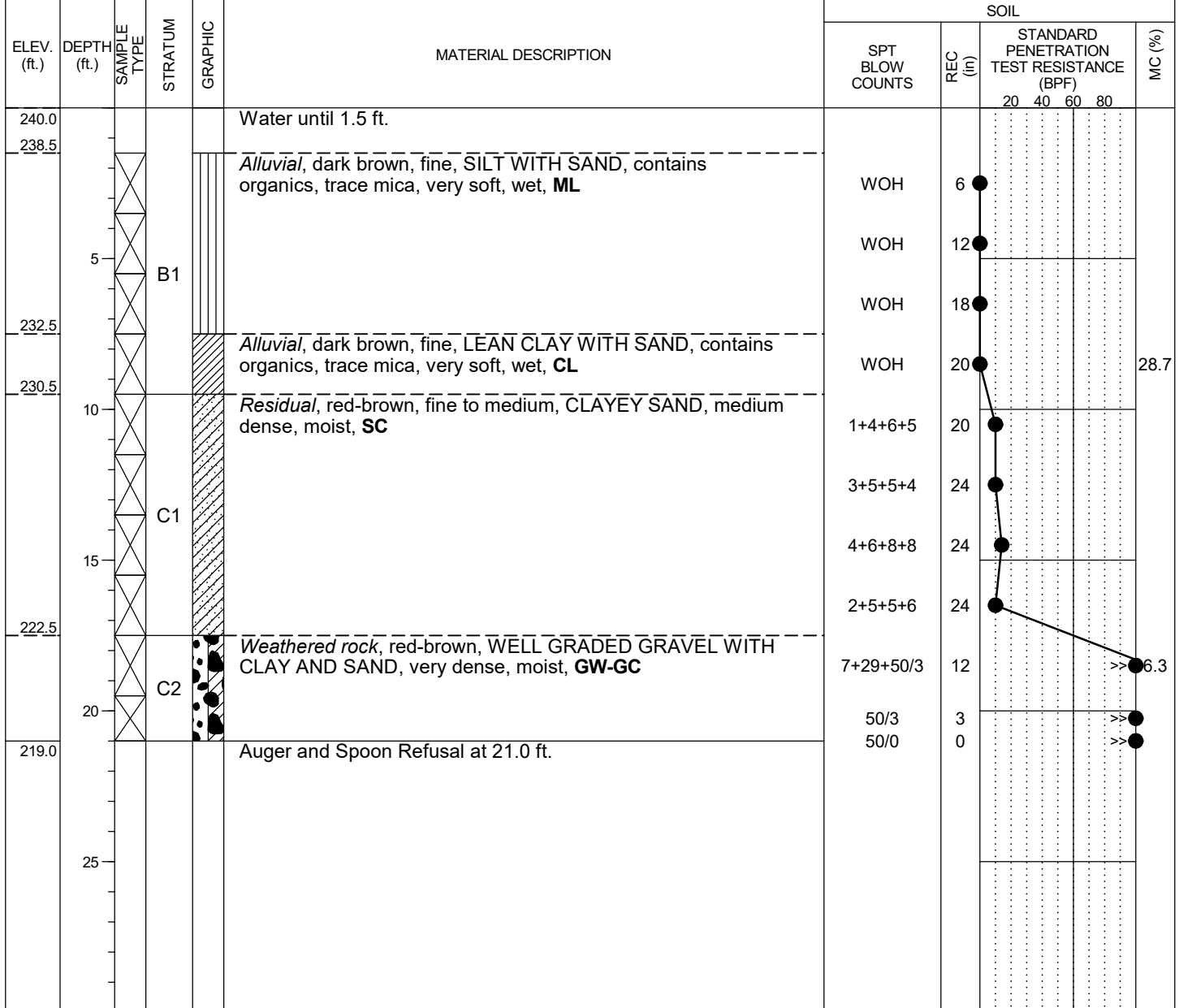
REMARKS: Offset 5.0 ft. east to collect Shelby tube at 15.5 ft.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-7</b>
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>	DATES DRILLED: <b>8/1/18 - 8/1/18</b>	
PROJECT NUMBER: <b>JD185123</b>	GROUND SURFACE ELEVATION (ft.): <b>240.0 ±</b>	DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>	DRILL RIG: <b>CME 55</b>	



GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	SAMPLE TYPES: SPT
--	----------------------

REMARKS:

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-8</b>	
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		SHEET 1 OF 1	
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>		DATES DRILLED: <b>8/6/18 - 8/6/18</b>	
PROJECT NUMBER: <b>JD185123</b>	GROUND SURFACE ELEVATION (ft.): <b>261.0 ±</b>	DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>		DRILL RIG: <b>CME 55</b>	

ELEV. (ft.)	DEPTH (ft.)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL			
						SPT BLOW COUNTS	REC (ft)	STANDARD PENETRATION TEST RESISTANCE (BPF) 20 40 60 80	MC (%)
261.0 L 260.8 259.0					Topsoil = 3 in. <i>Residual</i> , red-brown, fine, LEAN CLAY WITH SAND, firm, moist, <b>CL</b> Stiff	1+2+2+2	12		
257.0	5		C1		<i>Residual</i> , red-brown, fine, CLAYEY SAND, trace mica, medium dense, moist, <b>SC</b>	3+5+6+6	18		26.8
253.0	10				Brown	2+3+5+5	24		
249.0	15		C2		<i>Weathered rock</i> , brown, fine to medium, CLAYEY SAND, trace mica, medium dense, moist, <b>SC</b>	4+4+6+8	24		
247.0	15				Auger and Spoon Refusal at 14.0 ft.	2+4+7+6	24		
						2+3+5+8	18		
						3+7+12+50/5	18		23.6
						50/0	0		

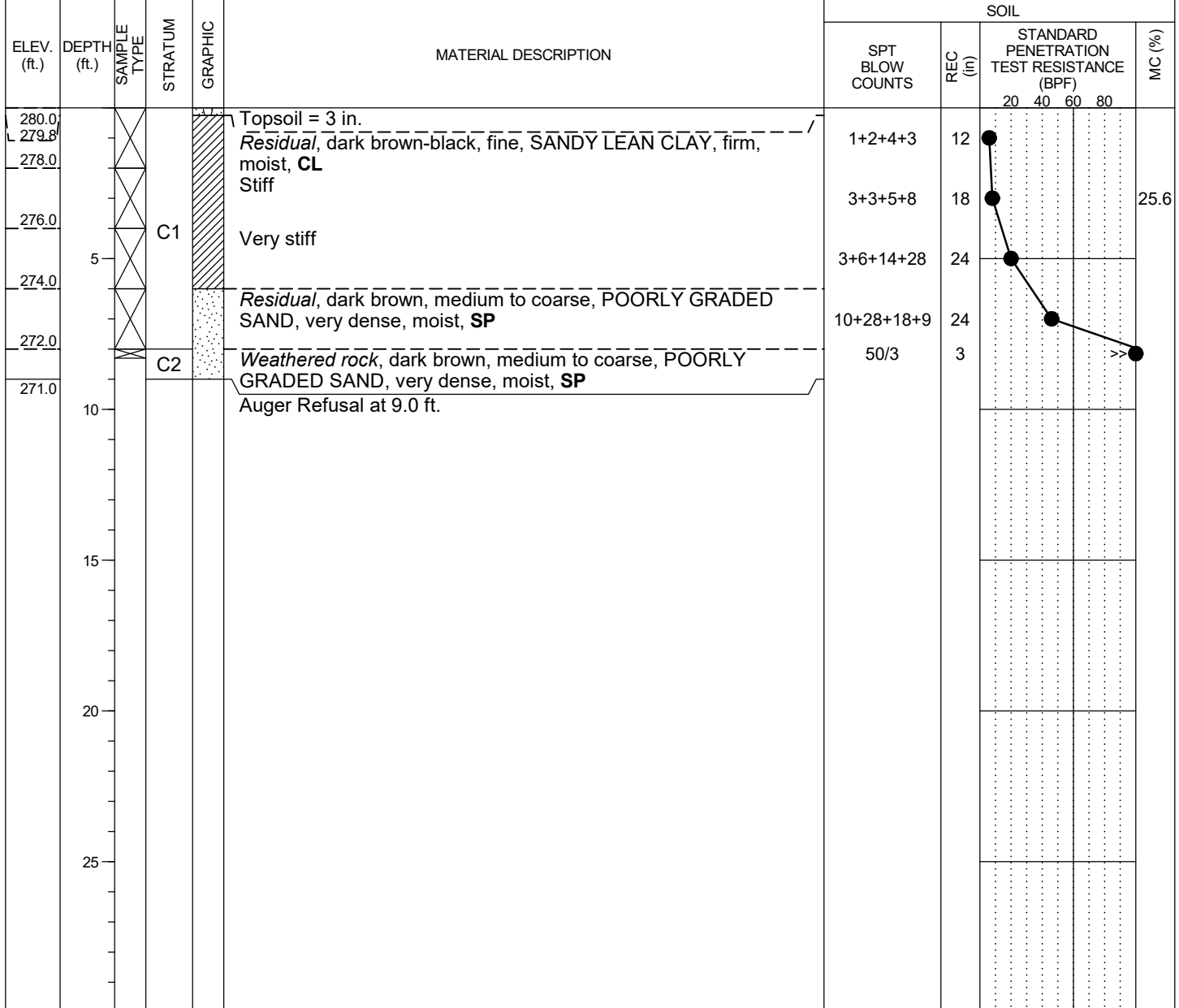
GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION CAVED: <u>9.0</u> ft. ELEV. <u>252.0</u>	SAMPLE TYPES: <input checked="" type="checkbox"/> SPT
--	--

REMARKS: Offset 3.0 ft. west to collect Shelby tube at 10.0 ft.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18



PROJECT: <b>Goose Creek Reservoir Pipeline</b>		LOGGED BY: <b>E. Miquelon</b>		BORING NUMBER: <b>PC-9</b>	
LOCATION: <b>Hearford Lane, Ashburn, Loudoun County, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		SHEET 1 OF 1	
OWNER/CLIENT: <b>Hazen and Sawyer</b>		DRILLER: <b>J. Leatherman</b>		DATES DRILLED: <b>8/6/18 - 8/6/18</b>	
PROJECT NUMBER: <b>JD185123</b>	GROUND SURFACE ELEVATION (ft.): <b>280.0 ±</b>	DRILLING METHOD: <b>3.25 ID HSA; Automatic Hammer</b>		DRILL RIG: <b>CME 55</b>	



GROUND WATER LEVELS: NOT ENCOUNTERED DURING DRILLING NOT ENCOUNTERED UPON COMPLETION	CAVED: <u>7.0</u> ft. ELEV. <u>273.0</u>	SAMPLE TYPES: <input checked="" type="checkbox"/> SPT
--	--	--

REMARKS: Offset 3.0 ft. west to collect Shelby tube at 5.0 ft.

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

BOREHOLE/TEST PIT GOOSE CREEK RESERVOIR- LOGS.GPJ GEOCONCEPTS 20170216.GDT 9/25/18

# Appendix B

## Soil Laboratory Test Results

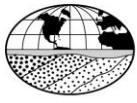
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Liquid and Plastic Limit, and Grain Size Analysis Test Data (26 pages)

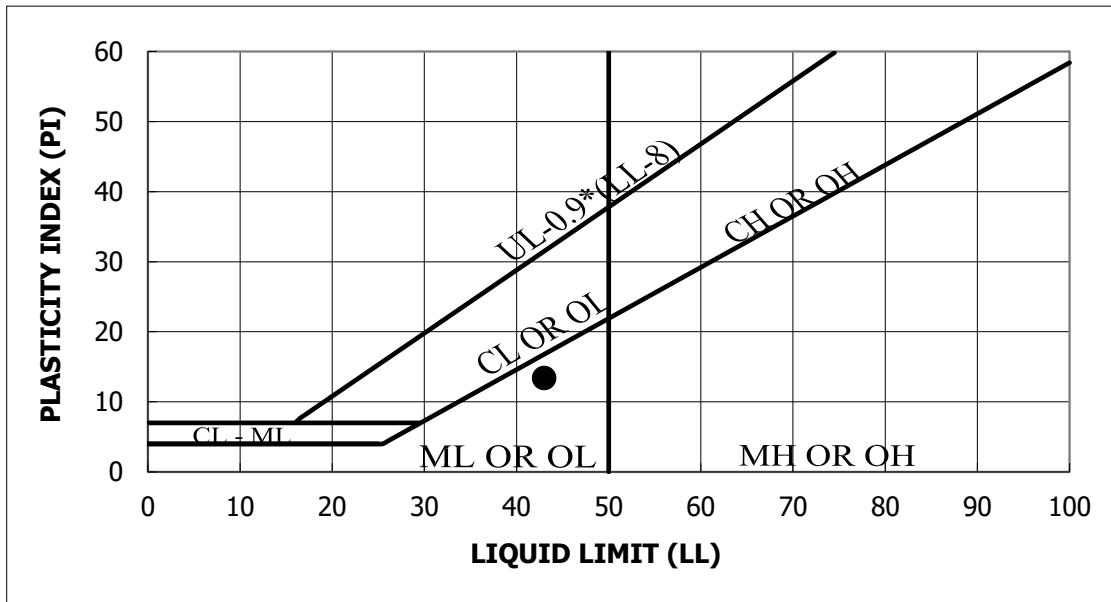
Corrosion Series Test Results (3 pages)

Unconfined Compression Test Data (2 pages)

Direct Shear Test Data (2 pages)



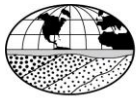
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	BR-1	<b>Depth (Feet)</b>	13.5
<b>Lab Order No.</b>	4381-2	<b>Date</b>	8/14/2018



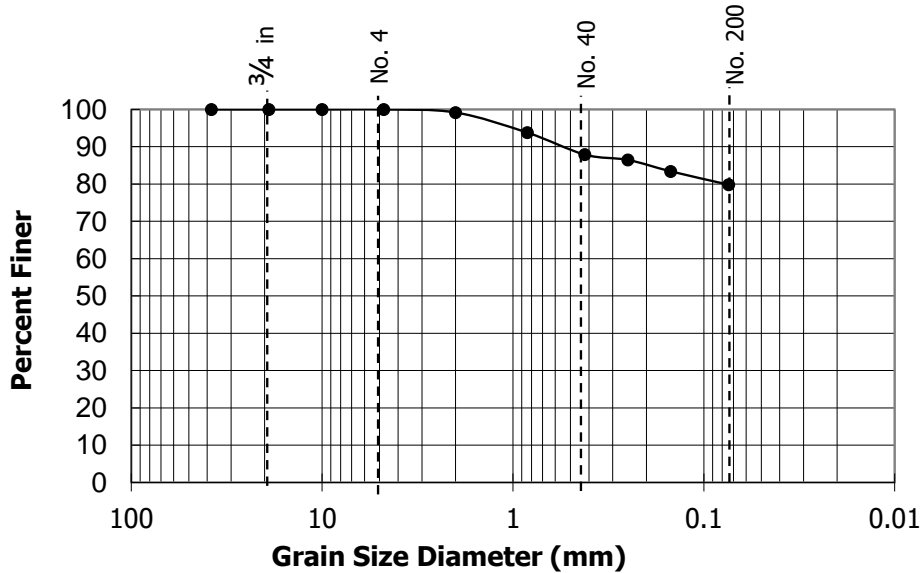
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Silt with sand	43	30	13	100.0	79.8	ML	51.8
<b>Color</b>	Brown		AASHTO Classification		A-7-5		

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	BR-1	<b>Depth (Feet)</b>	13.5
<b>Lab Order No.</b>	4381-2	<b>Date</b>	8/14/2018



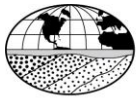
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	99
#20	94
#40	88
#60	86
#100	83
#200	80
Pan	--

<b>USCS Group Symbol</b>	<b>ML</b>
<b>USCS Group Name</b>	<b>Silt with sand</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	<b>43</b>
<b>PI</b>	<b>13</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>20.2</b>
<b>Fines</b>	<b>79.8</b>
<b>AASHTO Classification</b>	<b>A-7-5</b>
<b>Color</b>	<b>Brown</b>

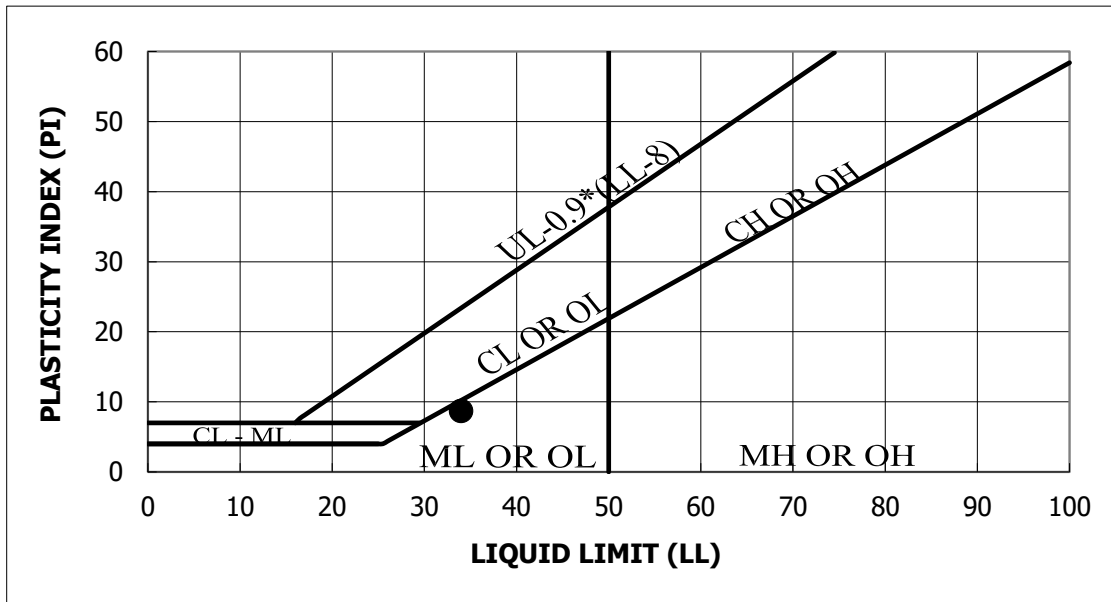
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



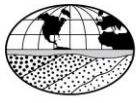
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	BR-2	<b>Depth (Feet)</b>	2.5
<b>Lab Order No.</b>	4381-3	<b>Date</b>	8/14/2018



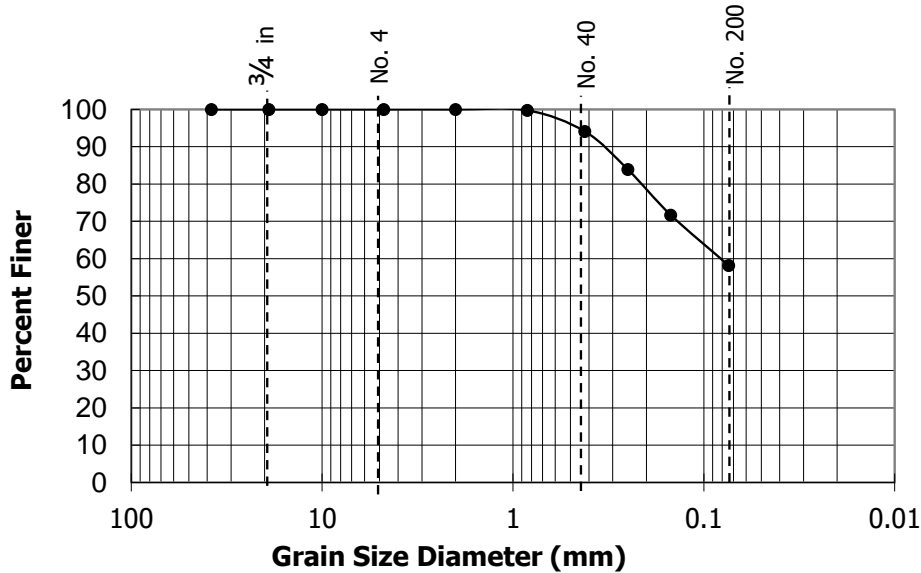
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Silt	34	25	9	100.0	58.2	ML	48.9
<b>Color</b>	Brown		AASHTO Classification			A-4	

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	BR-2	<b>Depth (Feet)</b>	2.5
<b>Lab Order No.</b>	4381-3	<b>Date</b>	8/14/2018



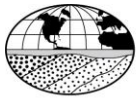
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	94
#60	84
#100	72
#200	58
Pan	--

<b>USCS Group Symbol</b>	<b>ML</b>
<b>USCS Group Name</b>	<b>sandy Silt</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	<b>34</b>
<b>PI</b>	<b>9</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>41.8</b>
<b>Fines</b>	<b>58.2</b>
<b>AASHTO Classification</b>	<b>A-4</b>
<b>Color</b>	<b>Brown</b>

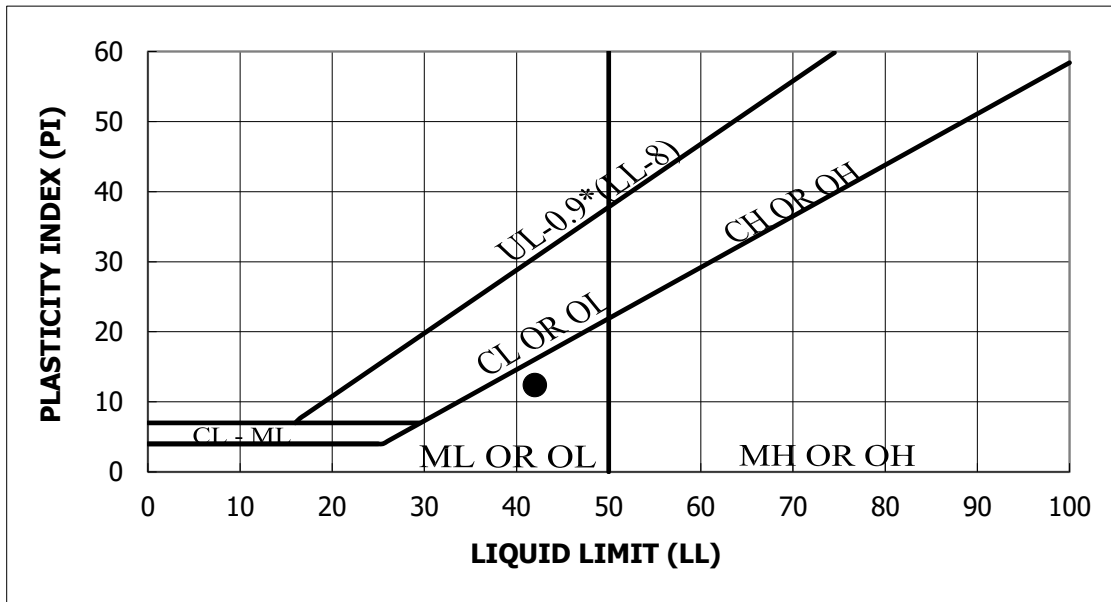
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



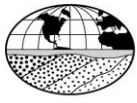
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-1	<b>Depth (Feet)</b>	2
<b>Lab Order No.</b>	4381-5	<b>Date</b>	8/14/2018



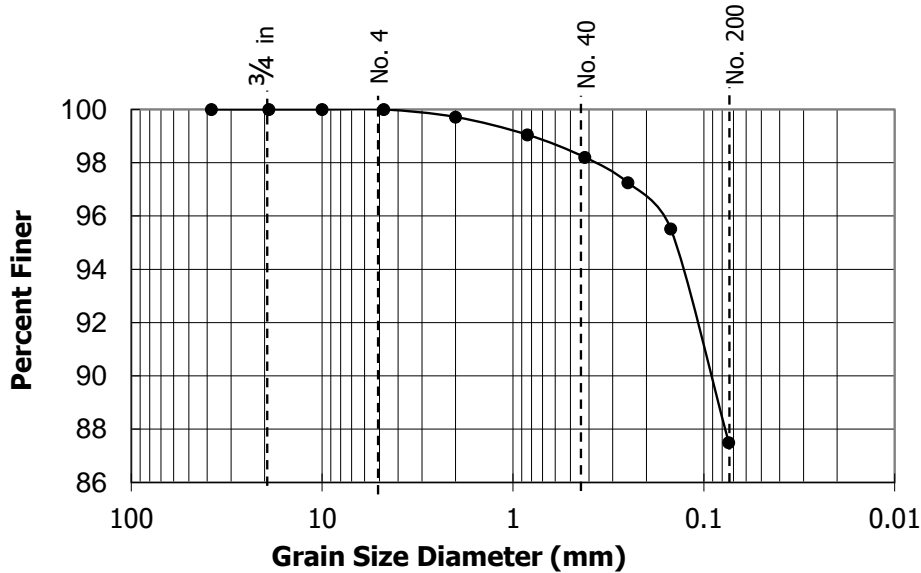
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Silt	42	30	12	100.0	87.5	ML	52.0
<b>Color</b>	Brown		AASHTO Classification		A-7-5		

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-1	<b>Depth (Feet)</b>	2
<b>Lab Order No.</b>	4381-5	<b>Date</b>	8/14/2018



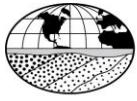
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	99
#40	98
#60	97
#100	96
#200	87
Pan	--

<b>USCS Group Symbol</b>	<b>ML</b>
<b>USCS Group Name</b>	<b>Silt</b>
<b>Cu</b>	<b>---</b>
<b>Cc</b>	<b>---</b>
<b>LL</b>	<b>42</b>
<b>PI</b>	<b>12</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>12.5</b>
<b>Fines</b>	<b>87.5</b>
<b>AASHTO Classification</b>	<b>A-7-5</b>
<b>Color</b>	<b>Brown</b>

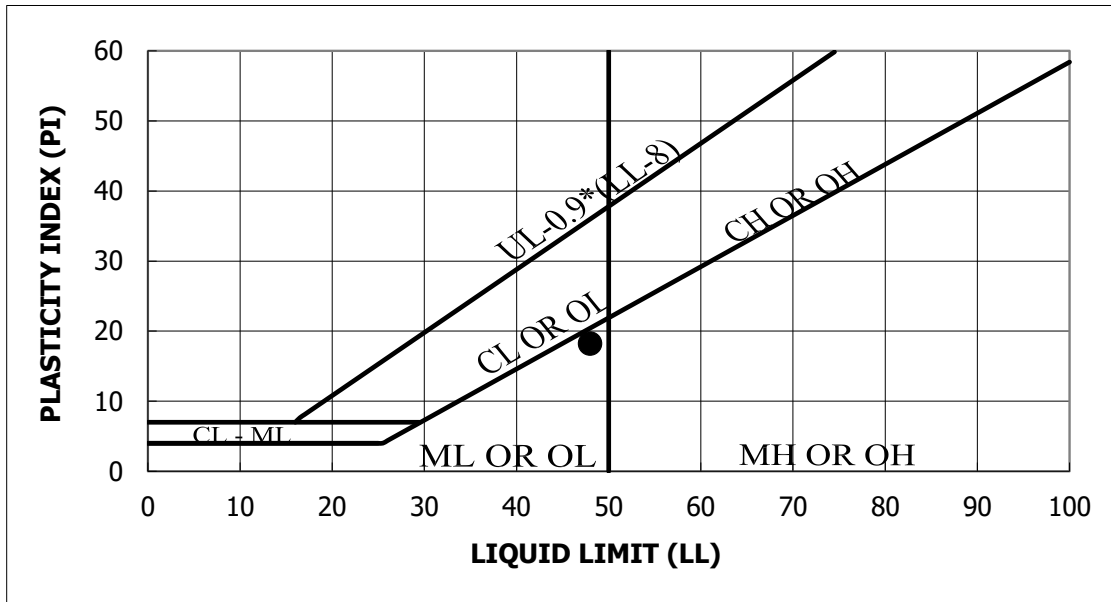
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



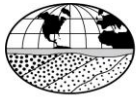
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-1	<b>Depth (Feet)</b>	5.0-7.0
<b>Lab Order No.</b>	4385-1	<b>Date</b>	8/22/2018



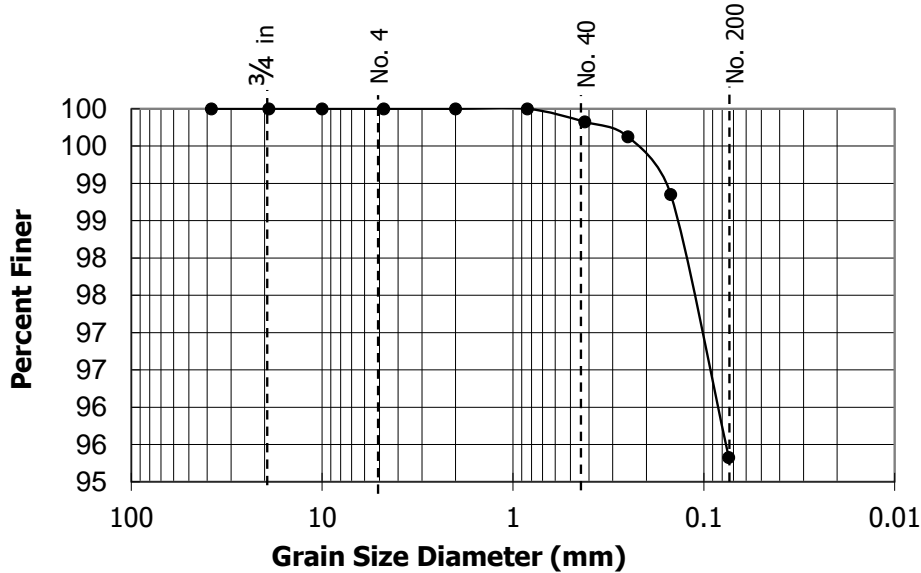
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Silt	48	30	18	100.0	95.3	ML	59.7
<b>Color</b>	Brown		AASHTO Classification		A-7-5		

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by *Daniel A. Wejert*



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-1	<b>Depth (Feet)</b>	5.0-7.0
<b>Lab Order No.</b>	4385-1	<b>Date</b>	8/22/2018



SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	100
#60	100
#100	99
#200	95
Pan	--

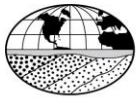
<b>USCS Group Symbol</b>	<b>ML</b>
<b>USCS Group Name</b>	<b>Silt</b>
<b>Cu</b>	<b>---</b>
<b>Cc</b>	<b>---</b>
<b>LL</b>	<b>48</b>
<b>PI</b>	<b>18</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>4.7</b>
<b>Fines</b>	<b>95.3</b>
<b>AASHTO Classification</b>	<b>A-7-5</b>
<b>Color</b>	<b>Brown</b>

Test Method: ASTM D 422

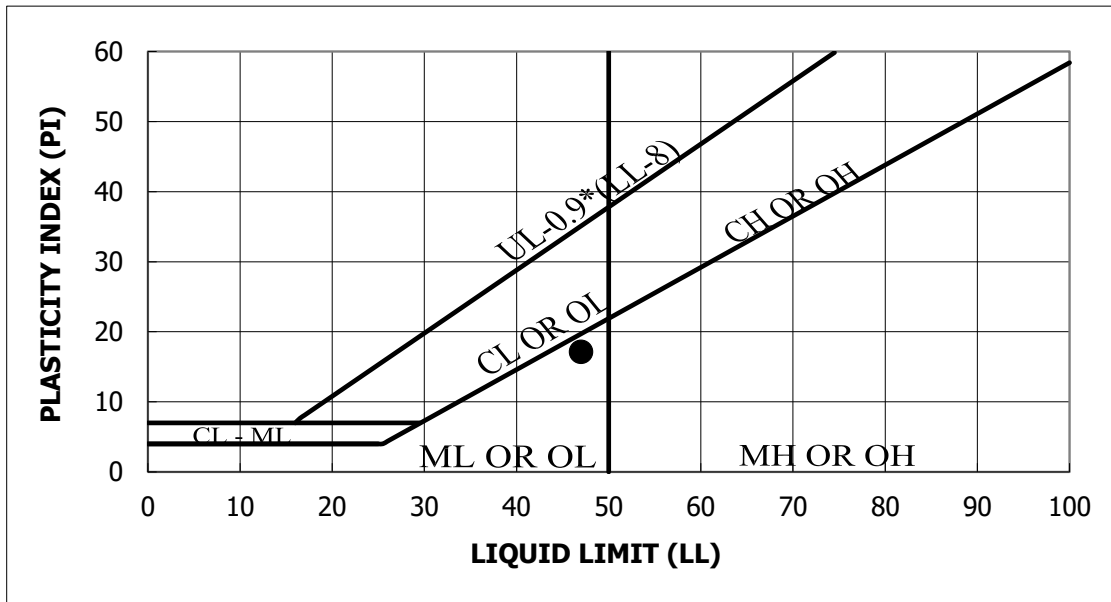
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:

*Daniel A. Wijet*



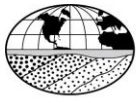
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-2	<b>Depth (Feet)</b>	16
<b>Lab Order No.</b>	4381-7	<b>Date</b>	8/14/2018



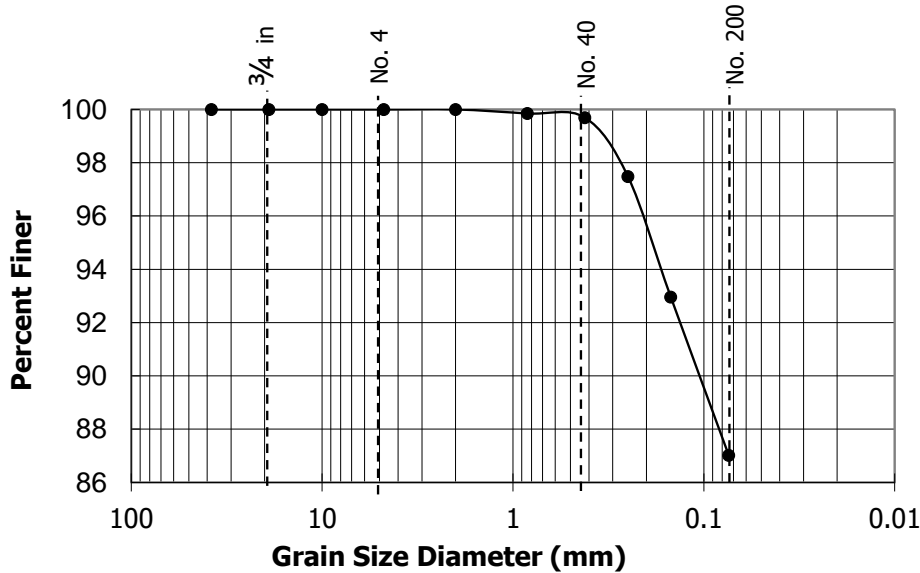
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Silt	47	30	17	100.0	87.0	ML	65.5
<b>Color</b>	Brown		AASHTO Classification		A-7-5		

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-2	<b>Depth (Feet)</b>	16
<b>Lab Order No.</b>	4381-7	<b>Date</b>	8/14/2018



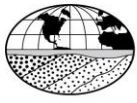
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	100
#60	97
#100	93
#200	87
Pan	--

<b>USCS Group Symbol</b>	<b>ML</b>
<b>USCS Group Name</b>	<b>Silt</b>
<b>Cu</b>	<b>---</b>
<b>Cc</b>	<b>---</b>
<b>LL</b>	<b>47</b>
<b>PI</b>	<b>17</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>13.0</b>
<b>Fines</b>	<b>87.0</b>
<b>AASHTO Classification</b>	<b>A-7-5</b>
<b>Color</b>	<b>Brown</b>

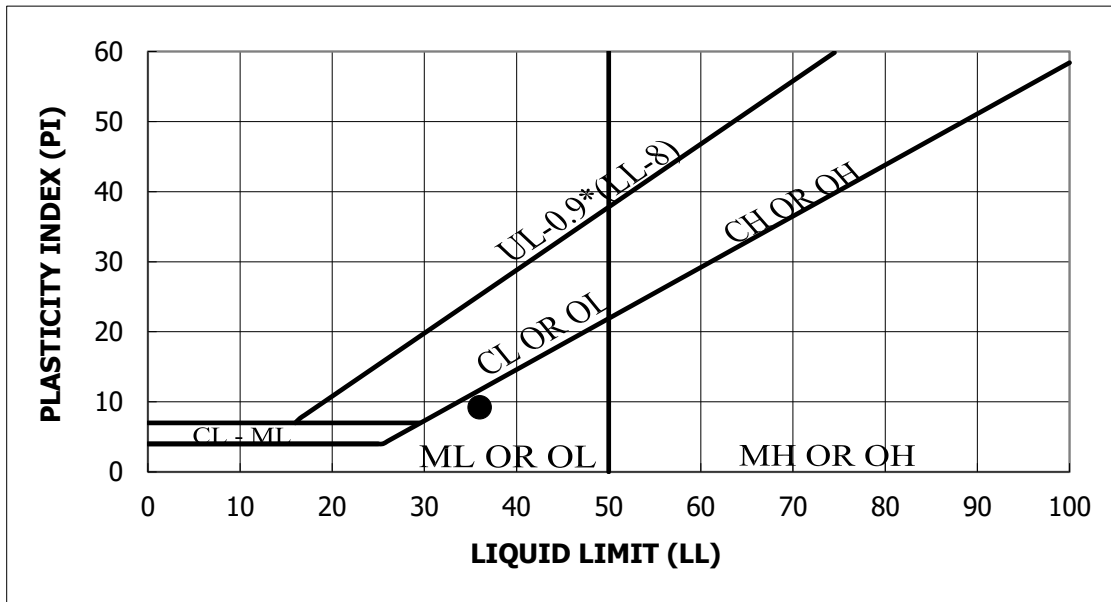
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



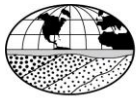
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	JD185123	Project Name	Goose Creek Reservoir
Sample ID	PC-3	Depth (Feet)	17.5
Lab Order No.	4381-8	Date	8/14/2018



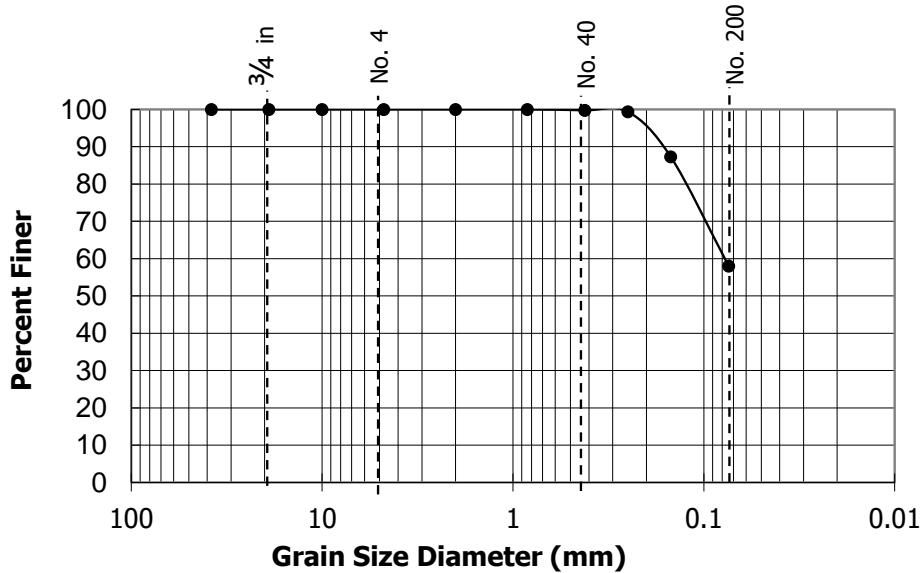
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Silt	36	27	9	100.0	58.0	ML	65.3
Color	Brown		AASHTO Classification			A-4	

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-3	<b>Depth (Feet)</b>	17.5
<b>Lab Order No.</b>	4381-8	<b>Date</b>	8/14/2018



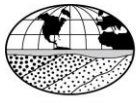
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	100
#60	99
#100	87
#200	58
Pan	--

<b>USCS Group Symbol</b>	<b>ML</b>
<b>USCS Group Name</b>	<b>sandy Silt</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	<b>36</b>
<b>PI</b>	<b>9</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>42.0</b>
<b>Fines</b>	<b>58.0</b>
<b>AASHTO Classification</b>	<b>A-4</b>
<b>Color</b>	<b>Brown</b>

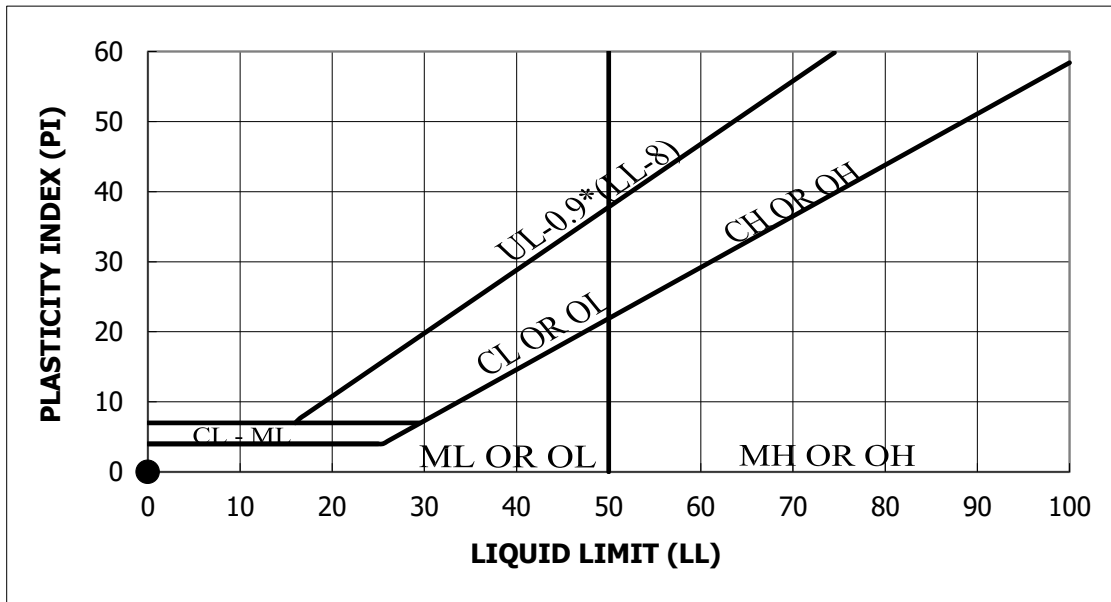
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-4	<b>Depth (Feet)</b>	21
<b>Lab Order No.</b>	4381-10	<b>Date</b>	8/14/2018

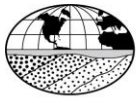


Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
<b>SILTY SAND</b>	NP	NP	NP	100.0	16.6	SM	70.8
<b>Color</b>	Brown		AASHTO Classification		A-2-4		

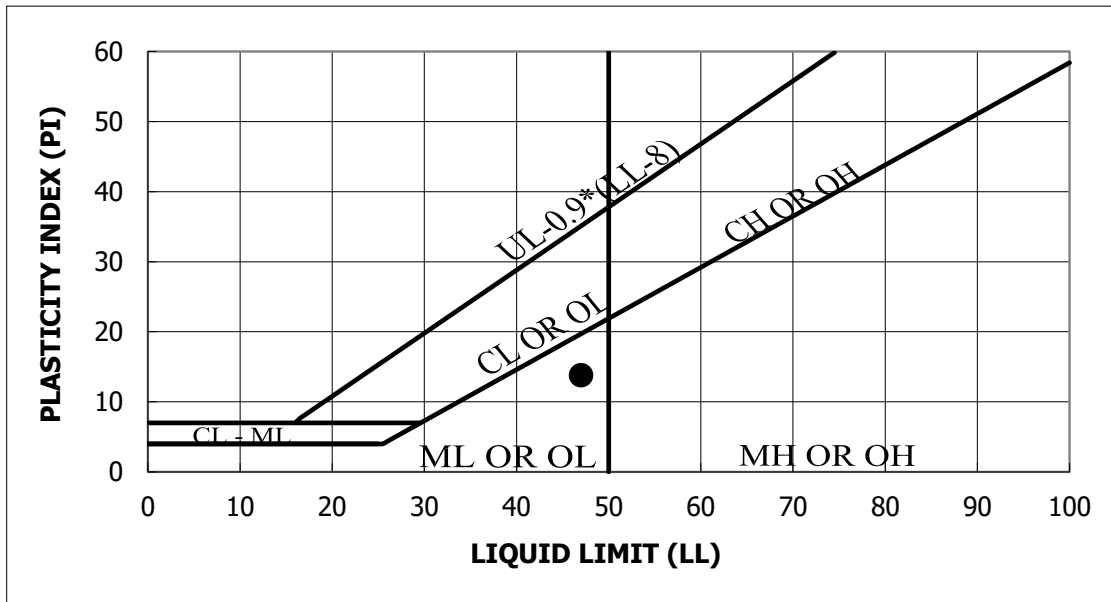
Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 





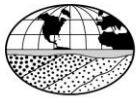
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-6	<b>Depth (Feet)</b>	9.5
<b>Lab Order No.</b>	4381-12	<b>Date</b>	8/14/2018



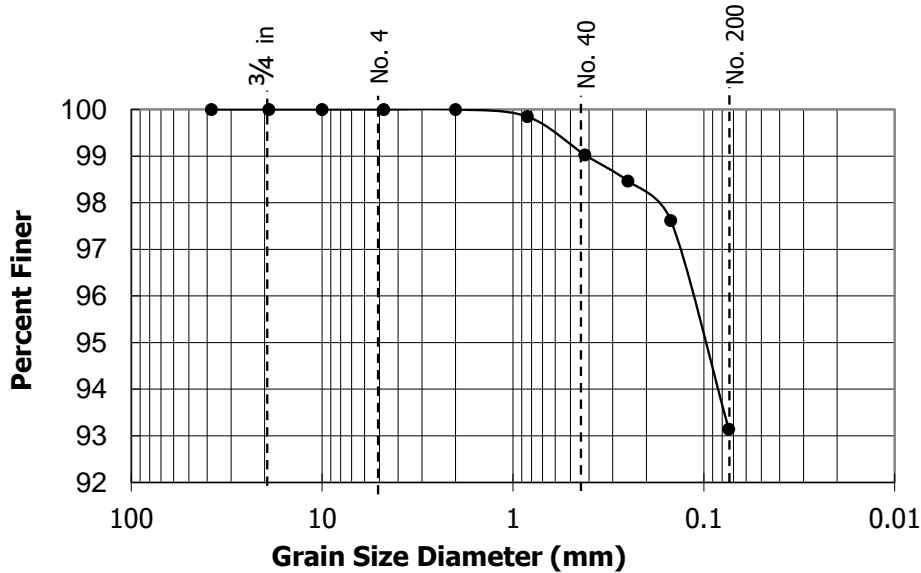
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Silt	47	33	14	100.0	93.1	ML	93.1
<b>Color</b>	Brown		AASHTO Classification		A-7-5		

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-6	<b>Depth (Feet)</b>	9.5
<b>Lab Order No.</b>	4381-12	<b>Date</b>	8/14/2018



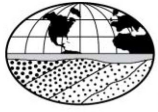
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	99
#60	98
#100	98
#200	93
Pan	--

<b>USCS Group Symbol</b>	<b>ML</b>
<b>USCS Group Name</b>	<b>Silt</b>
<b>Cu</b>	<b>---</b>
<b>Cc</b>	<b>---</b>
<b>LL</b>	<b>47</b>
<b>PI</b>	<b>14</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>6.9</b>
<b>Fines</b>	<b>93.1</b>
<b>AASHTO Classification</b>	<b>A-7-5</b>
<b>Color</b>	<b>Brown</b>

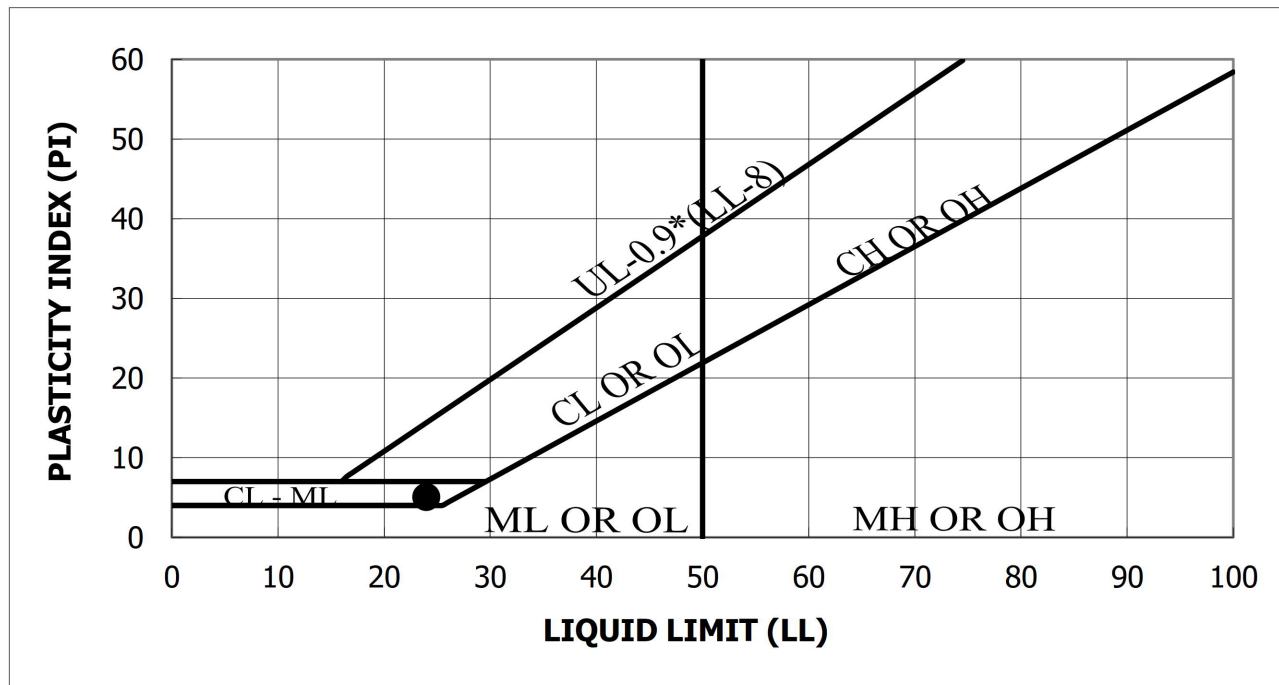
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



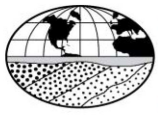
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	JD185123	Project Name	Goose Creek Reservoir
Sample ID	PC-6	Depth (Feet)	15.5-17.5
Lab Order No.	4404-1	Date	9/13/2018



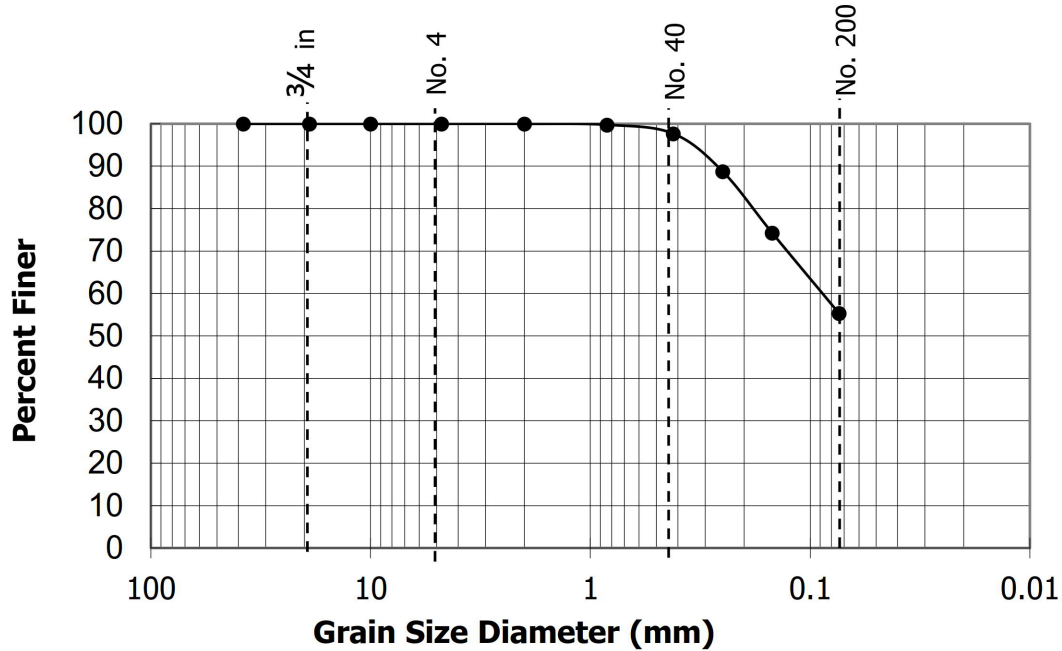
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy silty Clay	24	19	5	100.0	55.4	CL-ML	22.0
Color	Brown		AASHTO Classification			A-4	

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by *Darla Wijet*



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-6	<b>Depth (Feet)</b>	15.5-17.5
<b>Lab Order No.</b>	4404-1	<b>Date</b>	9/13/2018



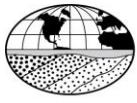
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	98
#60	89
#100	74
#200	55
Pan	--

<b>USCS Group Symbol</b>	<b>CL-ML</b>
<b>USCS Group Name</b>	<b>sandy silty Clay</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	<b>24</b>
<b>PI</b>	<b>5</b>
<b>Gravel</b>	<b>0.0</b>
<b>Sand</b>	<b>44.6</b>
<b>Fines</b>	<b>55.4</b>
<b>AASHTO Classification</b>	<b>A-4</b>
<b>Color</b>	<b>Brown</b>

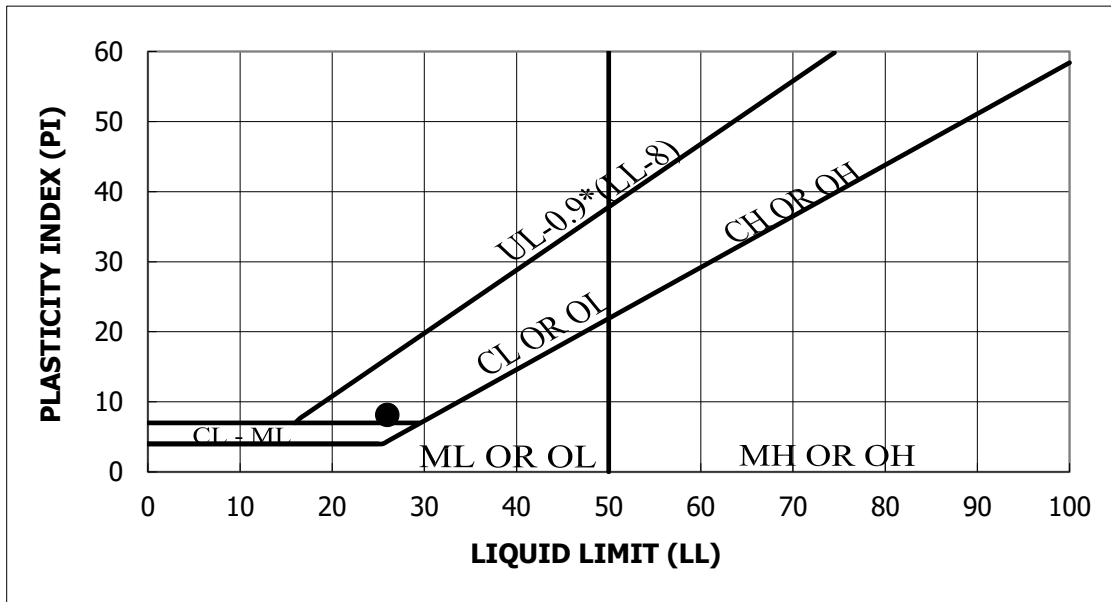
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



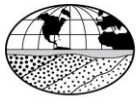
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-7	<b>Depth (Feet)</b>	7.5
<b>Lab Order No.</b>	4381-14	<b>Date</b>	8/14/2018



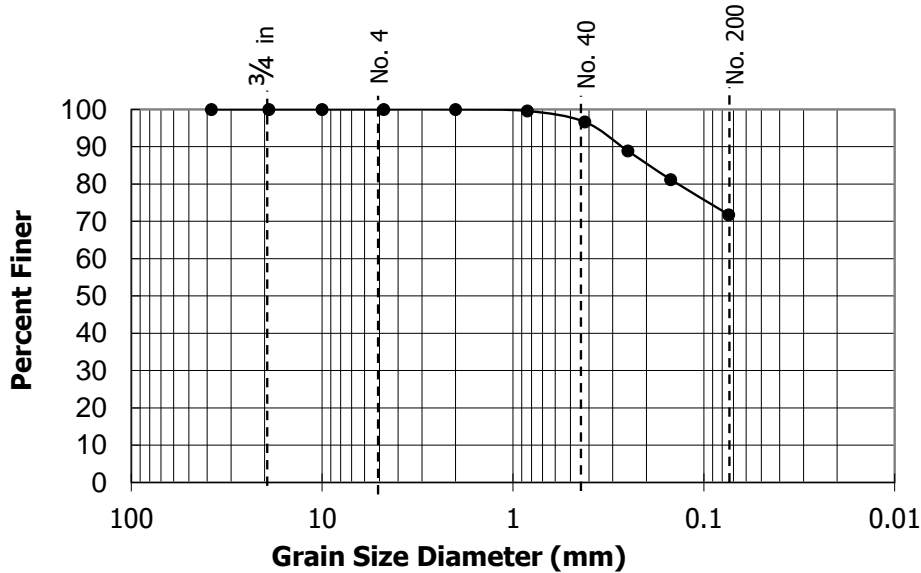
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Lean Clay with sand	26	18	8	100.0	71.8	CL	28.7
<b>Color</b>	Brown		AASHTO Classification			A-4	

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	JD185123	Project Name	Goose Creek Reservoir
Sample ID	PC-7	Depth (Feet)	7.5
Lab Order No.	4381-14	Date	8/14/2018



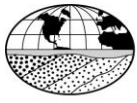
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	97
#60	89
#100	81
#200	72
Pan	--

USCS Group Symbol	CL
USCS Group Name	Lean Clay with sand
Cu	---
Cc	---
LL	26
PI	8
Gravel	0.0
Sand	28.2
Fines	71.8
AASHTO Classification	A-4
Color	Brown

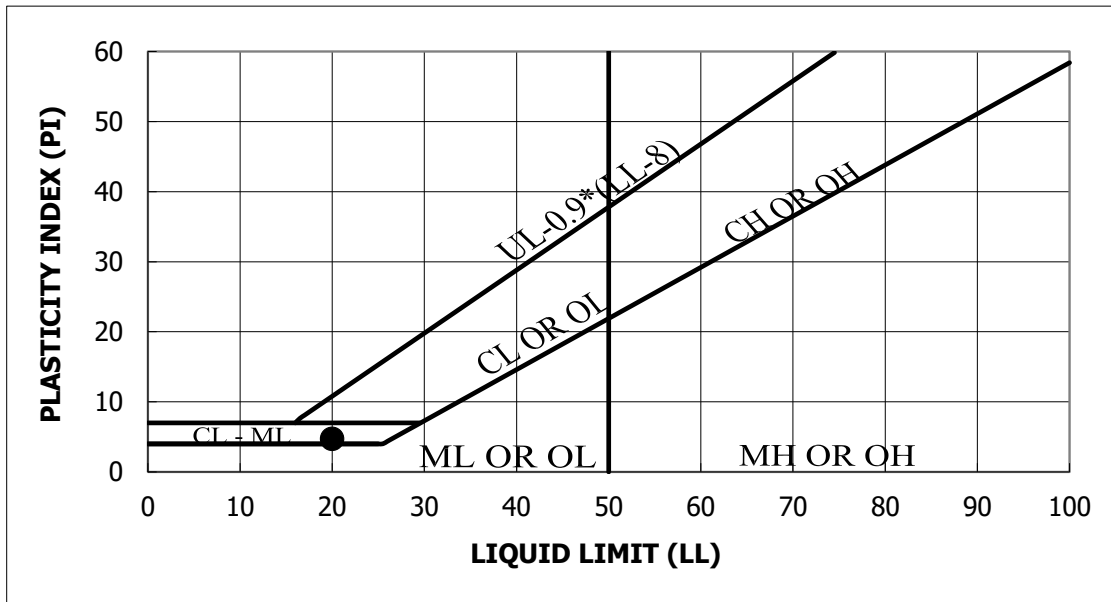
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:




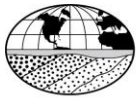
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-7	<b>Depth (Feet)</b>	17.5
<b>Lab Order No.</b>	4381-11	<b>Date</b>	8/14/2018



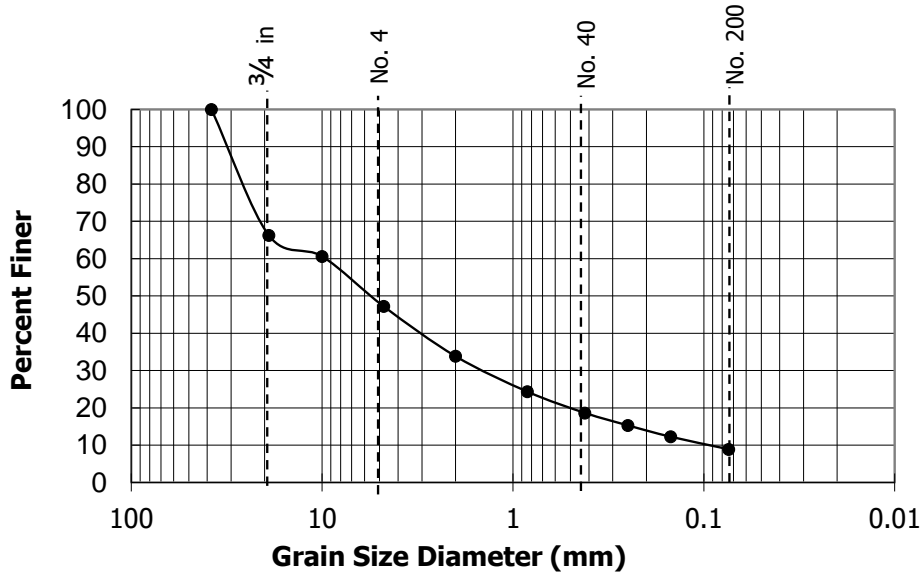
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
<b>WELL GRADED GRAVEL with clay &amp; sand</b>	20	15	5	47.2	8.9	GW-GC	6.3
<b>Color</b>	Brown		AASHTO Classification		A-1-a		

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	JD185123	Project Name	Goose Creek Reservoir
Sample ID	PC-7	Depth (Feet)	17.5
Lab Order No.	4381-11	Date	8/14/2018



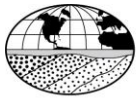
SIEVE	% Passing
1 1/2 "	100
3/4"	66
3/8"	61
#4	47
#10	34
#20	24
#40	19
#60	15
#100	12
#200	9
Pan	--

USCS Group Symbol	GW-GC
USCS Group Name	WELL GRADED GRAVEL with clay &
Cu	99.0
Cc	2.4
LL	20
PI	5
Gravel	52.8
Sand	38.3
Fines	8.9
AASHTO Classification	A-1-a
Color	Brown

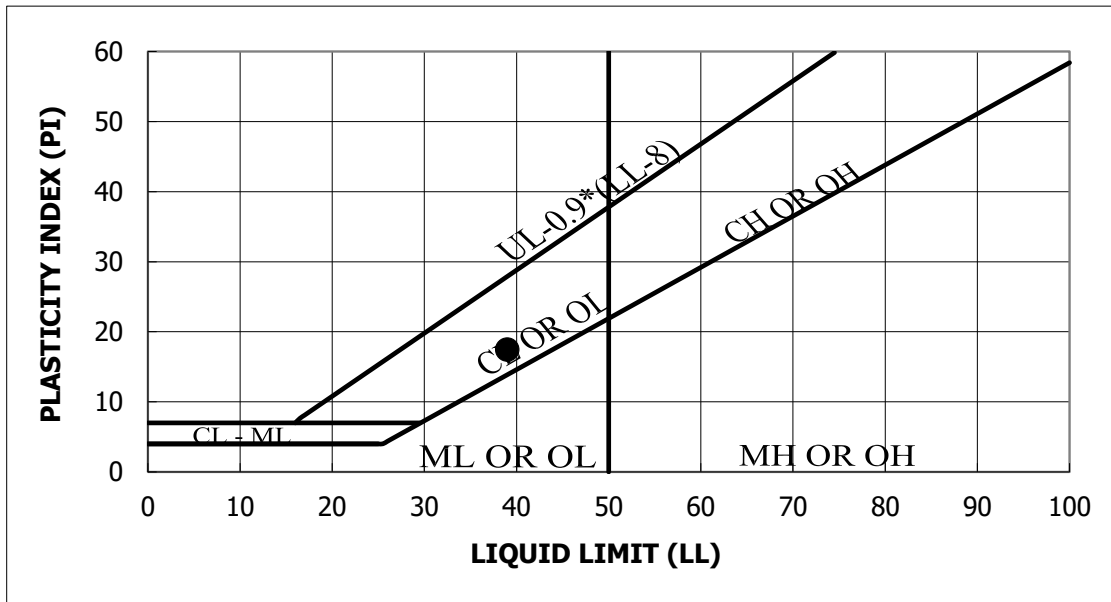
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



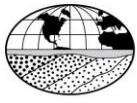
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	JD185123	Project Name	Goose Creek Reservoir
Sample ID	PC-8	Depth (Feet)	12
Lab Order No.	4381-15	Date	8/14/2018



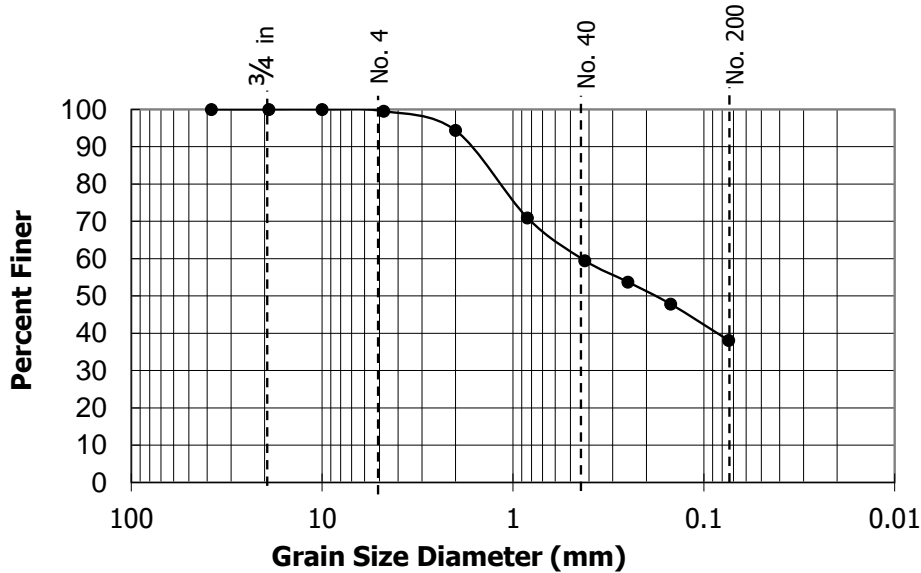
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	39	22	17	99.5	38.1	SC	23.6
Color	Brown		AASHTO Classification			A-6	

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-8	<b>Depth (Feet)</b>	12
<b>Lab Order No.</b>	4381-15	<b>Date</b>	8/14/2018



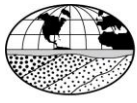
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	94
#20	71
#40	59
#60	54
#100	48
#200	38
Pan	--

<b>USCS Group Symbol</b>	<b>SC</b>
<b>USCS Group Name</b>	<b>CLAYEY SAND</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	<b>39</b>
<b>PI</b>	<b>17</b>
<b>Gravel</b>	<b>0.5</b>
<b>Sand</b>	<b>61.5</b>
<b>Fines</b>	<b>38.1</b>
<b>AASHTO Classification</b>	<b>A-6</b>
<b>Color</b>	<b>Brown</b>

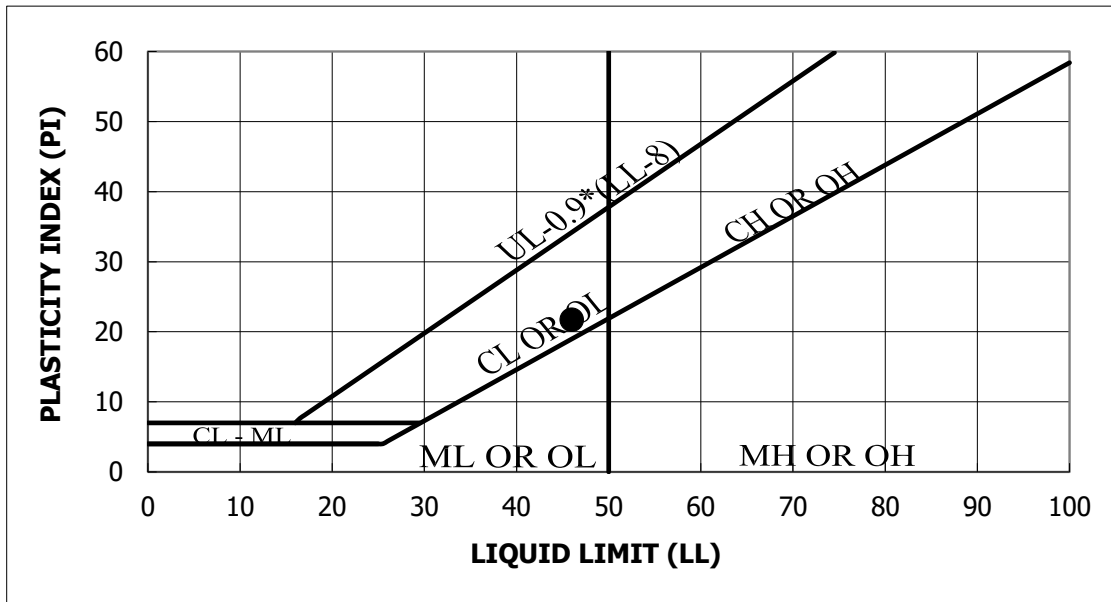
Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



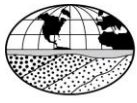
LIQUID AND PLASTIC LIMIT - ASTM D4318			
<b>Project No.</b>	JD185123	<b>Project Name</b>	Goose Creek Reservoir
<b>Sample ID</b>	PC-9	<b>Depth (Feet)</b>	2
<b>Lab Order No.</b>	4381-16	<b>Date</b>	8/14/2018



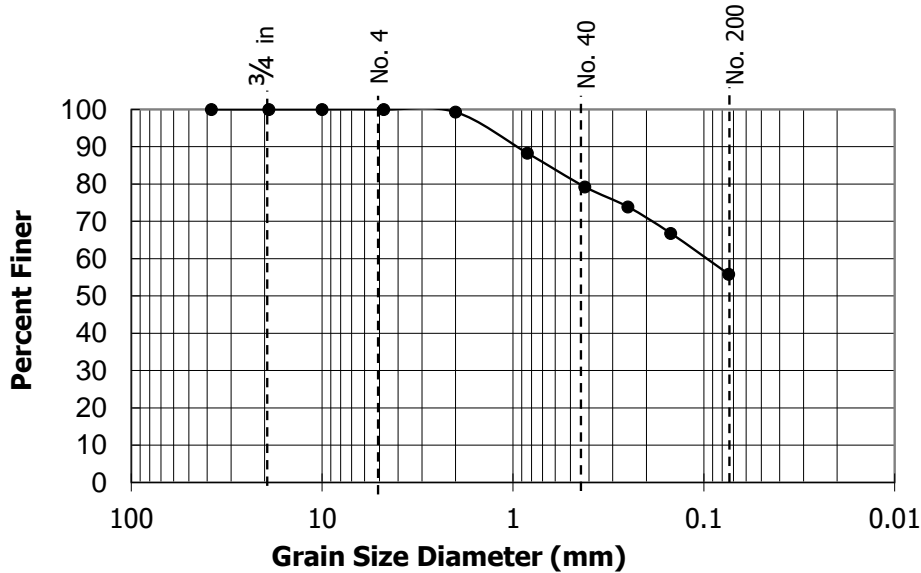
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Lean Clay	46	24	22	100.0	55.8	CL	25.6
<b>Color</b>	Brown		AASHTO Classification		A-7-6		

Test Method: ASTM D 4318  
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by 



GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	JD185123	Project Name	Goose Creek Reservoir
Sample ID	PC-9	Depth (Feet)	2
Lab Order No.	4381-16	Date	8/14/2018



SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	99
#20	88
#40	79
#60	74
#100	67
#200	56
Pan	--

USCS Group Symbol	CL
USCS Group Name	sandy Lean Clay
Cu	---
Cc	---
LL	46
PI	22
Gravel	0.0
Sand	44.2
Fines	55.8
AASHTO Classification	A-7-6
Color	Brown

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:



HP ENVIRONMENTAL INCORPORATED  
**Certificate of Laboratory Analysis**

GeoConcepts Engineering, Inc  
 Eric Miquelon  
 19955 Highland Vista Dr., Suite 170  
 Ashburn, VA 20147

Report Number: **184667**  
 Date Received: 08/13/18 14:15  
 Date Reported: 08/17/18 14:00  
 Project Location: Goose Creek Reservoir

Client Sample No: **PC-1**  
 Sample Matrix: Soil  
 Sample Description: 5-10 ft

Lab Sample No.: 184667-01  
 Collection Date/Time: 08/03/18 00:00

**Soil Corrosion Potential Tests**

Parameter	Method	Result	Units	Limit	Dilution	Qualifier	Cont.	Analysis Date	Analyst
Resistivity	ASTM G187	<b>3400</b>	ohm-cm	N/A	1		A	08/14/18	JMP
Redox Potential	Electrode	+ <b>311</b>	mV	N/A	1		A	08/17/18	JMP
pH	CA-643	<b>6.5</b>	pH	N/A			A	08/15/18	JMP
Chloride (Water Soluble)	CA-422	<b>4.2</b>	mg/Kg	2.5	1		A	08/16/18	JMP
Sulfate (Water Soluble)	EPA 375.4	<b>30</b>	mg/Kg	5.0	1		A	08/16/18	JMP
Sulfide (Water Soluble)	EPA 376.2	< 1.2	mg/Kg	1.2	1	U	A	08/16/18	JMP
Moisture (Percent)	EPA	<b>60</b>	%	N/A			A	08/14/18	JMP

Client Sample No: **PC-4**  
 Sample Matrix: Soil  
 Sample Description: 20-25 ft

Lab Sample No.: 184667-02  
 Collection Date/Time: 07/31/18 00:00

**Soil Corrosion Potential Tests**

Parameter	Method	Result	Units	Limit	Dilution	Qualifier	Cont.	Analysis Date	Analyst
Resistivity	ASTM G187	<b>3600</b>	ohm-cm	N/A	1		A	08/14/18	JMP
Redox Potential	Electrode	+ <b>291</b>	mV	N/A	1		A	08/17/18	JMP
pH	CA-643	<b>6.6</b>	pH	N/A			A	08/15/18	JMP
Chloride (Water Soluble)	CA-422	<b>8.2</b>	mg/Kg	2.5	1	D	A	08/16/18	JMP
Sulfate (Water Soluble)	EPA 375.4	<b>130</b>	mg/Kg	5.0	1	D	A	08/16/18	JMP
Sulfide (Water Soluble)	EPA 376.2	< 1.2	mg/Kg	1.2	1	U	A	08/16/18	JMP
Moisture (Percent)	EPA	<b>46</b>	%	N/A			A	08/14/18	JMP

Client Sample No: **PC-8**  
 Sample Matrix: Soil  
 Sample Description: 9-14 ft

Lab Sample No.: 184667-03  
 Collection Date/Time: 08/06/18 00:00

**Soil Corrosion Potential Tests**

Parameter	Method	Result	Units	Limit	Dilution	Qualifier	Cont.	Analysis Date	Analyst
Resistivity	ASTM G187	<b>2100</b>	ohm-cm	N/A	1		A	08/14/18	JMP
Redox Potential	Electrode	+ <b>279</b>	mV	N/A	1		A	08/17/18	JMP
pH	CA-643	<b>4.9</b>	pH	N/A			A	08/15/18	JMP
Chloride (Water Soluble)	CA-422	<b>20</b>	mg/Kg	2.5	1	D	A	08/16/18	JMP
Sulfate (Water Soluble)	EPA 375.4	<b>120</b>	mg/Kg	5.0	1	D	A	08/16/18	JMP
Sulfide (Water Soluble)	EPA 376.2	< 1.2	mg/Kg	1.2	1	U	A	08/16/18	JMP
Moisture (Percent)	EPA	<b>36</b>	%	N/A			A	08/14/18	JMP

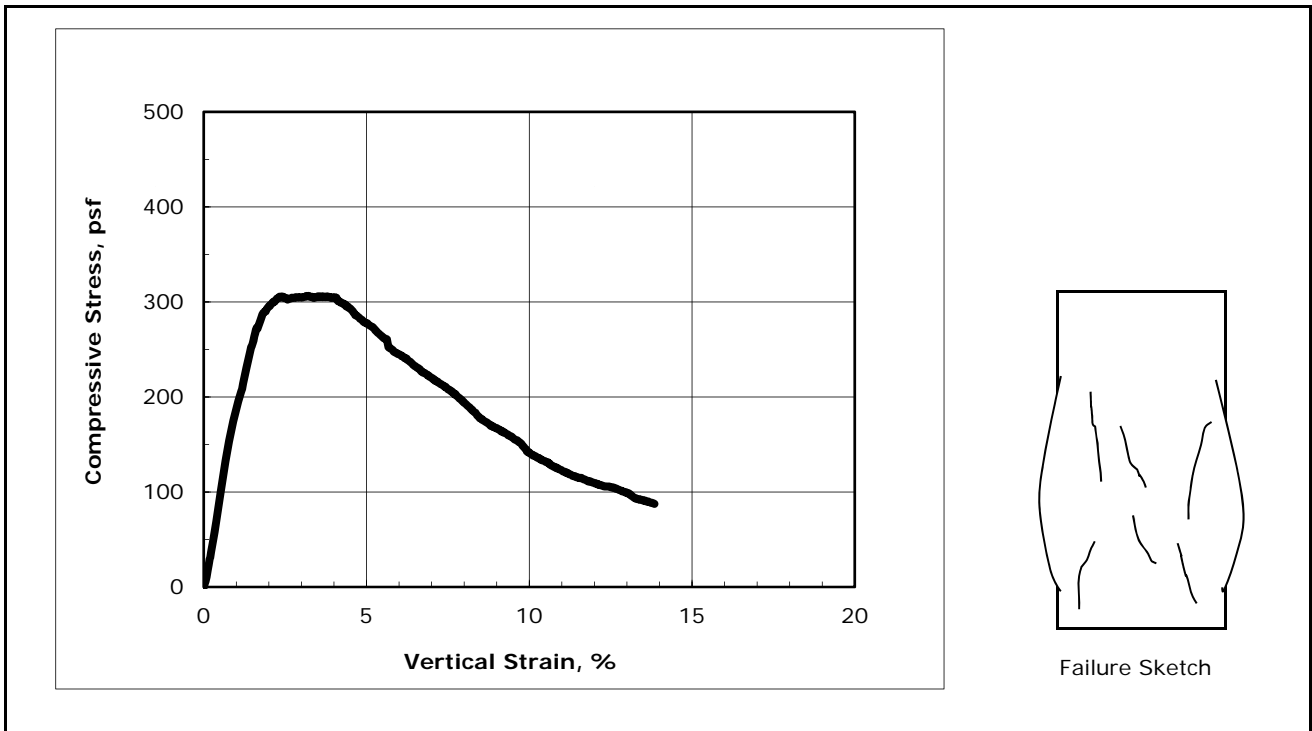






Client:	Terracon Consultants, Inc.
Project Name:	Goose Creek Reservoir (JD185123)
Project Location:	Ashburn, VA
GTX #:	308672
Test Date:	08/29/18
Tested By:	md
Checked By:	njh
Boring ID:	BR-2
Sample ID:	---
Depth, ft:	10.5-12.5
Visual Description:	Moist, brown clay and silt
Test No.:	UC-2

## Unconfined Compressive Strength by ASTM D2166



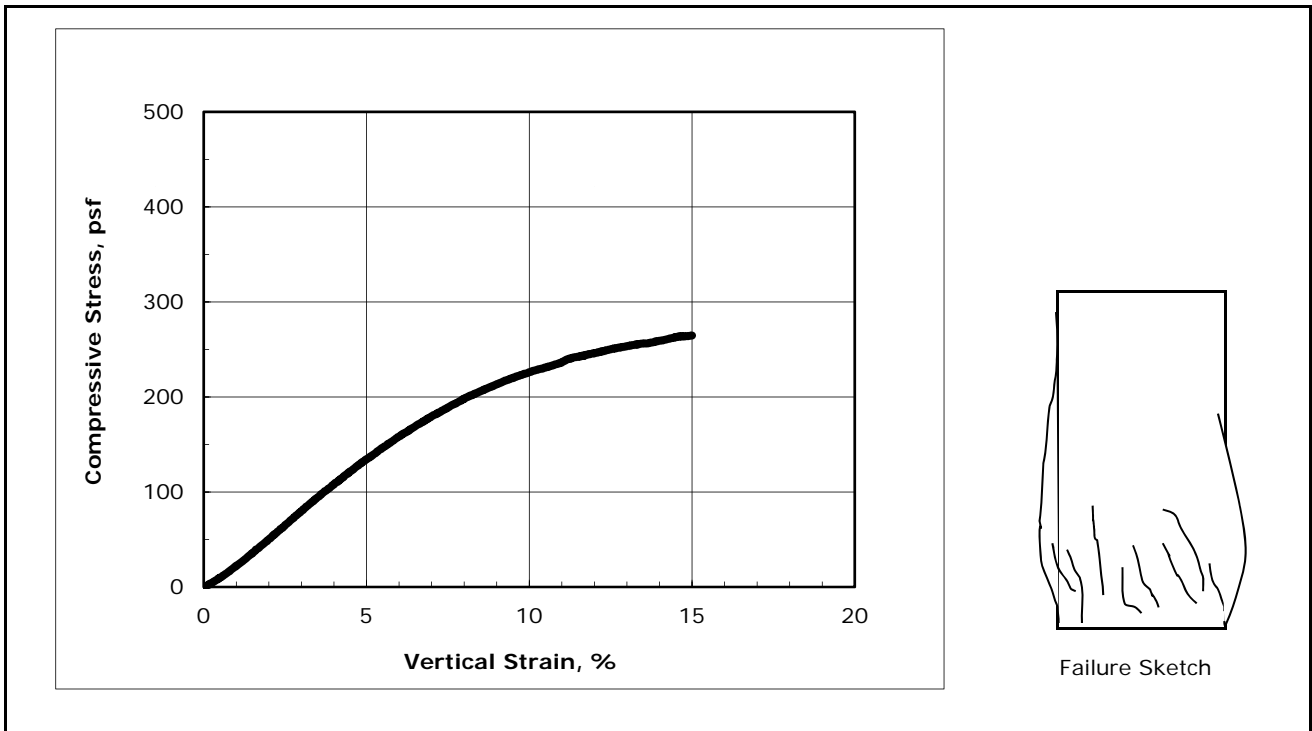
Initial Diameter, in:	2.87	Compressive Strength, psf	306
Initial Height, in:	6.11	Shear Strength, psf:	153
Height to Diameter Ratio:	2.13	Strain Rate, %/min:	1
Initial Mass, grams:	1327	Strain at Failure, %:	3.2
Initial Bulk Density, pcf:	127.9	Sample Type:	intact
Initial Moisture Content, %:	23.2	Liquid Limit:	---
Initial Dry Density, pcf:	103.8	Plastic Limit:	---
Initial Degree of Saturation:	99.3	Plasticity Index:	---
Initial Void Ratio:	0.63	% Passing #200 sieve:	---
Estimated Specific Gravity:	2.72	Soil Classification:	---
		Group Symbol:	---

Notes: Moisture content obtained before shear from sample trimmings  
 Moisture Content determined by ASTM D2216  
 Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.  
 "---" indicates testing required to determine these values was not requested



Client:	Terracon Consultants, Inc.
Project Name:	Goose Creek Reservoir (JD185123)
Project Location:	Ashburn, VA
GTX #:	308672
Test Date:	08/29/18
Tested By:	md
Checked By:	njh
Boring ID:	PC-1A
Sample ID:	---
Depth, ft:	5-7
Visual Description:	Wet, dark green clay and silt
Test No.:	UC-1

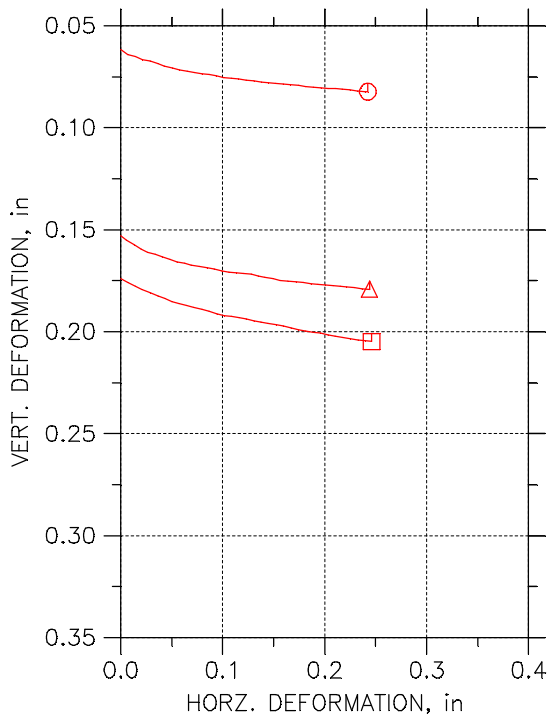
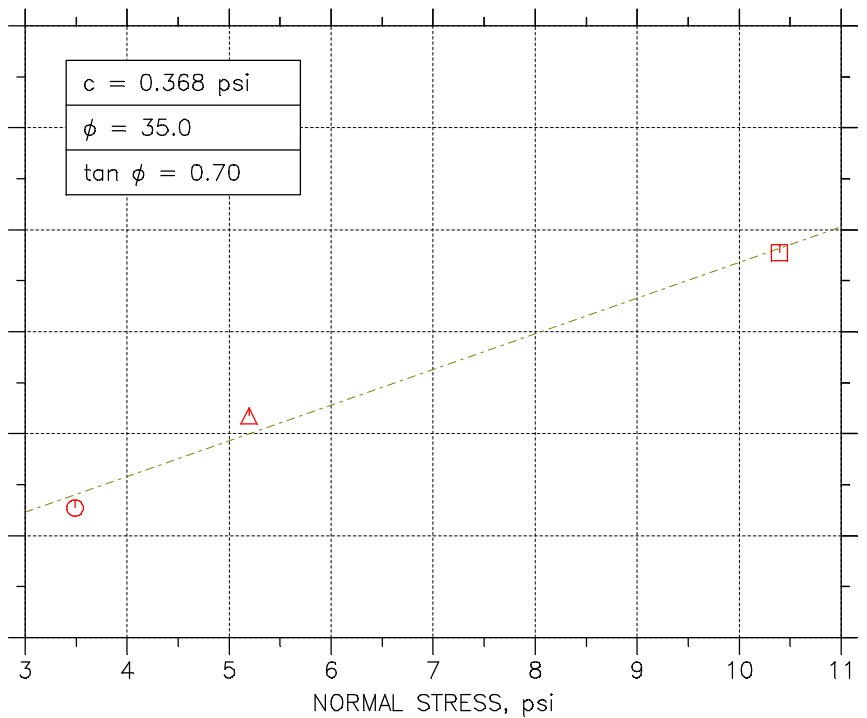
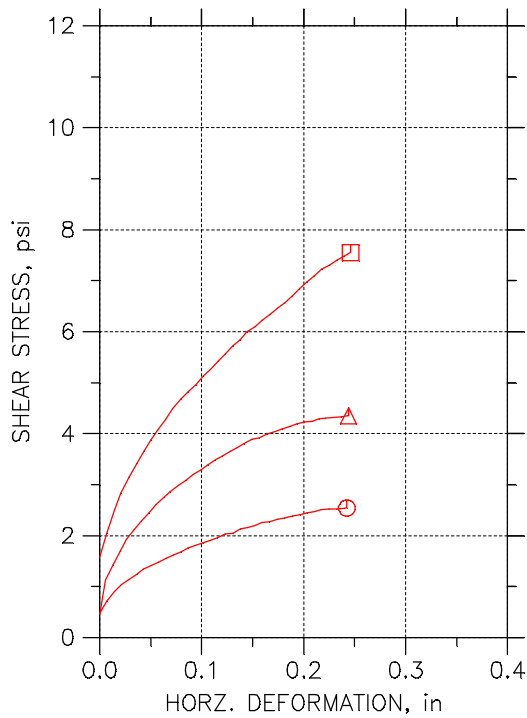
## Unconfined Compressive Strength by ASTM D2166



Initial Diameter, in:	2.88	Compressive Strength, psf	265
Initial Height, in:	6.18	Shear Strength, psf:	132
Height to Diameter Ratio:	2.15	Strain Rate, %/min:	1
Initial Mass, grams:	1031	Strain at Failure, %:	15
Initial Bulk Density, pcf:	97.6	Sample Type:	intact
Initial Moisture Content, %:	54.7	Liquid Limit:	---
Initial Dry Density, pcf:	63.1	Plastic Limit:	---
Initial Degree of Saturation:	88.3	Plasticity Index:	---
Initial Void Ratio:	1.67	% Passing #200 sieve:	---
Estimated Specific Gravity:	2.7	Soil Classification:	---
		Group Symbol:	---

Notes: Moisture content obtained before shear from sample trimmings  
 Moisture Content determined by ASTM D2216  
 Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.  
 "---" indicates testing required to determine these values was not requested

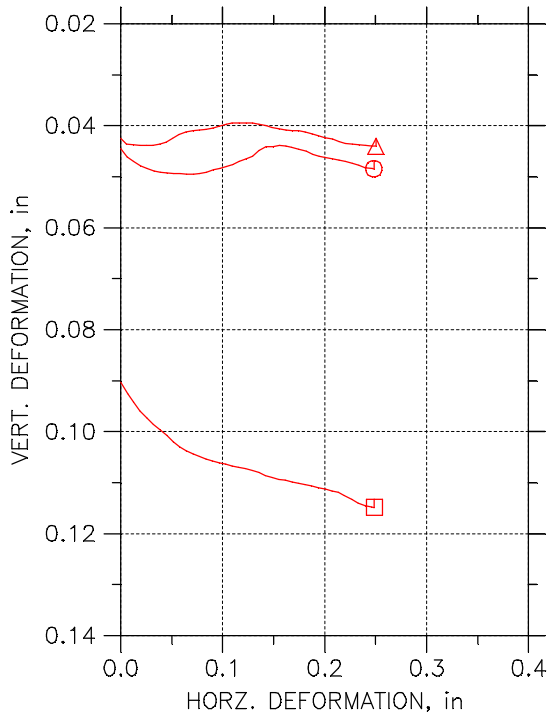
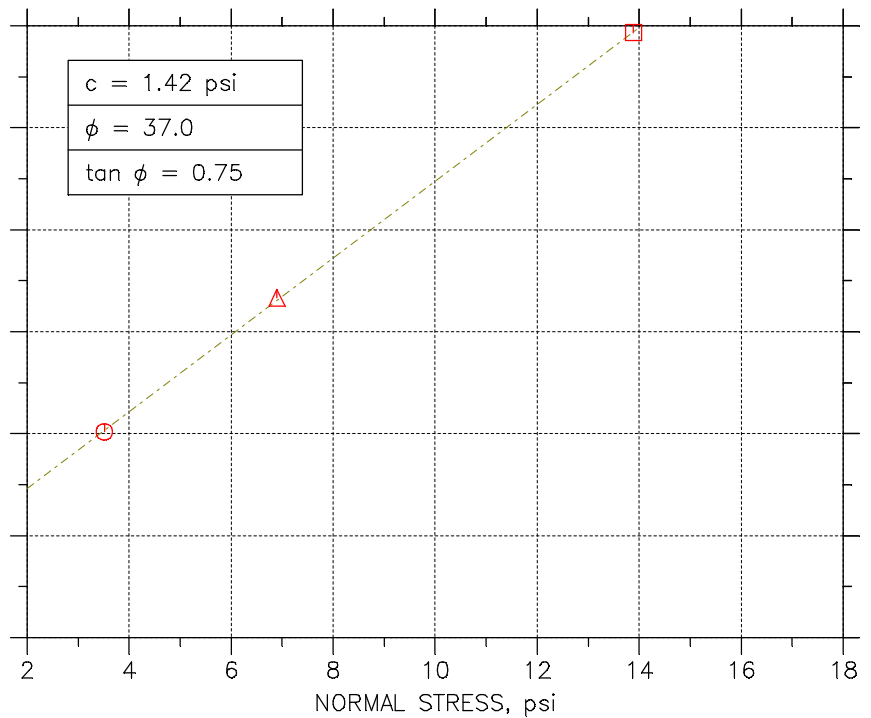
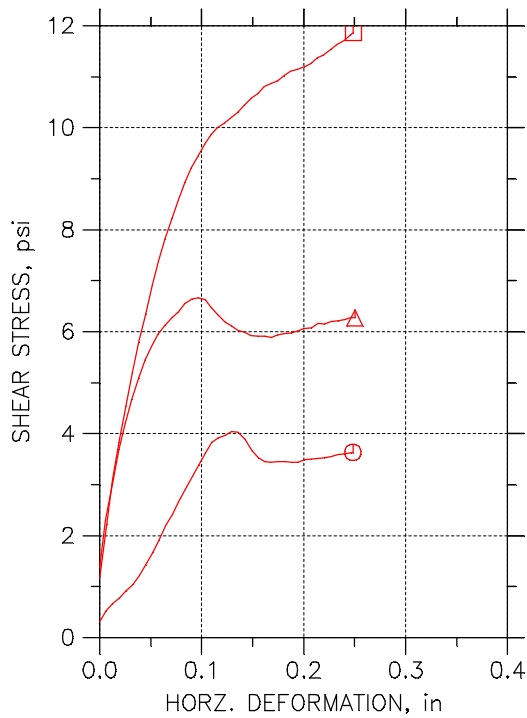
# DIRECT SHEAR TEST REPORT



Symbol	⊙	△	□	
Test No.	3.5 psi	5.2 psi	10.4 psi	
Sample No.	A-1	A-2	A-3	
Shape	Circular	Circular	Circular	
Initial	Dimension, in	2.5	2.5	2.5
	Area, in <sup>2</sup>	4.9087	4.9087	4.9087
	Height, in	1	1	1
	Water Content, %	61.18	62.12	64.54
	Dry Density, pcf	61.776	61.466	61.931
	Saturation, %	96.62	97.32	102.33
	Void Ratio	1.678	1.6915	1.6712
Consol. Height, in		0.94063	0.85113	0.8353
Consol. Void Ratio		1.519	1.2908	1.2313
Final	Water Content, %	51.26	50.63	49.12
	Dry Density, pcf	67.321	74.886	77.883
	Saturation, %	93.20	110.96	115.80
	Void Ratio	1.4574	1.2091	1.1241
Normal Stress, psi		3.4882	5.1944	10.395
Max. Shear Stress, psi		2.5443	4.3509	7.5515
Ult. Shear Stress, psi		2.5443	4.3509	7.5515
Time to Failure, min		667.8	679.26	675.61
Disp. Rate, in/min		0.00035	0.00035	0.00035
Estimated Specific Gravity		2.65	2.65	2.65
Liquid Limit		48	48	48
Plastic Limit		30	30	30
Plasticity Index		18	18	18

Project: Goose Creek Reservoir	
Location: Ashburn, VA	
Project No.: JD185123	
Boring No.: PC-1	
Sample Type: Undisturbed	
Description: Brown SILT (ML)	
Remarks: (5.0'-7.0')	

# DIRECT SHEAR TEST REPORT



Symbol	⊙	△	□	
Test No.	3.5 psi	6.9 psi	13.9 psi	
Sample No.	A-1	A-2	A-3	
Shape	Circular	Circular	Circular	
Initial	Dimension, in	2.5	2.5	2.5
	Area, in <sup>2</sup>	4.9087	4.9087	4.9087
	Height, in	1	1	1
	Water Content, %	22.79	22.63	24.84
	Dry Density, pcf	102.83	107.33	99.339
	Saturation, %	99.21	110.79	98.95
	Void Ratio	0.6088	0.54133	0.66536
Consol. Height, in	0.95893	0.96057	0.91483	
Consol. Void Ratio	0.54272	0.48055	0.52351	
Final	Water Content, %	23.25	22.70	23.83
	Dry Density, pcf	108.07	112.28	112.23
	Saturation, %	116.04	127.09	133.19
	Void Ratio	0.53084	0.47343	0.4741
Normal Stress, psi	3.5135	6.9006	13.89	
Max. Shear Stress, psi	4.0383	6.6638	11.865	
Ult. Shear Stress, psi	3.632	6.27	11.865	
Time to Failure, min	100	75.001	192.2	
Disp. Rate, in/min	0.00125	0.00125	0.00125	
Estimated Specific Gravity	2.65	2.65	2.65	
Liquid Limit	24	24	24	
Plastic Limit	19	19	19	
Plasticity Index	5	5	5	

Project: Goose Creek Reservoir
Location: Loudoun County, VA
Project No.: JD185123
Boring No.: PC-6
Sample Type: Undisturbed
Description: Brown Sandy Silty CLAY (CL-ML)
Remarks: 15.5' - 17.5'