GEOTECHNICAL ENGINEERING REPORT

Retaining Wall Replacement
2900 South Eads Street
Arlington, VA

Schnabel Reference 17C12005
April 24, 2017

Schnabel ENGINEERING

April 24, 2017

Mr. Jason J. Lynch, LEED AP BD+C
Program Manager
TMG Construction Corporation
741 Miller Drive, SE
Leesburg, Virginia 20175

Subject: **Project 17C12005, Geotechnical Engineering Report, 2900 South Eads Street Retaining Wall Replacement Project, Arlington, Virginia**

Dear Mr. Lynch:

SCHNABEL ENGINEERING, LLC (Schnabel) is pleased to submit our geotechnical engineering report for this project. This study was performed in accordance with our revised proposal dated December 12, 2017, as authorized by you on February 2, 2017.

SCOPE OF SERVICES

Our revised proposal defines the scope of services for this project. The scope of services includes the following:

- Subsurface exploration including three test borings and one temporary water observation well installed along the toe of the proposed retaining structure.
- Field engineering services, including site reconnaissance, boring layout, logging the subsurface exploration, and collecting long-term groundwater measurements.
- Soil laboratory testing including moisture content, Atterberg Limits, gradation analysis, and direct shear testing of relatively undisturbed samples.
- Geotechnical engineering analysis and report, including:
    - Estimated subsurface conditions and groundwater levels within the area explored based on data collected in our and GeoConcepts' subsurface explorations.
    - Recommended Seismic Site Class and Seismic Site Coefficients in accordance with IBC 2012 for use in design based on the subsurface exploration data.
    - Recommended earth pressures, subdrainage, and backfill requirements for the proposed retaining wall system.
    - Earthwork recommendations for construction of backfill and load-bearing fill including an assessment of on-site soils for use as backfill and fill, subgrade preparation, and compaction criteria.
    - A recommended slope stabilization system including general discussions involving the system as well as discussions concerning constructability, global stability and cost effectiveness.

PROJECT DESCRIPTION

Site Description

The project is located on the property of 2900 South Eads Street in Arlington, VA, which is situated between Fort Scott Drive to the north and 31st Street S to the south. The property is specifically bounded by an apartment building located at 2868 Fort Scott Drive to the north, South Eads Street to the east, 3000 South Eads Street property to the south, and a vacant wooded area leading into residential lots to the west. The property is occupied by a warehouse/storage building. An existing retaining wall is located along the western boundary of the site providing partial grade separation between the property and the vacant wooded area and adjacent residential lots to the west, including an apartment building. The existing retaining wall is aligned in an approximate north-south direction, is approximately 80 ft long, and is about 7 ft high at its tallest section. The retaining wall consists of soldier piles and lagging and retains a slope that varies from a low of about EL 35 to 40 ft at the back of the wall to a high of about EL 85 ft at the boundary of the vacant wooded lot and the residential/apartment building lots. Several components of the retaining wall are showing signs of deterioration, distress, and/or have failed.

We obtained the site information from the site plans by STV Inc. (STV), dated October 10, 2014, through our site visits, and review of available site aerial photography. A Site Vicinity Map is included as Figure 1.

Proposed Construction By Others

We understand that Arlington County is currently considering the replacement of the existing retaining wall due to its deteriorating condition and concerns regarding the global stability of the existing slope. Based upon the recommendations presented by GeoConcepts in their geotechnical engineering report, three replacement retaining wall system concepts were presented in the Preliminary Engineering Report prepared by STV. The three retaining wall systems consisted of an anchored sheet pile wall, a cast-in-place concrete cantilevered wall, and a soldier pile and lagging system with the piles embedded into drilled caissons.

Schnabel's conceptual level recommended design is discussed in the Slope Stabilization System section of this report.

SUBSURFACE EXPLORATION AND LABORATORY TESTING PROGRAM

We performed a subsurface exploration and field testing program to estimate the subsurface stratigraphy underlying the site and to evaluate the geotechnical properties of the materials encountered. This program included test borings and installing one temporary groundwater observation well. Exploration methods used are discussed below. The appendices contain the results of our exploration.

Subsurface Exploration Methods

Test Borings

Schnabel's subcontractor, Connelly and Associates, Inc., drilled three test borings under our observation from February 20 to 24, 2017. The Standard Penetration Test (SPT) was performed at selected depths in the borings. Appendix A includes specific observations, remarks, and logs for the borings; classification criteria; drilling methods; and sampling protocols. Figure 2, included at the end of this report, indicates the approximate test boring locations.   We will retain soil samples up to 45 days beyond the issuance of this report, unless you request other disposition.

The SPT samples were obtained using a hydraulically driven automatic trip hammer (ATH). Most correlations with SPT data are based on N-values collected with a safety hammer. The energy applied to the split-spoon sampler using the ATH is about 33 percent greater than that applied using the safety hammer, resulting in lower N-values. The hammer blows shown on the boring logs are uncorrected for the higher energy. However, we correct SPT N values for the higher energy when using N values in our analyses.

Soil Laboratory Testing

Our laboratory performed index tests on selected samples collected during the subsurface exploration. The index testing included natural moisture content, Atterberg limits, and gradation tests and aided in the classification of materials encountered in the subsurface exploration and provided data for use in the development of our recommended slope stabilization system. The results of the laboratory tests performed by our laboratories are included in Appendix B and are summarized for each stratum in the Site Geology and Subsurface Conditions section of this report. Selected test results are also shown on the boring logs in Appendix A.

Selected tests were performed by our subcontractor, GeoTesting Express, in Acton, Massachusetts. This testing was used to aid in the classification of materials encountered in the subsurface exploration and the development of shear strength soil parameters to be used in the design of the selected slope stabilization system.

Index Testing

We performed index testing on samples collected as part of the exploration to provide soil classifications and to provide parameters for use with published correlations with soil properties. Index testing included performing natural moisture content, Atterberg Limits, and gradation tests on several jar samples of the fine-grained and coarse-grained alluvial soils as well as the fine-grained and coarse-grained Potomac Formation soils.

Shear Strength Testing

<u>Consolidated-Drained Direct Shear Tests</u>

GeoTesting Express conducted three Consolidated-Drained Direct Shear tests on samples representing the fine- and coarse-grained Potomac Formation soils, respectively, to evaluate the shear strength of these materials. The testing was conducted in accordance with method ASTM D3080. The purpose of conducting a Consolidated-Direct Direct Shear test is to measure the shear strength under drained conditions. A specimen is confined under vertical and normal stress, and a horizontal force is applied as to fail the specimen along a horizontal plane. Two of the tests were performed on reconstituted samples fine-grained soil samples, and one test was performed on an intact sample coarse-grained soil sample. Performing these tests on reconstituted samples of fine-grained soil samples allow for the determination of the material’s fully softened shear strength parameters.

Consolidated Drained Repeated Direct Shear Tests

GeoTesting Express conducted two Consolidated-Drained Repeated Direct Shear Tests on relatively undisturbed samples of fine-grained soil samples. The repeated direct shear test is used to measure the residual shear strength of a soil under drained conditions by placing a normal stress on a soil sample that is repeatedly sheared by reversal of the direction of shear until a minimum/residual shear stress is determined. The repeated direct shear tests were performed in accordance with the United States Army Corps of Engineers laboratory testing procedures, USACE EM 1110-2-1906, using sufficient stress reversals to obtain large strains to determine both the peak and post-peak (i.e., residual) shear strength of the soil.

Previous Explorations by Others

GeoConcepts prepared a geotechnical engineering report dated October 9, 2014, for this project. In support of their analyses, GeoConcepts performed a subsurface exploration program consisting of five soil test borings with SPT. GeoConcepts also performed soil laboratory tests on samples obtained from the site. Testing included natural moisture content, grain size distribution, and Atterberg limits. Logs for the borings included in this exploration are included in Appendix B and laboratory test results are presented in Appendix D.

This data was developed by others and we were not present during collection of this information. We have reviewed the data for reasonableness, but we assume no responsibility for the completeness and accuracy of this information.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

Site Geology

Based on our regional experience and published geologic information, the project site is located within the Atlantic Coastal Plain Physiographic Province. The subsurface conditions in this area are typically comprised of Quaternary age terrace alluvial deposits consisting of gravel, sand, silt, and clay. The alluvial deposits are underlain by cretaceous age sediments identified as part of the Potomac Formation. The Potomac Group sediments form a wedge that rapidly thickens toward the east. Bedrock is expected to exist at depths greater than 150 ft below the ground surface.

The terraced alluvium was deposited during the Pleistocene epoch through the deposition of sediment from the ancestral Potomac River. The fine-grained and coarse-grained alluvial deposits have been designated as Strata B1 and B2, respectively. The soils of the Potomac Formation have been overconsolidated due to a greater height of overburden in the past which has since been eroded. Based on our local experience, the Potomac clays are typically overconsolidated by at least 3 tons per square foot (tsf) in excess of the existing overburden pressure. Due to variable erosional features, softening of the Potomac sediments, and very similar material types, the border between the terraced alluvium and Potomac deposits is not always easily determined and not well defined. The fine-grained and coarse-grained Potomac Formation soils have been designated as Strata C1 and C2, respectively.

Generalized Subsurface Stratigraphy

We characterized the following generalized subsurface stratigraphy based on the recent and previous subsurface explorations and laboratory test data included in the appendices.

Ground Cover

We encountered between 4 and 6 inches of topsoil in borings 17BH-02 and 17BH-03. We also encountered 6 inches of concrete beneath the topsoil in boring 17BH-02.

Stratum A: Existing Fill

GeoConcepts encountered existing fill of Stratum A in Boring B-3. The existing fill consisted of lean clay (CL) and poorly graded sand (SP) and contained various amounts of sand and quartz fragments.

Stratum B1: Fine-Grained Terrace Alluvium

Below the ground cover and interlayered with the coarse-grained soils of Stratum B2, Borings 17BH-01 and 17BH-03 encountered the fine-grained alluvial soils of Stratum B1 to a depth of up to 5 ft below the existing ground surface. The stratum consisted of fine-grained soils identified as SANDY LEAN CLAY (CL) with varying amounts of gravel. The SPT N-values ranged from 6 to 13 (bpf) indicating firm to stiff consistencies.

Stratum B2: Coarse-Grained Terrace Alluvium

Below the ground cover and interlayered with the fine-grained soils of Stratum B1, Borings 17BH-01 and 17BH-03 encountered the coarse-grained alluvial soils of Stratum B2 to a depth of up to 28.7 ft below the existing ground surface. The stratum consisted of coarse-grained soils including POORLY GRADED SAND WITH SILT (SP-SM) and SILTY SAND (SM) with varying amounts of gravel and mica. The SPT N-values ranged from 6 to 20 blows per foot (bpf) indicating loose to medium dense relative densities.

Laboratory tests performed on three samples from this stratum yielded natural moisture contents of 7.2 to 10.1 percent. Index testing was performed on a single sample from this stratum and the results indicated the stratum is of low plasticity with non-plastic Liquid Limits and Plasticity Indices.

Stratum C1: Fine-Grained Potomac Formation

Below the Terrace Alluvium and interlayered with the coarse-grained soils of Stratum C2, all borings encountered the fine-grained alluvial soils of Stratum C1 to a depth of up to 90 ft below the existing ground surface. The stratum consisted of fine-grained soils identified as FAT CLAY (CH) and ELASTIC SILT (MH) with varying amounts of sand, gravel, mica, and lignite. The SPT N-values ranged from 11 to 62 (bpf) indicating stiff to very hard consistencies.

Laboratory tests performed on the samples from this stratum indicated that this stratum is generally of high plasticity with Liquid Limits of 57 and 71 and Plasticity Indices of 31 and 41. The natural moisture contents of nine samples tested ranged from 23.2 to 34.1 percent.

The results of the consolidated drained repeated direct shear tests and the consolidated drained direct shear tests performed on samples of this stratum are summarized in the table below.

Table 1: Summary of Stratum C1 Shear Strength Test Results

Boring ID	Sample ID	Sample Depth (ft)	Peak Shear Strength Parameters		Post-Peak (i.e. Residual) Shear Strength Parameters		Fully Softened Shear Strength Parameters	
			c'	**ϕ'**	c'	**ϕ'**	c'	**ϕ'**
17BH-02	ST-1	15	700	30.3	0	26.1	369	28.6
17BH-03	ST-1	30	769	30.3	0	15.0	312	33.5

Stratum C2: Coarse-Grained Potomac Formation

Below the Terrace Alluvium and interlayered with the fine-grained soils of Stratum C1, all borings encountered the coarse-grained Potomac Formation soils of Stratum C2 to a depth of up to 83.5 ft below the existing ground surface. The stratum consisted of CLAYEY SAND (SC) and SILTY SAND (SM) with varying amounts of gravel, mica, and lignite. The SPT N-values ranged from 23 to 51 blows per foot (bpf) indicating medium dense to very dense relative densities.

Laboratory tests performed on the samples from this stratum indicated that the fines portion of this stratum is generally of low to medium plasticity with Liquid Limits of Non-Plastic (NP) to 43 and Plasticity Indices of NP to 24. The natural moisture contents of eight samples tested ranged from 11.1 to 25.5 percent.

The results of the consolidated drained repeated direct shear tests and the consolidated drained direct shear tests performed on samples of this stratum are summarized in the table below.

Table 2: Summary of Stratum C2 Shear Strength Test Results

Boring ID	Sample ID	Sample Depth (ft)	Shear Strength Parameters	
			c'	**ϕ'**
17BH-02	ST-2	50	256	32.0

Groundwater

Groundwater level observations were made in the test borings during drilling operations and after completion of drilling. Groundwater was encountered in Boring 17BH-01 at a depth of 10 ft. Groundwater was not encountered in Borings 17BH-02 and 17BH-03 prior to the introduction of water from mud rotary and pitcher sampling techniques.

Our drilling subcontractor installed a water observation well in Boring 17BH-01. The groundwater level readings recorded approximately three days after drilling show the groundwater level fluctuating between depths of approximately 15 ft and 26 ft. We did not obtain long-term water level readings in the remaining borings since we backfilled them upon completion for safety.

The groundwater levels on the logs indicate our estimate of the hydrostatic water table at the time of our subsurface exploration. The final design should anticipate the fluctuation of the hydrostatic water table depending on variations in precipitation, surface runoff, pumping, evaporation, leaking utilities, stream levels, and similar factors.

Seismic Site Classification

We evaluated the Seismic Site Class and Seismic Site Coefficients for this project according to the International Building Code (IBC) Section 1615 (2012). Our analysis indicates Site Class D for this location. This Site Class was evaluated based on corrected SPT N-values. Based on S_S = 0.118 and S_1 = 0.051, we estimated a maximum site ground acceleration of 0.08 g.

GEOTECHNICAL RECOMMENDATIONS

We based our geotechnical engineering analysis on the information developed from our and Geoconcepts' subsurface exploration and soil laboratory testing, along with the site plans and project documents. The following sections of the report provide our detailed recommendations.

Existing Slope Stability

We evaluated two sections of the existing slope for stability. The approximate location of these sections are provided on Figure 3, included at the end of this report. The subsurface profiles for both sections were based upon the subsurface materials encountered in our borings. The geometry and soil profiles were evaluated utilizing SLOPE/W©, Version 2012 software. SLOPE/W© is a computer program for two-dimensional slope stability analyses developed by GEO-SLOPE International Ltd., that uses the limit equilibrium approach. Slope stability analyses were conducted analyzing a drained condition of the slope.

Based on the results of our subsurface exploration, the slope, which generally consists of Terrace Alluvium soils of Strata B1 and B2, is underlain by interlayered layers of Strata C1 and C2. In the Metropolitan DC area, the high plasticity soils of Stratum C1 are known to be highly over-consolidated, stiff-fissured, and are documented to have the potential for slickensides, slope stability issues, and sensitivity to moisture change. We considered the results of the residual laboratory shear testing we performed on the soils of Stratum C1 in our analysis. The table below summarizes the shear strength parameters which were utilized in the analyses.

Table 3: Summary of Soil Parameters for Existing Slope Stability Analyses

Soil type	Moist Unit Weight, γ (pcf)	Cohesion, c' (psf)	Angle of Internal Friction, ϕ' (degrees)
Terrace Alluvium (Stratum B2)	125	0	32
Fine-Grained Potomac Formation Soils (Stratum C1)	110	0	16
Coarse-Grained Potomac Formation Soils (Stratum C1)	110	0	32

The parameters in the table above are based on lab testing, correlations with SPT data from the borings, and our local experience with similar soils.

The results of the stability analyses indicate that the existing slope is unstable to marginally stable. Our analyses indicate that the northern portion of the slope with a slope angle as steep as 0.75 horizontal to 1 vertical (0.75H:1V), Section A-A' on Figure 3, has a factor of safety of less than 1.0 with a critical slip surface exiting through the slope face. We believe that failure is imminent or has already occurred at this location. Our analyses indicate that the southern portion of the slope with a slope angle averaging about 2H:1V but as steep as 1H:1V in some locations, Section B-B' on Figure 3, has a factor of safety of approximately 1.1 with a deeper-seated critical slip surface existing in front of the tow of the slope. The results of our stability analyses are summarized in the table below, and the output is included in Appendix D.

Table 4: Summary of Existing Slope Stability Analyses

Section Evaluated	Maximum Height of Slope, ft	Maximum Existing Slope Angle	Factor of Safety
A-A'	22	0.75H:1V	0.89
B-B'	42	1H:1V	1.11

Due to the instability of the existing slope, our recommended slope stabilization system is discussed below.

Slope Stabilization System

The slope stabilization system must consider the existing condition of the slope including site accessibility. This is particularly the case along the northern portion of the site where the existing retaining wall is showing noticeable amounts of movement at the toe, the existing slope is steeper than 1H:1V, and there is less than 3 ft of clearance between the building and the toe of the slope.

From a conceptual standpoint, we believe that a feasible slope stabilization system consists of a 2H:1V slope. In order to obtain a 2H:1V slope, we recommend the design and construction of a two-tier wall system consisting of an upper wall and lower wall. The upper wall would be located only on the northern portion of the existing slope crest due to the space limitations along the toe in this area. The lower wall would continue the entire length of the slope near the toe. The upper wall may consist of cantilevered, drilled soldier piles and timber lagging retaining soil up to 8 ft in height. The lower wall would consist of drilled soldier piles and timber lagging with a single level of tiebacks retaining soil up to 18 ft in height. Figures 4 and 5, included at the end of this report, show two cross-sections of the proposed slope stabilization system along different portions of the slope alignment. Note that typically, timber lagging has a design life of roughly 20 to 30 years. If a longer design life is necessary or long-term maintenance of the timber lagging is not preferred, pre-cast concrete lagging may be used as an alternative. The final grading would consist of a 2H:1V slope behind the lower wall and would be generally level between the toe of the lower wall and the existing building. We recommend that the retaining wall be designed with a subdrainage system so that it is not subjected to a hydrostatic pressure.

We anticipate that the northern portion of the upper wall would be constructed first. The lower wall would then be constructed to accommodate the grading and installation of the tiebacks. The constructed upper wall will provide the access to build a working platform for the northern portion of the lower wall construction.

The table below summarizes the shear strength parameters we recommend for the design of our recommended slope stabilization system. Note the recommended shear strength parameters for Stratum

C1 materials are based upon the fully-softened results of the direct shear testing performed on reconstituted samples of fine-grained Potomac Formation soils. The fully-softened results were considered because the portion of the proposed slope stabilization system will be constructed from the top-down, and tiebacks will be installed to limit movement of the retained soils. The anticipated movement of the soldier pile and lagging wall with tiebacks is much less than the strain required to engage residual shear strength parameters in the fine-grained Potomac Formation soils.

Table 5: Recommended Shear Strength Parameters for Slope Stabilization Design

Soil type	Moist Unit Weight, γ (pcf)	Cohesion, c' (psf)	Angle of Internal Friction, ϕ' (degrees)
Terrace Deposits (Stratum B2)	125	0	32
Fine-Grained Potomac Formation Soils (Stratum C1)	110	350	28
Coarse-Grained Potomac Formation Soils (Stratum C1)	110	0	32

The upper and lower-tier retaining walls should be designed to resist lateral earth pressures developed from the surrounding soil, backfill, and surcharge loads. Earth pressures should be calculated based on a moist unit weight of 120 pcf. Active and passive earth pressure coefficients should be used for site retaining wall design. The table below includes recommended earth pressure coefficients. The values in this table were developed assuming level conditions and backfill with a 2H:1V slope.

Table 6: Earth Pressure Coefficients

Backfill Slope or Toe Slope Conditions	Active Earth Pressure		Passive Earth Pressure	
	Static, K_a	Dynamic, ΔK_{ae}	Static, K_p	Dynamic, ΔK_{pe}
Level	0.31	0.02	3.26	-0.07
2H:1V	0.47	0.07	1.24	-0.10

Drainage should be provided behind soldier pile and lagging retaining walls to reduce the possibility of hydrostatic pressures acting on the walls. Either gaps in the lagging or installation of a drainage panel behind the retaining walls may be implemented. The earth pressure recommendations presented herein consider that any groundwater, surface infiltration, or perched groundwater occurring in the soils behind the walls is collected and disposed of.

In addition to lateral earth pressures from backfill and surrounding soils, site retaining walls should also be designed to resist surcharge loads within the area defined by a 45-degree slope from the bottom of the walls. Lateral earth pressures from surcharge loads can be estimated with a uniform lateral pressure equal to the lateral earth pressure coefficient times the vertical surcharge pressure. Backfill placed adjacent to walls should meet the specification and compaction requirements for compacted fill.

Specific details regarding the design and construction of the retaining walls must be provided by a Professional Engineer registered in the Commonwealth of Virginia.

Temporary and Permanent Slopes

We expect that temporary slopes will be utilized to accommodate construction of the new retaining walls. We recommend temporary excavation slopes be constructed in accordance with OSHA guidelines as a function of the material type(s) observed during excavation; however we generally expect that temporary slopes may be graded to 1H:1V.

We recommend that permanent slopes constructed above the top of the lower-tier retaining wall be graded to 2H:1V.

Site Grading and Earthwork

We anticipate that construction of the new retaining walls will require earthwork in the form of cuts and fills to reach finished grades. Please note that final grading should be determined during the design of the slope stabilization system design. Recommendations for compacted fill subgrade preparation and compacted fill and backfill placement are presented in subsequent subsections.

Compacted Fill Subgrades

Subgrades to receive compacted structural fill should be stripped of debris, vegetation, topsoil, and organic matter and should be free of snow, ice, and frozen soils. If snow, ice, or frozen soils are present at subgrade levels, these materials should be removed as recommended by the Geotechnical Engineer. Fill subgrades should consist of suitable soils as detailed herein.

Very loose or soft near-surface soils are not considered suitable for support of new compacted fill. If these soils are encountered, they should be excavated from beneath areas to receive fill. Removal of unsuitable soils near the edge of fill embankments should extend at least ½H horizontally beyond the limits of fill, where H is the depth of undercut below fill subgrade level.

Evaluation of the fill subgrades should be performed under the observation of the Geotechnical Engineer.

Subgrade evaluation techniques could include a combination of probing with a penetrometer, drilling hand augers, or observing test pits. The fill subgrades should provide sufficient stability to allow placement of subsequent lifts and compaction of fill to the specified density. Areas that do not provide sufficient stability to allow placement of fill should initially be scarified, dried/wetted, and recompacted or undercut.

Construction traffic on stripped or undercut subgrades should be limited to reduce disturbance of underlying soil. Maintaining positive drainage and sealing of subgrades with a smooth drum roller should be performed to maintain subgrades free of water and to minimize disturbance of the subgrade soils before placing fill materials.

Some existing utilities may be present on the project site. Existing utilities will need to be removed before earthwork construction.

Compacted structural fill subgrades should not be steeper than about 4H:1V. If steeper slopes are present, subgrades should be benched to permit placement of horizontal lifts of fill.

Compacted Fill

Compacted structural fill and backfill should consist of non-organic soils classifying as SC, SM, SP, SW, GC, GM, GP, or GW according to ASTM D2487. Fill and backfill materials should not contain particles larger than half of the lift thickness. Backfill materials placed behind the new retaining walls may also consist of open-graded crushed stone such as VDOT (AASHTO M43) No. 78 or No. 57 stone.

Compacted structural fill should be placed in maximum 8-inch thick horizontal, loose lifts when compacted with a roller. Fill should be compacted to at least 95 percent of the maximum dry density per ASTM D698 (standard Proctor). Soil moisture contents at the time of compaction should be within 20 percent of the soils' optimum moisture content. In other words, if the optimum moisture content for compaction is 20 percent, adequate compaction can usually be achieved when the moisture content of the fill material is between 16 and 24 percent

Backfill placed in excavations, trenches, and other areas that large compaction equipment cannot access should be placed in maximum 6-inch thick lifts. Backfill should meet the material, placement, and compaction requirements outlined above.

Based on the soil laboratory test data performed to date, the coarse-grained soils of Strata B2 and C2 are generally expected to be suitable for reuse as compacted fill and backfill, but careful screening during excavation operations will be necessary to separate suitable soils from unsuitable soils. The fine-grained soils of Strata B1 and C1 will not be suitable for reuse. Successful re-use of the excavated, on-site soils meeting the classification requirements outlined above as compacted structural fill and backfill will depend on their natural moisture contents during excavation. Scarifying and drying of these soils may be necessary to achieve the recommended compaction. Drying of these soils will likely result in some delays, and may not be possible during cooler, wetter weather. We recommend the earthwork be performed during the warmer, drier times of the year.

CONSTRUCTION CONSIDERATIONS

Site Grading and Earthwork

The on-site soils are susceptible to moisture changes, will be easily disturbed, and will be difficult to compact under wet weather conditions. Drying and reworking of the soils are likely to be difficult during periods of wet months. We recommend that, if possible, earthwork be performed during the warmer, drier times of the year to limit the potential for disturbance of on-site soils.

Traffic on stripped or undercut subgrades should be limited to reduce disturbance of underlying soils. Also, using lightweight and/or track-mounted equipment for stripping will limit the disturbance of underlying soils, and may reduce the undercut volume needed. The Contractor should provide site drainage to maintain subgrades free of water and to avoid saturation and disturbance of the subgrade soils before placing compacted structural fill. This site drainage will be important during all phases of the construction work. The Contractor should be responsible for reworking of subgrades and compacted structural fill that were initially considered suitable but were later disturbed by equipment and/or weather.

Engineering Services During Construction

The engineering recommendations provided in this report are based on the information obtained from the subsurface exploration and laboratory testing. However, conditions on the site may vary between the discrete locations observed at the time of our subsurface exploration. The nature and extent of variations between borings may not become evident until during construction.

To account for this variability, we should provide professional observation and testing of subsurface conditions revealed during construction as an extension of our engineering services. These services will also help in evaluating the contractor's conformance with the plans and specifications in accordance with building code requirements. Because of our unique position to understand the intent of the geotechnical engineering recommendations and future geostructural design, retaining Schnabel for these services will allow the owner to receive consistent service throughout the project construction.

General Specification Recommendations

An allowance should be established to account for possible additional costs that may be required to construct earthwork as recommended in this report and slope stabilization system design to be performed at a later date. Additional costs may be incurred for a variety of reasons including variation of soil between soil borings, greater than anticipated unsuitable and/or existing fill soils, wet on-site soils, obstructions (e.g., boulders, concrete, construction debris, etc.), perched water conditions, etc.

The project specifications should indicate the Contractor's responsibility for providing adequate site drainage during construction. Inadequate drainage will most likely lead to disturbance of soils by construction traffic/operations and increased volume of undercut.

This report may be made available to prospective bidders for informational purposes only. We recommend that the project specifications contain the following statement:

> *Schnabel Engineering, LLC has prepared this geotechnical engineering report for this project. This report is for informational purposes only and is not part of the contract documents. The opinions expressed represent the Geotechnical Engineer's interpretation of the subsurface conditions, tests, and the results of analyses conducted. Should the data contained in this report not be adequate for the Contractor's purposes, the Contractor may make, before bidding, independent exploration, tests and analyses. This report may be examined by bidders at the office of the Owner, or copies may be obtained from the Owner at nominal charge.*

Additional data and reports prepared by others that could have an impact upon the Contractor's bid should also be made available to prospective bidders for informational purposes.

LIMITATIONS

We based the analyses and recommendations submitted in this report on the information revealed by our exploration and the previous exploration by Geoconcepts. We attempted to provide for normal contingencies, but the possibility remains that unexpected conditions may be encountered during construction.

This report has been prepared to aid in the evaluation of this site and to assist in the design of the project. It is intended for use concerning this specific project. We based our recommendations on information on the site and proposed construction as described in this report. Substantial changes in loads, locations, or grades should be brought to our attention so we can modify our recommendations as needed. We would appreciate an opportunity to review the plans and specifications as they pertain to the recommendations contained in this report, and to submit our comments to you based on this review.

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or other instrument of service.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING, LLC

COMMONWEALTH OF VIRGINIA
EVAN M RUGGLES
Lic. No. 0402053792
PROFESSIONAL ENGINEER

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GAB:EMR:JLM:sam
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Figures
Appendix A: Subsurface Exploration Data
Appendix B: GeoConcepts Subsurface Exploration Data
Appendix C: Soil Laboratory Test Data
Appendix D: GeoConcepts Soil Laboratory Test Data
Appendix E: Slope Stability Analyses

FIGURES

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community
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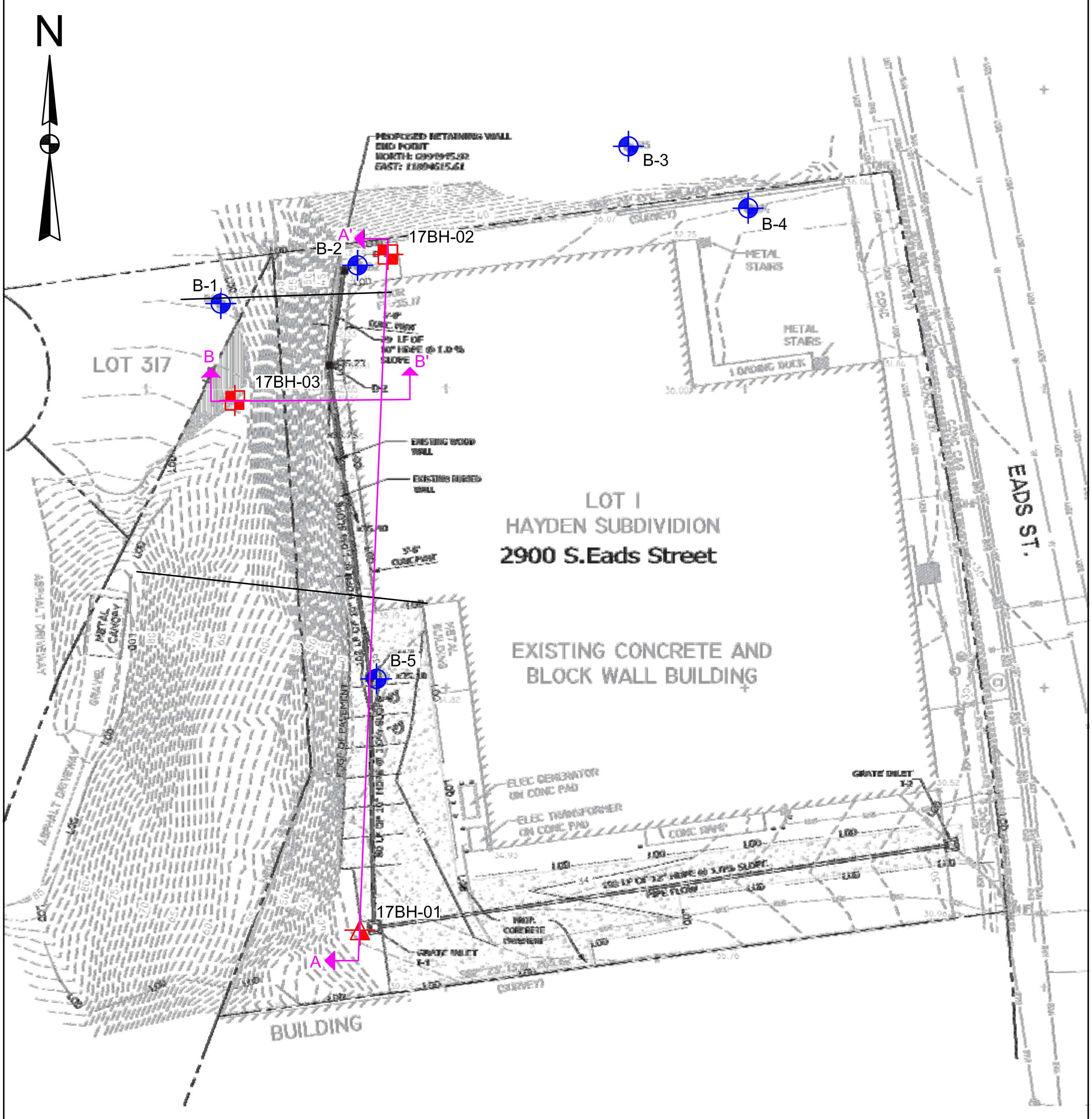
NOT TO SCALE

Schnabel ENGINEERING	2900 SOUTH EADS RETAINING WALL REPLACEMENT ARLINGTON, VA PROJECT NO. 17C12005	SITE VICINITY MAP FIGURE 1

arcgis

3/16/2017 This Map was Created In Schnabel Engineerings Site Vicinity Map Application



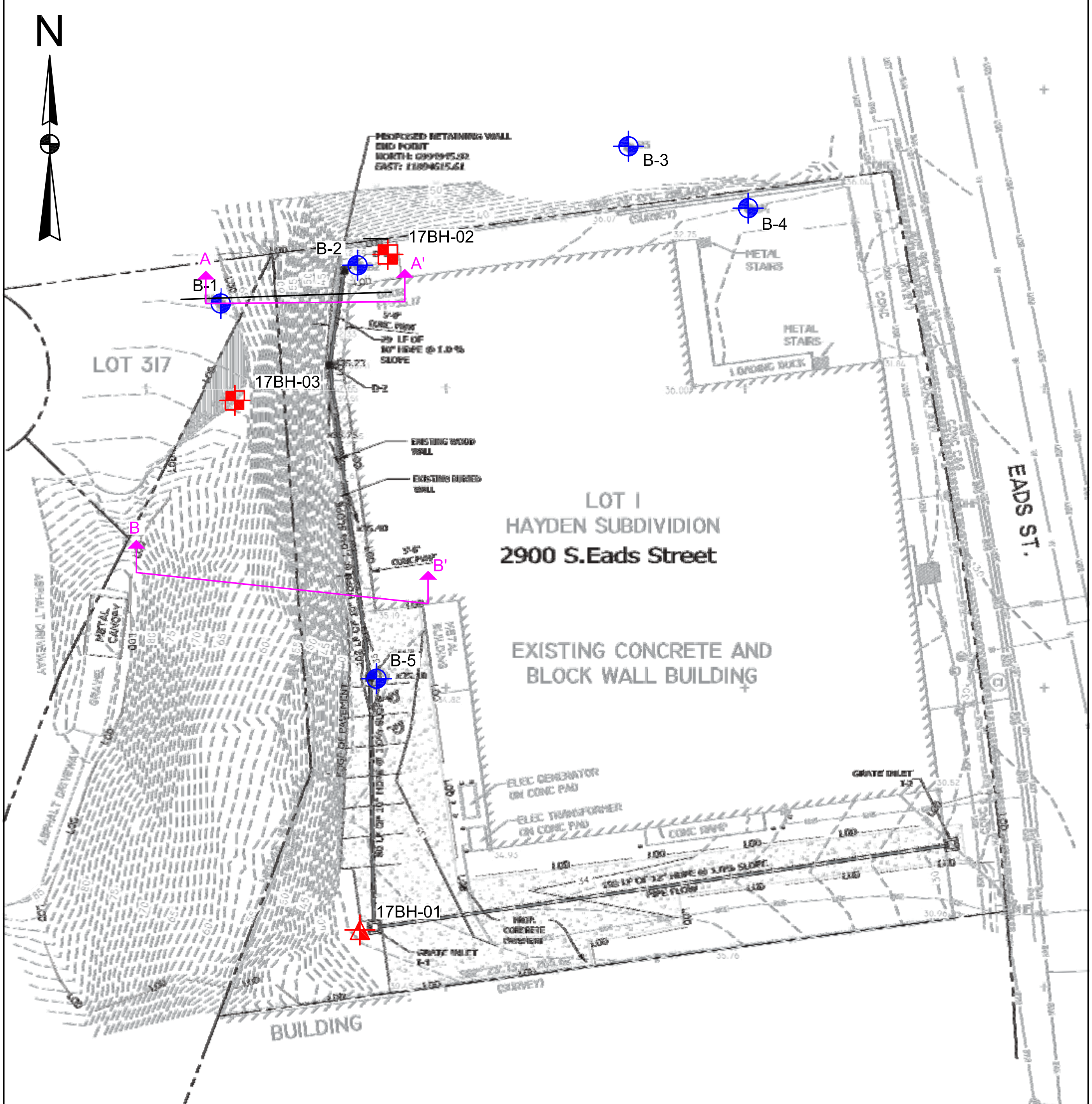
LEGEND

- PREVIOUS GEOCONCEPTS BORING LOCATION
- SUBSURFACE PROFILES
- 2017 SCHNABEL BORING LOCATION
- 2017 SCHNABEL BORING LOCATION AND GROUNDWATER MONITORING WELL LOCATION

SCALE: 1"=50'

0 50' 100'

Schnabel ENGINEERING	2900 SOUTH EADS RETAINING WALL REPLACEMENT ARLINGTON, VIRGINIA PROJECT NO. 17C12005	BORING LOCATION PLAN FIGURE 2



LEGEND

- PREVIOUS GEOCONCEPTS BORING LOCATION
- CONCEPTUAL SKETCHES PROFILE LINES
- 2017 SCHNABEL BORING LOCATION
- 2017 SCHNABEL BORING LOCATION AND GROUNDWATER MONITORING WELL LOCATION

SCALE: 1"=50'

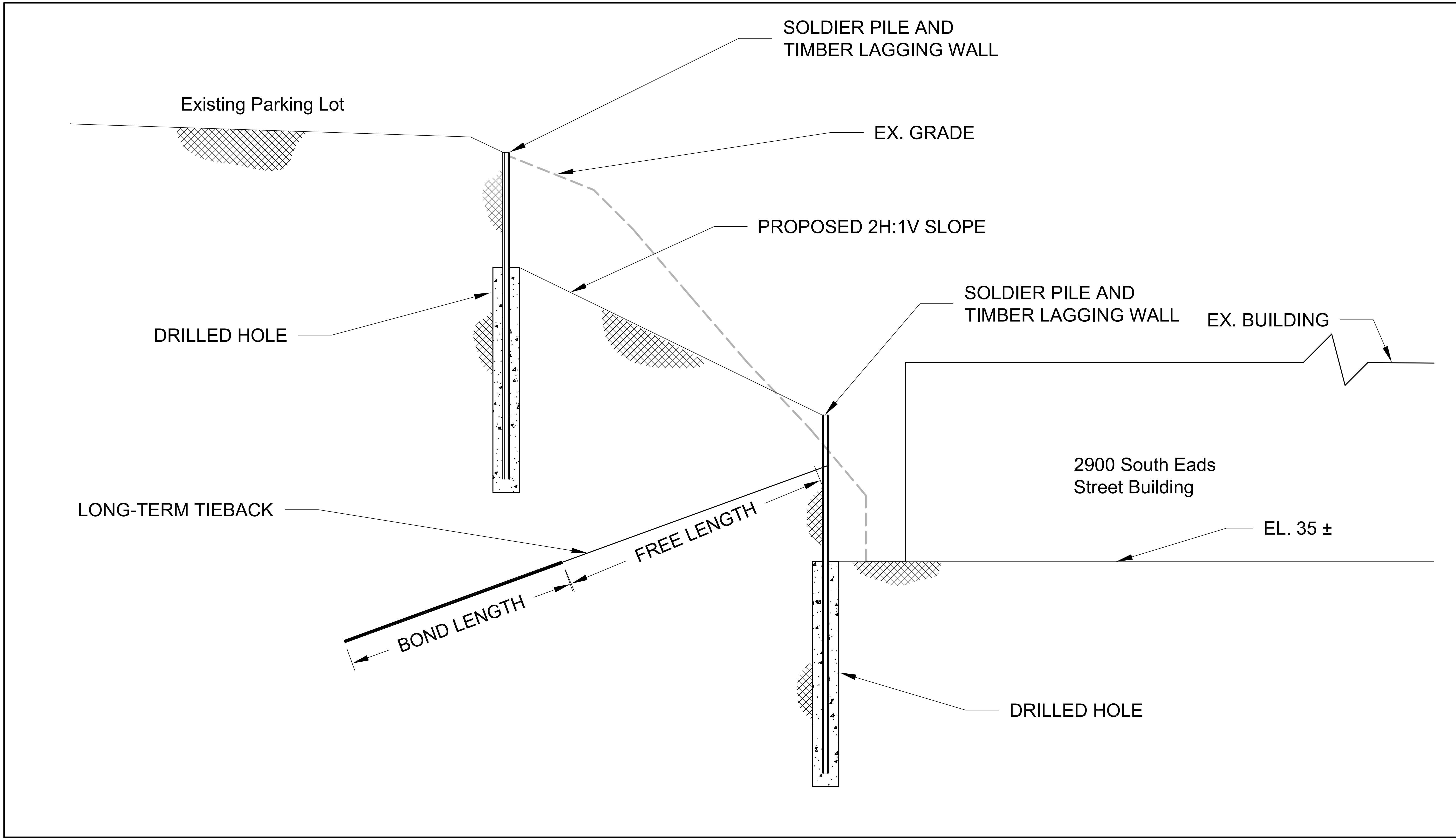
0 50' 100'

Schnabel ENGINEERING

2900 SOUTH EADS RETAINING WALL REPLACEMENT
ARLINGTON, VIRGINIA
PROJECT NO. 17C12005

RECOMMENDED SLOPE STABILIZATION SYSTEM CONCEPTUAL SKETCHES PLAN

FIGURE 3

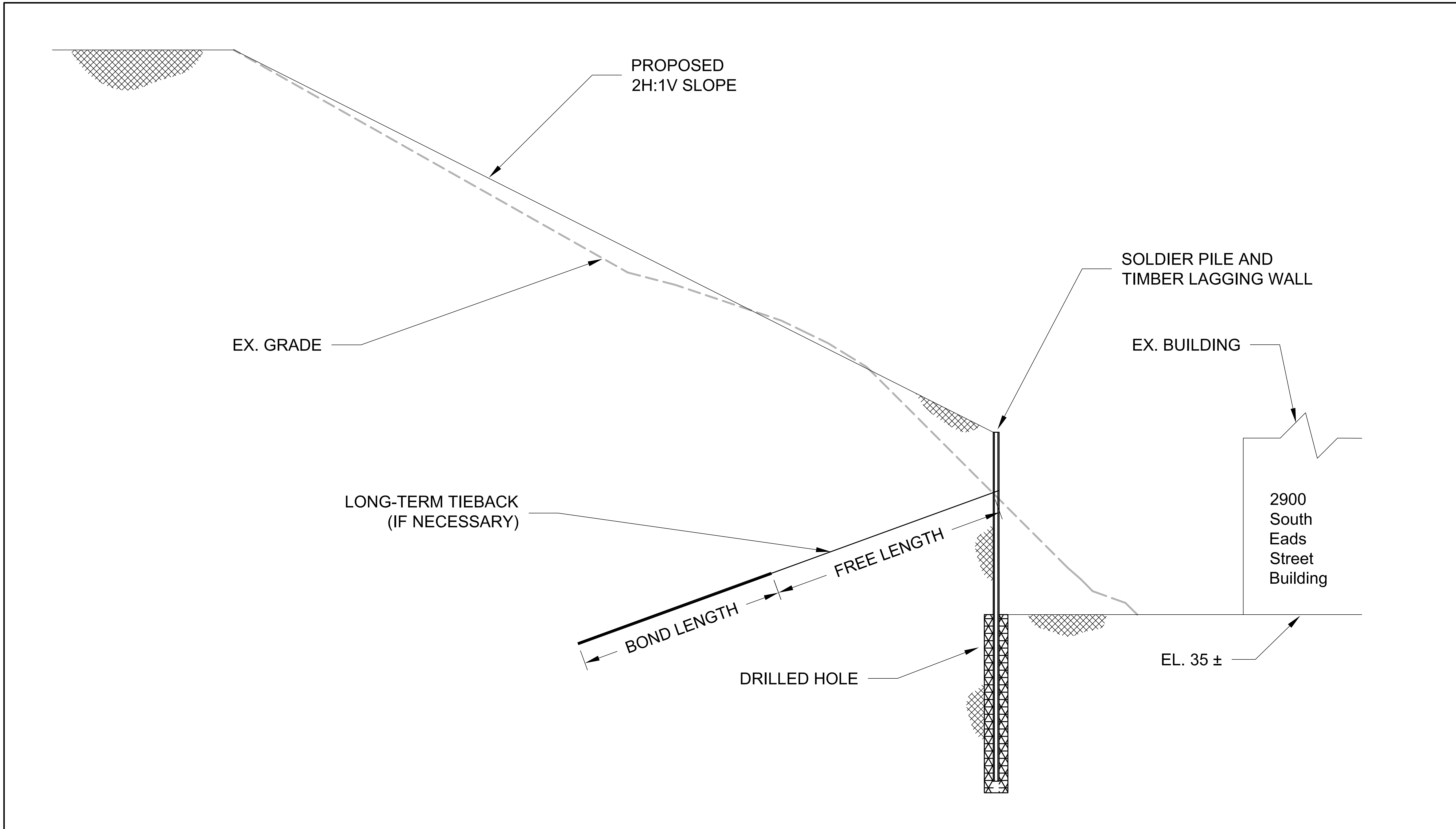


Schnabel ENGINEERING

2900 SOUTH EADS RETAINING WALL REPLACEMENT
ARLINGTON, VIRGINIA
PROJECT NO. 17C12005

RECOMMENDED SLOPE STABILIZATION SYSTEM
CONCEPTUAL SKETCHES
SECTION A-A'

Figure 4



Schnabel ENGINEERING	2900 SOUTH EADS RETAINING WALL REPLACEMENT ARLINGTON, VIRGINIA PROJECT NO. 17C12005	RECOMMENDED SLOPE STABILIZATION SYSTEM CONCEPTUAL SKETCHES SECTION B-B'

Figure 5

APPENDIX A

SUBSURFACE EXPLORATION DATA

SUBSURFACE EXPLORATION PROCEDURES

Test Borings – Hollow Stem Augers

The borings are advanced by turning a continuous flight auger with a center opening of 2¼ or 3¼ 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.

Test Borings – Mud Rotary

Drillers advanced the borings using mud rotary drilling techniques. The boring is advanced with a drill string consisting of a 3⅞-inch diameter tri-cone roller bit attached to A-sized drilled rods. Bentonite drilling fluid is pumped through the drill rods to flush cuttings to the surface. The borehole remains full of drilling fluid to maintain the sides of the borehole. At the designated depth, the drillers removed the drill string and performed the Standard Penetration Test (SPT). Water level data is indicated on the logs.

Standard Penetration Test Results

The numbers in the Sampling Data column of the boring logs represent Standard Penetration Test (SPT) results. Each number represents the blows needed to drive a 2-inch O.D., 1⅜-inch I.D. split-spoon sampler 6 inches, using a 140-pound hammer falling 30 inches. The sampler is typically driven a total of 18 or 24 inches. The first 6 inches are considered a seating interval. The total of the number of blows for the second and third 6-inch intervals is the SPT "N value." The SPT is performed according to ASTM D1586.

Soil Classification Criteria

The group symbols on the logs represent the Unified Soil Classification System Group Symbols (ASTM D2487) based on visual observation and limited laboratory testing of the samples. Criteria for visual identification of soil samples are included in this appendix. Some variation can be expected between samples visually classified and samples classified in the laboratory.

Pocket Penetrometer Results

The values following "PP=" in the sampling data column of the logs represent pocket penetrometer readings. Pocket penetrometer readings provide an estimate of the unconfined compressive strength of fine-grained soils.

Water Observation Wells

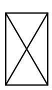
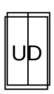
A temporary water observation well was installed in Boring 17BH-01 by inserting a hand-slotted, 1¼-inch PVC pipe in the boring. The pipe was capped and the area surrounding the pipe was backfilled with cuttings from the boring.

Boring Locations and Elevations

Borings were located by taping off distances from existing features depicted on existing topographic site plans. Approximate boring locations are shown on Figure 2. Locations and elevations should be considered no more accurate than the methods used to determine them

GENERAL NOTES FOR SUBSURFACE EXPLORATION LOGS

1. Numbers in sampling data column next to Standard Penetration Test (SPT) symbols indicate blows required to drive a 2-inch O.D., 1⅜-inch I.D. sampling spoon 6 inches using a 140 pound hammer falling 30 inches. The Standard Penetration Test (SPT) N value is the number of blows required to drive the sampler 12 inches, after a 6 inch seating interval. The Standard Penetration Test is performed in general accordance with ASTM D1586.
2. Visual classification of soil is in accordance with terminology set forth in "Identification of Soil." The ASTM D2487 group symbols (e.g., CL) shown in the classification column are based on visual observations.
3. Estimated water levels indicated on the logs are only estimates from available data and may vary with precipitation, porosity of the soil, site topography, and other factors.
4. Refusal at the surface of rock, boulder, or other obstruction is defined as an SPT resistance of 50 blows for 1 inch or less of penetration.
5. The logs and related information depict subsurface conditions only at the specific locations and at the particular time when drilled or excavated. Soil conditions at other locations may differ from conditions occurring at these locations. Also, the passage of time may result in a change in the subsurface soil and water level conditions at the subsurface exploration location.
6. The stratification lines represent the approximate boundary between soil and rock types as obtained from the subsurface exploration. Some variation may also be expected vertically between samples taken. The soil profile, water level observations and penetration resistances presented on these 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. Key to symbols and abbreviations:

	S-1, SPT 5+10+1	Sample No., Standard Penetration Test Number of blows in each 6-inch increment
	PB-1, PB Rec=24", 100%	Sample No., 3" Pitcher Barrel Sample Recovery in inches, Percent Recovery

LL	Liquid Limit
MC	Moisture Content (percent)
PL	Plastic Limit
PP	Pocket Penetrometer Reading (tsf)
%Passing#200	Percent by weight passing a No. 200 Sieve

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	Gravels – More than 50% of coarse fraction retained on No. 4 sieve Coarse, ¾” to 3” Fine, No. 4 to ¾”	Clean Gravels Less than 5% fines	GW	WELL GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		Gravels with fines More than 12% fines	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	Sands – 50% or more of coarse Fraction passes No. 4 sieve Coarse, No. 10 to No. 4 Medium, No. 40 to No. 10 Fine, No. 200 to No. 40	Clean Sands Less than 5% fines	SW	WELL GRADED SAND
			SP	POORLY GRADED SAND
		Sands with fines More than 12% fines	SM	SILTY SAND
			SC	CLAYEY SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays – Liquid Limit less than 50 Low to medium plasticity	Inorganic	CL	LEAN CLAY
			ML	SILT
		Organic	OL	ORGANIC CLAY
				ORGANIC SILT
	Silts and Clays – Liquid Limit 50 or more Medium to high plasticity	Inorganic	CH	FAT CLAY
			MH	ELASTIC SILT
		Organic	OH	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color and organic odor		PT	PEAT

II. DEFINITION OF SOIL COMPONENT PROPORTIONS (ASTM D2487)

			Examples
Adjective Form	GRAVELLY SANDY	>30% to <50% coarse grained component in a fine-grained soil	GRAVELLY LEAN CLAY
	CLAYEY SILTY	>12% to <50% fine grained component in a coarse-grained soil	SILTY SAND
“With”	WITH GRAVEL WITH SAND	>15% to <30% coarse grained component in a fine-grained soil	FAT CLAY WITH GRAVEL
	WITH GRAVEL WITH SAND	>15% to <50% coarse grained component in a coarse-grained soil	POORLY GRADED GRAVEL WITH SAND
	WITH SILT WITH CLAY	>5% to <12% fine grained component in a coarse-grained soil	POORLY GRADED SAND WITH SILT

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS .... Unified Soil Classification Symbols are shown above as group symbols. A dual symbol “-“ indicates the soil belongs to two groups. A borderline symbol “/” indicates the soil belongs to two possible groups.

FILL .... Man-made deposit containing soil, rock and often foreign matter.

PROBABLE FILL .... Soils which contain no visually detected foreign matter but which are suspect with regard to origin.

DISINTEGRATED ROCK (DR) .... Residual materials with a standard penetration resistance (SPT) between 60 blows per foot and refusal. Refusal is defined as an SPT of 100 blows for 2" or less penetration.

PARTIALLY WEATHERED ROCK (PWR)......................... Residual materials with a standard penetration resistance (SPT) between 100 blows per foot and refusal. Refusal is defined as an SPT of 100 blows for 2" or less penetration.

BOULDERS & COBBLES..... Boulders are considered rounded pieces of rock larger than 12 inches, while cobbles range from 3 to 12-inch size.

LENSES................................. 0 to ½-inch seam within a material in a test pit.

LAYERS .... ½ to 12-inch seam within a material in a test pit.

POCKET .... Discontinuous body within a material in a test pit.

MOISTURE CONDITIONS..... Wet, moist or dry to indicate visual appearance of specimen.

COLOR .... Overall color, with modifiers such as light to dark or variation in coloration.

Schnabel ENGINEERING **TEST BORING LOG**

Project: 2900 South Eads Street Retaining Wall
Arlington, VA

Boring Number: 17BH-01
Contract Number: 17C12005
Sheet: 1 of 2

Contractor: Connelly and Associates, Inc.
Frederick, Maryland

Contractor Foreman: C. Wolfe

Schnabel Representative: A. Bowers

Equipment: CME 550 ATV

Method: 3-1/4" I.D. Hollow Stem Auger

Hammer Type: Auto Hammer (140 lb)

Dates Started: 2/20/17 **Finished:** 2/21/17

Location: See Location Plan

Ground Surface Elevation: 36± (ft) **Total Depth:** 70.0 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	2/20	8:55 AM	10.0'	---	---
After Drilling ▽	2/21	3:00 PM	29.7'	---	---
Observation Well ▼	2/22	7:25 AM	14.9'	---	---
Observation Well ▼	2/23	8:50 AM	23.3'	---	---
Observation Well ▼	2/23	1:30 PM	24.2'	---	---
Observation Well ▼	2/24	12:15 PM	26.3'	---	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
1.3	0.0 - 1.3 ft: SANDY LEAN CLAY; moist, light brown and brown	CL	34.7	B1		SPT-1, SS 2+2+4 REC=18", 100%	PP = 3.75 tsf	
	1.3 - 8.5 ft: POORLY GRADED SAND WITH SILT; moist, light gray	SP-SM		B2		SPT-2, SS 3+7+7 REC=18", 100%	MC = 8.0%	
					5	SPT-3, SS 4+4+6 REC=14", 78%		
8.5	8.5 - 19.1 ft: FAT CLAY; moist, light gray and reddish brown, contains lignite, estimated <5% fine to coarse grained sand ▽	CH	27.5	C1	10	SPT-4, SS 3+4+7 REC=18", 100%	LL = 65 PI = 34 MC = 29.5% % Passing #200 = 97.3 PP = 4.25 tsf	
	14.0 ft: Change: reddish brown, contains quartz fragments				15	SPT-5, SS 11+9+18 REC=14", 78%	PP = 4.25 tsf	13.5 - 14.0 ft: Sand lense consisting of Poorly Graded Sand with Silt (SP-SM) and Gravel containing quartz fragments
19.1	18.5 ft: Change: no quartz fragments		16.9					
	19.1 - 48.5 ft: SILTY SAND; moist, light gray, contains mica	SM		C2	20	SPT-6, SS 10+18+13 REC=18", 100%	MC = 28.4% PP = 4.50 tsf	
	24.8 ft: Change: light brown and whitish brown ▼				25	SPT-7, SS 10+11+20 REC=18", 100%	PP = 4.25 tsf	24.0 - 24.5 ft: Lense of Fat Clay with Sand (CH), fine grained sand, reddish brown and light brown
	28.5 ft: Change: light gray and yellowish brown ▽				30	SPT-8, SS 7+12+11 REC=18", 100%	LL = 38 PI = 11 MC = 25.5% % Passing #200 = 32.0	
	33.5 ft: Change: light gray with streaks of yellowish brown				35	SPT-9, SS 10+15+18 REC=18", 100%		
	38.5 ft: Change: light gray with streaks of reddish brown					SPT-10, SS 11+17+24	MC = 21.1%	

(continued)

Schnabel ENGINEERING TEST BORING LOG	Project: 2900 South Eads Street Retaining Wall Arlington, VA	Boring Number: 17BH-01 Contract Number: 17C12005 Sheet: 2 of 2

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
		SM		C2		REC=18", 100%		
					45	SPT-11, SS 5+10+15 REC=18", 100%		
48.5	48.5 - 58.5 ft: FAT CLAY; moist, gray, estimated 5 - 10% fine to coarse grained sand, contains mica	CH	-12.5		50	SPT-12, SS 10+15+18 REC=18", 100%	MC = 26.1% PP = 4.50 tsf	
	53.5 ft: Change: bluish gray with streaks of reddish brown, estimated <5% fine grained sand				55	SPT-13, SS 5+12+19 REC=18", 100%	PP >4.50 tsf	
58.5	58.5 - 70.0 ft: ELASTIC SILT; moist, gray and reddish brown, estimated <5% fine grained sand	MH	-22.5	C1	60	SPT-14, SS 7+14+23 REC=18", 100%	LL = 71 PI = 35 MC = 27.0% % Passing #200 = 98.3 PP >4.50 tsf	
	63.5 ft: Change: bluish gray and reddish brown				65	SPT-15, SS 12+16+25 REC=18", 100%	PP >4.50 tsf	
70.0			-34.0		70	SPT-16, SS 14+28+30 REC=18", 100%	MC = 24.2% PP >4.50 tsf	

Bottom of Boring at 70.0 ft.
1.25" permanent water observation well installed upon completion.

Schnabel ENGINEERING — TEST BORING LOG	Project: 2900 South Eads Street Retaining Wall, Arlington, VA	Boring Number: 17BH-02
		Contract Number: 17C12005
		Sheet: 1 of 2

Contractor: Connelly and Associates, Inc.
Frederick, Maryland

Contractor Foreman: C. Wolfe

Schnabel Representative: A. Bowers

Equipment: CME 550 ATV

Method: 3-1/4" I.D. Hollow Stem Auger and Mud Rotary

Hammer Type: Auto Hammer (140 lb)

Dates Started: 2/21/17 **Finished:** 2/22/17

Location: See Location Plan

Ground Surface Elevation: 35± (ft) **Total Depth:** 70.5 ft

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	2/21	11:31 AM	Dry	15.0'	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.5	0.0 - 0.5 ft: Topsoil		34.5					
1.0	0.5 - 1.0 ft: Concrete		34.0			SPT-1, SS 6+7+9 REC=18", 100%		
2.5	1.0 - 2.5 ft: SILTY SAND; moist, bluish gray and reddish brown, contains mica	SC	32.5	C2		SPT-2, SS 8+9+11 REC=18", 100%	MC = 34.1% PP = 3.75 tsf	
13.8	2.5 - 13.8 ft: FAT CLAY WITH SAND; moist, gray with streaks of reddish brown	CH	21.2	C1	5	SPT-3, SS 5+8+10 REC=18", 100%	PP = 3.75 tsf	
					10	SPT-4, SS 8+11+13 REC=18", 100%	MC = 23.2% PP = 4.25 tsf	
						SPT-5, SS 7+12+18 REC=18", 100%	PP = 4.25 tsf	
18.5	13.8 - 18.5 ft: FAT CLAY; moist, gray	CH	16.5		15	PB-1, UNDIST REC=30", 83%	PP >4.50 tsf LL = 59 PI = 31 MC = 26.0% % Passing #200 = 93.3	
38.5	18.5 - 38.5 ft: CLAYEY SAND; moist, light gray, contains mica	SC	-3.5	C2	20	SPT-6, SS 7+12+15 REC=18", 100%		
	23.5 ft: Change: light gray with streaks of yellowish brown				25	SPT-7, SS 11+16+19 REC=18", 100%		
	28.5 ft: Change: with speckles of black, contains lignite				30	SPT-8, SS 12+14+19 REC=18", 100%	LL = 43 PI = 21 MC = 22.5% % Passing #200 = 20.8	
	33.5 ft: Change: gray with streaks of reddish brown				35	SPT-9, SS 10+15+19 REC=18", 100%		35.0 ft: - Stopped at 35 ft because ran out of mud
	38.5 - 43.5 ft: CLAYEY SAND WITH GRAVEL; rounded, fine to medium	SC				SPT-10, SS 16+22+29	MC = 16.1%	

(continued)

Schnabel Engineering TEST BORING LOG	Project: 2900 South Eads Street Retaining Wall, Arlington, VA	Boring Number: 17BH-02
		Contract Number: 17C12005
		Sheet: 2 of 2

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	gravel; moist, gray with mottles of black	SC		C2		REC=18", 100%		
43.5	43.5 - 48.5 ft: FAT CLAY WITH SAND; moist, gray and reddish brown, contains mica	CH	-8.5		45	SPT-11, SS 11+19+26 REC=18", 100%	PP >4.50 tsf	
48.5	48.5 - 53.5 ft: SANDY FAT CLAY; moist, bluish gray and reddish brown, contains mica 50.0 ft: Change: bluish gray with mottles of reddish brown	CH	-13.5	C1	50	SPT-12, SS 11+15+19 REC=18", 100% PB-2, UNDIST REC=16", 67%	LL = 42 PI = 2. MC = 24.0% % Passing #200 = 45.8	50.0 ft: - Top of sample classified as Clayey Gravel with Sand (GC). Following cutting and trimming of sample, most of the recovered sample appeared to be Sandy Fat Clay (CH)
53.5	53.5 - 63.5 ft: CLAYEY SAND; moist, bluish gray, contains mica 58.5 ft:	SC	-18.5	C2	55 60	SPT-13, SS 12+19+27 REC=18", 100% SPT-14, SS 11+15+24 REC=18", 100%		
63.5	63.5 - 70.5 ft: FAT CLAY WITH SAND; moist, bluish gray with mottles of reddish brown, contains mica 69.0 ft: Change: gray with mottles of reddish brown	CH	-28.5	C1	65 70	SPT-15, SS 13+24+35 REC=18", 100% PB-3, UNDIST REC=20", 56% SPT-16, SS 13+18+21 REC=18", 100%	PP >4.50 tsf PP >4.50 tsf PP >4.50 tsf	
70.5			-35.5					

Bottom of Boring at 70.5 ft.
Boring backfilled with cuttings upon completion.

Schnabel ENGINEERING TEST BORING LOG	Project: 2900 South Eads Street Retaining Wall Arlington, VA	Boring Number: 17BH-03 Contract Number: 17C12005 Sheet: 1 of 2

Contractor: Connelly and Associates, Inc. Frederick, Maryland
Contractor Foreman: C. Wolfe
Schnabel Representative: A. Bowers
Equipment: CME 550 ATV
Method: 3-1/4" I.D. Hollow Stem Auger and Mud Rotary

Hammer Type: Auto Hammer (140 lb)
Dates Started: 2/23/17 **Finished:** 2/24/17
Location: See Location Plan

Ground Surface Elevation: 69± (ft) **Total Depth:** 90.0 ft

Groundwater Observations

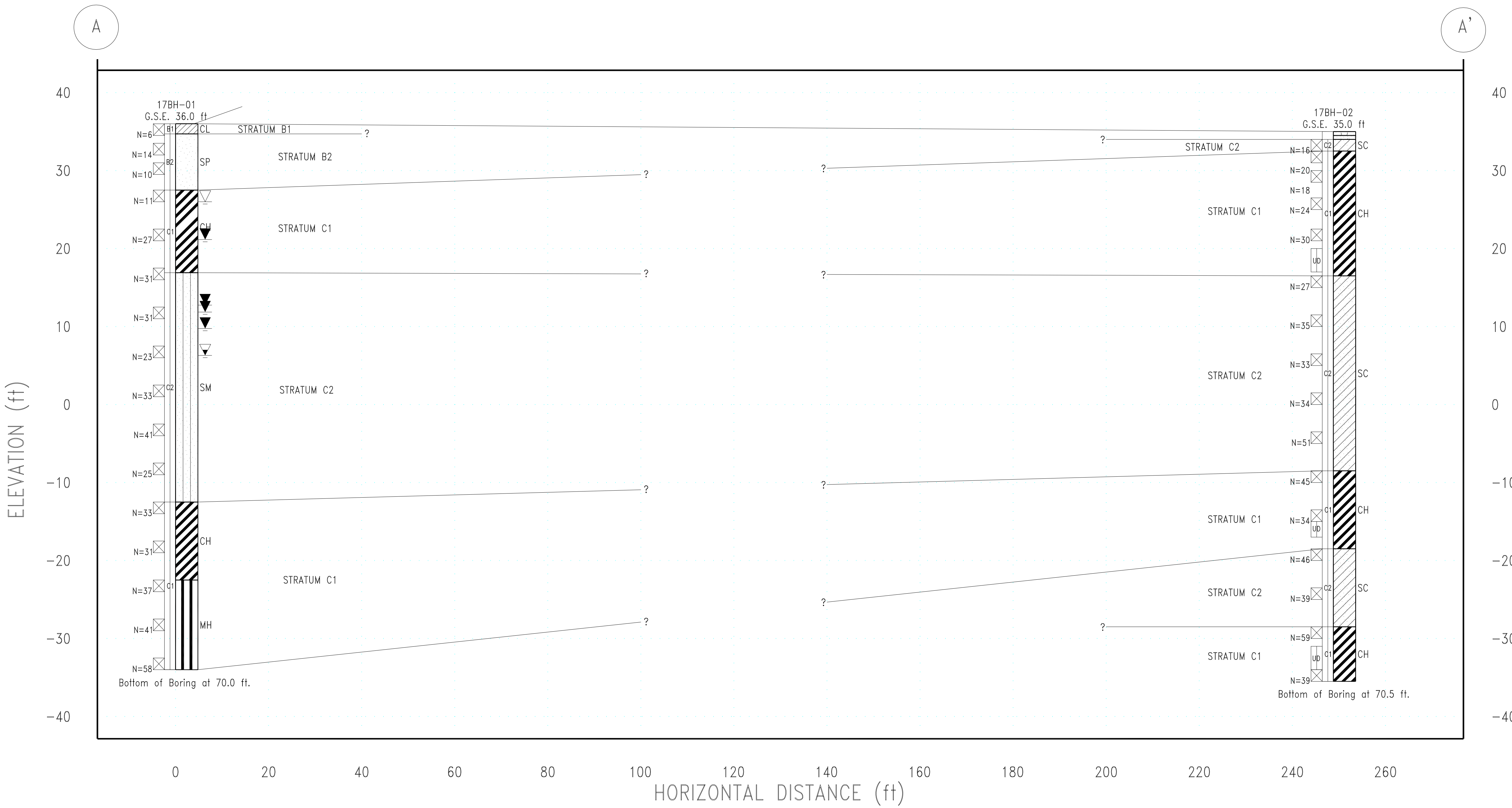
	Date	Time	Depth	Casing	Caved
Encountered ▽	2/23	1:17 PM	Dry	30.0'	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.3	0.0 - 0.3 ft: Topsoil		68.7			SPT-1, SS 1+2+4 REC=11", 61%		
2.5	0.3 - 2.5 ft: SILTY SAND WITH GRAVEL; rounded, fine gravel; moist, light brown	SM	66.5	B2				
5.0	2.5 - 5.0 ft: SANDY LEAN CLAY; moist, brown, contains roots, estimated <5% gravel	CL	64.0	B1		SPT-2, SS 3+3+10 REC=16", 89%		
	5.0 - 28.7 ft: SILTY SAND WITH GRAVEL; angular, fine to medium gravel; moist, brown and white				5	SPT-3, SS 10+9+7 REC=18", 100%	MC = 7.2%	
	8.5 ft: Change: light gray with mottles of reddish brown, contains mica				10	SPT-4, SS 12+12+8 REC=13", 72%		
	13.5 ft: Change: no gravel	SM		B2	15	SPT-5, SS 2+4+6 REC=18", 100%	LL = NP PI = NP MC = 11.1% % Passing #200 = 15.1	
	19.3 ft: Change: reddish brown with mottles of light gray				20	SPT-6, SS 5+7+11 REC=18", 100%		
28.7			40.3		25	SPT-7, SS 5+5+9 REC=16", 89%	MC = 10.1%	
32.5	28.7 - 32.5 ft: FAT CLAY WITH SAND; moist, bluish gray and reddish brown, contains mica	CH	36.5	C1	30	SPT-8, SS 3+6+13 REC=18", 100% PB-1, SH REC=30", 100%	PP >4.50 tsf LL = 66 PI = 41 MC = 26.0% % Passing #200 = 90.3	
38.5	32.5 - 38.5 ft: CLAYEY SAND; moist, gray with streaks of yellowish brown, contains mica	SC	30.5	C2	35	SPT-9, SS 15+21+26 REC=18", 100%		
39.7	38.5 - 39.7 ft: FAT CLAY WITH SAND; moist, gray with streaks of reddish *(continued)*	CH	29.3	C1		SPT-10, SS 7+8+24		

Schnabel Engineering TEST BORING LOG	Project: 2900 South Eads Street Retaining Wall, Arlington, VA	Boring Number: 17BH-03
		Contract Number: 17C12005
		Sheet: 2 of 2

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	brown, contains mica					REC=18", 100%		
	39.7 - 43.5 ft: CLAYEY SAND; moist, brown and reddish brown	SC		C2				
43.5	43.5 - 53.8 ft: FAT CLAY WITH SAND; moist, reddish brown with streaks of gray, contains mica	CH	25.5	C1	45	SPT-11, SS 10+19+26 REC=18", 100%	MC = 27.6% PP >4.50 tsf	
					50	SPT-12, SS 14+21+41 REC=18", 100%	PP >4.50 tsf	
53.8	53.8 - 58.5 ft: CLAYEY SAND; moist, light gray with streaks of yellowish brown	SC	15.2	C2	55	SPT-13, SS 11+15+26 REC=18", 100%	MC = 17.9% PP >4.50 tsf	
58.5	58.5 - 63.5 ft: FAT CLAY WITH SAND; moist, gray, contains mica	CH	10.5	C1	60	SPT-14, SS 8+18+29 REC=18", 100%	PP >4.50 tsf	
63.5	63.5 - 78.5 ft: CLAYEY SAND; moist, light gray and yellowish brown, contains mica, contains lignite	SC	5.5	C2	65	SPT-15, SS 11+21+25 REC=18", 100%	MC = 15.4%	
					70	SPT-16, SS 12+19+21 REC=18", 100%		
					75	SPT-17, SS 8+14+18 REC=18", 100%	MC = 21.4%	
78.5	78.5 - 83.5 ft: CLAYEY SAND WITH GRAVEL; rounded, fine to medium gravel; moist, gray and reddish brown	SC	-9.5		80	SPT-18, SS 8+15+36 REC=18", 100%		
83.5	83.5 - 90.0 ft: FAT CLAY WITH SAND; moist, gray and yellowish brown, contains mica	CH	-14.5	C1	85	SPT-19, SS 14+20+32 REC=18", 100%	MC = 23.3%	
	88.5 ft: Change: with mottles of reddish brown					SPT-20, SS 9+19+37 REC=18", 100%		
90.0			-21.0		90			

Bottom of Boring at 90.0 ft.
Boring backfilled with cuttings upon completion.



LEGEND

CL, CH, MH, Concrete, SP, SM, Topsoil, SC

GENERAL NOTES

1. THE NUMBER TO THE RIGHT OF BORING COLUMNS INDICATES THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2 INCH O.D. 1-3/8 INCH I.D. SAMPLING SPOON ONE FOOT USING A 140 POUND HAMMER FALLING 30 INCHES PER ASTM D1586.

2. THE NUMBER TO THE LEFT OF THE BORING COLUMNS INDICATES THE BOTTOM DEPTH OF THE VARIOUS STRATA IN FEET.

3. A DESCRIPTION OF THE STRATUM DESIGNATIONS IS PROVIDED IN THE BODY OF THE REPORT.

4. A PLAN INDICATING THE LOCATIONS OF THE SUBSURFACE PROFILES IS INCLUDED IN THE REPORT.

5. ESTIMATED GROUNDWATER LEVELS INDICATED ARE ONLY ESTIMATES FROM AVAILABLE DATA AND MAY VARY WITH PRECIPITATION, POROSITY OF THE SOIL, SITE TOPOGRAPHY, ETC.

6. G.S.E. = GROUND SURFACE ELEVATION.

7. THIS DRAWING CONTAINS INTERPRETATIONS OF TEST BORING DATA AND SHOULD NOT BE USED AS A PART OF THE CONTRACT DOCUMENTS.

8. THIS PROFILE WAS DEVELOPED BY INTERPOLATION BETWEEN WIDELY SPACED BORINGS. ONLY AT THE BORING LOCATIONS SHOULD IT BE CONSIDERED AS AN APPROXIMATE REPRESENTATION AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS.

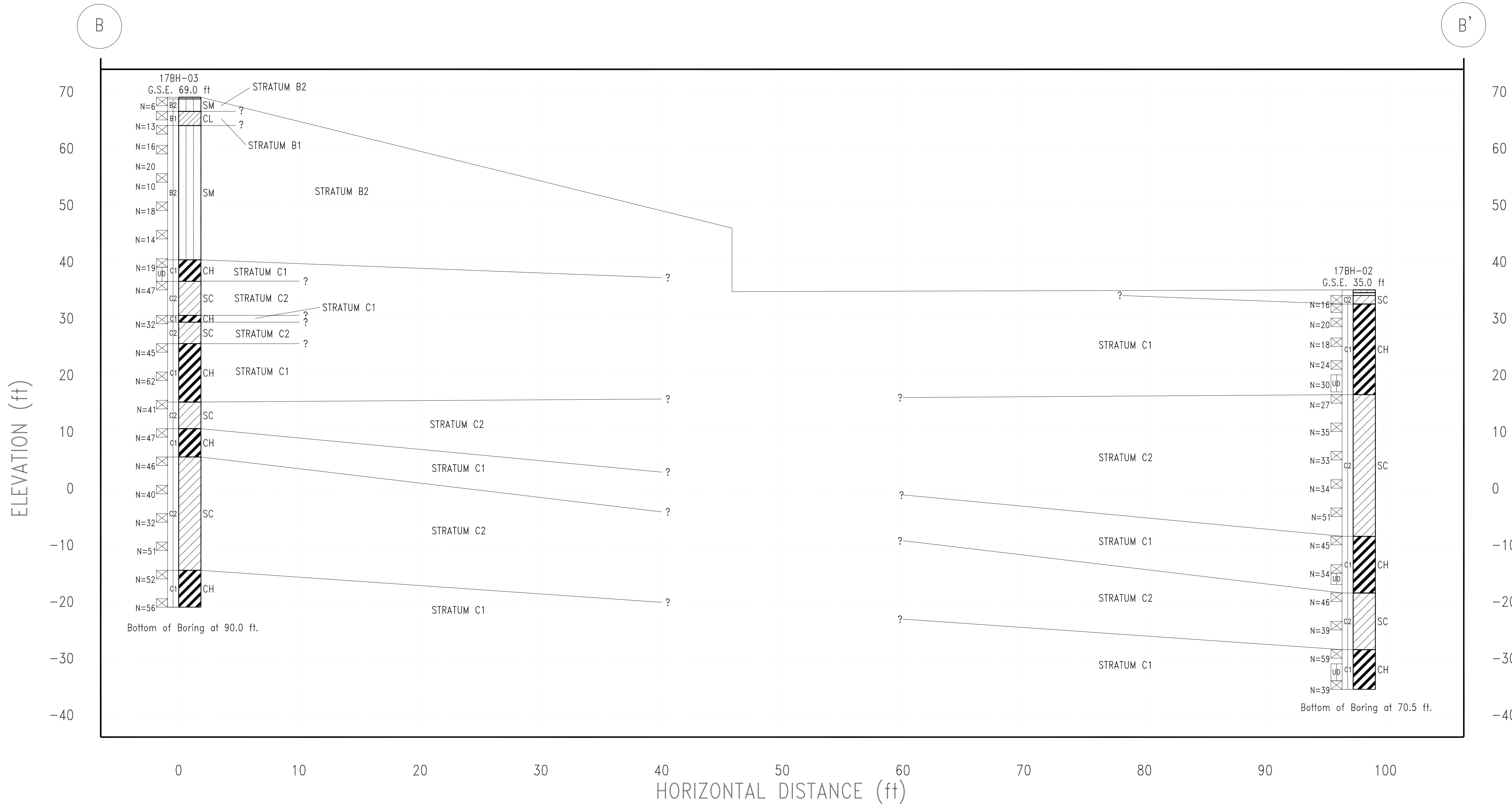
Schnabel ENGINEERING

2900 SOUTH EADS RETAINING WALL REPLACEMENT
ARLINGTON, VIRGINIA

PROJECT NO. 17C12005

SUBSURFACE PROFILE A-A'

FIGURE A1



LEGEND

CL, CH, MH, Concrete, SP, SM, Topsoil, SC

GENERAL NOTES

1. THE NUMBER TO THE RIGHT OF BORING COLUMNS INDICATES THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2 INCH O.D. 1-3/8 INCH I.D. SAMPLING SPOON ONE FOOT USING A 140 POUND HAMMER FALLING 30 INCHES PER ASTM D1586.

2. THE NUMBER TO THE LEFT OF THE BORING COLUMNS INDICATES THE BOTTOM DEPTH OF THE VARIOUS STRATA IN FEET.

3. A DESCRIPTION OF THE STRATUM DESIGNATIONS IS PROVIDED IN THE BODY OF THE REPORT.

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6. G.S.E. = GROUND SURFACE ELEVATION.

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8. THIS PROFILE WAS DEVELOPED BY INTERPOLATION BETWEEN WIDELY SPACED BORINGS. ONLY AT THE BORING LOCATIONS SHOULD IT BE CONSIDERED AS AN APPROXIMATE REPRESENTATION AND THEN ONLY TO THE DEGREE IMPLIED BY THE NOTES ON THE BORING LOGS.

Schnabel ENGINEERING

2900 SOUTH EADS RETAINING WALL REPLACEMENT
ARLINGTON, VIRGINIA
PROJECT NO. 17C12005

SUBSURFACE PROFILE B-B'

FIGURE A2

APPENDIX B

GEOCONCEPTS SUBSURFACE EXPLORATION DATA

GeoConcepts Boring Logs, B-1 through B-5

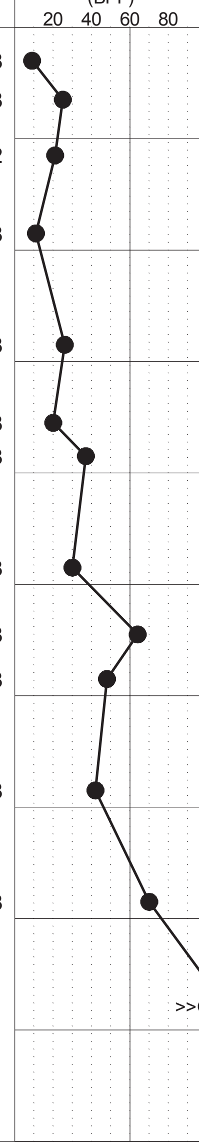
GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, VA 20147
703-726-8030
703-726-8032 fax

PROJECT: 2900 South Eads Street Retaining Wall	LOGGED BY: K. Fordney	BORING NUMBER: **B-1** SHEET 1 OF 1
LOCATION: Arlington, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	
OWNER/CLIENT: STV Inc.	DRILLER: K. Kersh	DATES DRILLED: 8/4/14 - 8/4/14
PROJECT NUMBER: 14130 / GROUND SURFACE ELEVATION (ft): 66.8	DRILLING METHOD: 3.25" I.D. HSA	OFFSET NOTES:

ELEV. (ft)	STRATUM	MATERIAL DESCRIPTION	SPT BLOW COUNTS	REC (in)	MC (%)
66.8		Asphalt = 0.42ft.			
66.4	B	*Terrace deposit*, brown, **f**, clayey SAND, loose, moist, contains quartz fragments, **SC**	3+5+4+3	18	
64.3	B	*Terrace deposit*, brown, **f**, silty SAND, medium dense, moist, contains quartz fragments, **SM**	5+6+19	18	
61.8	B	Without quartz fragments	7+8+13	12	
58.3	B	*Terrace deposit*, brown, **f**, clayey SAND, medium dense, moist, **SC**	5+5+6	18	
53.3	C1	*Potomac formation*, gray and brown, **f**, FAT CLAY with sand, very stiff, moist, **CH**	5+8+18	18	
49.8	C2	*Potomac formation*, orange and gray, **f**, POORLY GRADED SAND with clay, medium dense, moist, **SC**	7+8+12	18	10.7
48.3	C1	*Potomac formation*, gray, FAT CLAY with sand, hard, moist, **CH**	9+17+20	18	33.1
43.3	C2	*Potomac formation*, green - gray, **c**, clayey SAND, dense, moist, **SC**	8+13+17	18	18.5
40.3	C2	Brown and gray, **f**, very dense	14+29+35	18	
	C2		12+21+27	18	
	C2		10+20+22	18	
28.3	C2	*Potomac formation*, brown and blue gray, silty SAND, very dense, wet, **SM**	14+28+42	18	29.4
			30+50/5	11	
		Bottom of Boring at 44.4 ft			

DEPTH (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

STANDARD PENETRATION TEST RESISTANCE (BPF)



GROUND WATER LEVELS:

ENCOUNTERED: 34.0 ft ELEV. 32.8

8/6/2014 32.3 ft ELEV. 34.5

SAMPLE TYPES: Split Spoon; Shelby Tube

REMARKS:

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

GeoConcepts Engineering, Inc.

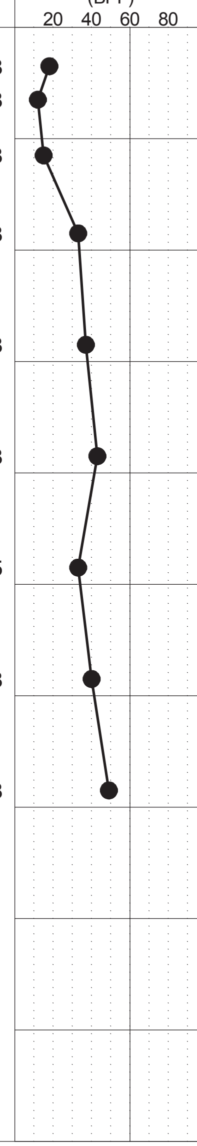
19955 Highland Vista Dr., #170
Ashburn, VA 20147

703-726-8030
703-726-8032 fax

PROJECT: 2900 South Eads Street Retaining Wall	LOGGED BY: K. Fordney	BORING NUMBER: **B-2** SHEET 1 OF 1
LOCATION: Arlington, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	
OWNER/CLIENT: STV Inc.	DRILLER: K. Kersh	DATES DRILLED: 8/6/14 - 8/6/14
PROJECT NUMBER: 14130 / GROUND SURFACE ELEVATION (ft): 34.7	DRILLING METHOD: 3.25" I.D. HSA	OFFSET NOTES:

ELEV. (ft)	DEPTH (ft)	SAMPLE TYPE	STRATUM	MATERIAL DESCRIPTION	SPT BLOW COUNTS	REC (in)	MC (%)
34.7	0			Concrete = 0.5ft.			
34.2	0.5	Split Spoon		*Potomac formation*, gray and orange yellow, **f**, LEAN CLAY with sand, very stiff, moist, **CL**	5+7+11	18	
32.2	2.5	Split Spoon	C1	*Potomac formation*, gray, **f**, FAT CLAY with sand, very stiff, moist, **CH**	4+5+7	18	
	5	Split Spoon	C1		5+6+9	18	29.5
26.2	8.5	Split Spoon	C1	Dark brown and gray, hard	12+15+18	18	
21.2	13.5	Split Spoon	C1	*Potomac formation*, gray, **f**, sandy FAT CLAY, very stiff, moist, **CH**	14+16+21	18	23.7
16.2	18.5	Split Spoon	C1	Brown	15+19+24	18	
11.2	23.5	Split Spoon	C2	*Potomac formation*, gray and brown, **f**, clayey SAND, dense, moist, **SC**	11+15+18	15	21.8
	28.5	Split Spoon	C2		14+19+21	18	
1.2	33.5	Split Spoon	C2	Gray and yellow	16+22+27	18	
	35			Bottom of Boring at 35.0 ft			

STANDARD PENETRATION TEST RESISTANCE (BPF)



GROUND WATER LEVELS:

NOT ENCOUNTERED DURING DRILLING

SAMPLE TYPES:

Split Spoon

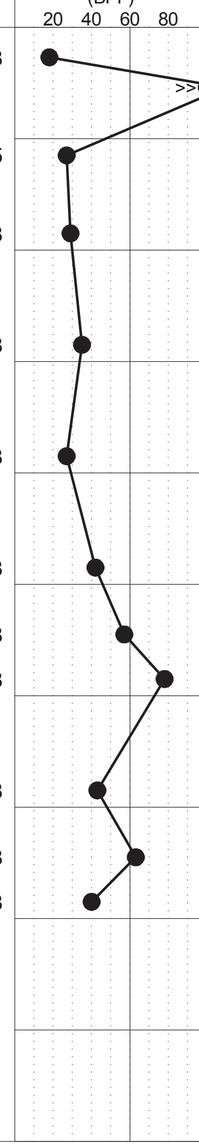
REMARKS:

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

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, VA 20147
703-726-8030
703-726-8032 fax

PROJECT: 2900 South Eads Street Retaining Wall	LOGGED BY: K. Fordney	BORING NUMBER: **B-3**
LOCATION: Arlington, Virginia	DRILLING CONTRACTOR: Connelly and Associates, Inc.	SHEET 1 OF 1
OWNER/CLIENT: STV Inc.	DRILLER: K. Kersh	DATES DRILLED: 8/5/14 - 8/5/14
PROJECT NUMBER: 14130 / GROUND SURFACE ELEVATION (ft): 48.0	DRILLING METHOD: 3.25" I.D. HSA	OFFSET NOTES:

ELEV. (ft)	SAMPLE TYPE	STRATUM	MATERIAL DESCRIPTION	SPT BLOW COUNTS	REC (in)	STANDARD PENETRATION TEST RESISTANCE (BPF)	MC (%)
48.0			Asphalt = 0.25ft.				
47.7	Split Spoon	A	*Fill*, light brown, **f-c**, POORLY GRADED SAND, medium dense, moist, contains quartz fragments, **SP**	3+5+13+14	18		
	Split Spoon			50/5	2	>>14.0	
45.5			*Fill*, brown, **f-c**, LEAN CLAY with sand, very hard, moist, contains quartz fragments, **CL**				
43.0	Split Spoon	C1	*Potomac formation*, gray, LEAN CLAY, very stiff, moist, **CL**	10+14+13	15		
39.5	Split Spoon	C2	*Potomac formation*, gray and yellow, **f**, silty SAND, medium dense, moist, **SM**	5+11+18	18		
34.5	Split Spoon		Dense	8+15+20	18		
29.5	Split Spoon	C1	*Potomac formation*, gray and red brown, FAT CLAY, very stiff, moist, **CH**	7+9+18	18		
24.5	Split Spoon, Shelby Tube		Gray, hard	7+13+29	18		
21.5	Split Spoon	C2	*Potomac formation*, gray, **f**, clayey SAND, very dense, moist, **SC**	21+25+32	18		
	Split Spoon			25+28+50	18		
14.5	Split Spoon, Shelby Tube	C1	*Potomac formation*, gray, **f**, FAT CLAY with sand, hard, moist, **CH**	7+15+28	18		
11.5	Split Spoon	C2	*Potomac formation*, gray and orange, **f**, clayey SAND, very dense, moist, **SC**	14+26+37	18		
9.5	Split Spoon		Dense	11+17+23	18		
			Bottom of Boring at 40.0 ft				



GROUND WATER LEVELS:

NOT ENCOUNTERED DURING DRILLING

NOT ENCOUNTERED AFTER DRILLING

SAMPLE TYPES:

Split Spoon

Shelby Tube

REMARKS:

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

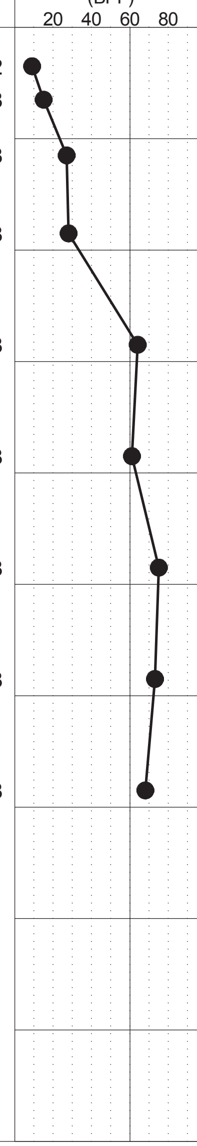
BOREHOLE/TEST PIT LOGS.GPJ TRAINING 8_14A.GPJ 10/3/14

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., #170
Ashburn, VA 20147
703-726-8030
703-726-8032 fax

PROJECT:	LOGGED BY:	BORING NUMBER:
2900 South Eads Street Retaining Wall	**K. Fordney**	**B-4**
LOCATION: **Arlington, Virginia**	DRILLING CONTRACTOR: **Connelly and Associates, Inc.**	SHEET 1 OF 1
OWNER/CLIENT: **STV Inc.**	DRILLER: **K. Kersh**	DATES DRILLED: **8/6/14 - 8/6/14**
PROJECT NUMBER: **14130** GROUND SURFACE ELEVATION (ft): **33.0**	DRILLING METHOD: **3.25" I.D. HSA**	OFFSET NOTES:

ELEV. (ft)	DEPTH (ft)	SAMPLE TYPE	STRATUM	MATERIAL DESCRIPTION	SPT BLOW COUNTS	REC (in)	MC (%)
33.0				Concrete = 0.67ft.			
32.7 / 32.3		Split Spoon		Crushed stone = 0.33ft.	3+4+5	12	
32.0		Split Spoon	C2	*Potomac formation*, orange brown and gray, **f**, clayey SAND, medium dense, moist, **SC**	4+7+8	18	
30.5	5	Split Spoon	C2	Brown and gray	6+11+16	18	25.9
24.5	10	Split Spoon	C2	Gray orange and red brown	7+10+18	18	
19.5	15	Split Spoon	C2	Light gray, **f**, very dense, moist	12+25+39	18	
	20	Split Spoon	C2		9+24+37	18	
9.5	25	Split Spoon	C2	Light gray orange and tan	20+29+46	18	
	30	Split Spoon	C2		16+31+42	18	
	35	Split Spoon	C2		19+27+41	18	
				Bottom of Boring at 35.0 ft			

STANDARD PENETRATION TEST RESISTANCE (BPF)



GROUND WATER LEVELS:

NOT ENCOUNTERED DURING DRILLING

SAMPLE TYPES:

Split Spoon

REMARKS:

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

GeoConcepts Engineering, Inc.

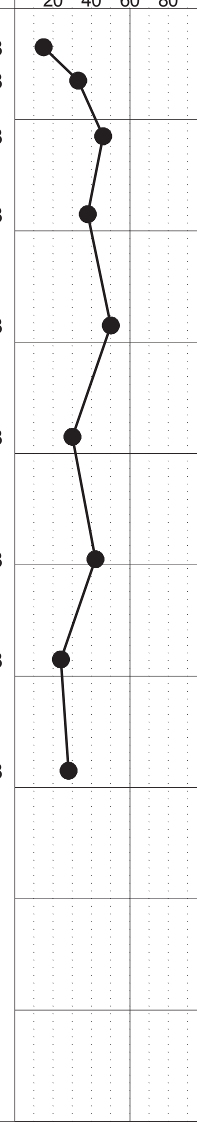
19955 Highland Vista Dr., #170
Ashburn, VA 20147

703-726-8030
703-726-8032 fax

PROJECT: 2900 South Eads Street Retaining Wall		LOGGED BY: K. Fordney	BORING NUMBER: **B-5** SHEET 1 OF 1
LOCATION: Arlington, Virginia		DRILLING CONTRACTOR: Connelly and Associates, Inc.	
OWNER/CLIENT: STV Inc.		DRILLER: K. Kersh	DATES DRILLED: 8/6/14 - 8/6/14
PROJECT NUMBER: 14130	GROUND SURFACE ELEVATION (ft): 35.2	DRILLING METHOD: 3.25" I.D. HSA	OFFSET NOTES:

ELEV. (ft)	DEPTH (ft)	SAMPLE TYPE	STRATUM	MATERIAL DESCRIPTION	SPT BLOW COUNTS	REC (in)	MC (%)
35.2				Concrete = 0.67ft.			
34.5		Split Spoon		Crushed stone = 0.33ft.	6+6+9	18	
34.2							
32.7		Split Spoon	C2	*Potomac formation*, gray, **f-c**, silty SAND, medium dense, moist, **SM**	9+14+19	18	
	5	Split Spoon	C2	*Potomac formation*, gray and brown, **f-c**, clayey SAND, dense, moist, **SC**	16+22+24	18	
26.7		Split Spoon	C1	*Potomac formation*, gray and red brown, FAT CLAY, hard, moist, **CH**	12+16+22	18	
21.7	15	Split Spoon	C2	*Potomac formation*, gray and red brown, **f**, clayey SAND, dense, moist, **SC**	19+23+27	18	24.8
	20	Split Spoon	C2		10+12+18	18	
	25	Split Spoon	C2		12+14+28	18	
6.7	30	Split Spoon	C2	Gray, medium dense	10+11+13	18	
1.7	35	Split Spoon	C2	Gray and yellow	8+11+17	18	19.2
	35			Bottom of Boring at 35.0 ft			

SOIL — STANDARD PENETRATION TEST RESISTANCE (BPF) 20 40 60 80



GROUND WATER LEVELS:

ENCOUNTERED: 23.5 ft ELEV. 11.7

SAMPLE TYPES: Split Spoon

REMARKS:

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

APPENDIX C

SOIL LABORATORY TEST DATA

Summary of Laboratory Tests
Atterberg Limits
Gradation Curves
Consolidated Drained Repeated Direct Shear Tests
Consolidated-Drained Direct Shear Tests

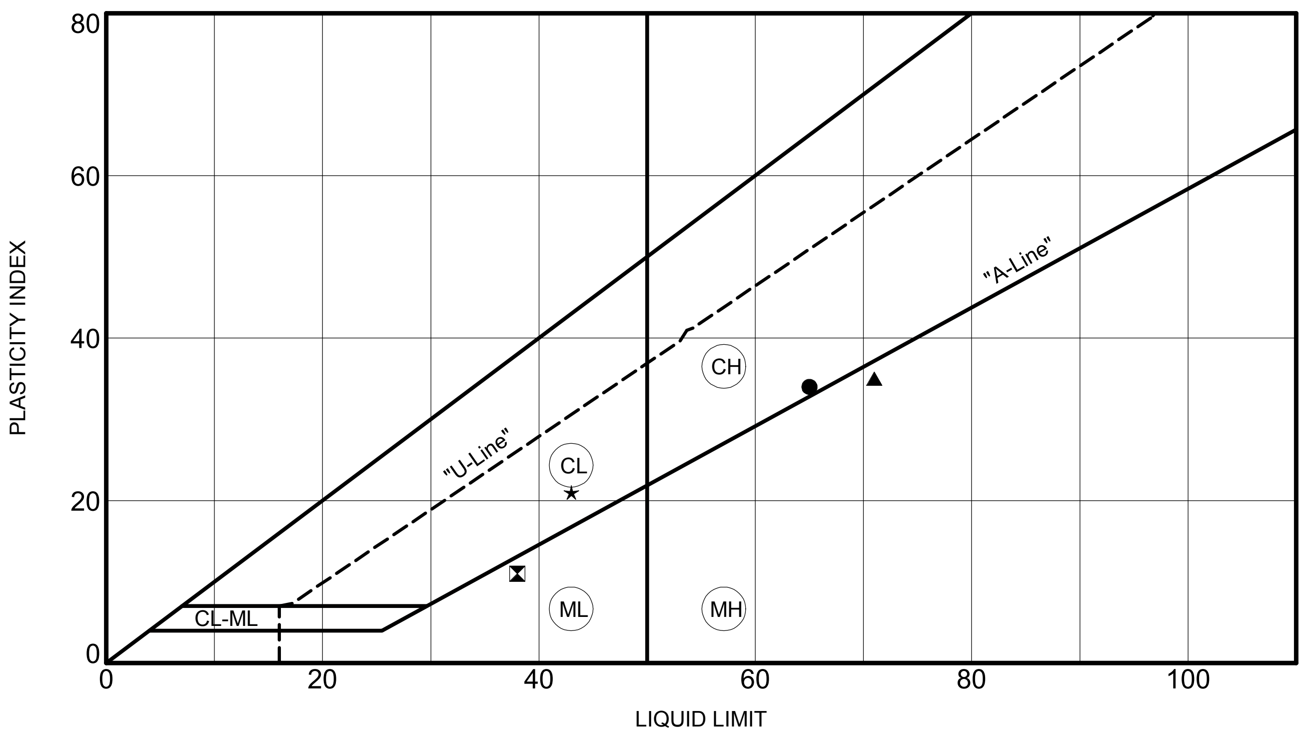
Summary of Laboratory Tests

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Passing No. 200 Sieve	% Passing No. 40 Sieve	% Retained No. 4 Sieve
17BH-01	8.5 - 10.0 27.5 - 26.0	Jar	FAT CLAY (CH), gray	C1	29.5	65	31	34	97.3	99.8	--
17BH-01	28.5 - 30.0 7.5 - 6.0	Jar	SILTY SAND (SM), fine to medium grained sand, light gray and brown	C2	25.5	38	27	11	32.0	97.1	--
17BH-01	58.5 - 60.0 -22.5 - -24.0	Jar	ELASTIC SILT (MH), grayish brown	C1	27.0	71	36	35	98.3	99.6	0.0
17BH-02	28.5 - 30.0 6.5 - 5.0	Jar	CLAYEY SAND (SC), fine to coarse grained sand, light brown and gray	C2	22.5	43	22	21	20.8	61.4	0.0
17BH-03	13.5 - 15.0 55.5 - 54.0	Jar	SILTY SAND (SM), fine to coarse grained sand, light gray	C2	11.1	NP	NP	NP	15.1	49.6	--

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; ND=Not Detected; ; P=Present; T=Trace; -- indicates no test performed

Schnabel ENGINEERING

Project: 2900 South Eads Street Retaining Wall
Arlington, VA



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Description
●	**17BH-01**	**8.5 ft**	**65**	**31**	**34**	**97**	**FAT CLAY (CH), gray**
⧗	**17BH-01**	**28.5 ft**	**38**	**27**	**11**	**32**	**SILTY SAND (SM), fine to medium grained sand, light gray and brown**
▲	**17BH-01**	**58.5 ft**	**71**	**36**	**35**	**98**	**ELASTIC SILT (MH), grayish brown**
★	**17BH-02**	**28.5 ft**	**43**	**22**	**21**	**21**	**CLAYEY SAND (SC), fine to coarse grained sand, light brown and gray**

Schnabel
ENGINEERING

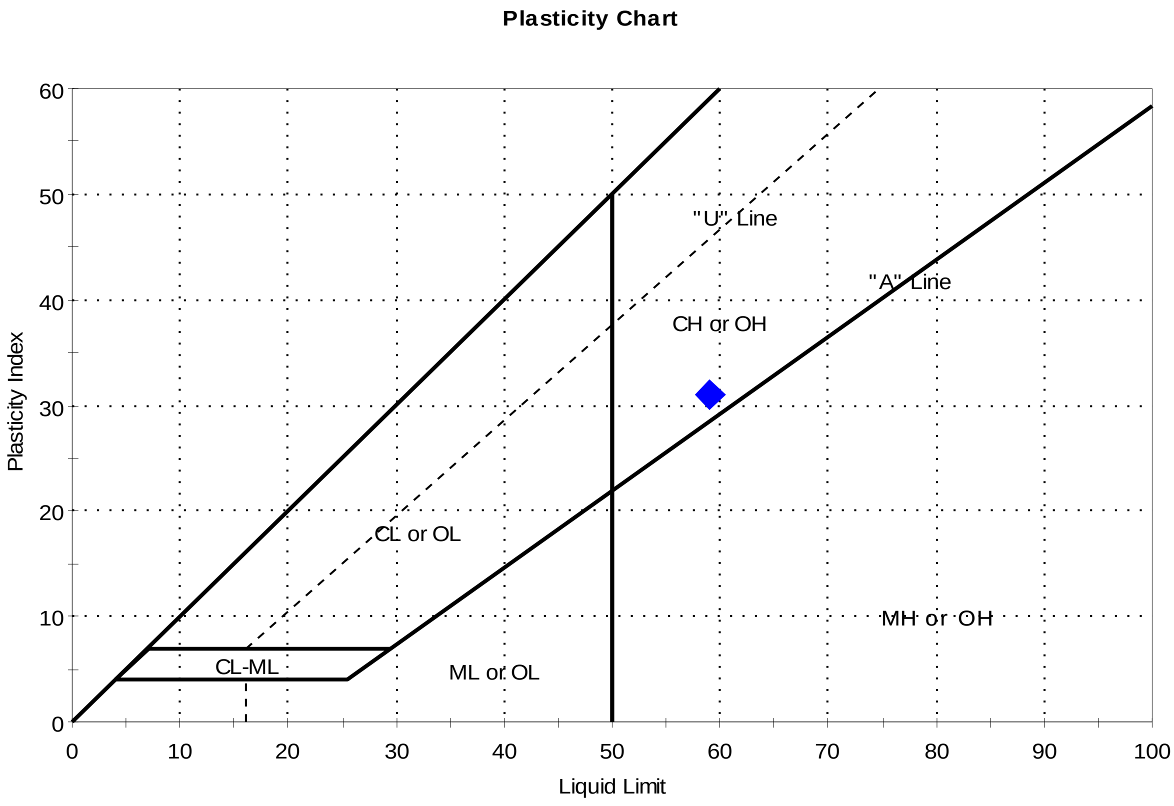
ATTERBERG LIMITS

Project: 2900 South Eads Street Retaining Wall
Arlington, VA

Contract: 17C12005

Client:	Schnabel Engineering, LLC		
Project:	S. Eads Retaining Wall Replacement		
Location:	---	Project No:	GTX-306099
Boring ID: B-2	Sample Type: tube	Tested By:	cam
Sample ID: ST-1	Test Date: 04/18/17	Checked By:	jdt
Depth : 15.0 ft	Test Id: 406781		
Test Comment:	---		
Visual Description:	Moist, greenish gray clay		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-1	B-2	15.0 ft	26	59	28	31	-0.1	Fat clay (CH)

Sample Prepared using the WET method

0% Retained on #40 Sieve

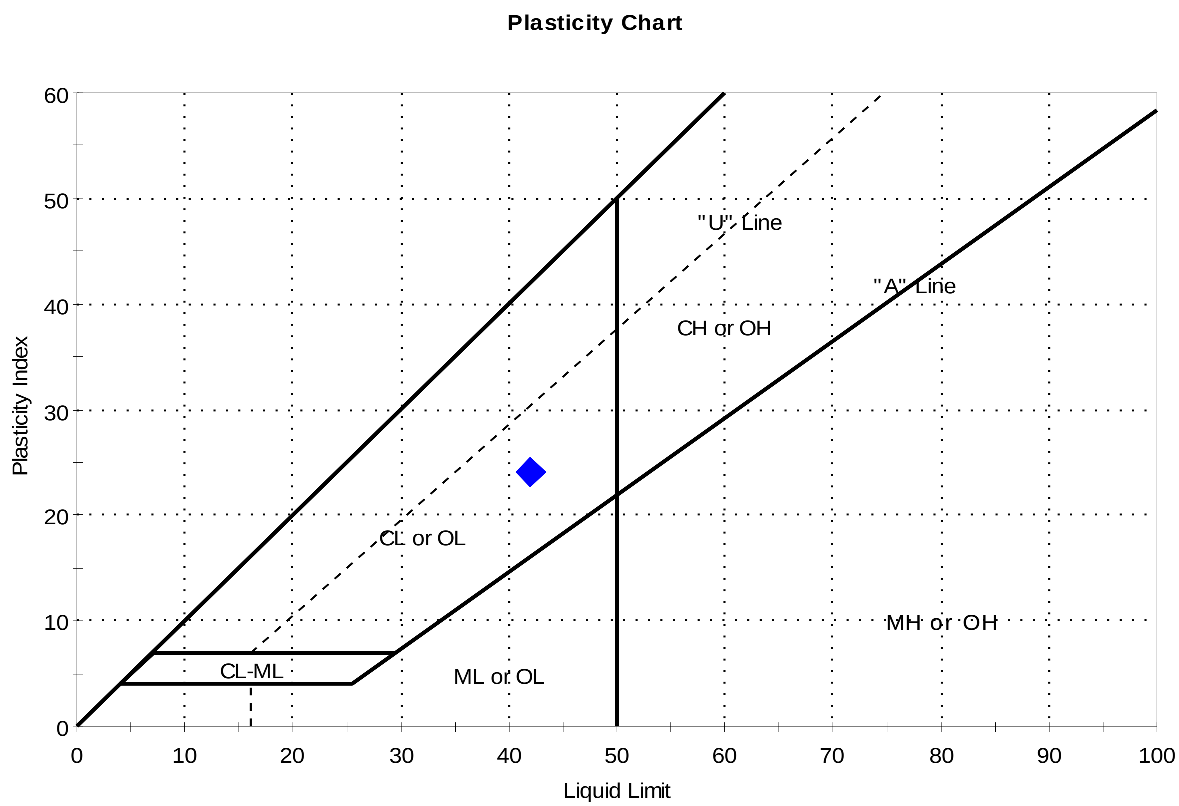
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Schnabel Engineering, LLC		
Project:	S. Eads Retaining Wall Replacement		
Location:	---	Project No:	GTX-306099
Boring ID: B-2	Sample Type: tube	Tested By:	cam
Sample ID: ST-2	Test Date: 03/31/17	Checked By:	jdt
Depth : 50.0 ft	Test Id: 406782		
Test Comment:	---		
Visual Description:	Moist, greenish gray clayey gravel with sand		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-2	B-2	50.0 ft	24	42	18	24	0.2	Clayey gravel with sand (GC)

Sample Prepared using the WET method

35% Retained on #40 Sieve

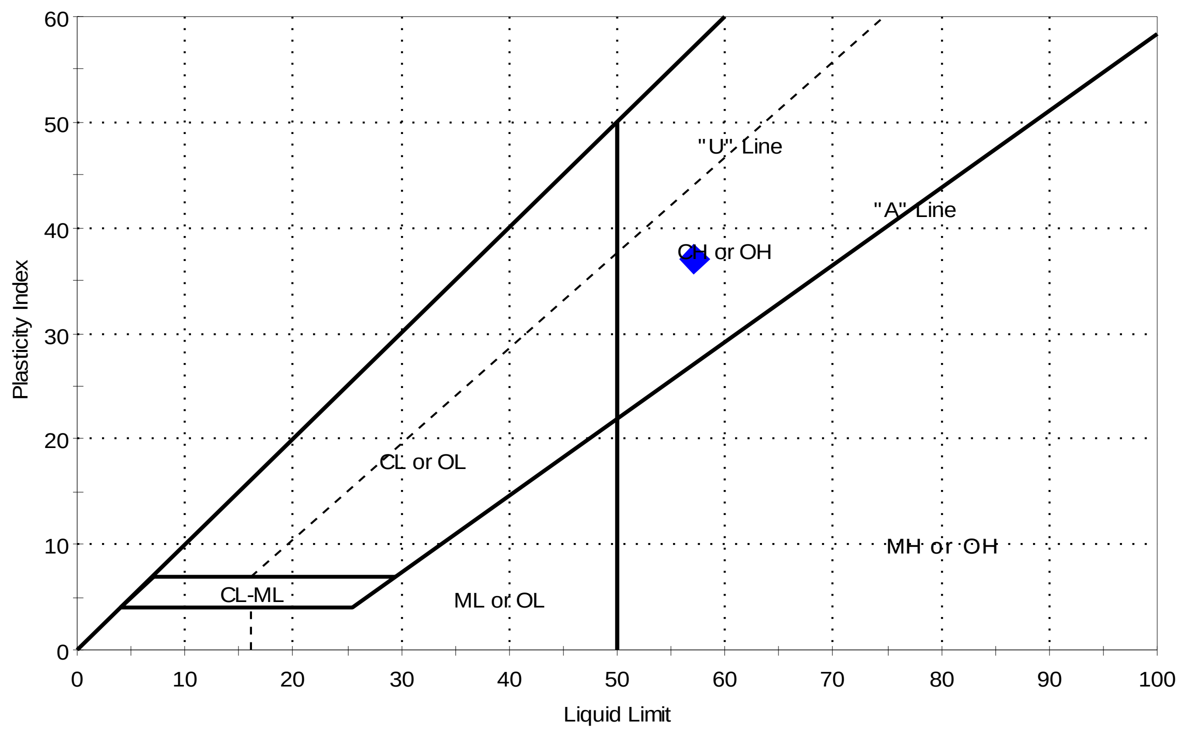
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Schnabel Engineering, LLC				
Project:	S. Eads Retaining Wall Replacement				
Location:	---			Project No:	GTX-306099
Boring ID:	B-2	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-3	Test Date:	04/20/17	Checked By:	jdt
Depth :	66.0 ft	Test Id:	406783		
Test Comment:	---				
Visual Description:	Moist, greenish gray clay with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-3	B-2	66.0 ft	25	57	20	37	0.1	Fat clay with sand (CH)

Sample Prepared using the WET method

0% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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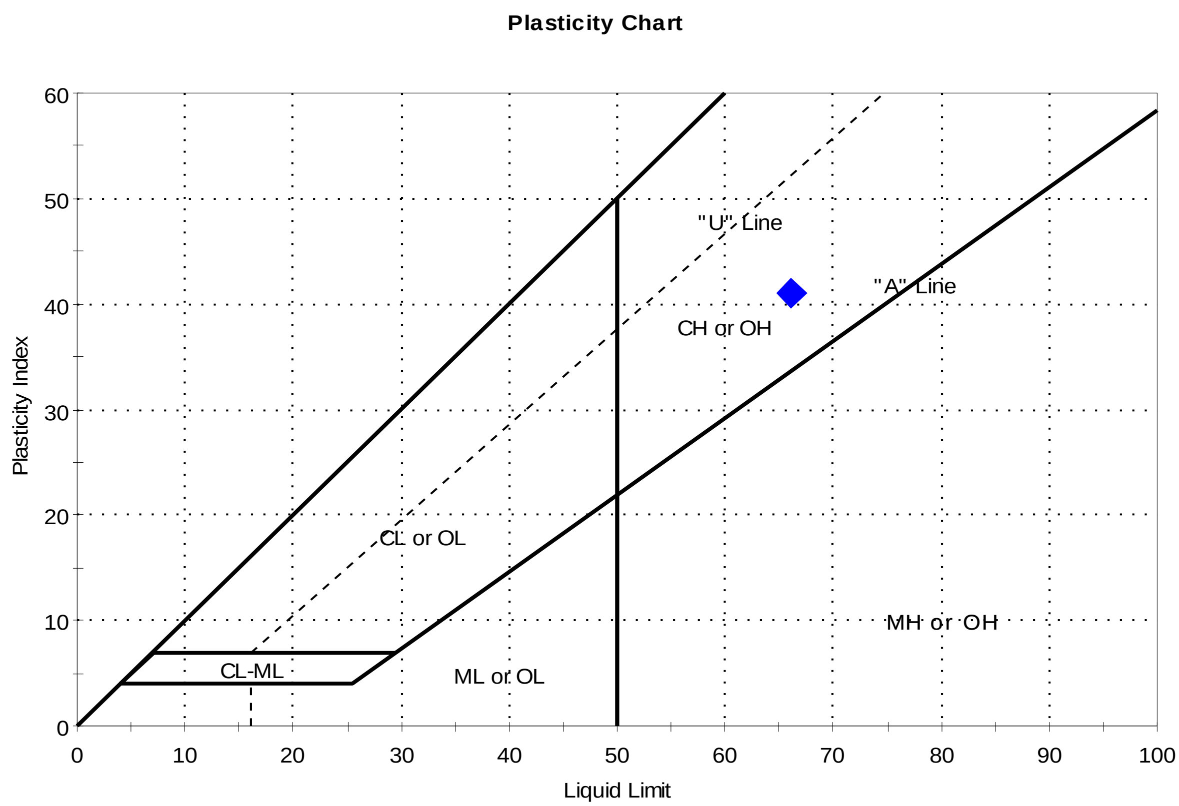
Client:	Schnabel Engineering, LLC				
Project:	S. Eads Retaining Wall Replacement				
Location:	---			Project No:	GTX-306099
Boring ID:	B-3	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-1	Test Date:	04/20/17	Checked By:	jdt
Depth :	30 ft	Test Id:	406785		
Test Comment:	---				
Visual Description:	Moist, light grayish brown clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	ST-1	B-3	30 ft	26	66	25	41	0	Fat clay (CH)

Sample Prepared using the WET method

0% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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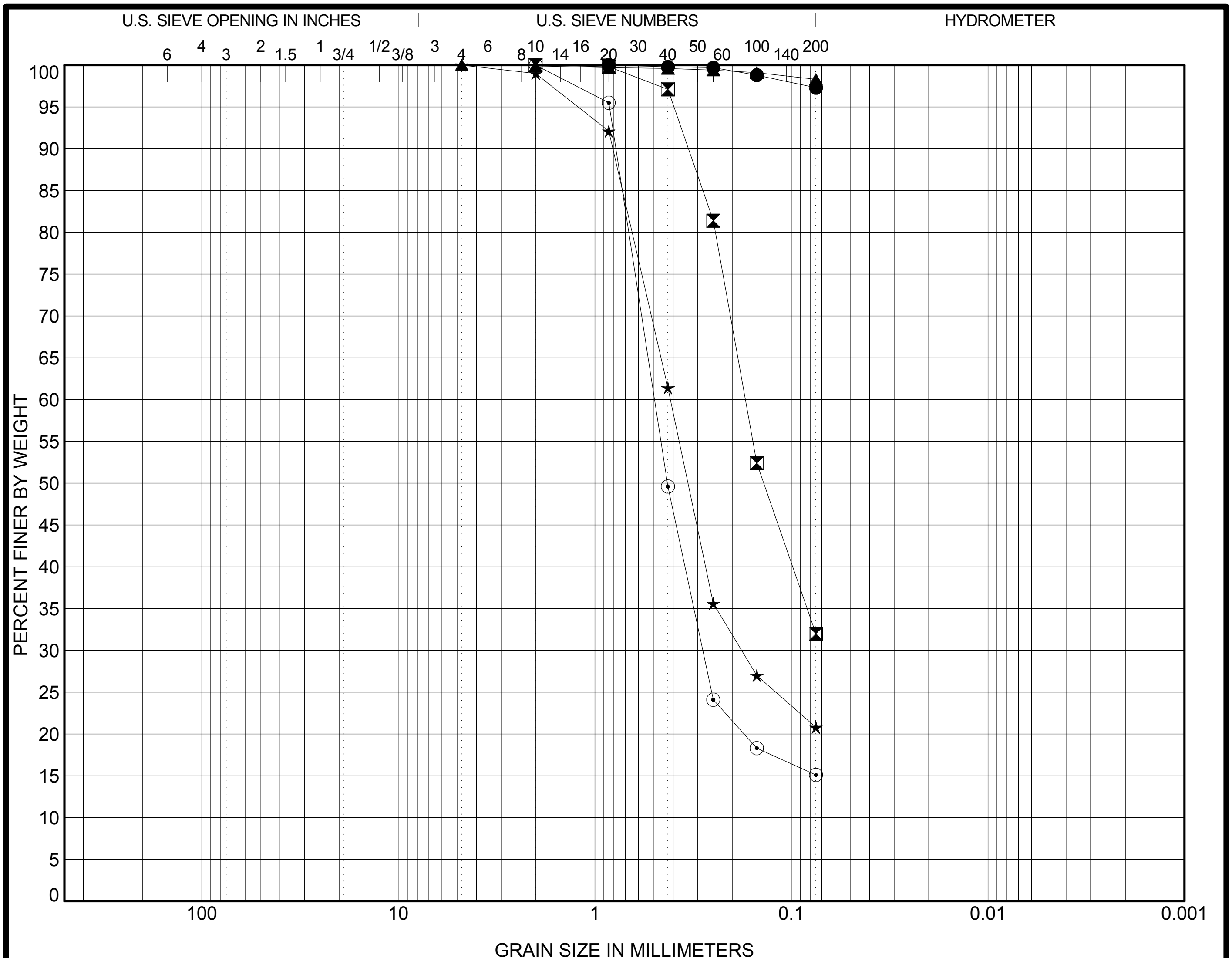


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI	Cc	Cu
●	**17BH-01**	**8.5 ft**	**FAT CLAY (CH), gray**	**65**	**31**	**34**	**--**	**--**
⧗	**17BH-01**	**28.5 ft**	**SILTY SAND (SM), fine to medium grained sand, light gray and brown**	**38**	**27**	**11**	**--**	**--**
▲	**17BH-01**	**58.5 ft**	**ELASTIC SILT (MH), grayish brown**	**71**	**36**	**35**	**--**	**--**
★	**17BH-02**	**28.5 ft**	**CLAYEY SAND (SC), fine to coarse grained sand, light brown and gray**	**43**	**22**	**21**	**--**	**--**
⊙	**17BH-03**	**13.5 ft**	**SILTY SAND (SM), fine to coarse grained sand, light gray**	**NP**	**NP**	**NP**	**--**	**--**

	Specimen		Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**17BH-01**	**8.5 ft**	**ASTM D422**	**0.85**						**97.3**	
⧗	**17BH-01**	**28.5 ft**	**ASTM D422**	**2**	**0.171**					**32.0**	
▲	**17BH-01**	**58.5 ft**	**ASTM D422**	**4.75**				**0.0**	**1.7**	**98.3**	
★	**17BH-02**	**28.5 ft**	**ASTM D422**	**4.75**	**0.413**	**0.179**		**0.0**	**79.2**	**20.8**	
⊙	**17BH-03**	**13.5 ft**	**ASTM D422**	**2**	**0.497**	**0.283**				**15.1**	

Schnabel ENGINEERING

GRADATION CURVES

Project: 2900 South Eads Street Retaining Wall
Arlington, VA

Contract: 17C12005

SIEVE 5 SHEET; P:S EADS RETAINING WALL.GPJ; D: L:GINT LIBRARY 2015 02-16 (NCO).GLB; Print:3/16/17

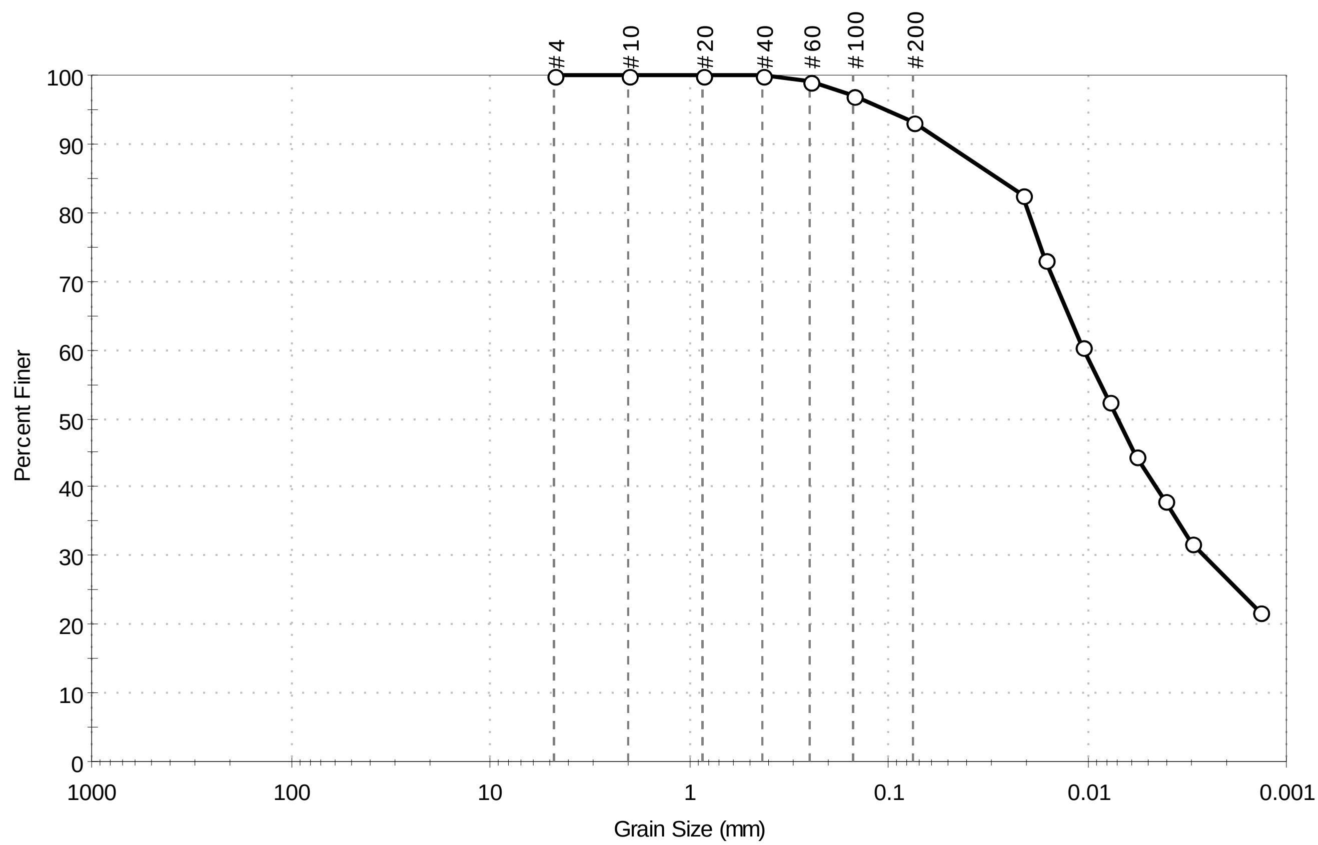
Client:	Schnabel Engineering, LLC				
Project:	S. Eads Retaining Wall Replacement				
Location:	---			Project No:	GTX-306099
Boring ID:	B-2	Sample Type:	tube	Tested By:	jbr
Sample ID:	ST-1	Test Date:	04/18/17	Checked By:	jdt
Depth :	15.0 ft	Test Id:	406786		

Test Comment: ---

Visual Description: Moist, greenish gray clay

Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	6.7	93.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	97		
#200	0.075	93		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0213	83		
---	0.0163	73		
---	0.0105	60		
---	0.0077	53		
---	0.0057	45		
---	0.0041	38		
---	0.0030	32		
---	0.0014	22		

Coefficients

D_{85} = 0.0282 mm	D_{30} = 0.0026 mm
D_{60} = 0.0103 mm	D_{15} = N/A
D_{50} = 0.0070 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Fat clay (CH)

AASHTO Clayey Soils (A-7-6 (34))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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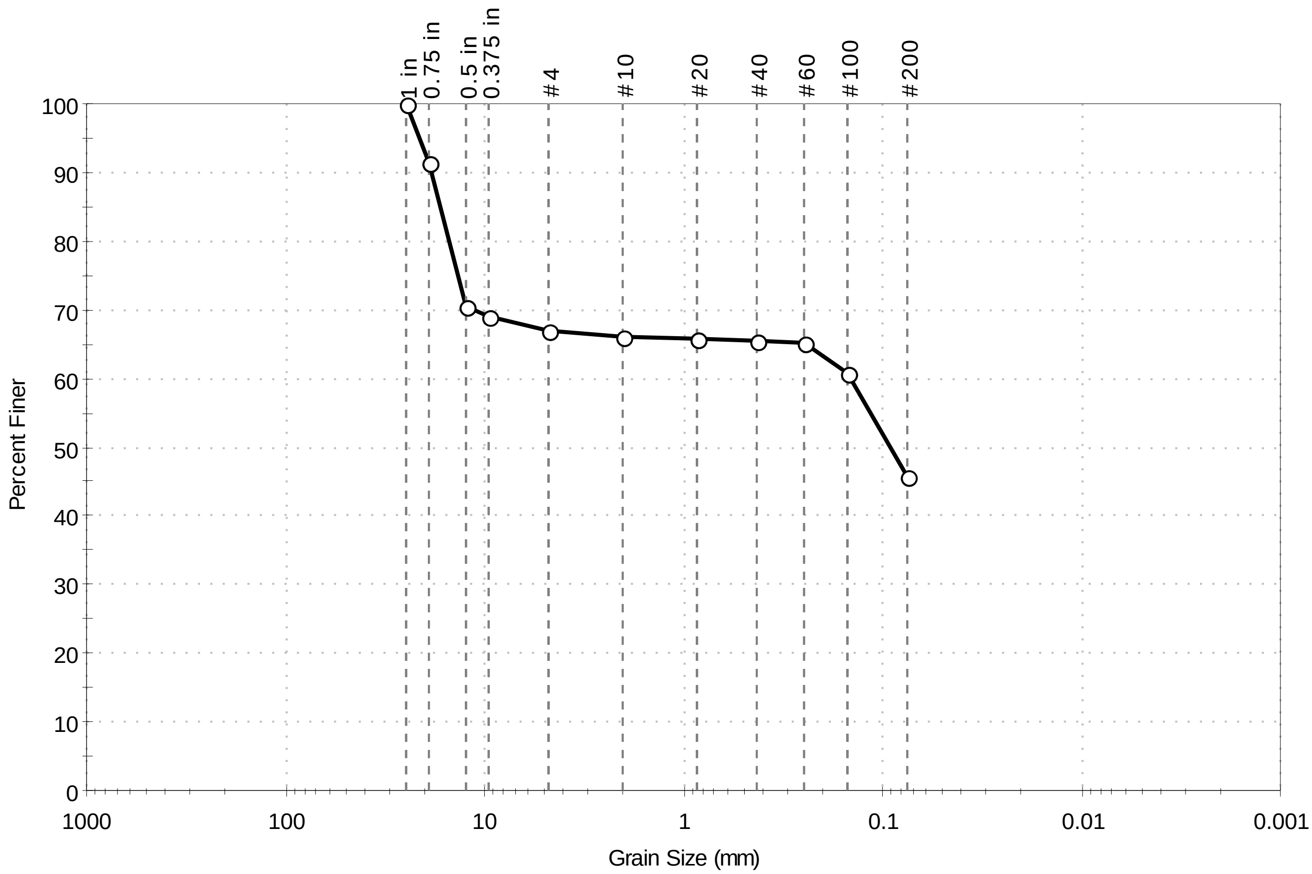
Client:	Schnabel Engineering, LLC			
Project:	S. Eads Retaining Wall Replacement			
Location:	---		Project No:	GTX-306099
Boring ID: B-2		Sample Type: tube	Tested By:	jbr
Sample ID: ST-2		Test Date: 04/03/17	Checked By:	jdt
Depth : 50.0 ft		Test Id: 406787		
Test Comment:	---			
Visual Description:	Moist, greenish gray clayey gravel with sand			
Sample Comment:	---			

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	33.1	21.1	45.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	91		
0.5 in	12.50	71		
0.375 in	9.50	69		
#4	4.75	67		
#10	2.00	66		
#20	0.85	66		
#40	0.42	65		
#60	0.25	65		
#100	0.15	61		
#200	0.075	46		

Coefficients

D_{85} = 16.6981 mm D_{30} = N/A

D_{60} = 0.1457 mm D_{15} = N/A

D_{50} = 0.0915 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM   Clayey gravel with sand (GC)

AASHTO   Clayey Soils (A-7-6 (7))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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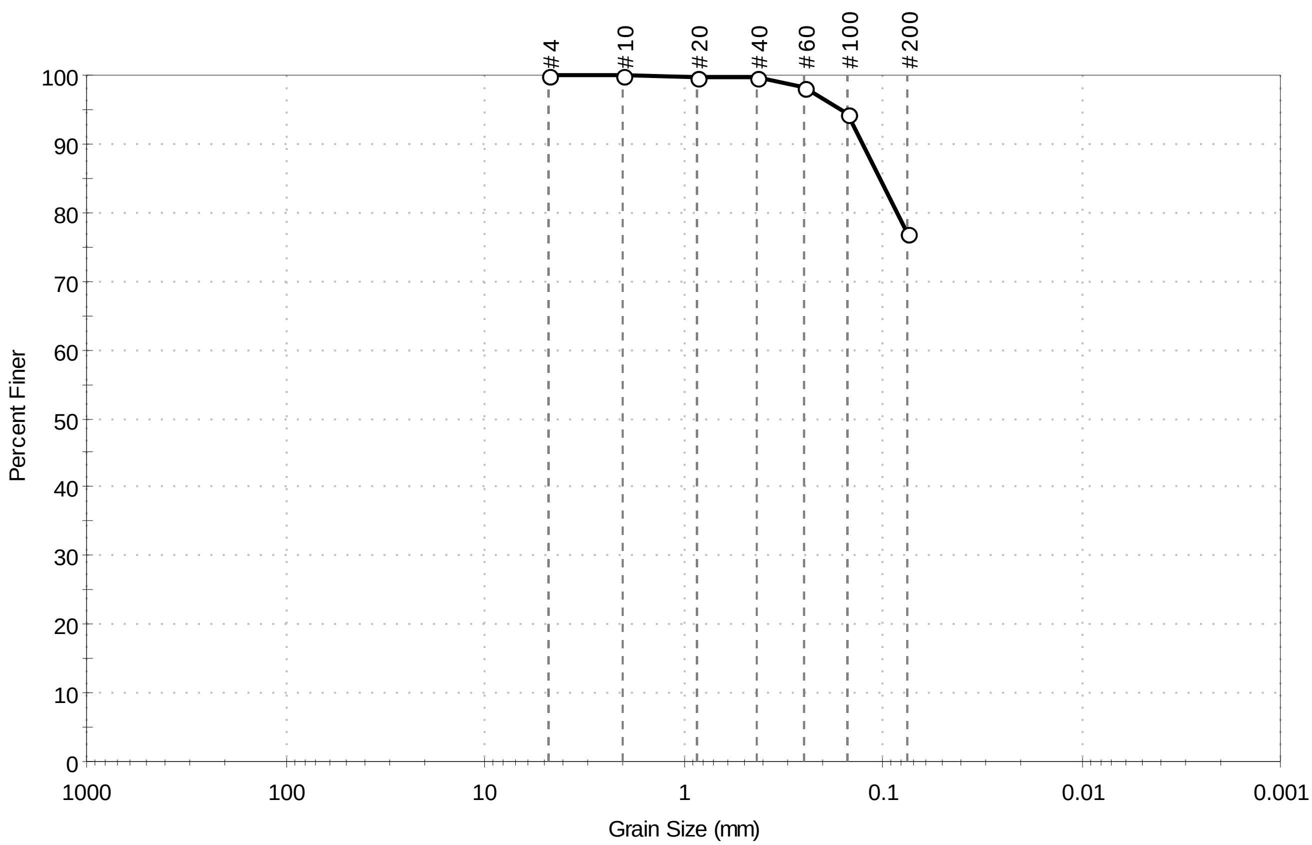
Client:	Schnabel Engineering, LLC		
Project:	S. Eads Retaining Wall Replacement		
Location:	---	Project No:	GTX-306099
Boring ID: B-2	Sample Type: tube	Tested By:	jbr
Sample ID: ST-3	Test Date: 04/20/17	Checked By:	jdt
Depth : 66.0 ft	Test Id: 406788		
Test Comment:	---		
Visual Description:	Moist, greenish gray clay with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	23.0	77.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	98		
#100	0.15	94		
#200	0.075	77		

Coefficients

D_{85} = 0.1033 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Fat clay with sand (CH)

AASHTO Clayey Soils (A-7-6 (29))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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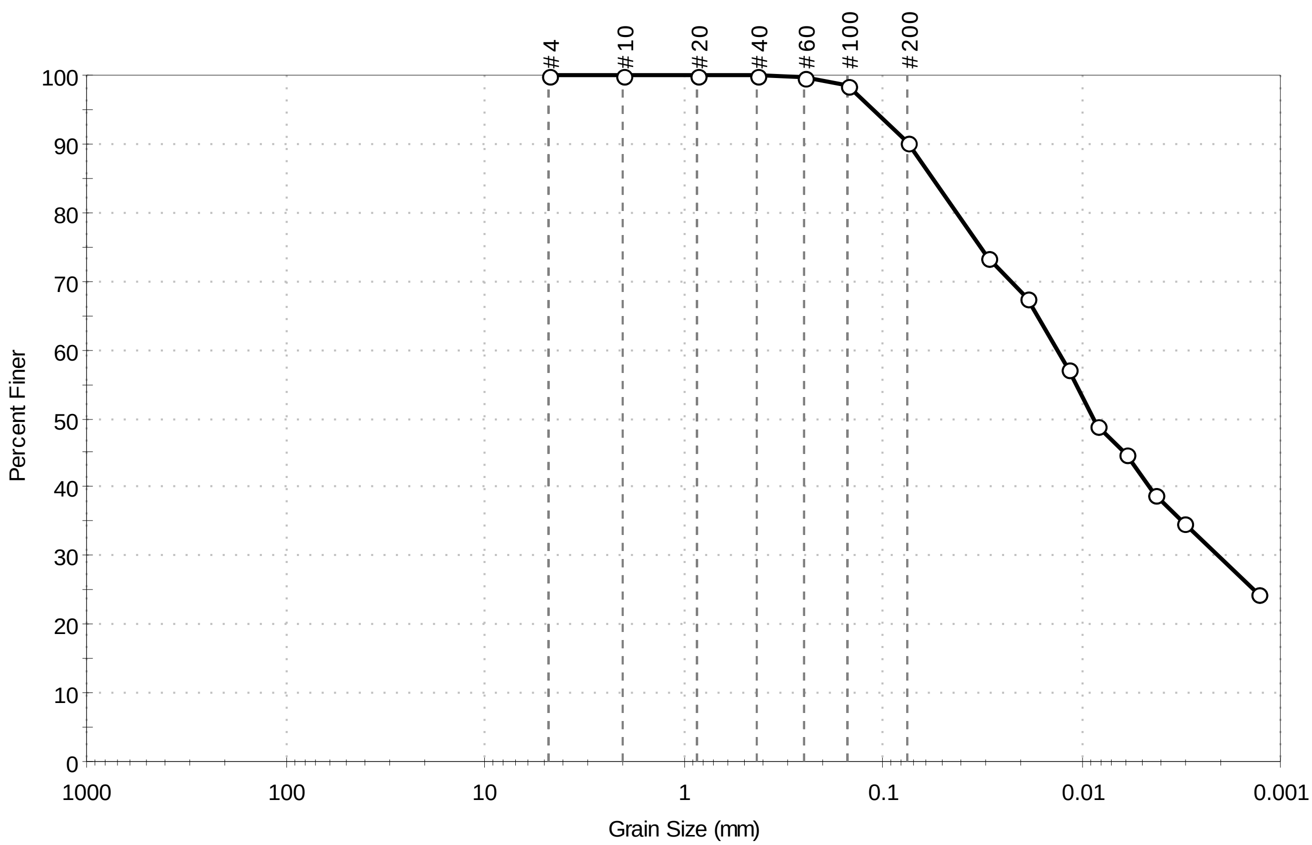
Client:	Schnabel Engineering, LLC		
Project:	S. Eads Retaining Wall Replacement		
Location:	---	Project No:	GTX-306099
Boring ID: B-3	Sample Type: tube	Tested By:	jbr
Sample ID: ST-1	Test Date: 04/20/17	Checked By:	jdt
Depth : 30 ft	Test Id: 406790		
Test Comment:	---		
Visual Description:	Moist, light grayish brown clay		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	9.7	90.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	98		
#200	0.075	90		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0298	74		
---	0.0189	67		
---	0.0116	57		
---	0.0083	49		
---	0.0060	45		
---	0.0043	39		
---	0.0031	35		
---	0.0013	25		

Coefficients

D_{85} = 0.0560 mm | D_{30} = 0.0021 mm

D_{60} = 0.0132 mm | D_{15} = N/A

D_{50} = 0.0087 mm | D_{10} = N/A

C_u = N/A | C_c = N/A

Classification

ASTM Fat clay (CH)

AASHTO Clayey Soils (A-7-6 (42))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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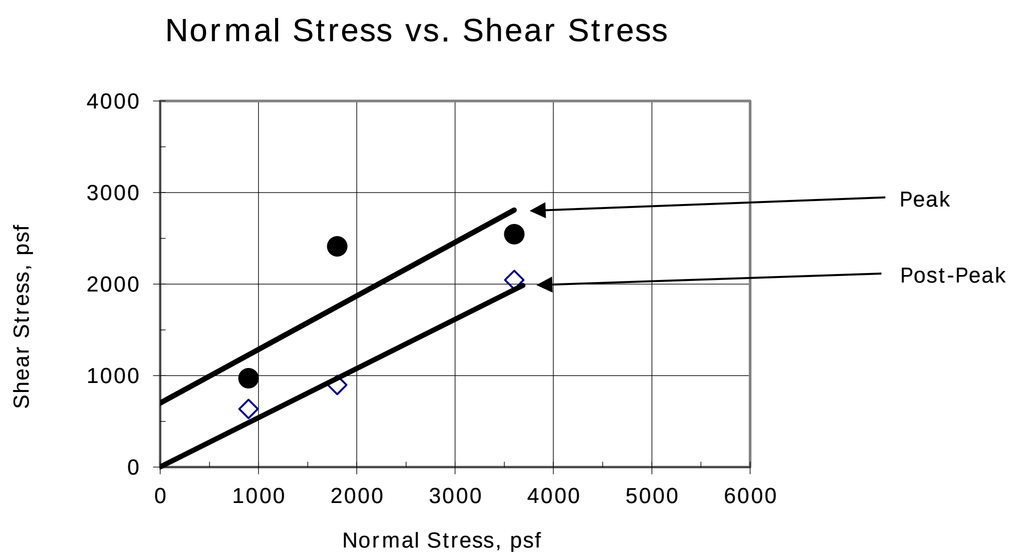
Client:	Schnabel Engineering, LLC		
Project Name:	S. Eads Retaining Wall Replacement		
Project Location:	---		
GTX #:	306099	Tested By:	md
Test Date:	04/07/17	Checked By:	jdt
Boring ID:	B-2		
Sample ID:	ST-1		
Depth, ft:	15		
Description:	Moist, greenish gray clay		
Preparation:	Extruded from tube, cut and trimmed and tested at the as-received moisture and density.		

Direct Shear (ASTM D3080) and Residual Shear (USACOE EM1110-modified)

Parameter	Point 1	Point 2	Point 3
Test No.	RS-2-1	RS-2-2	RS-2-3
Initial Moisture Content, %	26.5	27.3	28.0
Initial Dry Density, pcf	94.3	92.2	91.6
Nominal Rate of Shear Strain, inches/min	0.00035	0.00035	0.00035
Vertical Consolidation Stress, psf	900	1800	3600
Peak Shear Stress, psf	971	2410	2544
Post-Peak Shear Stress, psf	637	899	2044
Final Moisture Content , %	41.6	37.6	38.6

Peak Friction Angle, degrees:	30.3	Post-Peak Friction Angle, degrees:	26.1
Peak Cohesion, psf:	700	Post-Peak Cohesion, psf:	0



Comments: See attached plots for additional information

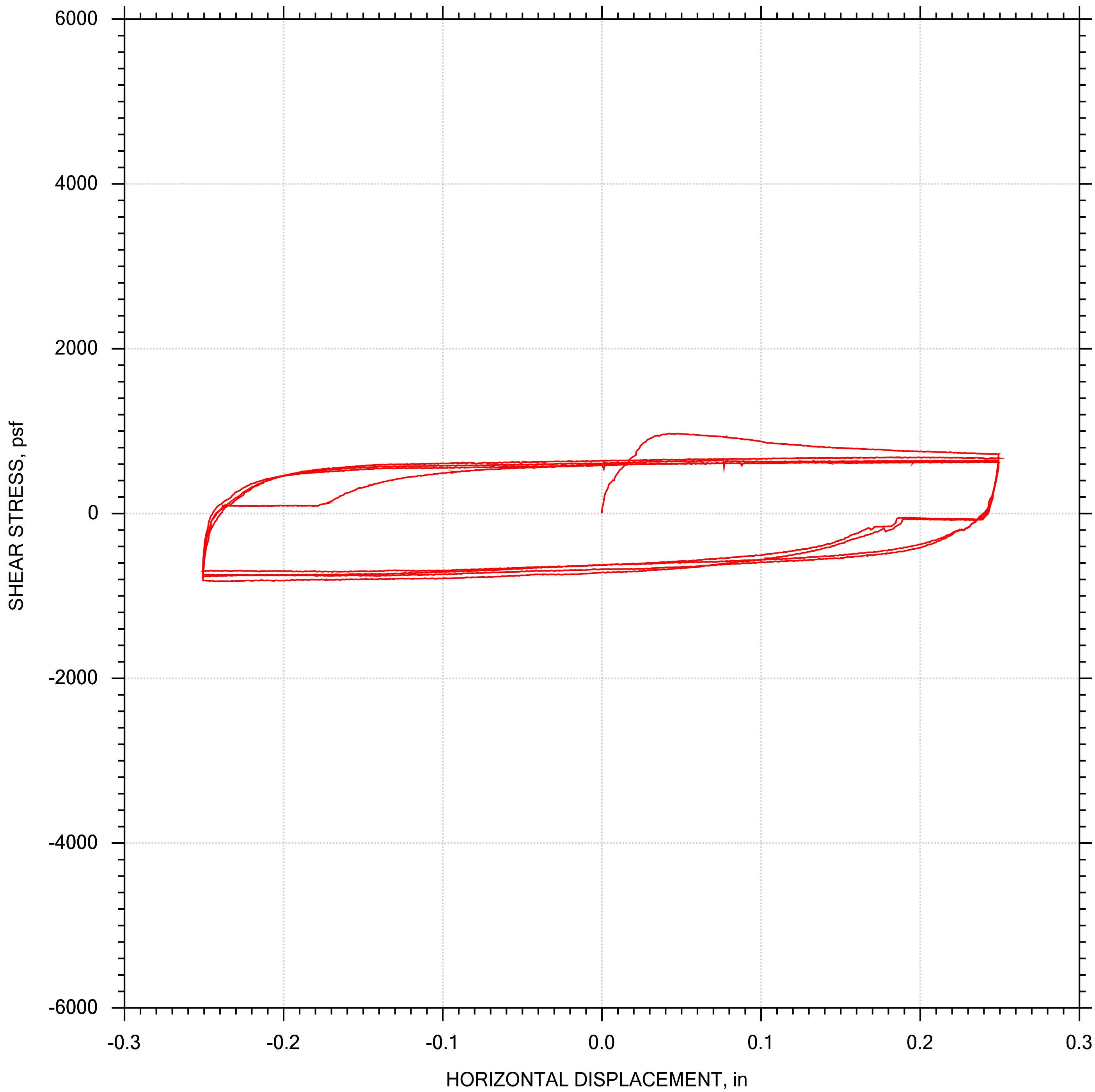
Peak shear strength determined by shearing specimen at 0.00035 ipm

Post-Peak (Residual) strength determined after 3 shearing cycles at 0.0035 ipm followed by one cycle at 0.00035 ipm.

Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

RESIDUAL SHEAR TEST

Point 1 - 900 psf

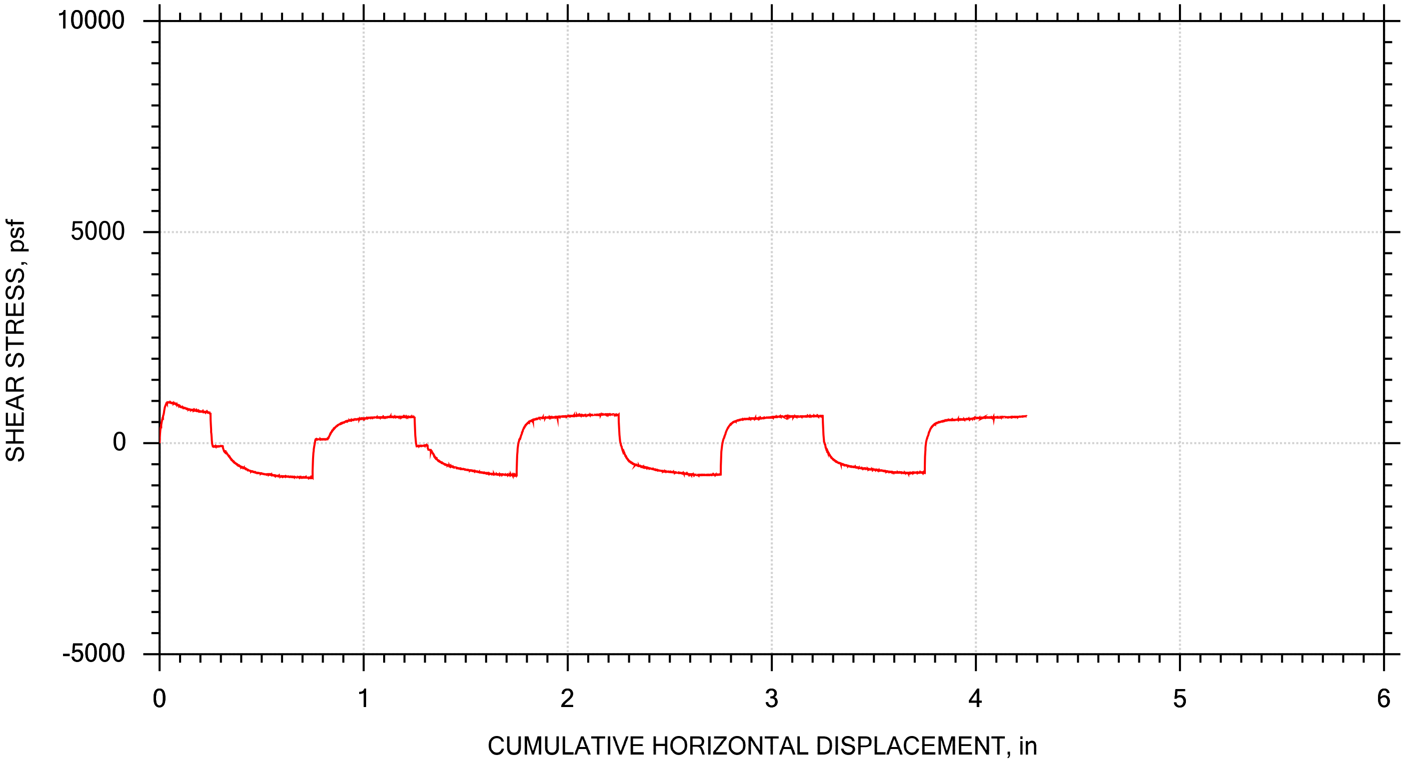


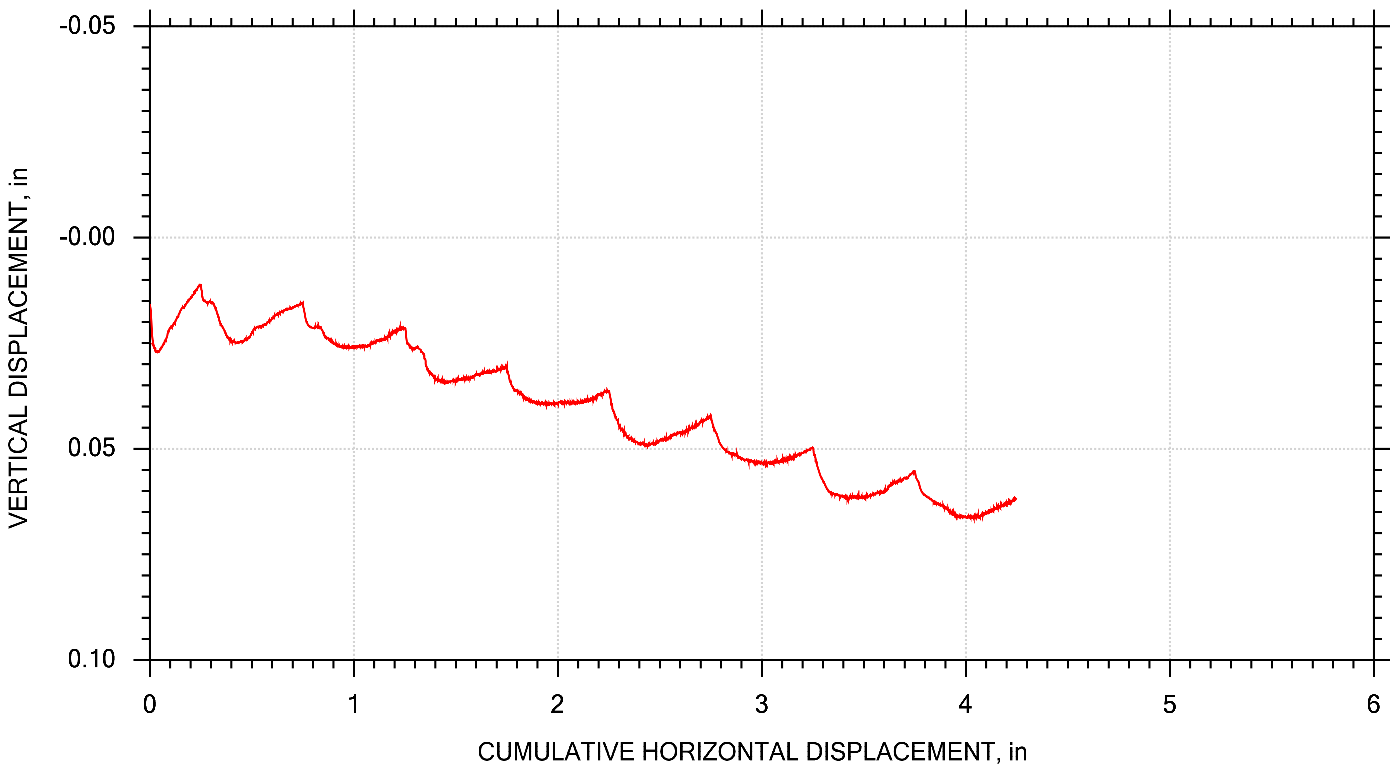
Project: S. Eads Retaining Wall Replacem	Location: ---	Project No.: GTX-306099
Boring No.: B-2	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/07/17	Depth: 15 ft
Test No.: RS-2-1	Sample Type: intact	Elevation: ---
Description: Moist, greenish gray clay		
Remarks: System J		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-2-1j.dat		

GeoTesting EXPRESS

RESIDUAL SHEAR TEST

Point 1 - 900 psf

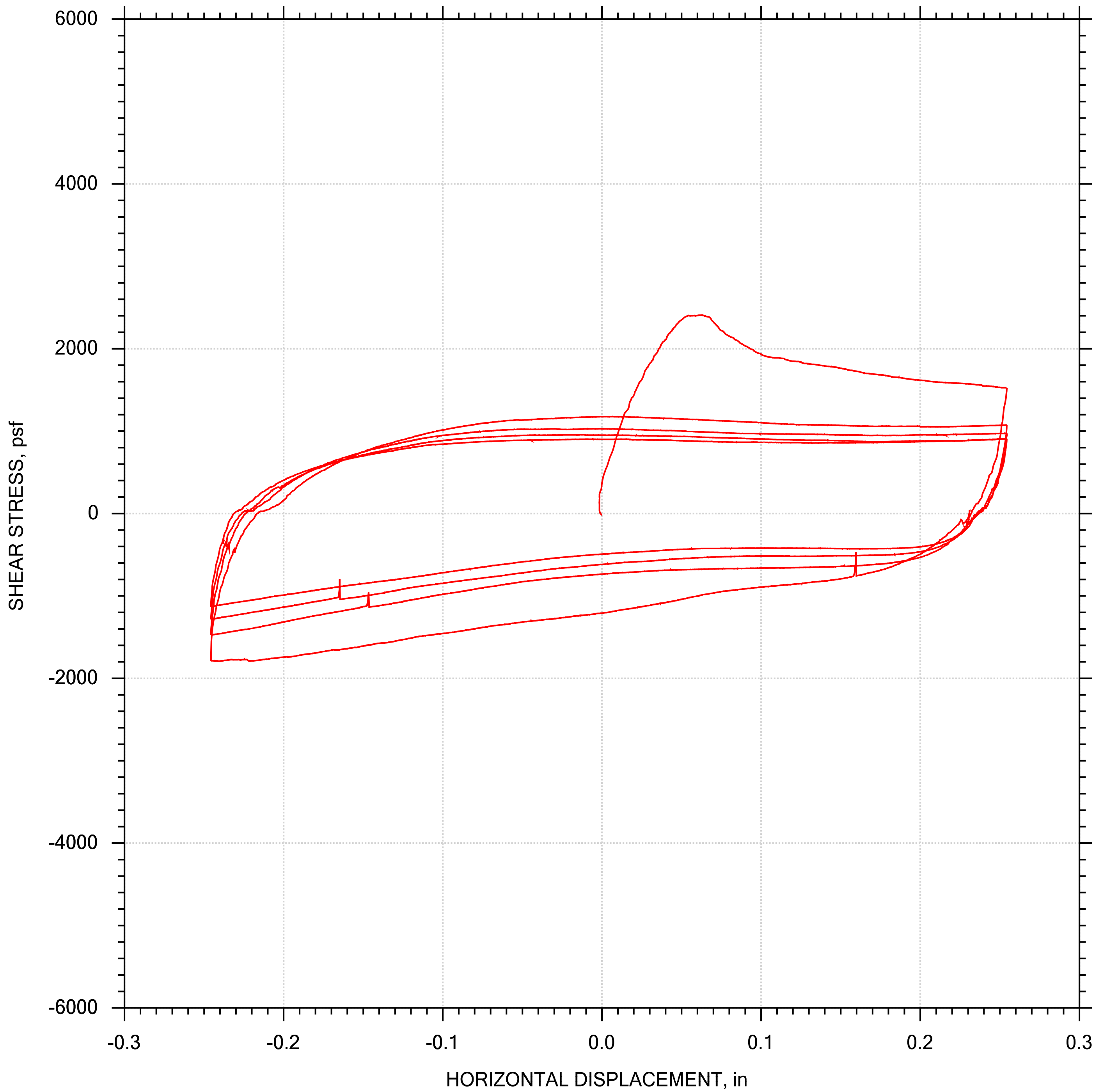




Project: S. Eads Retaining Wall Replacem	Location: ---	Project No.: GTX-306099
Boring No.: B-2	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/07/17	Depth: 15 ft
Test No.: RS-2-1	Sample Type: intact	Elevation: ---
Description: Moist, greenish gray clay		
Remarks: System J		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-2-1j.dat		

RESIDUAL SHEAR TEST

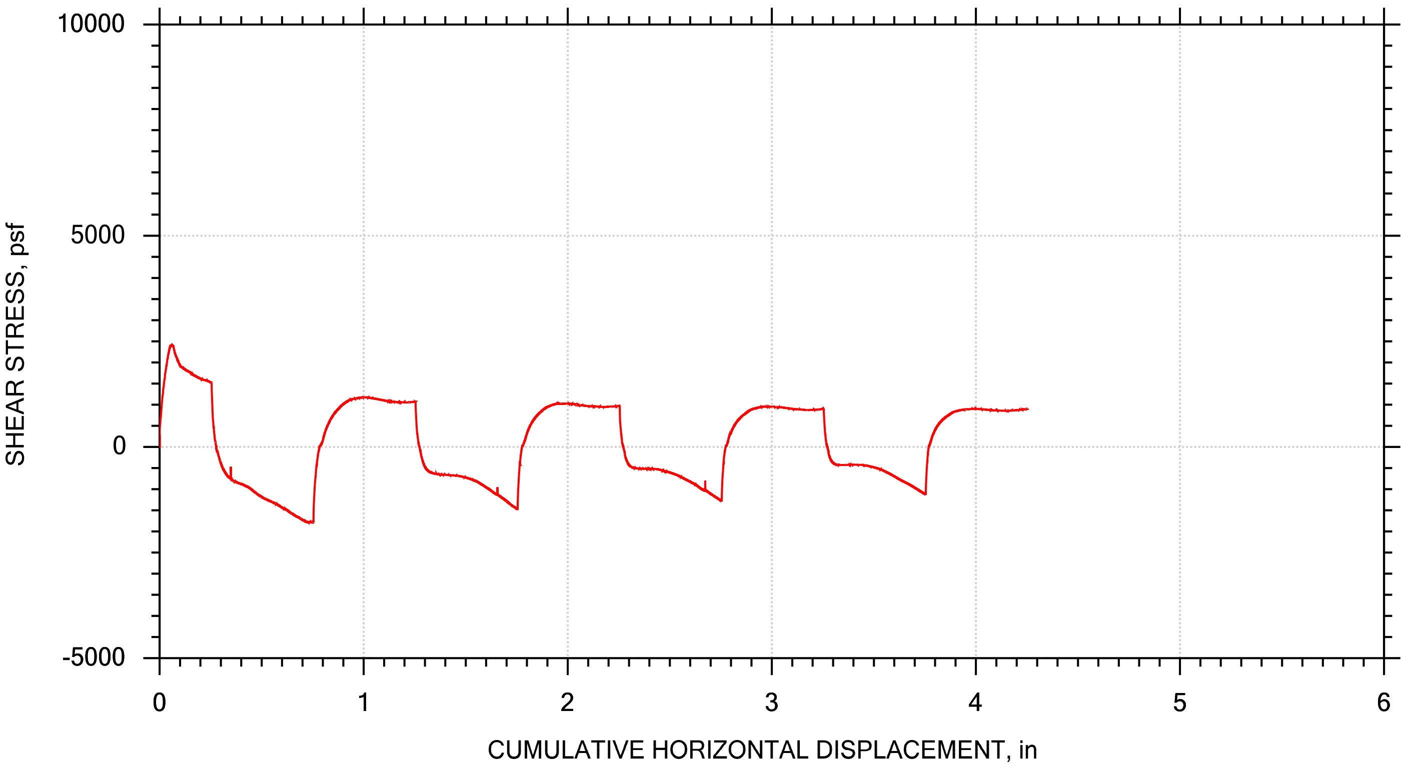
Point 2 - 1800 psf

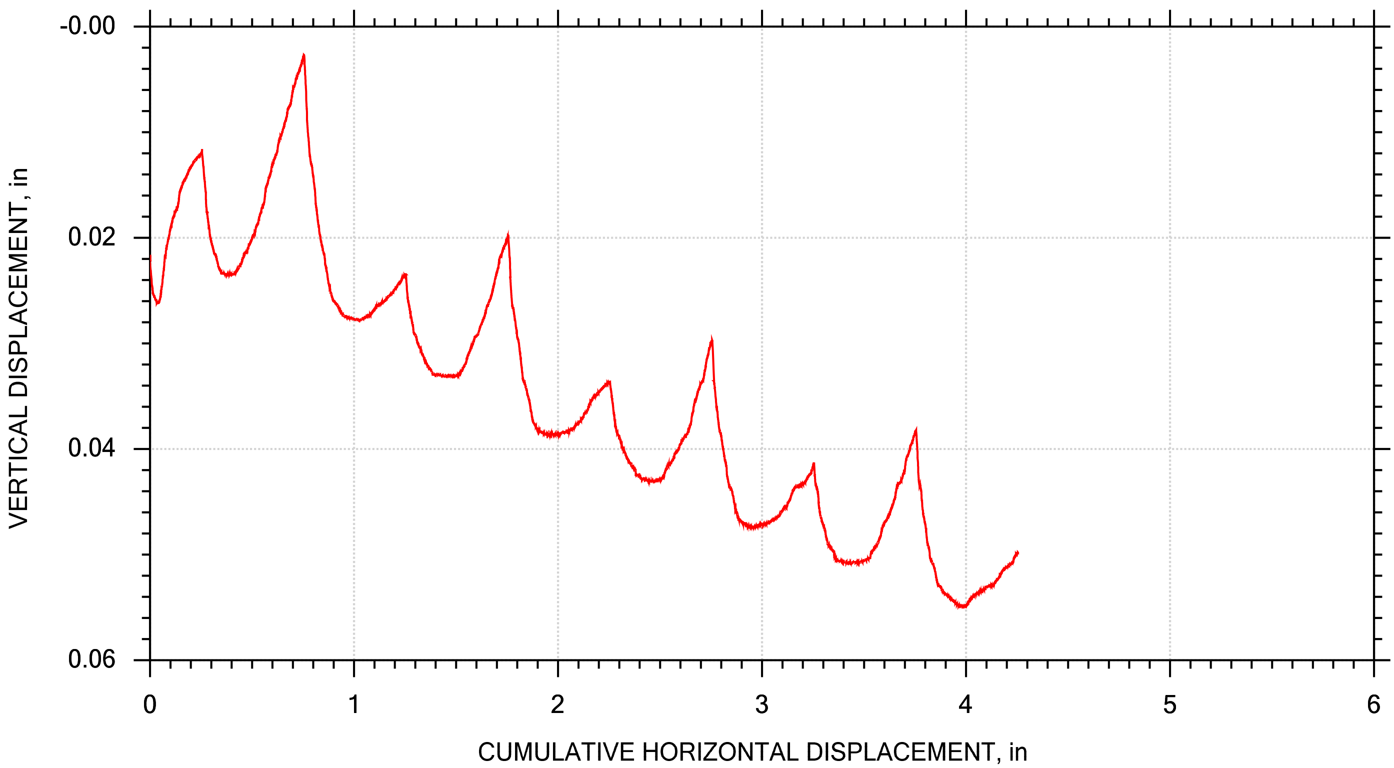


Project: S. Eads Retaining Wall Replacem	Location: ---	Project No.: GTX-306099
Boring No.: B-2	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/07/17	Depth: 15 ft
Test No.: RS-2-2	Sample Type: Tube	Elevation: ---
Description: Moist, greenish gray clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-2-2j.dat		

RESIDUAL SHEAR TEST

Point 2 - 1800 psf



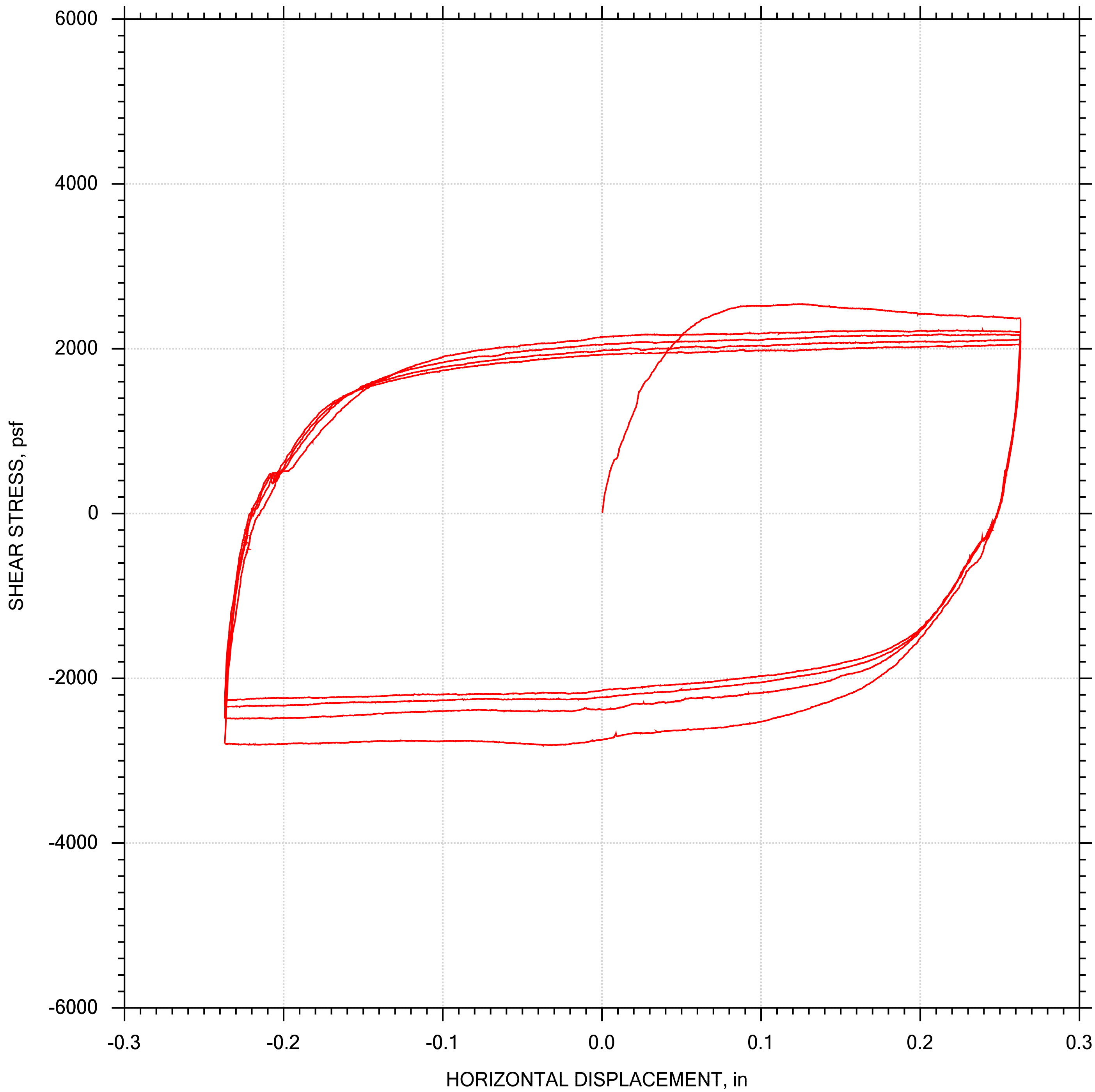


Project: S. Eads Retaining Wall Replacem	Location: ---	Project No.: GTX-306099
Boring No.: B-2	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/07/17	Depth: 15 ft
Test No.: RS-2-2	Sample Type: Tube	Elevation: ---
Description: Moist, greenish gray clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-2-2j.dat		

GeoTesting EXPRESS

RESIDUAL SHEAR TEST

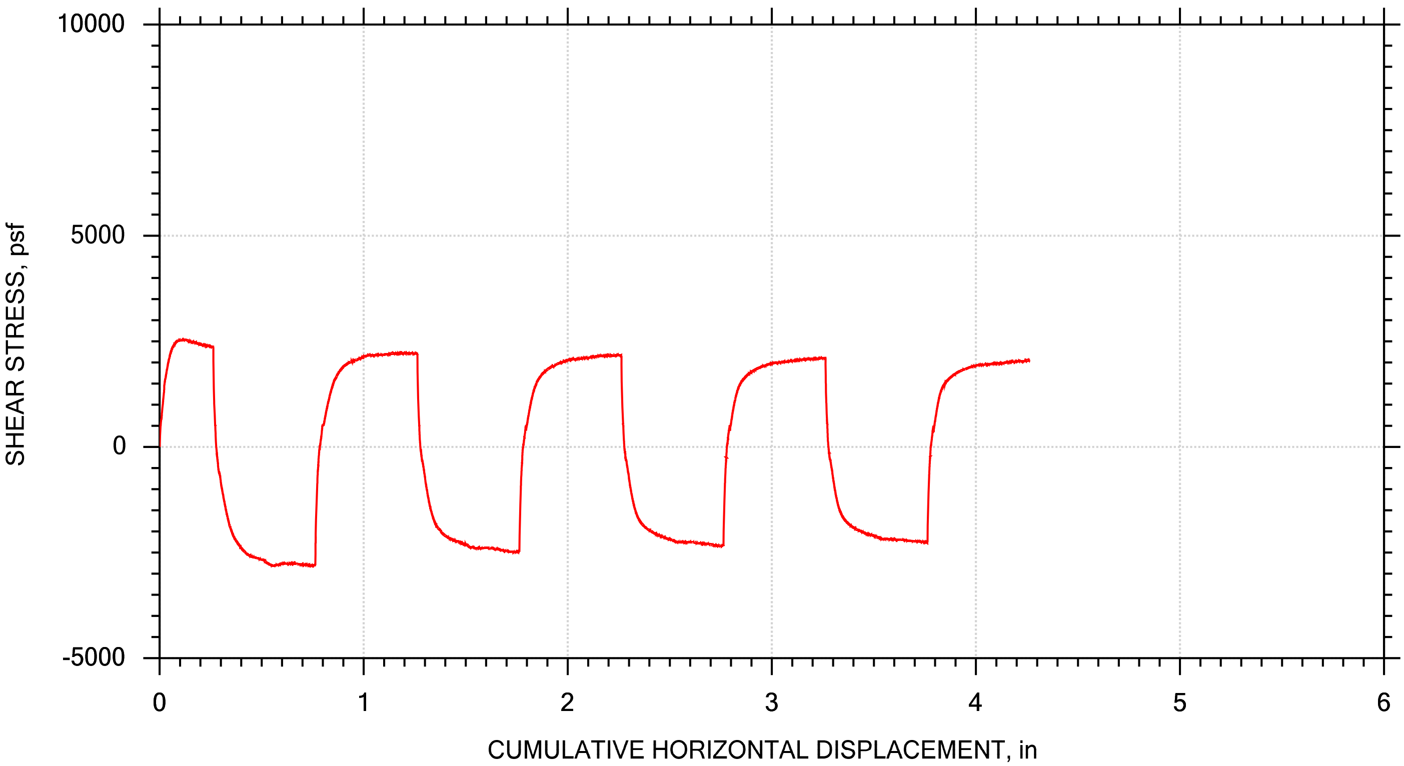
Point 3 - 3600 psf

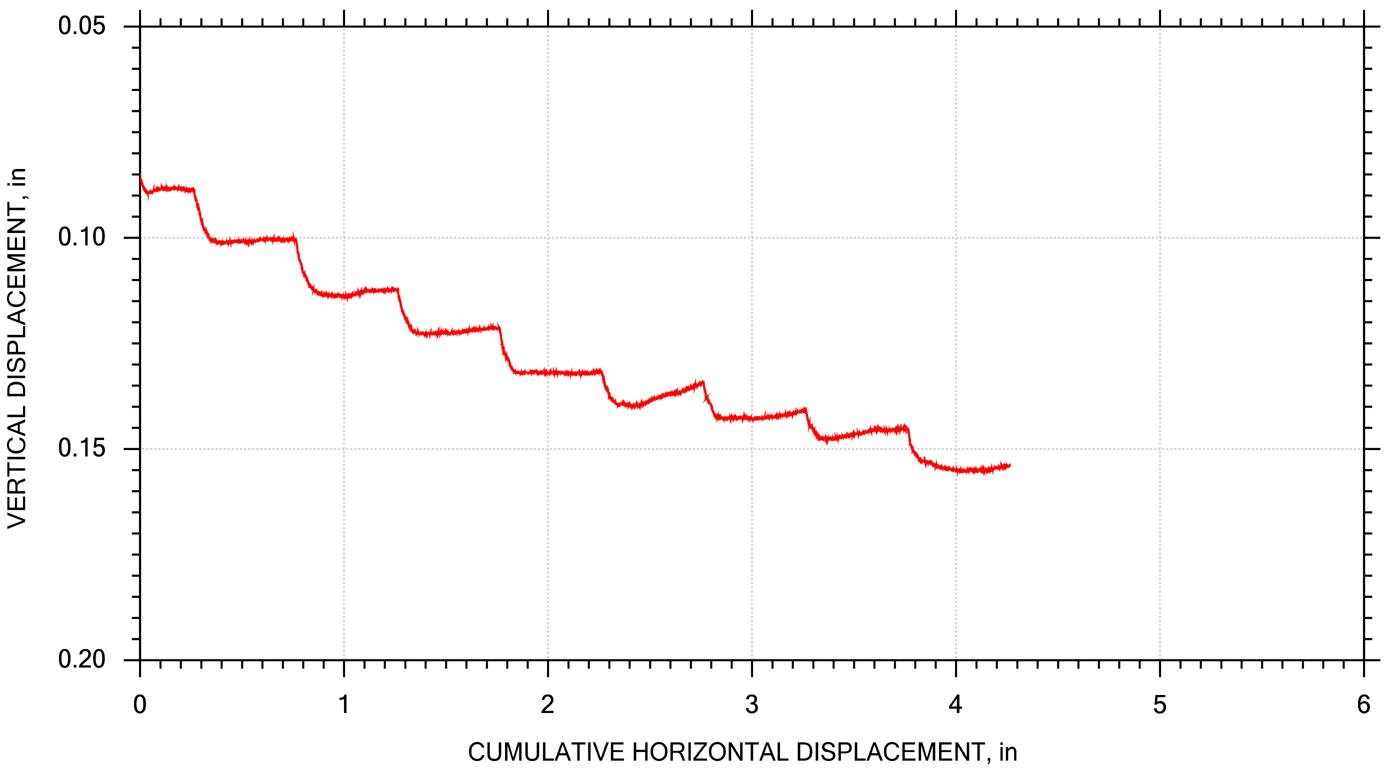


Project: S. Eads Retaining Wall Replacem	Location: ---	Project No.: GTX-306099
Boring No.: B-2	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/07/17	Depth: 15 ft
Test No.: RS-2-3	Sample Type: Tube	Elevation: ---
Description: Moist, greenish gray clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-2-3j2.dat		

RESIDUAL SHEAR TEST

Point 3 - 3600 psf





Project: S. Eads Retaining Wall Replacem	Location: ---	Project No.: GTX-306099
Boring No.: B-2	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/07/17	Depth: 15 ft
Test No.: RS-2-3	Sample Type: Tube	Elevation: ---
Description: Moist, greenish gray clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-2-3j2.dat		

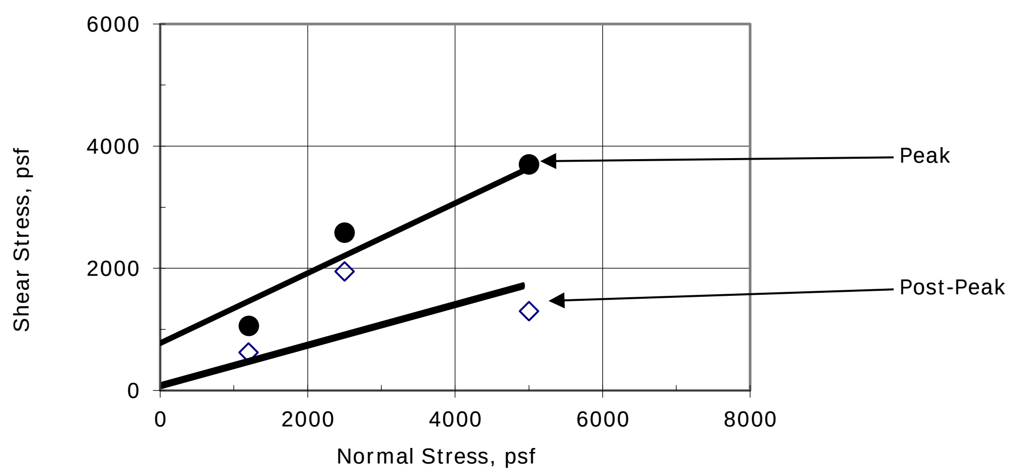
Client:	Schnabel Engineering, LLC		
Project Name:	S. Eads Retaining Wall Replacement		
Project Location:	---		
GTX #:	306099	Tested By:	md
Test Date:	03/23/17	Checked By:	jdt
Boring ID:	B-3		
Sample ID:	ST-1		
Depth, ft:	30		
Description:	Moist, light grayish brown clay		
Preparation:	Extruded from tube, cut and trimmed and tested at the as-received moisture and density.		

Direct Shear (ASTM D3080) and Residual Shear (USACOE EM1110-modified)

Parameter	Point 1	Point 2	Point 3
Test No.	RS-1	RS-2	RS-3
Initial Moisture Content, %	27.1	25.5	25.7
Initial Dry Density, pcf	86.4	87.6	90.0
Nominal Rate of Shear Strain, inches/min	0.00035	0.00035	0.00035
Vertical Consolidation Stress, psf	1200	2500	5000
Peak Shear Stress, psf	1630	2586	3704
Post-Peak Shear Stress, psf	620	1950	1300
Final Moisture Content , %	41.6	34.7	33.3

Peak Friction Angle, degrees:	30.3	Post-Peak Friction Angle, degrees:	15.0
Peak Cohesion, psf:	769	Post-Peak Cohesion, psf:	0

Normal Stress vs. Shear Stress



Comments: See attached plots for additional information

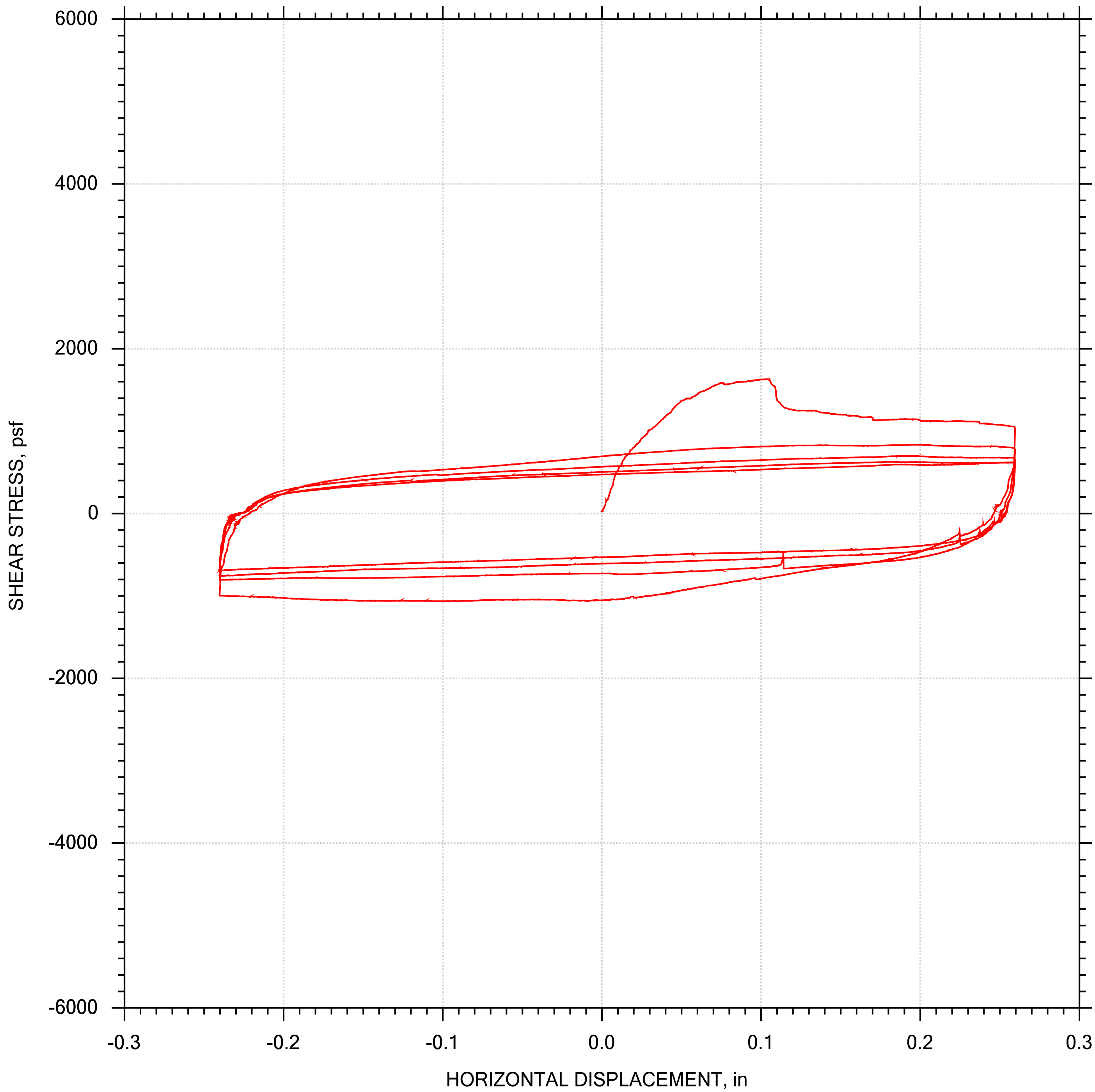
Peak shear strength determined by shearing specimen at 0.00035 ipm

Post-Peak (Residual) strength determined after 3 shearing cycles at 0.0035 ipm followed by one cycle at 0.00035 ipm.

Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

RESIDUAL SHEAR TEST

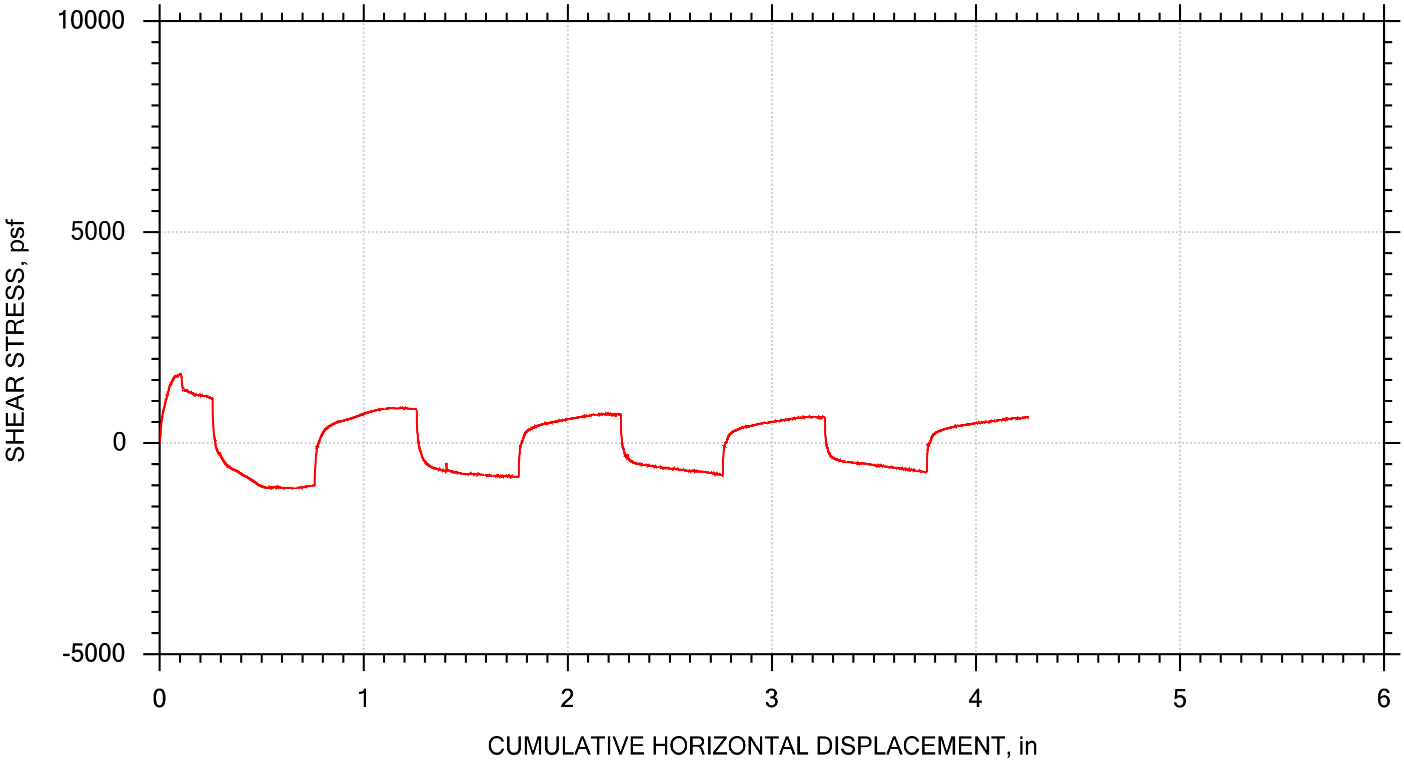
Point 1 - 1200 psf

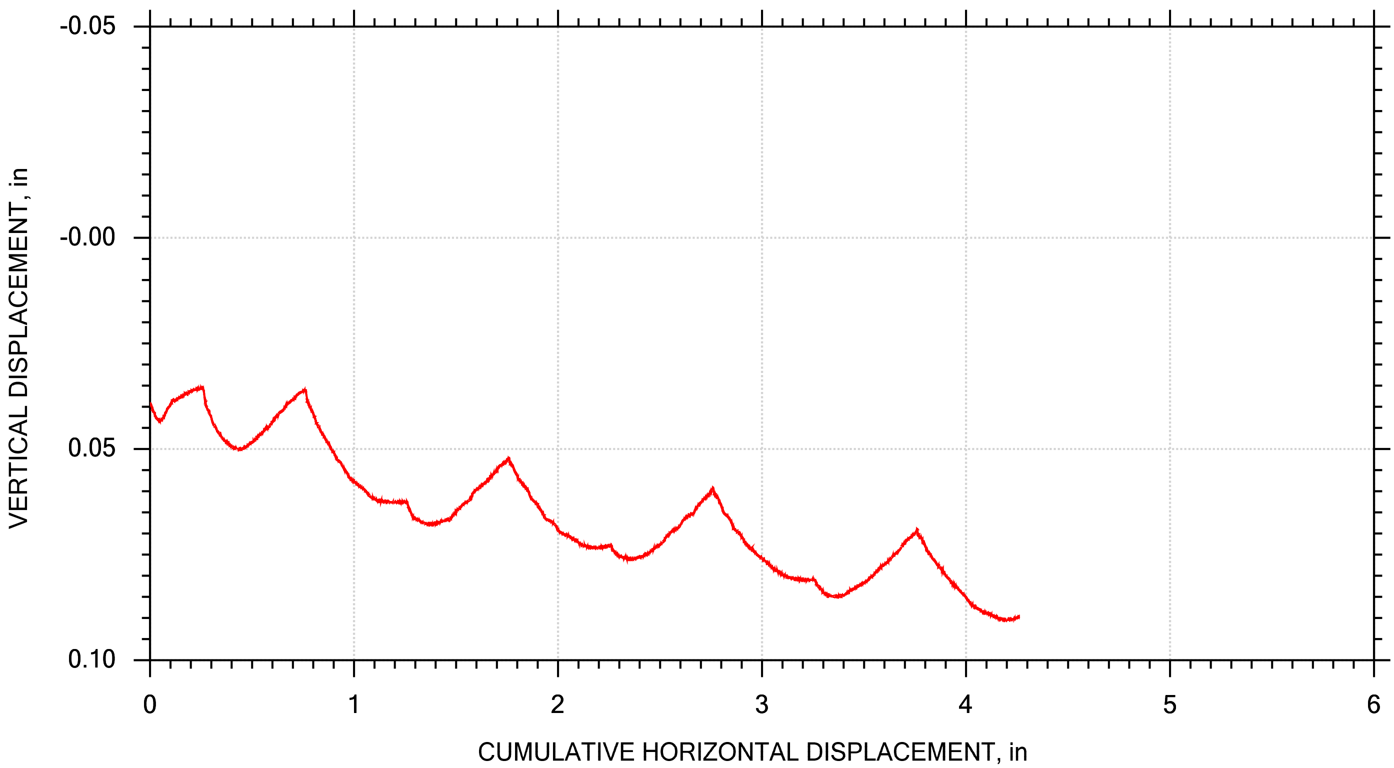


Project: S. Eads Retaining Wall Replace	Location: ---	Project No.: GTX-306099
Boring No.: B-3	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/03/17	Depth: 30 ft
Test No.: RS-1-1	Sample Type: Tube	Elevation: ---
Description: Moist, light grayish brown clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-1-1.dat		

RESIDUAL SHEAR TEST

Point 1 - 1200 psf

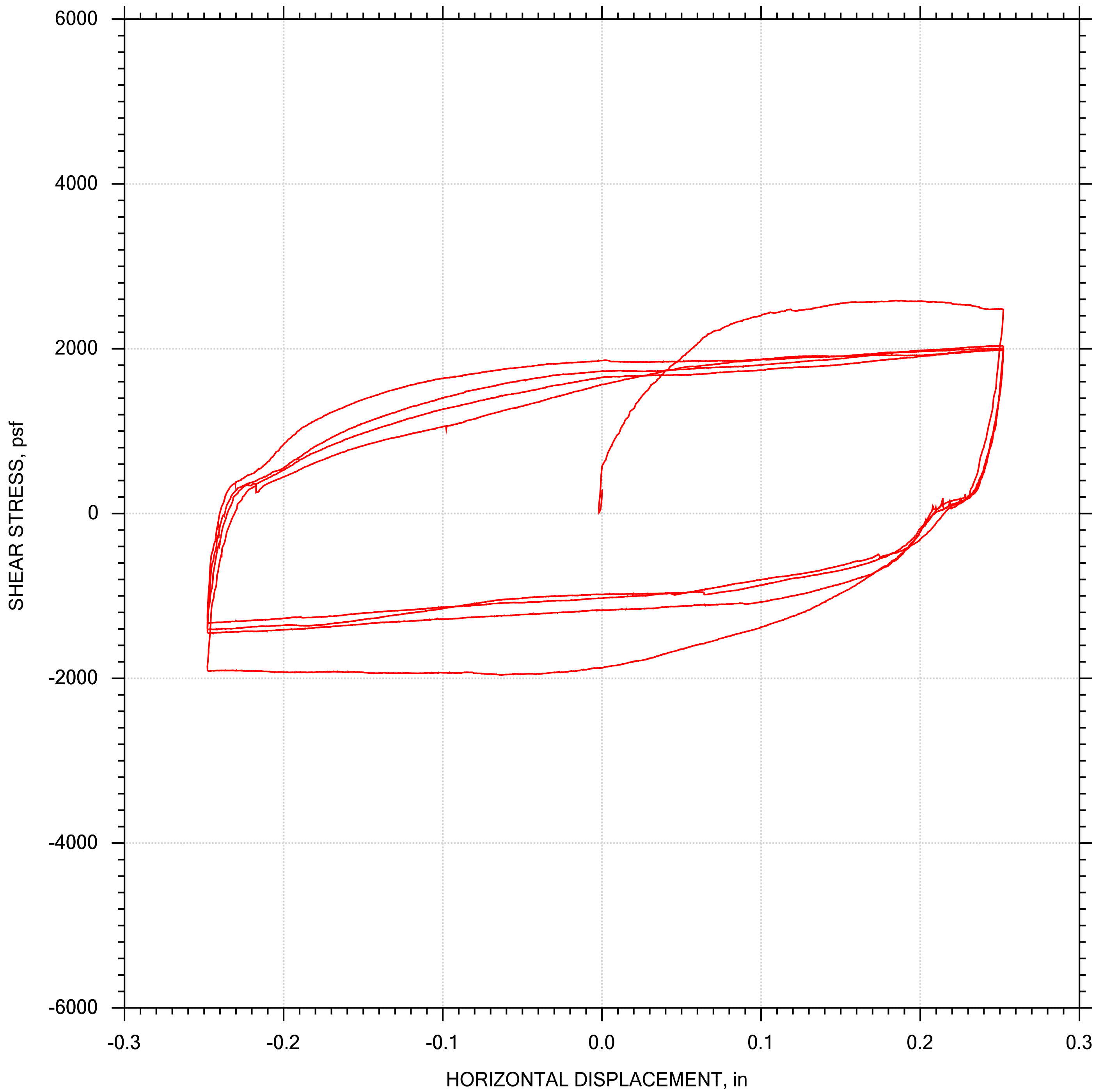




Project: S. Eads Retaining Wall Replace	Location: ---	Project No.: GTX-306099
Boring No.: B-3	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 04/03/17	Depth: 30 ft
Test No.: RS-1-1	Sample Type: Tube	Elevation: ---
Description: Moist, light grayish brown clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-1-1.dat		

RESIDUAL SHEAR TEST

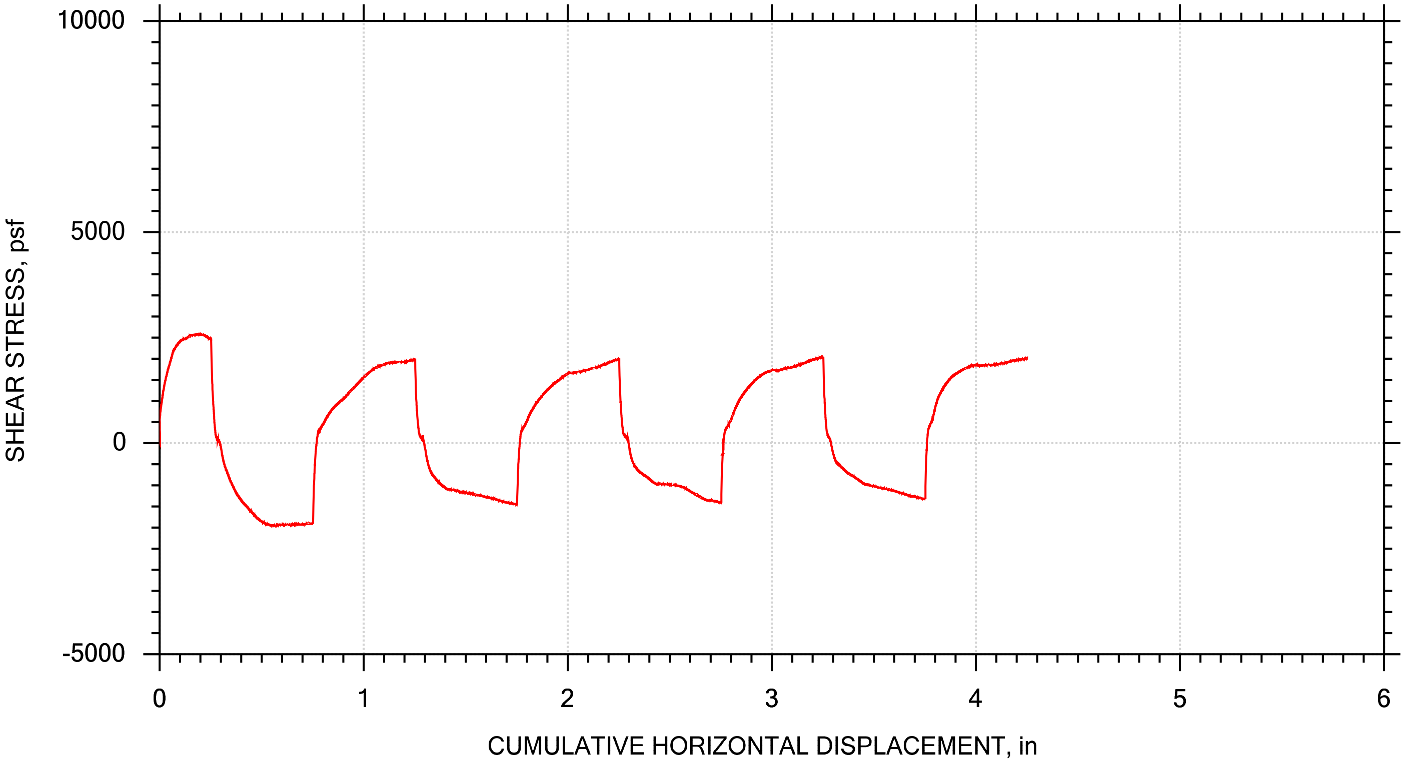
Point 2 - 2500 psf

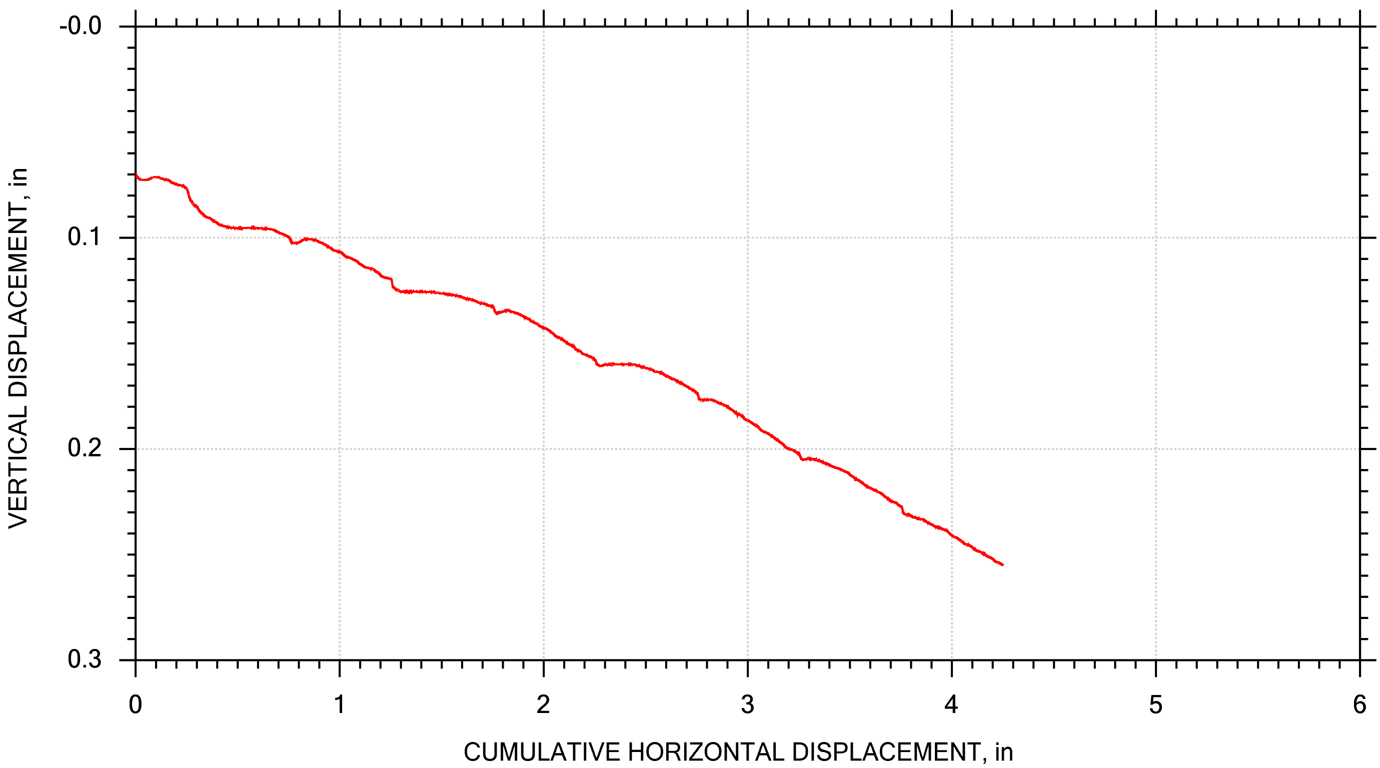


Project: S. Eads Retaining Wall Replace	Location:	Project No.: GTX-306099
Boring No.: B-3	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 03/24/17	Depth: 30 ft
Test No.: RS-1-2	Sample Type: Tube	Elevation: ---
Description: Moist, light grayish brown clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-1-2 j.dat		

RESIDUAL SHEAR TEST

Point 2 - 2500 psf

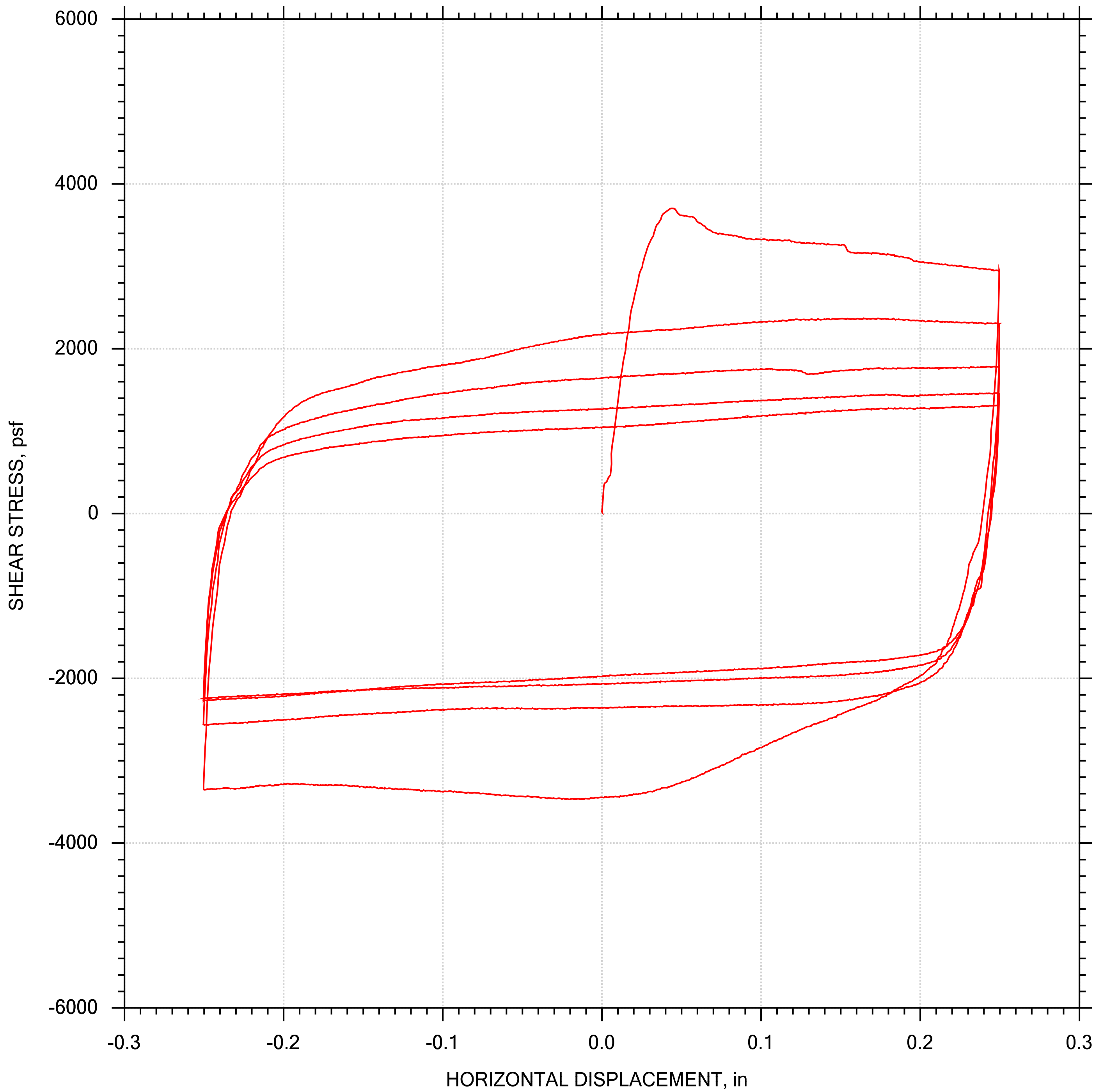




Project: S. Eads Retaining Wall Replace	Location:	Project No.: GTX-306099
Boring No.: B-3	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 03/24/17	Depth: 30 ft
Test No.: RS-1-2	Sample Type: Tube	Elevation: ---
Description: Moist, light grayish brown clay		
Remarks: System L		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-1-2 j.dat		

RESIDUAL SHEAR TEST

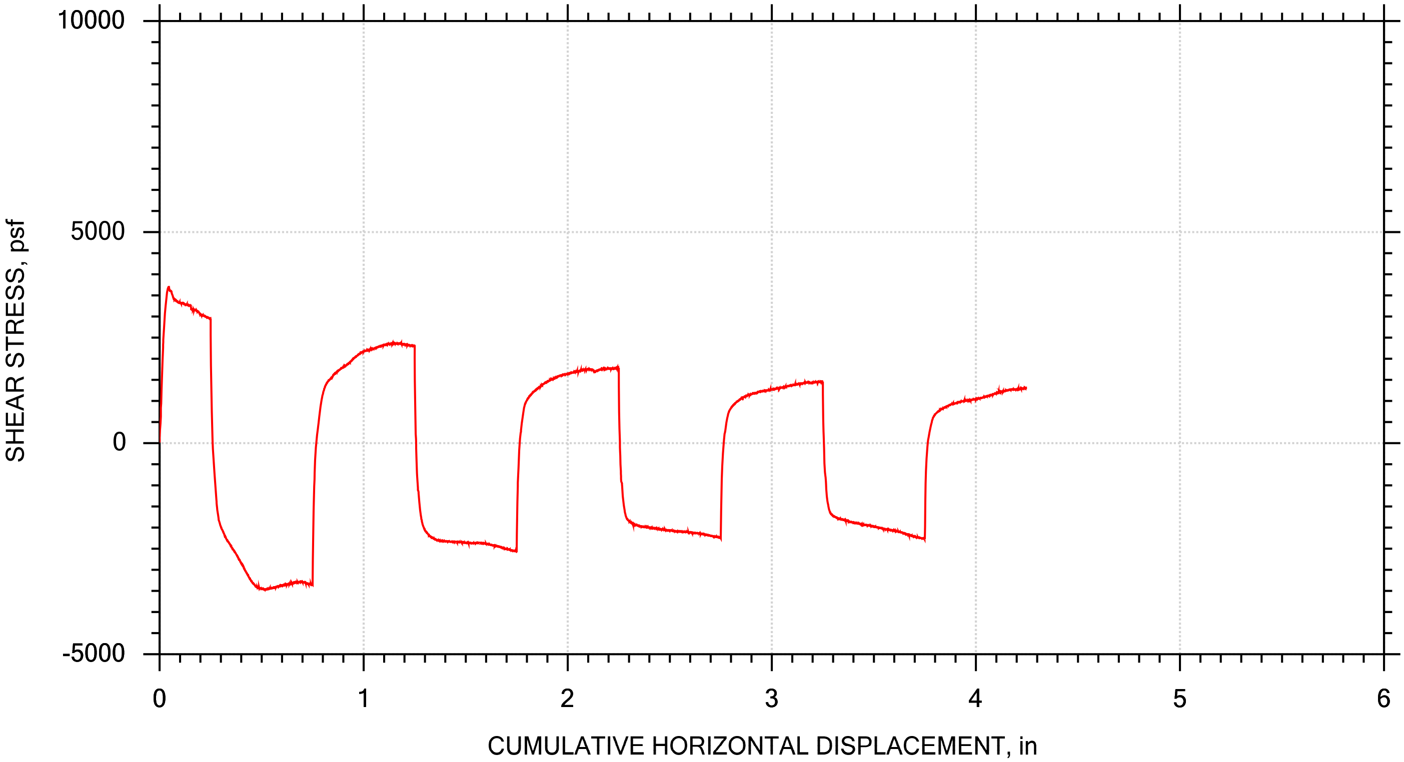
Point 3 - 5000 psf

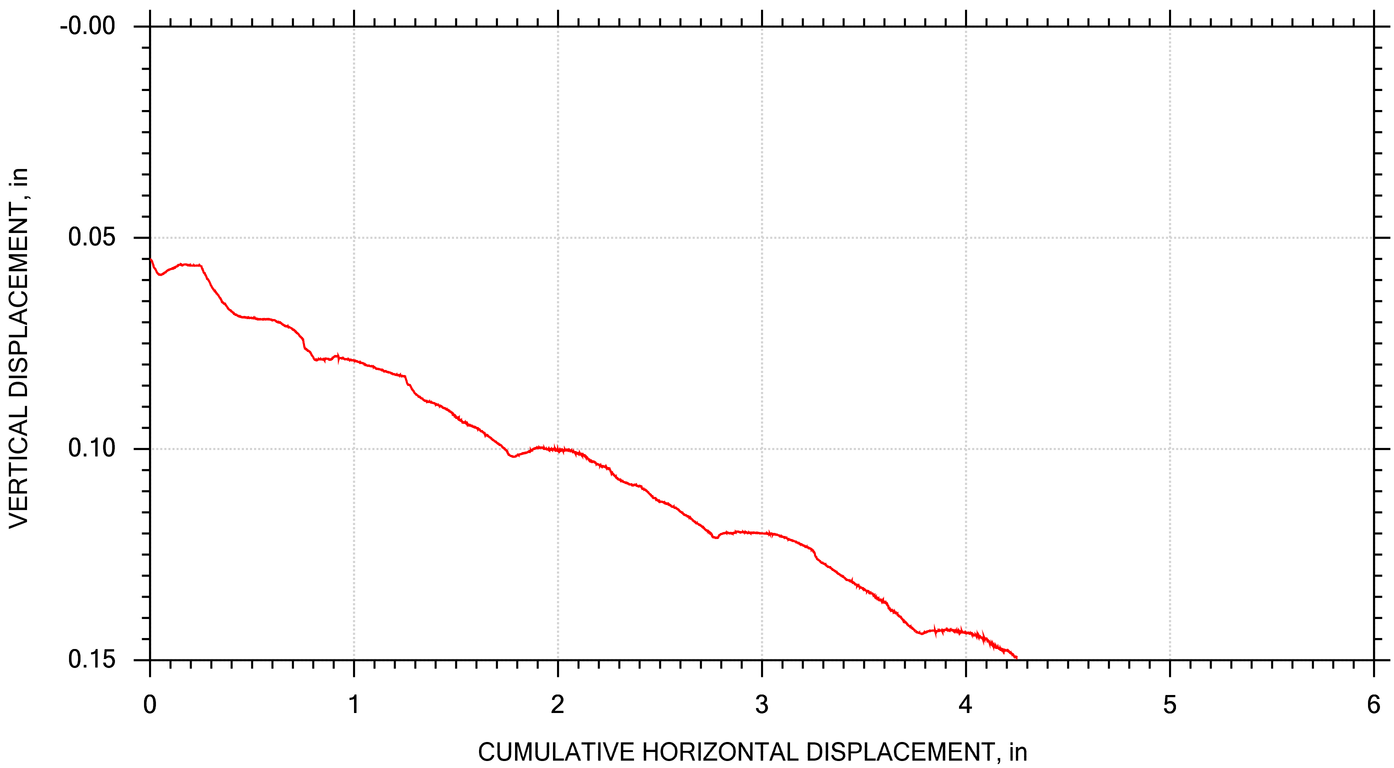


Project: S. Eads Retaining Wall Replace	Location:	Project No.: GTX-306099
Boring No.: B-3	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 03/26/17	Depth: 30 ft
Test No.: RS-1-3A	Sample Type: intact	Elevation: ---
Description: Moist, light grayish brown clay		
Remarks: System J		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-1-3A.dat		

RESIDUAL SHEAR TEST

Point 3 - 5000 psf

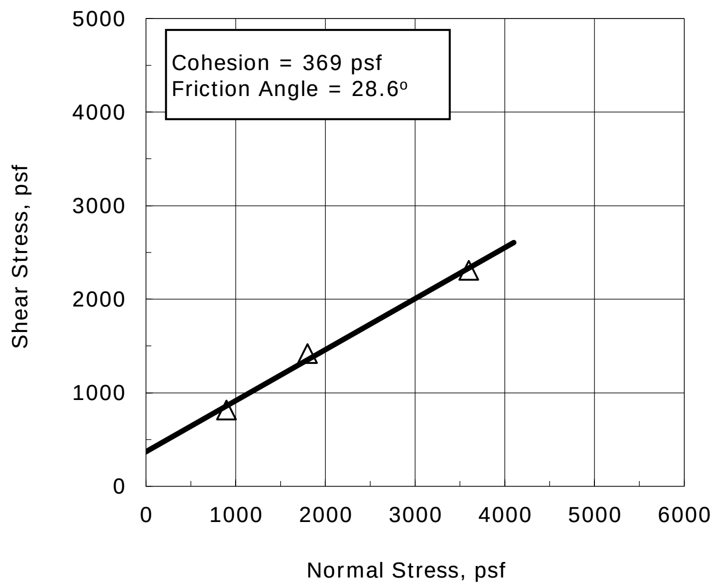


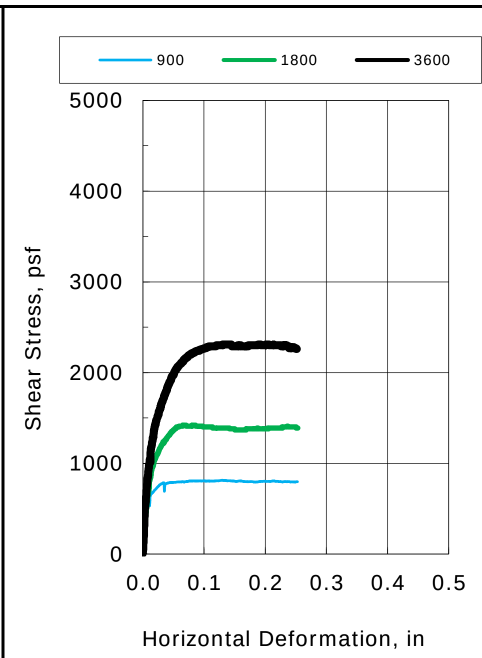


Project: S. Eads Retaining Wall Replace	Location:	Project No.: GTX-306099
Boring No.: B-3	Tested By: md	Checked By: jdt
Sample No.: ST-1	Test Date: 03/26/17	Depth: 30 ft
Test No.: RS-1-3A	Sample Type: intact	Elevation: ---
Description: Moist, light grayish brown clay		
Remarks: System J		
File: \\HAL1\Projects\GTX306099 - Schnabel - S Eads Retaining Wall\6 Lab Testing\Soil\RS\306099-RS-1-3A.dat		

Client:	Schnabel Engineering, LLC
Project Name:	S. Eads Retaining Wall Replacement
Project Location:	---
GTX #:	306099
Test Date:	04/18/17
Tested By:	md
Checked By:	jdt
Boring ID:	B-2
Sample ID:	ST-1
Depth, ft:	15
Visual Description:	Moist, greenish gray clay

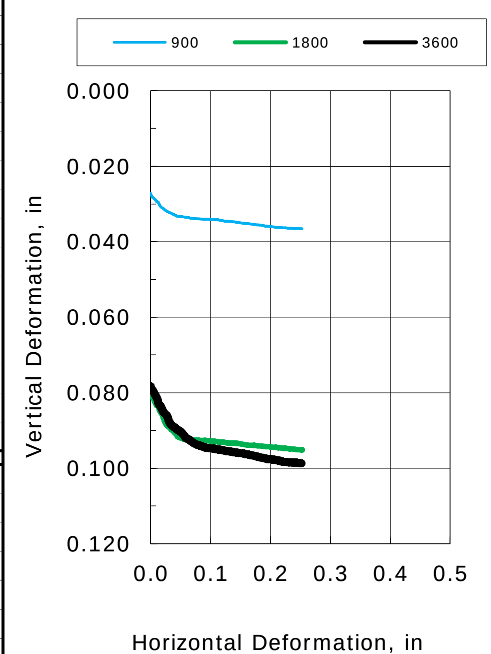
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D3080





Test No.:	DS-3-1	DS-3-2	DS-3-3
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	152.0	152.0	152.0
Initial Dry Density, pcf:	92.7	92.7	92.7
Initial Moisture Content, %:	27.2	27.2	27.2
Initial Bulk Density, pcf:	118.0	118.0	118.0
Initial Degree of Saturation:	89.9	89.9	89.9
Initial Void Ratio:	0.82	0.82	0.82
Final Dry Density, pcf:	96.2	102.5	102.9
Final Moisture Content, %:	33.3	31.2	31.7
Final Bulk Density, pcf:	128.2	134.5	135.5
Normal Stress, psf:	900	1800	3600
Maximum Shear Stress, psf:	814	1420	2310
Shear Rate, in/min:	0.00035	0.00035	0.00035

Sample Type:	reconstituted
Estimated Specific Gravity:	2.75
Liquid Limit:	59
Plastic Limit:	28
Plasticity Index:	31
% Passing #200 sieve:	93.3
Soil Classification:	Fat Clay
Group Symbol:	CH



Notes:

Material greater than #5 sieve screened out of sample prior to testing

Moisture content obtained before shear from sample trimmings (one representative moisture content used for all three specimens).

Moisture Content determined by ASTM D2216

Percent passing #200 sieve determined by ASTM D422

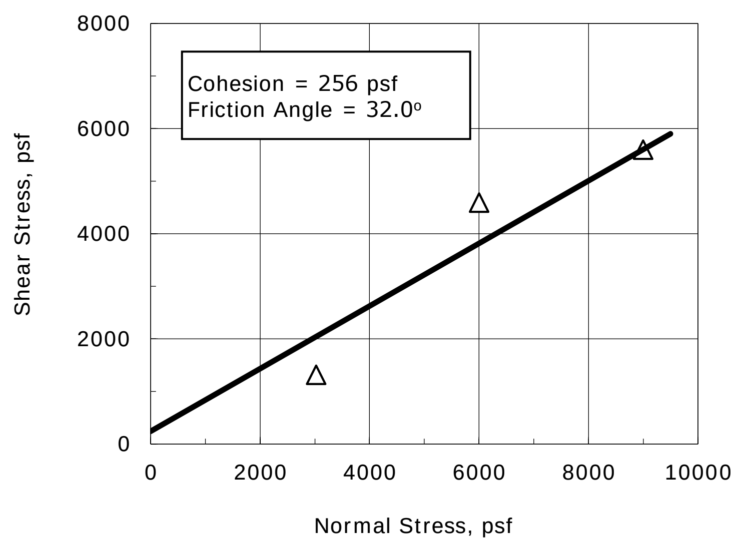
Atterberg Limits determined by ASTM D4318

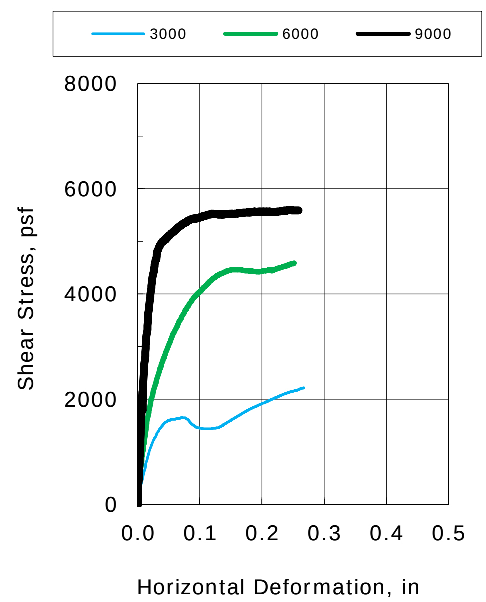
As requested, the test specimens were reconstituted to the approximate as-received density and moisture content.

Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

Client:	Schnabel Engineering, LLC
Project Name:	S. Eads Retaining Wall Replacement
Project Location:	---
GTX #:	306099
Test Date:	04/14/17
Tested By:	md
Checked By:	jdt
Boring ID:	B-2
Sample ID:	ST-2
Depth, ft:	50
Visual Description:	Moist, greenish gray clayey gravel with sand

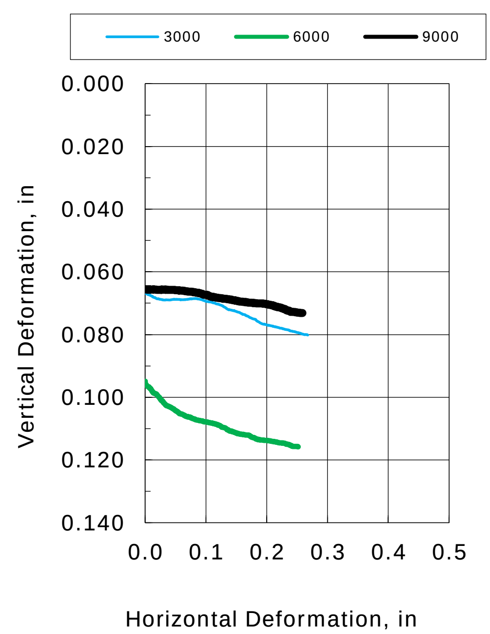
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D3080





Test No.:	DS-2-1	DS-2-2	DS-2-3
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	149.1	136.9	144.9
Initial Dry Density, pcf:	93.2	84.9	92.1
Initial Moisture Content, %:	24.1	25.2	22.1
Initial Bulk Density, pcf:	115.7	106.3	112.5
Initial Degree of Saturation:	80.5	69.0	71.8
Initial Void Ratio:	0.81	0.99	0.83
Final Dry Density, pcf:	101.3	96.0	99.4
Final Moisture Content, %:	27.5	27.9	26.5
Final Bulk Density, pcf:	129.2	122.8	125.7
Normal Stress, psf:	3000	6000	9000
Maximum Shear Stress, psf:	2220	4590	5600
Shear Rate, in/min:	0.001	0.001	0.001

Sample Type:	intact
Estimated Specific Gravity:	2.70
Liquid Limit:	42
Plastic Limit:	18
Plasticity Index:	24
% Passing #200 sieve:	45.8
Soil Classification:	Clayey Gravel with Sand
Group Symbol:	GC



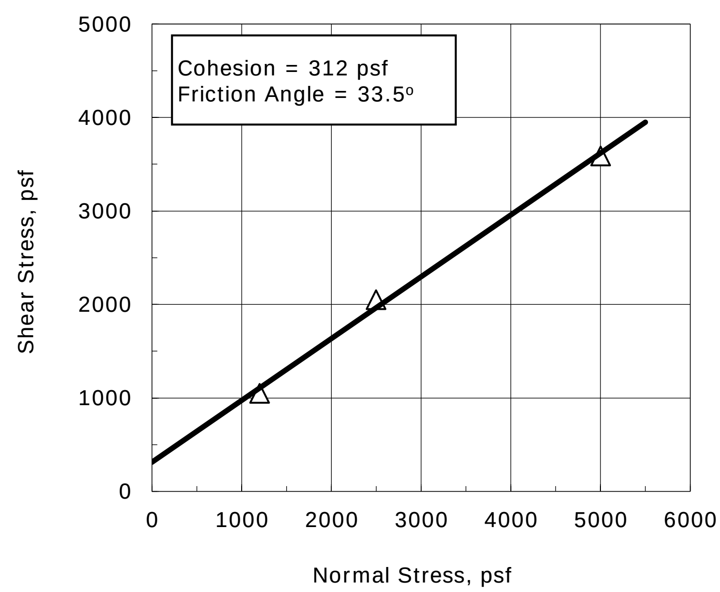
Notes:
Moisture content obtained before shear from sample trimmings
Moisture Content determined by ASTM D2216
Percent passing #200 sieve determined by ASTM D422
Atterberg Limits determined by ASTM D4318
The test specimens were extruded from the tube and tested at the as-received density and moisture content.

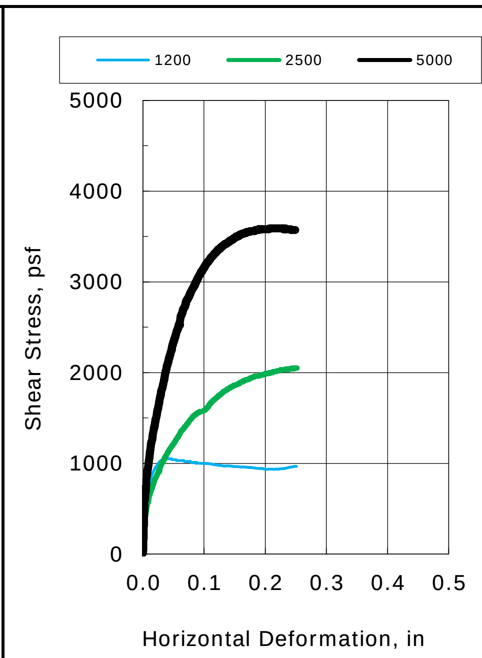
Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

GeoTesting EXPRESS

Client:	Schnabel Engineering, LLC
Project Name:	S. Eads Retaining Wall Replacement
Project Location:	---
GTX #:	306099
Test Date:	04/12/17
Tested By:	md
Checked By:	jdt
Boring ID:	B-3
Sample ID:	ST-1
Depth, ft:	30
Visual Description:	Moist, light grayish brown clay

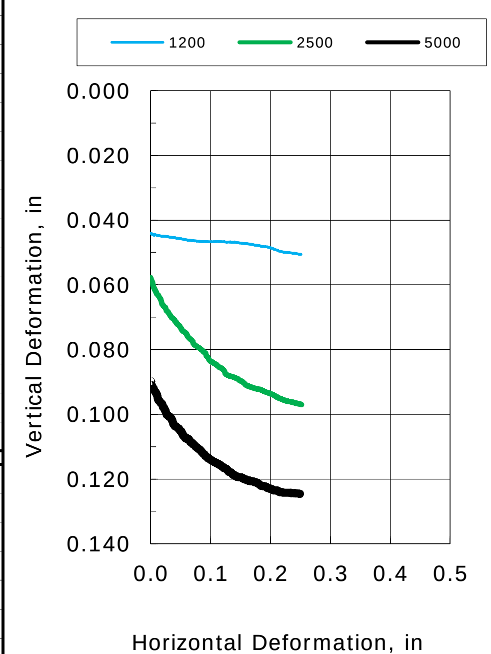
Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D3080





Test No.:	DS-1-1	DS-1-2	DS-1-3
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	142.4	142.4	142.4
Initial Dry Density, pcf:	87.4	87.4	87.4
Initial Moisture Content, %:	26.5	26.5	26.5
Initial Bulk Density, pcf:	110.5	110.5	110.5
Initial Degree of Saturation:	75.5	75.6	75.6
Initial Void Ratio:	0.96	0.96	0.96
Final Dry Density, pcf:	92.1	96.8	99.8
Final Moisture Content, %:	38.1	38.5	33.9
Final Bulk Density, pcf:	127.1	134.0	133.7
Normal Stress, psf:	1200	2500	5000
Maximum Shear Stress, psf:	1050	2050	3590
Shear Rate, in/min:	0.00035	0.00035	0.00035

Sample Type:	reconstituted
Estimated Specific Gravity:	2.75
Liquid Limit:	66
Plastic Limit:	25
Plasticity Index:	41
% Passing #200 sieve:	90.3
Soil Classification:	Fat Clay
Group Symbol:	CH



Notes:
- Material greater than #5 sieve screened out of sample prior to testing
- Moisture content obtained before shear from sample trimmings (one representative moisture content used for all three specimens).
- Moisture Content determined by ASTM D2216
- Percent passing #200 sieve determined by ASTM D422
- Atterberg Limits determined by ASTM D4318
- As requested, the test specimens were reconstituted to the approximate as-received density and moisture content.
- Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

APPENDIX D

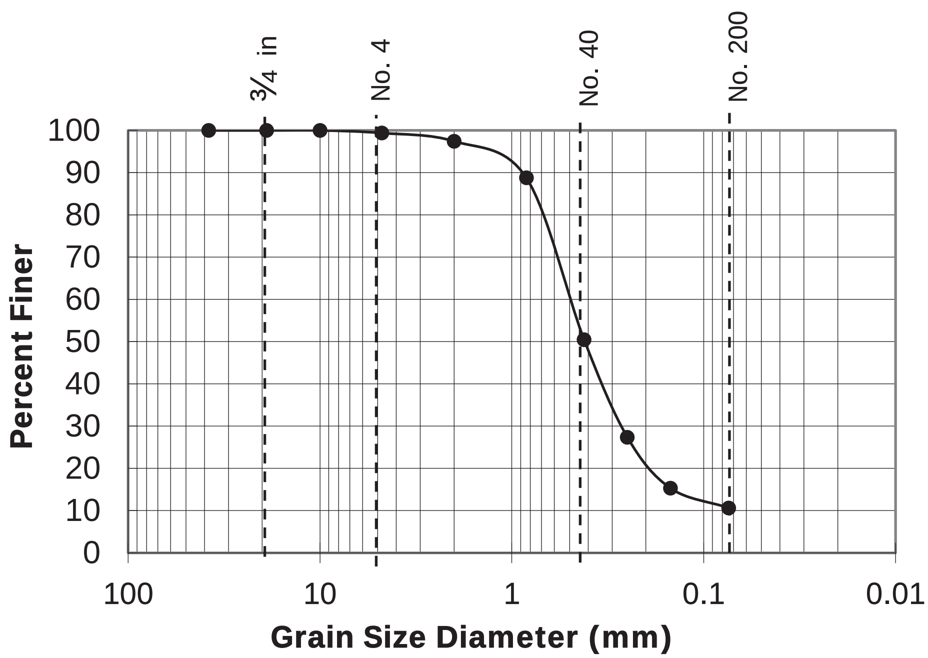
GEOCONCEPTS SOIL LABORATORY TEST DATA

Gradation Curves

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., Suite 170
Ashburn, Virginia 20147
(703) 726-8030
www.geoconcepts-eng.com

GRAIN SIZE ANALYSIS - ASTM D422

Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-1	**Depth (Feet)**	17.0'-18.5'
Lab Order No.	3345-1	**Date**	8/20/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**99**
#10	**97**
#20	**89**
#40	**50**
#60	**27**
#100	**15**
#200	**11**
Pan	**--**

USCS Group Symbol	**SP-SC**
USCS Group Name	**POORLY GRADED SAND with clay**
Cu	**---**
Cc	**---**
LL	**39**
PI	**14**
Gravel	**0.6**
Sand	**88.7**
Fines	**10.6**
AASHTO Classification	**A-2-6**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:___________________

Reviewed by: Shaun Harris

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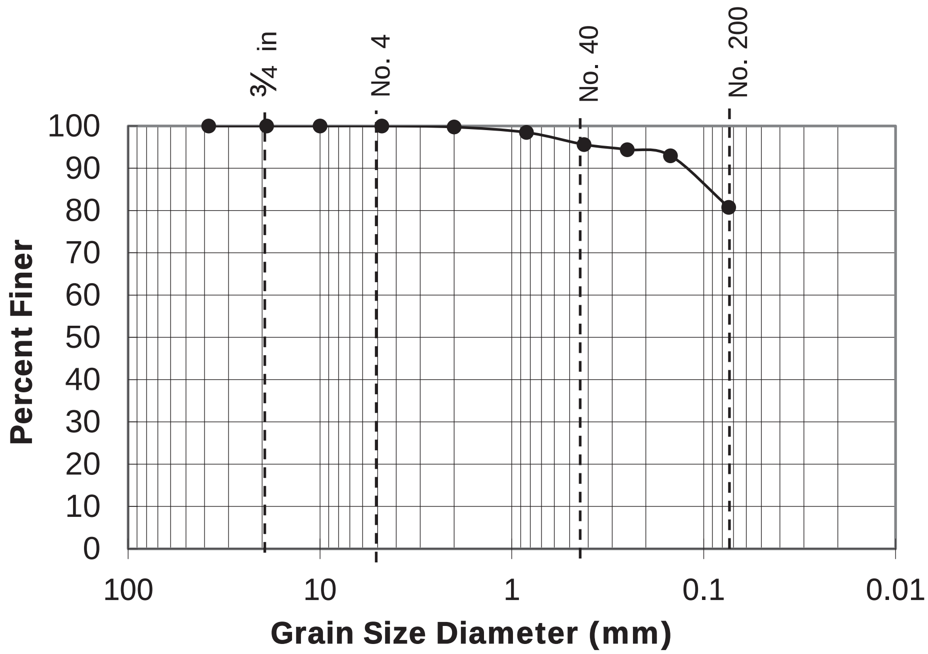
www.geoconcepts-eng.com

GRAIN SIZE ANALYSIS - ASTM D422

Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-1	**Depth (Feet)**	18.5'-20.0'
Lab Order No.	3372-1	**Date**	9/8/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**98**
#40	**96**
#60	**94**
#100	**93**
#200	**81**
Pan	**--**

USCS Group Symbol	**CH**
USCS Group Name	**Fat Clay with sand**
Cu	**---**
Cc	**---**
LL	**71**
PI	**44**
Gravel	**0.0**
Sand	**19.2**
Fines	**80.8**
AASHTO Classification	**A-7-6**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:__________________

Reviewed by: [signature]

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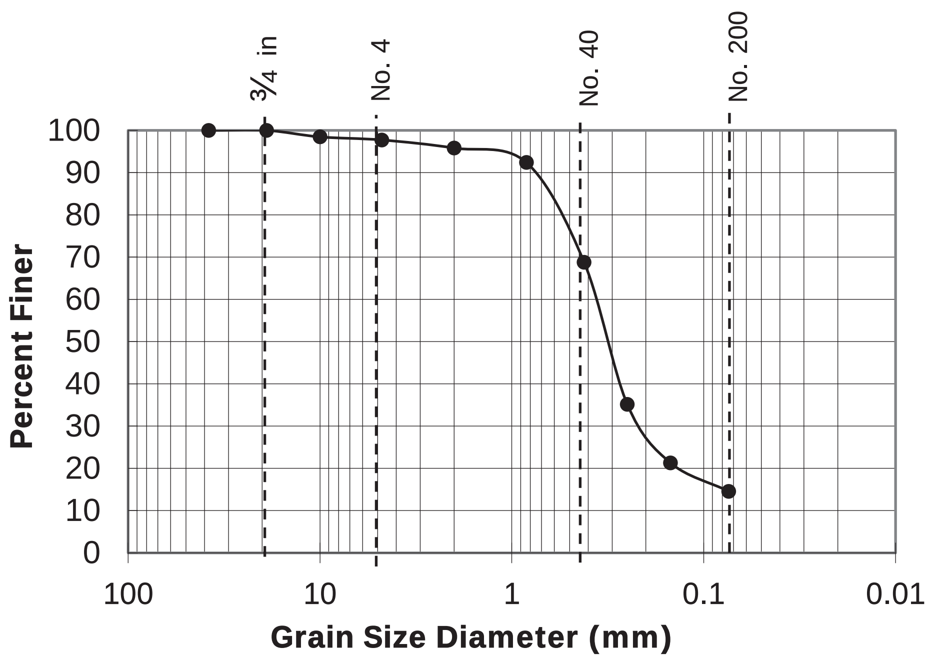
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-1	**Depth (Feet)**	25.0'-26.5'
Lab Order No.	3345-5	**Date**	8/20/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**98**
#4	**98**
#10	**96**
#20	**92**
#40	**69**
#60	**35**
#100	**21**
#200	**15**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**57**
PI	**38**
Gravel	**2.3**
Sand	**83.2**
Fines	**14.6**
AASHTO Classification	**A-2-7**
Color	**Greenish Gray**

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:___________________

Reviewed by: [signature]

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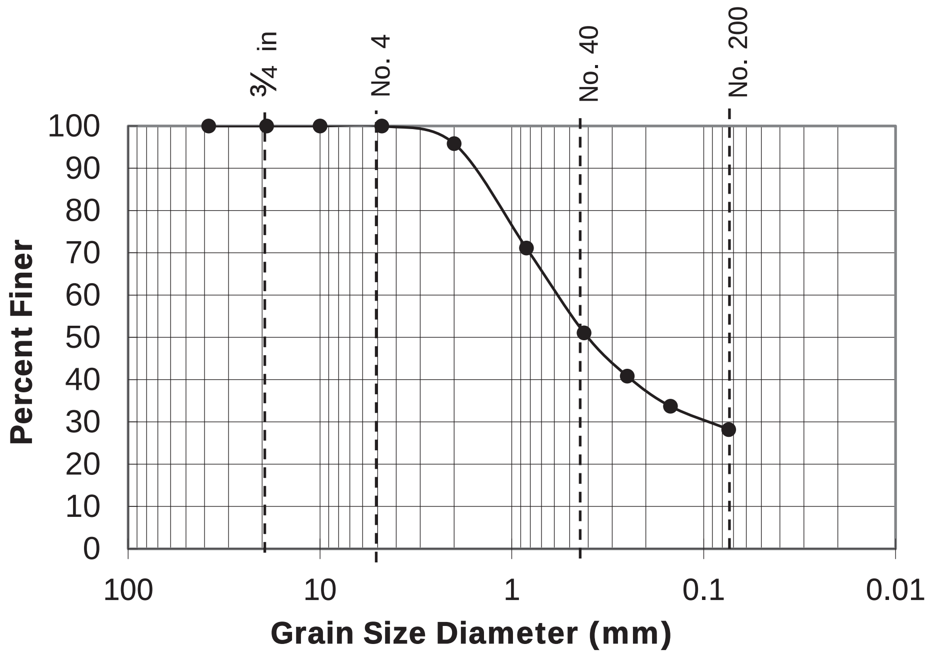
GRAIN SIZE ANALYSIS - ASTM D422

Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-1	**Depth (Feet)**	38.5'-40.0'
Lab Order No.	3345-2	**Date**	8/20/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**96**
#20	**71**
#40	**51**
#60	**41**
#100	**34**
#200	**28**
Pan	**--**

USCS Group Symbol	**SM**
USCS Group Name	**SILTY SAND**
Cu	**---**
Cc	**---**
LL	**56**
PI	**25**
Gravel	**0.0**
Sand	**71.8**
Fines	**28.2**
AASHTO Classification	**A-2-7**
Color	**Dark Brownish Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:__________________

Reviewed by: [signature]

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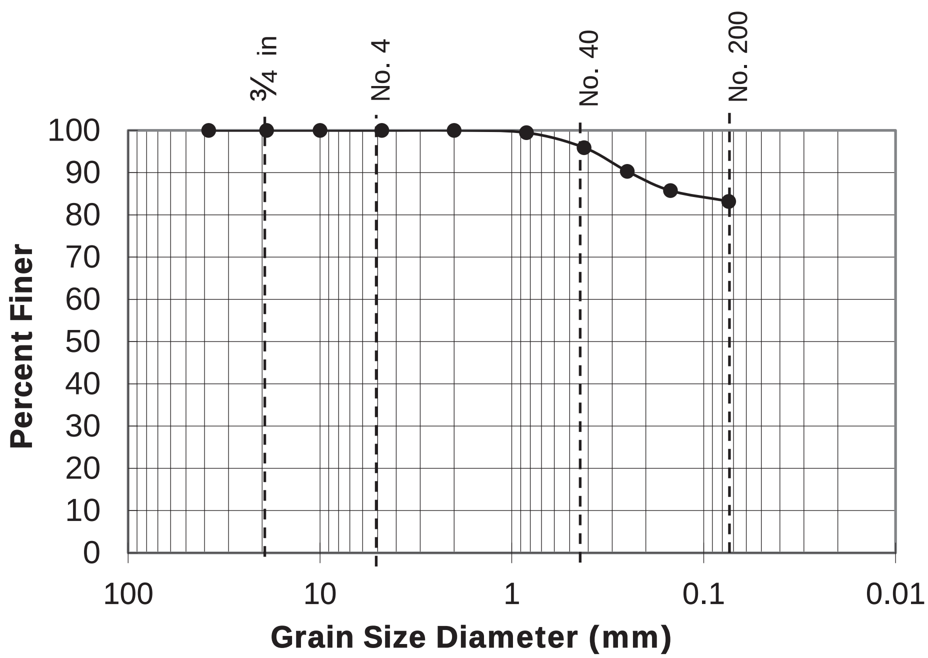
GRAIN SIZE ANALYSIS - ASTM D422

Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-2	**Depth (Feet)**	5.0'-6.5'
Lab Order No.	3372-2	**Date**	9/8/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**99**
#40	**96**
#60	**90**
#100	**86**
#200	**83**
Pan	**--**

USCS Group Symbol	**CH**
USCS Group Name	**Fat Clay with sand**
Cu	**---**
Cc	**---**
LL	**70**
PI	**42**
Gravel	**0.0**
Sand	**16.8**
Fines	**83.2**
AASHTO Classification	**A-7-6**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:____________________

Reviewed by: Shawn Harris

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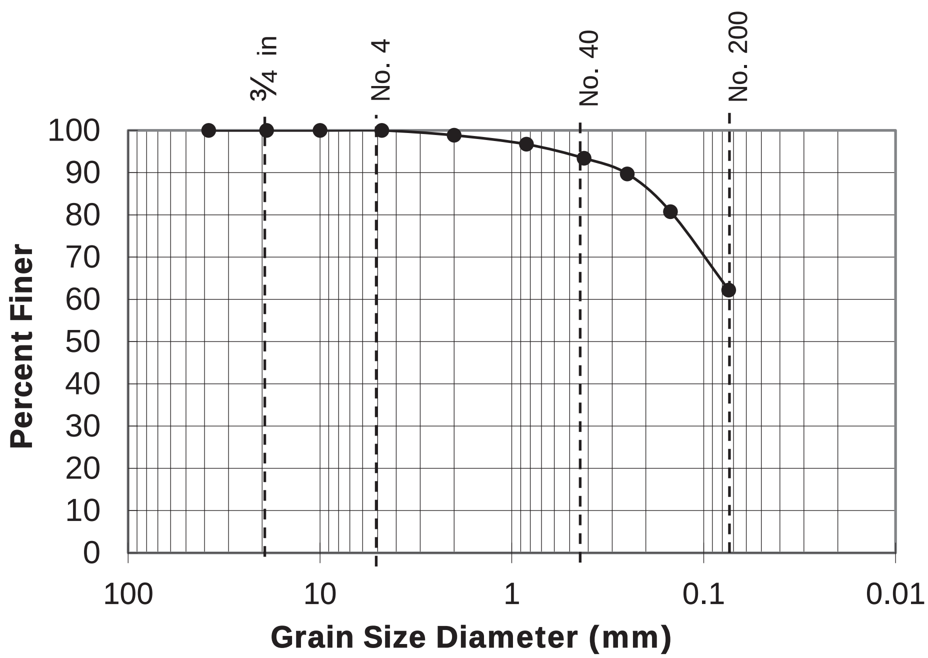
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-2	**Depth (Feet)**	13.5'-15.0'
Lab Order No.	3372-3	**Date**	9/8/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**99**
#20	**97**
#40	**93**
#60	**90**
#100	**81**
#200	**62**
Pan	**--**

USCS Group Symbol	**CH**
USCS Group Name	**sandy Fat Clay**
Cu	**---**
Cc	**---**
LL	**64**
PI	**42**
Gravel	**0.0**
Sand	**37.8**
Fines	**62.2**
AASHTO Classification	**A-7-6**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:__________________

Reviewed by: [signature]

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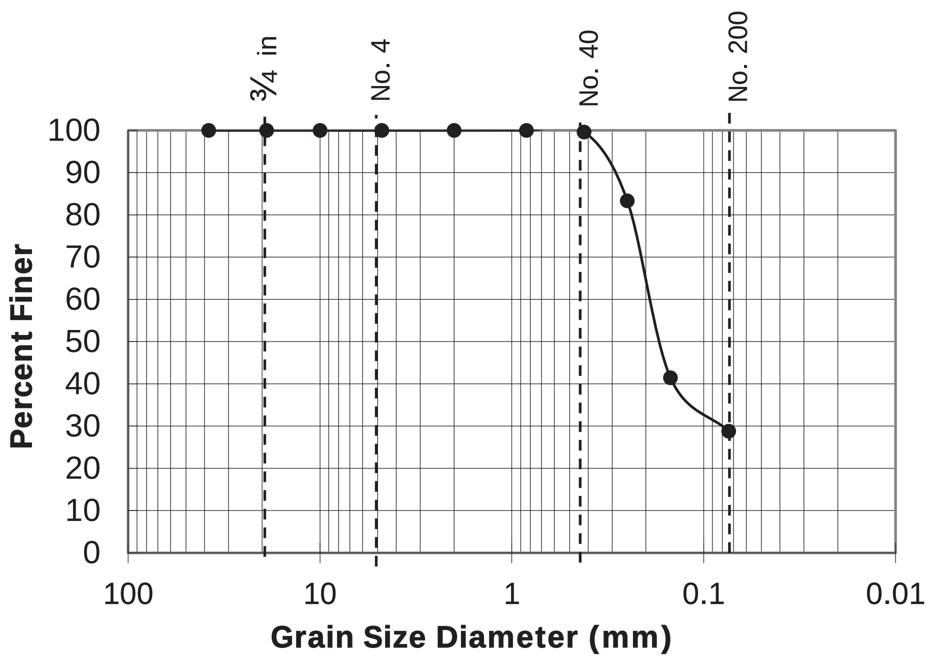
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-2	**Depth (Feet)**	23.5'-25.0'
Lab Order No.	3345-3	**Date**	8/20/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**100**
#40	**100**
#60	**83**
#100	**41**
#200	**29**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**47**
PI	**28**
Gravel	**0.0**
Sand	**71.2**
Fines	**28.8**
AASHTO Classification	**A-2-7**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:__________________

Reviewed by: Shawn Harris

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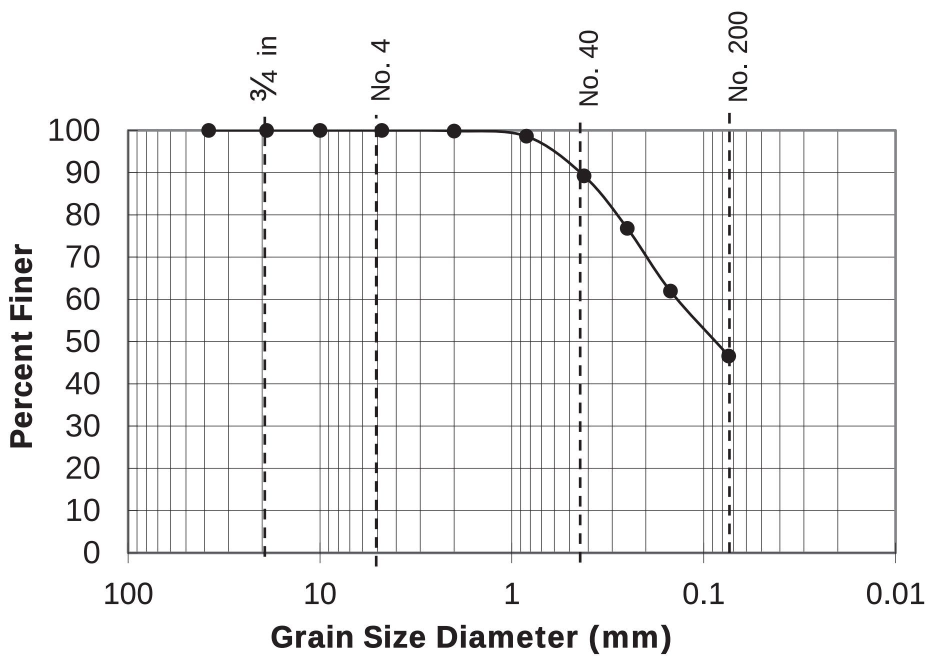
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-4	**Depth (Feet)**	5.0'-6.5'
Lab Order No.	3345-6	**Date**	8/20/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**99**
#40	**89**
#60	**77**
#100	**62**
#200	**47**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**59**
PI	**36**
Gravel	**0.0**
Sand	**53.4**
Fines	**46.6**
AASHTO Classification	**A-7-6**
Color	**Gray**

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:____________________

Reviewed by: Shawn Harris

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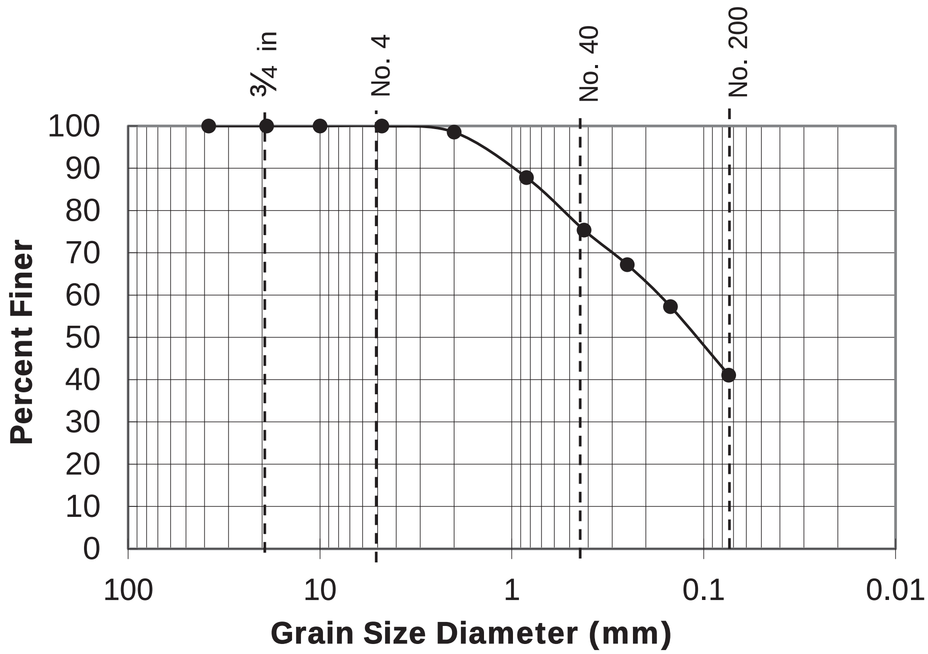
GRAIN SIZE ANALYSIS - ASTM D422

Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-5	**Depth (Feet)**	13.5'-15.0'
Lab Order No.	3345-7	**Date**	8/20/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**99**
#20	**88**
#40	**75**
#60	**67**
#100	**57**
#200	**41**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**60**
PI	**36**
Gravel	**0.0**
Sand	**58.9**
Fines	**41.1**
AASHTO Classification	**A-7-6**
Color	**Gray**

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:____________________

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., Suite 170
Ashburn, Virginia 20147
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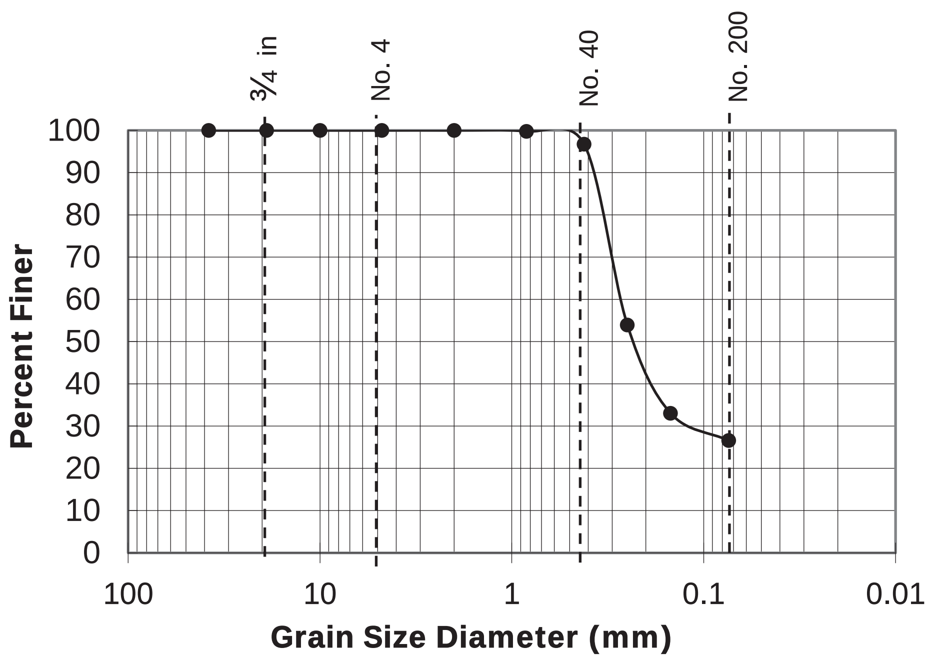
GRAIN SIZE ANALYSIS - ASTM D422

Project No.	14130	**Project Name**	2900 S. Eads St. Retaining Wall
Test Boring No.	B-5	**Depth (Feet)**	33.5'-35.0'
Lab Order No.	3345-8	**Date**	8/20/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**100**
#20	**100**
#40	**97**
#60	**54**
#100	**33**
#200	**27**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**39**
PI	**17**
Gravel	**0.0**
Sand	**73.4**
Fines	**26.6**
AASHTO Classification	**A-2-6**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

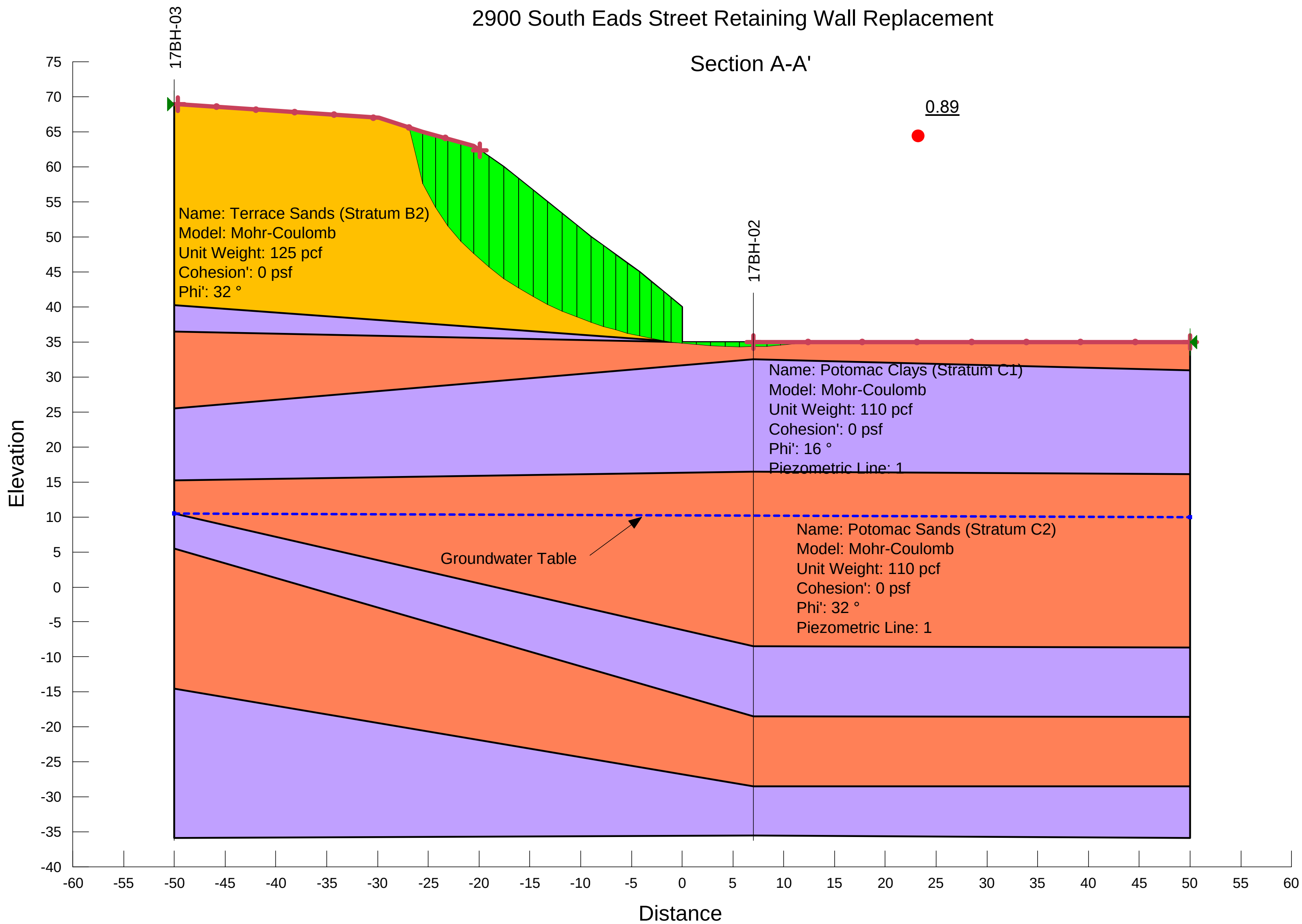
Tested by:__________________

Reviewed by: Shaw Harris

APPENDIX E

SLOPE STABILITY ANALYSES

Section A-A' Results and Output
Section B-B' Results and Output



2900 South Eads Street Retaining Wall Replacement
Section A-A'
17BH-03
17BH-02
0.89
Name: Terrace Sands (Stratum B2)
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 32 °
Name: Potomac Clays (Stratum C1)
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 16 °
Piezometric Line: 1
Name: Potomac Sands (Stratum C2)
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Piezometric Line: 1
Groundwater Table
Elevation
Distance
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-60
-55
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60

Slope Stability

File Information

Title: South Eads Ret. Wall Section A-A'
Created By: Evan Ruggles
Last Edited By: Evan Ruggles
Revision Number: 83
File Version: 8.2
Tool Version: 8.12.3.7901
Date: 4/20/2017
Time: 3:31:49 PM
File Name: Slope Stability - Existing.gsz
Directory: G:\2011-2020\2017\Sterling\Projects\17C12005 - S Eads Retaining Wall\03-SE Products\02-Calcs\Slope Stability\Slope Stability\
Last Solved Date: 4/20/2017
Last Solved Time: 3:31:56 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Slope Stability

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- Lambda
  - Lambda 1: -1
  - Lambda 2: -0.8
  - Lambda 3: -0.6
  - Lambda 4: -0.4
  - Lambda 5: -0.2

Lambda 6: 0
Lambda 7: 0.2
Lambda 8: 0.4
Lambda 9: 0.6
Lambda 10: 0.8
Lambda 11: 1
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Left to Right
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 3 ft
Optimization Maximum Iterations: 2,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Terrace Sands (Stratum B2)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °

Potomac Clays (Stratum C1)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 16 °
Phi-B: 0 °

Pore Water Pressure
Piezometric Line: 1

Potomac Sands (Stratum C2)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-49.677911, 68.968031) ft
Left-Zone Right Coordinate: (-19.907927, 62.357927) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (7, 35) ft
Right-Zone Right Coordinate: (50, 35) ft
Right-Zone Increment: 8
Radius Increments: 20

Slip Surface Limits

Left Coordinate: (-50, 69) ft
Right Coordinate: (50, 35) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-50	10.5
Coordinate 2	50	10

Points

	X (ft)	Y (ft)
Point 1	-29.85	67

Point 2	-25.55	65
Point 3	-20.55	63
Point 4	-17.55	60
Point 5	-13.25	55
Point 6	-8.95	50
Point 7	-4.2	45
Point 8	0	40
Point 9	0	35
Point 10	-50	69
Point 11	50	35
Point 12	7	35
Point 13	7	32.5
Point 14	7	16.5
Point 15	7	-8.5
Point 16	7	-18.5
Point 17	7	-28.5
Point 18	7	-35.5
Point 19	-50	66.5
Point 20	-50	64
Point 21	-50	40.3
Point 22	-50	36.5
Point 23	-50	25.5
Point 24	-50	15.2
Point 25	-50	10.5
Point 26	-50	5.5
Point 27	-50	-14.5
Point 28	-50	-21
Point 29	50	-28.449205
Point 30	50	-35.870737
Point 31	-50	-35.870737
Point 32	50	-18.553829
Point 33	50	-8.658454
Point 34	50	16.079985
Point 35	50	30.923049
Point 36	-50	10
Point 37	50	10

Regions

	Material	Points	Area (ft²)
Region 1	Terrace Sands (Stratum B2)	10,1,2,3,4,5,6,7,8,9,21,20,19	1,153.1
Region 2	Potomac Clays (Stratum C1)	27,17,29,30,18,31,28	1,118.6
Region 3	Potomac Sands (Stratum C2)	27,26,16,32,29,17	1,282.8
Region 4	Potomac Clays (Stratum C1)	26,25,15,33,32,16	855.25
Region 5	Potomac Sands (Stratum C2)	25,24,14,34,33,15	1,915.8
Region 6	Potomac Clays (Stratum C1)	23,13,35,34,14,24	1,412.7
Region 7	Potomac Clays (Stratum C1)	22,9,21	95
Region 8	Potomac Sands (Stratum C2)	11,12,9,22,23,13,35	520.9

Current Slip Surface

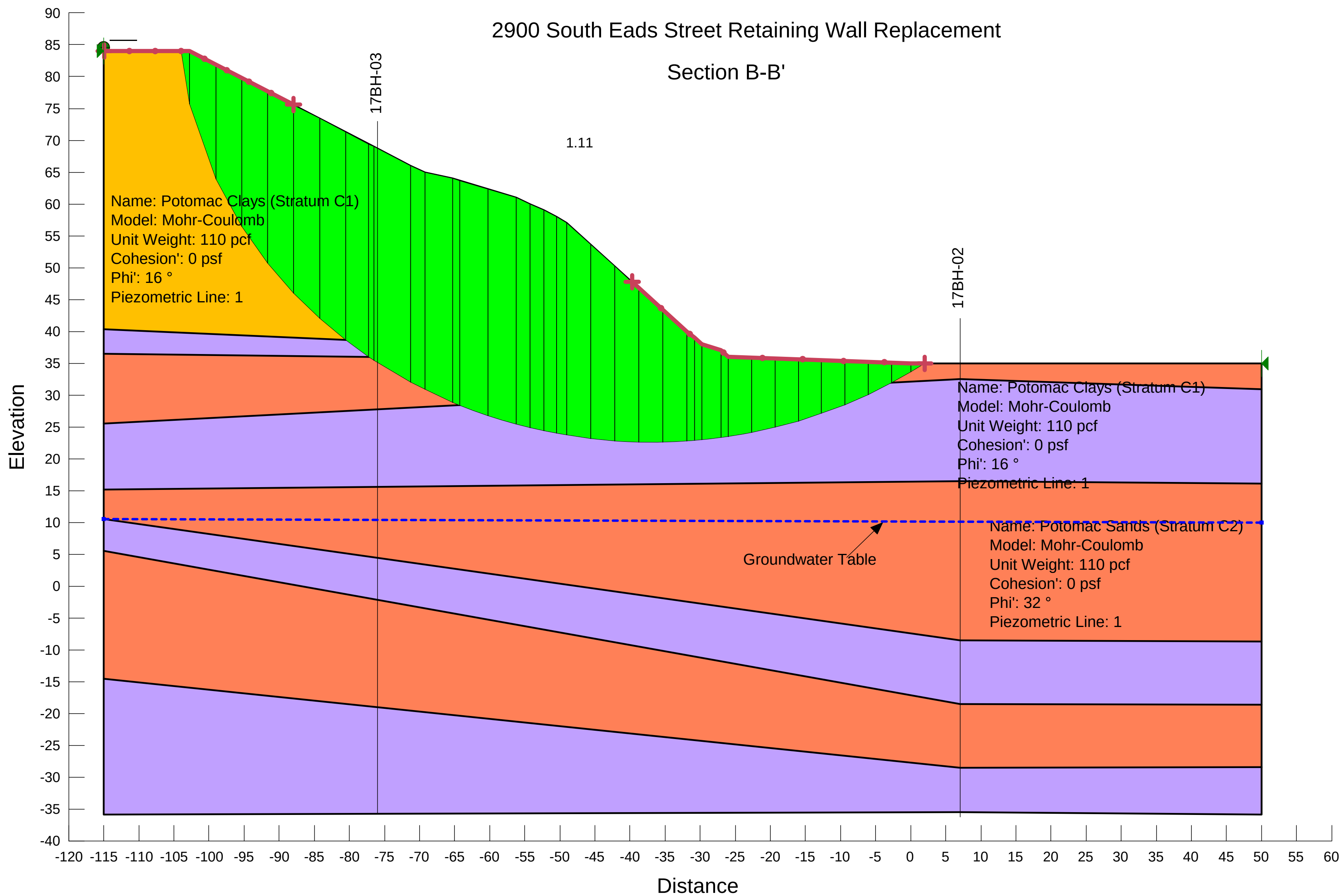
Slip Surface: 1,176
F of S: 0.89
Volume: 323.59873 ft³
Weight: 40,357.347 lbs
Resisting Moment: 702,563.21 lbs-ft
Activating Moment: 785,854.15 lbs-ft
Resisting Force: 16,820.641 lbs
Activating Force: 18,816.335 lbs
F of S Rank: 1
Exit: (12.375, 35) ft
Entry: (-26.862053, 65.610257) ft
Radius: 32.596266 ft
Center: (5.7083983, 66.907255) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	-26.206027	61.637364	0	79.154013	49.460917	0
Slice 2	-24.925	55.921655	0	314.44274	196.48563	0
Slice 3	-23.675	52.870515	0	457.59424	285.93662	0
Slice 4	-22.425	50.491088	0	576.79067	360.41881	0

Slice 5	-21.175	48.506848	0	685.80088	428.53595	0
Slice 6	-19.8	46.649324	0	776.74817	485.36613	0
Slice 7	-18.3	44.887215	0	851.93583	532.34859	0
Slice 8	-16.833333	43.382765	0	919.3941	574.50119	0
Slice 9	-15.4	42.086559	0	979.63538	612.14412	0
Slice 10	-13.966667	40.934192	0	1,042.7247	651.56673	0
Slice 11	-12.533333	39.907113	0	1,108.3375	692.56615	0
Slice 12	-11.1	38.991409	0	1,174.7355	734.05619	0
Slice 13	-9.6666667	38.17638	0	1,238.3994	773.83781	0
Slice 14	-8.35625	37.508804	0	1,297.2463	810.60944	0
Slice 15	-7.16875	36.969356	0	1,348.4532	842.60709	0
Slice 16	-5.98125	36.485815	0	1,384.866	865.36032	0
Slice 17	-4.79375	36.055545	0	1,399.0527	874.22515	0
Slice 18	-3.6062195	35.676333	0	1,370.4131	856.32917	0
Slice 19	-2.4186586	35.346338	0	1,288.5255	805.16012	0
Slice 20	-1.4707183	35.113467	-1,551.0215	896.34184	257.02189	0
Slice 21	-0.55827927	34.924109	-1,539.4902	1,080.1994	674.98347	0
Slice 22	0.7	34.705848	-1,526.2633	112.17118	70.092334	0
Slice 23	2.1	34.518987	-1,515.04	149.21155	93.237723	0

Slice 24	3.5	34.393455	-1,507.6436	169.03684	105.62594	0
Slice 25	4.9	34.32854	-1,504.0297	170.30762	106.42001	0
Slice 26	6.3	34.32388	-1,504.1757	154.74163	96.693299	0
Slice 27	7.671875	34.377143	-1,507.9273	127.18749	79.475564	0
Slice 28	9.015625	34.486233	-1,515.1538	92.849991	58.019114	0
Slice 29	10.359375	34.651649	-1,525.895	55.427522	34.634959	0
Slice 30	11.703125	34.874264	-1,540.2054	17.845206	11.150922	0



2900 South Eads Street Retaining Wall Replacement
Section B-B'
1.11
17BH-03
17BH-02
Name: Potomac Clays (Stratum C1)
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 16 °
Piezometric Line: 1
Name: Potomac Clays (Stratum C1)
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 16 °
Piezometric Line: 1
Name: Potomac Sands (Stratum C2)
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Piezometric Line: 1
Groundwater Table
Elevation
Distance
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-120 -115 -110 -105 -100 -95 -90 -85 -80 -75 -70 -65 -60 -55 -50 -45 -40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50 55 60

Slope Stability

File Information

Title: South Eads Ret. Wall Section B-B'
Created By: Evan Ruggles
Last Edited By: Evan Ruggles
Revision Number: 85
File Version: 8.2
Tool Version: 8.12.3.7901
Date: 4/20/2017
Time: 4:55:23 PM
File Name: Slope Stability - Existing B-B.gsz
Directory: G:\2011-2020\2017\Sterling\Projects\17C12005 - S Eads Retaining Wall\03-SE Products\02-Calcs\Slope Stability\Slope Stability\
Last Solved Date: 4/20/2017
Last Solved Time: 4:55:36 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Slope Stability

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - Lambda
    - Lambda 1: -1
    - Lambda 2: -0.8
    - Lambda 3: -0.6
    - Lambda 4: -0.4
    - Lambda 5: -0.2

Lambda 6: 0
Lambda 7: 0.2
Lambda 8: 0.4
Lambda 9: 0.6
Lambda 10: 0.8
Lambda 11: 1
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Left to Right
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 3 ft
Optimization Maximum Iterations: 2,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Terrace Sands (Stratum B2)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °

Potomac Clays (Stratum C1)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 16 °
Phi-B: 0 °

Pore Water Pressure
Piezometric Line: 1

Potomac Sands (Stratum C2)

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-114.95905, 84) ft
Left-Zone Right Coordinate: (-88, 75.571429) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (-39.6935, 47.747924) ft
Right-Zone Right Coordinate: (2, 35) ft
Right-Zone Increment: 8
Radius Increments: 20

Slip Surface Limits

Left Coordinate: (-115, 84) ft
Right Coordinate: (50, 35) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-114.99366	10.5
Coordinate 2	50	10

Points

	X (ft)	Y (ft)
Point 1	0	35

Point 2	50	35
Point 3	7	35
Point 4	7	32.5
Point 5	7	16.5
Point 6	7	-8.5
Point 7	7	-18.5
Point 8	7	-28.5
Point 9	7	-35.5
Point 10	-115	40.3
Point 11	-115	36.5
Point 12	-115	25.5
Point 13	-115	15.2
Point 14	-115	10.5
Point 15	-115	5.5
Point 16	-115	-14.5
Point 17	-115	-21
Point 18	50	-28.449205
Point 19	50	-35.870737
Point 20	-115	-35.870737
Point 21	50	-18.553829
Point 22	50	-8.658454
Point 23	50	16.079985
Point 24	50	30.923049
Point 25	-86.99498	10
Point 26	50	10
Point 27	-26	36
Point 28	-27	37
Point 29	-29.8	38
Point 30	-30.8	39
Point 31	-31.9	40
Point 32	-49	57
Point 33	-50.5	58
Point 34	-52.25	59
Point 35	-54.25	60
Point 36	-56.25	61
Point 37	-65.25	64

Point 38	-69.25	65
Point 39	-71.25	66
Point 40	-102.75	84
Point 41	-76.5	69
Point 42	-115	84

Regions

	Material	Points	Area (ft²)
Region 1	Potomac Clays (Stratum C1)	16,8,18,19,9,20,17	2,040.7
Region 2	Potomac Sands (Stratum C2)	16,15,7,21,18,8	2,257.8
Region 3	Potomac Clays (Stratum C1)	15,14,6,22,21,7	1,342.8
Region 4	Potomac Sands (Stratum C2)	14,13,5,23,22,6	2,881.1
Region 5	Potomac Clays (Stratum C1)	12,4,24,23,5,13	2,267.4
Region 6	Potomac Sands (Stratum C2)	2,3,1,11,12,4,24	959.65
Region 7	Potomac Clays (Stratum C1)	10,11,1,27	207.1
Region 8	Terrace Sands (Stratum B2)	42,40,41,39,38,37,36,35,34,33,32,31,30,29,28,27,10	2,429.1

Current Slip Surface

Slip Surface: 755
F of S: 1.11
Volume: 2,379.9252 ft³
Weight: 285,709.23 lbs
Resisting Moment: 3,601,044.3 lbs-ft
Activating Moment: 3,242,635.5 lbs-ft
Resisting Force: 94,446.288 lbs
Activating Force: 85,175.052 lbs
F of S Rank: 1
Exit: (2, 35) ft
Entry: (-104.01003, 84) ft
Radius: 67.348861 ft

Center: (-115, 84.550017) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	-103.38002	79.856447	0	107.63435	67.257404	0
Slice 2	-100.89848	69.82921	0	546.95176	341.77339	0
Slice 3	-97.195443	60.196372	0	1,074.1026	671.17376	0
Slice 4	-93.492405	53.569215	0	1,454.7979	909.05863	0
Slice 5	-89.789367	48.339558	0	1,764.9098	1,102.838	0
Slice 6	-86.086329	44.007157	0	2,034.7136	1,271.4302	0
Slice 7	-82.383291	40.330546	0	2,280.7944	1,425.1985	0
Slice 8	-78.88373	37.321052	-1,680.4619	2,734.5361	784.1156	0
Slice 9	-76.867844	35.736463	-1,581.9648	2,580.367	1,612.3923	0
Slice 10	-73.875	33.740284	-1,457.9692	2,732.2928	1,707.326	0
Slice 11	-70.25	31.445561	-1,315.464	2,934.6374	1,833.765	0
Slice 12	-67.25	29.86682	-1,217.5178	3,157.914	1,973.2837	0
Slice 13	-64.757968	28.634276	-1,141.0783	3,369.8839	2,105.7372	0
Slice 14	-62.261952	27.596815	-1,076.8127	3,503.052	1,004.484	0
Slice 15	-58.253984	26.11322	-984.99429	3,707.3925	1,063.0777	0
Slice 16	-55.25	25.160993	-926.14339	3,840.7333	1,101.3126	0

Slice 17	-53.25	24.628337	-893.28382	3,897.7694	1,117.6674	0
Slice 18	-51.375	24.186245	-866.05185	3,938.8018	1,129.4332	0
Slice 19	-49.75	23.848536	-845.2861	3,952.8376	1,133.458	0
Slice 20	-47.29	23.43663	-820.04833	3,872.5104	1,110.4245	0
Slice 21	-43.87	22.992883	-793.00526	3,681.6134	1,055.6857	0
Slice 22	-40.45	22.725916	-776.99325	3,435.9253	985.23573	0
Slice 23	-37.03	22.633621	-771.88072	3,127.9173	896.91584	0
Slice 24	-33.61	22.715276	-777.62269	2,751.9068	789.09658	0
Slice 25	-31.35	22.845275	-786.16204	2,474.557	709.56779	0
Slice 26	-30.3	22.940394	-792.29601	2,337.1557	670.16861	0
Slice 27	-28.4	23.168521	-806.89043	2,192.725	628.75378	0
Slice 28	-26.5	23.425565	-823.28926	2,033.9968	583.23921	0
Slice 29	-24.337465	23.820329	-848.33143	1,914.8233	549.06674	0
Slice 30	-21.012396	24.541152	-893.93957	1,810.5977	519.18054	0
Slice 31	-17.687326	25.441286	-950.73668	1,656.8733	475.10076	0
Slice 32	-14.362257	26.528386	-1,019.2005	1,455.9138	417.47657	0
Slice 33	-11.037187	27.812297	-1,099.9453	1,212.6541	347.72297	0
Slice 34	-7.7121178	29.305563	-1,193.7539	934.23133	267.88652	0
Slice 35	-4.3870483	31.024163	-1,301.6233	629.16155	180.40917	0

Slice 36	-1.3622568	32.789424	-1,412.3475	445.35031	278.28576	0
Slice 37	1	34.318406	-1,508.2027	129.18432	80.723324	0