Geotechnical Engineering Report

Lubber Run Park Pedestrian Bridge
Arlington, Arlington County, VA
June 17, 2022
Terracon Project No. JD205321

Prepared for:
Volkert, Inc
Springfield, VA

Prepared by:
Terracon Consultants, Inc.
Ashburn, Virginia

June 17, 2022

Volkert, Inc
6225 Brandon Avenue, #540
Springfield, VA 22150

Attn: Mr. Brian Graham - Bridge Section Manager
P: (703) 738-8331
E: brian.graham@volkert.com

Re: Geotechnical Engineering Report
Lubber Run Park Pedestrian Bridge
124 – 132 North Columbus Street
Arlington, Arlington County, VA
Terracon Project No. JD205321

Dear Mr. Graham:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PJD205321 dated November 1, 2020. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

COMMONWEALTH OF VIRGINIA
SUSHANT UPADHYAYA
Lic. No. 051941
PROFESSIONAL ENGINEER

Braque Mathson, EIT
Senior Project Manager

Sushant Upadhyaya, PhD, PE, D.GE, PMP, RMP
Principal

REPORT TOPICS

Note: This report was originally delivered in a web-based format. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report

Lubber Run Park Pedestrian Bridge
124 – 132 North Columbus Street
Arlington, Arlington County, VA
Terracon Project No. JD205321
June 17, 2022

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed pedestrian bridge to be located at 124 – 132 North Columbus Street in Arlington, Arlington County, VA. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Recommended foundation options and engineering design parameters
- Site preparation and earthwork
- Lateral earth pressures

The geotechnical engineering Scope of Services for this project included the advancement of one test boring to a depth of 18 feet below existing site grades. Due to the access issues, we could not drill at the west abutment. Therefore, we evaluated the subsurface profile based on the visual inspection of the soils around the embankment, see photography log.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and cross section in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located near 124 – 132 North Columbus Street in Arlington County, Virginia. 38.8690, -77.11840 (See **Site Location)**

Item	Description
Existing Improvements	Pedestrian trails, amphitheater, restrooms, underground utilities. The abutments from the existing bridge are still in place. 
Current Ground Cover	Earthen, lightly-moderately vegetated, asphalt paved trail
Existing Topography	The elevation along the bridge alignment is at about EL 185 to EL 187 Elevation values are expressed relative to local mean sea level (LMSL)
Geology	The site is mapped in the Quaternary aged alluvium associated with the adjacent stream. The Indian Run Formation of the Cambrian geologic period underlies the alluvium. The Indian Run Formation is a foliated sedimentary mélange with medium grained matrix and fragments of quartz, metavolcanic rocks, metagabbro, schist, and metasandstone.

A photo of the embankment cut with elevations and strata is provided in our **Photography Log**.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Lubber Run 2 Before and After and Lubber Run illustrative plan pdf's
Project Description	Construct a new single span bridge. The east abutment will be approximately at the same location as the old bridge. However, the new abutment will be moved slightly north to keep the bridge alignment straight.
Service Loads	Vertical = 68.2 kips Moment at center of footing = 38.2 kip-ft Horizontal = 14.4 kips

Item	Description
Strength 1	Vertical = 93.6 kips Moment at center of footing = 42.1 kip-ft Horizontal = 19.6 kips
Finished Elevation	At about existing grade
Below-Grade Structures	Abutment walls
Foundations	Shallow spread footings. Bottom of footing is planned at elevation (EL) 178.5 (West Abutment), EL 177.0 (East Abutment)

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section. The generalized subsurface materials encountered in the test borings completed at the site have been assigned to the strata shown in table below. A subsurface profile, Figure A-1 is presented at the end of this report.

Layer Name	General Description
Fill	generally medium dense, fine to coarse, SILTY SAND (FILL) with gravel, contains wood, micaceous, moist, gray, yellow
Alluvium	generally very dense, fine to medium, SILTY SAND (SM), micaceous, moist, gray
IGM	generally very dense fine to medium, SILTY SAND (SM), micaceous, moist, gray
Bedrock	generally hard, MICA SCHIST, slightly weathered, dark gray, moderately fractured, poorly foliated

Groundwater Conditions

Groundwater level observations were made in the field during and upon completion of the test boring. Groundwater was not encountered during drilling and core water was introduced during rock coring. Expect groundwater conditions to be near the bottom of the creek elevations.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for this project.

SOIL LABORATORY TEST RESULTS

Selected soil samples obtained from the field investigation were tested for grain size distribution, Atterberg limits, and natural moisture contents. A summary of soil laboratory test results is presented below in the table, and the results of natural moisture content tests are presented on the test boring logs at the end of this report.

Test Boring/ Test Pit No.	Depth (ft)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)
					Percent Retained #4 Sieve	Percent Passing #200 Sieve	LL	PL	PI	
20BH001	4-6	Split-Spoon	Alluvium	SILTY SAND (SM)	0	21.9	NP	NP	NP	4.2
20BH001	6-8	Split-Spoon	Residual	SILTY SAND (SM)	14.2	25.7	NP	NP	NP	7.8
20BH002	5-10	Bulk	Residual	POORLY GRADED SAND WITH SILT (SP-SM)	0.9	6.8	NP	NP	NP	11.0

Notes:

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

Grain Size (D_{50} and D_{90}) Test Results

Selected soil samples obtained from the field investigation were tested for grain size distribution. The interpretation of D_{50} and D_{90} was performed by us and summary of the results are presented in the table below. Scour analysis is to be completed by client. Scour depths are not provided to at the time of writing this report.

Test Boring/Test Pit No.	Approximate Depth (feet)	Approximate Elevation (feet)	D50 (mm)	D90 (mm)	USCS Group Name
22BH001	4-6	181	0.18	0.69	SILTY SAND (SM)
22BH001	6-8	179	0.20	1.2	SILTY SAND (SM)

Test Boring/Test Pit No.	Approximate Depth (feet)	Approximate Elevation (feet)	D50 (mm)	D90 (mm)	USCS Group Name
21BH002	5-10	182	0.41	9.5	POORLY GRADED SAND WITH SILT (SP-SM)

EARTHWORK

Earthwork is anticipated to include excavations and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavement.

Site Preparation

Unsuitable existing fill, soft or loose natural soils, organic material, and rubble should be stripped to approved subgrades as determined by the geotechnical engineer. Topsoil was not encountered in the soil test borings drilled at the site. However, topsoil may be encountered in the location off the existing trail, topsoil depths may vary widely across the site, particularly in previously cultivated areas. Stripping depths will probably extend to greater depths than the topsoil depths indicated herein due to the presence of minor amounts of organics, roots, and other surficial materials that will require removal as a part of the stripping operations.

The final subgrade should be observed by Geotechnical Engineer or by his or her representative to confirm that the subgrade appears to be stable. Since a proofroll cannot be performed, we recommend that a dynamic cone penetrometer (DCP) or geoprobe should be used to evaluate the subgrade. If unsuitable or soft soils are encountered at the proposed subgrade level, we recommend that the subgrade be undercut to a depth of 2 feet and the resulting excavation be filled with compacted VDOT 21A.

Existing Fill

As noted in **Geotechnical Characterization**, boring 22BH001 and sample location 22BH002 encountered existing fill to depths of about two to four feet. The fill appears to have been placed in a controlled manner, but we have no records to indicate the degree of control. Support of footings, floor slabs, and pavements, on or above existing fill soils, is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by following the recommendations contained in this report. The four feet of fill will be removed to construct the footings.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas. Earthen materials used for structural and general fill should meet the following material property requirements:

Soil Type [1,2]	USCS Classification	Acceptable Parameters (for Structural Fill)
Low Plasticity Cohesive	CL, CL-ML ML, SM, SC	Liquid Limit less than 40, Plasticity index less than 15 Less than 25% retained on No. 200 sieve
Granular	GW, GP, GM, GC, SW, SP, SM, SC	Less than 10% Passing No. 200 sieve

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. CH or MH soils should not be used for structural fill areas.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as Structural fill
Minimum Compaction Requirements [1]	100% of max. within 6-inches of finished pavement subgrade and floor slabs 98% of max. below foundations, below floor slabs, and more than 6-inches below finished pavement subgrade	92% of max.
Water Content Range [1]	Soils: ±20% of optimum moisture content Gravel: ±2% point of optimum moisture content	As required to achieve min. compaction requirements

1. Maximum density and optimum water content as determined by the standard Proctor test (VTM-1).

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

The groundwater table could affect over excavation efforts, especially for over-excavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps could be necessary to achieve the recommended depth of over-excavation.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer’s evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

We have computed the bearing resistance for the proposed abutment foundations when supported on natural soils below the existing fill. The factored bearing resistance at the strength limit state is calculated using a resistance factor of 0.45. A summary of factored resistance for service, strength, and extreme event limits, and estimated wall settlement, are presented in the table below. Bearing resistance and settlement calculations are provided at the end of this report.

Location [1]	Expected Footing Subgrade Elevation (ft)	Service Limit State Factored Resistance $\Phi_b = 1.00$ (ksf)	Strength Limit State Factored Resistance $\Phi_b = 0.45$ (ksf)	Extreme Event Limit State Factored Resistance $\Phi_b = 1.00$ (ksf)	Estimated Settlement (inch)	Expected Footing Subgrade Material	Coefficient of Sliding Friction [1]
Abutment A (West) [2]	178.5	20.5	20.5	45.6	0.9	IGM	0.60
Abutment B (East)	177.0	21.6	21.6	48.1	0.6	Bedrock	0.60

1. Coefficient of Sliding = Tan (ϕ)
2. Verify in the field the depth of expected footing subgrade.

Foundation Construction Considerations

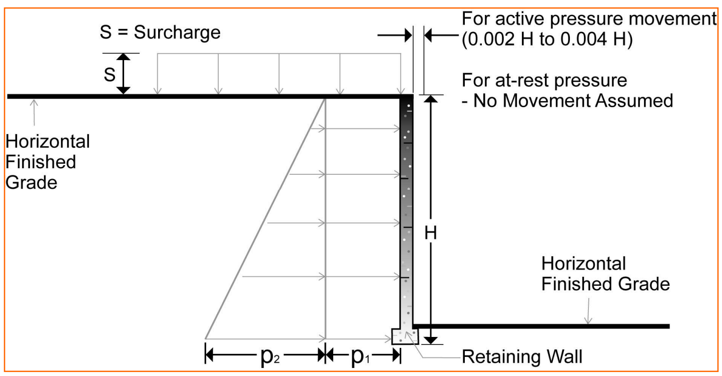
As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. It may be desirable to place a 3- to 4-inch thick "mud mat" of lean concrete immediately on the approved footing subgrade to avoid softening of the exposed subgrade. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The “at-rest” condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Material Description	Unit Weight, γ (pcf)	Friction Angle, ϕ (degrees)	Lateral Earth Pressure (LEP) Coefficients [1]			Equivalent Fluid Pressure (EFP) [2]		
			At-Rest (K_o)	Active (K_a) [3]	Passive (K_p)	At-Rest (K_o)	Active (K_a)	Passive (K_p)
Reinforced Backfill, Select Material (Type I)	145	38	0.38	0.24	4.20	56H	34H	610D
Existing Fill	110	26	0.56	0.39	2.50	63H	43H	283D
New Compacted Fill	120	30	0.50	0.33	3.00	60H	40H	360D
Alluvium	120	30	0.50	0.33	3.00	60H	40H	360D
IGM	130	34	0.44	0.28	3.50	53H	34H	420D

1. K_a = 1-sin(ϕ)/1+sin(ϕ), K_p = 1+sin(ϕ)/1-sin(ϕ); Horizontal Backslope
2. EFP = γ x LEP, H = height of the wall, D = depth of foundation embedment.
3. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.

Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

The lateral earth pressures shown in table above are applicable only to cases where a subdrainage system is installed. Hydrostatic pressures are not included in the lateral earth pressures assuming the use of relatively granular or free draining backfill, and subdrainage is installed.

Where applicable, the design should consider surcharge loads using a rectangular earth pressure distribution. The surcharge pressure ordinate should be obtained by multiplying the surface surcharge pressure (S) by the lateral earth pressure coefficient in table above for the respective backfill condition. Earth pressure recommendations consider a horizontal ground surface behind the wall. We should be contacted to provide alternative design parameters if sloping ground surface conditions are anticipated. In addition to static earth pressures, the structural designer should consider dynamic earth pressures due to seismic loading, as applicable.

CORROSIVITY

The corrosion series test results were evaluated to determine the corrosion potential of concrete. The resistivity of the samples ranges from 32,994 to 36,302 ohm-cm.

According to Section 8.8 of FHWA Publication NHI-05-042 dated April 2006, soils with sulfate ion content greater than 200 ppm and chloride ion content greater than 100 ppm are considered indicative of an aggressive subsurface environment. Also, according to AASHTO LRFD Bridge Design Specifications, soils with sulfate concentrations greater than 1,000 parts per million (ppm) should be considered as indicative of potential deterioration of concrete. Based on the test results, we believe that the subsurface conditions in the vicinity of the bridge is considered non-aggressive.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Tests	Boring Depth (feet)	Planned Location
1 (Boring)	18	Abutment B
1 (Test Pit)	10	Abutment A

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from topographic plan. If elevations and a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous hollow stem flight augers. Continuous sampling was obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration or middle 12 inches of 24-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Also the embankment of the creek was visually observed and sampled. The maximum depth of the embankment was 10 feet below the existing ground surface.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil and rock strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D7012 Standard Test Method Rock Unconfined Compressive Strength
- AASHTO T289 Standard Test Method for pH Analysis of Soils
- AASHTO T290 Standard Test Method for Water-Soluble Sulfate Ion Content in Soils
- AASHTO T291 Standard Test Method for Water-Soluble Chloride Ion Content in Soils
- AASHTO T288 Standard Test Method for Soil Resistivity

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Rock classification was conducted using locally accepted practices for engineering purposes; petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification. Boring log rock classification was determined using the Description of Rock Properties.

PHOTOGRAPHY LOG

Location 22BH002

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Lubber Run Park Pedestrian Bridge ■ Arlington, Arlington County, VA
June 17, 2022 ■ Terracon Project No. JD205321

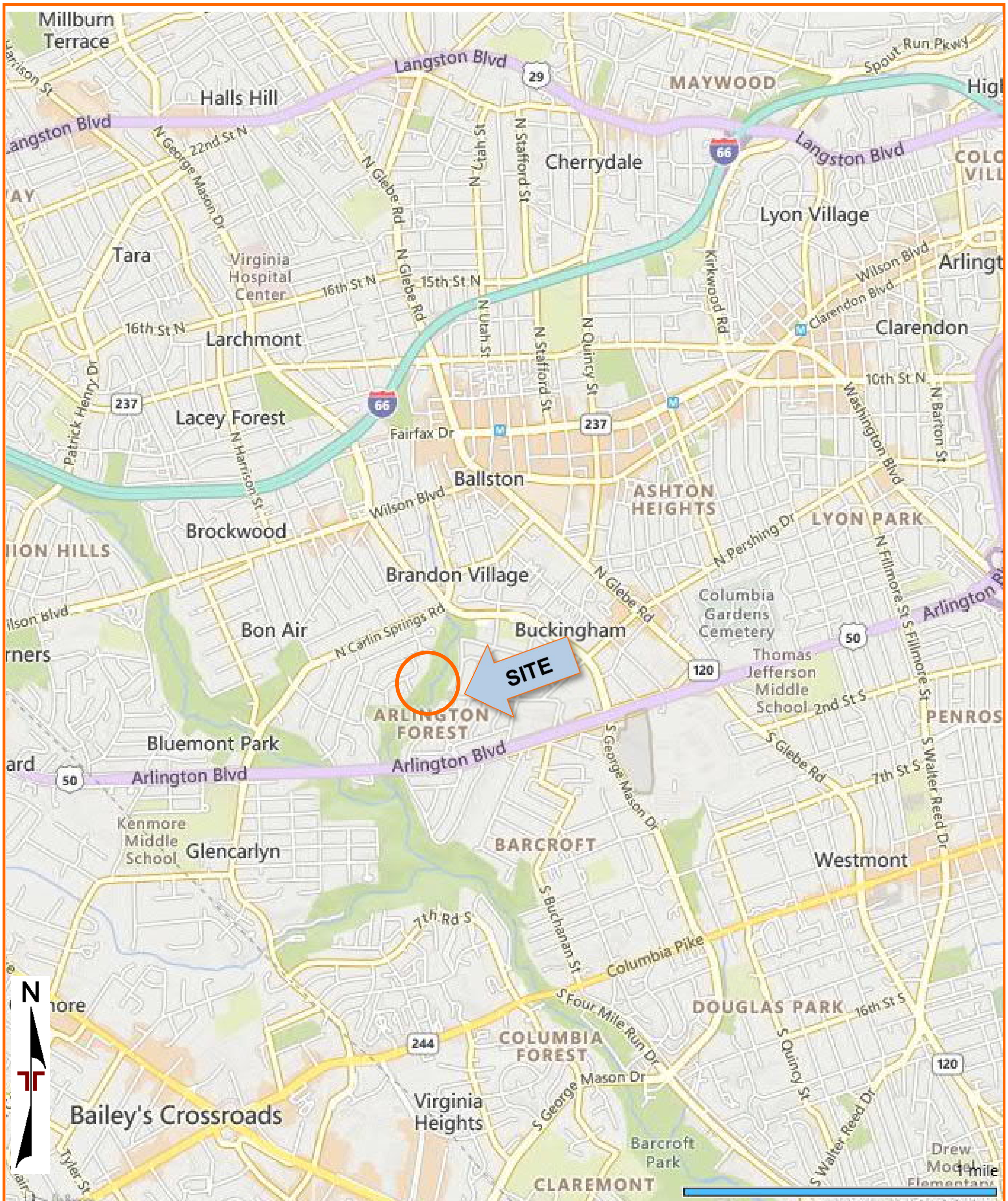


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Lubber Run Park Pedestrian Bridge ■ Arlington, Arlington County, VA

June 17, 2022 ■ Terracon Project No. JD205321

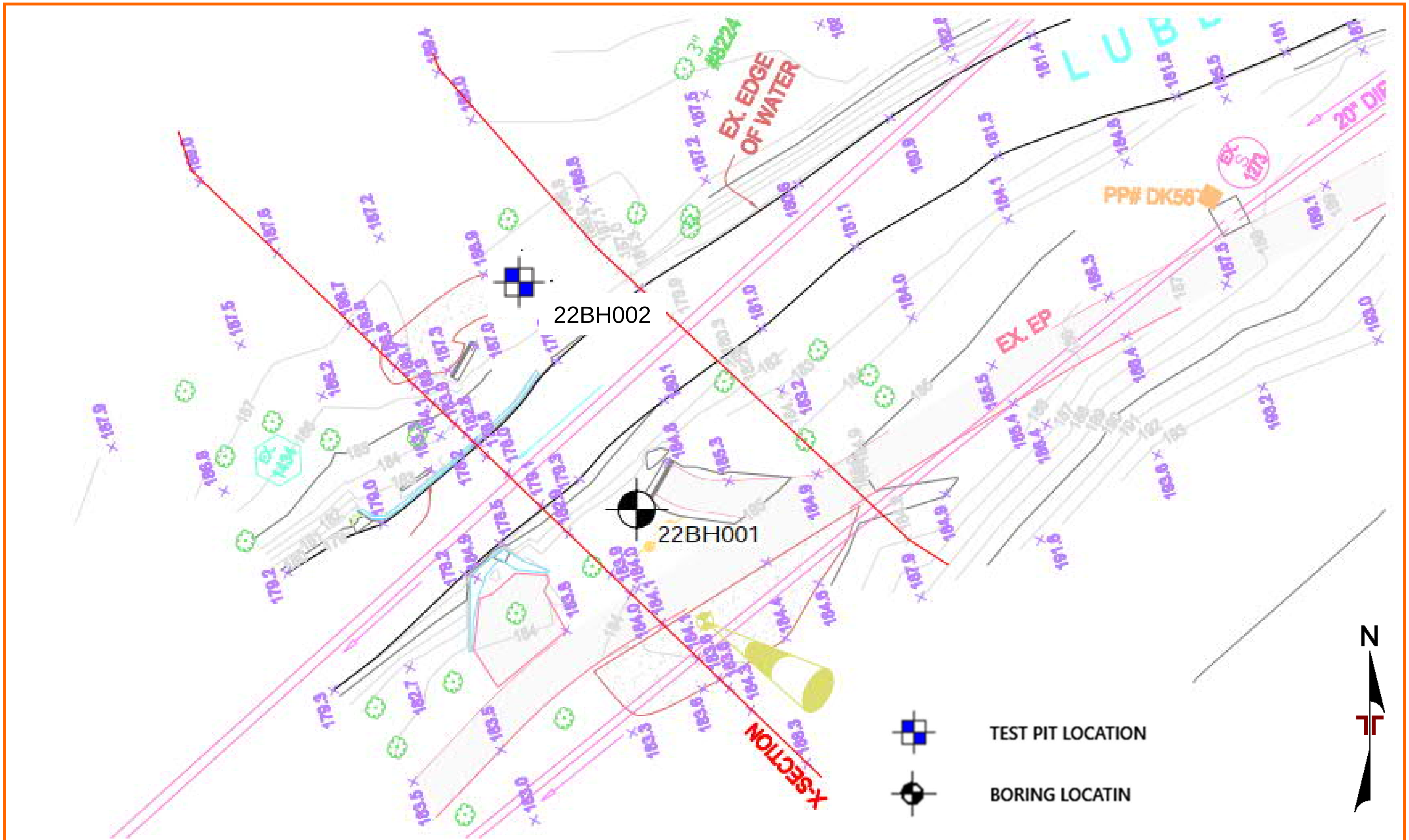
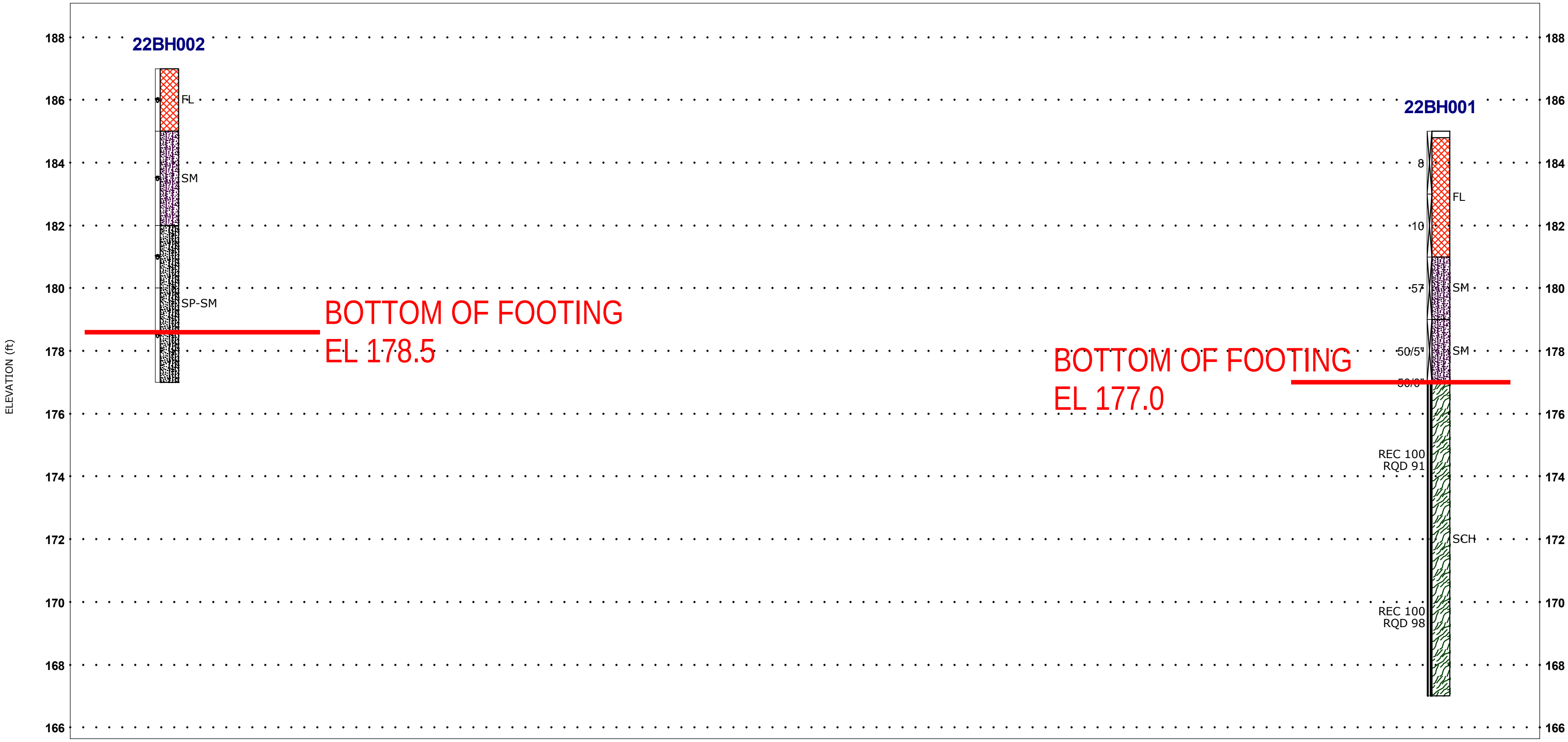


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					



Notes: See borehole logs for complete data
See Material and Sample Symbols List

The subsurface information shown on the boring logs in these plans was obtained with reasonable care and recorded in good faith solely for use by the Department in establishing design controls for the project. The Department has no reason to suspect that such information is not reasonably accurate as an approximate indication of the subsurface conditions at the sites where the borings were taken. The Department does not in any way warrant or guarantee that such data can be projected as indicative of conditions beyond the limits of the borings shown; and any such projections by bidders are purely interpretive and altogether speculative. Further, the Department does not in any way guarantee, either expressly or by implication, the sufficiency of the information for bid purposes.

The boring logs are made available to bidders in order that they may have access to subsurface data identical to that which is possessed by the Department, and are not intended as a substitute for personal investigation, interpretation and judgment by the bidders.

SPT_FENCEB:JD205321 LUBBER RUN BRIDGE_VDOT.GPJ:10.01.00.11:0210115/31/22

No.	Description	Date
Revisions		

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

LUBBER RUN PARK PEDESTRIAN BRIDGE
SUBSURFACE PROFILE

Drilled:	Date	Plan No.	Sheet No.
Logged:			
Checked:			

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
	Clean Gravels (Less than 5% fines)	
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
	Clean Sands (Less than 5% fines)	
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

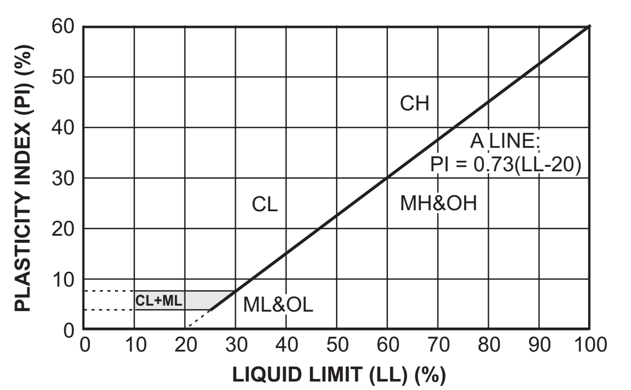
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



VDOT

MATERIAL AND SAMPLE SYMBOLS LIST

Pavement/Soils

ASPH- ASPHALT PVT	GP - Poorly-graded Gravel	MH - Elastic Silt	SC - Clayey Sand
CH - Fat Clay	GP-GC	MH/CH	SM - Silty Sand
CL - Lean Clay	GP-GM	MH/ML	SP - Poorly-Graded Sand
CL-ML	GW - Well-Graded Gravel	MH/SM	SP-SC
CONC- CONCRETE PVT	GW-GC	ML - Silt	SP-SM
FL -Fill	GW-GM	ML/CL	SW - Well-Graded Sand
GC - Clayey Gravel	GM/GP	ML/GM	SW-SC
GC-GM	GM/ML	ML/SM	
GM - Silty Gravel	GM/SM	SW-SM	

Sedimentary Rocks

CGL - Conglomorate	SE - Shell Bed
CLST - Cherty Limestone	SHL - Shale
COL - Coal	SLS - Siltstone
MST Mudstone	SST - Sandstone
GWK - Graywacke	SST-SHL - Interbedded Sandstone/Shale
LST - Limestone	SST-SLS - Interbedded Sandstone/Siltstone
UCY - Underclay	SHLS-Shaly Limestone
SHDS Shaly Dolostone	MSH Silty Shale
CHK Chalk	SSHL Sandy Shale

Igneous Rocks

- AND - Andesite
- BST - Basalt
- DBS - Diabase
- DRT - Diorite
- GBR - Gabbro
- GRD - Granodiorite
- GRN Granite
- POR - Porphyry
- RHY - Rhyolite

Metamorphic Rocks

- GGE - Gouge
- GNS - Gneiss
- MYL - Mylonite
- PHY - Phyllite
- SCH - Schist
- SLT - Slate

Misc.

- CAV - Cavity
- HWR Highly Weathered Rock
- BRC - Breccia

Sampling

- SPT
- Core
- Auger
- Vane
- Undisturbed
- Grab
- No Recovery
- Other

MATERIAL AND SAMPLE SYMBOLS LIST

Pavement/Soils	Sedimentary Rocks	Igneous Rocks	Metamorphic Rocks	Sampling
TOPS-TOPSOIL; SC/CH; CH/CL; CH/MH; CH/SC	BLD-Boulder Bed	CHT Charnocktite	MSLS Metasiltstone	
CL/ML; CL/SC; CL/CH; GP/GW; CRA Crushed Aggregate	DLS Dolostone		MSST Metasandstone	
GW/GP; ML/MH; GC/SC; OH/OL; GP/SP	LST-DLS-Interbedded Limestone/Dolostone		QZT - Quartzite	
OL/OH; PT Peat; OH Organic; SC/CL; OL Organic			SPS Soapstone	
SC/GC; SC-SM; SP/SW; SM/GM; SM/MH			MBST Metabasalt	
SM/ML; SM/SC; SP/GP; SW/SP			MBL Marble	

VDOT
Virginia Department of Transportation

PROJECT #: JD205321
LOCATION: Virginia
STRUCTURE: BRIDGE

22BH001

PAGE 1 OF 1

STATION:
LATITUDE: 38.869678° N
SURFACE ELEVATION: 185.0 ft

OFFSET:
LONGITUDE: 77.117375° W
COORD. DATUM: NAD 83

Date(s) Drilled: 2/18/2022 - 2/18/2022
Drilling Method(s): 3.25 HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: J. Labas (Terracon)
Logger:

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
DRY AFTER 0 HRS

FIELD DATA / FIELD DESCRIPTION OF STRATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		5-2-6-1	75	0-2			0.0 / 185.0 Topsoil = 2 in.			11.6	
		3-4-6-7	60	2-4			0.2 / 184.8 *Fill*, brown, fine to coarse, SILTY SAND FILL WITH GRAVEL, medium dense, contains wood, micaceous, moist **(SM)** **FL** SAME: below 2.0 ft. yellow, no wood			7.1	
5	180	10-18-39-45	75	4-6			4.0 / 181.0 *Alluvium*, gray, fine to medium, SILTY SAND, very dense, micaceous, moist **SM**	NP	NP	4.2	21.9
		29-50/5"	35	6-8			6.0 / 179.0 *IGM*, gray, fine to medium, SILTY SAND, very dense, micaceous, moist **SM** Auger and spoon refusal at 8.0 ft.	NP	NP	7.8	25.7
		50/0"		8-13	100	91	8.0 / 177.0 Slightly weathered, dark gray, hard, MICA SCHIST, moderately fractured, poorly foliated **SCH**				
10	175										
15	170			13-18	100	98					
							Bottom of borehole at 18.0 ft.				

REMARKS: Rig Type: D50. Cave-in at 12 ft.

PAGE 1 OF 1
22BH001

PROJECT #: JD205321
LOCATION: Virginia
STRUCTURE: BRIDGE

22BH002

Virginia Department of Transportation

STATION:
OFFSET:
LATITUDE: 38.869781° N
LONGITUDE: 77.117533° W
SURFACE ELEVATION: 187.0 ft
COORD. DATUM: NAD 83

Date(s) Drilled: 2/18/2022 - 2/18/2022
Drilling Method(s):
SPT Method:
Other Test(s):
Driller:
Logger:

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	186										0.0 / 187.0 *Fill*, brown, fine to coarse, SILTY SAND FILL WITH GRAVEL, micaceous, moist **(SM) FL**				
	184										2.0 / 185.0 *Alluvium*, brown, fine to coarse, SILTY SAND FILL WITH GRAVEL, micaceous, moist **SM**				
5	182				5						5.0 / 182.0 *IGM*, gray, fine to medium, POORLY GRADED SAND WITH SILT, micaceous, moist **SP-SM**	NP	NP	11.0	6.8
	180														
	178														
10					10						Bottom of embankment at 10.0 ft.				

REMARKS:

SUMMARY OF LABORATORY RESULTS

BORING ID	Depth (Ft.)	Soil Classification USCS & AASHTO	Water Content (%)	Liquid Limit	Plasticity Index	Plastic Limit	% Gravel	% Sand	% Fines
22BH001	0-2		11.6						
22BH001	2-4		7.1						
22BH001	4-6	SILTY SAND(SM) / A-2-4 (0)	4.2	NP	NP	NP	0.0	78.1	21.9
22BH001	6-8	SILTY SAND(SM) / A-2-4 (0)	7.8	NP	NP	NP	14.2	60.1	25.7
22BH002	5-10	POORLY GRADED SAND with SILT(SP-SM) / A-3 (0)	11.0	NP	NP	NP	0.9	92.2	6.8

PROJECT: Lubber Run Park Pedestrian Bridge

SITE: 124 - 132 N. Columbus St.
Arlington, VA

Terracon
19955 Highland Vista Dr Ste 170
Ashburn, VA
PH. 703-726-8030 FAX.

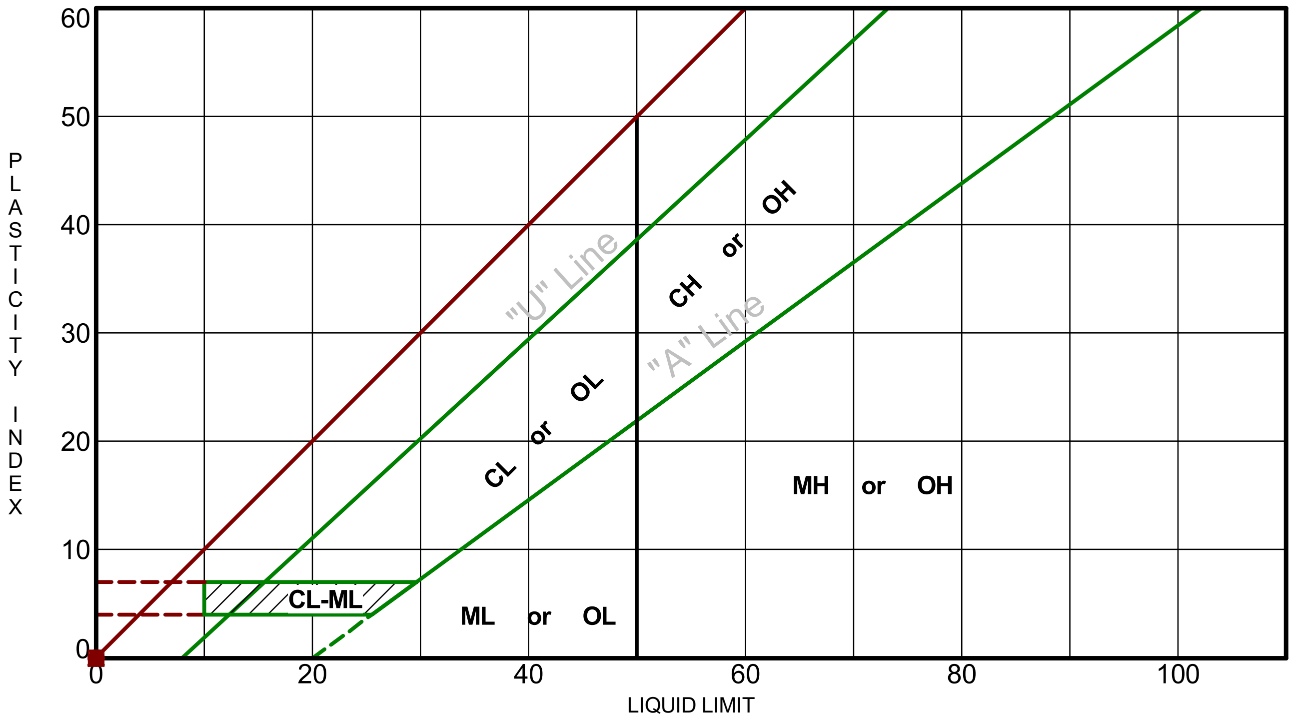
PROJECT NUMBER: JD205321

CLIENT: Volkert, Inc.
Springfield, VA

EXHIBIT: B-1

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	**22BH001**	**4 - 6**	**NP**	**NP**	**NP**	**21.9**	**SM**	**SILTY SAND**
⊠	**22BH001**	**6 - 8**	**NP**	**NP**	**NP**	**25.7**	**SM**	**SILTY SAND**
▲	**22BH002**	**5 - 10**	**NP**	**NP**	**NP**	**6.8**	**SP-SM**	**POORLY GRADED SAND with SILT**

PROJECT: Lubber Run Park Pedestrian Bridge

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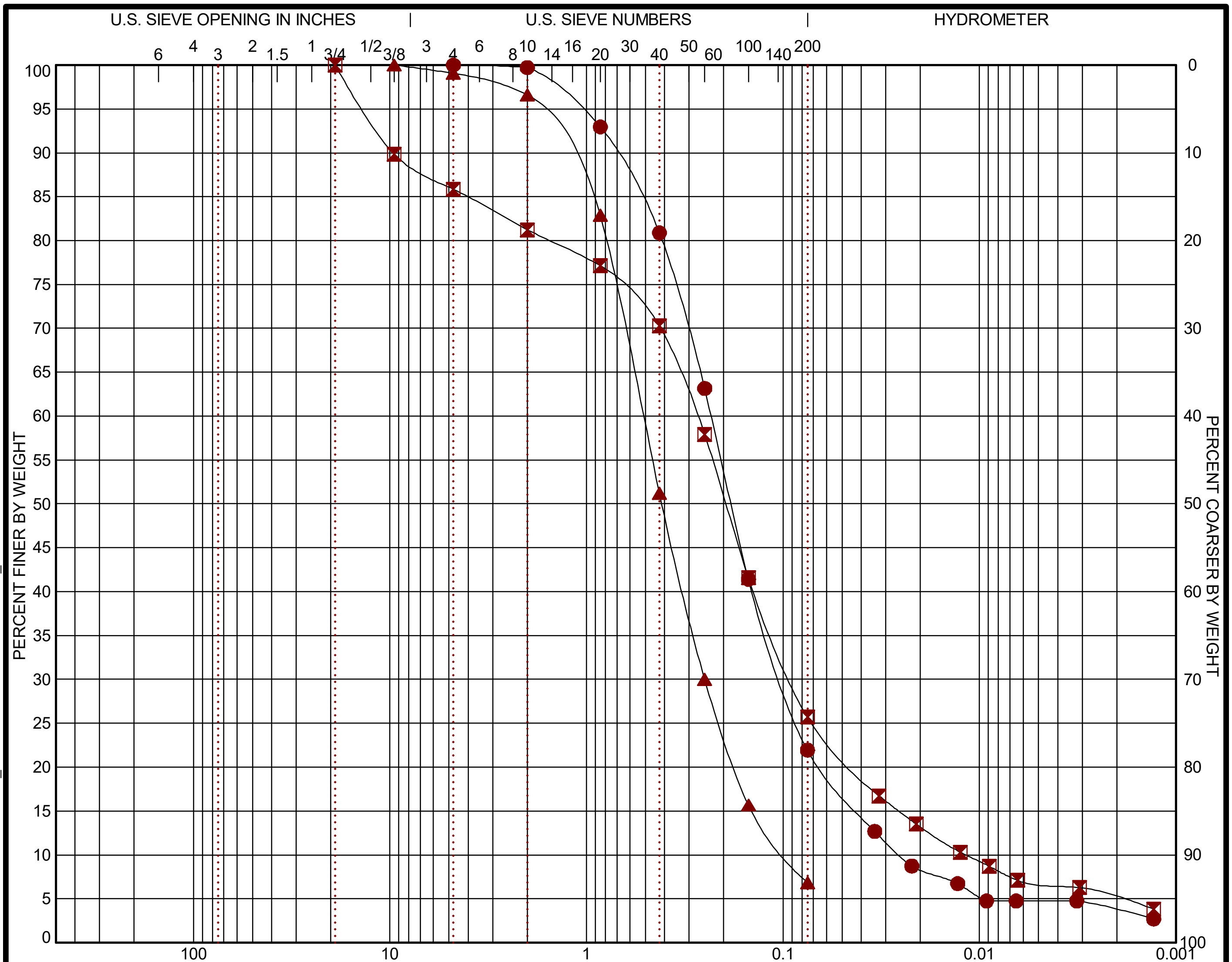
Springfield, VA

EXHIBIT: B-1

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**22BH001**	**4 - 6**	**0.0**	**0.0**	**78.1**	**17.2**		**4.7**	**SM**
⊠	**22BH001**	**6 - 8**	**0.0**	**14.2**	**60.1**	**18.9**		**6.8**	**SM**
▲	**22BH002**	**5 - 10**	**0.0**	**0.9**	**92.2**		**6.8**		**SP-SM**

	GRAIN SIZE		
	●	⊠	▲
D_{60}	**0.232**	**0.273**	**0.515**
D_{30}	**0.1**	**0.09**	**0.25**
D_{10}	**0.025**	**0.012**	**0.096**
	COEFFICIENTS		
C_C	**1.69**	**2.55**	**1.26**
C_U	**9.14**	**23.25**	**5.36**

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	**100.0**	**3/4"**	**100.0**	**3/8"**	**100.0**
#10	**99.71**	**3/8"**	**89.85**	**#4**	**99.06**
#20	**92.96**	**#4**	**85.85**	**#10**	**96.59**
#40	**80.88**	**#10**	**81.23**	**#20**	**82.88**
#60	**63.15**	**#20**	**77.14**	**#40**	**51.19**
#100	**41.4**	**#40**	**70.26**	**#60**	**29.99**
#200	**21.93**	**#60**	**57.93**	**#100**	**15.69**
		#100	**41.6**	**#200**	**6.83**
		#200	**25.7**		

SOIL DESCRIPTION
- ● SILTY SAND (SM)
- ⊠ SILTY SAND (SM)
- ▲ POORLY GRADED SAND with SILT (SP-SM)

REMARKS
- ●
- ⊠
- ▲

PROJECT: Lubber Run Park Pedestrian Bridge

SITE: 124 - 132 N. Columbus St.
Arlington, VA

Terracon
19955 Highland Vista Dr Ste 170
Ashburn, VA

PROJECT NUMBER: JD205321

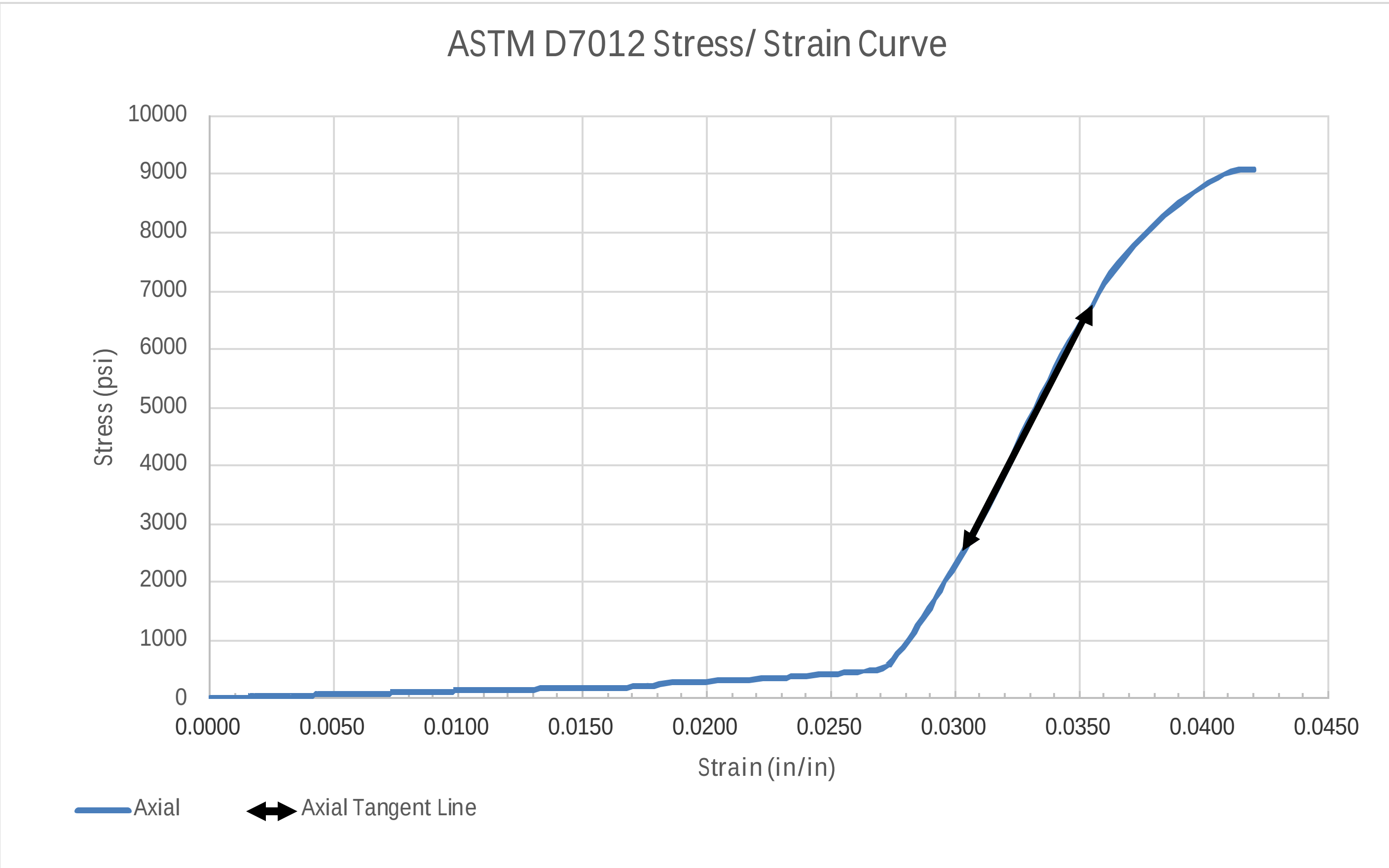
CLIENT: Volkert, Inc.
Springfield, VA

EXHIBIT: B-1

Rock Core D7012 Method C

Client	Project
Volkert, Inc	Lubber Run Park Pedestrian Bridge

Project No. JD205321



SAMPLE LOCATION			
Site:	Lubber Run Park Pedestrian Bridge		
Description:	Mica Schist		
Boring:	22BH001	Depth (feet):	8.1-13.1

SPECIMEN INFORMATION			
Sample No.:	6	Mass (g):	577.98
Length (in.):	4.16	Diameter (in.):	1.98
L/D Ratio:	2.101	Density (pcf):	171.900

TEST RESULTS	
Failure Load (lbs):	27951
Failure Strain (in/in):	0.044
Unconfined Compressive Strength (psi):	9,078
Elastic Modulus, E, (ksi):	815
Time of Failure (min):	03:08
Rate of Loading (in/sec):	0.04
Moisture Content Post-break:	0.41%

Rock Core D7012 Method C

Client
Volkert, Inc

Project
Lubber Run Bridges

Project No. JD205321

Equipment:	TICCS ID:
Calipers	W-44049
Scale	B-71466
Dial Indicator	C-70608
Compression (spherically seated)	C-48999

Samples were prepared and tested in accordance with ASTM D4543 and D7012. Deviations, if any, are noted below:
Notes:

Per ASTM D4543, this specimen has not met the requirements for flatness, by exceeding 0.001 inches.
Per ASTM D4543, this specimen has not met the requirements for parallelism, by exceeding 0.25º.

According to ASTM D7012 Section 8.2.1, this specimen, although not meeting all requirements of ASTM D4543 is acceptable for testing. However, the results reported may differ from results obtained from a test specimen that meets the requirements of D4543.

ROCK CORE PHOTO LOG

Lubber Run Park Pedestrian Bridge ■ Arlington, VA

Terracon Project No. JD205321

Run No. 1

Run No. 2

Test Borehole Number	Run No.	From (feet)	To (feet)	Recovery	Recovery	Rock Quality Designation (RQD)	Rock Quality Designation (RQD)
				(inches)	(%)	(inches)	(%)
22BH001	1	8	13	60	100	54.5	91
22BH001	2	13	18	60	100	59.0	98

CHEMICAL LABORATORY TEST REPORT

Project Number: JD205321
Report Date: 04/06/21

Client: Volkert, Inc **Project:** Lubber Run Park Pedestrian Bridge

Sample Submitted By: Adam Seip **Date Received:** 3/25/2022 Lab No.: 2504-2508

Results of Corrosivity Analysis

Lab Number	2504	2505	2507	2508
Sample Location	22BH001	22BH001	22BH002	22BH002
Sample Depth (ft.)	0.1-5.1	5.0-10.0	0.0-5.0	5.0-10.0
pH Analysis, AASHTO T 289	6.78	7.87	6.72	6.41
Water Soluble Sulfate (SO4), AASHTO T 290 (mg/kg)	16.3	5.8	19.8	4.2
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil	Nil	Nil
Water Soluble Chlorides, AASHTO T 291, (mg/kg)	47.0	69.2	220.1	249.1
Resistivity, AASHTO T 288, (ohm-cm)	Not Tested	32994	36302	Not Tested
Redox, ASTM G-200, (mV)	1673.0	1655	1746.1	1618.2

Analyzed By: Stewart Abrams

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

Terracon

Spread Footing Bearing Resistance - Strength and Extreme Limits

AASHTO LRFD Bridge Specifications 2020

Project Number: JD205321	**Project Engineer: BDM**
Project Name: Lubber Run Park Ped Bridge	**Principal Engineer: SU**
Project Location: Arlington, VA	**Date: June 2022**

Based on Bearing Capacity Equation 10.6.3.1.2a-1 of AASHTO LRFD Design Specifications
Table 10.5.5.2.2-1

γ (pcf), total or moist	135	130
Df (ft)	6.5	10
Dw, Depth of groundwater (feet)	10	10
φ_b	0.45	0.45
Location	**Abutment B (East)**	**Abutment A (West)**
B (ft)	5.5	5.5
L (ft)	10.33	10.33
Friction Angle (degree)	36	34
Cohesion, psf	0.0	0.0
Cwq	1.0	1.0
$Cw\gamma$	0.7	0.5
N_c	50.6	42.2
N_q	37.8	29.4
N_{gm}	56.3	41.1
RC_{BC}	1.0	1.0
q_n (ksf), nominal bearing resistance (Extreme)	48.1	45.6
q_R (ksf), factored resistance	21.6	20.5
Representative Boring No.	22BH001	22BH002
Existing Ground Elevation (ft)	185	187
Foundation Elevation (ft)	177.0	178.5
Expected Footing Subgrade Material	BEDROCK	IGM

Terracon

Bearing Capacity Service Limit and Elastic Settlement

AASHTO LRFD Bridge Specifications - 2020

Project Number: JD205321	**Project Engineer: BDM**
Project Name: Lubber Run Park Ped Bridge	**Principal Engineer: SU**
Project Location: Arlington, VA	**Date: June 2022**

Elastic Half Space Method; Equation 10.6.2.4.2-1

Parameters		Abutment B (East)	Abutment A (West)
q_0	Applied vertical stress (ksf)	21.0	20.0
B	Footing width (ft)	5.5	5.5
Length	Footing length (ft)	10.33	10.33
Es	Young's modulus of soil (ksi)	20.0	13.0
βz	Shape factor (from Table 10.6.2.4.2-1 AASHTO LRFD 2020 manual)	1	1
ν	Poisson's Ratio	0.2	0.2
L/B	L/B	1.88	1.88
A'	Effective area of footing (sq. ft)	56.8	56.8
Se	Elastic settlement (ft)	0.05	0.08
Se	**Elastic settlement (inch)**	**0.6**	**0.9**
Representative Boring No.		22BH001	22BH002
Expected Footing Subgrade Material		BEDROCK	IGM

Young's Modulus of Soil (ksi) - Table C10.4.6.3-1 (LRFD 2014)		
IGM - Average N = 50/6" (Layer thickness 2 ft) E = (0.097 x N160) =	13	ksi
Bedrock - Average N = 50/0" (Layer thickness 2 ft) E = (0.097 x N160) =	20	ksi
Weighted Average=	18.53	ksi