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Geotechnical

Solutions, Inc.

PRELIMINARY SUBSURFACE INVESTIGATION
AND
GEOTECHNICAL ENGINEERING REPORT

Smith - Haymarket
Prince William County, Virginia

Prepared for

VAN METRE COMMUNITIES, INC.
43045 Van Metre Drive, Suite 200
Broadlands, VA 20148

GSI Project No. GP-182504

January 22, 2019

Geotechnical Solutions, Inc.

Geotechnical Engineering
Environmental Consulting • Construction Materials

January 22, 2019

Mr. Derek DiDonato, P.E.,
Director of Engineering
VAN METRE COMMUNITIES, INC.
43045 Van Metre Drive, Suite 200
Broadlands, VA 20148

GSI Project No. GP-182504

Reference: Subsurface Exploration and Preliminary Geotechnical Engineering Report
Smith - Haymarket
Prince William County, Virginia

Dear Mr. DiDonato,

Geotechnical Solutions, Inc. (GSI) has completed the authorized preliminary subsurface investigation and the geotechnical report for the above referenced project site. A preliminary geotechnical report, including the results of our field exploration, laboratory testing program, engineering analysis, and our preliminary recommendations for the proposed development is enclosed with this report. The preliminary recommendations presented in this report are intended for use by your office and for the use of other design professionals involved with the design and implementation for the specific project described herein.

Eight (8) soil test borings, designated as B-1 through B-8, were performed for the proposed development. Based on our subsurface exploration, it is our professional opinion that the site is suitable for the proposed development. The most significant factor which may impact development on this site include depth to weathered rock. While this factor do not prevent development of the site as proposed, it should be recognized that higher costs will be incurred for development of this site than for sites without this problem.

We thank you for your confidence in our services. We will remain available for future consultation during the design and construction phases of the project. Should you have any questions regarding the content of this report, please do not hesitate to call us at (703) 657-0014.

Respectfully submitted,
GEOTECHNICAL SOLUTIONS, INC.

Saeed Fallah P.E.
Senior Project Manager

Abdallah Adas, P.E.
Principal Engineer

Attachment: GSI Preliminary Geotechnical Report No. GP-182504

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1.0 INTRODUCTION

Geotechnical Solutions, Inc. (GSI) has completed a preliminary subsurface investigation and a geotechnical study for a residential development in Prince William County, Virginia and referenced herein as "Smith – Haymarket".

The scope of our services was performed in accordance with GSI Proposal/Agreement No. GP-182504, dated January 2, 2019. Mr. Derek DiDonato, Engineering/Entitlements Land Manager – Mid Atlantic Division, at Van Metre Communities, Inc. authorized this work as a preliminary assessment of the subsurface conditions across the site to aid in the development of the property.

1.1 Purpose and Scope of Work

The objectives of this study are to determine the physical and geotechnical properties of the subsurface soil, groundwater conditions at the site, and provide preliminary assessment of those conditions with respect to the proposed plans for development of the property. More specifically, the objectives of this study are summarized as follows:

- Identify and evaluate the types of overburden soil at the boring locations. This identification includes soil classification, index properties and gradation.

- Preliminary evaluation of the on-site soil characteristics encountered in the soil borings. Specifically, we will discuss the suitability of the on-site materials for reuse as engineered fill to support the floor slab. We will also include compaction requirements and suitable material guidelines.

- Provide preliminary assessment of the presence of groundwater, both as perched condition above or within restrictive layers, or as permanent water table within the substrata.

- Provide preliminary general construction guidelines for site grading and earthwork activities including the suitability and engineering applications of the on-site borrow materials, temporary control of groundwater, and placement of compacted fill and backfill for building, pavement areas and site utilities.

- Preliminary recommendations for allowable bearing pressure for the most feasible foundations and estimates of predicted foundation settlement.

- Provide preliminary recommendations for permanent dewatering system for the foundation. Temporary excavation and temporary protection, such as temporary dewatering systems.

- Preliminary recommendations for seismic design parameters as determined in accordance with IBC 2012 Table 1613.5.2.

- Discuss relevant geotechnical concerns encountered or noted during our presence on site that may impact the proposed development.

- Provide preliminary assessment of the suitability and engineering application of soils encountered at the boring locations for use during the construction phase of the project.

The scope of our work includes a review of the field and laboratory results obtained during the subsurface investigation; a site reconnaissance by our engineering staff; an analysis of the data obtained; and the preparation of this preliminary geotechnical report based on the preliminary layout plan/ Sketch Study, titled "Smith - Haymarket", prepared by Dewberry dated July 16, 2015. This report summarizes the findings of our field and laboratory test results and presents our preliminary recommendations for the proposed development of the property.

1.2 Site Location and Description

The proposed site is an assemblage of three undeveloped lands located at 6701 Hunting Path Road, 14860 Washington Street, and 15850 Washington Street in Haymarket, Virginia with GPIN Numbers 7298-90-7006, 7297-99-8684, and 7397-09-0978 respectively, based on Prince William County (PWC) Mapper. The combined land has a total area of 7.1± acres and is bordered by existing residential communities to the north and east, Washington Street (VA Route 55) to the south, and Hunting Path Road along with a commercial property to the west and southwest of the overall site.

This site mostly consists of moderately to heavily wooded area on the northern and middle portion of the site and open field areas with mature trees on the southern part of the property. Based on the PWC topographic map, the property is characterized by relatively flat to moderately sloping downward topography from the west and south toward the northeast with an uphill slope at the north of the site. The general ground surface elevations at the site vary from a high of approximately EL. 374± feet, Mean Sea Level (MSL) at northwest corner of the site to a low of approximately EL. 352± feet, MSL, at the northeast corner of the property, for a total relief of approximately 22± feet.

The approximate location of the site is shown on the Site Vicinity Map presented in the Appendix of this report.

1.3 Project Description

A preliminary sketch plan prepared by Dewberry dated July 16, 2015 was provided to us. Based on this study plan we understand that the project planned for thirty-seven (37) townhouses with garages and associated site utilities, roadways, and parking area on the northern half of the site. Also, a storm water management facility is planned in the northeast portion of the overall site as part of the development. In the south half of the site, a Primrose School with through access road and parking area will be placed on approximately 1.2± acres of land. A lot with approximate size of 1± acre will remain vacant at southwest of the property for future development.

We anticipate the planned townhouses will be constructed as wood-framed, multi-story structures with brick veneer skin and slabs-on-grade. The future school may comprise of structural steel and cold form framing. Footings, slabs, and foundation walls for the structures will be cast-in-place concrete. The perimeter wall footings and the interior column footings are expected to have loads on the order of 2 to 5 kips per linear foot and up to 40 to 80 kips, respectively. The anticipated total tolerable settlements of up to 1.0 inch and differential settlements of up to 0.75 inch will be considered in the foundation design in accordance with generally accepted engineering design practices. GSI should be advised if the actual loads exceed the estimated values so the recommendations outlined in this report can be updated.

No additional information was provided at the time this report was prepared.

2.0 EXPLORATION PROCEDURES

2.1 Subsurface Exploration

The subsurface exploration included eight (8) soil test borings, designated as Borings B-1 through B-8, that were proposed to be advanced to a maximum depth of 15 feet from the grade level. All borings were planned to be drilled to the proposed depth or to auger/spoon refusal, which ever occurred first. The boring locations were selected by GSI based on the provided preliminary layouts for the proposed development. Also, the borings were field located by GSI utilizing the GPS method. The ground surface elevations at the boring locations were interpolated from Prince William County Topographic map. The boring locations and elevations should be deemed accurate with regard to the methods used. The approximate locations of the borings are shown on the Boring Location Plan (BLP) in the Appendix of this report.

The soil borings were performed with a CME 550 ATV-mounted drilling rig, which utilized continuous flight, hollow stem augers to advance the boreholes. The specific drilling methods are noted on the individual boring logs.

Representative soil samples were obtained by means of the split-barrel sampling procedure in accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-barrel sampler is driven into the soil 18 inches by a manual or an automatic 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through a 12-inch interval is termed the Standard Penetration Test (SPT) N-value and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

Upon completion, the boreholes were backfilled with the auger spoils generated during drilling operations. A field log of the soils encountered in the borings was maintained by the drill crew. The soil samples were placed in sealed jars and transported to our materials laboratory in Chantilly, Virginia for visual evaluation, classification and material testing.

Materials encountered during the field investigation were visually classified by a GSI's geotechnical engineer in accordance with ASTM Standard D-2488, "Description and Identification of Soils - Visual-Manual Method" and the Unified Soil Classification System (USCS). The field observations include the description of each soil stratum encountered, the estimated depth and thickness of each layer, and groundwater observations. These field observations are recorded on the individual boring log sheets that are presented in the Appendix of this report.

Groundwater observations were made during the drilling of the test borings by a visual examination of recovered samples from the standard penetration tests, auger cuttings, and water marks on the split-barrel sampler and drill rods. Further, groundwater readings were taken after completion of each boring prior to backfilling.

2.2 Laboratory Testing

Representative soil samples were collected from the test borings and transported to our office in Chantilly, Virginia for laboratory testing. Selected samples were classified in accordance with ASTM Standard D-2487 "Classification of Soils for Engineering Purposes" by performing specific laboratory tests. The laboratory tests included the following test methods.

ASTM D-2216	Determination of Moisture Content of Soils
ASTM D-6913	Particle Size Analysis of Soils
ASTM D-4318	Atterberg Limits (LL, PL & PI)

These tests were performed to determine the physical characteristics and soil classification of the various soils encountered during the subsurface investigation. The laboratory test results are presented on the individual data sheets that can be found in the Appendix of this report.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received as to their disposition.

3.0 RESULTS

3.1 Site Geology

A review of the published geological information indicates that the site is geologically located in the Culpeper Basin of Virginia within the Piedmont Physiographic province. The basin extends from the Rapidan River near Madison Mills, Virginia Northeastward toward the Potomac River and terminates just west of Fredrick, Maryland.

The Culpeper Basin was formed by rifting (the separation of tectonic plates), which occurred following the formation of the ancestral Blue Ridge Mountains. The rift basin created a large playa sea, which was subsequently filled by erosional deposits from the ancestral Blue Ridge

Mountains. Because of the discontinuities in the earth's crust, these sedimentary deposits were subsequently intruded by igneous materials penetrating the earth's crust. The subsequent intrusion by igneous materials creates a much more variable geologic profile than would be expected had this area remained sedimentary deposits only. As such, the Culpeper Basin now includes several primary rock types. These materials range from sedimentary siltstone and sandstone to metamorphic hornfels to igneous basalt and diabase rock.

At this site, our geologic overlay indicates that the site should be expected to consist of Catharpin Creek Formation of Jurassic and/or Triassic age. The Catharpin Creek Formation is composed of interlayered sandstone, siltstone, shale, and conglomerate. Siltstone rocks typically weather to low plasticity silt and clay soils. The sandstone rocks typically weather to low to medium plasticity silty sand and clayey sand soils.

Residual soils are characterized as highly structured sands, silts, and clays that transition abruptly to broken and weathered rock and finally fresh competent rock. The major limitation to development is depth to rock. Many areas of the Culpeper Basin are noted for seasonal high groundwater due to the shallow depth to bedrock and low permeability soils.

3.2 Prince William County Soil Mapping

Based on our review of the soil survey of Prince William County, published by the National Cooperative Soil Survey, the soils at the site are predominantly within the Arcola-Panorama-Nestoria group. The soil units within the site are the following:

Table 1 – Prince William County Soils

Soil Name	Soil Number	Soil Class.	Soil Name	Soil Number	Soil Class.
Arcola silt loam	4B	II	Manassas silt loam	35B	III
Arcola-Nestoria complex	5C	II			

These soils are classified by Prince William County as Category II and III soil, indicating that they are considered as "Potential Problem Soils" for general land development and may pose some difficulties during earthwork activities which may require engineering solutions.

Slope runoff and seasonal high-water tables in the spring and winter are the main limitations for building site development. Some of these limitations can be overcome by using subsurface drainage and by diverting the surface water. Additionally, limitations for vehicular traffic support are anticipated within these soil types but can be overcome by strengthening or replacing the base material.

A Soil Type Map is included in the Appendix of this report.

3.3 Subsurface Observations

Based on the results of our field investigation, the subsurface conditions and stratification as observed in the borings were generally found to be consistent with the published geologic data. Attempts have been made to group the soils into distinctive strata. The variations identified as discontinuities within the individual strata should be anticipated across the site. Therefore, it is important to note that the stratifications of the soil profiles in the boring logs represent the approximate boundaries between the different layers. In-situ transitions within strata may be more gradual rather than distinct. Surface materials at the eight (8) borings consisted of approximately 4 to 8 inches of topsoil.

Stratum I: Cohesive Soils

This stratum was encountered in the eight (8) borings. These soils were encountered beneath the surficial topsoil and extended to the top of Stratum II at depths ranging between 3 and 10.5 feet below existing grades. The material consists of Sandy Lean CLAY (CL), Sandy SILT (ML), and Fat CLAY (CH) with varying amounts of rock fragments. Stratum I soils were typically very soft to hard (cohesive soils) based on SPT N-values ranging between 4 and 50 blows per foot (bpf). The higher SPT N-values are likely due to the rock fragments in the stratum.

Stratum II: Weathered Rock (Siltstone)

Stratum II was encountered in the eight (8) borings. This stratum consists of Weathered Rock (Siltstone) encountered at depths ranging between 3 and 10.5 feet below existing grade. This stratum consists mainly of fragmented rock particles and cemented but discontinuous rock layers that have been subjected to alteration by chemical and/or mechanical factors.

This material retains the properties of the parent rock. The depth of this stratum is generally indicative of the last rippable material before difficult excavation techniques, such as chipping, pneumatic hammering and rock saw excavation or blasting for deep utilities, would typically be required during site development.

Beneath this stratum, the transition into a more competent rock can be expected. The borings were extended through Stratum II and terminated at depths ranging between 6.5 and 14.3 feet below existing grades.

3.4 Depth to Weathered Rock

Severely weathered and decomposed rock has been defined as residual rock material with standard penetration test N-value of 60 bpf or higher. Non-rippable rock depth is identified on the boring logs as the depth where the SPT blow count is 50 blows required for one-tenth of a foot or less.

Auger refusal and spoon refusal typically indicates depth to non-rippable rock. The auger refusal was encountered in Boring B-4. At this site, the auger advanced to the depths ranging between 6.5 and 14.3 feet below existing ground level.

3.5 Groundwater Conditions

Observations for groundwater are typically made during sampling and upon completion of drilling. In auger drilling water is not introduced into the test locations and groundwater position can often be determined by observing water flowing into or out of the open borehole. Furthermore, visual observation of soil samples retrieved during testing operations can often be used in evaluating groundwater conditions.

Groundwater was not encountered in the eight (8) borings and they were observed to be dry at completion of drilling operations; however, perched water tables commonly encountered in this area. The borings were backfilled with auger cuttings on completion for safety concerns; therefore, 24-hour water observations were not made. The perched water is typically related to rainfall entering the site, either directly or by overland flow from adjacent properties, and percolating down through the slightly to moderately permeable surficial soils until it reaches the soil rock interface. Once the water reaches the nearly unweathered, virtually impermeable, siltstone, it begins to flow along the intersection of the unweathered rock and the soil. This groundwater flow continues downhill, occasionally surfacing to form as wet springs and intermittent streams. Usually a persistent water table occurs only in low-lying areas and adjacent to creeks; otherwise, it is related to rainfall and thus only transient in occurrence. Impervious layers, highly permeable fracture zones and utility beds can distort seepage patterns; consequently, only the lower limits of the saprolite remain saturated for extended periods.

The soil test borings caved at depths ranging between 1.5 and 3.5 feet. Groundwater seepage should be anticipated below the cave-in depths recorded during drilling due to hydrostatic conditions that caused water-softened sidewall soils to collapse into the open borehole.

3.6 Laboratory Test Results

Soil classification, moisture content, liquid limit, and grain size were performed on representative samples recovered from the borings. The laboratory soil testing was performed per ASTM D-2487. The data obtained from the laboratory tests are included on the respective boring logs or on separate sheets in the Appendix at the end of this report.

The summary of the laboratory test results is shown in Table 2 below:

Table 2 – Laboratory Test Results Summary

Sample Location	USCS Classification	Percent Fines (-#200 Sieve)	Liquid Limit (LL)	Plasticity Index (PI)	Natural Moisture (%)
B-5 (S-3 @ 5.0'-6.5')	CL	89.3	42	19	19.5
B-7(S-2 @ 2.5'-4.0')	CL	96.0	40	16	19.2

4.0 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

The following information is based upon the findings of this geotechnical study and a review of a preliminary sketch layout plan prepared by Dewberry dated July 16, 2015 and provided to us by Van Metre Communities, Inc.

We believe that the project site is generally suitable for the construction of the proposed detached and attached single family residences with the associated site. However, the development cost of this property may be influenced by the depth to weathered rock at this site. Relevant preliminary geotechnical concerns related to the construction and development of this site have been addressed in the following sections of this report.

The following sections provide preliminary general construction guidelines for earthwork activities which include excavations for underground site utilities and the preparation of subgrades for access roads and drive ways. Preliminary Geotechnical recommendations are also provided for the support of building foundations and possible below grade foundation walls.

4.1 Suitability of On-site Materials

The on-site Sandy Lean CLAY (CL) and Sandy SILT (ML) with varying amounts of rock fragments soils of Stratum I are generally considered suitable for use as structural fill. However, materials having liquid limit values greater than 40 and plasticity index values equal to or greater than 15, such as Fat CLAY (CH) and Elastic SILT (MH) soils, are generally not suitable for use as compacted structural fill to support foundations or pavements. These soils are subject to high shrink-swell potential with variations in soil moisture.

Expansive soils including natural and/or man-placed fill, such as Fat CLAY, if encountered are not considered suitable for building pads, foundation backfill, and backfill around structures. Expansive soil is defined by the International Building Code as: "Soils meeting all four of the following provisions. They shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity Index (PI) of 15 or greater determined in accordance with ASTM D 4318.

2. More than 10 percent of the soil particles pass a No. 200 sieve (75 μm), determined in accordance with ASTM D 422.

3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.

4. Expansion Index greater than 20, determined in accordance with ASTM D 4829."

Therefore, all borrow materials, including the fine-grained fraction of SC and SM type soils, should be tested for classification and shrink/swell characteristics prior to their use as structural fill or backfill material.

4.1.1 High Plasticity Soils

High shrink swell type soil (CH/MH) was encountered in Boring B-5. These soils are common in this geology. If these soils (CH/MH) are encountered at or near footing subgrade during construction, the material shall be removed and replaced with properly compacted structural fill. As an alternative method, the foundation subgrade shall be extended to a depth of at least 4 feet below finished exterior grade, or through the (CH/MH) materials if less than 4 feet below finished exterior grade. The deeper embedment depth will extend the footings below the typical depth of seasonal moisture fluctuation in the high plasticity/elastic soils. At the 4-foot minimum embedment depth, the footing may bear on high plasticity/elastic (CH/MH) type soils or on non-expansive soils. Also, if footings placed at a normal embedment depth of 2.5 feet extend below the thickness of the high plasticity/elastic soils, then the footings can be structured at nominal depth.

4.1.2 Sedimentary Siltstone Rock

Sedimentary siltstone was encountered in the eight (8) soil test borings, at the site. Fresh, unweathered siltstone will typically excavate in large platy pieces that are difficult to compact for suitable long-term performance. Once exposed to moisture and weather conditions, these materials rapidly degrade due to weathering. Therefore, larger rock fragments must be compacted with sufficient energy to substantially break them down into soil size particles during construction.

As noted, the siltstone onsite is expected to be non-durable and will likely break down after weathering over a short duration. Durability is the term used to describe the ability of a rock or rock-like material to withstand long term chemical or mechanical weathering without size degradation. Therefore, the use of this material should be carefully controlled to prevent settlement or consolidation of fill below roadways and structures. Selection of proper equipment and aggressive working of these materials will be necessary to reduce the rock to sufficient size and generate adequate fines to fill voids. In this regard, loose lift thickness in controlled fills should be maintained at 6 inches or less to ensure adequate crushing and blending of the rock with soil and rock fines. Maximum rock particle size should be kept within 3 to 4 inches with 2-inch thick plates within the upper 5 feet of fill beneath structures and the upper 2 feet of fill below pavement. The samples should have at least 20% passing the #200 sieve and 50% passing the #40 sieve. The maximum rock particle size in deeper fill should be maintained at 10 inches or less. Normally, a vibratory sheepsfoot roller with a minimum dynamic force of 15 to 25 tons is required to accomplish this size reduction.

Proctor compaction tests should be performed with at least three cycles to model compaction of the rock, each cycle demonstrating increasing mechanical breakdown of the rock. The Geotechnical Engineer should select the most appropriate "Proctor Curve" for earthwork compaction.

We expect that periodic wetting of the fill will also be necessary to bring it to an acceptable moisture level. Careful monitoring of this process of crushing, watering and blending is necessary to ensure a uniformly compacted fills mass. Therefore, full time observation and testing by a qualified representative of the geotechnical engineer is recommended during all controlled fill operations.

4.1.3 Rock Excavation/Blasting Operations

Grading and utility installation at depths greater than 2 to 3 feet below auger refusal or spoon refusal grades are anticipated to involve rock excavation/blasting. Siltstone can generally be excavated an additional 1 to 2 feet below the refusal depths noted utilizing single tooth rippers or hoe rams operating in open excavations or borrow pits. Below this depth, blasting is normally required.

The specification should include a definition of rock excavation to account for authorized changes to the scope of work. The following is a definition of rock excavation you may wish to consider: For trenches and footings, rock is defined as any material, which cannot be dislodged by a CAT-325 hydraulic backhoe or equivalent without the use of drilling, blasting, or use of a hoe ram. For mass excavation during site grading, rock is defined as material that cannot be dislodged by a D-8 Caterpillar tractor, or equivalent, equipped with a hydraulically operated single-tooth power ripper. This classification does not include material such as loose rock, concrete, or other material that cannot be removed by conventional methods but, for reasons of economy in excavating, the contractor chooses to remove by drilling, blasting or hoe ramming.

Blasting for installation of utilities or mass excavation is a common practice in this area. Of paramount concern, and a problem of significant potential cost, is that of "overshooting" the rock, especially within laminated siltstone. Overshooting is more problematic in laminated materials where seismic forces generated by blasting are transmitted downward and outward beyond the shot point. Massive formations typically adsorb most of the shot force resulting in only localized breakage. Siltstone, however, is blast sensitive and will delaminate or fracture well beyond the desired shot zone. When the rock delaminates, the release of overburden pressure causes the underlying rock to expand vertically along bedding planes below the desired depth of excavation. This can result in settlement if the fractures later consolidate under the load of a foundation or embankment. Footings placed to bear over the zone delaminated by blasting can experience settlement as the rock either decomposes or reseats under load to a more consolidated state.

Weathering can exacerbate settlement after it is disturbed. Therefore, charge patterns and depths should be carefully selected. If over-blasting occurs, the disturbed materials must be removed and replaced, often at significant cost. The geotechnical engineer should meet with the grading contractor and blasting crews to review shot patterns and blasting procedures to minimize difficulties associated with over-blasting, if necessary.

4.2 Existing Structures/Fills

No man-placed fills or existing structures were found during our site visit and preliminary subsurface investigation; however, all existing on-site structures, if encountered, including utilities (wells, septic pumps, drain fields, etc.), and existing man-placed fill material at the site shall be removed in their entirety and properly abandoned within the offset stakeout of the proposed building locations and pavement areas. All existing wells shall be abandoned in accordance with County Health Department criteria and requirements.

4.3 Excavation of On-site Materials

We anticipate that conventional earth-moving equipment, equivalent to a CAT 963 front-end loader and CAT 325 backhoe, will be suitable for the excavation of the on-site Stratum I soils. Heavy earth-moving equipment, i.e., dozers with ripper attachments is recommended for mass excavation and grading into severely weathered and decomposed rock layers of Stratum II as mentioned earlier in **Section 4.1.2** of this report.

Based on the findings of the borings, however, rock excavation/blasting measures may be necessary for the installation of deep site utilities having invert elevations below spoon refusal as defined on the boring log sheets. We recommend the boring logs should be reviewed carefully to identify the location, depth and thickness of non-rippable rock layers. We further recommend that all site contractors should be prepared to test drill the location of all deep utilities to accurately determine rock excavation quantities during bidding.

Depending on the season and precipitation, groundwater seepage may be encountered during excavations, particularly at the soil/rock interface. Therefore, temporary dewatering measures, i.e. sump pits and continuous pumping, may be required during the excavation for site utilities or below-grade foundations.

4.4 General Site Grading

4.4.1 Earthwork Operations

We recommend that the earthwork clearing operations be extended at least 10 feet beyond the building and pavement limits as shown on the approved final plans. Stripping limits should be extended an additional 1 foot for each foot of fill required at the building's exterior edge. The proper execution of earthwork operations will be a key factor in the development of the project site. Specifically, preparations of the subgrade, field identification of high plasticity soils, (CH/MH) soils, and existing fill materials encountered in the boring log locations and other areas on site. This must be performed throughout the proposed structural areas along with the use of acceptable fill materials placed with adequate compaction effort. The following sections outline the earthwork requirements.

4.4.2 Existing Fill Material

Existing fill was not encountered during this preliminary subsurface investigation. However, if undocumented man-placed fill is encountered during construction, the existing fill shall be removed in its entirety and replaced with suitable on-site materials and compacted back to proposed design grades. This material should be replaced with structural fill material that meets the criteria outlined in **Section 4.4.5** of this report.

4.4.3 Stripping of Topsoil

All areas proposed for cut or fill should be cleared, grubbed and stripped of all topsoil to the proposed limits of construction as shown on the approved plans for this project. The depth of the topsoil encountered at the test boring locations was approximately 4 to 8 inches. However, this depth can increase in Swales, low-lying areas, near existing structures, and if stripping occurs during the winter months. As a result, we recommend stripping depths between 10 and 12 inches to remove the topsoil and deeper organic root material. In wooded areas of the site, root balls from the trees must be excavated deeper to remove the major roots, thus increasing the volume to be excavated and trucked off site; therefore, we recommend that the depth of stripping be determined in the field. Topsoil may be stockpiled for later use in landscape areas.

4.4.4 Proofrolling

All areas delineated and surveyed in the field to receive structural fill should be proofrolled with a fully loaded rubber-tired dump truck, having an axle weight of at least 10 tons to identify all soft or unstable areas to be undercut. Due to the presence of softer, near surface natural deposits, localized soft and/or unsuitable deposits requiring removal and replacement should be expected during proofrolling operations, especially in low lying areas. The geotechnical engineer or his assigned representative shall decide on the depth of undercut to avoid the removal of suitable or otherwise firm soils.

4.4.5 Borrow Material

All borrow material, whether on-site or imported from an off-site source, shall be tested for suitability and quality prior to its use as fill or backfill. The material shall be tested to determine particle gradation, plasticity, maximum dry density, and optimum moisture content.

The following standard tests shall be performed to determine the above properties of all imported fill material:

Particle Size Analysis of Soils	ASTM D-6913
Atterberg Limits	ASTM D-4318
Standard Proctor	VTM-1, ASTM D-698

Structural fill material shall consist of quality, free of organic, low plasticity soil that classify as GW, GP, GM, GC, SW, SP, SC, CL, ML or SM in accordance with ASTM D-2487 and shall have a maximum of 30% retained on a standard ¾-inch sieve. Structural fill that classifies as SC and SM shall be tested to ensure that the material has a liquid limit less than 40 and plasticity index less than 15. Fine-grained material from on or off site borrow sources that classifies as CL and ML should be tested to ensure that the material has a liquid limit of less than 40 and plasticity index less than 15, and a maximum of 70% passing a U.S. Standard No. 200 sieve. All fill material should be free of ice, snow, organic material, construction debris, rock sizes greater than 4 inches, marine clay soils, or other deleterious material.

4.4.6 Fill Placement and Testing

In- place density tests should be performed with at least one test per 2,500 square foot of fill area for each lift of fill placed.

Fill material placed in pavement areas should be placed in no greater than 8-inch thick loose lifts and compacted to at least 95% of the maximum dry density as determined per VTM-1 method (ASTM D698). However, the final one (1) foot of fill should be compacted to 100% of the maximum dry density of the same standard. The moisture content of the fill being placed should be within a 2 percent deviation of the optimum moisture content of the material. The controlled fill should extend at least 2 feet laterally outside the curb line plus one (1) foot for every foot of fill above the subgrade. All VDOT roadways and frontage improvements should be constructed in accordance with VDOT Road and Bridge Specifications.

Fill materials in building areas should be placed in no greater than 8-inch thick loose lifts and compacted to at least 95% of the maximum available dry density as determined in accordance with the Standard Proctor (ASTM D698). Deep fill is not anticipated in this site, however, where fill depths in excess of 10 feet are required, if applicable, we recommend that the compaction criteria be increased to 98% of the maximum dry density obtained in accordance with ASTM D698 the Standard Proctor Method for the full depth of fill. The moisture content of the fill being placed should be within a 2 percent deviation of the optimum moisture content of the material. The controlled fill for the building pads shall extend at least 5 feet laterally outside the building pad plus 1 foot for each foot of fill above the existing subgrade.

Granular soils (Unified Soil Classification System SM or better) should be compacted with a smooth drum vibratory roller or rubber-tired compactor. Cohesive soils should be compacted with a sheepsfoot roller, preferably a Cat 815.

Fill material should not be placed on frozen soils. All frozen soils should be removed prior to continuation of fill operations. Borrow fill materials should not contain frozen materials at the time of placement. All frost-heaved soils should be removed prior to placement of fill, stone, concrete, or asphalt.

All new fill materials should be properly benched into the existing slopes to prevent the formation of shear planes at the interface of the fill mass and the existing natural soils. The width and height of the bench will depend upon the slope of the existing hillside.

To ensure proper compaction efforts, field density determinations should be performed in accordance with specifications set forth in ASTM D-6938 (nuclear method) or D-1556 (sand cone method). We recommend that density tests be performed on every lift of compacted structural fill placed in building areas.

All earthworks should be monitored on a full-time basis by a qualified inspector, acting under the guidance of a Professional Engineer registered in the Commonwealth of Virginia.

4.4.7 Groundwater Control

Groundwater conditions encountered at the site are strongly influenced by surface water flow and infiltration. Specifically, water that enters the site migrates downward to the interface of the soil and the deeper dense soils. Depending on the time of year construction occurs, perched groundwater may be encountered during excavations. Dewatering measures, including sump pits and continuous pumping efforts, are expected to be necessary, if perched water is encountered.

4.5 Preliminary Foundation Support Recommendations

Depending on the final grading and lower slab elevations, the proposed building can be supported on conventional shallow foundations consisting of continuous wall or column spread footings. The footings may be supported on approved low plasticity natural soils, weathered rock, or newly placed compacted structural fill.

Footings supported on natural undisturbed soils or newly placed compacted structural fill with an SPT-N value of at least 8 blows per foot (bpf) may be designed for a net allowable soil bearing pressure of 2,500 psf. The net allowable soil bearing pressure refers to that pressure which may be transmitted to the foundation bearing soils in excess of the final minimum surrounding overburden pressure. The use of the above-specified uniform allowable bearing capacity will minimize the total settlement to 1 inch with a differential settlement of 0.75-inch.

This allowable bearing pressure assumes that the bottom of the proposed footings will bear approximately 24 inches below the proposed finished floor elevation. Most of the soils at the foundation bearing elevation at the vicinity of the soil test borings are anticipated to be suitable for support of the proposed development on a shallow foundation system. Soft, unsuitable, and/or existing fill soils when observed at the footing bearing elevations should be undercut, removed, and replaced with an approved engineered fill.

Under no circumstances shall footings that are supported on near surface soft soils or new-engineered fill be designed for a bearing pressure greater than 2,500 psf without a written approval of the geotechnical engineer.

Footing lines to be located along a transition zone from natural soils to recently placed compacted structural fill, shall be reinforced with a minimum of two (2) #5 bars, which extend at least 60 inches horizontally in each direction from the transition plane to lessen the detrimental effects of differential settlement along the transition plane. The removal of existing fill or unsuitable materials, and replacement with compacted structural fill for footing support shall extend horizontally one foot beyond the edges of the footing for every 2 feet of vertical undercut.

If footing excavations encounter isolated areas of relatively hard rock at or above the planned footing elevations, we recommend that the rock should be over-excavated to a depth of approximately one foot below the foundation bearing elevation and backfilled with structural fill as described in **Section 4.4.6** of this report. The footings will then bear on more similar materials to limit stress concentrations and associated cracking.

If the visual inspection of the subgrade material and/or hand auger recovered material reveals the presence of fine-grain soils, i.e. clays or silts, we recommend that a sample of the soil subgrade be tested to ensure that high plasticity soils, having liquid limit values greater than 40 and plasticity index values equal to or greater than 15, are not present at the footing subgrade. Highly elastic or plastic soils, when encountered, should be undercut to at least 4 feet below the footing subgrade or to the depth of high plasticity soil, whichever comes first, and replaced with properly compacted structural fill. As an alternative, the footings may be lowered 4 feet below finished exterior grade or through the high plasticity soils, whichever comes first. This minimum depth for the foundation placement is recommended to prevent differential movement of the footing because of variable moisture changes in high plasticity soils.

The use of the above-specified uniform allowable bearing capacity will limit the total settlement to 1 inch with a differential settlement of ½ inch in accordance with standard engineering practices.

Due to the natural weathering of the residual soils, "stepping down" of footings 1 to 2 feet below designed grade to meet the required bearing capacity should be anticipated during construction.

Suitable natural subgrade elevations between boring locations may be estimated by interpolation. Final subgrades should be verified in the field by the Geotechnical Engineer or his designated representative.

As a minimum, wall footings should not be less than 18 inches in width and column footings should not be less than 30 inches in size for punching shear consideration only. Adequate frost cover protection for all exterior footings shall be provided at 2.5 feet below exterior grade along the footing lines.

Proper construction procedures should be followed to maintain the quality of the footing excavations. Footing subgrades should be protected from precipitation, seepage, surface run-off and frost. We recommend that footings be cast the same day of excavation. If that was not possible, then the footing subgrade shall be protected by pouring a 2-inch thick mud mat of lean concrete in the footing trenches. The thickness of the mud mat may not count as part of the footing thickness.

Finally, it should be noted that footings placed to bear on rock layers that have experienced delamination and possibly heaving due to blasting can experience settlement as the rock consolidates and reseats under the concentrated loads of the building. Therefore, the delaminated and/or heaved rock should be removed below the foundations.

4.6 Ground-Supported Slabs

Lower floor slab-on-grade subgrades shall be supported on low plasticity natural soils or on approved compacted structural fill. A subgrade reaction modulus of 125 pci may be used for the design of floor slabs-on-grade supported on low plasticity natural soils or approved compacted structural fill.

If the visual inspection of the subgrade material and/or hand auger recovered material reveals the presence of fine-grain soils, i.e. clays or silts, we recommend that a sample of the soil subgrade be tested to ensure that high plasticity/elastic soils, having liquid limit values greater than 40 and plasticity index values equal to or greater than 15, are not present at the slab subgrade. Highly elastic or plastic soils, when encountered, should be undercut to at least 2 feet below the slab subgrade and replaced with suitable properly compacted structural fill.

We recommend that all grade slabs be designed to be discontinuous at walls and pier footings so that differential settlement will not induce shear stresses in the floor slab. Furthermore, we recommend mesh reinforcement be included in the design of the floor slab to reduce shrinkage crack that may develop near the surface of the slab. The slab should rest upon a minimum of 4 inches of free draining granular base. A 6-mil polyethylene liner or similar vapor barrier should be provided between the underside of the slab and the granular base to limit moisture migration.

Where foundation below grade walls are considered (if applicable) we recommend that lateral and perimeter drains be installed below slabs-on-grade as discussed in **Section 4.8, "Waterproofing and Foundation Drains"**, of this report. Slab-on-grade subgrades shall be inspected by the Geotechnical Engineer for suitability and firmness prior to placement of the stone layer.

4.7 Below-grade Foundation Walls

Below-grade basement walls, if applicable, can be designed for an equivalent fluid pressure of 60 psf per foot of wall depth. The equivalent fluid pressure recommended assumes that on-site silty sand (SM) and/or sandy silt (ML) will be used as backfill against below grade walls. Soils having liquid limit values greater than 40 and plasticity index values equal to or greater than 15 shall not be allowed as backfill against the foundation walls. Backfill material shall not contain rock sizes greater than 4 inches in diameter. The backfill material shall be compacted to 95% of the maximum dry density in accordance with ASTM D698 Standard Proctor. Lighter compaction equipment should be used close to the below grade walls.

The lateral pressures recommended above also assume that adequate drainage behind the wall will be provided to prevent accumulation of free water. The recommendations do not include the effects of surcharge loading which shall be included in the wall design as additional lateral pressure acting uniformly against the wall.

For calculation of lateral pressure from surcharge loads, a Typical Lateral Earth Pressure Diagram is presented at the Appendix of this report. This will provide active and at-rest earth pressure coefficients for the wall design.

4.8 Waterproofing and Foundation Drains

We anticipate that seasonal perched groundwater levels may rise near proposed below grade foundations. Therefore, interior and exterior foundation drains are required where below grade walls are planned. The drain systems should be exterior to the wall and should include either granular backfill or man-made drainage materials to remove water from behind the walls.

The one-foot annular space between the outside of the walls and the excavation should be backfilled with a granular fill extending to a level of approximately 2 feet below the final outside grade. The remaining 2 feet should consist of clayey material (CL, CH/MH) to limit the amount of surface water infiltration into the granular material, and thus, reduce the excess water to be handled by the drainage system. The ground surface adjacent to the below grade walls should be kept properly graded to prevent ponding of water adjacent to the below grade walls.

The exterior drain shall consist of a 4-inch perforated flexible tube embedded in 12 inches of VDOT No. 57 stone or washed bank run gravel. The stone shall be wrapped with filter fabric to avoid clogging with fines.

The interior drain shall be installed under the slab and shall tie into the exterior drain via weep holes through the footings. The weep holes, 1.5-inch diameter PVC pipes, shall be spaced at no more than 8 feet on center. The interior drain shall also consist of a 12-inch layer of VDOT No. 57 stone wrapped with filter fabric. A properly installed permanent drain system will help reduce dampness in the lowest levels as a result of water that may become trapped in the soil adjacent to any below grade excavations.

The invert of the interior drain should be higher than the exterior drain to allow the flow of groundwater through the weep holes and safely discharge away from the structure if the structure is daylighted. The outlet pipe from the exterior drain shall be tied to the storm sewer or discharge to a point of daylight. The invert of interior drain should be lower than the exterior drain to allow the flow of groundwater through the weep holes and safely discharge away from the structure if the structure drains to a sump pit as directed by the Civil Engineer.

4.9 Stormwater Management (SWM) Facility

Based on the provided sketch plan the project will include the construction of a pond located northeast of the site. The SWM pond is planned to be placed in 1.3± acres east of residential area. We anticipate that the pond will be mostly in cut area and some man-placed fill may be required to achieve final dam elevations based on the site topographic map and provided layout.

Soil test boring B-5 was performed in the vicinity of the SWM ponds at the proposed pond basin and as indicated in Boring B-5, high plastic soil (CH) was encountered to the depth of 2 feet below ground level. In this boring depth to the weathered rock is approximately 10.5 feet below the surface level.

Man-placed fill was not encountered in Borings B-5 in vicinity of proposed SWM pond and it is not anticipated to be found in this area; however, if the undocumented man-placed fill encountered, it shall be removed in their entirety and replaced with structural fill material that meets the criterial outlined in **Sections 4.4.5** of this report.

The structural fill, if requires to be placed at the embankment or basin of this pond, shall consist of approved borrowed material that meets the requirements presented in Section 4.4.5 of this geotechnical report. Soils meeting the requirements in Section 4.4.5 are expected on-site. No additional information was provided for the pond; however, depending on whether this pond is a dry pond or a wet pond, a clay core, cut-off trench, and/or pond liner may be necessary across the basin to limit seepage through the dam embankment.

4.10 Underground Site Utilities

We anticipate that conventional earth-moving equipment will be suitable for the excavation of the on-site soils to the depths indicated in the test pits. Perched groundwater may be encountered during trench excavations, particularly in low-lying areas of the site.

Fill placement is expected in existing natural swales, intermittent streams, and permanent streams. Based on our experience with previous projects, surface water and groundwater will tend to flow along its natural path through the swales and streams. We recommend a French Drain system, or alternative pipe drainage system be constructed at the bottom of the existing natural swales and intermittent and permanent streams. The actual location and extent of the drainage system should be determined at the time of construction.

4.11 Seismic Design Considerations

The project site is located within a locality that employs the International Building Code (IBC), 2012 edition. As part of this code, the design of structures must consider dynamic forces resulting from seismic events. These forces are dependent upon the magnitude of the earthquake event as well as the properties of the soils that underlie the site.

Part of the IBC code procedure to evaluate seismic forces requires the evaluation of the Seismic Site Class, which categorizes the site based upon the characteristics of the subsurface profile within the upper 100 feet of the ground surface.

To define the Seismic Site Class for this project, and in accordance with your requested level of assessment, we have interpreted the results of the soil test borings drilled within the project site per Section 1613.5 of the code. The estimated soil properties are based upon data available in published geologic reports as well as our experience with subsurface conditions in the general site area.

Based upon our assessment, it is our opinion that the subsurface conditions within the areas of the site planned for building construction are consistent with the characteristics of Site Class "C" as defined in Table 1613.5.2 of the building code.

4.12 Pavement

1. Pavement

For the design and construction of the exterior pavement, we recommend that all topsoil and any soft or unsuitable materials be removed from the paved areas. The subgrade for paved areas within the right-of-way of roadways and parking areas, including curbs and sidewalks are anticipated to consist of onsite natural soil or newly placed and compacted structural fill. These soils are generally considered adequate for pavement support. However, final subgrades should be proof-rolled under the observation of the Geotechnical Engineer or his designated representative to determine whether soft or highly organic areas exist that will require removal and replacement with compacted structural fill. Soils placed and compacted in accordance with the requirements outlined in **Section 4.4.6, "Fill Placement and Testing"** of this report are considered adequate for pavement support.

If fine-grained soils having liquid limit and plasticity index values greater than 40 and 15, respectively, are encountered at proposed subgrades, these materials should be undercut to a depth of at least 2 feet below the pavement subgrade and replaced with properly compacted structural fill.

Prior to placement of subbase stone, we recommend that the subgrade be proof-rolled with a loaded dump truck to detect any soft, yielding or high plasticity soils. Unstable areas should be undercut and replaced with controlled-compacted fill. The fill should be compacted per requirements outlined in **Section 4.4.6, "Fill Placement and Testing"**, of this report.

An important consideration in the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should minimize the possibility of the subgrade materials becoming saturated over a long period of time.

If perched groundwater is encountered at or near pavement subgrade levels during construction, the Geotechnical Engineer may recommend the use of pavement underdrains (Standard VDOT UD-4) as necessary. All pavement materials and construction methods should comply with the current VDOT specifications. We would be pleased to be of further assistance to you in the design of the project pavements by providing additional recommendations during construction of the project.

2. Sidewalks

Although the performance of sidewalk installations at this site is not a structural component, we recommend that all sidewalk construction be underlain by at least 4 inches of granular material having a maximum aggregate size of 1.5 inches and no more than 2% passing the #200 sieve. This granular layer will reduce frost heaving of the exterior sidewalk slabs. In addition, positive drainage should, through the use of perforated or porous drain pipes, be provided under these sidewalks, and drainage should be routed to a suitable outlet.

3. Roof Drains

To limit the potential for creating wet yards surrounding the buildings and to minimize water infiltration below pavements, we recommend that the roof drain lines be piped to the nearest storm sewer inlets. In addition, where a wall is being proposed behind building and slopes directing runoff towards the top of wall, a drainage swale should be constructed above the

4.13 Excavated and Graded Slopes

For temporary cuts or excavations, side slopes as steep as 1.5H:1.0V are possible in the natural soils observed at this site. For long-term stability, side slopes should be no steeper than 3H:1V in either natural soils or fill soils. All temporary and permanent slopes should be aggressively protected, such as by seeding and mulching as soon as possible after placement, to prevent from sloughing and erosion.

5.0 CLOSING REMARKS

5.1 Construction Considerations

Major difficulties during construction of this project are not anticipated, provided some precautionary measures are taken during the removal and replacement of the exiting fill and to ensure that preparation of the subgrade is accomplished by the recommended procedures. Therefore, we recommend that all excavations be properly dewatered, as necessary, using conventional sump pit and pumping operations. The site should be graded such that surface water runoff is directed away from the excavations.

The surficial soils contain fines which are considered moderately erodible. The Contractor should provide and maintain good site drainage during earthwork operations to help maintain the integrity of the surface soils. The surface of the site should be kept properly graded to enhance drainage of the surface water away from the proposed construction areas during the earthwork phase. We recommend that surface drainage be diverted around the proposed building area without significantly interrupting its pattern. Other practices would involve sealing the exposed soils daily with a smooth drum roller to reduce the potential for infiltration of surface water in the exposed soils. All erosion and sedimentation shall be controlled in accordance with sound engineering practice and current County requirements.

5.2 Qualifications

In providing this exploration and professional preliminary recommendations our services were performed in accordance with generally accepted engineering principles and practices. No warranty, either expressed or implied, is made to the professional advice included in this report.

This preliminary report has been prepared for the exclusive use of the Client to assist them and their engineers during the design and construction phases of the proposed development. The analysis and conclusions in this report were based on the results of subsurface investigations performed throughout the development history of this property.

Once final grading plans have been prepared by the Civil Engineer, GSI should be contacted to review the updated plans and provide a final geotechnical report for County submittal and construction purposes.

Please be advised that although the test borings were logged by experienced engineers, it is sometimes difficult to record changes in subsoil stratigraphy within narrow limits; therefore, some deviation in the materials reported on the field logs and the materials encountered in the field should be anticipated. Any change in soil type observed during construction or change in proposed location of the structure or grades should be provided to us so that we may modify portions of this text if necessary. Any conclusions or recommendations that are based on data contained in this report that are made by others are the responsibility of others.

Should any builders and/or future developer(s), elect to retain the services of another engineering firm for the development of this project, such action constitutes a legal released of our firm from all liabilities and responsibilities arising out any and all deviations, modifications, and alterations to the requirements of this report.

It is probable, due to borehole spacing requirements and the passage of time, variations in reported soil and groundwater conditions may be found during construction. We strongly recommend that such variations be immediately brought to our attention to determine their effect on foundation design.

This report does not address any environmental issues or impact, if any, on the project.

APPENDIX

Site Vicinity Map

Prince William County Soil Map

Unified Soil Classification System

Reference Notes for Boring Logs

GSI Test Boring Logs (B-1 through B-8)

Generalized Soil Profile

Laboratory Test Results

Lateral Earth Pressure Diagram

Residential Below Ground Drainage Detail

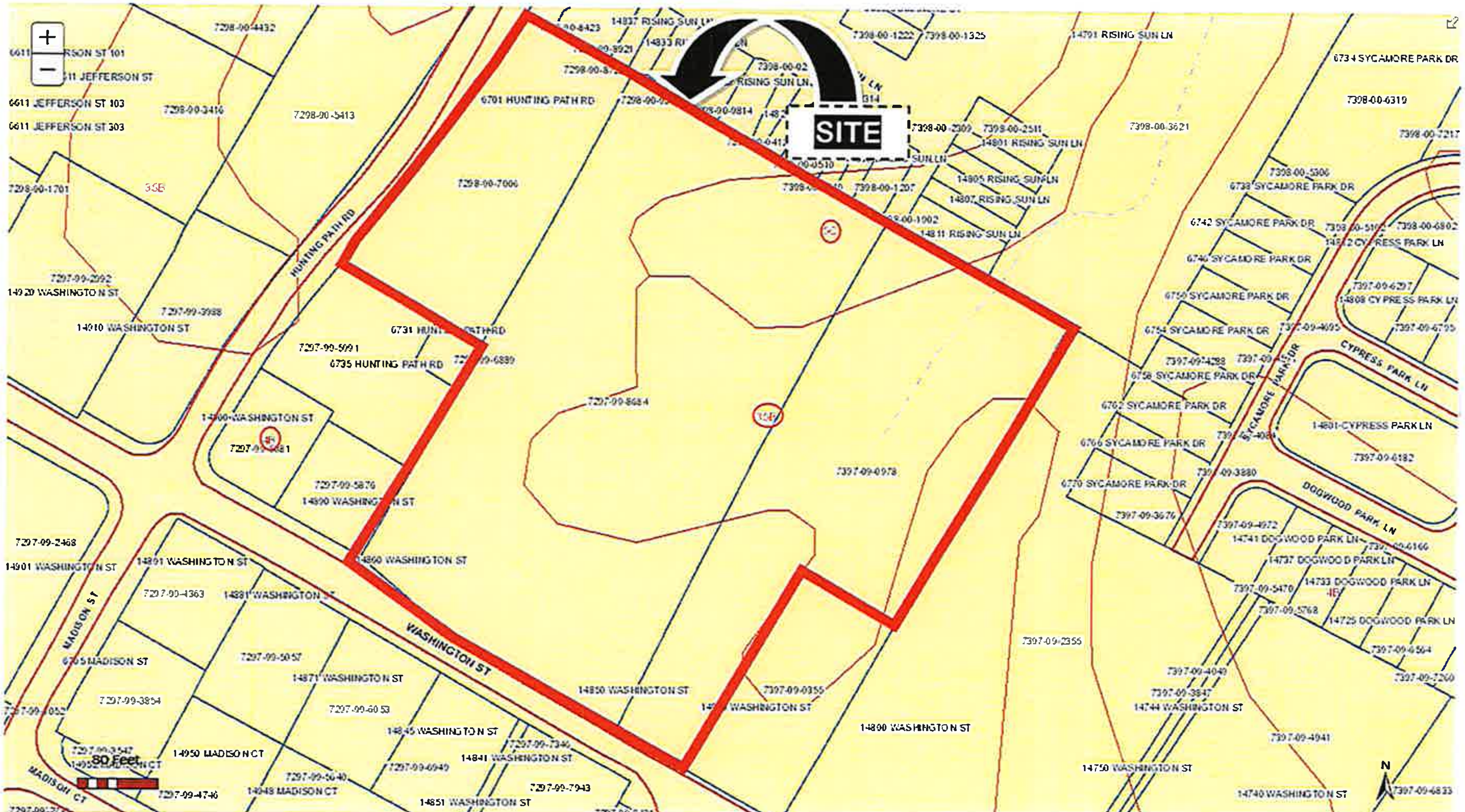
NRCS - Custom Soil Resource Report for Prince William County

GSI Boring Location Plan (BLP)

Source: Google Earth

Scale: As shown

Geotechnical Solutions, Inc.	SMITH – HAYMARKET PRINCE WILLIAM COUNTY, VA	GSI Project No. GP-182504
		January 2019
	Geotechnical Solutions, Inc. 3859 Centerview Drive, Suite 160 Chantilly, VA 20151	SITE VICINITY MAP



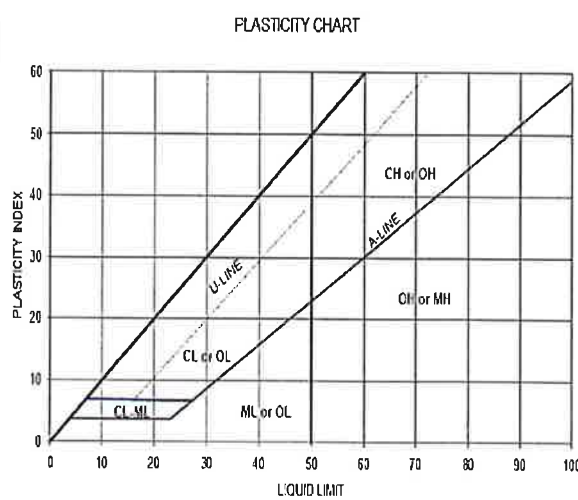
Source: Loudoun County Mapper

Scale: As Shown

Geotechnical Solutions, Inc.	SMITH – HAYMARKET PRINCE WILLIAM COUNTY, VA	GSI Project No. GP-182504
		January 2019
	Geotechnical Solutions, Inc. 3859 Centerview Drive, Suite 160 Chantilly, VA 20151	SITE SOIL MAP

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentage 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[b]	$C_u=D_{60}/D_{10}$ greater than 4 $C_c=(D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand mixtures		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
				u				
			GC		Clayey gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u=D_{60}/D_{10}$ greater than 6 $C_c=(D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. less than 7	
Fine-grained soils (More than half 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 or clayey fine sands, or clayey silts with slight plasticity	Plasticity chart (see below)		
			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 greater than 50)		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			



[a] Division of GM and SM groups into subdivision of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder. From Table 2.16 – Winterkorn and Fang, 1975)

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, NQ, BX, BQ, PX, PQ	PM	Pressure Meter
DC	Dutch Cone Penetrometer	RD	Rock Bit (tri-cone) Drilling
BS	Bulk Sample of Cuttings	AP	Auger Probe
HSA	Hollow Stem Auger	WS	Wash Sample

II. Correlation of Penetration Resistance to Soil Properties

Standard Penetration (blows/foot) refers to the blows per foot of a 140 lb. hammer falling 30 inches on a 2-inch OD split spoon sampler, as specified in ASTM D-1586. The blow count is commonly referred to as the SPT N-value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Blows/ft.	*Density*	*Relative Properties*	
Under 3 blows/ft.	Very Loose	Adjective Form	36% to 49%
4 to 6 blows/ft.	Loose	With	21% to 35%
7 to 10 blows/ft.	Firm	Some	11% to 20%
11 to 30 blows/ft.	Medium Dense	Trace	1% to 10%
31 to 50 blows/ft.	Dense		
51 to 80 blows/ft.	Very Dense		
Over 80 blows/ft.	Extremely Dense		

Particle Size Identification

Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00 mm to ¼ inch (dia. Of lead pencil)
	Medium	0.42 to 2.00 mm (dia. Of broom straw)
	Fine	0.074 to 0.42 mm (dia. Of human hair)
Silt and Clay		0.0 to 0.74 mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

Blows/ft.	*Consistency*	*Unconfined Compressive Strength, Qp (tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 4	Very Soft	Under 0.25	None to Slight	0-4
4 to 5	Soft	0.25-0.49	Slight	5-7
6 to 10	Medium Stiff	0.50-0.99	Medium	8-22
11 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.99		
31 to 50	Hard	4.00-8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

At Completion   After 24 Hours   Boring Cave-in

The water levels are those water levels actually measures in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several day for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

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PROJECT: Smith - Haymarket **PROJECT NO.:** GP-182504
CLIENT: VAN METRE COMMUNITIES, INC. **BORING NO.:** B-1
PROJECT LOCATION: Prince William County, VA
LOCATION: As Shown on the Boring Location Plan **ELEVATION:** 366±ft MSL
DRILLER: Recon Drilling, Inc. (W. Rodas) **LOGGED BY:** S. Fallah
DRILLING METHOD: 2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig) **DATE:** 1/9/2019
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** NA **CAVING>** 3.0 ft

Depth/Elevation (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200	Penetration
0 / 366	Topsoil [6-Inch]									
0.5	Dark Brown Sandy SILT, trace Mica, Moist, Medium Stiff to Very Hard	ML	S-1	3 4 4	15					8
			S-2	15 20 30	18	13.0				50
4.5	Dark Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-3	38 50/5"	11					50/5"
			S-4	40 50/3"	9					50/3"
			S-5	40 50/2"	6					50/2"
14.2	Boring Terminated @ 14.2 feet									

Depth scale (feet / elevation): 0, 365, 2.5, 362.5, 5, 360, 7.5, 357.5, 10, 355, 12.5, 352.5, 15, 350

Chart legend: PI |—| LL; Water Content - ⊗; Penetration - ●; 10 20 30 40 50

Boring was back filled upon completion.
The elevation is based on Google Earth.

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

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PROJECT:	Smith - Haymarket	PROJECT NO.:	GP-182504
CLIENT:	VAN METRE COMMUNITIES, INC.	BORING NO.:	B-2
PROJECT LOCATION:	Prince William County, VA		
LOCATION:	As Shown on the Boring Location Plan	ELEVATION:	364±ft MSL
DRILLER:	Recon Drilling, Inc. (W. Rodas)	LOGGED BY:	S. Fallah
DRILLING METHOD:	2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig)	DATE:	1/9/2019
DEPTH TO WATER> INITIAL:	Dry; AFTER 24 HOURS: NA	CAVING>	3.0 ft

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Depth/Elevation (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200	Penetration
0 – 0.4	Topsoil [5-Inch]									
0.4 – 2.0	Dark Brown Sandy Lean CLAY, trace Rock Fragments and Roots, Moist, Medium Stiff	CL	S-1	3 4 6	18	21.8				10
2.0 – 3.0	Dull Brown Sandy SILT, with Rock Fragments, trace Mica, Moist, Very Hard	ML	S-2	30 38 50/5"	17					88
3.0 – 14.3	Dark Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-3	50/5"	5					50/5"
			S-4	38 50/4"	10					50/4"
			S-5	40 50/4"	10					50/4"
14.3	Boring Terminated @ 14.3 feet									

Elevation scale: 0, 362.5, 2.5, 360, 5, 357.5, 7.5, 355, 10, 352.5, 12.5, 350, 15, 347.5

Chart legend: PI ├─┤ LL; Water Content - ◎; Penetration - ●; 10 20 30 40 50

Boring was back filled upon completion.
The elevation is based on Google Earth.

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PROJECT: Smith - Haymarket | PROJECT NO.: GP-182504

CLIENT: VAN METRE COMMUNITIES, INC. | BORING NO.: B-3

PROJECT LOCATION: Prince William County, VA

LOCATION: As Shown on the Boring Location Plan | ELEVATION: 364±ft MSL

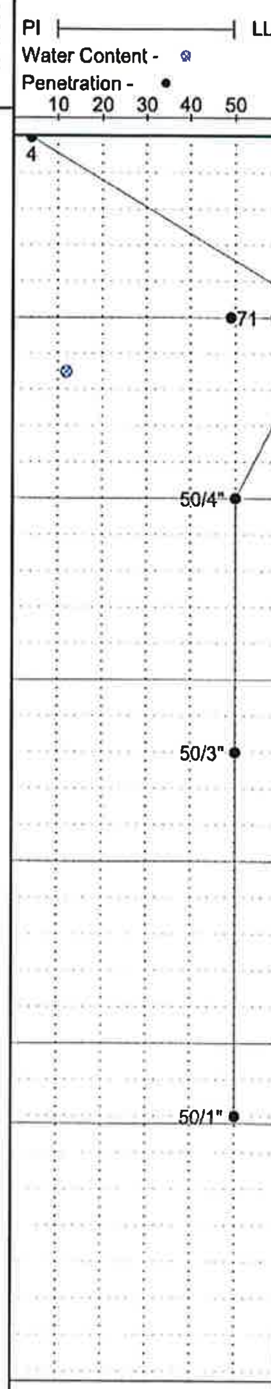
DRILLER: Recon Drilling, Inc. (W. Rodas) | LOGGED BY: S. Fallah

DRILLING METHOD: 2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig) | DATE: 1/9/2019

DEPTH TO WATER> INITIAL: Dry | AFTER 24 HOURS: NA | CAVING> 3.5 ft

Depth/Elevation (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200
0 – 0.3	Topsoil [4-Inch]								
0.3 – 2.0	Dark Brown Sandy Lean CLAY, trace Roots, Moist, Soft	CL	S-1	2 3 1	18				
2.0 – 3.0	Dull Reddish Brown Sandy SILT, with Rock Fragments, trace Mica, Moist, Very Hard	ML	S-2	20 31 40	18	12.1			
3.0 – 13.6	Dark Reddish Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-3	50/4"	4				
			S-4	50/3"	3				
			S-5	50/1"	1				
13.6	Boring Terminated @ 13.6 feet								

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15; Elevation scale: 362.5, 360, 357.5, 355, 352.5, 350, 347.5



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Boring was back filled upon completion.
The elevation is based on Google Earth.

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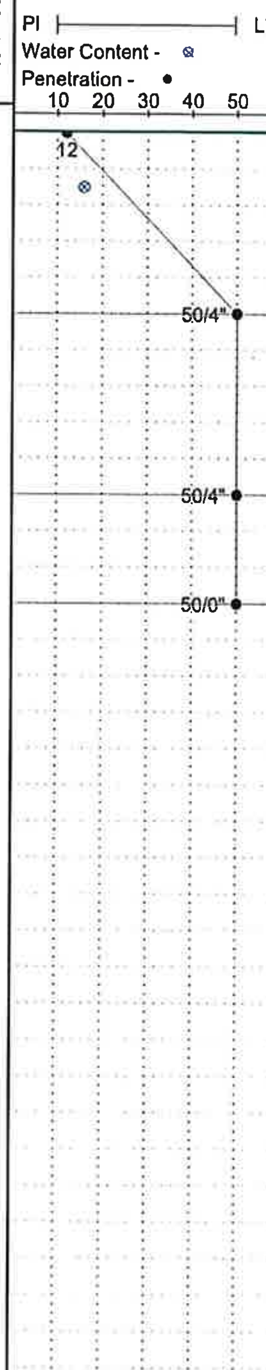
PROJECT: Smith - Haymarket
PROJECT NO.: GP-182504
CLIENT: VAN METRE COMMUNITIES, INC.
BORING NO.: B-4
PROJECT LOCATION: Prince William County, VA
LOCATION: As Shown on the Boring Location Plan
ELEVATION: 362±ft MSL
DRILLER: Recon Drilling, Inc. (W. Rodas)
LOGGED BY: S. Fallah
DRILLING METHOD: 2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig)
DATE: 1/9/2019
DEPTH TO WATER> INITIAL: Dry AFTER 24 HOURS: NA CAVING> 1.5 ft

Depth/Elevation (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200
0 – 0.6	Topsoil [7-Inch]								
0.6 – 1.5	Dark Brown Sandy Lean CLAY, trace Roots and Rock Fragments, Moist, Stiff	CL	S-1	4 6 6	18	16.0			
1.5 – 3	Dark Reddish Brown Sandy SILT, with Rock Fragments, Moist, Very Hard	ML	S-2	30 50/4"	10				
3 – 6.5	Dull Reddish Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-3	50/4"	4				
			S-4	50/0"	0				
6.5	Auger and Spoon Refusal @ 6.5 feet								

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15; Elevation scale: 360, 357.5, 355, 352.5, 350, 347.5, 345



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Boring was back filled upon completion.
The elevation is based on Google Earth.

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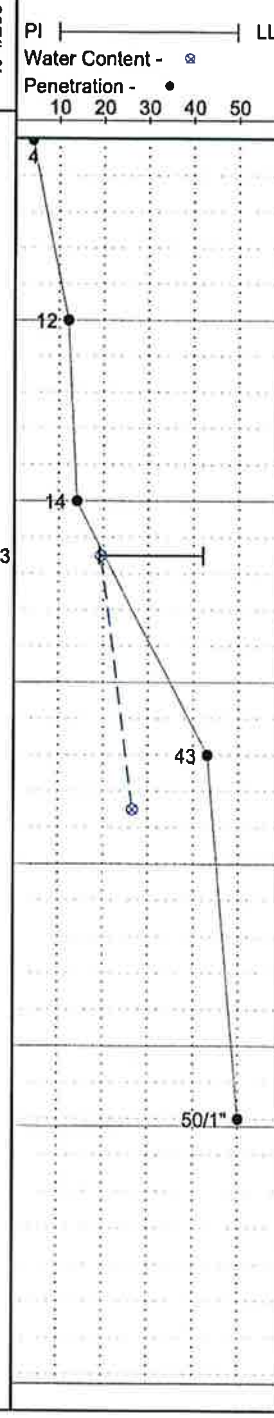
PROJECT: Smith - Haymarket **PROJECT NO.:** GP-182504
CLIENT: VAN METRE COMMUNITIES, INC. **BORING NO.:** B-5
PROJECT LOCATION: Prince William County, VA
LOCATION: As Shown on the Boring Location Plan **ELEVATION:** 356±ft MSL
DRILLER: Recon Drilling, Inc. (W. Rodas) **LOGGED BY:** S. Fallah
DRILLING METHOD: 2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig) **DATE:** 1/9/2019
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** NA **CAVING>** 3.5 ft

Depth (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200
0–0.4	Topsoil [5-Inch]								
0.4–2	Dark Brown Fat CLAY, with Sand, trace Roots, Moist, Soft	CH	S-1	2 2 2	18				
2–8.0	Dark Brown Sandy Lean CLAY, trace Roots, Moist, Stiff	CL	S-2	4 6 6	18				
	Dark brown lean CLAY		S-3	6 7 7	18	19.5	42	19	89.3
8.0–10.5	Dark Reddish Brown Sandy SILT, with Rock Fragments, Moist, Hard	ML	S-4	14 18 25	18	26.7			
10.5–13.6	Dark Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-5	50/1"	1				
	Boring Terminated @ 13.6 feet								

Depth/Elevation scale: 0, 2.5, 5, 7.5, 10, 12.5, 15 (depth); 355, 352.5, 350, 347.5, 345, 342.5, 340 (elevation)



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Boring was back filled upon completion.
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PROJECT: Smith - Haymarket	PROJECT NO.: GP-182504
CLIENT: VAN METRE COMMUNITIES, INC.	BORING NO.: B-6
PROJECT LOCATION: Prince William County, VA	
LOCATION: As Shown on the Boring Location Plan	ELEVATION: 361±ft MSL
DRILLER: Recon Drilling, Inc. (W. Rodas)	LOGGED BY: S. Fallah
DRILLING METHOD: 2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig)	DATE: 1/9/2019
DEPTH TO WATER> INITIAL: Dry AFTER 24 HOURS: NA	CAVING> 3.0 ft

Depth/Elevation (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200	Penetration
0 / 361	Topsoil [8-Inch]									
0.7	Dull Brown Sandy Lean CLAY, trace Roots, Moist, Soft	CL	S-1	WOH 2 2	18	25.8				4
1.5	Dark Reddish Brown Sandy SILT, with Mica and Rock Fragments, Moist, Very Hard	ML	S-2	40 50/4"	10					50/4"
3.0	Dull Reddish Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-3	50/3"	3					50/3"
			S-4	50/1"	1					50/1"
13.6	Boring Terminated @ 13.6 feet		S-5	50/1"	1					50/1"

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15; Elevation scale: 360, 357.5, 355, 352.5, 350, 347.5, 345

Chart legend: PI |—| LL; Water Content - ⊗; Penetration - ●; scale 10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Boring was back filled upon completion.
The elevation is based on Google Earth.

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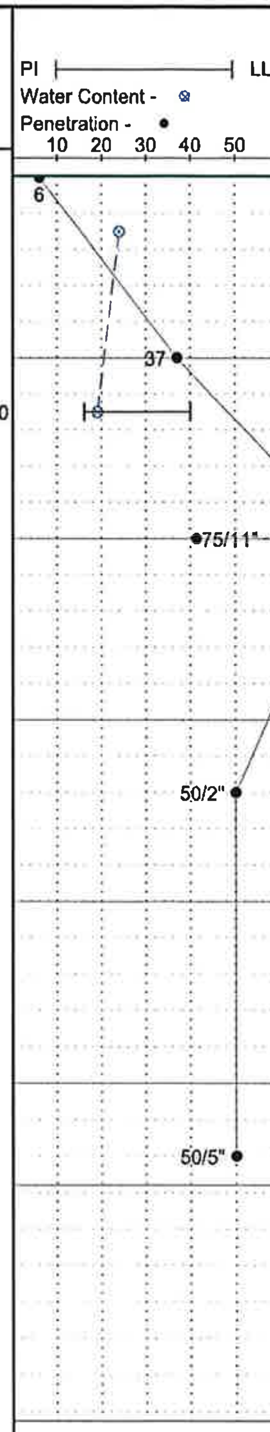
PROJECT: Smith - Haymarket	PROJECT NO.: GP-182504
CLIENT: VAN METRE COMMUNITIES, INC.	BORING NO.: B-7
PROJECT LOCATION: Prince William County, VA	
LOCATION: As Shown on the Boring Location Plan	ELEVATION: 373±ft MSL
DRILLER: Recon Drilling, Inc. (W. Rodas)	LOGGED BY: S. Fallah
DRILLING METHOD: 2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig)	DATE: 1/9/2019
DEPTH TO WATER> INITIAL: Dry AFTER 24 HOURS: NA	CAVING> 3.5 ft

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Depth/Elevation (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200
0 / 373	Topsoil [6-Inch]								
0.5	Dark Reddish Brown Sandy Lean CLAY, trace Roots, Moist, Medium Stiff to Hard	CL	S-1	2 2 4	18	24.1			
			S-2	14 17 20	18	19.2	40	16	96.0
4.5	Reddish Brown Sandy SILT, with Rock Fragments, Moist, Very Hard	ML	S-3	23 25 50/5"	17				
6.0	Reddish Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-4	50/2"	2				
			S-5	50/5"	5				
13.9	Boring Terminated @ 13.9 feet								

Depth scale (feet): 0, 2.5, 5, 7.5, 10, 12.5, 15; Elevation: 372.5, 370, 367.5, 365, 362.5, 360, 357.5



Boring was back filled upon completion.
The elevation is based on Google Earth.

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PROJECT: Smith - Haymarket **PROJECT NO.:** GP-182504

CLIENT: VAN METRE COMMUNITIES, INC. **BORING NO.:** B-8

PROJECT LOCATION: Prince William County, VA

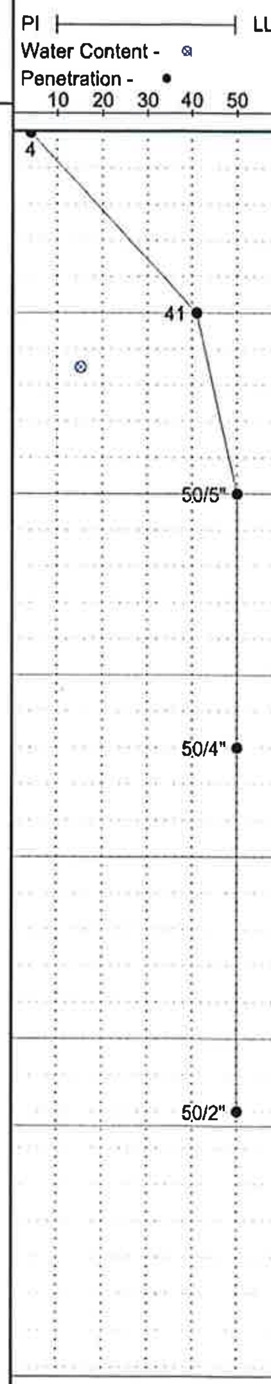
LOCATION: As Shown on the Boring Location Plan **ELEVATION:** 367±ft MSL

DRILLER: Recon Drilling, Inc. (W. Rodas) **LOGGED BY:** S. Fallah

DRILLING METHOD: 2.25" I.D. HSA w/Autohammer (CME 550 ATV Rig) **DATE:** 1/9/2019

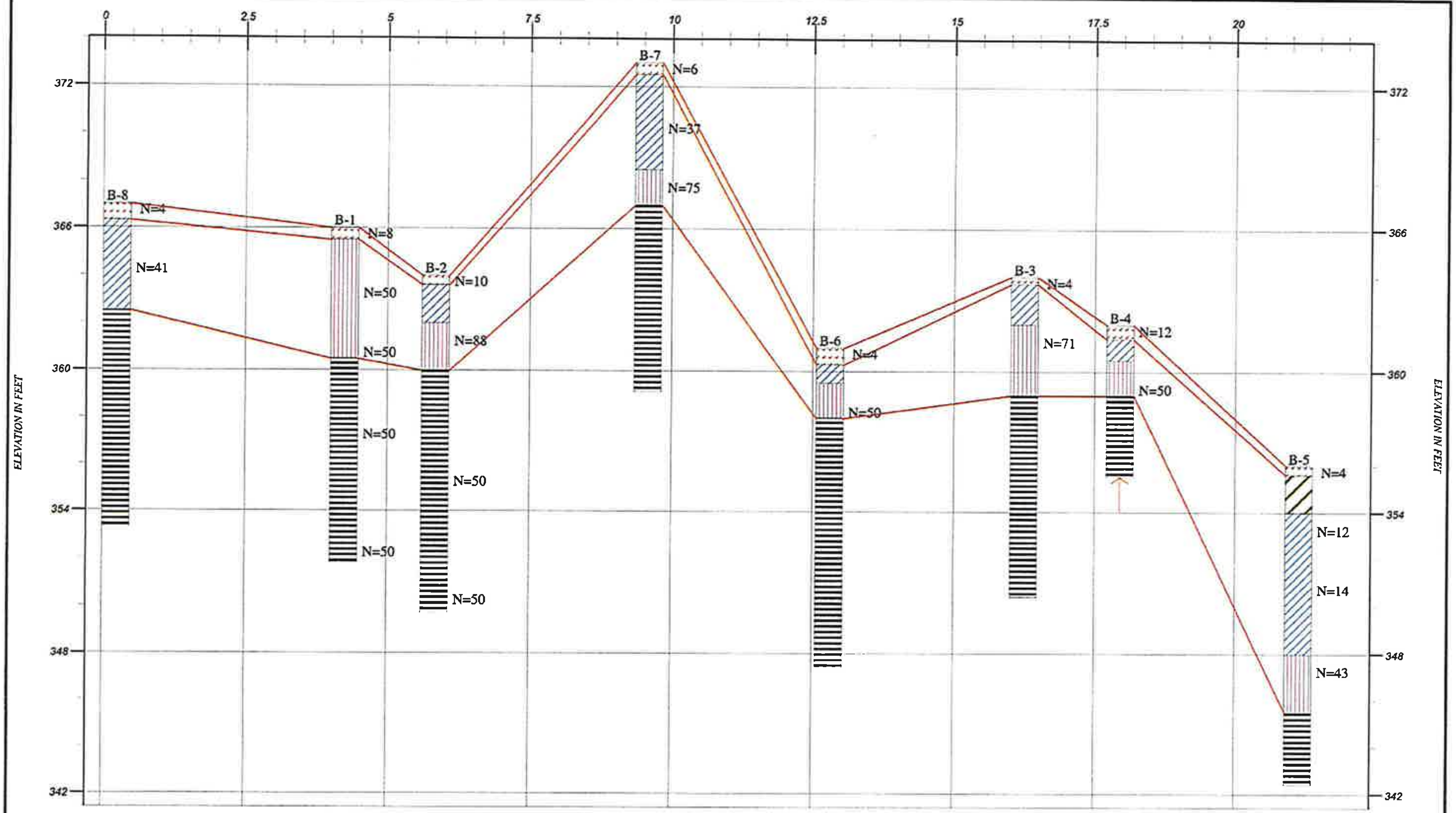
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** NA **CAVING>** 2.5 ft

Depth/Elevation (feet)	Description	USCS Class.	Sample No.	Blow Counts	Recovery (in.)	Moisture Content (%)	Liquid Limit	Plasticity Index	%<#200
0 / 367	Topsoil [8-Inch]								
0.7	Dark Brown Sandy Lean CLAY, trace Roots and Rock Fragments, Moist, Soft to Hard	CL	S-1	WOH 2 2	18				
			S-2	14 19 22	18	15.2			
4.5	Brown Weathered Rock, Moist to Dry, Very Dense to Extremely Dense	WR	S-3	50/5"	5				
			S-4	50/4"	3				
			S-5	50/2"	2				
13.7	Boring Terminated @ 13.7 feet								

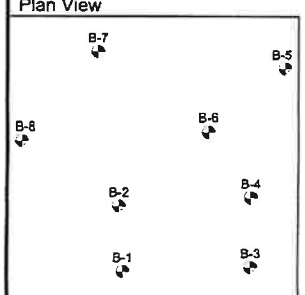


This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Boring was back filled upon completion.
The elevation is based on Google Earth.



Plan View



Strata symbols

- Topsoil
- Low plasticity clay
- Description not given for: "WR"
- Silt
- High plasticity clay

Geotechnical Solutions, Inc.

GENERALIZED SOIL PROFILE

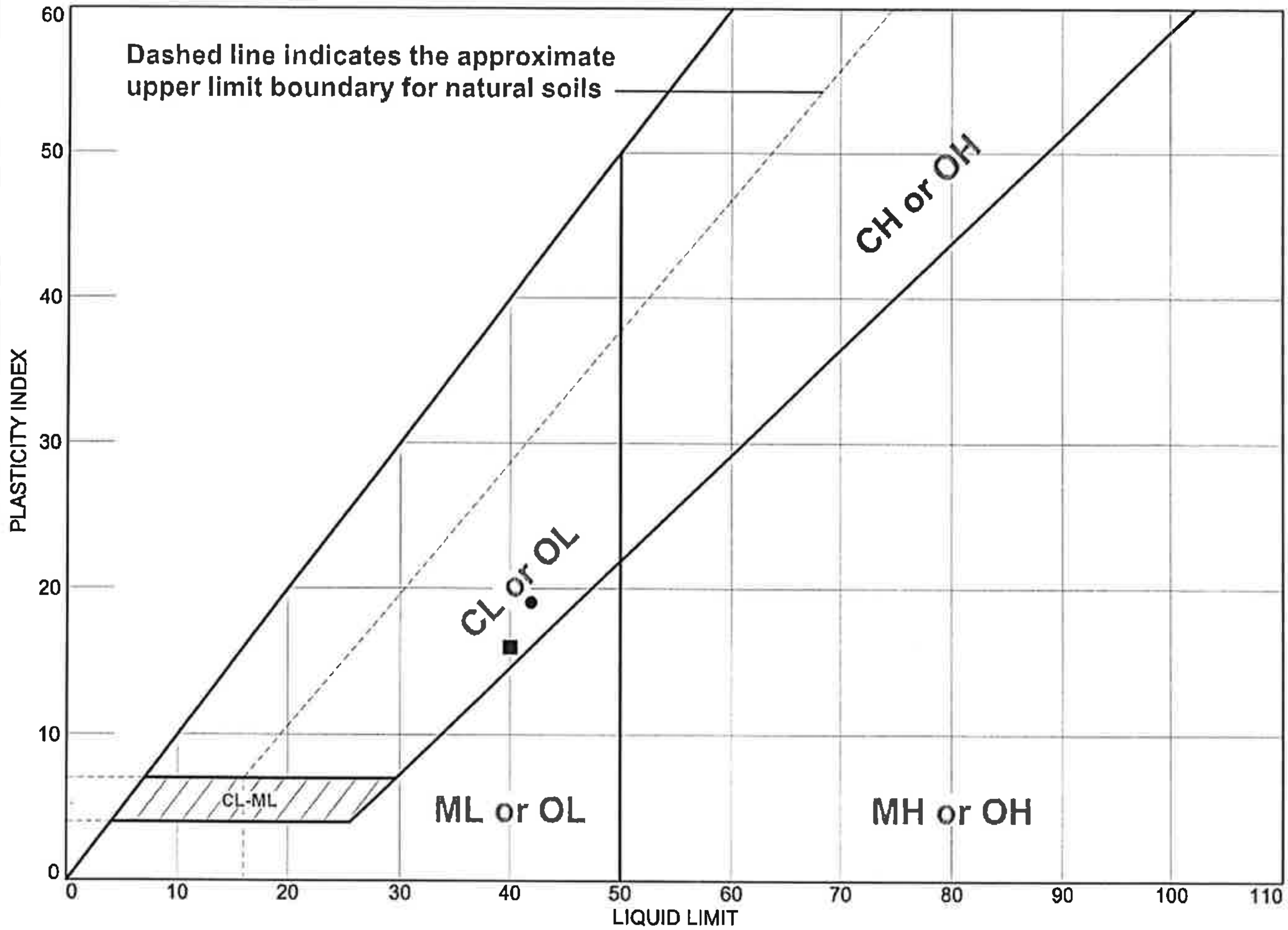
HORIZONTAL SCALE: 1"=(proportional)' VERTICAL SCALE: 1"=6'	DRAWN BY/APPROVED BY	DATE DRAWN
	SFB/AAA	1/17/2019

Smith - Haymarket

PROJECT NO. GP-182504

FIG. NO.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Brown Lean CLAY	42	23	19	93.4	89.3	CL
■	Reddish brown lean CLAY	40	24	16	98.0	96.0	CL

Project No. GP-182504 **Client:** VAN METRE COMMUNITIES, INC.

Project: Smith - Haymarket

●**Source of Sample:** B-5 **Depth:** 5.0 **Sample Number:** S-3

■**Source of Sample:** B-7 **Depth:** 2.5 **Sample Number:** S-2

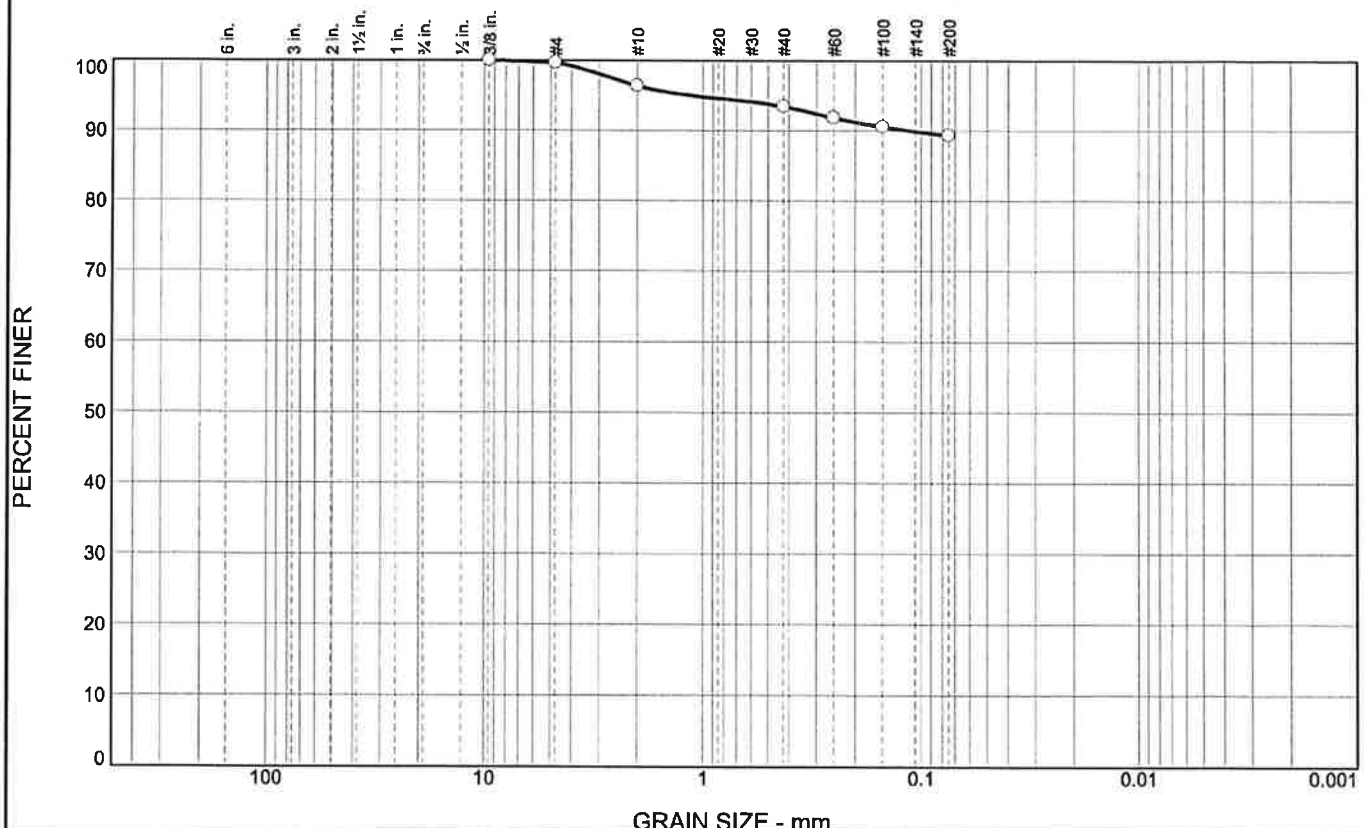
Remarks:

Geotechnical Solutions, Inc.

Chantilly, Virginia

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	3.2	3.0	4.1	89.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.6		
#10	96.4		
#40	93.4		
#60	91.9		
#100	90.6		
#200	89.3		

* (no specification provided)

Material Description

Dark Brown Lean CLAY

Atterberg Limits

PL= 23 LL= 42 PI= 19

Coefficients

D_{90}= 0.1125 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(18)

Remarks

Natural moisture content 19.5%

Source of Sample: B-5 **Depth:** 5.0
Sample Number: S-3

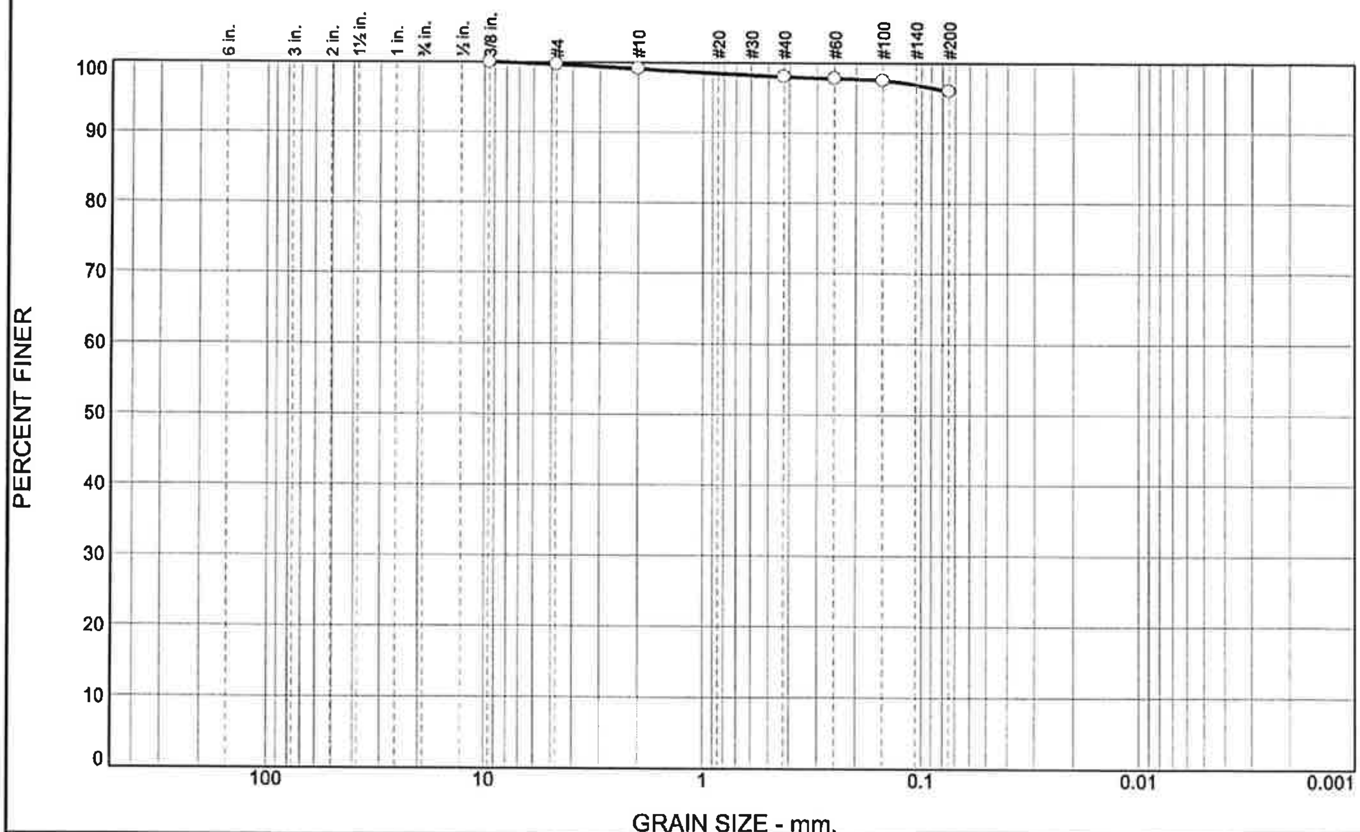
Date: 1-16-19

Geotechnical Solutions, Inc.
Chantilly, Virginia

Client: VAN METRE COMMUNITIES, INC.
Project: Smith - Haymarket

Project No: GP-182504 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	0.6	1.1	2.0	96.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	99.7		
#10	99.1		
#40	98.0		
#60	97.8		
#100	97.5		
#200	96.0		

* (no specification provided)

Material Description

Reddish Brown Lean CLAY

Atterberg Limits

PL= 24 LL= 40 PI= 16

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(17)

Remarks

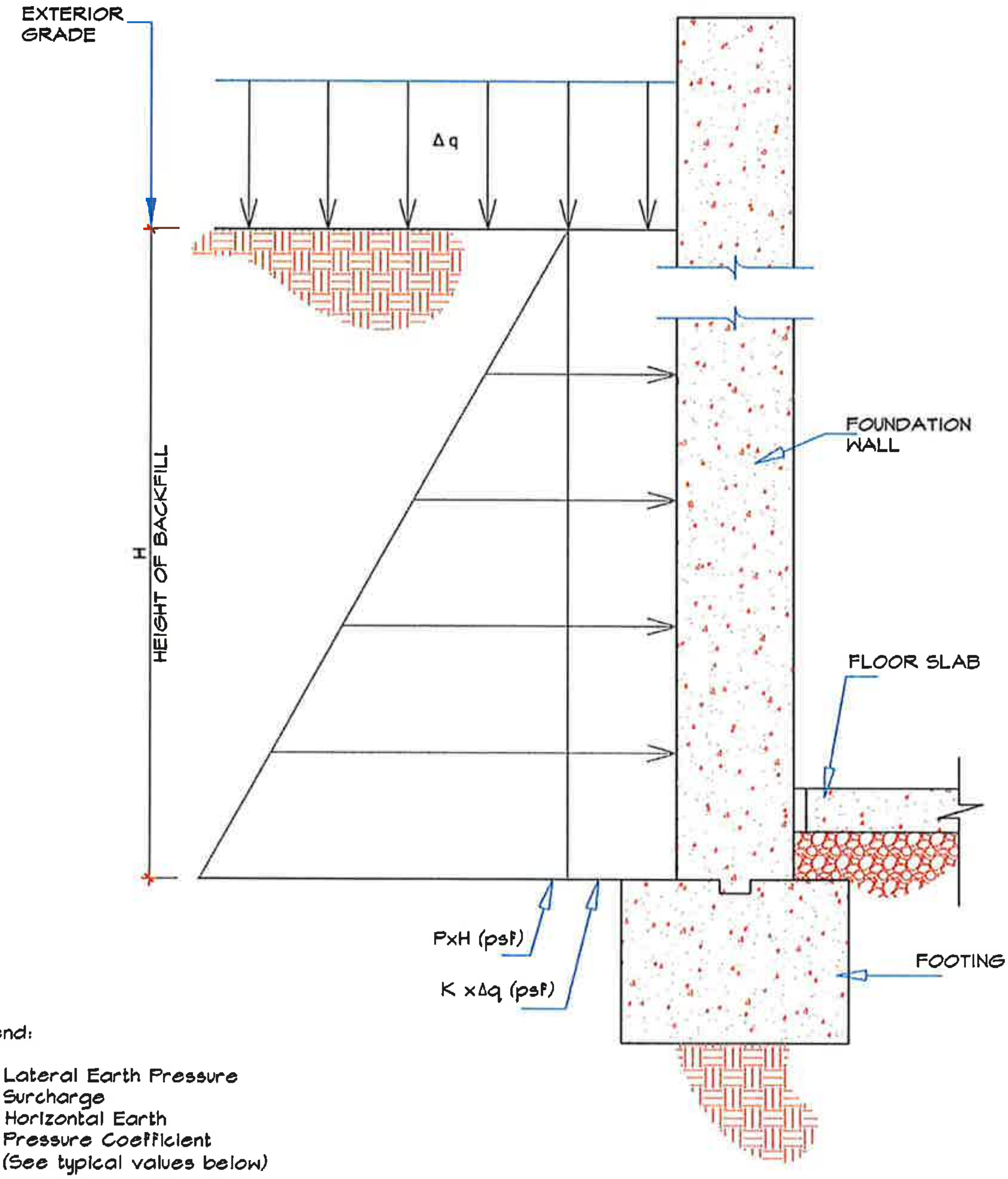
Natural moisture content 19.2%

Source of Sample: B-7 **Depth:** 2.5
Sample Number: S-2

Date: 1-16-19

Geotechnical Solutions, Inc.
Chantilly, Virginia

Client: VAN METRE COMMUNITIES, INC.
Project: Smith - Haymarket
Project No: GP-182504 **Figure**



Legend:

P = Lateral Earth Pressure
Δq = Surcharge
K = Horizontal Earth Pressure Coefficient (See typical values below)

SOIL	ACTIVE	AT REST
SILT (ML)	0.36	0.53
GRANULAR (SP)	0.33	0.50

N.T.S.

Geotechnical Solutions, Inc.
3859 Centerview Drive, Suite 160
Chantilly, VA 20151
TEL: (703) 657-0014
FAX: (703) 657-0666
www.geotechnical-solutions.com

LATERAL EARTH PRESSURE BASEMENT OR BELOW GRADE WALL WITH SURCHARGE

Note:

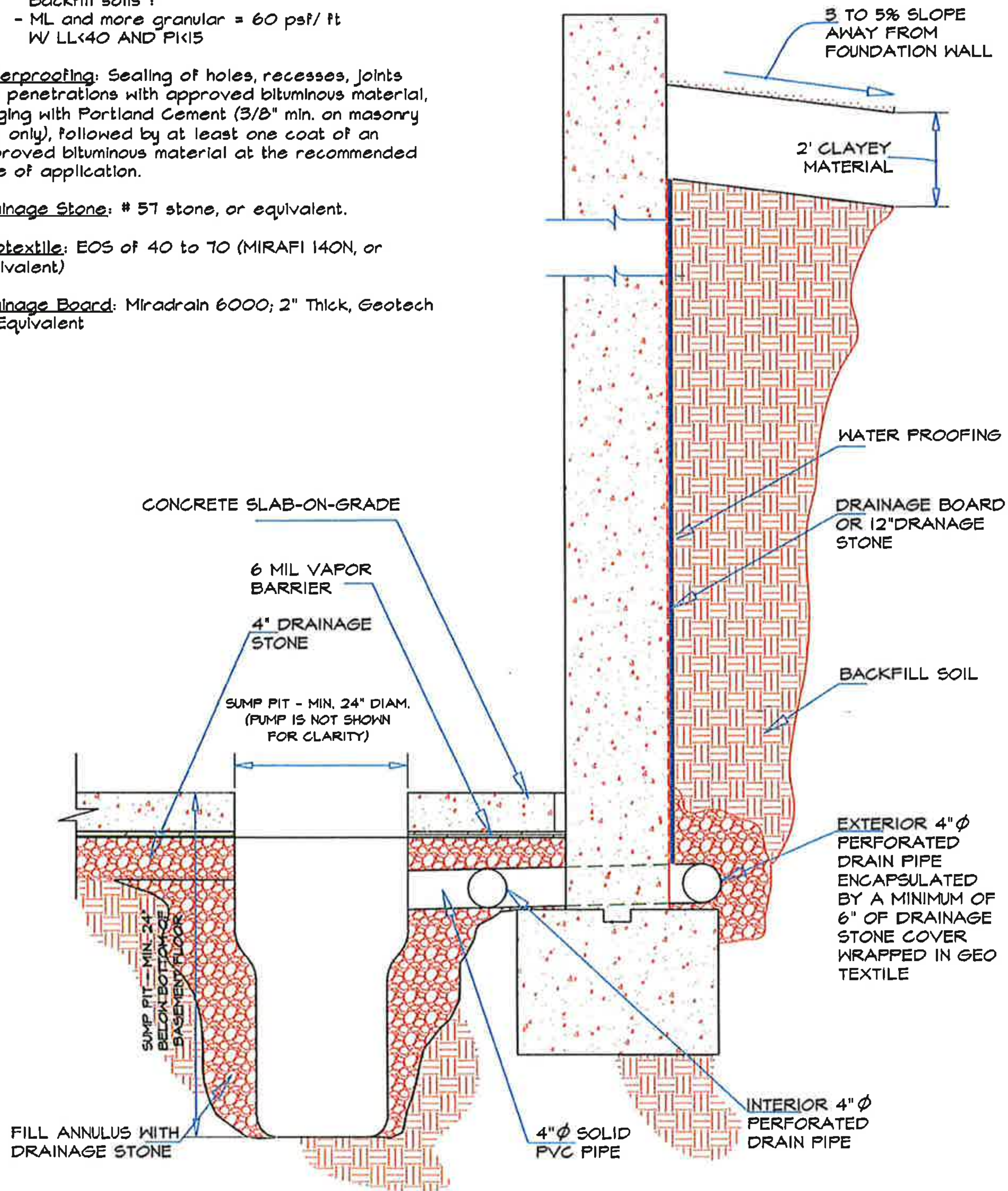
a.) Below grade at rest lateral earth pressure design requirements:
(excluding surcharge loads):
Backfill soils :
- ML and more granular = 60 psf/ ft
W/ LL<40 AND PI<15

Waterproofing: Sealing of holes, recesses, joints and penetrations with approved bituminous material, purging with Portland Cement (3/8" min. on masonry wall only), followed by at least one coat of an approved bituminous material at the recommended rate of application.

Drainage Stone: # 57 stone, or equivalent.

Geotextile: EOS of 40 to 70 (MIRAFI 140N, or equivalent)

Drainage Board: Miradrain 6000; 2" Thick, Geotech or Equivalent



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RESIDENTIAL BELOW GROUND DRAINAGE DETAIL (high ground water condition)

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Prince William County, Virginia

January 17, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,800 if printed on A portrait (8.5" x 11") sheet.

N

0 25 50 100 150 Meters

0 50 100 200 300 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Prince William County, Virginia
Survey Area Data: Version 15, Aug 28, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 25, 2014—Mar 10, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
4B	Arcola silt loam, 2 to 7 percent slopes	4.3	57.2%
5C	Arcola-Nestoria complex, 7 to 15 percent slopes	0.8	10.5%
35B	Manassas silt loam, 2 to 7 percent slopes	2.4	32.4%
Totals for Area of Interest		**7.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Prince William County, Virginia

4B—Arcola silt loam, 2 to 7 percent slopes

Map Unit Setting

National map unit symbol: khcb
Elevation: 300 to 800 feet
Mean annual precipitation: 19 to 50 inches
Mean annual air temperature: 46 to 69 degrees F
Frost-free period: 168 to 211 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Arcola and similar soils: 80 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arcola

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Triassic residuum

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 22 inches: gravelly silt loam
H3 - 22 to 28 inches: very gravelly silt loam
H4 - 28 to 48 inches: bedrock
H5 - 48 to 58 inches: bedrock

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock; 40 to 60 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Albano

Percent of map unit: 5 percent

Landform: Depressions
Landform position (three-dimensional): Head slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

5C—Arcola-Nestoria complex, 7 to 15 percent slopes

Map Unit Setting

National map unit symbol: khcr
Elevation: 300 to 800 feet
Mean annual precipitation: 19 to 50 inches
Mean annual air temperature: 46 to 69 degrees F
Frost-free period: 168 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Arcola and similar soils: 50 percent
Nestoria and similar soils: 30 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arcola

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Triassic residuum

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 22 inches: gravelly silt loam
H3 - 22 to 28 inches: very gravelly silt loam
H4 - 28 to 48 inches: bedrock
H5 - 48 to 58 inches: bedrock

Properties and qualities

Slope: 7 to 15 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock; 40 to 60 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Hydric soil rating: No

Description of Nestoria

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Triassic residuum

Typical profile

H1 - 0 to 8 inches: channery silt loam
H2 - 8 to 14 inches: very channery silt loam
H3 - 14 to 18 inches: very channery silt loam
H4 - 18 to 30 inches: bedrock
H5 - 30 to 34 inches: bedrock

Properties and qualities

Slope: 7 to 15 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock; 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Albano

Percent of map unit: 5 percent
Landform: Depressions
Landform position (three-dimensional): Head slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

35B—Manassas silt loam, 2 to 7 percent slopes

Map Unit Setting

National map unit symbol: khbj
Elevation: 400 to 800 feet
Mean annual precipitation: 19 to 50 inches
Mean annual air temperature: 46 to 69 degrees F
Frost-free period: 168 to 211 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Manassas and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manassas

Setting

Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Triassic residuum

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 43 inches: silt loam
H3 - 43 to 49 inches: channery sandy loam
H4 - 49 to 60 inches: bedrock

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Albano

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Head slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

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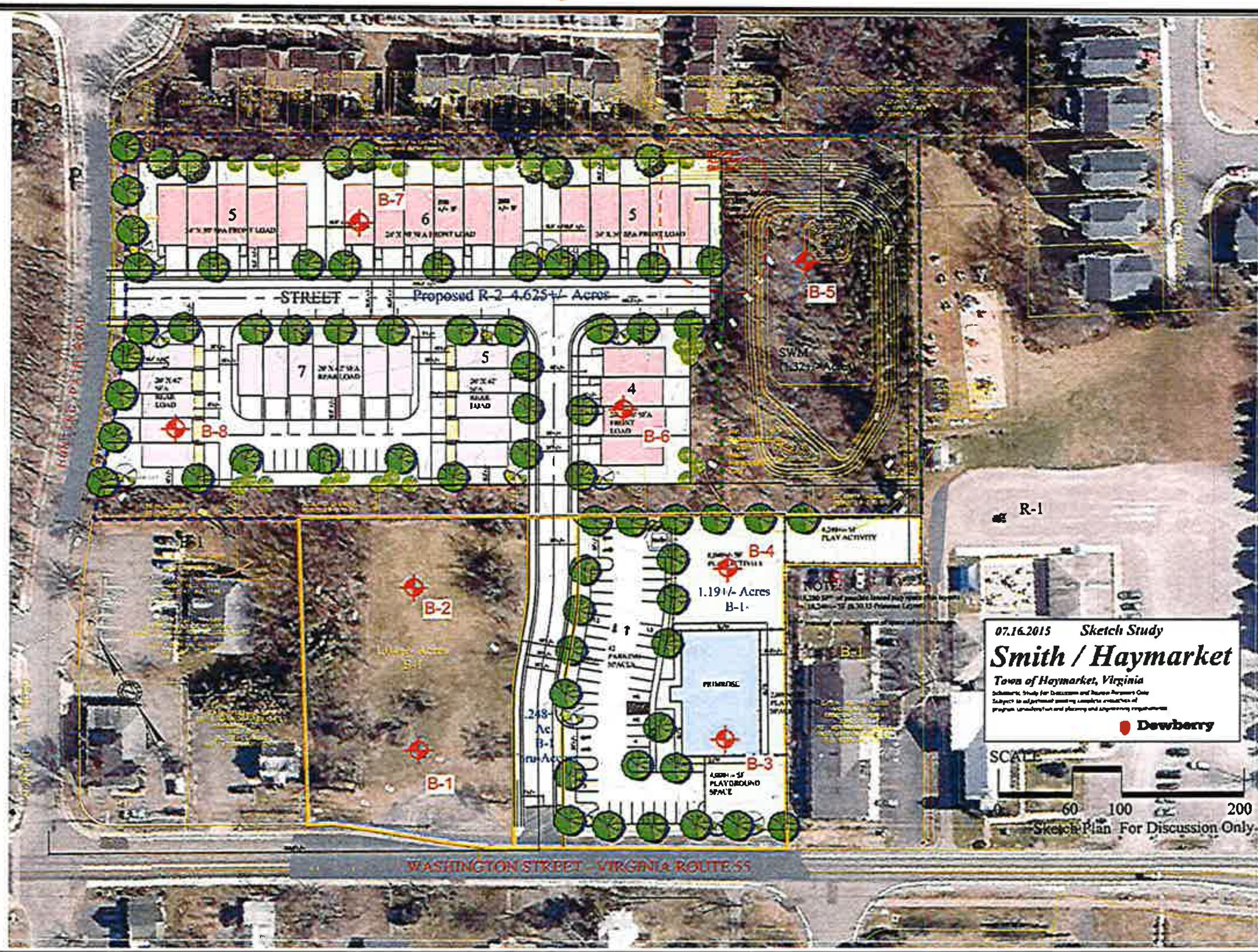

Approximate Boring Location

Geotechnical Solutions, Inc.	Geotechnical Solutions, Inc. 3859 Centerview Drive, Suite 160 Chantilly, VA 20151	SMITH – HAYMARKET PRINCE WILLIAM COUNTY, VA BORING LOCATIONS PLAN	Base Map Provided by: Dewberry Drawn by: SF/ Approved by: AAA Scale: NTS Date: January 2019 / GSI Job No. GP-182504

Geotechnical

Solutions, Inc.

Geotechnical Solutions, Inc.

- **Geotechnical Engineering**
- **Environmental Consulting**
- **Construction Services**

Conditions of Approval

SUP#2019-XXXX

April 23, 2019

1. LANDUSE

1.1 Development shall be in substantial accord with the Generalized Development and Special Use Permit Plan entitled "Smith Property at Haymarket" prepared by The Engineering Groupe and dated April 2, 2019 (4 sheets) (the "GDP") with the size, construction details and locations of buildings, roadways and other features being approximate subject to final engineering at site plan and with the color, construction materials and appearance of structures being subject to the issuance of certificates of appropriateness by the Town of Haymarket ("Town") Architectural Review Board (ARB) at advertised public meetings.

1.2 Residential Development on the Property shall not exceed 38 townhouse units in the location generally shown on the GDP.

1.3 Townhouse dwellings shall be either 20' or 24'-wide units.

1.4 Development of the Property shall be in substantial conformity with the GDP. Precise locations of roads, lot lines, lot widths and depths, utility lines, and other features generally depicted on the GDP will be determined at the time of site or subdivision plan approval.

1.5 The Property shall be developed as a single-unified development to include a common architectural theme as specifically approved through certificates of appropriateness by the ARB and integrated vehicular and pedestrian access ways as depicted on the GDP and finalized through site plan approval.

2. ARCHITECTURAL DESIGN, SIGNAGE AND LANDSCAPING

2.1 The Applicant will use best efforts to ensure that the height of Townhouse units will not exceed 40-feet as measured from the finished grade. To the extent final grading results in height, as measured from the finished grade over 40 feet, then the applicable side yard setback shall be increased by .5 feet for every foot over 40 feet. Architectural details of the townhouse units will be determined through the issuance of certificates of appropriateness issued by the ARB.

3. STORMWATER MANAGEMENT

3.1 Storm water management for the Property shall employ best management practices ("BMP").

3.2 Storm water retention shall be provided at site plan as approved by the Town.

3.3 Storm water management facilities shall be maintained by the appropriate owners' associations provided below.

4. CREATION OF HOMEOWNERS' ASSOCIATION

4.1 The Property shall be made subject a homeowners' association that shall be created and be made responsible for the maintenance and repair of common areas, including common open space that may be established in accordance with the requirements of the Town zoning ordinance. The HOA shall be granted such other responsibilities, duties and powers as a customary for such associations, or as may be required to affect the purposes for which the HOA is created. Such HOA shall also be granted sufficient powers that may be necessary, by regular dues, special dues or assessments, to raise revenue sufficient to perform the duties assigned hereby, or by the documents creating the association.

4.2 The HOA documents shall prohibit the use or conversion of garages for living space, or for the primary purpose of storage of anything other than parked vehicles.

4.3 The covenants, conditions and restrictions of the HOA shall be subject to review and approval of the Zoning Administrator prior to recordation thereof, to ensure conformance of the requirements of these proffers.

5. PARKS AND RECREATION

5.1 The Applicant shall make a contribution for park purposes in the amount of $3,792 per residential townhouse unit, payable upon the issuance of an occupancy permit for each such unit.

5.2 The Applicant shall reserve the open space or areas shown on the GDP as "Play Area" or "Tot Lot" for play areas or tot lots.

6. PUBLIC SAFETY

6.1 The Applicant shall make a contribution for public safety purposes in the amount of $280.00 per residential townhouse unit payable upon the issuance of a building permit for each such unit.

7. TRANSPORTATION

7.1 The Applicant will construct a 5-foot wide concrete sidewalk along the western edge of the property, on the east side of Hunting Path Road.

7.2 The Applicant shall make a contribution for transportation purposes in the amount of $3,799 per townhouse unit, payable upon issuance of an occupancy permit for each such townhouse unit.

8. FIRE AND RESCUE

8.1 The Applicant shall make a contribution for fire and rescue purposes in the amount of $974 per townhouse unit, payable upon the issuance of a building permit for each such unit.

9. TOWN ADMINISTRATION

9.1 The Applicant shall make a contribution for Town administration in the amount of $171 per townhouse unit, payable upon the issuance of a building permit for each such unit.

10. SCHOOLS

10.1 The Applicant shall make a contribution for schools in the amount of $10,300 per residential townhouse unit, payable upon the issuance of an occupancy permit for each such unit.

SIGNATURES ON FOLLOWING PAGES

RECEIVED APR 24 2019

APPLICANT:

Van Metre Communities, L.L.C.

a Virginia Limited Liability Company

By: Van Metre Homes, Inc., its manager

By: ______________________________

Name: ___________________________

Title: ____________________________

RECEIVED APR 24 2019