Hydrology Analysis

Takoma Park
Water and Sewer Main Replacements / Relocations
Eastern Avenue Between Walnut Avenue and 5th Avenue

Contract No. BR/CR/LR5355C12

Takoma Park
Montgomery County, Maryland

September 2016

Prepared for:

Washington Suburban Sanitary Commission
14501 Sweitzer Lane
Laurel, Maryland 20707

Prepared by:

The Wilson T. Ballard Company
17 Gwynns Mill Court
Owings Mills, Maryland 21117

Table of Contents

I. Introduction and Project Narrative

The Washington Suburban Sanitary Commission has retained The Wilson T. Ballard Company to provide engineering services for a Water and Sewer Rehabilitation project in Montgomery County. The project consists of designing and preparing contract documents for construction of small diameter water and sewer main replacement and relocation and water and sewer house service reconnections in an environmentally sensitive way. The project is located along Eastern Avenue between Walnut Avenue and 5th Street in the City of Takoma Park in Montgomery County, Maryland.

The proposed sewer line replacement will be placed in a new WSSC easement aligned with the rear property boundaries of the properties on the Eastern Avenue frontage road, adjacent to the rear property boundaries along Westmoreland Avenue.

In conjunction with alignment studies for the proposed Water and Sewer replacement project, we have performed a hydrology survey in order to determine the possible effects of clearing the WSSC easement for construction of the sewer mains and sewer service connection.

II. Project Area

The study neighborhood is located in Maryland near the border with the District of Columbia in Takoma Park. The area is on a steep grade, falling from Eastern Avenue to past Westmoreland Avenue. All of the roadways in the area are closed section, and all runoff from roadway surfaces, as well as most sidewalks, is conveyed along the road to a closed storm drain system.

Concerns have been raised by homeowners, primarily those along the southern side of Westmoreland Avenue, regarding incidence of water infiltration into basements. Multiple homes have reported such water infiltration is happening under current conditions, and the worry is that changing the runoff and groundwater recharge conditions by clearing of the easement area for construction of the proposed sewer line will increase the amount of water available for this kind of infiltration. At particular issue is the removal of several large trees within and adjacent to the easement area, specifically the effect of removing their water uptake from the soil.

III. Sources of Information

Multiple sources of information were used in the development of this report, including:

- Natural Resources Conservation Service Web Soil Survey for Washington D.C., Montgomery County, and Prince George's County.
- USDA – SCS, TR-55 2nd Ed. June 1986
- SHA Highway Drainage Manual
- Aerial Mapping Imagery from 6" MDiMAP
- Site Surveys performed by Buchart Horn, Inc. and AB Consultants, Inc. for the project

- Geotechnical report performed by Advantage Engineers for the project
- Site Visit

IV. Discussion

Site Conditions

The existing conditions in the construction area are generally natural areas, with some areas of improvement such as backyard water features and sheds. There is tree canopy over the majority of the area, and the ground cover is generally vines, clover, and brush. The project, proposed as an open-trench construction of an 8-inch sewer line through 15 properties between Walnut and First Avenues and 5 properties between First and Second Avenues, would remove approximately 39 trees over 8" diameter at breast height (DBH). This will reduce the tree canopy, particularly with the removal of several large oak trees. The proposed construction will also remove the existing ground cover from the area of the proposed trench and will include the stabilization of the disturbed area with grass. The disturbed area is expected to naturally return to a ground cover condition similar to the current condition within a few years.

Soil Conditions

Soil conditions in the area are those of very hard soils, although the available soil surveys disagree on the underlying hydrologic soil group (HSG), a measure of the runoff potential of soils. We believe this is due to the location of the area of investigation lying on the corner of the Montgomery County soil survey. The Montgomery County Soil Survey shows the area between Eastern and Westmoreland Avenues as HSG 'B', which has a moderate infiltration rate when thoroughly wet, but the adjacent D.C. and Prince George's soil surveys show the area as HSG 'C', which has a slow infiltration rate when thoroughly wet. Based on the normal shape of HSG 'C' locations, the area of investigation could likely be considered 'C' as well, especially since the difference in the classification is between Chillum Silt-Loam in Montgomery and Chillum-Urban Land Complex in the other two surveys, for areas of similar urbanization.

A geotechnical investigation for the project has been performed, including multiple soil borings. 4 of the 5 borings were taken on the roads around the block - two on Second Avenue, one on Walnut Avenue, and one on Westmoreland Avenue – while the fifth was taken in the back yard of 6745 Eastern Avenue. These borings show a trend of groundwater getting closer to the surface as surface elevation drops: No water was found in the backyard Boring 5, while Boring 3 on Westmoreland Avenue showed groundwater at a depth of 3.5'. Shallower groundwater was found on the northwest end of the project area than the southeast end, with borings on Second Avenue showing groundwater depths of 13' and 11.5'.

Effect of Tree Removal

We have reviewed available literature on the effect of trees on groundwater, and while the general belief has been that tree cover tends to reduce available water for groundwater recharge through uptake and transpiration, a recently published study[1] has shown that some conditions of intermediate tree cover can increase groundwater recharge. So there appears to be no clear relationship between individual trees and groundwater amounts that we can draw from published studies.

However, due to the steep slopes and low infiltration rates we believe that the primary effect of trees on groundwater infiltration in this area is due to the surface irregularity caused by tree roots. Roots, both exposed and subsurface, cause local storage of rainfall and runoff, providing the opportunity for the trapped water to infiltrate, where otherwise it would run off down the steep slope. The effect of the sewer construction on these tree roots will be minimal, because even those trees that will be removed adjacent to the sewer alignment will not be grubbed. Therefore, we do not think the removal of trees will have a predictable significant effect on either groundwater or surface water from rainfall.

Excavation and Backfill of Sewer Pipe Trench

The trench excavation for the proposed sewer pipe will be minimized to the greatest extent practicable, limiting the area of actual ground disturbance to the smallest possible area. The pipe bedding will consist of borrow aggregate surrounding the pipe to 1' above the top of the pipe, and local soils replaced to finished grade. The minimum cover over the proposed sewer pipe is 3.5', resulting in a minimum of 2.5' of soil over the pipe bedding. Since the pipe excavation will disturb the soil, it is likely that there will be some additional infiltration for this area, at least for a period after the construction is finished. However, the minimal area of this disturbance and the likelihood of quick reestablishment of natural vegetation should limit the amount of time that this trench area has any effect on groundwater. There is not to be any significant mounding of the dirt backfill, so there will not be additional water trapped for infiltration.

Change to Runoff Curve Number

The other major effect that could cause a change to the runoff and infiltration of the project area is the change in landuse, which would be represented by a change in the "Runoff coefficient", a measure of the runoff potential of an area based on the type of landuse. Using the Natural Resources Conservation Service (NRCS) *Urban Hydrology for Small Watersheds* methodology, also known as "TR-55", the current conditions would be judged by a hydrologist to be either "Woods in Good Condition" or "Brush in Good Condition." "Good" condition refers to the amount of area covered by vegetation, and since there are no large bare spots, even under the tree canopy, this area would be considered "Good". These two conditions have Runoff Curve Numbers (RCN) of 65 for Brush and 70 for Woods, assuming C soils. After construction, it is likely that the area of disturbance will revert to Brush, or eventually Woods.

Since Brush has a lower curve number than Woods, after the area is regrown the proposed runoff would be slightly lower than in existing conditions, but since the overall change would be less than 1 whole number in weighted RCN, and RCN is rounded to the whole number for hydrology computation, the net effect of the clearing and sewer construction would be, essentially, no effect on the runoff potential of the area.

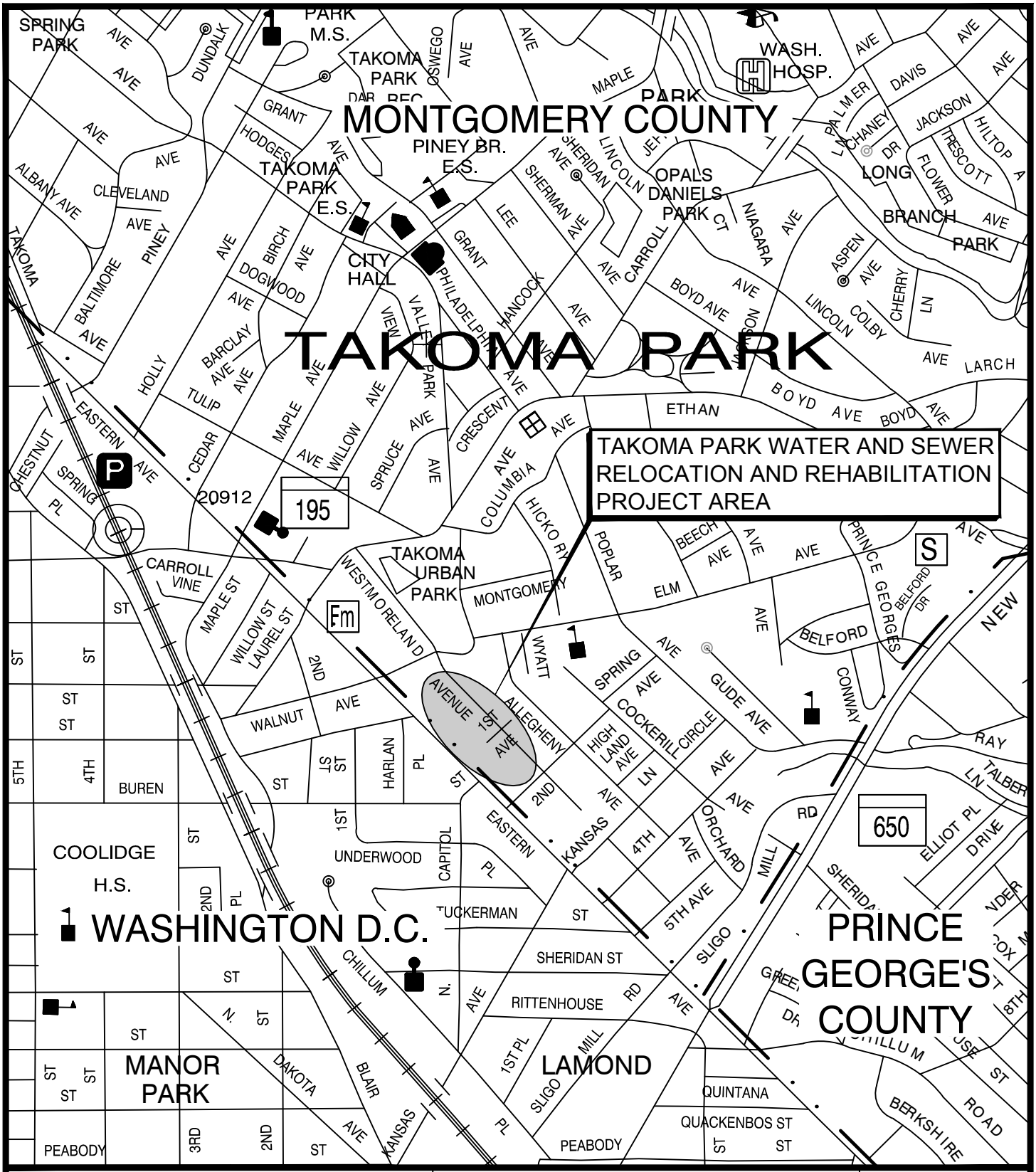
V. Conclusion

The Takoma Park Water and Sewer Rehabilitation will construct approximately 850 l.f. of sewer along the rear property lines of properties along Eastern Avenue. The neighborhood is worried that the proposed construction, which would involve the cutting of trees, clearing of brush, and trenching of the sewer line, will have an adverse impact on the houses along the south side of Westmoreland Avenue, either due to increased potential for groundwater infiltration into basements, or through additional surface flow causing erosion.

We have investigated the area through site visits, landuse mapping, geotechnical investigation, and review of literature regarding research into the effect of trees on groundwater infiltration. Through our analysis, we find that the proposed construction of the sewer line will have minimal effect on the runoff potential of the study area, and thus will not cause significant increases in either runoff or groundwater infiltration.

VI. References

1. U. Iistedt *et al*, Intermediate tree cover can maximize groundwater recharge in the seasonally dry tropics, *nature.com, Scientific Reports* 6, Article number: 21930, (February 24, 2016)



GRAPHIC SCALE
1000 500 0 1000
SCALE: 1"=1000'

Washington Suburban Sanitary Commission

COUNTY: MONTGOMERY

STATE: MARYLAND

DATE: 9/20/2016

CONTRACT NO.: BR/CR/LR 535C12

THE WILSON T. BALLARD CO.

VICINITY MAP

THE WILSON T. BALLARD CO.

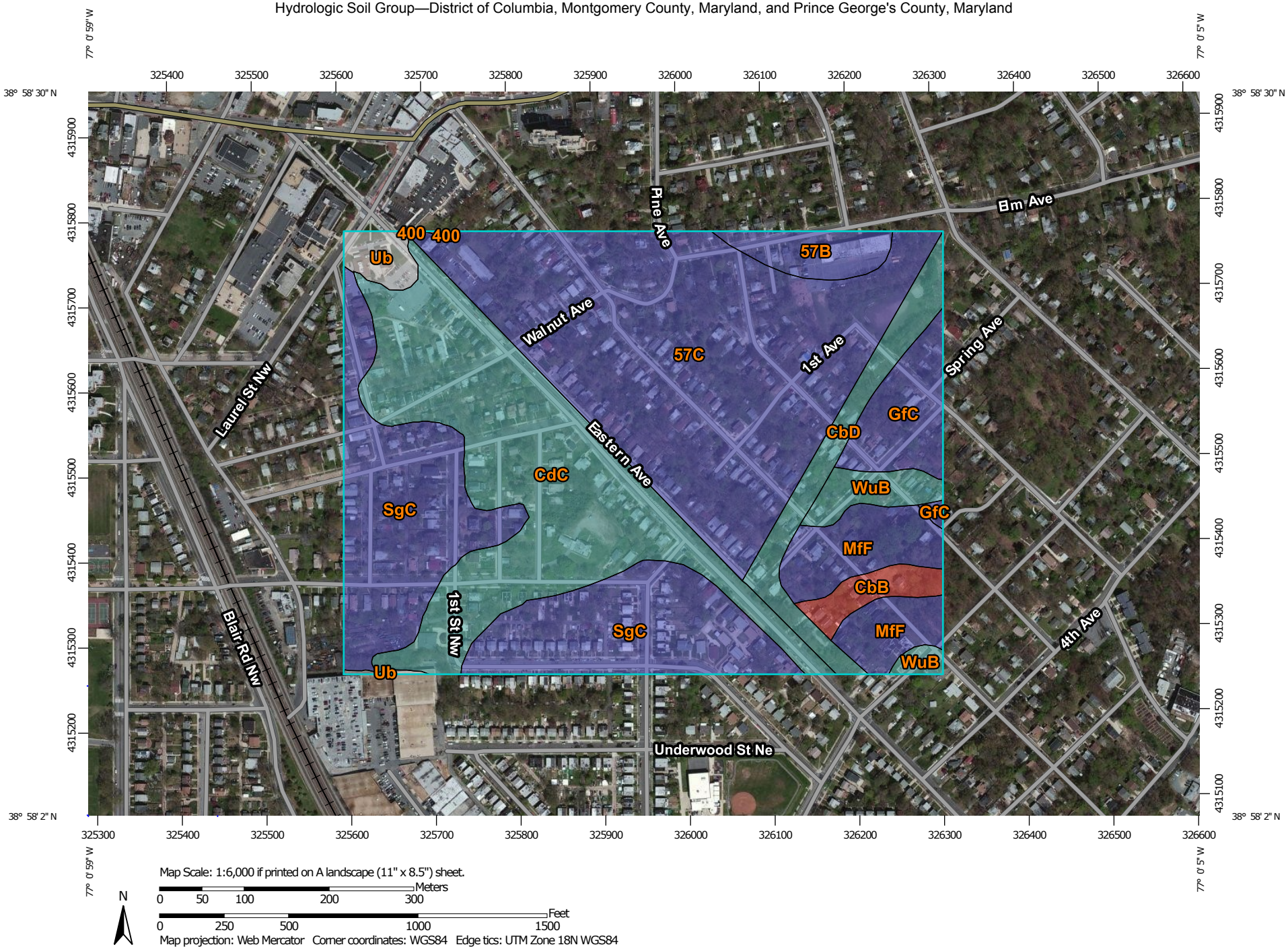
Washington Suburban Sanitary Commission

DRAINAGE STUDY AREAS

100 0 100

SCALE IN FEET

COUNTY:	MONTGOMERY
STATE:	MARYLAND
DATE:	9/20/2016
CONTRACT NO:	BR/CR/LR 535C12


77° 0' 59" W
77° 0' 5" W
38° 58' 30" N
38° 58' 2" N
325400
325500
325600
325700
325800
325900
326000
326100
326200
326300
326400
326500
326600
325300
4315900
4315800
4315700
4315600
4315500
4315400
4315300
4315200
4315100
400
Ub
57B
57C
CdC
SgC
GfC
CbD
WuB
MfF
CbB
Pine Ave
Elm Ave
Walnut Ave
1st Ave
Spring Ave
Laurel St NW
Eastern Ave
1st St NW
Blair Rd NW
4th Ave
Underwood St Ne
Map Scale: 1:6,000 if printed on A landscape (11" x 8.5") sheet.
Meters
0 50 100 200 300
Feet
0 250 500 1000 1500
N
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 Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 scales ranging from 1:12,000 to 1:15,800.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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: District of Columbia
Survey Area Data: Version 9, Sep 29, 2015

Soil Survey Area: Montgomery County, Maryland
Survey Area Data: Version 11, Sep 22, 2015

Soil Survey Area: Prince George's County, Maryland
Survey Area Data: Version 13, Sep 30, 2015

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Data not available.

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — District of Columbia (DC001)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
CdC	Chillum-Urban land complex, 8 to 15 percent slopes	C	21.3	23.3%
SgC	Sassafras-Urban land complex, 8 to 15 percent slopes	B	19.4	21.2%
Ub	Urban land		1.3	1.4%
Subtotals for Soil Survey Area			**42.0**	**45.9%**
Totals for Area of Interest			**91.4**	**100.0%**

Hydrologic Soil Group— Summary by Map Unit — Montgomery County, Maryland (MD031)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
57B	Chillum silt loam, 3 to 8 percent slopes	B	2.2	2.4%
57C	Chillum silt loam, 8 to 15 percent slopes	B	30.2	33.0%
400	Urban land	D	0.1	0.1%
Subtotals for Soil Survey Area			**32.5**	**35.5%**
Totals for Area of Interest			**91.4**	**100.0%**

Hydrologic Soil Group— Summary by Map Unit — Prince George's County, Maryland (MD033)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
CbB	Chillum-Urban land complex, 0 to 5 percent slopes	D	1.5	1.7%
CbD	Chillum-Urban land complex, 5 to 15 percent slopes	C	4.2	4.6%
GfC	Glenelg-Wheaton-Urban land complex, 8 to 15 percent slopes	B	3.6	4.0%
MfF	Manor-Brinklow complex, 25 to 65 percent slopes, very rocky	B	5.6	6.1%
WuB	Woodstown-Urban land complex, 0 to 5 percent slopes	C	2.1	2.3%
Subtotals for Soil Survey Area			**17.0**	**18.6%**
Totals for Area of Interest			**91.4**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

ADVANTAGE ENGINEERS

May 2, 2011

Mr. David W. Shirk, P.E.
Buchart Horn
445 West Philadelphia Street
York, PA 17401

RE: Geotechnical Engineering Report
Takoma Park - Water & Sewer Main Rehabilitation
Takoma Park, Maryland
Advantage Project No.: 110005601

Dear Mr. Shirk:

In accordance with your request, Advantage Engineers (Advantage) has completed an engineering analysis of the above referenced project site in order to evaluate the suitability of the subsurface soils across the project site. This correspondence serves to summarize our findings.

SITE AND PROJECT DESCRIPTION

The project site currently consists of existing paved roads and residential properties bound by Westmoreland Avenue, Walnut Avenue, Eastern Avenue, and 1st Avenue in Takoma Park, Maryland. The site is immediately bordered in all directions by residential properties. The location of the site in relation to the surrounding area is presented on the attached *Topographic Map*. The project will consist of replacing/relocating the existing water and sewer mains beneath Eastern Avenue. According to information provided by the client, the relocated water and sewer piping will run in an easement between the rear lots of the homes along Westmoreland Avenue and Eastern Avenue. The proposed invert elevations of the water and sewer main were unknown at the time of this report.

SCOPE OF WORK

The objective of our work was to evaluate the engineering characteristics of the underlying soils and bedrock in an effort to develop construction recommendations for the proposed sewer relocation. The scope of work for this project included the completion of a field investigation, laboratory testing program, and engineering analysis of the data obtained. The results of our investigation, conclusions, and recommendations regarding replacement and relocation of the proposed utilities are presented below.

SUBSURFACE FIELD INVESTIGATION

In an effort to evaluate subsurface conditions along the proposed new sewer alignment, 5 test borings (referenced as B-1 through B-5) were conducted on April 13 and 15, 2011. Supervision and monitoring of the test boring operation were provided by a representative of Advantage. The test borings were field located by the client prior to our arrival. Test borings B-2 and B-3 were offset approximately 57 feet southwest and 11 feet southeast, respectively, due underground utilities and

overhead power lines and trees. Test boring B-4 was offset approximately 39 feet northeast due to parked cars. The approximate test boring locations are shown on the attached *Test Boring Location Plan* (Dwg. No.: 110005601-A-100).

The test borings were advanced using a truck-mounted drill rig equipped with hollow-stem augers. Split-spoon samples, conducted in accordance with ASTM standard D1586, were taken throughout the entire depth of the borings and the Standard Penetration Test (SPT) values were recorded for each sample obtained. The SPT values, which are a measure of relative density or consistency, are the number of blows required to drive a 2-inch (outer-diameter), split-barrel sampler 2 feet using a 140-pound weight dropped 30 inches. The number of blows required to advance the sampler over the 12-inch interval from 6 to 18 inches is considered the "N" value.

Data pertaining to the subsurface investigation was documented in the field and is presented in detail on the *Test Boring Profiles* and *Test Boring Logs*, presented within the Appendix. The *Test Boring Profiles* (Dwg. No.: 110005601-A) depict cross-sections of the subsurface conditions encountered within each test boring, including: soil types, depths of individual strata, and recorded "N" values. The *Test Boring Logs* contain general information about the subsurface program and specific data regarding each test boring, including: sample depths, blow counts per six (6) inches of penetration, and detailed characterizations of the subsurface materials encountered.

LABORATORY ANALYSIS

All soils encountered at the site were visually reviewed and classified by Advantage. One (1) representative soil sample was subjected to laboratory analyses in an effort to verify visual classification and to establish engineering parameters. The laboratory testing conducted on the sample consisted of standard classification testing, completed in accordance with ASTM standard D2487. The tests performed included Natural Moisture Content (ASTM D2216), Sieve Analysis (ASTM D422), and Atterberg Limits Determination (ASTM D4318).

A Unified Soil Classification System (USCS) Group Symbol and ASTM Group Name have been assigned to the soil analyzed. The results of the testing conducted are presented below in Table I. A graphical depiction of the gradation analysis is attached for review.

TABLE I

LABORATORY RESULTS	
Boring Number	B1/B3
Sample Depth (ft.)	8.0' – 10.0'
Soil Type	Stratum I
Particle Size Distribution (Percent)	
Gravel	9.2
Sand	55.8
Silt/Clay	35.0
Atterberg Limits	
Liquid Limit	35
Plastic Limit	20
Plasticity Index	15
Natural Moisture Content	14.5%
USCS Group Symbol	SC
ASTM Group Name	Clayey Sand

In addition, soil was collected and subjected to laboratory analyses which consisted of the following:

- Twenty-four (24) natural moisture content determinations per ASTM-D2216
- One (1) Moisture-density relationship per ASTM-D698 (Standard Proctor)
- One (1) pH measurement per ASTM-G51
- One (1) soil resistivity measurement per AASHTO T288

The results of these analyses are attached.

SUBSURFACE CONDITIONS

Geology

According to Maryland Geological Survey's, Geologic Map of Maryland, 1968, the project site is underlain by the Potomac Group (Geologic Symbol Kp). The rock in this formation consist Interbedded quartzose gravels; protoquartzitic to orthoquartzitic argillaceous sands; and white, dark gray and multicolored silts and clays; thickness 0 to 800 feet.

Soil

The surfaces of test borings were found to be covered by the following surficial elements:

- Test borings B-1 and B-2 were found to be covered by approximately 2 inches of asphalt and 4 inches of stone sub-base, and 4 inches of asphalt and 8 inches of stone sub-base, respectively.
- Test borings B-3 and B-4 were found to be covered by approximately 3.25 inches of asphalt followed by 8 and 7 inches of concrete, respectively.
- Test boring B-5 was found to be covered by approximately 4 inches of topsoil and organic debris.

Beneath these surficial elements, subsurface conditions were found to be generally uniform, consisting of a single, naturally-occurring soil stratum, referenced herein as Stratum I. A general description of the soil encountered at the site is as follows:

Stratum I – Brown clayey sand with varying amounts of gravel

Stratum I was encountered immediately below the surficial elements and extended to the termination depths of the test borings; approximately 15 feet below existing site grades. The "N" values, recorded within this soil, were found to range from 3 to 31 blows per foot, and show Stratum I to be generally medium dense to very dense in relative density.

USCS standard classification testing conducted on a representative sample of Stratum I, show this soil to be moderately well graded and plastic, with a natural moisture content of approximately 14.5%. Stratum I is described under the Unified Soil Classification System (USCS) as Clayey Sand, with the accompanying group symbol of SC. 24 samples of Stratum I were subjected to moisture content determination. The results indicate that the moisture content within Stratum I ranges from 4.7% to 25.4%, with an average value of 14.9%

A representative sample was also subjected to pH analysis and resistivity. The results indicate a soil pH of 5.1 and a minimum resistivity of 7.7 kohms-cm.

A bulk sample of Stratum I was subjected to moisture-density relationship testing in accordance with ASTM-D698 (Standard Proctor). The results show Stratum I to have a minimum dry density of 118.5 pcf at an optimum moisture content of 10.3%.

Bedrock

The bedrock surface was not encountered during test boring operation. The bedrock surface would have been defined as the depth at which auger refusal was encountered.

Groundwater

Groundwater was encountered in test borings B-1 through B-4 at depths ranging from approximately 3.5 to 13 feet below existing site grades. Groundwater measurements were obtained directly after the drilling procedure was completed at each test boring. Test borings B-3 and B-4 required the introduction of water to core through the existing concrete; therefore, actual groundwater elevations may be deeper than those recorded. These observations were made at the time of the field operations and groundwater table elevations will vary with daily, seasonal, and climatological variations.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our field investigation and laboratory testing, we offer the following conclusions with regard to subsurface conditions within the proposed sewer/water alignment.

- The overburden soils, referenced as Stratum I, were found to be moderately well graded, plastic, and classified as Sandy Clay according to the USCS. Based on the observations made during the field investigation and the engineering characteristics of the soils of Stratum I, this soil is suitable for reuse in backfilling of the utility trenches.

- The bedrock surface was not encountered during the test boring operation.

- Groundwater was encountered in test borings B-1 through B-4 at depths ranging from approximately 3.5 to 13 feet below existing site grades. Therefore, dewatering will likely be required during pipe installation and backfilling. It is expected that dewatering will be accomplished via submersible pumps. Specification for the contract should be of the performance type, requiring the Contractor to lower and maintain the water table a minimum of 2 feet below the utility invert elevation during pipe installation and 2 feet below the elevation of soil in the trench during backfilling.

- The soil was found to have a pH of 5.1 and resistivity of 7.7 kohms-cm. According to the American Water Works Association (AWWA), this soil is not corrosive to grey or ductile cast iron pipe.

- The following soil criteria are provided for use in design of temporary excavation support systems:

    - Internal angle of friction (Ø) = 30°
    - Cohesion (c) = 250psf
    - Moist Unit Weight = 135 pcf

LIMITATIONS

The conclusions contained in this report are based upon the subsurface data collected and on details stated in this report. Should conditions arise which differ from those specifically stated herein, our office should be notified immediately, so that our recommendations can be reviewed and revised, if necessary.

The conclusions presented herein should be applied only to the subsurface exploration completed for the proposed replacing/relocating of the existing water and sewer main for Eastern Avenue in Takoma Park, Maryland. Advantage takes no responsibility in utilizing this information for any other purpose.

We trust that this is the information you require. Should you have any questions or if we may be of further assistance, please don't hesitate to contact our office.

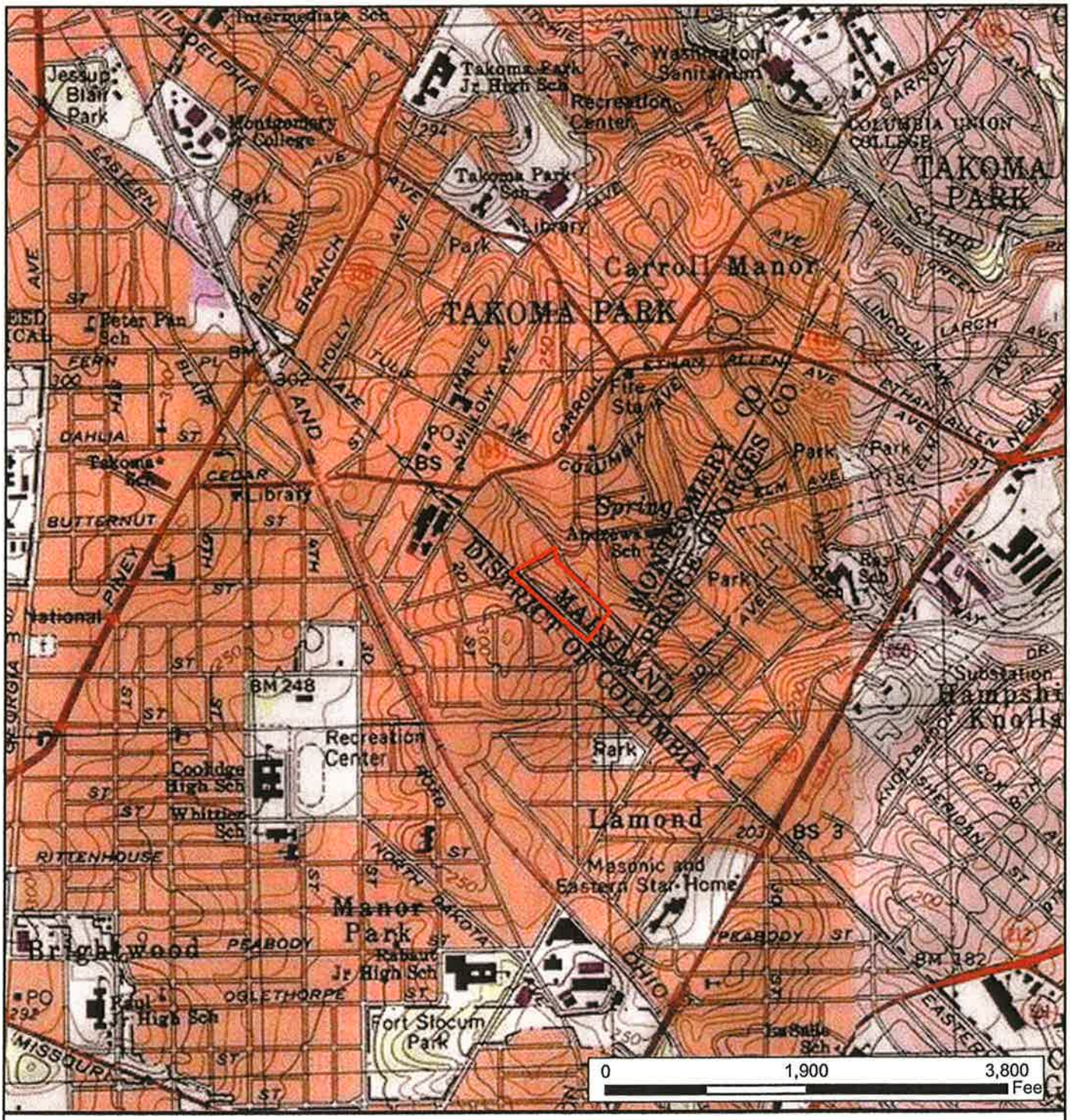
Sincerely,
ADVANTAGE ENGINEERS, LLC

Daniel R. Schauble, Jr.
Director of Geotechnical Services

Edward L. Balsavage, P.E.
Managing Principal

ATTACHMENTS

Topographic Map



Legend

Subject Property

ADVANTAGE ENGINEERS

Takoma Park - Water & Sewer Main Rehabilitation

Takoma Park, Maryland

Project #: 110005601
April 2011

Geologic Map

Legend

- Kp — Potomac Group
- wbg — Boulder Gneiss
- Subject Property

ADVANTAGE ENGINEERS

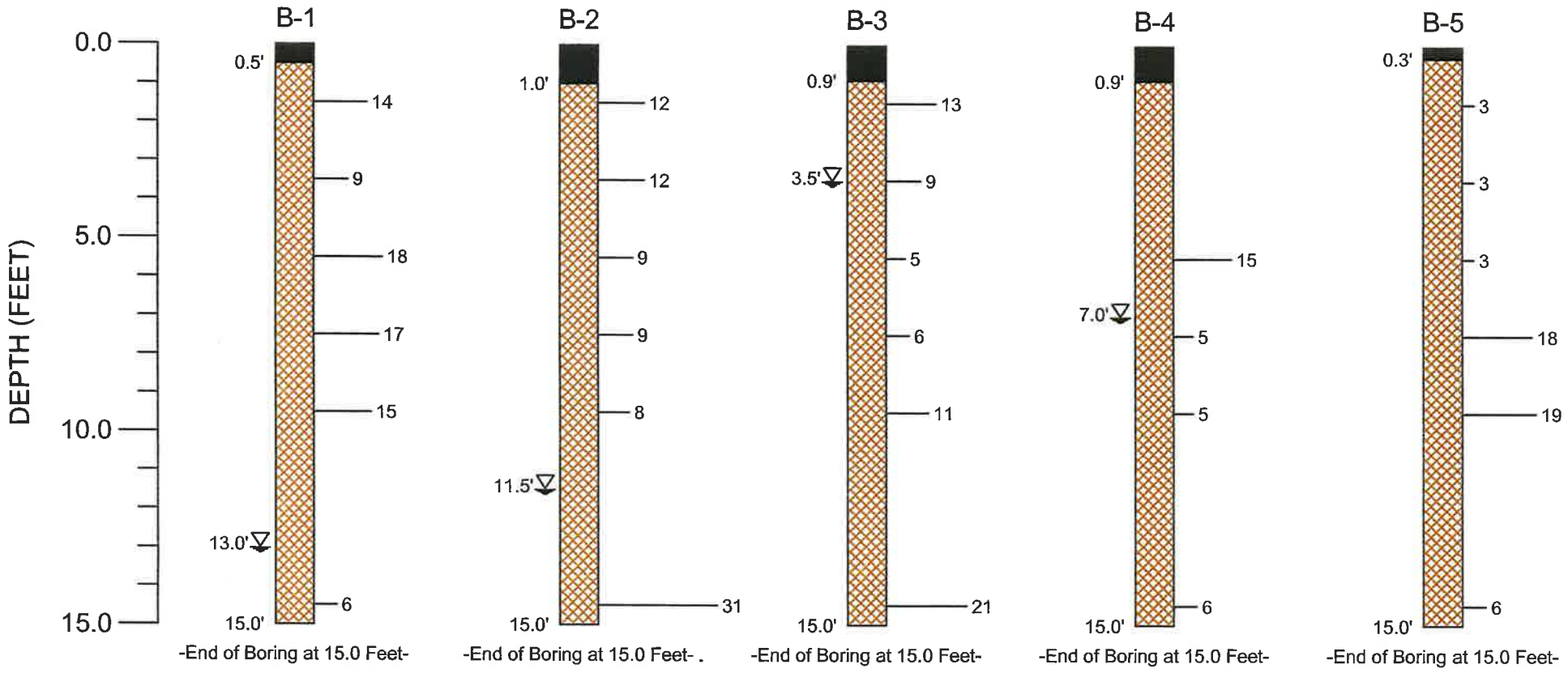
Takoma Park - Water & Sewer Main Rehabilitation

Takoma Park, Maryland

Project #: 110005601
April 2011

B-# APPROXIMATE TEST BORING LOCATIONS

SCALE: NTS	DRAWING NUMBER: 110005601-A-100	TEST BORING LOCATION PLAN PREPARED FOR TAKOMA PARK - WATER & SEWER MAIN REHABILITATION	ADVANTAGE ENGINEERS telecommunications | environmental | geotechnical 910 CENTURY DRIVE MECHANICSBURG, PA 17055 PH (717) 458-0800 FAX (717) 458-0801
DRAWN BY: K.BARNHART	CHECKED BY: D.BUCKWALTER		
APPROVED BY: D.SCHAUBLE	DATE: 04-18-11	TAKOMA PARK MARYLAND	



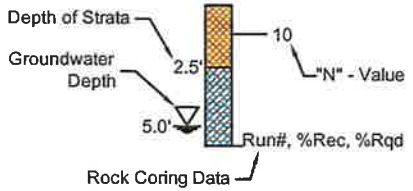
LEGEND

TOPSOIL/PAVEMENT/CONCRETE

STRATUM I BROWN TO TAN TO WHITE CLAYEY SAND WITH VARYING AMOUNTS OF GRAVEL

SCALE: AS SHOWN	DRAWING NUMBER: 110005601-A
DRAWN BY: K. BARNHART	CHECKED BY: D. BUCKWALTER
APPROVED BY: D. SCHAUBLE	DATE: 04-12-2011

KEY:



TEST BORING PROFILES

PREPARED FOR

TAKOMA PARK - WATER & SEWER MAIN REHABILITATION

TAKOMA PARK MARYLAND

ADVANTAGE ENGINEERS
telecommunications | environmental | geotechnical
910 CENTURY DRIVE
MECHANICSBURG, PA 17055
PH (717) 458-0800
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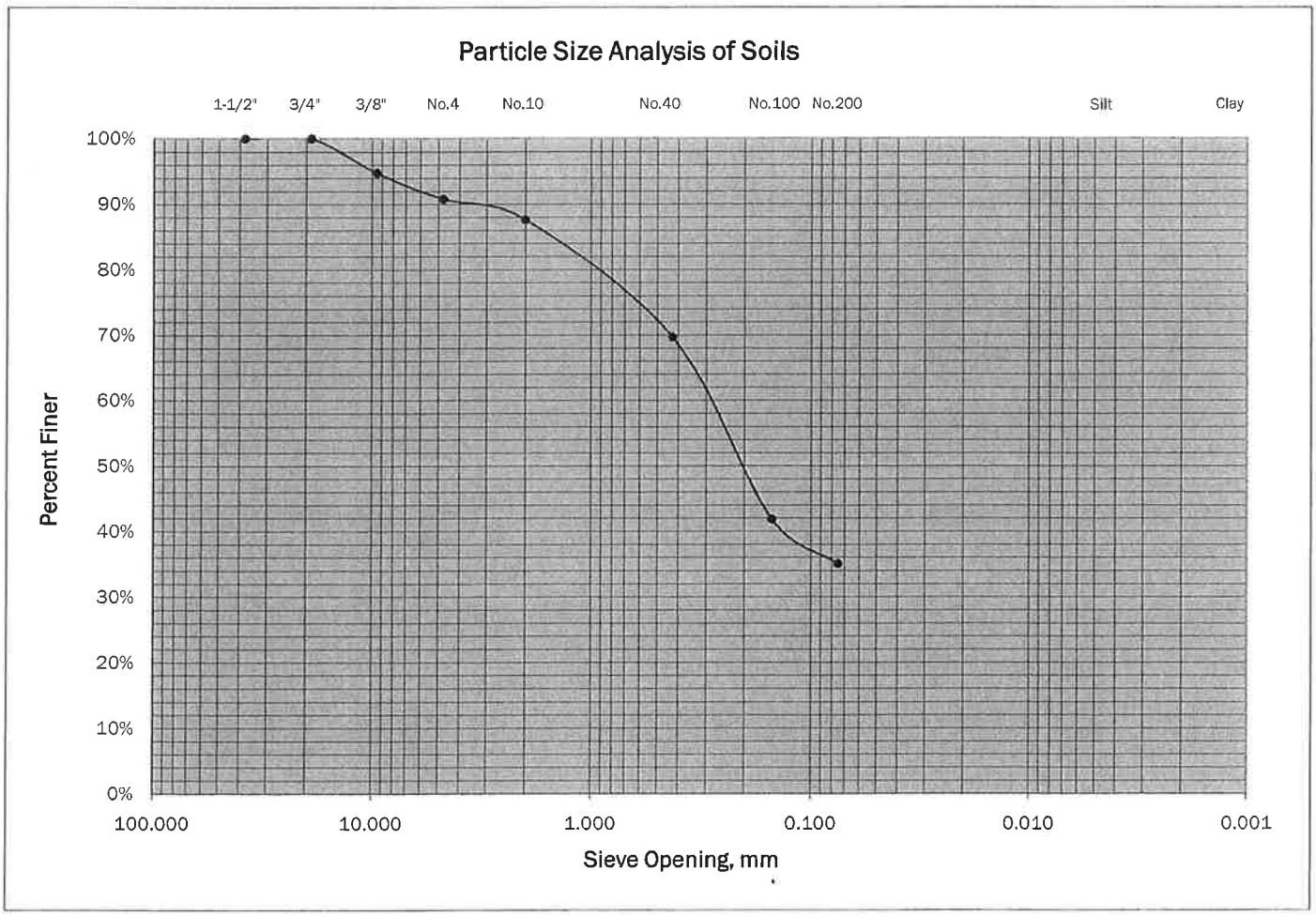
Soil Classification Report

Per ASTM Designations D 2487 - 00 and D 2488 - 00



As-Received Moisture 14.5%	
USCS Classification: Clayey Sand - SC	
Gravel: 9.2% Coarse: 0.0% Fine: 9.2%	
Sand: 55.8% Coarse: 3.2% Medium: 18.0% Fine: 34.6%	
Silt: Clay: Colloids:	
Gravel Description: Brown to white to grey subangular to rounded	
Sand Description: Brown to white to grey subangular to rounded	
Consistency: N/A Dry Strength: Low	
Dilatancy: Rapid Toughness: Medium	
Structure: Homogeneous Cementation: Weak	
Boring: B1/B-3	
Sample: Composite Depth: 8'-10'	
Project: Takoma Park - Water & Sewer Main Rehabilitation	
Client: Buchart Horn, Incorporated	
AE Project Number: 110005601	

Particle Size Distribution

US Standard Sieve Size		Opening (mm)	%Finer
GRAVEL Coarse	1-1/2"	38.0	100.0%
	3/4"	19.0	100.0%
Fine	3/8"	9.50	94.8%
	No. 4	4.75	90.8%
SAND Coarse	No. 10	2.00	87.7%
Medium	No. 40	0.425	69.7%
	No. 100	0.150	41.8%
Fine	No. 200	0.075	35.1%
Hydrometer Analysis	Silt Size	0.005	
	Clay Size	0.001	

D_{60}:	D_{30}:	D_{10}:	Cu:	Cc:

Atterberg Limits	LL: 35	PL: 20	PI: 15
Description: Brown			
Remarks: Stratum I			
Report Date: April 18, 2011			

ADVANTAGE ENGINEERS

Construction Materials Laboratory Test Report

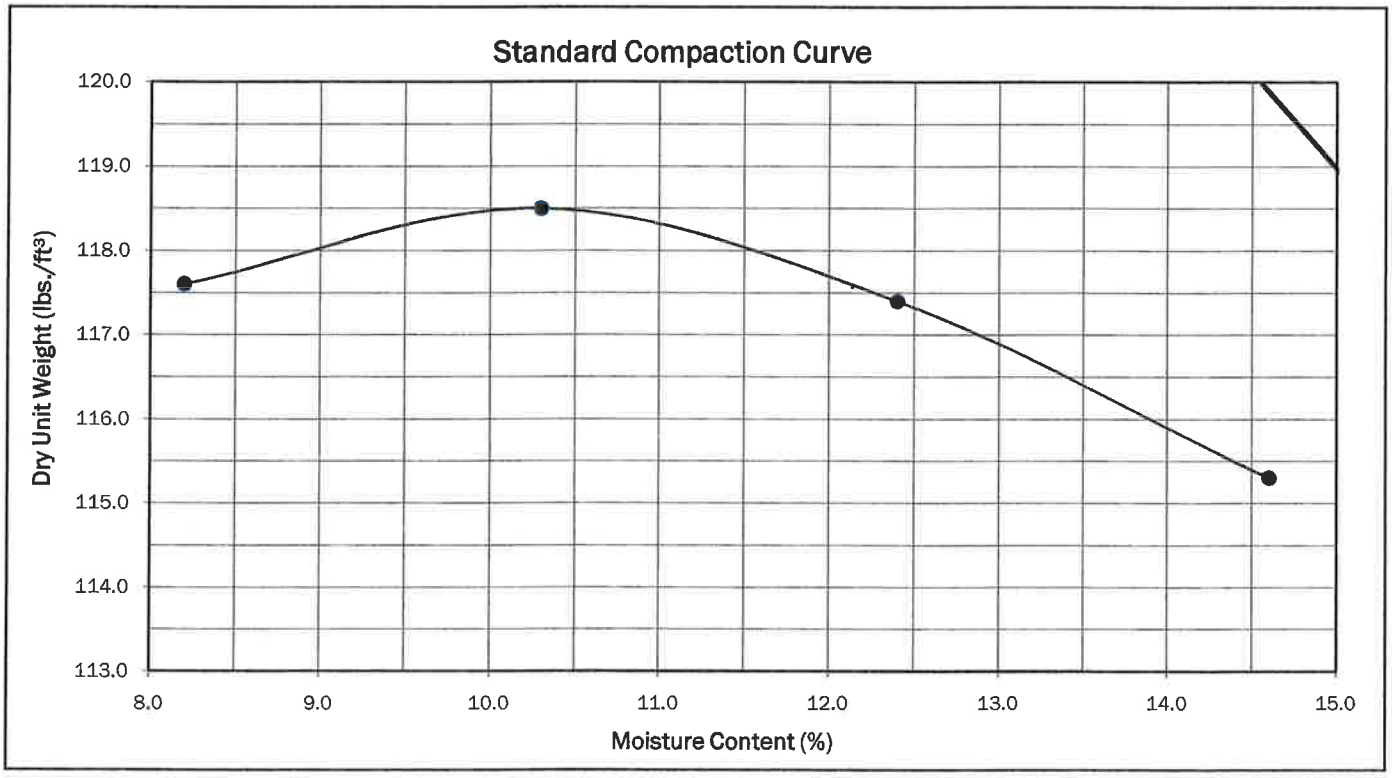
Laboratory Compaction Characteristics Using Standard Effort

Per ASTM Designation D 698 - 07, Method C ~ AASHTO Designation T 99 - 01, Method D

Date:	April 26, 2011		**Project :**	Takoma Park - Water and Sewer Rehabilitation	
Client:	Buchart Horn, Incorporated		**Advantage Project Number:**	110005601	
Sample Description:	Brown Clayey Sand		**Sample ID:**	B-1/B-3 (8' - 10')	
Rammer Used:	Manual	**Preparation Method:**	Moist	**As Received Moisture:**	

Test Data

	Point #1	Point #2	Point #3	Point #4
Wet Density (lbs./ft.³):	127.3	130.7	131.9	132.1
Moisture Content (%):	8.2	10.3	12.4	14.6
Dry Density (lbs./ft.³):	117.6	118.5	117.4	115.3



Maximum Dry Unit Weight:	**118.5 lbs./ft.³**	**Optimum Moisture Content:**	**10.3 %**

Reviewed by: _____

telecommunications | environmental | geotechnical

910 Century Drive, Mechanicsburg, Pennsylvania 17055
(717) 458-0800 (717) 458-0801(fax)

ADVANTAGE ENGINEERS

LABORATORY MOISTURE CONTENT DETERMINATION

Project Name: Takoma Park - Water and Sewer Main Rehabilitation

Client: Buchart Horn, Incorp.

Project No.: 110005601

Date: 4/18/2011

	Specimen 1	Specimen 2	Specimen 3	Specimen 4
Boring No.	B1	B1	B1	B-1
Sample No.	S-1	S-2	S-3	S-4
Depth (feet)	0'-2'	2'-4'	4'-6'	6'-8'
Tare Number	S	V	Z	K
Wt. Sample + Tare (wet) (grams)	248.91	228.79	202.76	259.13
Wt. Sample + Tare (dry) (grams)	230.50	195.03	184.02	224.46
Wt. Water (grams)	18.41	33.76	18.74	34.67
Wt. Tare (grams)	8.28	8.41	8.35	8.48
Wt. Dry Soil (grams)	222.22	186.62	175.67	215.98
% Moisture	8.3%	18.1%	10.7%	16.1%

ADVANTAGE ENGINEERS

LABORATORY MOISTURE CONTENT DETERMINATION

Project Name: Takoma Park - Water and Sewer Main Rehabilitation

Client: Buchart Horn, Incorp.

Project No.: 110005601

Date: 4/18/2011

	Specimen 5	Specimen 6	Specimen 7	Specimen 8
Boring No.	B1	B2	B2	B2
Sample No.	S-6	S-1	S-2	S-3
Depth (feet)	13.5'-15'	1'-3'	3'-5'	5'-7'
Tare Number	I	N	Y	S7
Wt. Sample + Tare (wet) (grams)	265.80	196.39	203.88	263.86
Wt. Sample + Tare (dry) (grams)	226.25	182.29	178.61	232.06
Wt. Water (grams)	39.55	14.10	25.27	31.80
Wt. Tare (grams)	8.26	8.31	8.33	9.28
Wt. Dry Soil (grams)	217.99	173.98	170.28	222.78
% Moisture	18.1%	8.1%	14.8%	14.3%

ADVANTAGE ENGINEERS

LABORATORY MOISTURE CONTENT DETERMINATION

Project Name: Takoma Park - Water and Sewer Main Rehabilitation

Client: Buchart Horn, Incorp.

Project No.: 110005601

Date: 4/18/2011

	Specimen 9	Specimen 10	Specimen 11	Specimen 12
Boring No.	B2	B2	B2	B3
Sample No.	S-4	S-5	S-6	S-1
Depth (feet)	7'-9'	9'-11'	13.5'-15'	1'-2'
Tare Number	M	O	G	S24
Wt. Sample + Tare (wet) (grams)	285.51	208.78	302.78	246.90
Wt. Sample + Tare (dry) (grams)	250.51	168.23	255.98	228.41
Wt. Water (grams)	35.00	40.55	46.80	18.49
Wt. Tare (grams)	8.35	8.29	8.34	9.16
Wt. Dry Soil (grams)	242.16	159.94	247.64	219.25
% Moisture	14.5%	25.4%	18.9%	8.4%

ADVANTAGE ENGINEERS

LABORATORY MOISTURE CONTENT DETERMINATION

Project Name: Takoma Park - Water and Sewer Main Rehabilitation

Client: Buchart Horn, Incorp.

Project No.: 110005601

Date: 4/18/2011

	Specimen 13	Specimen 14	Specimen 15	Specimen 16
Boring No.	B3	B3	B3	B3
Sample No.	S-2	S-3	S-4	S-6
Depth (feet)	2'-4'	4'-6'	6'-8'	13'-15'
Tare Number	S21	S22	S25	S9
Wt. Sample + Tare (wet) (grams)	287.24	296.84	249.86	272.56
Wt. Sample + Tare (dry) (grams)	274.68	273.70	223.68	230.51
Wt. Water (grams)	12.56	23.14	26.18	42.05
Wt. Tare (grams)	9.41	9.15	9.16	9.25
Wt. Dry Soil (grams)	265.27	264.55	214.52	221.26
% Moisture	4.7%	8.7%	12.2%	19.0%

ADVANTAGE ENGINEERS

LABORATORY MOISTURE CONTENT DETERMINATION

Project Name: Takoma Park - Water and Sewer Main Rehabilitation

Client: Buchart Horn, Incorp.

Project No.: 110005601

Date: 4/18/2011

	Specimen 17	Specimen 18	Specimen 19	Specimen 20
Boring No.	B4	B4	B4	B5
Sample No.	S-1	S-2	S-3	S-1
Depth (feet)	4'-6'	6'-8'	13'-15'	0'-2'
Tare Number	P	X	S23	J
Wt. Sample + Tare (wet) (grams)	251.83	308.26	233.80	237.22
Wt. Sample + Tare (dry) (grams)	220.76	269.35	196.54	202.80
Wt. Water (grams)	31.07	38.91	37.26	34.42
Wt. Tare (grams)	8.26	8.37	9.10	8.29
Wt. Dry Soil (grams)	212.50	260.98	187.44	194.51
% Moisture	14.6%	14.9%	19.9%	17.7%

ADVANTAGE ENGINEERS

LABORATORY MOISTURE CONTENT DETERMINATION

Project Name: Takoma Park - Water and Sewer Main Rehabilitation

Client: Buchart Horn, Incorp.

Project No.: 110005601

Date: 4/18/2011

	Specimen 21	Specimen 22	Specimen 23	Specimen 24
Boring No.	B5	B5	B5	B5
Sample No.	S-2	S-3	S-4	S-6
Depth (feet)	2'-4'	4'-6'	6'-8'	13'-15'
Tare Number	T	Q	R	W
Wt. Sample + Tare (wet) (grams)	312.74	206.74	237.52	220.89
Wt. Sample + Tare (dry) (grams)	270.72	172.61	205.66	190.59
Wt. Water (grams)	42.02	34.13	31.86	30.30
Wt. Tare (grams)	8.23	8.31	8.16	8.38
Wt. Dry Soil (grams)	262.49	164.30	197.50	182.21
% Moisture	16.0%	20.8%	16.1%	16.6%

Boring No.	Sample No.	Sample Depth (ft)	pH		Chloride Content (ppm)	Sulfate Content (ppm)	Minimum Resistivity (kohms x cm)	* Soil Classification
			in water	in CaCl solution				
B-5	S-1	10.0	5.1	4.4	No Testing Requested			lean clay with sand, cl/a-6
B-1/B-5	S-1	8.0 - 10.0	No Testing Requested				7.7	lean clay with sand, cl/a-6

* Uppercase denotes laboratory classification, lowercase denotes visual classification.

Project: Takoma Park - Water and Sewer Main Rehabilitation
Project #: 11001-16
Test Date: 04/20/11
Tested By: DFS/KJE
Checked By: dsr

GTS TECHNOLOGIES

CHEMICAL TESTING SUMMARY

pH - ASTM D 4972 Method A, Resistivity - AASHTO T288

4/20/2011

441 Friendship Road . Harrisburg, PA 17111 . Ph: 717/236-3006 . Fax: 717/233-0994 . www.gtstech.com

TEST BORING LOG

SHEET 1 OF 1

PROJECT NAME: Takoma Park - Water & Sewer Main Rehabilitation
PROJECT NUMBER: 110005601
CLIENT: Buchart Horn, Incorporated

LOCATION: See Test Boring Location Plan (110005601-A-100)

☐ FIELD SURVEYED ☐ TOPO ESTIMATE

BORING NO.: B-1

ELEV

GROUNDWATER DATA: Wet
Depth: ±13.0'
Time: Completion

DEPTH (feet)	SAMPLE NUMBER	SAMPLE DEPTH (ft)	BLOWS PER 6"	SOIL DESCRIPTION	REMARKS
				0.0' - 0.5' Asphalt and stone sub-base	**Pavement**
	S-1	0'-2'	34-9-5-3	0.5' - 15.0' Dense tan clayey sand	
	S-2	2'-4'	3-4-5-8	Stiff brown sandy clay; trace mottling	
5	S-3	4'-6'	8-8-10-13	Dense brown clayey sand; trace gravel	
	S-4	6'-8'	5-8-9-9		
10	S-5	8'-10'	5-7-8-8	No Recovery	
					H_2O @ 13.0'
15	S-6	13.5'-15'	2-3-3	Loose white to tan silty sand	**Stratum I**
				-End of Boring at 15.0 Feet-	
20					
25					

ADVANTAGE ENGINEERS

910 Century Drive, Mechanicsburg, PA 17055
(717) 458-0800 FAX: (717) 458-0801
www.advantageengineers.com

RIG TYPE: Truck Mounted CME-55

DRILLING METHOD: Hollow Stem Auger

ADVANTAGE REP.: K.Barnhart

DRAWN/COMPILED BY: K. Barnhart

DATE DRILLED: 4/13/11

TEST BORING LOG

SHEET 1 OF 1

PROJECT NAME: Takoma Park - Water & Sewer Main Rehabilitation
PROJECT NUMBER: 110005601
CLIENT: Buchart Horn, Incorporated

BORING NO.: B-2

LOCATION: See Test Boring Location Plan (110005601-A-100)

☐ FIELD SURVEYED ☐ TOPO ESTIMATE

ELEV

GROUNDWATER DATA: Wet
Depth: ±11.5'
Time: Completion

DEPTH (feet)	SAMPLE NUMBER	SAMPLE DEPTH (ft)	BLOWS PER 6"	SOIL DESCRIPTION	REMARKS
				0.0' - 1.0' Asphalt and stone sub-base	**Pavement**
				1.0' - 15.0'	
	S-1	1'-3'	4-6-6-8	Dense brown clayey sand; trace gravel	
5	S-2	3'-5'	4-6-6-7	Dense tan to brown clayey sand; trace gravel	
	S-3	5'-7'	3-4-5-7	Medium dense tan to brown clayey sand	
	S-4	7'-9'	3-4-5-4		
10	S-5	9'-11'	3-4-4-6	Medium dense tan to brown silty sand	H_2O @ 11.5'
15	S-6	13.5'-15'	5-13-18	Very dense tan to brown silty sand	**Stratum I**
				-End of Boring at 15.0 Feet-	
20					
25					

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RIG TYPE: Truck Mounted CME-55

DRILLING METHOD: Hollow Stem Auger

ADVANTAGE REP.: K.Barnhart

DRAWN/COMPILED BY: K. Barnhart

DATE DRILLED: 4/13/11

TEST BORING LOG

SHEET 1 OF 1

PROJECT NAME: Takoma Park - Water & Sewer Main Rehabilitation
PROJECT NUMBER: 110005601
CLIENT: Buchart Horn, Incorporated

BORING NO.: B-3

LOCATION: See Test Boring Location Plan (110005601-A-100)

[ ] FIELD SURVEYED [ ] TOPO ESTIMATE

ELEV

GROUNDWATER DATA: Wet
Depth: ±3.5'
Time: Completion

DEPTH (feet)	SAMPLE NUMBER	SAMPLE DEPTH (ft)	BLOWS PER 6"	SOIL DESCRIPTION		REMARKS
				0.0' - 0.9'	3.25" asphalt and 8" concrete	Pavement/Concrete
	S-1	1'-2'	6-7	0.9' - 15.0'	Dense white to tan clayey sand; little gravel	
	S-2	2'-4'	5-5-4-3		Medium dense white to tan clayey sand; little gravel	H_2O @ 3.5'
5						
	S-3	4'-6'	3-3-2-2			
	S-4	6'-8'	2-2-4-4			
10	S-5	8'-10'	5-6-5-4		No recovery	
15	S-6	13'-15'	5-8-13-15		Dense brown to white to green sitly sand	Stratum I
					-End of Boring at 15.0 Feet-	
20						
25						

ADVANTAGE ENGINEERS

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RIG TYPE: Truck Mounted CME-55

DRILLING METHOD: Hollow Stem Auger

ADVANTAGE REP.: K.Barnhart

DRAWN/COMPILED BY: K. Barnhart

DATE DRILLED: 4/13/11

TEST BORING LOG

SHEET 1 OF 1

PROJECT NAME: Takoma Park - Water & Sewer Main Rehabilitation
PROJECT NUMBER: 110005601
CLIENT: Buchart Horn, Incorporated

BORING NO.: B-4

LOCATION: See Test Boring Location Plan (110005601-A-100)

☐ FIELD SURVEYED ☐ TOPO ESTIMATE

ELEV

GROUNDWATER DATA: Wet
Depth: ±7.0'
Time: Completion

DEPTH (feet)	SAMPLE NUMBER	SAMPLE DEPTH (ft)	BLOWS PER 6"	SOIL DESCRIPTION	REMARKS
				0.0' - 0.9' 3.25" asphalt and 7" concrete	Pavement/Concrete
				0.9' - 15.0'	
5				-Augered to 4 feet due to issues with the existing concrete-	
	S-1	4'-6'	16-8-7-11	Dense tan to brown clayey sand	
	S-2	6'-8'	2-3-2-3	Medium dense brown silty sand	H_2O @ 7.0'
10	S-3	8'-10'	2-3-2-4	No recovery	
15	S-4	13'-15'	1-2-4-5	Loose brown silty sand	Stratum I
				-End of Boring at 15.0 Feet-	
20					
25					

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www.advantageengineers.com

RIG TYPE: Truck Mounted CME-55

DRILLING METHOD: Hollow Stem Auger

ADVANTAGE REP.: K.Barnhart

DRAWN/COMPILED BY: K. Barnhart

DATE DRILLED: 4/13/11

TEST BORING LOG

SHEET 1 OF 1

PROJECT NAME: Takoma Park - Water & Sewer Main Rehabilitation
PROJECT NUMBER: 110005601
CLIENT: Buchart Horn, Incorporated

LOCATION: See Test Boring Location Plan (110005601-A-100)

FIELD SURVEYED ☐ TOPO ESTIMATE ☐

BORING NO.: B-5

ELEV

GROUNDWATER DATA: Dry
Depth: Not Encounterd
Time: Completion

DEPTH (feet)	SAMPLE NUMBER	SAMPLE DEPTH (ft)	BLOWS PER 6"	SOIL DESCRIPTION	REMARKS
				0.0' - 0.3' Dark brown sandy clay with organic debris	**Topsoil**
	S-1	0'-2'	1-1-2-2	0.3' - 15.0' Medium dense tan to brown clayey sand	
	S-2	2'-4'	1-1-2-2	Loose brown clayey sand	
5					
	S-3	4'-6'	1-1-2-3		
	S-4	6'-8'	5-7-11-11	Very stiff brown sandy clay	
10	S-5	8'-10'	5-6-13-8	Dense brown clayey sand	
15	S-6	13.5'-15'	2-2-4	Loose white to tan silty sand	**Stratum I**
				-End of Boring at 15.0 Feet-	
20					
25					

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DATE DRILLED: 4/13/11