DEPARTMENT OF **ENERGY & ENVIRONMENT**

Ft Greble Recreation Center

Project Area Assessment Report, July 2019

DPR II – Design and Build 4 LID Sites

Contract Number CW712222

Prepared By

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DEPARTMENT OF ENERGY & ENVIRONMENT

Natural Resources Design

an ecologically focused design firm

Washington DC

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1. EXECUTIVE SUMMARY

This assessment report identifies existing site conditions that could influence the selected Best Management Practice (BMP) designs. There are several factors noted that could have a significant impact upon the original designs anticipated for this location.

The project site area consists of an L-shaped turf area located outside the fencing at the northern corner of the existing baseball field and adjacent to Leckie Elementary school. Proposed improvements consist of two bioretention basins and/or water quality swales to treat and convey runoff from a portion of the baseball field and overflow from the Leckie Elementary site.

During the field assessment, existing drainage issues (ponding) was noted at the school site. Based upon the site survey, it appears feasible to capture and incorporate runoff from this low area of the school site into the proposed BMP design. This approach will provide a larger stormwater benefit while eliminating a site nuisance at the school

2. PROJECT OVERVIEW

This site is part of a DC Department of Energy & Environment (DOEE) funded stormwater management & nutrient reduction project that includes four park sites within the District of Columbia.

The Fort Greble Recreation site is located in southwest DC along Chesapeake Street SW (Figure 1). The recreation center consists of a playground and splash park, community center, and a baseball field.

The area involved with this project is an existing turf area is along the northern side of the site, and is bounded by the baseball fencing, Lechie Elementary school and Chesapeake Street SW (Figure 2).

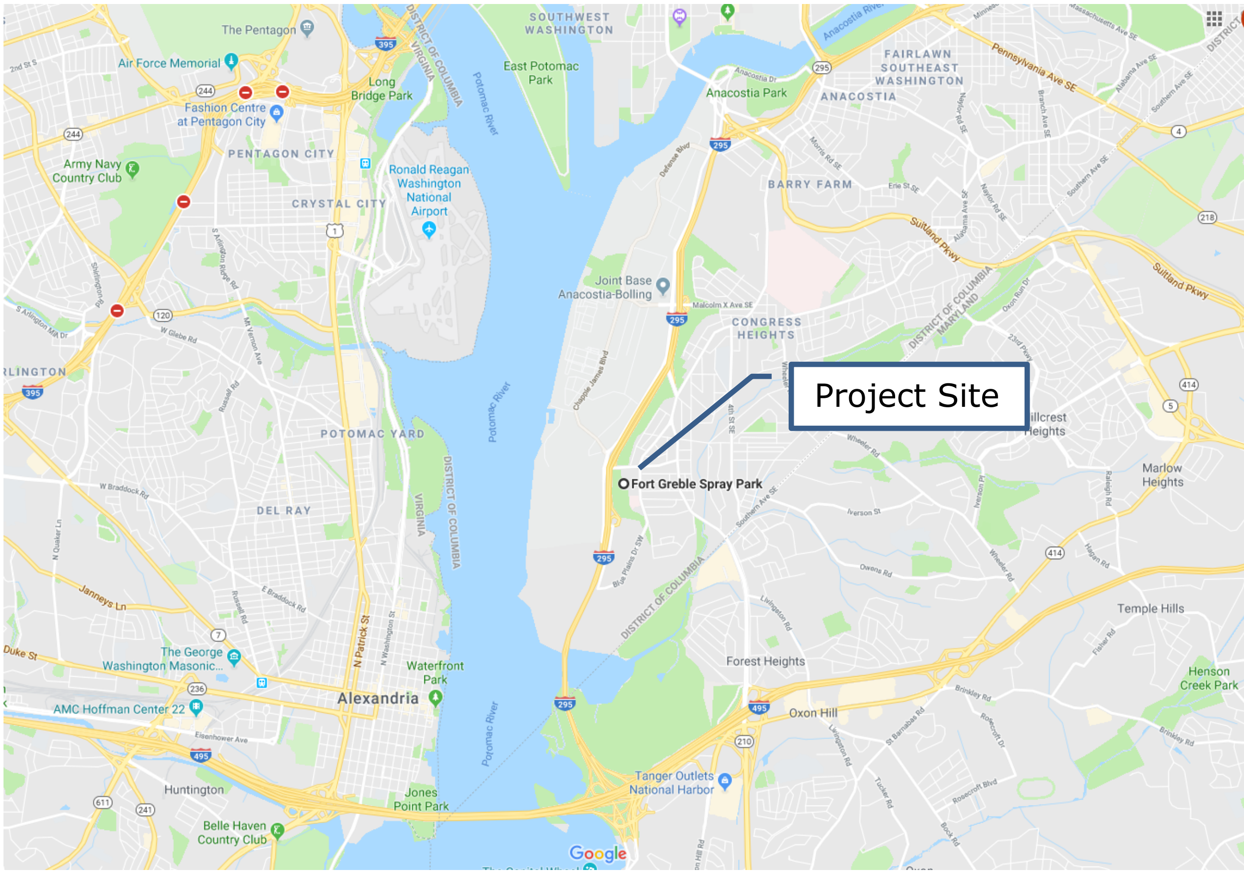


Figure 1- Vicinity Map *© Google 2019*

Figure 2: Project Site as provided in DPRII RFP

General objectives for this project are to design and construct stormwater improvements to reduce stormwater nutrients and volumes from the impervious areas of this site and to protect trees and soils from erosion.

Specific objectives identified in the RFP for this site include:

1. Installation of a water quality swale on the hillside adjacent to Chesapeake Street SW at the existing outfall.
2. Installation of a water quality swale in the NE corner of the site adjacent to the athletic field and Leckie Elementary School.

The purpose of this **Current Project Area Assessment Detailed Report** is to compile existing site information that may impact stormwater design approaches and scope for this property. Based upon this site data, various stormwater management (SWM) opportunities, limitations and maintenance considerations are presented. This assessment includes work described within the project proposal and contract as well as other opportunities that became apparent during the site evaluation process.

3. EXISTING SITE CONDITIONS

The site information included within this assessment is compiled from several sources of information, including:

- Topographic site survey (Appendix A)
- Geotechnical Evaluation (Appendix B)
- GIS data
- Site visits and observations
- Record Drawings

In areas where discrepancies are identified, field data is given preference over general site data or historical documents, with the nature and significance of the discrepancies noted.

3.1 Topographical Survey

A topographical field survey of the anticipated BMP area was prepared by Sustainable Land Surveys, LLC of Washington, DC. A copy of this survey is included as Appendix – A. Topography of the project area is fairly flat (2% - 5% slopes), with a 16% sloping bank from the project area down to Chesapeake St. SW. **3.2 Site Utilities**

Existing site utilities are minimal within the anticipated project area. There is a waterline supplying an existing (non-functional) water fountain and a short stormwater culvert in the area. There are signs of an irrigation system, but this does not appear to be located in the site area. Gas and electric distribution lines are located under the sidewalk along the street.

3.3 Soil & Vegetation Conditions

<u>Soil Mapping</u>: Based upon the USDA Websoil Survey (included as part of the geotechnical evaluation report), soils across the site consist of various loams. There are no significant restrictive layers (groundwater, bedrock, dense clays) noted, and soils are generally well drained.

<u>Geotechnical Evaluation</u>: A field evaluation of existing soil conditions at the site was performed by Natural Resources Design on July 18, 2019. This report is included as Appendix – B. Two soil borings and infiltration tests were performed at the site, one adjacent to the existing culvert outfall, and one in the space between the baseball field and the school. Due to dense cobbles in the soil, both borings were terminated at a depth of 36".

Infiltration Testing: Soil infiltration test was performed at the two boring locations, in conformance with Appendix "O" of the DOEE Stormwater Management requirements. This test was performed with a fixed-head permeameter at a depth of 36". The measured infiltration rate at the boring near the culvert outfall was moderate (0.7 inches per hour). The boring between the school and the baseball field had no measurable infiltration. As noted in the soil report, this area of the site was recently used as a construction access and staging area during construction of an elevator at Leckie Elementary School and could be compacted as a result.

Soil Erosion: No significant areas of soil erosion were noted at this site.

Existing Vegetation: Vegetation at this site consists primarily of managed turf in good condition. There is a strip of invasive plants between the project area and the school.

4. EXISTING STORMWATER MANAGEMENT

The project site receives stormwater runoff from the adjacent baseball field (managed turf), as well as from Leckie Elementary, as described below.

Surface Cover: The approximate baseball field area draining to the project site is 10,000 sf managed turf and 350 sf impervious. Drainage from Leckie Elementary school includes roughly 7,000 sf impervious area and 3,000 sf managed turf.

Drainage Patterns: An existing grass swale runs along the fencing to the baseball field, passing under the corner of the fence, then out to an outfall at the top of a grass bank above Chesapeake Street SW. This swale captures some runoff from Leckie Elementary as well as the majority of the baseball field area. During site reconnaissance, it was noted that the lower paved area of the school yard adjacent to the project site ponds stormwater. This area receives runoff from adjacent roof drains and surface runoff from sidewalks and a playground area. With no drainage structure at this location, significant ponding occurs in this area of the site.

5. STORMWATER MANAGEMENT OPPORTUNITIES

During the preliminary assessment of this site it was determined that addressing the stormwater ponding issues at Leckie Elementary should be considered as an objective for this project. Given this, SWM opportunities identified include:

Bioretention Basin 1 – A bioretention basin could be implemented at the upper portion of the existing grass swale to capture and treat runoff form the adjacent school. A shallow drainage system (trench drain or similar approach) will be required to effectively capture and convey stormwater from the school site to this BMP.

Dry Swale or Grass Swale – The existing grass swale could be converted to a dry swale or reconfigured to provide better treatment as a grass swale (with the addition of check dams and regrading).

Bioretention Basin 2 – A second bioretention basin could be constructed in the area near the existing culvert outfall at the top of the hill. This basin would form a treatment train with Basin 1 and/or the swale improvements, which would reduce the required basin sizing or allow for treatment of a larger design storm.

<u>Stormwater Quality Volumes</u>:

Based upon the site survey and proposed site improvements, NRD has delineated the anticipated drainage areas to the proposed bioretention basins to calculate the required Stormwater Retention Volume (SWRv). Following the 30% submittal, NRD will conduct a detailed hydrologic analysis to determine the adequate sizing of the selected BMPs and associated flow control structures.

The required SWRv for the proposed BMPs were calculated in accordance with the DOEE Stormwater Management Guidebook (July 2013). Based upon the project location, this proposed retrofit project uses a 1.2-inch design storm for calculating the SWRv, using Equation 2.1 from the guidebook. Table 1 below shows the drainage area characteristics and SWRv.

Table 1: SWRv Calculations

		Contributing Drainage Area (CDA)					Stormwater Retention Volume
		Paved	Compacted	Natural	Total	P	(SWRv)
CDA	Description	Sf	sf	sf	sf	in	cf
1	Bioretention Basin 1	7,000	3,000	0	10,000	1.2	740
2	Dry Swale or Grass Swale	7,300	4,000	0	11,300	1.2	794
3	Bioretention Basin 2	7,300	14,000	0	21,300	1.2	1,044

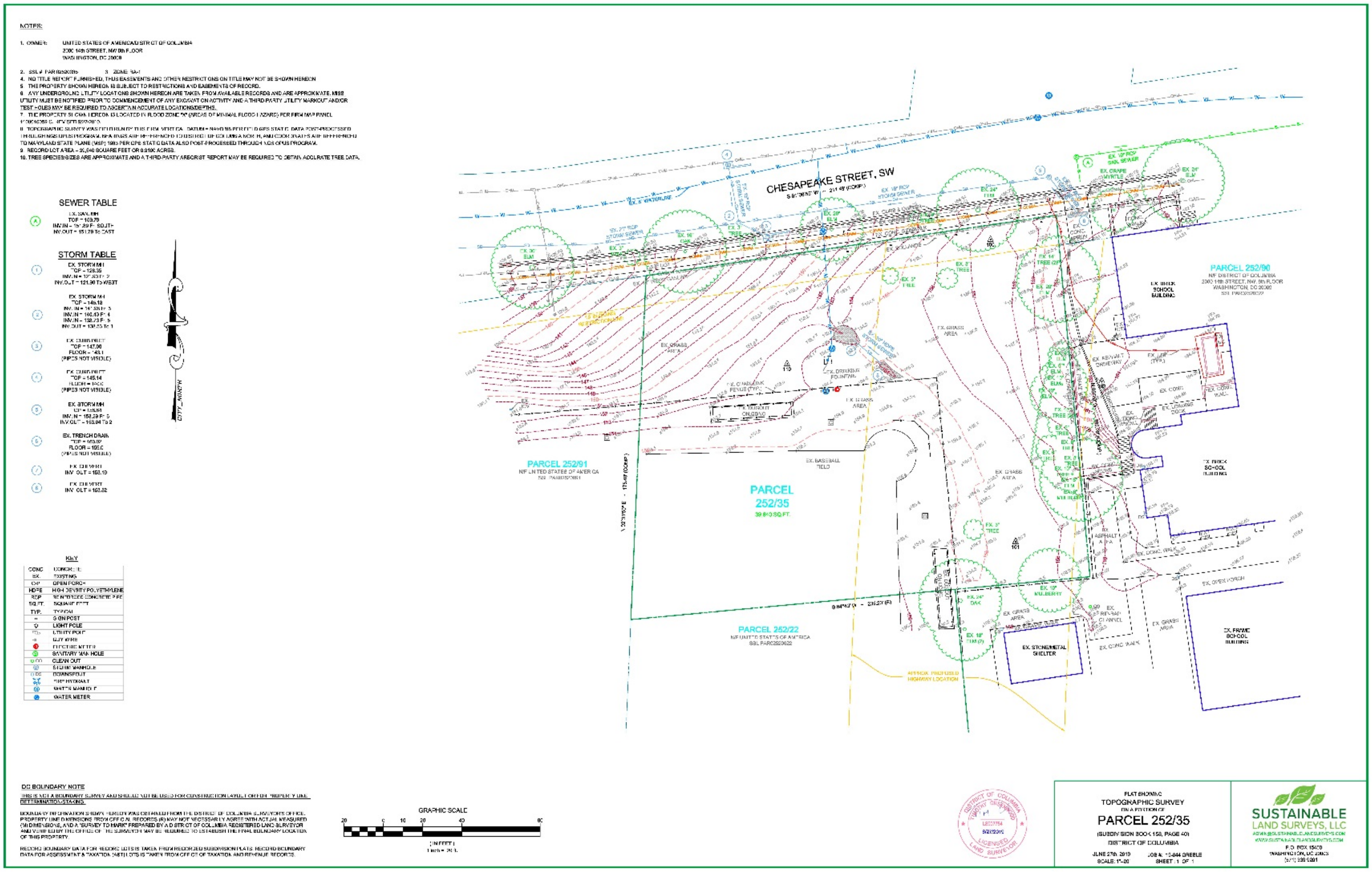
6. CONCLUSIONS

Development of suitable BMPs at the Fort Greble Recreation Center site will include the capture and management of impervious area runoff from the adjacent Leckie Elementary school site. Soils in the project area are suitable for construction of infiltration based BMPs that incorporate underdrain system.

Additional features planned for this project include the addition of multiple trees to create a grove and potential educational area that would benefit the school and general public.

7. APPENDICES

Appendix A: Survey



Appendix B: Geotechnical Report

Report of
Subsurface Exploration, Soil Testing, and
Geotechnical Engineering Evaluation

Fort Greble Recreation Center
Martin Luther King Jr Ave. SW & Elmira St. SW
Washington DC

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July 19, 2019

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1. INTRODUCTION

1.1 Project Information

This site is part of a DC Department of Energy & Environment (DOEE) funded stormwater management & nutrient reduction project that includes four park sites within the District of Columbia. The Fort Stevens Recreation Center consists of basketball courts, a playground and splash park, community center, community garden and a baseball field. The specific project area is located north and east of the baseball field, bordered by the fence, Leckie Elementary School and Chesapeake Street SW.

It has been noted that the soils situated between the baseball fence and Leckie Elementary School may have been compacted and/or disturbed during recent construction at the school (within the past 9 months), since this area was used for a stone construction entrance and material laydown area.

Project objectives are to design and construct stormwater improvements to reduce stormwater nutrients and volumes flowing onto this area of the site from adjacent properties. The purpose of this geotechnical evaluation is to provide site soils information for use as part of the Best Management Practice (BMP) stormwater design process.

1.2 Scope of Services

The purposes of our involvement on this project were as follows: 1) provide general descriptions of the subsurface soil conditions encountered at the boring location, 2) identify subsurface water levels (if any), and 3) provide geotechnical parameters and recommendations for stormwater infiltration and general construction. To accomplish the above objectives, we undertook the following scope of services:

1. Visited the site to observe existing surface conditions and features;
2. Coordinated with Miss Utility services for utility clearance;
3. Reviewed readily available geologic and subsurface information relative to the project site;
4. Executed a geotechnical subsurface exploration program consisting of two (2) hand-augered borings drilled to the depths indicated in the Boring Logs shown in Appendix B.
5. Performed two (2) field infiltration tests in general accordance with Appendix O of the DC Stormwater Management Handbook to determine approximate rates of infiltration;
6. Performed field testing on recovered soil samples to ascertain characteristic soil properties;
7. Prepared this written report summarizing our geotechnical engineering work on the project, providing descriptions of the subsurface conditions encountered, and discussing geotechnical related aspects of the proposed construction.

Our geotechnical scope of services did not include foundation or pavement design or recommendations, a survey of boring locations and elevations, quantity estimates, preparation of plans or specifications, or the identification and evaluation of wetland and/or other environmental aspects of the project site.

2 SUBSURFACE EXPLORATION PROCEDURES

Our geotechnical subsurface exploration program consisted of two (2) test borings designated B-1 and B-2.

The exploration was performed on July 18, 2019 at the approximate locations shown on the attached Boring Location Plan (Drawing No. 2, Appendix B). In consideration of the methods used in their determination, the boring locations shown on the attached Boring Location Plan should be considered approximate. The test borings were performed using a hand auger with a 3-1/4" diameter chuck. The soils at B-1 location were very rocky, requiring a vacuum auger to achieve the desired depths.

Boring B-1 was located below an existing culvert discharge area. This boring was advanced to a depth of 36 inches through densely rocky soils. No indications of seasonally high groundwater were observed, and soils appeared well drained. A screening infiltration test was performed in this boring to determine the general suitability for locating an infiltration practice.

Boring B-2 was performed in the space between Leckie Elementary and the baseball field fencing, to a depth of 36 inches below existing grade. No indications of seasonally high groundwater were observed. The boring was terminated due to the presence of cobbles, and a screening infiltration test was performed in this bore hole.

Upon completion of the field testing, all boreholes were backfilled.

Representative soil samples were visually classified on the basis of texture and plasticity in general accordance with the Unified Soil Classification System (USCS) (ASTM D2487) and/or the Visual-Manual Procedure (ASTM D 2488). The group symbol for each soil type, based on the USCS, is indicated in the parentheses following the soil description on the boring logs. The engineer grouped the various soil types into zones noted on the boring log. The stratification lines designating the interfaces between earth materials on the boring log are approximate; in situ, the transitions may be gradual. Copies of our boring logs (soil profiles) and classification procedures are provided in Appendix B.

3 SITE AND SUBSURFACE CONDITIONS

3.1 Site Description

The two site areas evaluated consisted of managed turf areas located adjacent to the grass swale that conveys surface runoff along the side of the baseball field fencing, discharging near the top of the grass slope above Chesapeake Street SW. Ground slopes were approximately 5% at B-1 location, and less than 2% at B-2.

3.2 Regional Geology

Based upon the USGS soils mapping for the project site, the underlying site soils consist in the areas of exploration included:

Chillum-Urban land complex (B-1) – This soil complex consists of 40% Urban land, 20% Chillum soil, and 40% minor components. Chillum is a mixture of silty and gravelly loams with moderately high to high Ksat values (0.20 – 1.98 inches/hour). Hydrologic Soil Group C.

Udorthents, gravelly, smoothed (B-2) – a gravelly loam soil with moderately low to high Ksat values (0.06 to 5.95 inches/hour). Hydrologic Group A.

The Websoil Survey report for the project site is attached as Appendix C.

3.3 General

The subsurface conditions discussed in the following paragraphs and those shown on the attached boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Transitions between different soil strata are usually less distinct than those shown on the boring logs. Sometimes the relatively small sample obtained in the field is insufficient to definitely describe the origin of the subsurface material. In these cases, we qualify our origin descriptions with "possible" before the word describing the material's origin (i.e. possible fill, possible residuum, etc.). Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times. Data from the specific test borings are shown on the attached boring logs in AppendixB.

Fill/Possible Fill Soils

Fill/Possible Fill may be any material that has been transported and deposited by man. There were no fill/possible fill soils identified in this evaluation.

4 SOIL INFILTRATION

4.1 Methodology

Infiltration testing was performed at both boring locations in accordance with the requirement of Appendix O – Geotechnical Information Requirements for Underground BMPs, Section O.3.

Infiltration testing equipment consisted of a constant head permeameter.
Both test holes were prepared by hand augering an 8.3 cm diameter bore hole to a depth of 36".

Infiltration testing was performed until a constant rate of water drop in the device was achieved. Field saturated hydraulic conductivity (Kfs) rates were calculated using the appropriate soil texture chart ("*Most structured soils from clays through loams; Also includes unstructured medium and fine sands"*).

Hydraulic conductivity rates are converted to percolation time using an appropriate conversion factor, as shown in Appendix D.

4.2 Field Infiltration Testing

The results of the infiltration field test are included in the table below.

Test Location	**Depth (feet)**	**Field Hydraulic Conductivity**	**Average Rate of Infiltration**
B-1	3.0	0.7	inches/hr
B-2	3.0	None	

5 RECOMMENDATIONS

The infiltration test results for location B-1 are within the typical range for the soils encountered. Results for location B-2 (no infiltration) are significantly lower than anticipated for the soil type. This may be due to soil compaction and disturbance in this area during recent construction activities.

Based upon the observed site conditions, it is noted that any subsurface infiltration features utilized on this project ***will*** need to incorporate an underdrain.

6 LIMITATIONS

This report has been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made. Our findings and considerations are based on site observations. The findings and considerations do not reflect variations in subsurface conditions which could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to re-evaluate our recommendations based upon on-site observations of the conditions.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at theboring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should evaluate earthwork and any pavement construction to verify that the conditions anticipated in design actually exist. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, orrecommendations

APPENDIX A

FIGURE 1 – VICINITY MAP

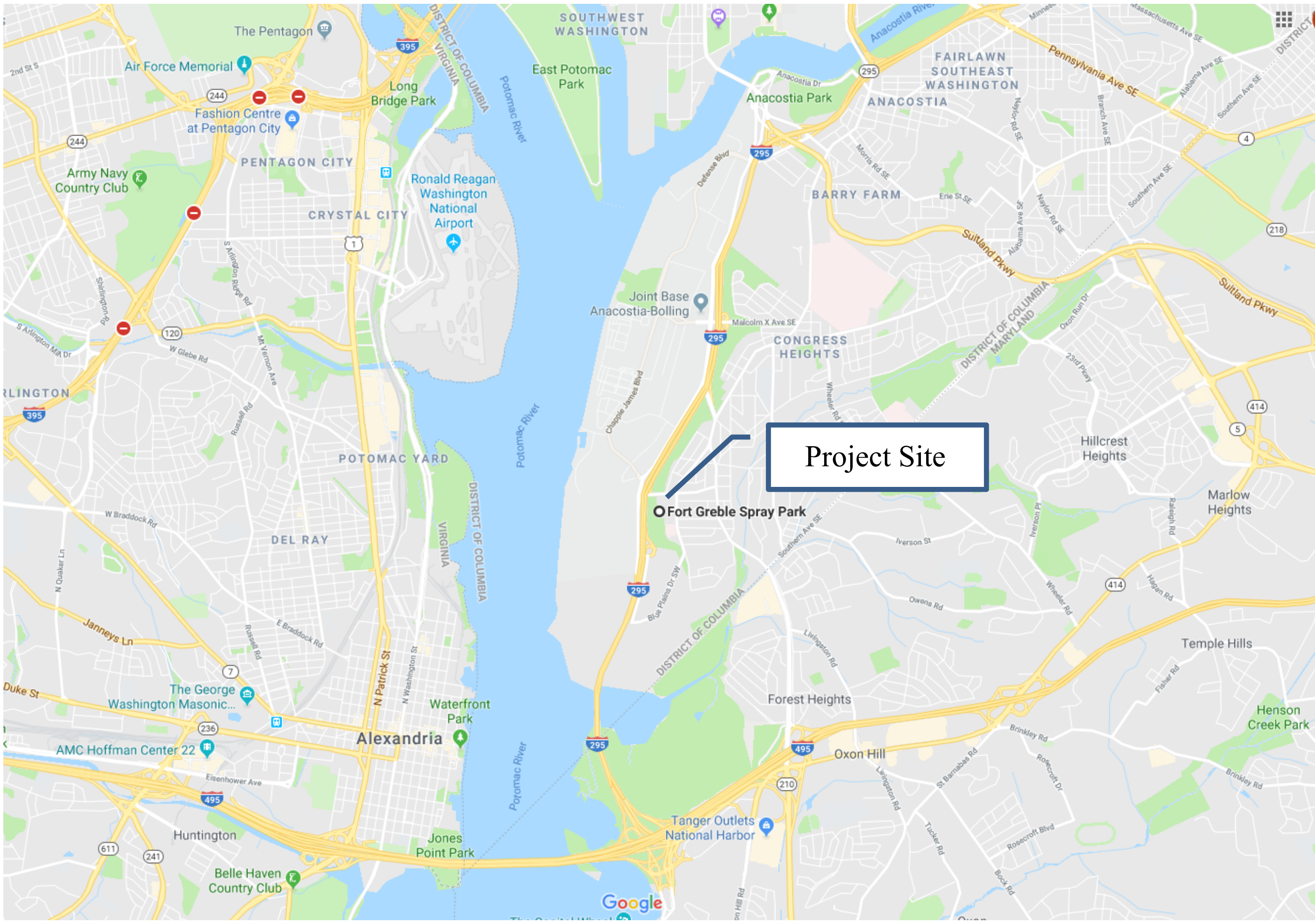

Figure 1 - Vicinity Map *2019©Google*

APPENDIX B

SOILS BORING INFORMATION

Figure 2- Boring Location Map

Project:	Project Number:	Client:	Date:
Fort Greble	193003	NRD	7/18/2019

Address, City, State	Elevation:	Total Depth of Boring:
MLK Jr. Ave SW & Chesapeake St SW		36"

Logged By:	Bit Type:	Diameter:
C. Sonne	Hand Auger	3.25"
Boring No.	**Groundwater Depth:**	
B-1	None Encountered	

Depth (feet)	Sample Type	Sample Number	Graphic Log	DESCRIPTION
0.33				Topsoil
0.83	☒	1		Clay
				Silty Clay Loam
	☒	2		*large gravel & very dense cobbles*
3				Boring Terminated (36")
5				
8				
10				

Natural Resources Design, LLC

Boring Log: Sheet 1 of 1

☒ Bulk/ Bag Sample

▼ Stabllized Ground water

▽ Groundwater At time of Drilling

Project: Fort Greble	Project Number: 193003	Client: NRD	Date: 7/18/2019
Address, City, State: MLK Jr. Ave SW & Chesapeake St SW		Elevation:	Total Depth of Boring: 36"
Logged By: C. Sonne		Bit Type: Hand Auger	Diameter: 3.25"
Boring No. B-2		Groundwater Depth: None Encountered	

Depth (feet)	Sample Type	Sample Number	Graphic Log	DESCRIPTION
0.33				Topsoil
	☒	1		Sandy Loam
1.5				
				Clay
	☒	2		
2.7				Sandy Clay Loam
3	☒	3		Boring Terminated (36")
5				
8				
10				

Natural Resources Design, LLC

Boring Log: Sheet 1 of 1

☒ Bulk/ Bag Sample

Stabllized Ground water

Groundwater At time of Drilling

APPENDIX C

WEBSOIL SURVEY REPORT

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

District of Columbia

May 31, 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.

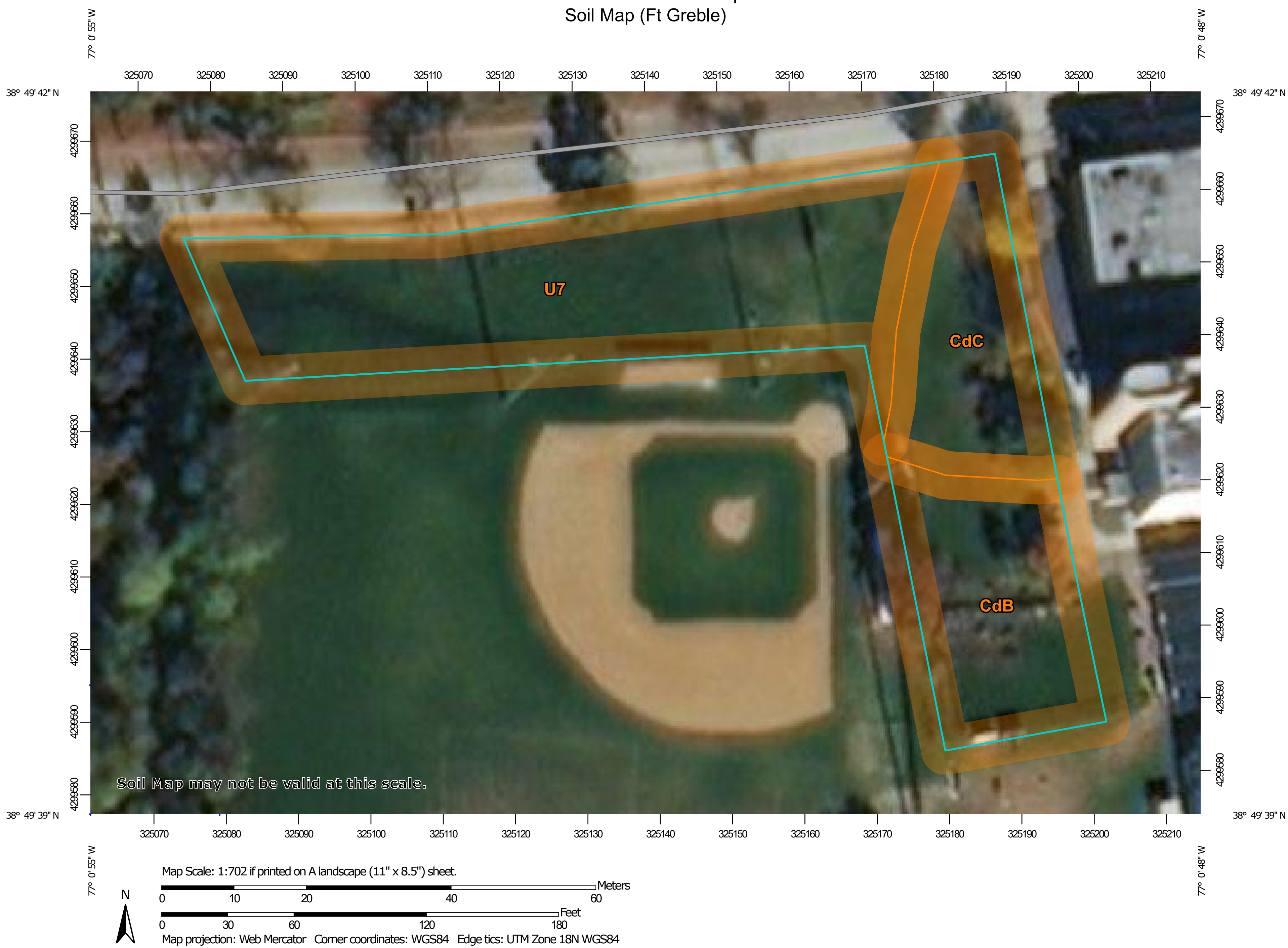
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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.

Soil Map (Ft Greble)



Map Scale: 1:702 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 10, 20, 40, 60

Feet: 0, 30, 60, 120, 180

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 1:12,000.

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: District of Columbia
Survey Area Data: Version 12, Sep 10, 2018

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

Date(s) aerial images were photographed: May 3, 2015—Feb 22, 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 (Ft Greble)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CdB	Chillum-Urban land complex, 0 to 8 percent slopes	0.2	23.0%
CdC	Chillum-Urban land complex, 8 to 15 percent slopes	0.2	20.3%
U7	Udorthents, gravelly, smoothed	0.5	56.7%
Totals for Area of Interest		**0.9**	**100.0%**

Map Unit Descriptions (Ft Greble)

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.

District of Columbia

CdB—Chillum-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 49sq
Elevation: 20 to 650 feet
Mean annual precipitation: 30 to 55 inches
Mean annual air temperature: 45 to 61 degrees F
Frost-free period: 160 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 40 percent
Chillum and similar soils: 40 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 10 inches to
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: No

Description of Chillum

Typical profile

A - 0 to 2 inches: silt loam
E - 2 to 9 inches: gravelly loam
Bt1 - 9 to 12 inches: gravelly loam
Bt2 - 12 to 24 inches: clay loam
2BC - 24 to 34 inches: loamy sand
3C - 34 to 72 inches: gravelly silty clay loam

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

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

Minor Components

Beltsville

Percent of map unit: 5 percent
Hydric soil rating: No

Croom

Percent of map unit: 5 percent
Hydric soil rating: No

Sassafras

Percent of map unit: 5 percent
Hydric soil rating: No

Bourne

Percent of map unit: 5 percent
Hydric soil rating: No

CdC—Chillum-Urban land complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 49sr
Elevation: 20 to 370 feet
Mean annual precipitation: 30 to 55 inches
Mean annual air temperature: 45 to 61 degrees F
Frost-free period: 160 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Chillum and similar soils: 40 percent
Urban land: 40 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chillum

Typical profile

A - 0 to 2 inches: silt loam
E - 2 to 9 inches: gravelly loam
Bt1 - 9 to 12 inches: gravelly loam
Bt2 - 12 to 24 inches: clay loam
2BC - 24 to 34 inches: loamy sand
3C - 34 to 72 inches: gravelly silty clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

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

Description of Urban Land

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 10 inches to
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: No

Minor Components

Bourne

Percent of map unit: 5 percent
Hydric soil rating: No

Croom

Percent of map unit: 5 percent
Hydric soil rating: No

Sassafras

Percent of map unit: 5 percent
Hydric soil rating: No

Unnamed soils

Percent of map unit: 5 percent
Hydric soil rating: No

U7—Udorthents, gravelly, smoothed

Map Unit Setting

National map unit symbol: 49wl
Mean annual precipitation: 38 to 44 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 150 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Typical profile

H1 - 0 to 5 inches: gravelly loam
H2 - 5 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 10 inches to
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 5.95 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 1.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: A
Hydric soil rating: No

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APPENDIX D

Infiltration Testing Calculations

Project: Fort Greble – Boring B-1

Performed By: C. Sonne **Date:** 7/18/2019

Weather Conditions: Partly Cloudy, 95 degrees

Rainfall in Past 48 Hr.? 0 in.

Time	Duration (min)	Elevation (cm)	Elev. Change (cm)	Rate of Drop (cm/min)
10:00 am		84.8		
	25		0.93	0.037
10:25		85.7		
	5		0.14	0.027
10:30		85.8		
	15		0.45	0.03
10:45		86.3		
	15		0.45	0.03
11:00		86.7		

STABILIZED RATE: 0.03 cm/min

Project: Fort Greble – Boring B-2

Performed By: C. Sonne **Date:** 7/18/2019

Weather Conditions: Partly Cloudy, 95 degrees

Rainfall in Past 48 Hr.? 0 in.

Time	Duration (min)	Elevation (cm)	Elev. Change (cm)	Rate of Drop (cm/min)
12:15 pm		66.7		
	15		0	0
12:30		66.7		
	15		0	0
12:45		66.7		
	15		0	0
1:00		66.7		
	15		0	0
1:15		66.7		

STABILIZED RATE: None

Natural Resources Design

an ecologically focused design firm
Washington DC

Boring B-1

CONSTANT HEAD WELL PERMEAMETER
SINGLE PONDED HEIGHT METHOD

Most structured soils from clays through loams;
Also includes unstructured medium and fine sands.
The first choice for most soils.

d - well hole diameter (cm)	8.3	**a* - sat/unsatflow ratio (cm-1)**	0.12
H - height of water in well (cm)	15.0	**C - shape factor**	1.36

R(cm/min)	Kfs (m/sec)	R(cm/min)	Kfs (m/sec)	R(cm/min)	Kfs (m/sec)
0.01	**5.3E-08**	2.7	1.4E-05	21.0	1.1E-04
0.02	**1.1E-07**	2.8	1.5E-05	22.0	1.2E-04
0.03	**1.6E-07**	2.9	1.5E-05	23.0	1.2E-04
0.04	**2.1E-07**	3.0	1.6E-05	24.0	1.3E-04
0.05	**2.7E-07**	3.1	1.6E-05	25.0	1.3E-04
0.06	**3.2E-07**	3.2	1.7E-05	26.0	1.4E-04
0.07	**3.7E-07**	3.3	1.8E-05	27.0	1.4E-04
0.08	**4.3E-07**	3.4	1.8E-05	28.0	1.5E-04
0.09	**4.8E-07**	3.5	1.9E-05	29.0	1.5E-04
0.10	**5.3E-07**	3.6	1.9E-05	30.0	1.6E-04
0.15	**8.0E-07**	3.7	2.0E-05	31.0	1.6E-04
0.20	**1.1E-06**	3.8	2.0E-05	32.0	1.7E-04
0.25	**1.3E-06**	3.9	2.1E-05	33.0	1.8E-04
0.30	**1.6E-06**	4.0	2.1E-05	34.0	1.8E-04
0.35	**1.9E-06**	4.1	2.2E-05	35.0	1.9E-04
0.40	**2.1E-06**	4.2	2.2E-05	36.0	1.9E-04
0.45	**2.4E-06**	4.3	2.3E-05	37.0	2.0E-04
0.50	**2.7E-06**	4.4	2.3E-05	38.0	2.0E-04
0.55	**2.9E-06**	4.5	2.4E-05	39.0	2.1E-04
0.60	**3.2E-06**	4.6	2.4E-05	40.0	2.1E-04
0.65	**3.5E-06**	4.7	2.5E-05	41.0	2.2E-04
0.70	**3.7E-06**	4.8	2.6E-05	42.0	2.2E-04
0.75	**4.0E-06**	4.9	2.6E-05	43.0	2.3E-04
0.80	**4.3E-06**	5.0	2.7E-05	44.0	2.3E-04
0.85	**4.5E-06**	5.5	2.9E-05	45.0	2.4E-04
0.90	**4.8E-06**	6.0	3.2E-05	46.0	2.4E-04
0.95	**5.1E-06**	6.5	3.5E-05	47.0	2.5E-04
1.0	**5.3E-06**	7.0	3.7E-05	48.0	2.6E-04
1.1	**5.9E-06**	7.5	4.0E-05	49.0	2.6E-04
1.2	**6.4E-06**	8.0	4.3E-05	50.0	2.7E-04
1.3	**6.9E-06**	8.5	4.5E-05	52.0	2.SE-04
1.4	**7.5E-06**	9.0	4.8E-05	54.0	2.9E-04
1.5	**8.0E-06**	9.5	5.1E-05	56.0	3.0E-04
1.6	**8.5E-06**	10.0	5.3E-05	58.0	3.1E-04
1.7	**9.0E-06**	11.0	5.9E-05	60.0	3.2E-04
1.8	**9.6E-06**	12.0	6.4E-05	62.0	3.3E-04
1.9	**1.0E-05**	13.0	6.9E-05	64.0	3.4E-04
2.0	1.1E-05	14.0	7.5E-05	66.0	3.5E-04
2.1	**1.1E-05**	15.0	8.0E-05	68.0	3.6E-04
2.2	**1.2E-05**	16.0	8.5E-05	70.0	3.7E-04
2.3	**1.2E-05**	17.0	9.0E-05	72.0	3.8E-04
2.4	**1.3E-05**	18.0	9.6E-05	74.0	3.9E-04
2.5	**1.3E-05**	19.0	1.0E-04	76.0	4.0E-04
2.6	**1.4E-05**	20.0	1.1E-04	78.0	4.2E-04

R - quasi steady-state rate of fall **Kfs - field saturated hydraulic conductivity**

Perc Time (PT) = Kfs/m; m=conversion factor, based upon soil type (2.28E-07 for this soil type)

PT = 1.6E-07 / 2.28E-07; ***PT = 0.7 inches / hour measured***