



DEPARTMENT
OF **ENERGY &
ENVIRONMENT**

Natural
Resources
Design

an ecologically focused design firm
Washington DC

DEPARTMENT OF ENERGY & ENVIRONMENT

Ft Greble Recreation Center

Project Final Report, September 2020

DPR II – Design and Build 4 LID Sites

Contract Number CW712222

Prepared By

Natural Resources Design

Christopher Sonne, P.E., SITES AP

Barbara Neal, ISA #4283B, RCA#428

Lauren Wheeler, LEED AP, SITES AP

Sylvan Kaufman, PhD



TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1. Executive Summary	3
2. Project Overview	3
3. Existing Site Conditions	5
3.1 Topographical Survey	6
3.2 Site Utilities	6
3.3 Soil & Vegetation Conditions	6
4. Existing Stormwater Management	7
5. Stormwater Management Opportunities	7
6. Conclusions	12
7. BMP Scorecard	12
8. Appendices	13
Appendix A: Construction Plans	13
Appendix B: Geotechnical Report	14

1. EXECUTIVE SUMMARY

This report describes the existing site conditions that influenced the selected Best Management Practice (BMP) designs. There are several factors noted that have had a significant impact upon the original designs 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 a water quality swale 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) were noted at the school site. Modifications to the school site have been incorporated into the final design to eliminate the ponding concerns and increase the stormwater capture area for the project. This 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, Leckie Elementary school and Chesapeake Street SW (Figure 2).



Figure 1- Vicinity Map

© Google 2019



Figure 2: Project Site as provided in DPR II 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.

Specific objectives identified in the RFP for this site include:

- Installation of a water quality swale on the hillside adjacent to Chesapeake Street SW at the existing outfall.
- 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 Final Report is to present the stormwater management (SWM) opportunities selected to achieve the project objectives.

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. 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

Soil Mapping: 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.

Geotechnical Evaluation: 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 IMPROVEMENTS

In order to achieve the project objectives, the selected stormwater management improvements to be constructed at this site are as described below. A copy of these plans is included as Appendix A of this report.

Dry Swale – A dry swale (also called a bioretention swale) shall be used to capture, treat, and convey runoff from the project drainage area. In addition to capturing runoff from the

adjacent ball field and school yard, stormwater shall be piped into the swale from the existing and proposed trench drain structures. To allow for ease of access and maintenance, the swale has been divided into two sections, connected by a series of 8" PVC culverts. The overflow discharge from the swale is controlled by a concrete level spreader that will maintain a minimum 6" ponding depth in the swale and flow velocities below 2 feet per second in the grass level swale that conveys the excess runoff to the grass turf hillside below the project area.

Tree Planting – As a BMP, trees are an effective means to reduce urban runoff due to their ability to capture and utilize large amounts of stormwater. Additional benefits include reduction of heat island effect and improved site aesthetics. A total of 15 native species trees have been added to this site (1 small existing tree had to be removed to accommodate the proposed site improvements).

Stormwater Quality Volumes:

Based upon the site survey and proposed site improvements, NRD delineated the anticipated drainage areas to the proposed dry swale to calculate the required Stormwater Retention Volume (SWRv). A detailed hydrologic model was developed using HydroCAD runoff modelling software. This model was used to verify the ability of the system to convey a 15-year design storm with acceptable velocities and ponding depths.

The required SWRv for the proposed BMPs was calculated in accordance with the DOEE Stormwater Management Guidebook (January 2020). 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)				P	Stormwater Retention Volume (SWRv)
		Paved	Compacted	Natural	Total		
CDA	Description	Sf	sf	sf	sf	in	cf
1	Dry Swale or Grass Swale	7,300	4,000	0	11,300	1.2	794

6. MAINTENANCE REQUIREMENTS

As with any landscape-intensive site area, bioretention basins require regular maintenance to provide effective ongoing stormwater treatment while providing an aesthetically pleasing site impact.

Maintenance of bioretention areas should be integrated into routine landscape maintenance tasks. If landscaping contractors will be expected to perform maintenance, their contracts should contain specifics on unique bioretention landscaping needs, such as maintaining elevation differences needed for ponding, proper mulching, sediment and trash removal, and limited use of fertilizers and pesticides. A summary of common maintenance tasks and their frequency is provided in the following table:

Maintenance Tasks for Fort Greble Dry Swale

Frequency	Maintenance Tasks
Upon establishment	<ul style="list-style-type: none"> ▪ For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 0.5 inch of rainfall. Conduct any needed repairs or stabilization. ▪ Inspectors should look for bare or eroding areas in the CDA or around the bioretention area and make sure they are immediately stabilized with grass cover. ▪ One-time, spot fertilization may be needed for initial plantings. ▪ Watering is needed once a week during the first 2 months, and then as needed during first growing season (April through October), depending on rainfall. ▪ Remove and replace dead plants. Up to 10% of the plant stock may die off in the first year, so construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.
At least 4 times per year	<ul style="list-style-type: none"> ▪ Check inlet areas for accumulated grit, leaves, and debris that may block inflow. Remove these materials and dispose of as solid waste.
Twice during growing season	<ul style="list-style-type: none"> ▪ Spot weed, remove trash, and rake the mulch
Annually	<ul style="list-style-type: none"> ▪ Conduct a maintenance inspection ▪ Supplement mulch in devoid areas to maintain a 3-inch layer ▪ Prune trees and shrubs ▪ Remove sediment at inflow area
Once every 2–3 years	<ul style="list-style-type: none"> ▪ Remove and replace the mulch layer if necessary. (Note that mulch replacement/replenishment is not necessary if the basin surface is fully vegetated)
As needed	<ul style="list-style-type: none"> ▪ Add reinforcement planting to maintain desired vegetation density ▪ Remove invasive plants using recommended control methods ▪ Remove any dead or diseased plants ▪ Stabilize the CDA to prevent erosion

Standing water is the most common problem outside of routine maintenance. If water remains on the surface for more than 72 hours after a storm, adjustments to the grading may be needed or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment or a fine crust that builds up after the first several storm events. There are several methods that can be used to rehabilitate the

filter. These are listed below, starting with the simplest approach and ranging to more involved procedures (i.e., if the simpler actions do not solve the problem):

- Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain indicates standing water, then the underdrain must be clogged and will need to be cleaned out.
- Remove accumulated sediment and till 2 to 3 inches of sand into the upper 6 to 12 inches of soil.
- Install sand wicks from 3 inches below the surface to the underdrain layer. This reduces the average concentration of fines in the media bed and promotes quicker drawdown times. Sand wicks can be installed by excavating or auguring (i.e., using a tree auger or similar tool) down to the top of the underdrain layer to create vertical columns that are then filled with a clean open-graded coarse sand material (e.g., ASTM C-33, Standard Specification for Concrete Aggregates, concrete sand or similar approved sand mix for bioretention media). A sufficient number of wick drains of sufficient dimension should be installed to meet the design dewatering time for the facility.
- Remove and replace some or all of the filter media.

Maintenance Inspections. It is recommended that a qualified professional conduct a spring maintenance inspection and cleanup at the bioretention area. Maintenance inspections should include information about the inlets, the actual bioretention facility (sediment buildup, outlet conditions, etc.), and the state of vegetation (water stressed, dead, etc.) and are intended to highlight any issues that need or may need attention to maintain stormwater management functionality.

DOEE's maintenance inspection checklists for bioretention areas and the Maintenance Service Completion Inspection form can be found in Appendix M - Maintenance Inspection Checklists of the January 2020 Stormwater Guidebook.

7. CONCLUSIONS

The stormwater BMPs selected for the Fort Greble Recreation Center site will consist of a large dry swale (bioretention swale) with surrounding tree planting.

The capture area includes a portion of the Leckie Elementary School site, and should eliminate the existing ponding area in the playground.

Soils in the project area are suitable for construction of infiltration based BMPs that incorporate an underdrain system. The underdrain pipe shall discharge to the existing grade at the top of the turf bank, approximately 125 feet from the end of the swale.

Implementation of these improvements will provide a shaded public amenity area in addition to reducing stormwater runoff pollution from the project drainage area.

8. BMP SCORECARD

BMP Description	CDA (sf)				Volume Provided (cf)	Runoff Depth Captured per Imperv Acre	Pollutant Removal Rates		
	Impervious	Turf	BMP	Total			P	N	TSS
Dry Swale	13588	28052	2025	43,665	1800	1.4	76%	64%	81%

Includes trench drain and piping to capture Leckie drainage, regrading, tree planting, level spreader basin overflow & reverse french drain for underdrain

APPENDICES

Appendix A: Construction Plans (Refer to Permitting Document Set)

Appendix B: Geotechnical Report
(See insert on following pages)

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

Natural
Resources
Design

an ecologically focused design firm
Washington DC



Prepared by:

Natural Resources Design, LLC

1009 Shepherd St. NE
Washington, DC 20017
202.489.6214

July 19, 2019

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
Contents	
1.0 INTRODUCTION	1
1.1 Project Information	1
1.2 Scope of Services.....	1
2.0 SUBSURFACE EXPLORATION PROCEDURES	2
3.0 SITE AND SUBSURFACE CONDITIONS	3
3.1 Site Description	3
3.2 Regional Geology	3
4.0 SOILS INFILTRATION.....	4
4.1 Methodology.....	4
4.2 Field Infiltration Testing	5
5.0 RECOMMENDATIONS	6
6.0 LIMITATIONS.....	6

APPENDICES

APPENDIX A

Site Vicinity Map (Drawing No. 1)

APPENDIX B

Boring Location Plan (Drawing No. 2)

Boring Logs

APPENDIX C

Websoil Survey

APPENDIX D

Infiltration Testing Calculations

1.0 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.

2.0 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.

3.0 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.

3.2.1 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 Appendix B.

3.2.2 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.

4.0 SOILS 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	

5.0 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.

6.0 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 the boring 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, or recommendations.

APPENDIX A

FIGURE 1 – VICINITY MAP

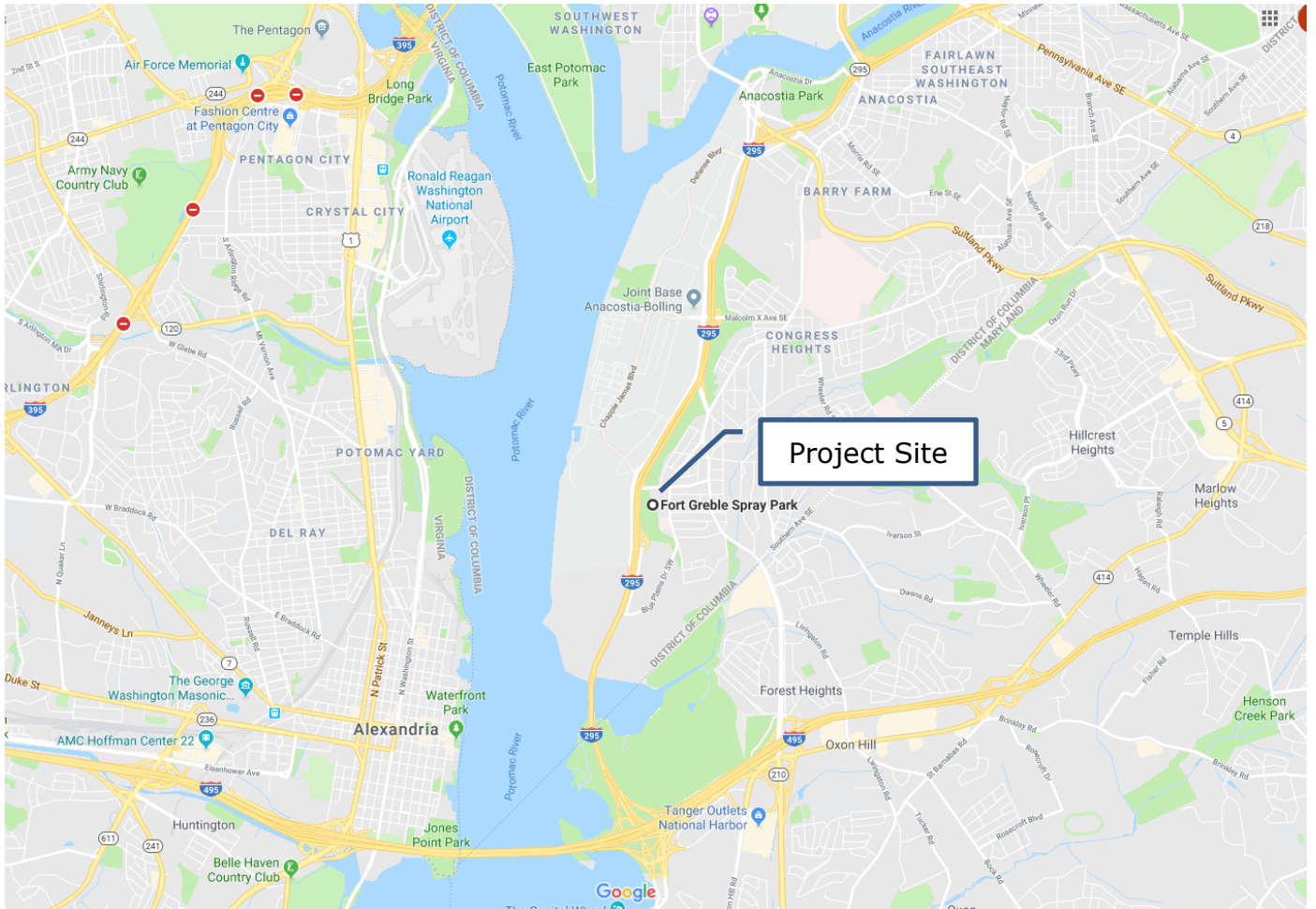


Figure 1 - Vicinity Map






2019©Google

APPENDIX B

SOILS BORING INFORMATION



Figure 2- Boring Location Map

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"	
Depth (feet)	Sample Type	Sample Number	Graphic Log	Logged By: C. Sonne		Bit Type: Hand Auger	
				Boring No. B-1		Groundwater Depth: None Encountered	
<u>DESCRIPTION</u>							
0.33				Topsoil			
0.83	⊗	1		Clay			
				Silty Clay Loam			
	⊗	2		<i>large gravel & very dense cobbles</i>			
3				Boring Terminated (36")			
5							
8							
10							






Natural Resources
Design, LLC

Boring Log: Sheet 1 of 1

⊗ Bulk/ Bag Sample

▼ Stabilized 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"	
Depth (feet)	Sample Type	Sample Number	Graphic Log	Logged By: C. Sonne		Bit Type: Hand Auger	
				Boring No. B-2		Groundwater Depth: None Encountered	
<u>DESCRIPTION</u>							
0.33	☒	1		Topsoil			
				Sandy Loam			
1.5		2		Clay			
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

▼ Stabilized Ground water

▽ Groundwater At time of Drilling

APPENDIX C

WEBSOIL SURVEY REPORT

Custom Soil Resource Report for District of Columbia



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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface	2
How Soil Surveys Are Made	5
Soil Map	8
Soil Map (Ft Greble).....	9
Legend.....	10
Map Unit Legend (Ft Greble).....	11
Map Unit Descriptions (Ft Greble).....	11
District of Columbia.....	13
CdB—Chillum-Urban land complex, 0 to 8 percent slopes.....	13
CdC—Chillum-Urban land complex, 8 to 15 percent slopes.....	14
U7—Udorthents, gravelly, smoothed.....	15
References	17

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

Custom Soil Resource Report

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

Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

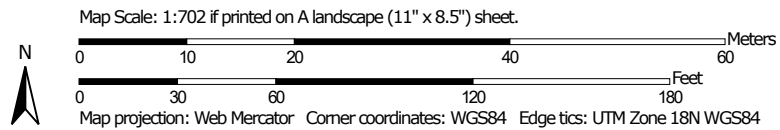
Soil Map

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

Custom Soil Resource Report Soil Map (Ft Greble)




Soil Map may not be valid at this scale.



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

Custom Soil Resource Report

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)

Custom Soil Resource Report

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

References

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

Custom Soil Resource Report

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

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

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)
0.01	5.3E-08
0.02	1.1E-07
0.03	1.6E-07
0.04	2.1E-07
0.05	2.7E-07
0.06	3.2E-07
0.07	3.7E-07
0.08	4.3E-07
0.09	4.8E-07
0.10	5.3E-07
0.15	8.0E-07
0.20	1.1E-06
0.25	1.3E-06
0.30	1.6E-06
0.35	1.9E-06
0.40	2.1E-06
0.45	2.4E-06
0.50	2.7E-06
0.55	2.9E-06
0.60	3.2E-06
0.65	3.5E-06
0.70	3.7E-06
0.75	4.0E-06
0.80	4.3E-06
0.85	4.5E-06
0.90	4.8E-06
0.95	5.1E-06
1.0	5.3E-06
1.1	5.9E-06
1.2	6.4E-06
1.3	6.9E-06
1.4	7.5E-06
1.5	8.0E-06
1.6	8.5E-06
1.7	9.0E-06
1.8	9.6E-06
1.9	1.0E-05
2.0	1.1E-05
2.1	1.1E-05
2.2	1.2E-05
2.3	1.2E-05
2.4	1.3E-05
2.5	1.3E-05
2.6	1.4E-05

R(cm/min)	Kfs (m/sec)
2.7	1.4E-05
2.8	1.5E-05
2.9	1.5E-05
3.0	1.6E-05
3.1	1.6E-05
3.2	1.7E-05
3.3	1.8E-05
3.4	1.8E-05
3.5	1.9E-05
3.6	1.9E-05
3.7	2.0E-05
3.8	2.0E-05
3.9	2.1E-05
4.0	2.1E-05
4.1	2.2E-05
4.2	2.2E-05
4.3	2.3E-05
4.4	2.3E-05
4.5	2.4E-05
4.6	2.4E-05
4.7	2.5E-05
4.8	2.6E-05
4.9	2.6E-05
5.0	2.7E-05
5.5	2.9E-05
6.0	3.2E-05
6.5	3.5E-05
7.0	3.7E-05
7.5	4.0E-05
8.0	4.3E-05
8.5	4.5E-05
9.0	4.8E-05
9.5	5.1E-05
10.0	5.3E-05
11.0	5.9E-05
12.0	6.4E-05
13.0	6.9E-05
14.0	7.5E-05
15.0	8.0E-05
16.0	8.5E-05
17.0	9.0E-05
18.0	9.6E-05
19.0	1.0E-04
20.0	1.1E-04

R(cm/min)	Kfs (m/sec)
21.0	1.1E-04
22.0	1.2E-04
23.0	1.2E-04
24.0	1.3E-04
25.0	1.3E-04
26.0	1.4E-04
27.0	1.4E-04
28.0	1.5E-04
29.0	1.5E-04
30.0	1.6E-04
31.0	1.6E-04
32.0	1.7E-04
33.0	1.8E-04
34.0	1.8E-04
35.0	1.9E-04
36.0	1.9E-04
37.0	2.0E-04
38.0	2.0E-04
39.0	2.1E-04
40.0	2.1E-04
41.0	2.2E-04
42.0	2.2E-04
43.0	2.3E-04
44.0	2.3E-04
45.0	2.4E-04
46.0	2.4E-04
47.0	2.5E-04
48.0	2.6E-04
49.0	2.6E-04
50.0	2.7E-04
52.0	2.9E-04
54.0	2.9E-04
56.0	3.0E-04
58.0	3.1E-04
60.0	3.2E-04
62.0	3.3E-04
64.0	3.4E-04
66.0	3.5E-04
68.0	3.6E-04
70.0	3.7E-04
72.0	3.8E-04
74.0	3.9E-04
76.0	4.0E-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**