CLOVER HILL DRAINAGE IMPROVEMENTS
FREDERICK, MD
30% SUBMISSION

AUGUST 2024

Prepared For:
Frederick County Division of Energy & Environment
30 North market Street
Frederick, Maryland 21701

Prepared By:

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I. INTRODUCTION

PURPOSE

The purpose of this report is to present the drainage improvements for the existing drainage infrastructure throughout the Clover Hill neighborhood. The neighborhood currently experiences flooding due to inadequate ditches and inverse grade storm drain culverts. Ditch and driveway culvert improvements are proposed to alleviate these flooding issues. There are also some existing ditches that will be re-graded to improve grass channel crediting where applicable.

PROJECT DESCRIPTION

The Clover Hill subdivision is located approximately 4 miles northwest of downtown City of Frederick, immediately north of Fort Detrick and Frederick Community College. The subdivision was built in four sections starting in 1960 and covers over 750 acres. The existing drainage system consists of open ditches and driveway culverts that convey runoff throughout the neighborhood. This discharge will continue to be conveyed by open channels and closed storm drain pipes outside the subdivision until it reaches Tuscarora Creek to the Monocacy River.

Many of the existing ditches are shallow v-ditches that do not have adequate capacity; therefore they overtop during storm events and cause flooding problems throughout the subdivision. The 2023 Clover Hill Drainage Capacity Study (2023 Study) found that about 15% of residents (that responded to their survey) reported frequent flooding on their property including overtopping of the ditches/driveway culverts and basement flooding. The proposed design will increase the ditch capacity and replace driveway culverts with inverse grade in order to better convey runoff.

II. HYDROLOGY

WATERSHED

The subdivision eventually discharges to Tuscarora Creek, a tributary of the Upper Monocacy River, MDE 8-digit Watershed 02-14-03-03. Tuscarora Creek and it's tributaries are Use III-P streams which means it is a nontidal cold water stream used for public water supply. In an effort to preserve fish spawning and migration in the waterway, in-stream work may not be conducted during the period of October 1st through April 30th, inclusive, during any year. ***Table 1*** below lists the Watershed Data information from MDE.

Table 1 – MDE Watershed Data

MDE 8-digit watershed number	MDE 8-digit watershed name	Designated Use	Tributary Name
02-14-03-03	Upper Monocacy River	III-P	Tuscarora Creek

SOILS

The U.S. Department of Agriculture, National Resources Conservation Service (NRCS) Web Soil Survey soil data was used to determine the soil types for the project. Soils are classified into hydrologic soil groups (HSG) based on their runoff potential; HSG A has the lowest runoff potential (sandy soil which allows infiltration) and HSG D has the highest runoff potential (mostly clay soil which does not allow water to infiltrate). The majority of the soils within the subdivision drainage areas are either HSG B (moderately low runoff potential) or HSG D (high runoff potential). All soil data can be found in ***Appendix B***.

DRAINAGE AREAS AND LAND USE

The drainage area and land use for the existing and proposed conditions were determined using survey data, aerial mapping, Geographic Information System (GIS) topography data, and site investigations. The drainage areas consist of roadway, grass open space in good condition, woods in good condition and residential areas. There are no proposed improvements other than the ditch re-grading and driveway replacements; therefore, the drainage area and land uses remain the same from the existing to proposed condition.

RAINFALL DATA

In order to determine peak discharges, rainfall intensities for every storm event are required. The National Oceanographic and Atmospheric Administration (NOAA) Atlas 14 data set was used to obtain point precipitation frequency estimates for a 24 hour duration for each storm event using type C rainfall distribution set. The 24 hour duration is the standard time period set by MDE, chosen to best protect channels from erosion after a project is complete and the distribution type is determined based on the geographic region in Maryland (Frederick falls within the type C zone). The precipitation frequency has been determined by NOAA based on their historical rainfall data. For example, it has been determined that once a year it rains a total of 2.57 inches over a 24 hour

period (1-yr storm 24-hr rainfall intensity). These rainfall intensities are used with other parameters (to be discussed) to determine the discharge values for a given area.

TIME OF CONCENTRATION (Tc)

The Highway Drainage Manual defines the time of concentration as the time it takes a drop of water falling on the hydraulically most distant point in the drainage area to travel through the DA to the outlet. This path represents the longest travel time, not necessarily the longest flow distance. TR-55 methodology was used to compute the time of concentration for each drainage area.

Tc paths are divided into 3 types of flow; Sheet Flow (the first 100 ft of flow over a plane surface), Shallow Concentrated Flow (flow over and area that does not have a defined channel shape) and Channel Flow (ditch and pipe flow). At this design stage, individual Tc paths were not computed for each ditch; each drainage area Tc was assumed to be 7 minutes per Table 2 in Chapter 4 of the Frederick County Streets and Roads Design Manual.

RUNOFF CURVE NUMBER (RCN)

The RCNs were developed using TR-55 methodology. There is a unique curve number for each combination of land use and hydrologic soil type, which is used to determine the runoff potential for a single area. For example, an open space area in HSG D will have a higher runoff potential than a wooded area in HSG A; therefore, the HSG D open space will have a higher RCN than the HSG A wooded area.

Curve numbers are assigned to each soil-land use combination to determine a weighted RCN for each drainage area. These curve numbers values were used in the rational method to compute the discharge through each ditch.

III. PROPOSED DESIGN

There are 4 main types of drainage improvements being proposed:

- Water Quantity Improvements: Regrade existing ditches to achieve improved conveyance and capacity
- Water Quality Improvements: Regrade existing ditches to improve grass channel crediting
- Storm Drain Improvements: Replace existing driveway culverts that have an inverse slope
- Fox Hunt Lane Improvements: Improve capacity of storm drain and channel at Fox Hunt Lane

WATER QUANTITY IMPROVEMENTS

The 2023 Study classified the ditches as high, medium and low priority based on the level of flooding reduction that could be provided (high = greatest reduction and low = least reduction). Since this study, the low priority ditches have been removed from the project and the high and medium priority ditches are now referred to as Quantity Ditches.

The typical Quantity ditch section is a 6 ft flat bottom ditch with varying roadside side slopes and 3:1 back side slopes. The longitudinal ditch slopes were determined by maintaining existing driveway culvert inverts and grading a uniform slope between culverts. The only exceptions to this were if the driveway culvert had an inverse slope, these slopes were corrected to provide positive drainage and the ditch slope was adjusted accordingly. All ditch computations can be found in ***Appendix C***.

WATER QUALITY IMPROVEMENTS

The 2023 Study identified 41 existing 2A grass swales within the project area for which Frederick County is currently receiving credit. There will be no impact to any of these swales. The 2023 Study also identified 44 existing ditches that had the potential to be retrofit to meet the water quality grass swale criteria and provide additional qualitative credit for the County, now referred to as Quality Ditches. Of the initially identified 44 ditches, 32 remain in the design; some ditches were combined and some did not meet the M-8 swale design criteria in the 2000 Maryland Stormwater Design Manual:

- Bottom width: between 2 and 8 feet
- Longitudinal slope: less than or equal to 4%
- Side slopes: 3:1 or flatter
- Surface Area: swale bottom surface area greater than or equal to 2% of the contributing drainage area
- ESDv storm: velocity less than or equal to 1 fps, flow depth less than or equal to 4 inches
- 10-year storm: safely convey with non-erosive velocity

The typical Quality ditch section is a 2 ft flat bottom ditch with varying roadside side slopes and 3:1 back side slopes. This bottom width was initially chosen with the County to try to minimize property impacts; however, only 5 of the Quality ditches meet the surface area requirement with a 2 ft bottom, resulting in 0.17 ac of credit. In order to receive impervious treatment credit, the 27

other ditch bottoms will have to be increased to at least 3 or 4 ft, which would result in 2.30 ac of credit.

The Quantity ditches were also evaluated based on the M-8 criteria in order to see if any additional credit could be claimed. It was determined that 17 Quantity ditches meet the M-8 criteria and would provide 2.46 ac of credit. There are 3 ditches could meet the criteria with increased bottom widths, which would result in an additional 0.36 ac of credit.

If the ditch bottom widths are increased as necessary, there are 52 ditches that would provide 5.28 ac of impervious area credit for the County. Ditch treatment computations can be found in ***Appendix C***.

STORM DRAIN IMPROVEMENTS

During the ditch improvement design, it was found that 43 pipes within the project area had inverse slopes and 14 were crushed or damaged. These 57 pipes will be replaced with a minimum slope of 0.5% to ensure positive drainage. The majority of the pipes in the subdivision are elliptical CMP accordingly to as-built records and topographic survey; therefore, they will be replaced with equivalent sized elliptical RCP in order to maintain adequate cover and provide a greater future pipe life.

FOX HUNT LANE IMPROVEMENTS

There is a drainage channel between Fox Hunt Lane and Christophers Crossing, approximately 300 feet north of Stone Ridge Drive, which was previously identified as a major flooding concern. Residents in this area have reported several instances of significant street and backyard flooding. The channel is eroding at the bottom and some down cutting is occurring. The proposed design will add check dams at the Fox Hunt Lane pipe entrance and throughout the existing channel in order to slow the 2 year storm. The channel will convey the 10 year storm with 1 foot of freeboard to the edge of road. The full proposed design memo and computations prepared by Coastal Resources Inc. can be found in ***Appendix E***.

The storm drain upstream of this channel also has proposed improvements. The existing culvert under Fox Hunt Lane is a 24”x35” CMP which immediately enters a 24” HDPE. This reduction in pipe size is contributing to the flooding experienced by the residents. The design flow from the Kellerton Development SWM report was used to evaluate the storm drain pipes. The analysis found that the 24” HDPE causes the road to overtop just before the design flow. The proposed improvements replace both existing pipes with 24”x38” HERCP, which would contain the design flow in the upstream ditch with over 18” of freeboard. Hydraulic computations can be found in ***Appendix C***.

IV. SEDIMENT CONTROL

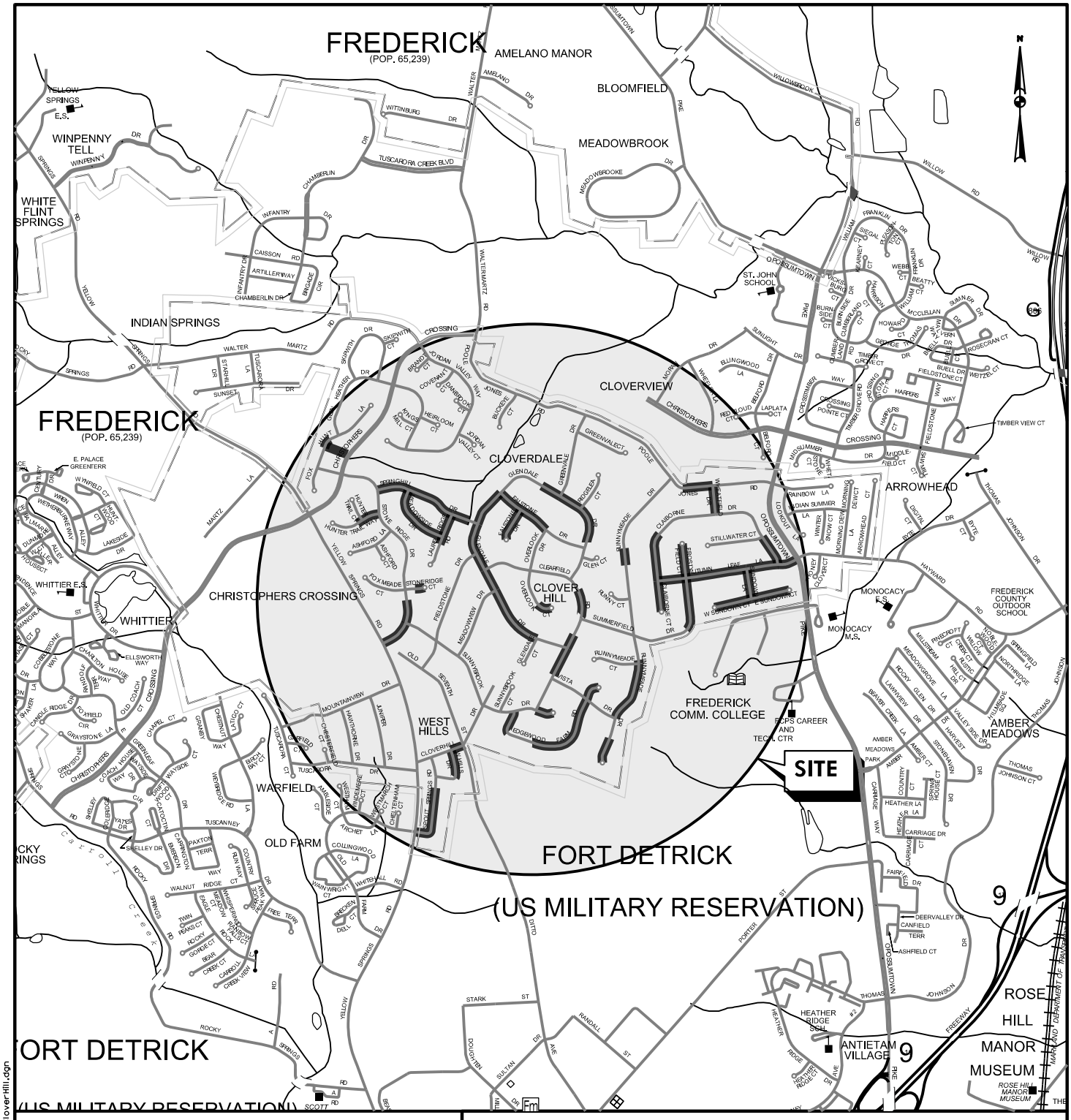
Due to the residential nature of the project area, there is limited space for erosion and sediment control measures. Erosion and Sediment control for this project will be achieved in accordance with the *2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control* manual. The project will be constructed in one stage with multiple work zones. Clear Water Diversion, modified swale protection, same day stabilization and other measures will be utilized to install the open and closed drainage systems. Upon completion of the improvements, all disturbed areas should be stabilized and any sediment devices should be removed with the approval of the E&S inspector.

V. CONCLUSION

In summary, the proposed project will have no change in impervious area. Since all the impervious disturbance is for drainage improvements it is considered a maintenance activity and there are no qualitative requirements.

Ditch improvements are proposed throughout the neighborhood that will increase ditch capacity to reduce flooding and provide qualitative benefit to the neighborhood. Storm drain improvements are also proposed to ensure positive drainage and more efficient flow.

Appendix A: Location Map



THE WILSON T. BALLARD CO.
CONSULTING ENGINEERS | OWINGS MILLS, MD

FREDERICK COUNTY, MARYLAND

CLOVER HILL DRAINAGE IMPROVEMENTS

LOCATION MAP

DATE
AUG 2024

1000' 0 1000' 2000'
SCALE: 1" = 1000'

BY: ADB -
PLOTTED: 8/26/2024
FILE: U:\Frederick County NPDES - Cloverhill\CAD\pDA-0001_CloverHill.dgn

Appendix B: Soils Map/Information

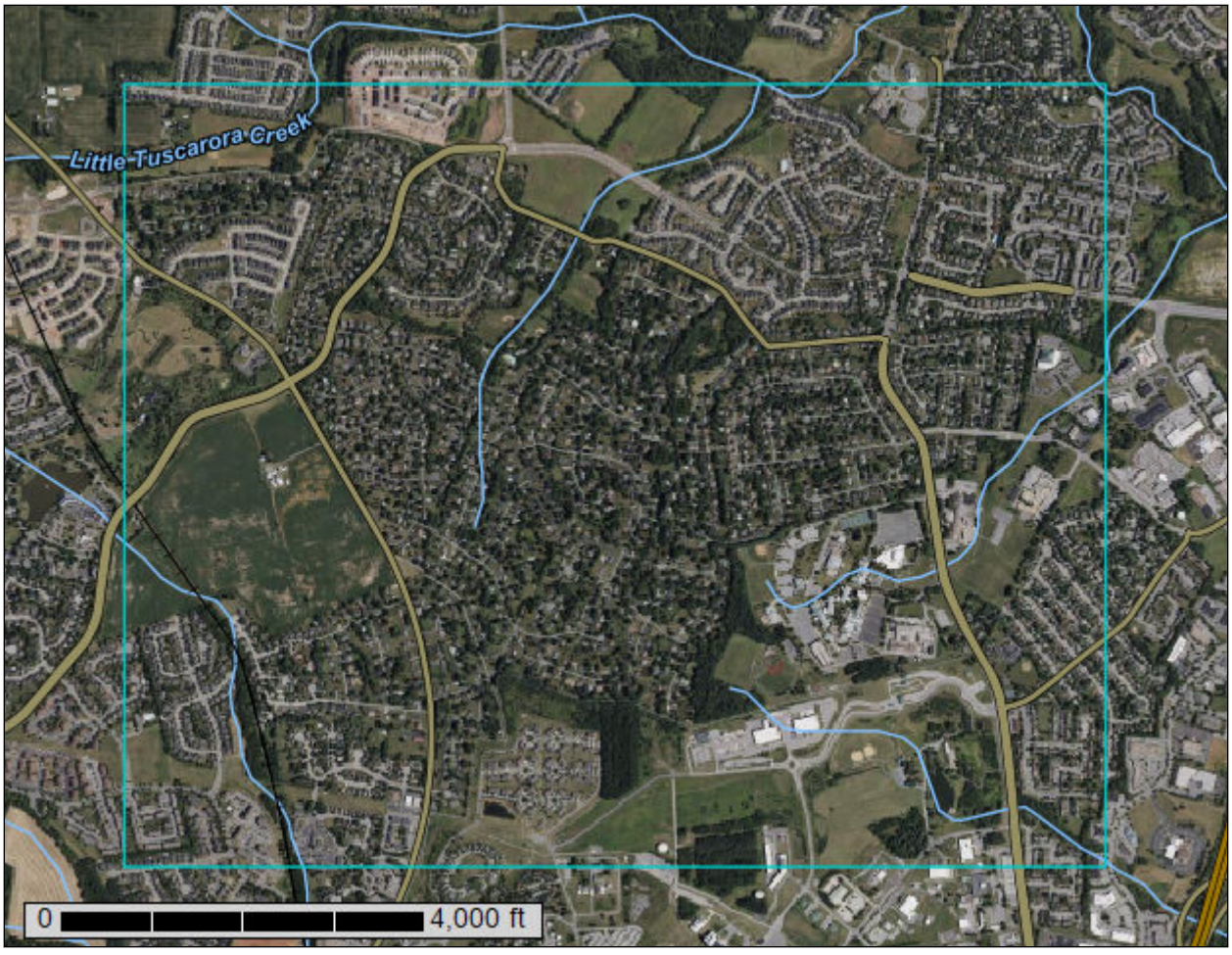
United States Department of Agriculture

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 Frederick County, Maryland



Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Erosion Factors

Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

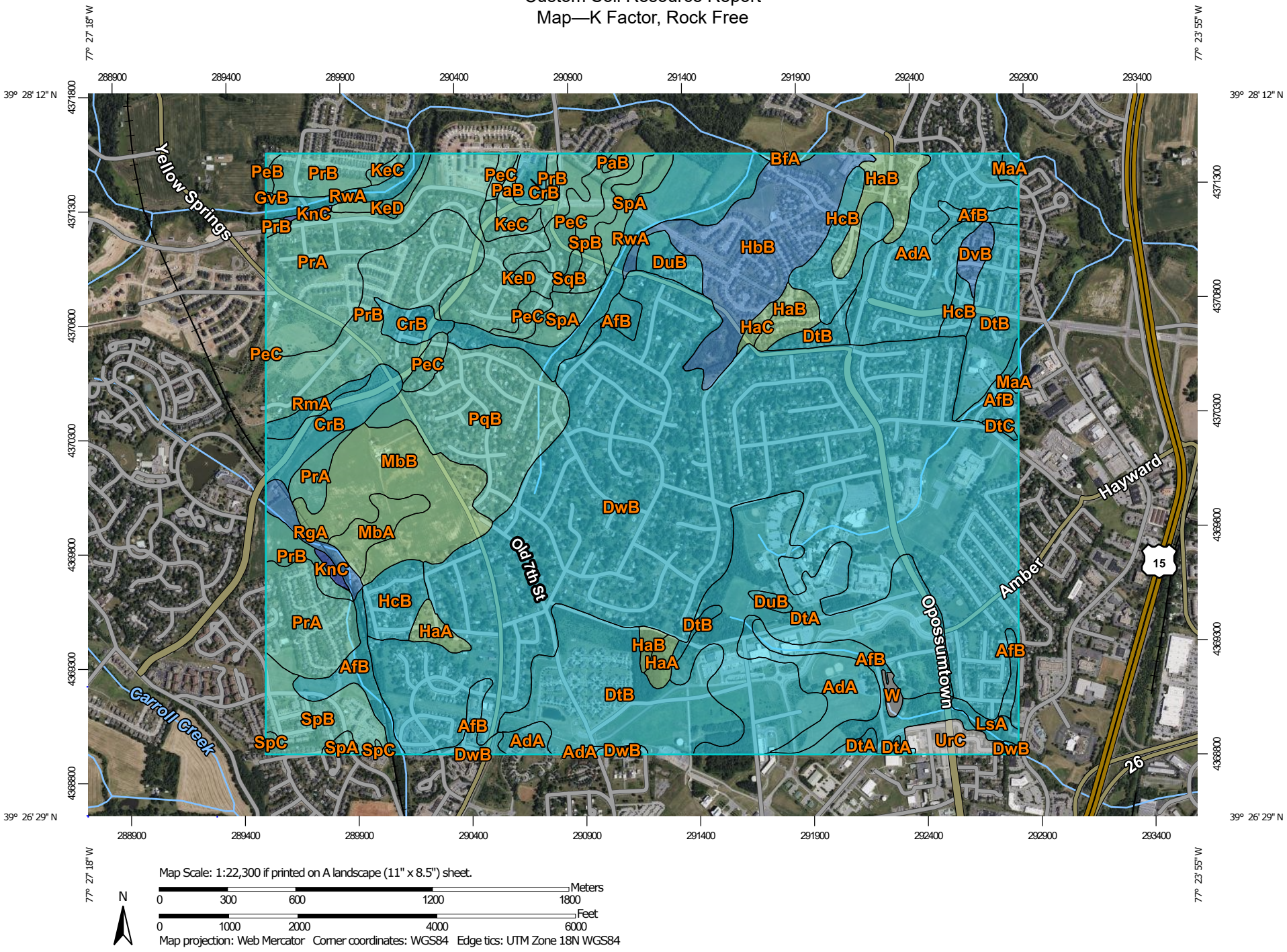
K Factor, Rock Free

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kf (rock free)" indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Factor K does not apply to organic horizons and is not reported for those layers.

Custom Soil Resource Report
Map—K Factor, Rock Free



Map Scale: 1:22,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 300 600 1200 1800

Feet: 0 1000 2000 4000 6000

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Lines

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Points

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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: Frederick County, Maryland
Survey Area Data: Version 20, Sep 12, 2023

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

Date(s) aerial images were photographed: May 9, 2022—Aug 15, 2022

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.

Table—K Factor, Rock Free

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Adamstown silt loam, 0 to 3 percent slopes	.37	113.5	5.3%
AfB	Adamstown-Funkstown complex, 0 to 8 percent slopes	.37	80.6	3.7%
BfA	Bermudian silt loam, 0 to 3 percent slopes	.32	2.0	0.1%
CrB	Croton-Abbottstown silt loams, 3 to 8 percent slopes	.37	41.7	1.9%
DtA	Duffield-Ryder silt loams, 0 to 3 percent slopes	.37	149.4	6.9%
DtB	Duffield-Ryder silt loams, 3 to 8 percent slopes	.37	142.1	6.6%
DtC	Duffield-Ryder silt loams, 8 to 15 percent slopes	.37	1.4	0.1%
DuB	Duffield and Ryder channery silt loams, 3 to 8 percent slopes	.37	13.8	0.6%
DvB	Duffield and Ryder channery silt loams, 3 to 8 percent slopes, rocky	.43	7.2	0.3%
DwB	Duffield-Hagerstown-Urban land complex, 3 to 8 percent slopes	.37	703.5	32.6%
GvB	Glenville-Codorus complex, 3 to 8 percent slopes	.37	0.5	0.0%
HaA	Hagerstown loam, 0 to 3 percent slopes	.28	12.1	0.6%
HaB	Hagerstown loam, 3 to 8 percent slopes	.28	34.6	1.6%
HaC	Hagerstown loam, 8 to 15 percent slopes	.28	3.2	0.1%
HbB	Hagerstown silt loam, 3 to 8 percent slopes	.43	90.9	4.2%
HcB	Hagerstown-Opequon silty clay loams, 3 to 8 percent slopes, rocky	.37	51.5	2.4%
KeC	Klinesville very channery loam, 8 to 15 percent slopes	.32	9.1	0.4%
KeD	Klinesville very channery loam, 15 to 25 percent slopes	.32	10.7	0.5%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
KnC	Klinesville channery silt loam, 8 to 15 percent slopes	.49	3.1	0.1%
LsA	Lindside silt loam, 0 to 3 percent slopes	.37	5.6	0.3%
MaA	Melvin-Lindside silt loams, 0 to 3 percent slopes	.37	3.4	0.2%
MbA	Morven loam, 0 to 3 percent slopes	.28	14.3	0.7%
MbB	Morven loam, 3 to 8 percent slopes	.28	77.8	3.6%
PaB	Penn loam, 3 to 8 percent slopes	.32	15.9	0.7%
PeB	Penn channery loam, 3 to 8 percent slopes	.32	1.3	0.1%
PeC	Penn channery loam, 8 to 15 percent slopes	.32	32.2	1.5%
PqB	Penn-Reaville-Urban land complex, 0 to 8 percent slopes	.32	84.4	3.9%
PrA	Penn-Reaville silt loam, 0 to 3 percent slopes	.32	164.4	7.6%
PrB	Penn-Reaville silt loams, 3 to 8 percent slopes	.32	111.5	5.2%
RgA	Readington silt loam, 0 to 3 percent slopes	.43	9.8	0.5%
RmA	Reaville silt loam, 0 to 3 percent slopes	.37	7.3	0.3%
RwA	Rowland silt loam, 0 to 3 percent slopes	.37	64.4	3.0%
SpA	Springwood gravelly loam, 0 to 3 percent slopes	.32	26.0	1.2%
SpB	Springwood gravelly loam, 3 to 8 percent slopes	.32	47.0	2.2%
SpC	Springwood gravelly loam, 8 to 15 percent slopes	.32	1.3	0.1%
SqB	Springwood-Rock outcrop complex, 3 to 8 percent slopes	.32	2.8	0.1%
UrC	Urban land, 3 to 15 percent slopes		12.2	0.6%
W	Water		2.8	0.1%
Totals for Area of Interest			**2,155.4**	**100.0%**

Rating Options—K Factor, Rock Free

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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

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

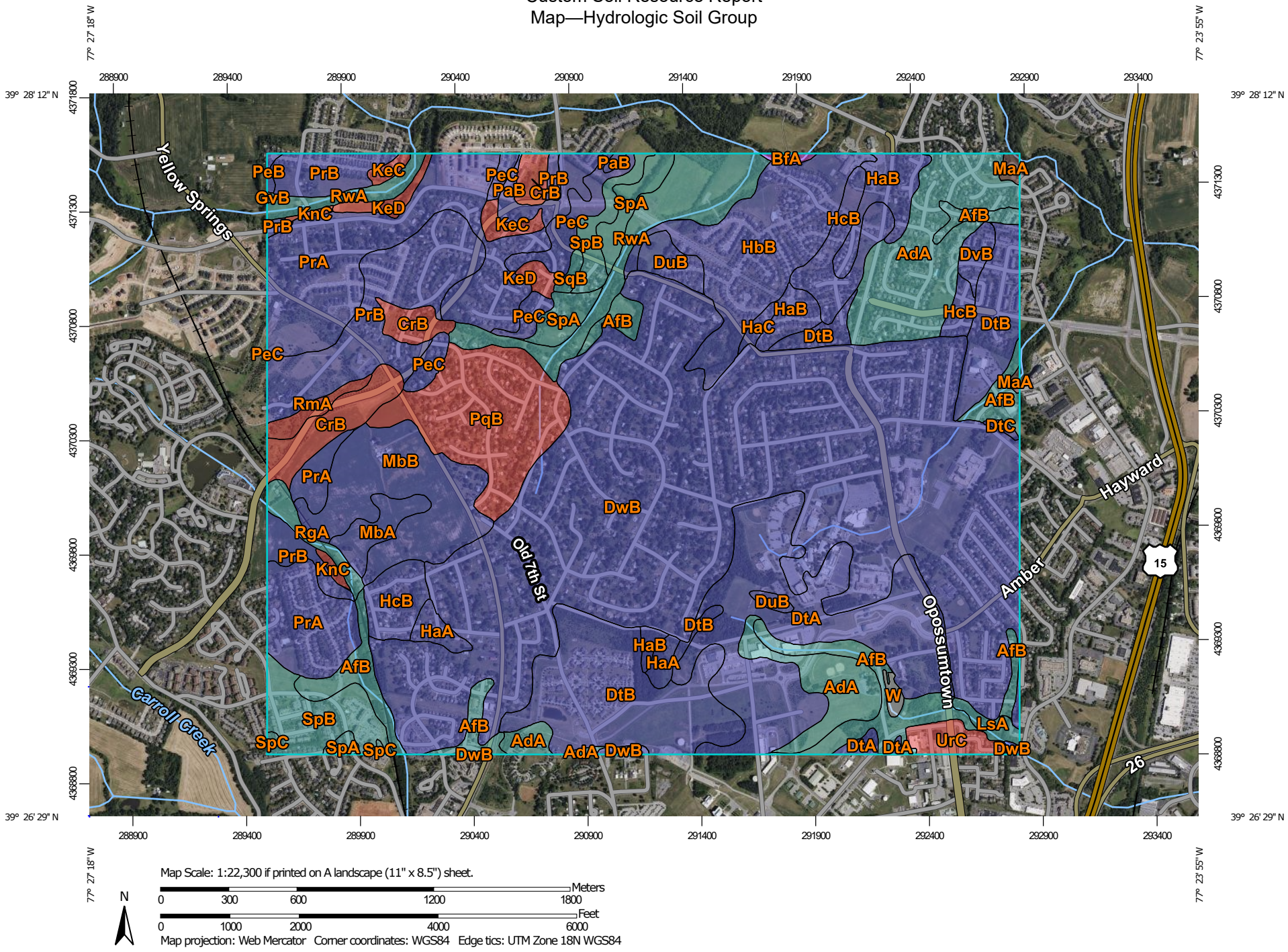
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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

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

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

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


77° 27' 18" W
77° 23' 55" W
39° 28' 12" N
39° 26' 29" N
288900
289400
289900
290400
290900
291400
291900
292400
292900
293400
4371800
4371300
4370800
4370300
4369800
4369300
4368800
Yellow Springs
Carroll Creek
Old 7th St
Opossumtown
Amber
Hayward
15
26
PeB
PrB
KeC
GvB
RwA
KeD
KnC
PrA
PaB
CrB
SpA
SpB
DuB
SqB
HbB
HaB
HaC
HcB
AdA
DvB
AfB
DtB
MaA
DtC
PeC
RmA
CrB
PqB
MbB
DwB
RgA
MbA
KnC
HaA
DtA
LsA
UrC
W
SpC
SpA
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Feet
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Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

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Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Adamstown silt loam, 0 to 3 percent slopes	C	113.5	5.3%
AfB	Adamstown-Funkstown complex, 0 to 8 percent slopes	C	80.6	3.7%
BfA	Bermudian silt loam, 0 to 3 percent slopes	A	2.0	0.1%
CrB	Croton-Abbottstown silt loams, 3 to 8 percent slopes	D	41.7	1.9%
DtA	Duffield-Ryder silt loams, 0 to 3 percent slopes	B	149.4	6.9%
DtB	Duffield-Ryder silt loams, 3 to 8 percent slopes	B	142.1	6.6%
DtC	Duffield-Ryder silt loams, 8 to 15 percent slopes	B	1.4	0.1%
DuB	Duffield and Ryder channery silt loams, 3 to 8 percent slopes	B	13.8	0.6%
DvB	Duffield and Ryder channery silt loams, 3 to 8 percent slopes, rocky	B	7.2	0.3%
DwB	Duffield-Hagerstown-Urban land complex, 3 to 8 percent slopes	B	703.5	32.6%
GvB	Glenville-Codorus complex, 3 to 8 percent slopes	C	0.5	0.0%
HaA	Hagerstown loam, 0 to 3 percent slopes	B	12.1	0.6%
HaB	Hagerstown loam, 3 to 8 percent slopes	B	34.6	1.6%
HaC	Hagerstown loam, 8 to 15 percent slopes	B	3.2	0.1%
HbB	Hagerstown silt loam, 3 to 8 percent slopes	B	90.9	4.2%
HcB	Hagerstown-Opequon silty clay loams, 3 to 8 percent slopes, rocky	B	51.5	2.4%
KeC	Klinesville very channery loam, 8 to 15 percent slopes	D	9.1	0.4%
KeD	Klinesville very channery loam, 15 to 25 percent slopes	D	10.7	0.5%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
KnC	Klinesville channery silt loam, 8 to 15 percent slopes	D	3.1	0.1%
LsA	Lindside silt loam, 0 to 3 percent slopes	C	5.6	0.3%
MaA	Melvin-Lindside silt loams, 0 to 3 percent slopes	B/D	3.4	0.2%
MbA	Morven loam, 0 to 3 percent slopes	B	14.3	0.7%
MbB	Morven loam, 3 to 8 percent slopes	B	77.8	3.6%
PaB	Penn loam, 3 to 8 percent slopes	B	15.9	0.7%
PeB	Penn channery loam, 3 to 8 percent slopes	B	1.3	0.1%
PeC	Penn channery loam, 8 to 15 percent slopes	B	32.2	1.5%
PqB	Penn-Reaville-Urban land complex, 0 to 8 percent slopes	D	84.4	3.9%
PrA	Penn-Reaville silt loam, 0 to 3 percent slopes	B	164.4	7.6%
PrB	Penn-Reaville silt loams, 3 to 8 percent slopes	B	111.5	5.2%
RgA	Readington silt loam, 0 to 3 percent slopes	C	9.8	0.5%
RmA	Reaville silt loam, 0 to 3 percent slopes	D	7.3	0.3%
RwA	Rowland silt loam, 0 to 3 percent slopes	C	64.4	3.0%
SpA	Springwood gravelly loam, 0 to 3 percent slopes	C	26.0	1.2%
SpB	Springwood gravelly loam, 3 to 8 percent slopes	C	47.0	2.2%
SpC	Springwood gravelly loam, 8 to 15 percent slopes	C	1.3	0.1%
SqB	Springwood-Rock outcrop complex, 3 to 8 percent slopes	C	2.8	0.1%
UrC	Urban land, 3 to 15 percent slopes	D	12.2	0.6%
W	Water		2.8	0.1%
Totals for Area of Interest			**2,155.4**	**100.0%**

Appendix C: Ditch and Drainage Computations

THE WILSON T. BALLARD CO.
CONSULTING ENGINEERS
17 Gwynns Mill Court • Owings Mills, MD 21117

Project: Clover Hill Drainage
Project No.: 100-291.05
Design Phase: Concept

Designed By: ADB
Checked By:
Date: 8/29/2024

		For Quantity		For Quality												
Ditch Type	Ditch Name	Total DA (ac)	IA (ac)	Total DA (ac)	IA (ac)	Bottom Width (ft)	Length (ft)	Treated Pe (in)	IAT (ac)	ESDv Depth (ft)	Af/DA	Bottom Width (ft)	Treated Pe (in)	IAT (ac)	Af/DA	Comments
Quality	SPRINGHILL-1	1.53	0.52	1.53	0.52	2	330	0.10		0.09	0.99%	5	0.25	0.13	2.48%	Redesign for Quality Credit
Quantity	SPRINGHILL-2	2.23	0.76	0.70	0.24	6	300	0.59	0.14	0.09	5.86%					
Quantity	SPRINGHILL-3	0.27	0.09	0.27	0.09	6	80	0.41	0.04	0.06	4.08%					
Quantity	SPRINGHILL-5	1.27	0.42	1.27	0.42	6	180	0.20		0.06	1.96%	7	0.23	0.10	2.29%	Redesign for Quality Credit
Quantity	MEADOWSIDE-1	1.61	0.43	1.61	0.43	6	210	0.18		0.07	1.80%	7	0.21	0.09	2.10%	Redesign for Quality Credit
Quantity	MEADOWSIDE-4	0.17	0.07	0.17	0.07	6	185	1.54	0.07	0.08	15.44%					
Quantity	SPRINGHILL-6	4.52	1.34	1.48	0.42	6	320	0.30	0.12	0.09	2.98%					
Quantity	SPRINGHILL-7	1.21	0.33	1.21	0.33	6	110	0.13		0.09	1.25%	8	0.17		1.67%	No Credit can be provided
Quantity	LAUREL-1	2.09	0.61	2.09	0.61	6	80	0.05		0.04	0.53%	8	0.07		0.70%	No Credit can be provided
Quality	HUNTER-1	0.67	0.21	0.67	0.21	2	240	0.17		0.10	1.66%	3	0.25	0.05	2.48%	Redesign for Quality Credit
Quantity	MEADOWSIDE-2	12.00	3.58	11.34	3.37	6	560	0.07		0.13	0.68%	8	0.09		0.91%	No Credit can be provided
Quantity	MEADOWSIDE-3	1.15	0.39	1.15	0.39	6	550	0.66	0.26	0.14	6.57%					
Quantity	LAUREL-2	16.47	4.94	1.23	0.36	6	250	0.28	0.10	0.14	2.81%					
Quantity	SPRINGHILL-8	0.51	0.14	0.51	0.14	6	140	0.37	0.05	0.06	3.75%					
Quantity	LAUREL-3	2.39	0.76	2.39	0.76	6	380	0.22	0.17	0.15	2.19%					
Quantity	SPRINGHILL-4	0.37	0.13	0.37	0.13	6	170	0.63	0.08	0.06	6.32%					
Quantity	GLENDALE-1	29.62	7.69	29.62	7.69	6	490	0.02		0.14	0.23%	8	0.03		0.30%	No Credit can be provided
Quantity	GLENDALE-2	36.98	9.86	7.37	2.17	6	375	0.07		0.17	0.70%	8	0.09		0.93%	No Credit can be provided
Quality	STONERIDGE-1	0.80	0.26	0.80	0.26	2	290	0.17		0.15	1.67%	3	0.25	0.06	2.51%	Redesign for Quality Credit
Quality	STONERIDGE-2	0.49	0.15	0.49	0.15	2	255	0.24	0.04	0.14	2.40%					
Quality	STONERIDGE-3	0.49	0.16	0.49	0.16	2	105	0.10		0.05	0.98%	5	0.24	0.04	2.45%	Redesign for Quality Credit
Quality	GLENDALE-5	3.01	0.61	3.01	0.61	2	315	0.05		0.10	0.48%	8	0.19		1.92%	No Credit can be provided
Quality	GLENDALE-6	6.92	1.73	6.92	1.73	2	760	0.05		0.20	0.50%	8	0.20	0.35	2.02%	Redesign for Quality Credit
Quantity	GLENDALE-4	3.33	1.04	3.33	1.04	6	320	0.13		0.12	1.32%	8	0.18		1.76%	No Credit can be provided
Quantity	GLENDALE-3	17.76	5.04	14.43	3.99	6	1020	0.10		0.32	0.97%	8	0.13		1.30%	No Credit can be provided
Quality	FALSTONE-2	1.21	0.40	1.21	0.40	2	295	0.11		0.14	1.12%	4	0.22	0.09	2.23%	Redesign for Quality Credit
Quantity	FALSTONE-1	6.55	1.78	5.34	1.38	6	325	0.08		0.14	0.84%	8	0.11		1.12%	No Credit can be provided
Quantity	FALSTONE-3	1.89	0.57	1.89	0.57	6	310	0.23	0.13	0.14	2.25%					
Quality	CLEARFIELD-1	1.31	0.37	1.31	0.37	2	300	0.11		0.14	1.05%	4	0.21	0.08	2.11%	Redesign for Quality Credit
Quantity	FALSTONE-4	32.51	8.57	29.31	7.62	6	160	0.01		0.09	0.08%	8	0.01		0.10%	No Credit can be provided
Quantity	FALSTONE-5	39.76	10.69	7.25	2.12	6	280	0.05		0.17	0.53%	8	0.07		0.71%	No Credit can be provided
Quality	CLAIBORNE-2	1.44	0.52	1.44	0.52	2	415	0.13		0.16	1.32%	4	0.26	0.14	2.64%	Redesign for Quality Credit
Quantity	CLAIBORNE-1	6.33	1.89	6.33	1.89	6	485	0.11		0.32	1.06%	8	0.14		1.41%	No Credit can be provided
Quantity	CLAIBORNE-3	2.28	0.78	2.28	0.78	6	310	0.19		0.14	1.87%	7	0.22	0.17	2.18%	Redesign for Quality Credit
Quantity	AUTUMN-1	10.74	3.45	0.68	0.26	6	270	0.54	0.14	0.13	5.44%					
Quality	FROSTY-1	1.19	0.45	1.19	0.45	2	325	0.13		0.12	1.26%	4	0.25	0.11	2.52%	Redesign for Quality Credit
Quantity	AUTUMN-2	22.28	7.29	10.36	3.39	6	1075	0.14		0.26	1.43%	8	0.19		1.91%	No Credit can be provided
Quality	WHEATFIELD-2	0.21	0.08	0.21	0.08	2	115	0.25	0.02	0.15	2.50%					
Quality	WHEATFIELD-3	0.24	0.10	0.24	0.10	2	160	0.30	0.03	0.18	3.03%					
Quantity	CLAIBORNE-4	15.27	5.07	15.27	5.07	6	350	0.03		0.14	0.32%	8	0.04		0.42%	No Credit can be provided
Quantity	CLAIBORNE-5	7.64	2.63	7.64	2.63	6	335	0.06		0.14	0.60%	8	0.08		0.81%	No Credit can be provided
Quantity	AUTUMN-3	45.50	15.10	0.31	0.11	6	170	0.74	0.09	0.06	7.45%					
Quantity	SUMMERFIELD-1	11.76	3.56	11.76	3.56	6	600	0.07		0.23	0.70%	8	0.09		0.94%	No Credit can be provided

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CONSULTING ENGINEERS
17 Gwynns Mill Court • Owings Mills, MD 21117

Project: Clover Hill Drainage
Project No.: 100-291.05
Design Phase: Concept

Designed By: ADB
Checked By:
Date: 8/29/2024

		For Quantity		For Quality												
Ditch Type	**Ditch Name**	**Total DA (ac)**	**IA (ac)**	**Total DA (ac)**	**IA (ac)**	**Bottom Width (ft)**	**Length (ft)**	**Treated Pe (in)**	**IAT (ac)**	**ESDv Depth (ft)**	**Af/DA**	**Bottom Width (ft)**	**Treated Pe (in)**	**IAT (ac)**	**Af/DA**	**Comments**
Quantity	AUTUMN-4	1.75	0.65	1.75	0.65	6	290	0.23	0.15	0.17	2.29%					
Quantity	AUTUMN-5	16.33	5.24	2.82	1.03	6	675	0.33	0.34	0.21	3.29%					
Quality	WSUNDOWN-1	2.83	0.86	2.83	0.86	2	400	0.06	0.06	0.17	0.65%	7	0.23	0.19	2.27%	Redesign for Quality Credit
Quantity	SUNDOWN-1	7.38	2.21	4.55	1.36	6	340	0.10		0.12	1.03%	8	0.14		1.37%	No Credit can be provided
Quantity	WSUNDOWN-2	0.90	0.30	0.90	0.30	6	200	0.31	0.09	0.11	3.07%					
Quantity	SUNDOWN-2	1.55	0.57	1.55	0.57	6	500	0.45	0.25	0.18	4.45%					
Quantity	AUTUMN-6	28.95	9.25	2.79	0.92	6	540	0.27	0.24	0.17	2.66%					
Quality	ESUNDOWN-1	0.59	0.22	0.59	0.22	2	210	0.16		0.07	1.64%	3	0.25	0.06	2.47%	Redesign for Quality Credit
Quality	RUNNYMEADE-3	1.51	0.41	1.51	0.41	2	550	0.17		0.15	1.67%	3	0.25	0.10	2.50%	Redesign for Quality Credit
Quality	CLEARFIELD-2	1.43	0.41	1.43	0.41	2	550	0.18		0.19	1.76%	3	0.26	0.11	2.65%	Redesign for Quality Credit
Quality	RUNNYMEADE-2B	0.78	0.21	0.78	0.21	2	325	0.19		0.11	1.91%	3	0.29	0.06	2.87%	Redesign for Quality Credit
Quality	RUNNYMEADE-1	0.76	0.26	0.76	0.26	2	310	0.19		0.16	1.86%	3	0.28	0.07	2.79%	Redesign for Quality Credit
Quality	EDGEWOOD-5	1.09	0.30	1.09	0.30	2	400	0.17		0.10	1.69%	3	0.25	0.08	2.53%	Redesign for Quality Credit
Quality	EDGEWOOD-6	0.55	0.19	0.55	0.19	2	155	0.13		0.08	1.29%	4	0.26	0.05	2.59%	Redesign for Quality Credit
Quality	EDGEWOOD-7	0.45	0.15	0.45	0.15	2	70	0.07		0.05	0.71%	6	0.21	0.03	2.12%	Redesign for Quality Credit
Quality	EDGEWOOD-3	0.42	0.12	0.42	0.12	2	200	0.22	0.03	0.09	2.20%					
Quality	SUNNYBROOK-1	0.66	0.21	0.66	0.21	2	240	0.17		0.04	1.66%	3	0.25	0.05	2.50%	Redesign for Quality Credit
Quality	EDGEWOOD-2	0.86	0.28	0.86	0.28	2	310	0.17		0.20	1.66%	3	0.25	0.07	2.49%	Redesign for Quality Credit
Quality	EDGEWOOD-4	8.67	2.56	6.74	1.95	2	70	0.00		0.11	0.05%	8	0.02		0.19%	No Credit can be provided
Quality	EDGEWOOD-1	1.63	0.45	1.63	0.45	2	585	0.16		0.13	1.65%	3	0.25	0.11	2.47%	Redesign for Quality Credit
Quality	WHILLS-1B	6.21	1.61	6.21	1.61	2	430	0.03		0.17	0.32%	8	0.13		1.27%	No Credit can be provided
Quality	SPOUTSPRING-1	1.50	0.58	1.50	0.58	2	630	0.19		0.25	1.93%	3	0.29	0.17	2.89%	Redesign for Quality Credit
Quality	POOLE-1	0.80	0.27	0.80	0.27	2	230	0.13		0.08	1.32%	4	0.26	0.07	2.65%	Redesign for Quality Credit
Quality	WHEATFIELD-1	0.27	0.10	0.27	0.10	2	70	0.12		0.04	1.19%	4	0.24	0.02	2.37%	Redesign for Quality Credit

Total Credit:	**2.63**	**ac**	**2.65**	**ac**
Credit from Quantity Ditches:	2.46	ac	0.36	ac
Credit from Quality Ditches:	0.17	ac	2.30	ac

THE WILSON T. BALLARD CO.
CONSULTING ENGINEERS
17 Gwynns Mill Court • Owings Mills, MD 21117

Frederick County Storm Drain Design Sheet (Pipe Capacity - Proposed Computations)

Project: CloverHill Drainage
Project No.: 100-291.05
Design Phase: Concept

Designed By: ADB
Checked By:
Date: 8/29/2024

Year Storm Event: 1in WQ
Rainfall Factor: 1
County: Frederick
Agency: DPW

Drainage Area		Contributing Area			1in WQ-Year Runoff			Channel Information							Results									Remarks
Channel Name	POI	Qa (App. D.11)	A AREA (AC.)	RCN Adj.	tc Time Conc. (MIN)	Ia/Pe (App. D.11)	Peak Runoff Q (CFS)	Left Side Slope (X:1)	Right Side Slope (X:1)	Bottom Width (FT)	Running Slope (%)	Lining Material	n Manning Coef.	Channel Length (FT)	Flow Depth (FT)	Flow Velocity (FT/S)	Flow Area (SF)	Wetted Perimeter (FT)	Hydraulic Radius (FT)	SHA Maximum Velocity (FT/S)	Channel Depth (FT)	Freeboard (FT)	Treated Pe (IN)	Comments
SPRINGHILL-1	1	0.036	1.526	99.027	7.00	0.20	0.08	3.00	6.00	2.00	3.8%	Grass	0.150	330	0.09	0.35	0.22	2.85	0.08	6.00	1.50	1.41	0.10	
SPRINGHILL-2	1	0.066	2.230	98.194	7.00	0.20	0.21	3.00	4.00	6.00	4.4%	Grass	0.150	300	0.09	0.39	0.54	6.63	0.08	6.00	1.75	1.66	0.19	
SPRINGHILL-3	1	0.137	0.270	95.871	7.00	0.21	0.05	5.00	3.00	6.00	1.1%	Grass	0.150	80	0.06	0.15	0.35	6.47	0.05	6.00	2.85	2.79	0.41	
SPRINGHILL-5	1	0.069	1.265	98.053	7.00	0.20	0.13	4.00	3.00	6.00	4.4%	Grass	0.150	180	0.06	0.32	0.39	6.46	0.06	6.00	1.60	1.54	0.20	
MEADOWSIDE-1	1	0.052	1.608	97.864	7.00	0.24	0.12	3.00	5.00	6.00	3.0%	Grass	0.150	210	0.07	0.28	0.43	6.56	0.07	6.00	1.40	1.33	0.18	Section taken in middle (shallowest)
MEADOWSIDE-4	1	0.668	0.165	89.090	7.00	0.16	0.16	4.00	3.00	6.00	3.2%	Grass	0.150	185	0.08	0.32	0.51	6.59	0.08	6.00	0.85	0.77	1.54	
SPRINGHILL-6	1	0.031	4.520	98.918	7.00	0.22	0.20	6.00	3.00	6.00	3.0%	Grass	0.150	320	0.09	0.34	0.59	6.86	0.09	6.00	1.00	0.91	0.10	Section taken at DS end (shallowest)
SPRINGHILL-7	1	0.037	1.208	98.514	7.00	0.24	0.06	3.00	6.00	6.00	0.3%	Grass	0.150	110	0.09	0.11	0.59	6.85	0.09	6.00	1.40	1.31	0.13	
LAUREL-1	2	0.017	2.091	99.407	7.00	0.23	0.05	3.00	4.00	6.00	2.8%	Grass	0.150	80	0.04	0.19	0.25	6.30	0.04	6.00	1.70	1.66	0.05	
HUNTER-1	2	0.054	0.665	98.239	7.00	0.22	0.05	8.00	3.00	2.00	1.1%	Grass	0.150	240	0.10	0.20	0.26	3.15	0.08	6.00	1.00	0.90	0.17	Section taken upstream (flattest and shallowest)
MEADOWSIDE-2	2	0.020	12.003	99.286	7.00	0.22	0.35	4.00	3.00	6.00	3.0%	Grass	0.150	560	0.13	0.42	0.84	6.94	0.12	6.00	2.00	1.87	0.06	
MEADOWSIDE-3	2	0.234	1.153	93.842	7.00	0.20	0.39	3.00	5.00	6.00	2.9%	Grass	0.150	550	0.14	0.43	0.91	7.15	0.13	6.00	1.40	1.26	0.66	Section taken at DS end (shallowest)
LAUREL-2	2	0.007	16.475	99.768	7.00	0.22	0.16	3.00	4.00	6.00	0.5%	Grass	0.150	250	0.14	0.18	0.89	7.00	0.13	6.00	2.40	2.26	0.02	Section taken upstream (flattest)
SPRINGHILL-8	2	0.114	0.515	95.798	7.00	0.23	0.08	4.00	3.00	6.00	2.6%	Grass	0.150	140	0.06	0.23	0.36	6.42	0.06	6.00	1.65	1.59	0.37	
LAUREL-3	2	0.074	2.386	97.734	7.00	0.21	0.25	5.00	3.00	6.00	1.0%	Grass	0.150	380	0.15	0.26	0.97	7.22	0.13	6.00	1.50	1.35	0.22	Section taken in middle (flattest)
SPRINGHILL-4	2	0.226	0.370	94.078	7.00	0.20	0.12	3.00	4.00	6.00	4.5%	Grass	0.150	170	0.06	0.32	0.38	6.44	0.06	6.00	1.50	1.44	0.63	
GLENDALE-1	2	0.006	29.615	99.718	7.00	0.25	0.27	3.00	4.00	6.00	1.5%	Grass	0.150	490	0.14	0.31	0.88	6.99	0.13	6.00	1.70	1.56	0.02	Section taken in middle (shallowest)
GLENDALE-2	2	0.004	36.982	99.830	7.00	0.24	0.21	3.00	4.00	6.00	0.4%	Grass	0.150	375	0.17	0.18	1.15	7.27	0.16	6.00	2.50	2.33	0.01	Section taken in middle (flattest)
STONERIDGE-1	2	0.057	0.795	98.287	7.00	0.21	0.07	7.00	3.00	2.00	0.4%	Grass	0.150	290	0.15	0.15	0.43	3.58	0.12	6.00	1.30	1.15	0.17	Section taken at DS end (flattest)
STONERIDGE-2	2	0.080	0.487	97.495	7.00	0.21	0.06	3.00	7.00	2.00	0.4%	Grass	0.150	255	0.14	0.15	0.39	3.45	0.11	6.00	1.30	1.16	0.24	Section taken in middle (flattest)
STONERIDGE-3	2	0.033	0.492	98.973	7.00	0.21	0.02	3.00	5.00	2.00	2.1%	Grass	0.150	105	0.05	0.19	0.12	2.45	0.05	6.00	1.30	1.25	0.10	Section taken at DS end (shallowest)
GLENDALE-5	3	0.011	3.009	99.307	7.00	0.29	0.05	3.00	6.00	2.00	0.9%	Grass	0.150	315	0.10	0.18	0.25	2.95	0.09	6.00	1.50	1.40	0.05	Section taken at DS end (flattest)
GLENDALE-6	3	0.014	6.917	99.361	7.00	0.25	0.14	6.00	3.00	2.00	0.7%	Grass	0.150	760	0.20	0.23	0.58	3.84	0.15	6.00	1.80	1.60	0.05	Section taken in middle (flattest)
GLENDALE-4	3	0.044	3.334	98.601	7.00	0.21	0.21	6.00	3.00	6.00	1.2%	Grass	0.150	320	0.12	0.26	0.82	7.15	0.11	6.00	1.30	1.18	0.13	Section taken upstream (flattest and shallowest)
GLENDALE-3	3	0.024	17.759	99.088	7.00	0.23	0.61	5.00	3.00	6.00	0.4%	Grass	0.150	1020	0.32	0.26	2.33	8.64	0.27	6.00	2.00	1.68	0.08	Section taken in middle (flattest)
FALSTONE-2	3	0.039	1.214	98.875	7.00	0.20	0.07	3.00	6.00	2.00	0.6%	Grass	0.150	295	0.14	0.18	0.38	3.32	0.11	6.00	1.40	1.26	0.11	Section taken upstream (flattest)
FALSTONE-1	3	0.020	6.551	99.185	7.00	0.24	0.19	3.00	5.00	6.00	0.7%	Grass	0.150	325	0.14	0.21	0.90	7.13	0.13	6.00	1.40	1.26	0.07	Section taken in middle (flattest)
FALSTONE-3	3	0.073	1.895	97.577	7.00	0.22	0.20	6.00	3.00	6.00	0.8%	Grass	0.150	310	0.14	0.22	0.90	7.25	0.12	6.00	1.40	1.26	0.23	Section taken in middle (flattest and shallowest)
CLEARFIELD-1	3	0.032	1.306	98.796	7.00	0.23	0.06	3.00	6.00	2.00	0.5%	Grass	0.150	300	0.14	0.16	0.37	3.30	0.11	6.00	1.40	1.26	0.11	Section taken from upstream (flattest)
FALSTONE-4	3	0.002	32.507	99.917	7.00	0.25	0.09	4.00	3.00	6.00	0.8%	Grass	0.150	160	0.09	0.17	0.54	6.62	0.08	6.00	2.00	1.91	0.01	
FALSTONE-5	3	0.003	39.757	99.883	7.00	0.24	0.16	3.00	3.00	6.00	0.3%	Grass	0.150	280	0.17	0.14	1.11	7.08	0.16	6.00	2.40	2.23	0.01	Section taken upstream (flattest)
CLAIBORNE-2	4	0.050	1.442	98.772	7.00	0.19	0.10	3.00	9.00	2.00	0.8%	Grass	0.150	415	0.16	0.22	0.48	3.97	0.12	6.00	1.10	0.94	0.13	Section taken in middle (flattest)
CLAIBORNE-1	4	0.034	6.328	98.836	7.00	0.22	0.30	6.00	3.00	6.00	0.1%	Grass	0.150	485	0.32	0.13	2.36	8.94	0.26	6.00	1.10	0.78	0.11	Section taken in middle (flattest and shallowest)
CLAIBORNE-3	4	0.067	2.283	98.166	7.00	0.20	0.22	3.00	7.00	6.00	0.9%	Grass	0.150	310	0.14	0.24	0.93	7.42	0.13	6.00	1.00	0.86	0.19	Section taken downstream (flattest)
AUTUMN-1	4	0.012	10.736	99.637	7.00	0.21	0.18	3.00	7.00	6.00	0.8%	Grass	0.150	270	0.13	0.21	0.85	7.32	0.12	6.00	1.20	1.07	0.03	Section taken in middle (flattest)
FROSTY-1	4	0.049	1.186	98.874	7.00	0.18	0.08	3.00	7.00	2.00	1.5%	Grass	0.150	325	0.12	0.26	0.32	3.27	0.10	6.00	1.30	1.18	0.13	Section taken in middle (flattest)
AUTUMN-2	4	0.023	22.280	99.317	7.00	0.21	0.73	3.00	3.00	6.00	1.3%	Grass	0.150	1075	0.26	0.42	1.73	7.62	0.23	6.00	1.80	1.54	0.07	Section taken in middle (flattest)
WHEATFIELD-2	4	0.095	0.211	97.732	7.00	0.19	0.03	6.00	3.00	2.00	0.1%	Grass	0.150	115	0.15	0.07	0.39	3.36	0.12	6.00	1.20	1.05	0.25	average
WHEATFIELD-3	4	0.124	0.242	97.463	7.00	0.17	0.04	3.00	6.00	2.00	0.1%	Grass	0.150	160	0.18	0.08	0.52	3.69	0.14	6.00	1.60	1.42	0.30	average
CLAIBORNE-4	4	0.011	15.268	99.679	7.00	0.20	0.24	4.00	3.00	6.00	1.2%	Grass	0.150	350	0.14	0.27	0.89	7.00	0.13	6.00	1.60	1.46	0.03	Section taken in middle (flattest)
CLAIBORNE-5	4	0.022	7.640	99.406	7.00	0.20	0.24	3.00	5.00	6.00	1.0%	Grass	0.150	335	0.14	0.25	0.94	7.18	0.13	6.00	1.60	1.46	0.06	Section taken in middle (flattest)
AUTUMN-3	4	0.002	45.503	99.948	7.00	0.20	0.12	3.00	2.00	6.00	3.7%	Grass	0.150	170	0.06	0.30	0.39	6.35	0.06	6.00	3.60	3.54	0.01	average
SUMMERFIELD-1	5	0.023	11.763	99.229	7.00	0.22	0.38	3.00	5.00	6.00	0.5%	Grass	0.150	600	0.23	0.24	1.58	7.89	0.20	6.00	1.50	1.27	0.07	Section taken upstream (flattest)
AUTUMN-4	5	0.088	1.748	97.961	7.00	0.18	0.22	6.00	3.00	6.00	0.5%	Grass	0.150	290	0.17	0.20	1.13	7.55	0.15	6.00	1.20	1.03	0.23	Section taken upstream (flattest and shallowest)
AUTUMN-5	5	0.019	16.333	99.406	7.00	0.21	0.45	3.00	3.00	6.00	1.0%	Grass	0.150	675	0.21	0.33	1.38	7.32	0.19	6.00	2.20	1.99	0.06	Section taken in middle (flattest)
WSUNDOWN-1	5	0.021	2.833	99.288	7.00	0.22	0.08	3.00	5.00	2.00	0.5%	Grass	0.150	400	0.17	0.18	0.46	3.41	0.13	6.00	1.70	1.53	0.06	Section taken downstream (flattest)
SUNDOWN-1	5	0.020	7.379	99.299	7.00	0.22	0.21	3.00	5.00	6.00	1.4%	Grass	0.150	340	0.12	0.27	0.78	7.00	0.11	6.00	1.40	1.28	0.06	Section taken in middle (flattest)
WSUNDOWN-2	5	0.108	0.898	97.001	7.00	0.20	0.14	5.00	3.00	6.00	0.9%	Grass	0.150	200	0.11	0.20	0.69	6.89	0.10	6.00	1.30	1.19	0.31	Section taken in middle (flattest)
SUNDOWN-2	5	0.170	1.547	96.037	7.00	0.19	0.38	5.00	3.00	6.00	1.2%	Grass	0.150	500	0.18	0.32	1.19	7.47	0.16	6.00	1.20	1.02	0.45	average
AUTUMN-6	5	0.009	28.952	99.729	7.00	0.21	0.36	3.00	3.00	6.00	1.3%	Grass	0.150	540	0.17	0.33	1.10	7.07	0.16	6.00	2.30	2.13	0.03	Section taken upstream (flattest)
ESUNDOWN-1	6	0.065	0.587	98.555	7.00	0.18	0.06	3.00	6.00	2.00	4.0%	Grass	0.150	210	0.07	0.32	0.17	2.69	0.06	6.00	1.50	1.43	0.16	average

*Note: Flowmaster was used to computer Velocity, Capacity Full, Normal Depth, and % Full - see attached output.

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Frederick County Storm Drain Design Sheet (Pipe Capacity - Proposed Computations)

Project: CloverHill Drainage
Project No.: 100-291.05
Design Phase: Concept

Designed By: ADB
Checked By:
Date: 8/29/2024

Year Storm Event: 1in WQ
Rainfall Factor: 1
County: Frederick
Agency: DPW

Drainage Area		Contributing Area			1in WQ-Year Runoff			Channel Information							Results									Remarks
Channel Name	POI	Qa (App. D.11)	A AREA (AC.)	RCN Adj.	tc Time Conc. (MIN)	Ia/Pe (App. D.11)	Peak Runoff Q (CFS)	Left Side Slope (X:1)	Right Side Slope (X:1)	Bottom Width (FT)	Running Slope (%)	Lining Material	n Manning Coef.	Channel Length (FT)	Flow Depth (FT)	Flow Velocity (FT/S)	Flow Area (SF)	Wetted Perimeter (FT)	Hydraulic Radius (FT)	SHA Maximum Velocity (FT/S)	Channel Depth (FT)	Freeboard (FT)	Treated Pe (IN)	Comments
RUNNYMEADE-3	7	0.049	1.513	98.027	7.00	0.24	0.10	6.00	3.00	2.00	1.3%	Grass	0.150	550	0.15	0.27	0.39	3.35	0.12	6.00	1.20	1.05	0.17	Section taken downstream (flattest and shallowest)
CLEARFIELD-2	7	0.054	1.431	98.001	7.00	0.23	0.11	8.00	3.00	2.00	0.5%	Grass	0.150	550	0.19	0.19	0.58	4.14	0.14	6.00	0.70	0.51	0.18	Section taken downstream (flattest)
RUNNYMEADE-2A	8	0.056	0.340	97.806	7.00	0.24	0.03	3.00	6.00	2.00	0.1%	Grass	0.150	140	0.14	0.07	0.37	3.30	0.11	6.00	0.60	0.46	0.19	average upstream
RUNNYMEADE-2B	8	0.055	0.780	97.716	7.00	0.24	0.06	3.00	6.00	2.00	1.2%	Grass	0.150	325	0.11	0.22	0.28	3.02	0.09	6.00	0.70	0.59	0.19	average downstream
RUNNYMEADE-1	8	0.065	0.764	98.147	7.00	0.20	0.07	6.00	3.00	2.00	0.4%	Grass	0.150	310	0.16	0.16	0.45	3.52	0.13	6.00	1.10	0.94	0.19	Section taken downstream (flattest)
EDGEWOOD-5	8	0.051	1.088	98.045	7.00	0.24	0.08	8.00	3.00	2.00	3.0%	Grass	0.150	400	0.10	0.32	0.25	3.09	0.08	6.00	1.10	1.00	0.17	average
EDGEWOOD-6	8	0.047	0.550	98.743	7.00	0.20	0.04	7.00	3.00	2.00	1.2%	Grass	0.150	155	0.08	0.18	0.20	2.85	0.07	6.00	1.00	0.92	0.13	average
EDGEWOOD-7	8	0.024	0.455	99.260	7.00	0.21	0.02	8.00	3.00	2.00	1.2%	Grass	0.150	70	0.05	0.14	0.11	2.56	0.04	6.00	0.50	0.45	0.07	average
EDGEWOOD-3	9	0.068	0.418	97.530	7.00	0.23	0.04	8.00	3.00	2.00	1.1%	Grass	0.150	200	0.09	0.18	0.22	2.99	0.07	6.00	1.10	1.01	0.22	average
EDGEWOOD-4	9	0.001	8.673	99.958	7.00	0.23	0.01	9.00	3.00	2.00	1.6%	Grass	0.150	70	0.04	0.14	0.10	2.54	0.04	6.00	1.10	1.06	0.00	average
EDGEWOOD-1	9	0.049	1.631	98.087	7.00	0.24	0.11	3.00	9.00	2.00	0.4%	Grass	0.150	585	0.20	0.17	0.65	4.48	0.15	6.00	0.75	0.55	0.16	Section taken downstream (flattest)
EDGEWOOD-2	9	0.057	0.858	98.321	7.00	0.21	0.07	9.00	3.00	2.00	1.3%	Grass	0.150	310	0.11	0.23	0.31	3.40	0.09	6.00	1.00	0.89	0.17	average
SUNNYBROOK-1	9	0.056	0.662	98.281	7.00	0.21	0.05	3.00	8.00	2.00	0.5%	Grass	0.150	240	0.13	0.15	0.35	3.45	0.10	6.00	1.10	0.97	0.17	Section taken upstream (flattest)
WHILLS-1A	10	0.004	4.421	99.836	7.00	0.25	0.02	3.00	4.00	2.00	1.3%	Grass	0.150	125	0.06	0.16	0.14	2.45	0.06	6.00	1.20	1.14	0.01	average
WHILLS-1B	10	0.009	6.206	99.607	7.00	0.25	0.08	3.00	3.00	2.00	0.5%	Grass	0.150	430	0.17	0.19	0.42	3.07	0.14	6.00	1.00	0.83	0.03	West Hills Section. Average
SPOUTSPRING-1	10	0.077	1.500	98.339	7.00	0.18	0.17	5.00	3.00	2.00	0.5%	Grass	0.150	630	0.25	0.23	0.74	4.05	0.18	6.00	0.90	0.65	0.19	Section taken middle (flattest)
POOLE-1	12	0.047	0.798	98.680	7.00	0.20	0.05	6.00	3.00	2.00	2.5%	Grass	0.150	230	0.08	0.27	0.20	2.77	0.07	6.00	0.50	0.42	0.13	Section taken upstream (shallowest)
WHEATFIELD-1	12	0.043	0.271	98.863	7.00	0.19	0.02	3.00	7.00	2.00	2.4%	Grass	0.150	70	0.04	0.18	0.10	2.44	0.04	6.00	1.50	1.46	0.12	average

*Note: Flowmaster was used to computer Velocity, Capacity Full, Normal Depth, and % Full - see attached output.

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17 Gwynns Mill Court • Owings Mills, MD 21117

Frederick County Storm Drain Design Sheet (Pipe Capacity - Proposed Computations)

Project: CloverHill Drainage
Project No.: 100-291.05
Design Phase: Concept

Designed By: ADB
Checked By:
Date: 8/29/2024

Year Storm Event: 10
Rainfall Factor: 1
County: Frederick
Agency: DPW

Drainage Area		Contributing Area			10-Year Runoff			Channel Information							Results									Remarks
Channel Name	POI	C AREA (#)	A AREA (AC.)	Δ CA	tc Time Conc. (MIN)	if Rain Intens. (IN/HR)	Peak Runoff Q (CFS)	Left Side Slope (X:1)	Right Side Slope (X:1)	Bottom Width (FT)	Running Slope (%)	Lining Material	n Manning Coef.	Channel Length (FT)	Flow Depth (FT)	Flow Velocity (FT/S)	Flow Area (SF)	Wetted Perimeter (FT)	Hydraulic Radius (FT)	SHA Maximum Velocity (FT/S)	Channel Depth (FT)	Freeboard (FT)	Treated Pe (IN)	Comments
SPRINGHILL-1	1	0.379	1.526	0.578	7.00	6.47	3.74	3.00	6.00	2.00	3.8%	Grass	0.106	330	0.58	1.39	2.68	7.37	0.36	6.00	1.50	0.92	0.10	
SPRINGHILL-2	1	0.380	2.230	0.848	7.00	6.47	5.49	3.00	4.00	6.00	4.4%	Grass	0.120	300	0.50	1.42	3.88	9.64	0.40	6.00	1.75	1.25	0.19	
SPRINGHILL-3	1	0.364	0.270	0.098	7.00	6.47	0.64	5.00	3.00	6.00	1.1%	Grass	0.150	80	0.25	0.37	1.71	8.03	0.21	6.00	2.85	2.60	0.41	
SPRINGHILL-5	1	0.384	1.265	0.486	7.00	6.47	3.15	4.00	3.00	6.00	4.4%	Grass	0.138	180	0.40	1.08	2.92	8.88	0.33	6.00	1.60	1.20	0.20	
MEADOWSIDE-1	1	0.320	1.608	0.514	7.00	6.47	3.33	3.00	5.00	6.00	3.0%	Grass	0.131	210	0.44	0.98	3.39	9.61	0.35	6.00	1.40	0.96	0.18	Section taken in middle (shallowest)
MEADOWSIDE-4	1	0.480	0.165	0.079	7.00	6.47	0.51	4.00	3.00	6.00	3.2%	Grass	0.150	185	0.16	0.49	1.04	7.16	0.15	6.00	0.85	0.69	1.54	
SPRINGHILL-6	1	0.348	4.520	1.574	7.00	6.47	10.18	6.00	3.00	6.00	3.0%	Grass	0.092	320	0.66	1.73	5.90	12.09	0.49	6.00	1.00	0.34	0.10	Section taken at DS end (shallowest)
SPRINGHILL-7	1	0.320	1.208	0.386	7.00	6.47	2.50	3.00	6.00	6.00	0.3%	Grass	0.102	110	0.61	0.47	5.28	11.60	0.46	6.00	1.40	0.79	0.13	
LAUREL-1	2	0.339	2.091	0.709	7.00	6.47	4.58	3.00	4.00	6.00	2.8%	Grass	0.118	80	0.51	1.16	3.97	9.71	0.41	6.00	1.70	1.19	0.05	
HUNTER-1	2	0.363	0.665	0.241	7.00	6.47	1.56	8.00	3.00	2.00	1.1%	Grass	0.117	240	0.52	0.62	2.50	7.80	0.32	6.00	1.00	0.48	0.17	Section taken upstream (flattest and shallowest)
MEADOWSIDE-2	2	0.347	12.003	4.171	7.00	6.47	26.99	4.00	3.00	6.00	3.0%	Grass	0.056	560	0.87	3.43	7.87	12.34	0.64	6.00	2.00	1.13	0.06	
MEADOWSIDE-3	2	0.386	1.153	0.445	7.00	6.47	2.88	3.00	5.00	6.00	2.9%	Grass	0.135	550	0.41	0.91	3.17	9.42	0.34	6.00	1.40	0.99	0.66	Section taken at DS end (shallowest)
LAUREL-2	2	0.349	16.475	5.747	7.00	6.47	37.19	3.00	4.00	6.00	0.5%	Grass	0.033	250	1.25	2.87	12.94	15.09	0.86	6.00	2.40	1.15	0.02	Section taken upstream (flattest)
SPRINGHILL-8	2	0.338	0.515	0.174	7.00	6.47	1.12	4.00	3.00	6.00	2.6%	Grass	0.150	140	0.27	0.61	1.86	7.95	0.23	6.00	1.65	1.38	0.37	
LAUREL-3	2	0.369	2.386	0.881	7.00	6.47	5.70	5.00	3.00	6.00	1.0%	Grass	0.093	380	0.66	1.01	5.67	11.43	0.50	6.00	1.50	0.84	0.22	Section taken in middle (flattest)
SPRINGHILL-4	2	0.384	0.370	0.142	7.00	6.47	0.92	3.00	4.00	6.00	4.5%	Grass	0.150	170	0.20	0.68	1.36	7.48	0.18	6.00	1.50	1.30	0.63	
GLENDALE-1	2	0.269	29.615	7.962	7.00	6.47	51.52	3.00	4.00	6.00	1.5%	Grass	0.033	490	1.11	4.68	11.02	14.11	0.78	6.00	1.70	0.59	0.02	Section taken in middle (shallowest)
GLENDALE-2	2	0.281	36.982	10.391	7.00	6.47	67.23	3.00	4.00	6.00	0.4%	Grass	0.033	375	1.77	3.11	21.60	18.90	1.14	6.00	2.50	0.73	0.01	Section taken in middle (flattest)
STONERIDGE-1	2	0.363	0.795	0.288	7.00	6.47	1.87	7.00	3.00	2.00	0.4%	Grass	0.093	290	0.65	0.54	3.44	8.68	0.40	6.00	1.30	0.65	0.17	Section taken at DS end (flattest)
STONERIDGE-2	2	0.387	0.487	0.188	7.00	6.47	1.22	3.00	7.00	2.00	0.4%	Grass	0.107	255	0.57	0.44	2.78	7.86	0.35	6.00	1.30	0.73	0.24	Section taken in middle (flattest)
STONERIDGE-3	2	0.383	0.492	0.188	7.00	6.47	1.22	3.00	5.00	2.00	2.1%	Grass	0.130	105	0.44	0.73	1.66	5.65	0.29	6.00	1.30	0.86	0.10	Section taken at DS end (shallowest)
GLENDALE-5	3	0.245	3.009	0.738	7.00	6.47	4.77	3.00	6.00	2.00	0.9%	Grass	0.074	315	0.77	1.14	4.18	9.09	0.46	6.00	1.50	0.73	0.05	Section taken at DS end (flattest)
GLENDALE-6	3	0.274	6.917	1.892	7.00	6.47	12.24	6.00	3.00	2.00	0.7%	Grass	0.041	760	0.95	2.04	6.00	10.81	0.55	6.00	1.80	0.85	0.05	Section taken in middle (flattest)
GLENDALE-4	3	0.302	3.334	1.006	7.00	6.47	6.51	6.00	3.00	6.00	1.2%	Grass	0.092	320	0.66	1.10	5.93	12.11	0.49	6.00	1.30	0.64	0.13	Section taken upstream (flattest and shallowest)
GLENDALE-3	3	0.275	17.759	4.891	7.00	6.47	31.65	5.00	3.00	6.00	0.4%	Grass	0.033	1020	1.19	2.47	12.80	15.83	0.81	6.00	2.00	0.81	0.08	Section taken in middle (flattest)
FALSTONE-2	3	0.313	1.214	0.380	7.00	6.47	2.46	3.00	6.00	2.00	0.6%	Grass	0.089	295	0.68	0.72	3.42	8.27	0.41	6.00	1.40	0.72	0.11	Section taken upstream (flattest)
FALSTONE-1	3	0.261	6.551	1.710	7.00	6.47	11.07	3.00	5.00	6.00	0.7%	Grass	0.062	325	0.83	1.43	7.76	12.87	0.60	6.00	1.40	0.57	0.07	Section taken in middle (flattest)
FALSTONE-3	3	0.286	1.895	0.542	7.00	6.47	3.50	6.00	3.00	6.00	0.8%	Grass	0.107	310	0.57	0.71	4.92	11.30	0.44	6.00	1.40	0.83	0.23	Section taken in middle (flattest and shallowest)
CLEARFIELD-1	3	0.272	1.306	0.355	7.00	6.47	2.30	3.00	6.00	2.00	0.5%	Grass	0.088	300	0.68	0.66	3.46	8.31	0.42	6.00	1.40	0.72	0.11	Section taken from upstream (flattest)
FALSTONE-4	3	0.262	32.507	8.532	7.00	6.47	55.20	4.00	3.00	6.00	0.8%	Grass	0.033	160	1.35	3.80	14.53	15.86	0.92	6.00	2.00	0.65	0.01	
FALSTONE-5	3	0.265	39.757	10.528	7.00	6.47	68.11	3.00	3.00	6.00	0.3%	Grass	0.033	280	2.06	2.71	25.15	19.05	1.32	6.00	2.40	0.34	0.01	Section taken upstream (flattest)
CLAIBORNE-2	4	0.339	1.442	0.488	7.00	6.47	3.16	3.00	9.00	2.00	0.8%	Grass	0.091	415	0.67	0.79	4.01	10.16	0.39	6.00	1.10	0.43	0.13	Section taken in middle (flattest)
CLAIBORNE-1	4	0.269	6.328	1.705	7.00	6.47	11.03	6.00	3.00	6.00	0.1%	Grass	0.034	485	0.99	1.06	10.38	15.17	0.68	6.00	1.10	0.11	0.11	Section taken in middle (flattest and shallowest)
CLAIBORNE-3	4	0.304	2.283	0.694	7.00	6.47	4.49	3.00	7.00	6.00	0.9%	Grass	0.101	310	0.61	0.82	5.49	12.22	0.45	6.00	1.00	0.39	0.19	Section taken downstream (flattest)
AUTUMN-1	4	0.291	10.736	3.128	7.00	6.47	20.24	3.00	7.00	6.00	0.8%	Grass	0.047	270	0.92	2.08	9.74	15.41	0.63	6.00	1.20	0.28	0.03	Section taken in middle (flattest)
FROSTY-1	4	0.342	1.186	0.406	7.00	6.47	2.63	3.00	7.00	2.00	1.5%	Grass	0.104	325	0.59	0.89	2.94	8.06	0.36	6.00	1.30	0.71	0.13	Section taken in middle (flattest)
AUTUMN-2	4	0.294	22.280	6.548	7.00	6.47	42.37	3.00	3.00	6.00	1.3%	Grass	0.033	1075	1.07	4.31	9.82	12.75	0.77	6.00	1.80	0.73	0.07	Section taken in middle (flattest)
WHEATFIELD-2	4	0.360	0.211	0.076	7.00	6.47	0.49	6.00	3.00	2.00	0.1%	Grass	0.113	115	0.54	0.20	2.40	7.01	0.34	6.00	1.20	0.66	0.25	average
WHEATFIELD-3	4	0.381	0.242	0.092	7.00	6.47	0.60	3.00	6.00	2.00	0.1%	Grass	0.106	160	0.58	0.22	2.66	7.35	0.36	6.00	1.60	1.02	0.30	average
CLAIBORNE-4	4	0.298	15.268	4.545	7.00	6.47	29.41	4.00	3.00	6.00	1.2%	Grass	0.039	350	0.96	3.25	9.04	13.03	0.69	6.00	1.60	0.64	0.03	Section taken in middle (flattest)
CLAIBORNE-5	4	0.311	7.640	2.377	7.00	6.47	15.38	3.00	5.00	6.00	1.0%	Grass	0.057	335	0.86	1.89	8.13	13.11	0.62	6.00	1.60	0.74	0.06	Section taken in middle (flattest)
AUTUMN-3	4	0.298	45.503	13.580	7.00	6.47	87.86	3.00	2.00	6.00	3.7%	Grass	0.033	170	1.22	7.94	11.06	12.60	0.88	6.00	3.60	2.38	0.01	average
SUMMERFIELD-1	5	0.279	11.763	3.283	7.00	6.47	21.24	3.00	5.00	6.00	0.5%	Grass	0.037	600	0.98	2.20	9.66	14.06	0.69	6.00	1.50	0.52	0.07	Section taken upstream (flattest)
AUTUMN-4	5	0.345	1.748	0.602	7.00	6.47	3.90	6.00	3.00	6.00	0.5%	Grass	0.095	290	0.64	0.68	5.74	11.96	0.48	6.00	1.20	0.56	0.23	Section taken upstream (flattest and shallowest)
AUTUMN-5	5	0.296	16.333	4.839	7.00	6.47	31.31	3.00	3.00	6.00	1.0%	Grass	0.034	675	0.99	3.51	8.92	12.28	0.73	6.00	2.20	1.21	0.06	Section taken in middle (flattest)
WSUNDOWN-1	5	0.282	2.833	0.799	7.00	6.47	5.17	3.00	5.00	2.00	0.5%	Grass	0.059	400	0.85	1.13	4.58	9.01	0.51	6.00	1.70	0.85	0.06	Section taken downstream (flattest)
SUNDOWN-1	5	0.273	7.379	2.012	7.00	6.47	13.02	3.00	5.00	6.00	1.4%	Grass	0.069	340	0.80	1.78	7.30	12.57	0.58	6.00	1.40	0.60	0.06	Section taken in middle (flattest)
WSUNDOWN-2	5	0.321	0.898	0.289	7.00	6.47	1.87	5.00	3.00	6.00	0.9%	Grass	0.130	200	0.44	0.54	3.43	9.65	0.36	6.00	1.30	0.86	0.31	Section taken in middle (flattest)
SUNDOWN-2	5	0.344	1.547	0.532	7.00	6.47	3.44	5.00	3.00	6.00	1.2%	Grass	0.114	500	0.53	0.79	4.33	10.40	0.42	6.00	1.20	0.67	0.45	average
AUTUMN-6	5	0.294	28.952	8.505	7.00	6.47	55.03	3.00	3.00	6.00	1.3%	Grass	0.033	540	1.22	4.65	11.84	13.74	0.86	6.00	2.30	1.08	0.03	Section taken upstream (flattest)
ESUNDOWN-1	6	0.350	0.587	0.205	7.00	6.47	1.33	3.00	6.00	2.00	4.0%	Grass	0.138	210	0.40	0.89	1.50	5.66	0.26	6.00	1.50	1.10	0.16	average

*Note: Flowmaster was used to computer Velocity, Capacity Full, Normal Depth, and % Full - see attached output.

THE WILSON T. BALLARD CO.
CONSULTING ENGINEERS
17 Gwynns Mill Court • Owings Mills, MD 21117

Frederick County Storm Drain Design Sheet (Pipe Capacity - Proposed Computations)

Project: CloverHill Drainage
Project No.: 100-291.05
Design Phase: Concept

Designed By: ADB
Checked By:
Date: 8/29/2024

Year Storm Event: 10
Rainfall Factor: 1
County: Frederick
Agency: DPW

Drainage Area		Contributing Area			10-Year Runoff			Channel Information							Results									Remarks
Channel Name	POI	C AREA (#)	A AREA (AC.)	Δ CA	tc Time Conc. (MIN)	if Rain Intens. (IN/HR)	Peak Runoff Q (CFS)	Left Side Slope (X:1)	Right Side Slope (X:1)	Bottom Width (FT)	Running Slope (%)	Lining Material	n Manning Coef.	Channel Length (FT)	Flow Depth (FT)	Flow Velocity (FT/S)	Flow Area (SF)	Wetted Perimeter (FT)	Hydraulic Radius (FT)	SHA Maximum Velocity (FT/S)	Channel Depth (FT)	Freeboard (FT)	Treated Pe (IN)	Comments
RUNNYMEADE-3	7	0.281	1.513	0.426	7.00	6.47	2.76	6.00	3.00	2.00	1.3%	Grass	0.098	550	0.63	0.92	3.01	7.78	0.39	6.00	1.20	0.57	0.17	Section taken downstream (flattest and shallowest)
CLEARFIELD-2	7	0.294	1.431	0.420	7.00	6.47	2.72	8.00	3.00	2.00	0.5%	Grass	0.086	550	0.69	0.67	4.03	9.79	0.41	6.00	0.70	0.01	0.18	Section taken downstream (flattest)
RUNNYMEADE-2A	8	0.287	0.340	0.098	7.00	6.47	0.63	3.00	6.00	2.00	0.1%	Grass	0.105	140	0.59	0.23	2.74	7.44	0.37	6.00	0.60	0.01	0.19	average upstream
RUNNYMEADE-2B	8	0.282	0.780	0.220	7.00	6.47	1.42	3.00	6.00	2.00	1.2%	Grass	0.118	325	0.51	0.65	2.18	6.71	0.33	6.00	0.70	0.19	0.19	average downstream
RUNNYMEADE-1	8	0.334	0.764	0.255	7.00	6.47	1.65	6.00	3.00	2.00	0.4%	Grass	0.096	310	0.64	0.53	3.12	7.92	0.39	6.00	1.10	0.46	0.19	Section taken downstream (flattest)
EDGEWOOD-5	8	0.286	1.088	0.311	7.00	6.47	2.01	8.00	3.00	2.00	3.0%	Grass	0.125	400	0.47	0.92	2.18	7.32	0.30	6.00	1.10	0.63	0.17	average
EDGEWOOD-6	8	0.344	0.550	0.189	7.00	6.47	1.22	7.00	3.00	2.00	1.2%	Grass	0.124	155	0.47	0.59	2.07	6.85	0.30	6.00	1.00	0.53	0.13	average
EDGEWOOD-7	8	0.316	0.455	0.143	7.00	6.47	0.93	8.00	3.00	2.00	1.2%	Grass	0.134	70	0.42	0.51	1.82	6.73	0.27	6.00	0.50	0.08	0.07	average
EDGEWOOD-3	9	0.303	0.418	0.126	7.00	6.47	0.82	8.00	3.00	2.00	1.1%	Grass	0.136	200	0.41	0.47	1.74	6.59	0.26	6.00	1.10	0.69	0.22	average
EDGEWOOD-4	9	0.279	8.673	2.421	7.00	6.47	15.67	9.00	3.00	2.00	1.6%	Grass	0.051	70	0.90	2.36	6.63	12.97	0.51	6.00	1.10	0.20	0.00	average
EDGEWOOD-1	9	0.286	1.631	0.467	7.00	6.47	3.02	3.00	9.00	2.00	0.4%	Grass	0.081	585	0.73	0.66	4.60	10.86	0.42	6.00	0.75	0.02	0.16	Section taken downstream (flattest)
EDGEWOOD-2	9	0.318	0.858	0.273	7.00	6.47	1.77	9.00	3.00	2.00	1.3%	Grass	0.117	310	0.52	0.67	2.63	8.30	0.32	6.00	1.00	0.48	0.17	average
SUNNYBROOK-1	9	0.305	0.662	0.202	7.00	6.47	1.31	3.00	8.00	2.00	0.5%	Grass	0.110	240	0.56	0.47	2.81	8.24	0.34	6.00	1.10	0.54	0.17	Section taken upstream (flattest)
WHILLS-1A	10	0.280	4.421	1.238	7.00	6.47	8.01	3.00	4.00	2.00	1.3%	Grass	0.058	125	0.86	1.87	4.28	8.24	0.52	6.00	1.20	0.34	0.01	average
WHILLS-1B	10	0.282	6.206	1.751	7.00	6.47	11.33	3.00	3.00	2.00	0.5%	Grass	0.033	430	1.00	2.27	5.00	8.32	0.60	6.00	1.00	0.00	0.03	West Hills Section. Average
SPOUTSPRING-1	10	0.361	1.500	0.541	7.00	6.47	3.50	5.00	3.00	2.00	0.5%	Grass	0.072	630	0.78	0.88	3.96	8.41	0.47	6.00	0.90	0.12	0.19	Section taken middle (flattest)
POOLE-1	12	0.319	0.798	0.254	7.00	6.47	1.64	6.00	3.00	2.00	2.5%	Grass	0.125	230	0.47	0.85	1.93	6.35	0.30	6.00	0.50	0.03	0.13	Section taken upstream (shallowest)
WHEATFIELD-1	12	0.339	0.271	0.092	7.00	6.47	0.59	3.00	7.00	2.00	2.4%	Grass	0.150	70	0.31	0.54	1.09	5.15	0.21	6.00	1.50	1.19	0.12	average

*Note: Flowmaster was used to computer Velocity, Capacity Full, Normal Depth, and % Full - see attached output.

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 20 cfs

Design Flow: 29 cfs

Maximum Flow: 45 cfs

Roadway Data for Crossing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 403.98 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

Culvert Site Data

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 399.85 ft

Outlet Station: 41.00 ft

Outlet Elevation: 399.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Pipe Arch

Barrel Span: 35.00 in

Barrel Rise: 24.00 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0250

Culvert Type: Straight

Inlet Configuration: Projecting

Inlet Depression: None

Table 1 - Summary of Culvert Flows at Crossing: ex 24x35

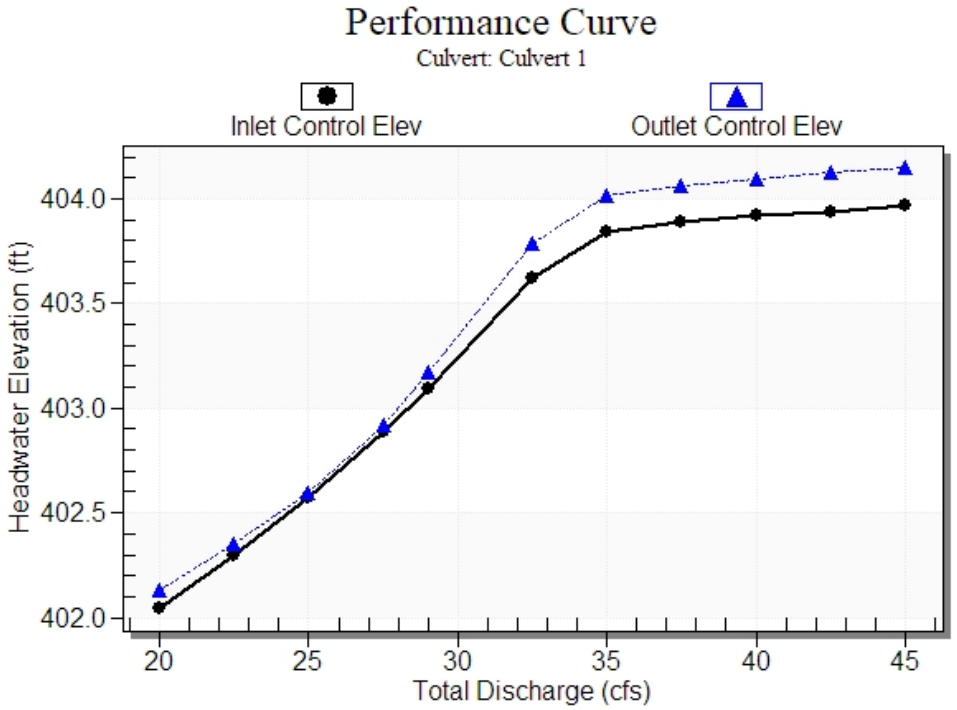
Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
402.13	20.00	20.00	0.00	1
402.35	22.50	22.50	0.00	1
402.60	25.00	25.00	0.00	1
402.92	27.50	27.50	0.00	1
403.17	**29.00**	**29.00**	**0.00**	**1**
403.78	32.50	32.50	0.00	1
404.02	35.00	33.86	1.04	16
404.06	37.50	34.10	3.34	6
404.09	40.00	34.29	5.66	5
404.12	42.50	34.40	8.01	4
404.15	45.00	34.59	10.37	4
403.98	33.66	33.66	0.00	Overtopping

The existing 24x35 CMP would contain the design flow with almost 10” freeboard.

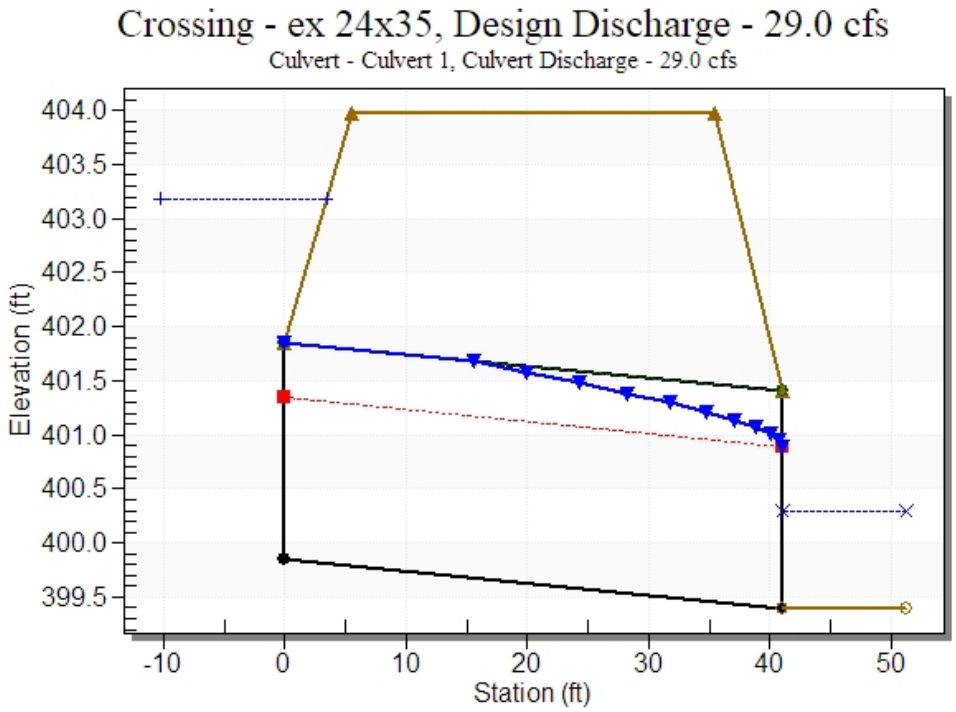
Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
20.00	20.00	402.13	2.193	2.285	7-M2c	1.514	1.215	1.215	0.754	6.283	4.594
22.50	22.50	402.35	2.443	2.503	7-M2c	2.000	1.297	1.297	0.795	6.627	4.734
25.00	25.00	402.60	2.723	2.746	7-M2c	2.000	1.379	1.379	0.833	6.949	4.864
27.50	27.50	402.92	3.036	3.071	7-M2c	2.000	1.453	1.453	0.869	7.291	4.985
29.00	29.00	403.17	3.241	3.324	7-M2c	2.000	1.495	1.495	0.890	7.500	5.053
32.50	32.50	403.78	3.769	3.935	7-M2c	2.000	1.585	1.585	0.936	8.002	5.202
35.00	33.86	404.02	3.994	4.167	7-M2c	2.000	1.618	1.618	0.966	8.204	5.301
37.50	34.10	404.06	4.035	4.210	7-M2c	2.000	1.623	1.623	0.996	8.240	5.395
40.00	34.29	404.09	4.067	4.244	7-M2c	2.000	1.628	1.628	1.024	8.268	5.484
42.50	34.40	404.12	4.087	4.273	7-M2c	2.000	1.630	1.630	1.051	8.285	5.570
45.00	34.59	404.15	4.120	4.300	7-M2c	2.000	1.635	1.635	1.078	8.314	5.651

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Culvert Data Summary - Culvert 2

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Summary of Culvert Flows at Crossing: ex 24

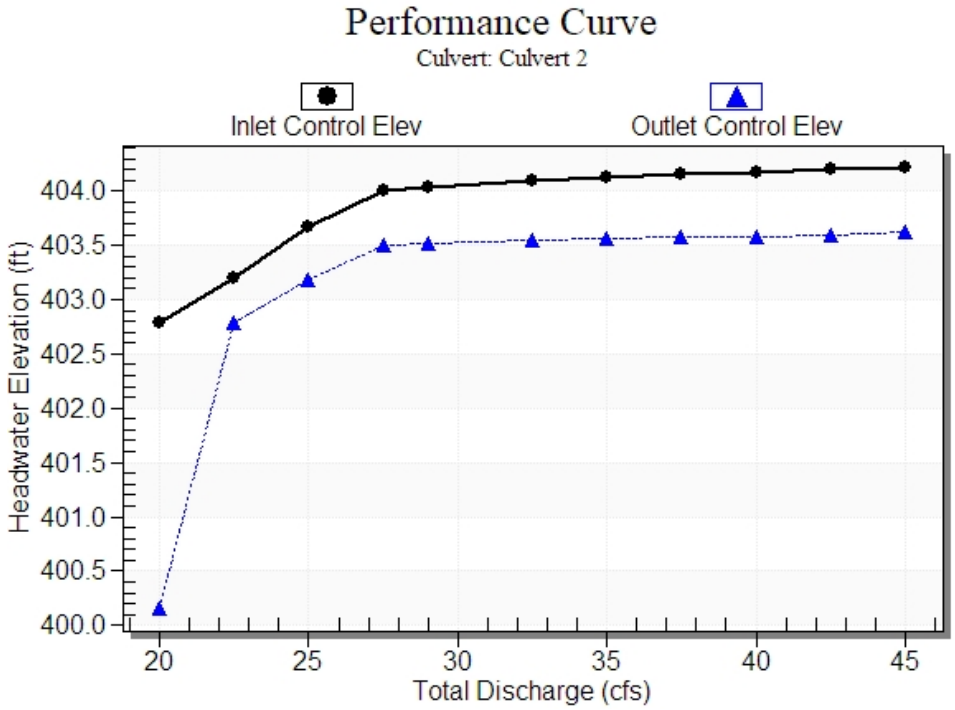
Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
402.78	20.00	20.00	0.00	1
403.20	22.50	22.50	0.00	1
403.68	25.00	25.00	0.00	1
404.01	27.50	26.60	0.81	22
404.04	**29.00**	**26.74**	**2.20**	**6**
404.09	32.50	26.97	5.45	5
404.12	35.00	27.11	7.81	4
404.15	37.50	27.23	10.22	4
404.17	40.00	27.35	12.62	4
404.20	42.50	27.45	14.95	3
404.22	45.00	27.55	17.36	3
403.98	26.46	26.46	0.00	Overtopping

The existing 24 HDPE restricts the flow and causes overtopping during the design storm.

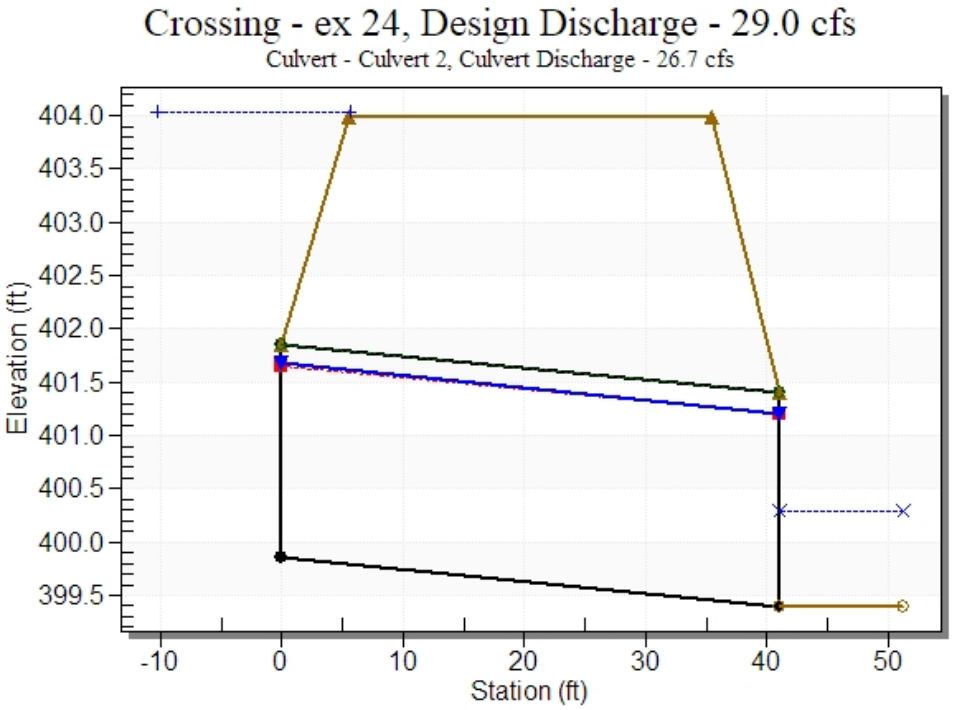
Table 4 - Culvert Summary Table: Culvert 2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
20.00	20.00	402.78	2.933	0.304	5-S2n	1.292	1.604	1.383	0.754	8.380	4.594
22.50	22.50	403.20	3.352	2.933	5-S2n	1.412	1.690	1.500	0.795	8.671	4.734
25.00	25.00	403.68	3.827	3.330	5-S2n	1.550	1.761	1.626	0.833	8.921	4.864
27.50	26.60	404.01	4.161	3.655	7-M2c	2.000	1.800	1.800	0.869	8.935	4.985
29.00	26.74	404.04	4.191	3.668	7-M2c	2.000	1.803	1.803	0.890	8.970	5.053
32.50	26.97	404.09	4.241	3.691	7-M2c	2.000	1.808	1.808	0.936	9.029	5.202
35.00	27.11	404.12	4.271	3.706	7-M2c	2.000	1.811	1.811	0.966	9.064	5.301
37.50	27.23	404.15	4.298	3.721	7-M2c	2.000	1.813	1.813	0.996	9.096	5.395
40.00	27.35	404.17	4.324	3.735	7-M2c	2.000	1.816	1.816	1.024	9.126	5.484
42.50	27.45	404.20	4.346	3.748	7-M2c	2.000	1.818	1.818	1.051	9.152	5.570
45.00	27.55	404.22	4.369	3.776	7-M2c	2.000	1.820	1.820	1.078	9.179	5.651

Culvert Performance Curve Plot: Culvert 2



Water Surface Profile Plot for Culvert: Culvert 2



Culvert Data Summary - Culvert 3

Barrel Shape: Elliptical

Barrel Span: 38.00 in

Barrel Rise: 24.00 in

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 5 - Summary of Culvert Flows at Crossing: pr 24x38

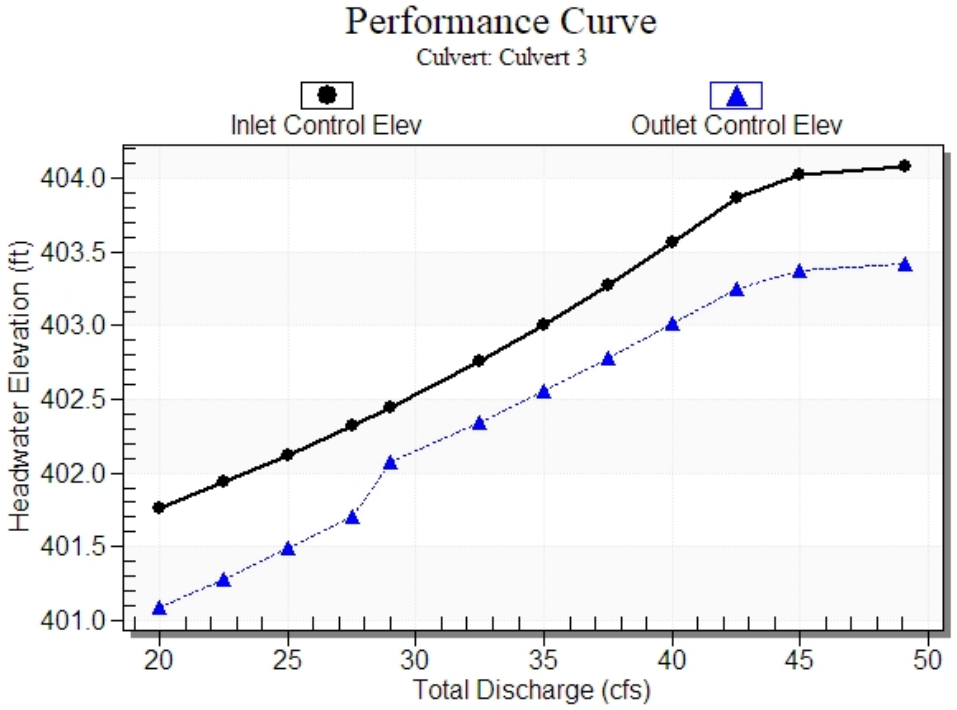
Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
401.76	20.00	20.00	0.00	1
401.94	22.50	22.50	0.00	1
402.12	25.00	25.00	0.00	1
402.32	27.50	27.50	0.00	1
402.45	**29.00**	**29.00**	**0.00**	**1**
402.76	32.50	32.50	0.00	1
403.01	35.00	35.00	0.00	1
403.28	37.50	37.50	0.00	1
403.56	40.00	40.00	0.00	1
403.87	42.50	42.50	0.00	1
404.02	45.00	43.68	1.24	12
403.98	43.36	43.36	0.00	Overtopping

The proposed 24x38 HERCP contains the design flow with over 18” freeboard.

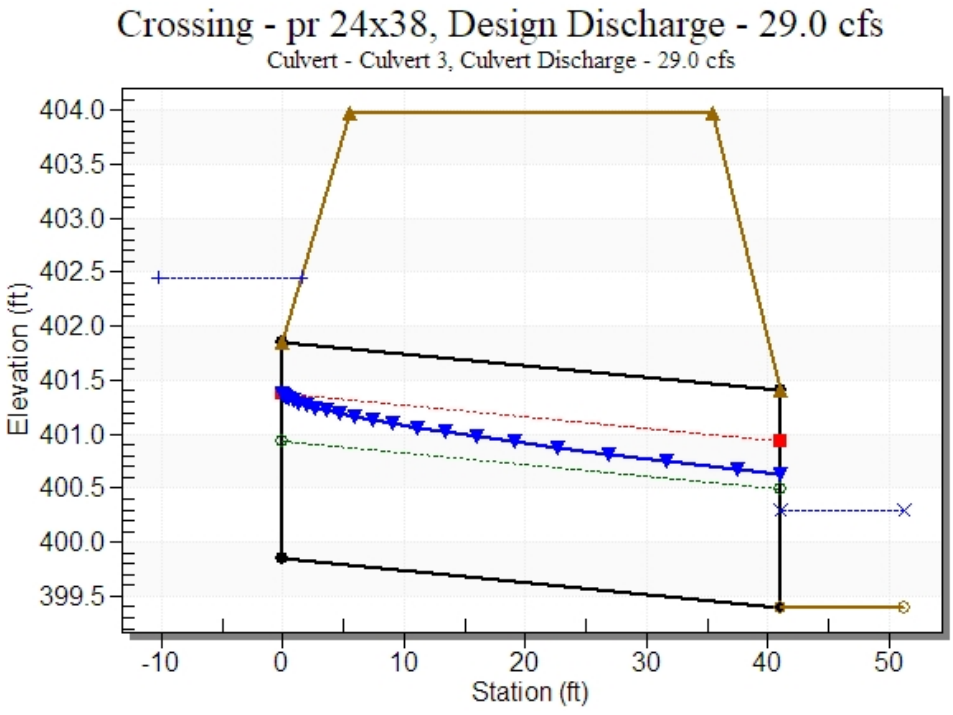
Table 6 - Culvert Summary Table: Culvert 3

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
20.00	20.00	401.76	1.909	1.236	1-S2n	0.876	1.254	0.975	0.754	7.786	4.594
22.50	22.50	401.94	2.086	1.431	5-S2n	0.936	1.335	1.048	0.795	8.030	4.734
25.00	25.00	402.12	2.272	1.639	5-S2n	0.995	1.414	1.118	0.833	8.254	4.864
27.50	27.50	402.32	2.470	1.853	5-S2n	1.054	1.486	1.185	0.869	8.477	4.985
29.00	29.00	402.45	2.596	2.222	5-S2n	1.088	1.527	1.225	0.890	8.603	5.053
32.50	32.50	402.76	2.913	2.499	5-S2n	1.167	1.616	1.315	0.936	8.896	5.202
35.00	35.00	403.01	3.160	2.710	5-S2n	1.223	1.673	1.378	0.966	9.100	5.301
37.50	37.50	403.28	3.427	2.931	5-S2n	1.280	1.724	1.439	0.996	9.311	5.395
40.00	40.00	403.56	3.713	3.162	5-S2n	1.338	1.768	1.499	1.024	9.518	5.484
42.50	42.50	403.87	4.020	3.402	5-S2n	1.398	1.802	1.559	1.051	9.727	5.570
45.00	43.68	404.02	4.172	3.520	5-S2n	1.427	1.818	1.587	1.078	9.820	5.651

Culvert Performance Curve Plot: Culvert 3



Water Surface Profile Plot for Culvert: Culvert 3



ESD VOLUME SUMMARY

	DA A-1	DA A-2 (POND#1)	DA B (CPv DETENTION FACILTY)	DA-C	TOTAL
REQUIRED (cf)	14,890	46,629	28,811	5,334	**95,922**
PROVIDED ESD (cf)	15,742	26,982	22,180	5,397	70,301
PROVIDED Cpv (cf)	-----	20,174 +	12,850	------	33,024
TOTAL PROVIDED (cf)	15,742	47,156 +	35,030	5,397	**103,325**

Note that the bioretention volumes in DA A-2 and B were provided to achieve a minimum Pe=1" and the remaining Cpv that was necessary to meet the required ESD volume has been provided as storage at a facility at inlet #75 and within Pond #1. The combined ESD volume provided through bioretention and the Cpv volume is greater than the required volume.

SWM FACILITIES

In general the SWM facilities are designed to provide quantity control and water treatment per the MD 2011 SWM Manual. Pond #1 will provide control of the 100-year storm event to be less than existing conditions. The table below shows the design discharges from the facility. It should be noted that during the initial reviews and design of the pond the USGS soil survey had been updated for this area. The soils were classified as hydrologic soil group 'C' and have now been classified as hydrologic soil group 'B'. The pond design has been revised to reflect this change in soils but due to this change the pond is overdesigned for quantity management.

SWM POND #1

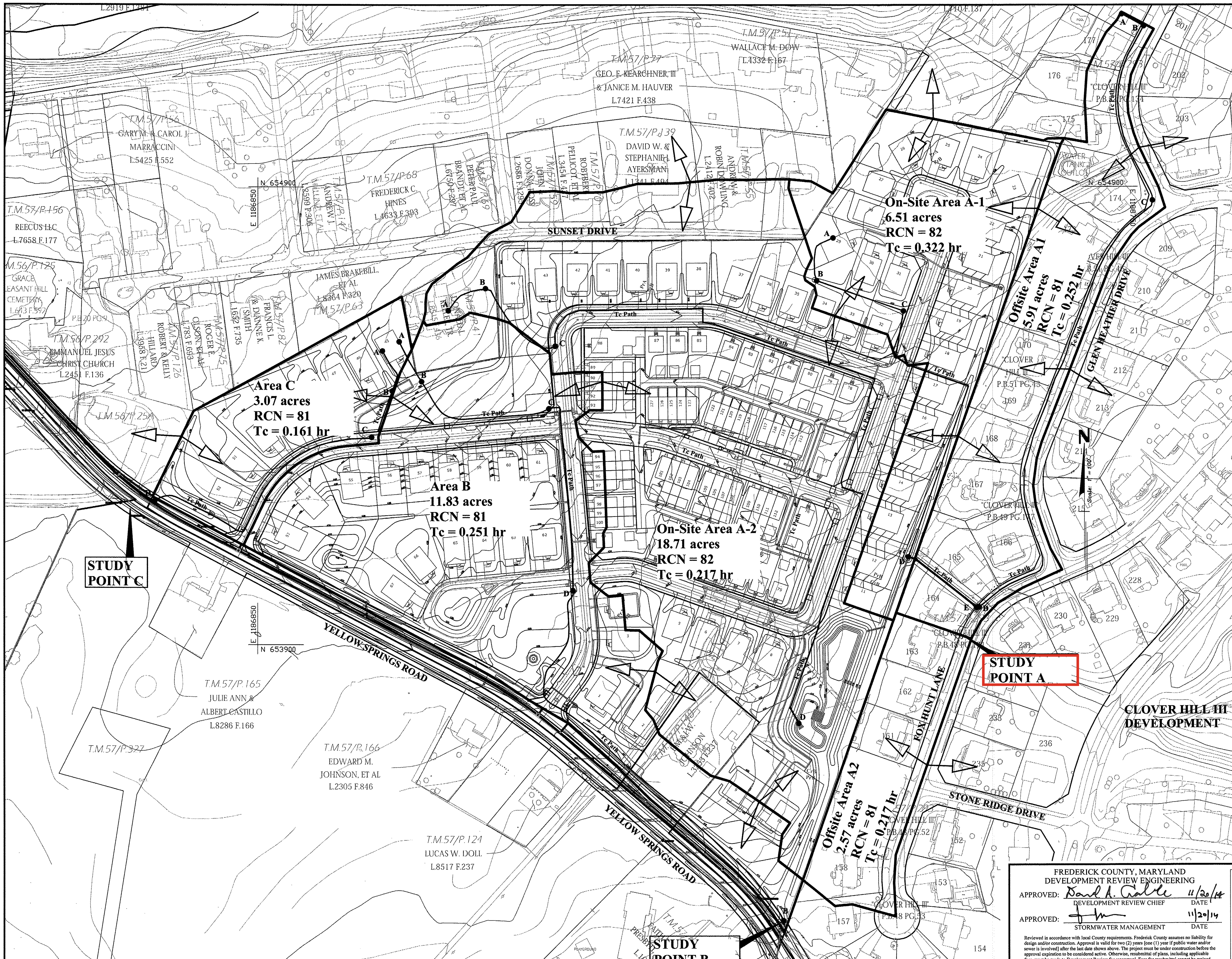
	EXISTING	PROPOSED			
STORM EVENT (YR)	**DA A (CFS)**	**DA A-1 (CFS)**	**DA A-2 POND OUTFALL (CFS)**	**DA A-OFFSITE (CFS)**	**TOTAL (CFS) (Outfall-A)**
2	**2.85**	3.38	0.34	5.07	**8.55**
10	**28.81**	11.73	1.30	17.29	**28.98**
100	**70.81**	22.34	21.52	32.79	**55.22**

CONCLUSIONS

ESD: ESD Facilities 5 & 6 have been changed from bioretention areas to dry swales. This change has been made as requested by The City of Frederick due to the location of these facilities. These ESD areas are located in front of the proposed townhouses. The water and sewer house connections cross underneath these ESD areas. Concerns of depth of the water and sewer house connections, promoting infiltration over sewer house connections and an inability to access for maintenance without disturbing the ESD facility are all factors in making ESD 5 & 6 a dryswale. ESD volume for this area has been provided by additional Cpv volume in the pond.

Pond #1: The Pond is designed to control the developed runoff from the 100-year storm event to less than the pre-developed rate. The pond controls more than is needed for the 10yr storm due to the DA that bypasses the pond. The CPv detention facility is designed to convey the 50yr storm event.

10



PROPSED CONDITIONS ANALYSIS

DRAINAGE AREA	STORM EVENT FLOWRATE (CFS)				
	1 YR	2 YR	10 YR	25 YR	100 YR
STUDY POINT A	18.0	26.50	55.40	61.60	111.50

NOTES:

1) THE ENTIRETY OF LAND BAY A IS COMPRISED OF C SOILS.

2) RROPOSED CONDITIONS WERE MODELED USING OPEN SPACE GOOD CONDITION, IMPERVIOUS AREA, AND RESIDENTIAL DISTRICT (1/3 ACRE).

3) PROPOSED CONTOURS ARE FROM PRELIMINARY PLAN GRADING CONCEPT.

4) FLOW RATES WERE COMPUTED USING TR-20 ROUTING AND PRELIMINARY SWM FACILITY DESIGN INFORMATION.

Symbol	Soil Type/Classification	HSG
PrA	Penn-Reaville silt loam, 0 to 3 percent slopes	C
PrB	Penn-Reaville silt loam, 3 to 8 percent slopes	C
CrB	Croton-Abbottstown silt loam, 3 to 8 percent slopes	C

LENGEND:

PROPOSED DRAINAGE DIVIDE	▬
TIME OF CONCENTRATION PATH	Tc Path
SOILS DELINEATION	PrB / PrA
EXISTING CONTOURS	450 / 448
PROPOSED CONTOURS	450 / 448

FROM KELLERTON OUTFALL PLANS

FOR CONSTRUCTION [redacted]

CALL "MISS UTILITY" AT 1-800-257-7777
48 Hours Before Start Of Construction

FREDERICK COUNTY, MARYLAND
DEVELOPMENT REVIEW ENGINEERING

APPROVED: [illegible] 11/20/14
DEVELOPMENT REVIEW CHIEF — DATE

APPROVED: [illegible] 11/20/14
STORMWATER MANAGEMENT — DATE

Reviewed in accordance with local County requirements. Frederick County assumes no liability for design and/or construction. Approval is valid for two (2) years [one (1) year if public water and/or sewer is involved] after the last date shown above. The project must be under construction before the approval expiration to be considered active. Otherwise, resubmittal of plans, including applicable fees, must be made to Development Review for reapproval. Fees for resubmittal cannot be waived.

REV. #	DATE	REVISION DESCRIPTION *FILL IN THESE BLOCKS FOR REVISIONS ONLY	ENGINEER/ CONSULTANT: DATE AND INITIAL	DEV. REVIEW DATE AND INITIAL

STATE OF MARYLAND — RANDALL DIRK FREY — REGISTERED PROFESSIONAL ENGINEER
2014.11.17

REVISION	DATE	REVISION	DATE

First Submittal 09/2014

Prepared for:
Kellerton Knolls
Client: Yankee Land Trust
8426 Yellow Springs Road
Frederick, MD 21701

301-471-0015
Contact: Mr. Dan Bittle

PROPOSED CONDITIONS MAP

RODGERS CONSULTING
Knowledge · Creativity · Enduring Values

19847 Century Boulevard
Suite 200
Germantown, Maryland 20874
Ph: 301.948.4700 (Main)
Ph: 301.253.6609 (Frederick)
Fx: 301.948.6256
www.rodgers.com

	BY	DATE
BASE DATA	CAD	06/14
DESIGNED	TJC	06/14
DRAWN	TJC	06/14
REVIEWED	RDF	06/14

RODGERS CONTACT:
RELEASE FOR ☐
BY____ DATE ____

LAND BAY A - STORM DRAIN OUTFALL PLAN
Kellerton Knolls
L. 8849 F. 196
FREDERICK ELECTION DISTRICT NO. 6
CITY OF FREDERICK, MARYLAND

SCALE: 1"=100'
JOB No. 1118A6
DATE: FEB. 2014
PC-1
SHEET No. 3 OF 5

KELLERTON KNOLLS - LAND BAY A

N:\MD-Frederick-City of Frederick\Keller Properties\autocad\Plot Plans\Storm Drain Outfall Plan (Land Bay A)\03-Proposed Conditions Map.dwg Sep 23, 2014, 9:36am

Appendix D: Drainage Area Mapping

CLOVER HILL DRAINAGE AREA MAP

LEGEND

- DRAINAGE AREA BOUNDARY
- POINT OF INVESTIGATION
- SOIL BOUNDARY
- SUBAREA DESIGNATION

POI 1
POI 2
POI 3
POI 4
POI 5
POI 6
POI 7
POI 8
POI 9
POI 10
POI 11
POI 12

FOX HUNT LANE
STONE RIDGE DRIVE
SPRINGHILL DRIVE
MEADOWSIDE DRIVE
HUNTER TRAIL WAY
LAUREL RIDGE ROAD
GLENDALE DRIVE
GLENDALE DRIVE (EAST)
FALSTONE DRIVE
FALSTONE COURT
STONE RIDGE COURT
OVERLOOK COURT
CLEARFIELD ROAD
RUNNYMEADE DRIVE
POOLE JONES ROAD
WHEATFIELD DRIVE
CLAIBORNE DRIVE (EAST)
CLAIBORNE DRIVE (WEST)
FROSTY FIELD COURT
AUTUMN LEAF LANE
SUMMERFIELD DRIVE
SUNDOWN LANE
EAST SUNDOWN COURT
WEST SUNDOWN COURT
EDGEWOOD FARM ROAD (SOUTH)
SUNNYBROOK DRIVE
WEST HILLS DRIVE
GLOVER HILL DRIVE
SPOUTSPRING ROAD

FOXHUNT-1
SPRINGHILL-1
SPRINGHILL-2
SPRINGHILL-3
SPRINGHILL-4
SPRINGHILL-5
SPRINGHILL-6
SPRINGHILL-7
SPRINGHILL-8
MEADOWSIDE-1
MEADOWSIDE-2
MEADOWSIDE-3
MEADOWSIDE-4
HUNTER-1
LAUREL-1
LAUREL-2
LAUREL-3
STONERIDGE-1
STONERIDGE-2
STONERIDGE-3
GLENDALE-1
GLENDALE-2
GLENDALE-3
GLENDALE-4
GLENDALE-5
GLENDALE-6
FALSTONE-1
FALSTONE-2
FALSTONE-3
FALSTONE-4
FALSTONE-5
FALSTONE-6
CLEARFIELD-1
CLEARFIELD-2
POOLE-1
WHEATFIELD-1
WHEATFIELD-2
WHEATFIELD-3
CLAIBORNE-1
CLAIBORNE-2
CLAIBORNE-3
CLAIBORNE-4
CLAIBORNE-5
AUTUMN-1
AUTUMN-2
AUTUMN-3
AUTUMN-4
AUTUMN-5
AUTUMN-6
FROSTY-1
SUMMERFIELD-1
SUNDOWN-1
SUNDOWN-2
SUNDOWN-3
WSUNDOWN-1
WSUNDOWN-2
RUNNYMEADE-1
RUNNYMEADE-2
RUNNYMEADE-3
RUNNYMEADE-4
EDGEWOOD-1
EDGEWOOD-2
EDGEWOOD-3
EDGEWOOD-4
EDGEWOOD-5
EDGEWOOD-6
EDGEWOOD-7
SUNNYBROOK-1
SUNNYBROOK-2
WHILLS-1A
WHILLS-1B
SPOUTSPRING-1

200' 0 200' 400'
SCALE: 1" = 200'

FILE: U:\Frederick County NPDES - Clover Hill\CAD\cDA-P001_CloverHill.dgn

Appendix E: Fox Hunt Lane Drainage Design Memo

Drainage Ditch Design

Clover Hill: Fox Hunt Lane

Frederick County, MD

August 2024

Prepared For:

Prepared By:

COASTAL RESOURCES INC.

25 Old Solomons Island Road, Annapolis, Maryland 21401

Table of Contents

Tables

Appendices

1.0 Introduction

The residents of the Clover Hill development are experiencing flooding caused by stormwater in several places. The drainage ditch between Fox Hunt Lane and Christophers Crossing is eroding and the residents are concerned with flooding.

2.0 Existing Conditions

Site Investigation

Coastal Resources, Inc. (CRI) performed a site visit on Monday, July 29, 2024. The watersheds were field verified, geomorphic measurements were made, and a pebble count was done. Photos were taken and photo points were logged. The ditch is currently eroding at the bottom and some downcutting is occurring. The adjacent landowner said that a lot of erosion has occurred, and they replaced twenty feet of the original cmp with hdpe pipe due to a failure of the original pipe. The resident showed pictures of people kayaking in the ditch in 2018. The water was muddy and may be when the Kellerton development sediment basin was in place before conversion into a stormwater management pond. Sediment Basins are only designed for the 2-year storm.

Hydrology

The project site is in Frederick County. Hydrology was completed to Fox Hunt Lane when the Kellerton development was designed. The following Study Point A values were retrieved from the 'Kellerton Land Bay A Final Stormwater Management and Storm Drain Report'(Fox & Assoc. Engineers, 2016). The proposed watershed to study point A includes three drainage areas and a pond. Study point A's outlet is in front of 8216 Fox Hunt Lane just above the Fox Hunt Lane culvert. The ditch drainage area outlet is the Christopher Crossings pipe. The following table shows the characteristics for the watersheds from both the Fox report and for the ditch drainage area.

Table 1. Watershed Characteristics

Drainage Area	Area, Acres	Curve Number	Time of Concentration, hr.
Study Point A existing	31.01	55	0.288
Study Point A proposed	33.72	66	0.217
Ditch	6.76	80	0.1

It is interesting to note that the proposed curve number is 66. This is because the use of ESD to the MEP allows the proposed conditions to be treated as 'woods in good condition'. When the additional drainage area to the ditch was evaluated, the curve number was 80 for 0.5 acre residential on mostly D soils with some B hydrologic soil group soils.

The following table shows the peak discharges from both the Fox report and the ditch drainage area. TR20 was used with the watershed and pond information from the report to obtain the peak flows with the ditch drainage area added.

Table 2. Peak Discharges

Recurrence Interval	1-Yr Storm	2-Yr Storm	10-Yr Storm	100-Yr Storm
Existing Peak Flow (cfs)	0.34	2.85	28.81	70.81
Proposed Peak Flow (cfs)	3.85	8.55	28.98	55.22
Proposed Peak Flow with ditch DA (cfs)	5.7	8.7	31.1	138.9

The report shows that there are larger peak discharges for the more frequent storms in the proposed condition. This may be what is causing the increase in flooding experienced by residents downstream. The occurrence of more intense and frequent storms may also be a contributing factor. Another factor is using such a small curve number for the proposed condition. There may be more flow getting to the ditch on Fox Hunt Lane then the report shows.

There are two pipes in series that convey water to the ditch. The first pipe is under Fox Hunt Lane, and it receives the flow from Study Point A. The next pipe collects water from a drop inlet and the Fox Hunt Lane pipe and conveys it to the ditch. Twenty feet of culvert below Fox Hunt Lane was replaced with 24" HDPE pipe at the outlet end due to failure. The 24" HDPE is the controlling capacity there. The following table shows the pipes and their capacities as determined from HY-8.

Table 3. Pipe Capacity

Location	Pipe Size	Pipe Capacity, cfs	10-Yr Water Surface Elevation, ft. (Top of Road/Ground)
Fox Hunt Lane	24"x35" arch CMP	29.41	402.94 (403.0) outlet control
Downstream of Fox Hunt Lane	24"x35" CMP and 24" HDPE	23.6	403.17 (403.1) outlet control
Christophers Crossing	24"x38" RCP	47.5	399.1 (400) outlet control

The area above the Christophers Crossing culvert acts as a pond. A structure was added to the TR20 here to determine the tailwater conditions of the ditch. The following table shows the water surface elevations for the different storms at the culvert.

Table 4. Water Surface Elevations at Christophers Crossing

Storm	Culvert Inlet elev., ft	WSE, ft	Top of Road, ft	Downstream Flow, cfs
1	396.34	397.0	400	6.0
2	396.34	397.3	400	9.2
10	396.34	399.0	400	30.3
100	396.34	401.5	400	140.2

3.0 Proposed Improvements

Check dams will be placed at the entrance to the pipe below Fox Hunt Lane and in the existing drainage ditch from the outlet of the pipe to Christophers Crossing. The check dams will be designed to slow the 2 year storm. The existing ditch is evaluated for the 10-year storm capacity. Placing a check dam at the entrance to the existing pipe below the Fox Hunt Lane pipe will increase the capacity of the existing pipe and reduce erosion due to overflow. The following tables show the increased pipe capacity, ditch capacity check, and check dam design.

Table 5. Pipe below Fox Hunt Lane Proposed Capacity

Pipe Size	Pipe Capacity, cfs	10-Yr Water Surface Elevation, ft. (Top of Road/Ground)
24"x35" CMP and 24" HDPE	28.4	404.22 (404.2 proposed) outlet control

Table 6. Ditch Design

Bottom width, ft.	10-Yr Depth of flow, ft.	Side slope ratio	Bed slope, ft/ft	Manning's n	10-Yr Flow Top width, ft.	Length, ft.	10-Yr Flow, cfs	10-Yr Velocity, fps
2	1.13	4:1	0.0177	0.035	11.0	165	31.3	4.24

The check dams were designed to allow mowing and will reduce erosive velocities.

Table 7. Check Dam Design

Top length, ft.	Height, ft	2-Yr Depth of flow, ft.	Flow slope ratio	Manning's n	2-Yr Flow Top width, ft.	Spacing, ft.	Flow, cfs	2-Yr Velocity, fps
1	0.75	0.65	4:1	0.035	7.2	47	9.26	3.1

4.0 Conclusion

The wet swale with check dams will be easier to maintain with 4:1 grassed check dams. The site is currently eroding at the bottom of the ditch. The check dams will help slow the velocity for the frequent more intense storms. The ditch will convey the 10-year storm with one foot of freeboard to the edge of the road.

APPENDIX A: Photos

Clover Hill Drainage Design Photolog

Start of Channel Facing Upstream

Start of Channel Facing Downstream

Mid Channel Facing Upstream

Mid Channel Facing Downstream

Clover Hill Drainage Design Photolog

End of Channel Facing Downstream

End of Channel Facing Culvert

XS1 Downstream

XS1 Upstream

XS2 Downstream

XS2 Upstream

XS2 RB

XS2 LB

XS3 Downstream

XS3 Upstream

XS3 RB

XS3 LB

APPENDIX B: Drainage Area Map

Clover Hill
Fox Hunt Lane Drainage Ditch
Appendix #:
Watershed Delineation Map

Frederick County, Maryland
August 2024

COASTAL RESOURCES INC.

Legend
- Intermediate_Contour_2014
- Index_Contour_2014
- globalwatershed

Frederickl_HSG
HydrolGrp
- B
- C
- D

0 50 100 feet
1 inch = 100 feet

Map Center, NAD83
39.4623°, -77.4402°

1 inch = 1 miles

APPENDIX C: Hydrology

CRI

Clover Hill
Fox Hunt Lane
Frederick NOAA-C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Total							
SHEET	99	0.0200	0.011				0.020
CHANNEL	884	0.0160	0.033	7.66	11.43	4.385	0.056
					Time of Concentration		0.1

==========

CRI

Clover Hill
Fox Hunt Lane
Frederick NOAA-C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Total	Residential districts (1/2 acre)	B	2.44	70
	Residential districts (1/2 acre)	D	4.32	85
	Total Area / Weighted Curve Number		6.76	80

==========

elevation, f	area, sf	area, ac	average are	delta elev, 1	volume, cf	cum vol, cf	volume, ac-ft	cum vol, ac-ft	Discharge, cfs	
396	4.78	0.00011	0	0	0	0.000	0	0.000	0.000	
398	166.4	0.00382	85.59	2	171.18	171.180	0.003929752	0.004	16	
399	3679.7	0.084474	1923.05	1	1923.05	2094.230	0.044147153	0.048	30	
400	6029	0.084474	1923.05	2	3846.1	4017.280	0.088294307	0.092	39.8	
401	10081	0.231428	6596.567	1	6596.5667	10613.847	0.151436333	0.244	50	
401.5	13353	0.306543	9821	0.5	4910.5	15524.347	0.112729568	0.356	150	

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WinTR-20 Printed Page File      Beginning of Input Data List
G:\Active\1 ASSOCIATES TEMP FILES\Katie S\TR-20\CloverHill\FoxHunt.inp

WinTR-20: Version 3.30                  0         0         1.0       0         ,
Clover Hill contract Fox Hunt Lane to Christophers Crossing

SUB-AREA:
          1         chrisx    GAGE      0.0102    66.       .322      NN
          2         Pond      GAGE      .029234   66.       .217
          3         chrisx    GAGE      .0133     66.       .252
          ditch     chrisx    GAGE      .01056    80.       .1


STREAM REACH:
          Pond      chrisx              pond
          chrisx    Outlet              above chri


STORM ANALYSIS:
          p1-06     GAGE                1.78      rtp1-06   2
          p2-06     GAGE                2.16      rtp2-06   2
          p10-12    GAGE                3.92      rtp10-12  2
          p100-24   GAGE                7.97      rtp100-24 2



STRUCTURE RATING:
          pond
                    407.      0.        0.
                    408.      .22       .36
                    410.      .4        .44
                    412.      .52       .54
                    413.      60.57     .59
                    414.      170.33    .63
                    416.      480.7     .74
          above chri
                    396.34    0.        0.
                    398.      16.       .004
                    399.      30.       .048
                    400.      39.8      0.092
                    401.      50.       .244
                    401.5     150.      .356



RAINFALL DISTRIBUTION:
          rtp1-06             0.1
                    0.0000    0.0065    0.0129    0.0194    0.0258
                    0.0323    0.0388    0.0452    0.0517    0.0581
                    0.0646    0.0710    0.0775    0.0840    0.0904
                    0.0969    0.1032    0.1095    0.1158    0.1222
                    0.1285    0.1402    0.1519    0.1636    0.1753
                    0.1871    0.2113    0.2355    0.2742    0.3359
                    0.5000    0.6641    0.7258    0.7645    0.7887
                    0.8129    0.8247    0.8364    0.8481    0.8598
                    0.8715    0.8778    0.8842    0.8905    0.8968
                    0.9031    0.9096    0.9160    0.9225    0.9290
                    0.9354    0.9419    0.9483    0.9548    0.9612
                    0.9677    0.9742    0.9806    0.9871    0.9935
```

```
          1.0000
rtp2-06             0.1
          0.0000    0.0065    0.0130    0.0195    0.0260
          0.0325    0.0390    0.0455    0.0520    0.0585
          0.0650    0.0715    0.0780    0.0845    0.0910
          0.0975    0.1037    0.1099    0.1160    0.1222
          0.1284    0.1400    0.1515    0.1631    0.1747
          0.1863    0.2111    0.2360    0.2756    0.3381
          0.5000    0.6619    0.7244    0.7640    0.7889
          0.8137    0.8253    0.8369    0.8485    0.8600
          0.8716    0.8778    0.8840    0.8901    0.8963
          0.9025    0.9090    0.9155    0.9220    0.9285
          0.9350    0.9415    0.9480    0.9545    0.9610
          0.9675    0.9740    0.9805    0.9870    0.9935
          1.0000
rtp10-12            0.1
          0.0000    0.0031    0.0061    0.0092    0.0122
          0.0153    0.0184    0.0214    0.0245    0.0275
          0.0306    0.0337    0.0367    0.0398    0.0428
          0.0459    0.0489    0.0520    0.0551    0.0581
          0.0612    0.0642    0.0673    0.0704    0.0734
          0.0765    0.0795    0.0826    0.0857    0.0887
          0.0918    0.0970    0.1022    0.1074    0.1126
          0.1178    0.1230    0.1282    0.1334    0.1386
          0.1438    0.1490    0.1542    0.1594    0.1646
          0.1698    0.1748    0.1798    0.1848    0.1898
          0.1948    0.2050    0.2153    0.2256    0.2358
          0.2461    0.2692    0.2922    0.3274    0.3797
          0.5000    0.6203    0.6726    0.7078    0.7308
          0.7539    0.7642    0.7744    0.7847    0.7950
          0.8052    0.8102    0.8152    0.8202    0.8252
          0.8302    0.8354    0.8406    0.8458    0.8510
          0.8562    0.8614    0.8666    0.8718    0.8770
          0.8822    0.8874    0.8926    0.8978    0.9030
          0.9082    0.9113    0.9143    0.9174    0.9205
          0.9235    0.9266    0.9296    0.9327    0.9358
          0.9388    0.9419    0.9449    0.9480    0.9511
          0.9541    0.9572    0.9602    0.9633    0.9663
          0.9694    0.9725    0.9755    0.9786    0.9816
          0.9847    0.9878    0.9908    0.9939    0.9969
          1.0000
rtp100-24           0.1
          0.0000    0.0015    0.0029    0.0044    0.0058
          0.0073    0.0087    0.0102    0.0116    0.0131
          0.0145    0.0160    0.0175    0.0189    0.0204
          0.0218    0.0233    0.0247    0.0262    0.0276
          0.0291    0.0306    0.0320    0.0335    0.0349
          0.0364    0.0378    0.0393    0.0407    0.0422
          0.0436    0.0451    0.0466    0.0480    0.0495
          0.0509    0.0524    0.0538    0.0553    0.0567
          0.0582    0.0596    0.0611    0.0626    0.0640
          0.0655    0.0669    0.0684    0.0698    0.0713
          0.0727    0.0742    0.0756    0.0771    0.0786
          0.0800    0.0815    0.0829    0.0844    0.0858
          0.0873    0.0902    0.0931    0.0959    0.0988
          0.1017    0.1046    0.1075    0.1104    0.1132
          0.1161    0.1190    0.1219    0.1248    0.1277
          0.1306    0.1334    0.1363    0.1392    0.1421
          0.1450    0.1479    0.1508    0.1536    0.1565
          0.1594    0.1623    0.1652    0.1681    0.1709
```

0.1738	0.1783	0.1827	0.1872	0.1916
0.1960	0.2005	0.2049	0.2094	0.2138
0.2183	0.2227	0.2272	0.2316	0.2360
0.2405	0.2448	0.2492	0.2535	0.2579
0.2622	0.2717	0.2812	0.2906	0.3001
0.3096	0.3300	0.3504	0.3793	0.4188
0.5000	0.5812	0.6207	0.6496	0.6700
0.6904	0.6999	0.7094	0.7188	0.7283
0.7378	0.7421	0.7465	0.7508	0.7552
0.7595	0.7640	0.7684	0.7728	0.7773
0.7817	0.7862	0.7906	0.7951	0.7995
0.8040	0.8084	0.8128	0.8173	0.8217
0.8262	0.8291	0.8319	0.8348	0.8377
0.8406	0.8435	0.8464	0.8492	0.8521
0.8550	0.8579	0.8608	0.8637	0.8666
0.8694	0.8723	0.8752	0.8781	0.8810
0.8839	0.8868	0.8896	0.8925	0.8954
0.8983	0.9012	0.9041	0.9069	0.9098
0.9127	0.9142	0.9156	0.9171	0.9185
0.9200	0.9214	0.9229	0.9244	0.9258
0.9273	0.9287	0.9302	0.9316	0.9331
0.9345	0.9360	0.9374	0.9389	0.9404
0.9418	0.9433	0.9447	0.9462	0.9476
0.9491	0.9505	0.9520	0.9534	0.9549
0.9564	0.9578	0.9593	0.9607	0.9622
0.9636	0.9651	0.9665	0.9680	0.9694
0.9709	0.9724	0.9738	0.9753	0.9767
0.9782	0.9796	0.9811	0.9825	0.9840
0.9855	0.9869	0.9884	0.9898	0.9913
0.9927	0.9942	0.9956	0.9971	0.9985
1.0000				

GLOBAL OUTPUT:

1.	0.1	YNNNN	YNNNNN

WinTR-20 Printed Page File End of Input Data List

Clover Hill contract Fox Hunt Lane to Christophers Crossing

Name of printed page file:
G:\Active\1 ASSOCIATES TEMP FILES\Katie S\TR-20\CloverHill\FoxHunt.out

STORM p1-06

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.029	GAGE	0.024		3.35	1.4	46.21
Pond	0.029	Upstream	0.024		3.35	1.4	46.21

Pond	0.029	Downstream	0.0	407.00	3.23	0.0	0.0
3	0.013	GAGE	0.0		3.05	0.0	0.0
ditch	0.011	GAGE	0.254		3.13	6.0	570.33
chrisx	0.063	Upstream	0.042		3.13	6.0	95.15
chrisx	0.063	Downstream	0.042	396.96	3.13	6.0	94.88
OUTLET	0.063		0.042		3.13	6.0	94.88

STORM p2-06

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.029	GAGE	0.117		3.26	4.1	139.07
Pond	0.029	Upstream	0.117		3.26	4.1	139.07
Pond	0.029	Downstream	0.0	407.00	3.10	0.0	0.0
3	0.013	GAGE	0.075		3.29	1.8	131.62
ditch	0.011	GAGE	0.426		3.12	9.2	874.50
chrisx	0.063	Upstream	0.093		3.12	9.2	145.90
chrisx	0.063	Downstream	0.093	397.30	3.13	9.2	145.52
OUTLET	0.063		0.093		3.13	9.2	145.52

STORM p10-12

Clover Hill contract Fox Hunt Lane to Christophers Crossing

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.029	GAGE	1.031		6.19	22.8	779.08
Pond	0.029	Upstream	1.031		6.19	22.8	779.08
Pond	0.029	Downstream	0.680	412.21	6.38	13.3	453.30
3	0.013	GAGE	0.621		6.21	9.8	735.73
ditch	0.011	GAGE	1.610		6.12	20.0	1895.48
chrisx	0.063	Upstream	0.809		6.13	32.1	507.83
chrisx	0.063	Downstream	0.809	399.03	6.17	30.3	479.33
OUTLET	0.063		0.809		6.17	30.3	479.33

STORM p100-24

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
2	0.029	GAGE	3.944		12.17	64.8	2216.76
Pond	0.029	Upstream	3.944		12.17	64.8	2216.76
Pond	0.029	Downstream	3.583	413.04	12.17	64.7	2213.97
3	0.013	GAGE	3.256		12.18	28.2	2119.13
ditch	0.011	GAGE	4.714		12.11	36.5	3458.18
chrisx	0.063	Upstream	3.646		12.14	141.1	2229.84
chrisx	0.063	Downstream	3.646	401.45	12.16	140.2	2215.11
OUTLET	0.063		3.646		12.16	140.2	2215.11

Area or Reach Identifier	Drainage Area (sq mi)	Peak Flow by Storm p1-06 (cfs)	p2-06 (cfs)	p10-12 (cfs)	p100-24 (cfs)	(cfs)
1	0.010	0.0	1.2	6.8	19.9	
2	0.029	1.4	4.1	22.8	64.8	
3	0.013	0.0	1.8	9.8	28.2	
ditch	0.011	6.0	9.2	20.0	36.5	
Pond	0.029	1.4	4.1	22.8	64.8	
DOWNSTREAM		0.0	0.0	13.3	64.7	
chrisx	0.063	6.0	9.2	32.1	141.1	
DOWNSTREAM		6.0	9.2	30.3	140.2	
OUTLET	0.063	6.0	9.2	30.3	140.2	

APPENDIX D: Hydraulics

Culvert Crossing: Fox Hunt

Crossing Summary Table

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
400.61	1 year	3.85	3.85	0.00	1
401.06	2 year	8.55	8.55	0.00	1
402.94	10 year	29.00	29.00	0.00	1
403.00	Overtopping	29.41	29.41	0.00	Overtopping

Culvert Crossing: Fox Hunt

Culvert Summary Table - Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1 year	3.85	3.85	400.61	0.72	0.76	3-M2t	0.52	0.48	0.49	0.50	3.42	2.26
2 year	8.55	8.55	401.06	1.16	1.21	2-M2c	0.82	0.75	0.75	0.72	4.55	2.77
10 year	29.00	29.00	402.94	2.86	3.09	7-M2c	2.00	1.50	1.50	1.22	7.48	3.78

Culvert Crossing: 24 inch below fox hunt

Crossing Summary Table

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
400.35	1 year	3.85	3.85	0.00	1
400.94	2 year	8.55	8.55	0.00	1
401.32	5 year	12.00	12.00	0.00	1
403.17	10 year	29.00	24.01	4.99	13
403.25	25 year	40.00	24.36	15.57	6
403.31	50 year	50.00	24.40	25.55	5
403.37	100 year	60.00	24.13	35.85	5
403.41	200 year	70.00	23.77	46.22	5
403.54	500 year	100.00	22.86	77.14	4
403.10	Overtopping	23.69	23.69	0.00	Overtopping

Culvert Crossing: 24 inch below fox hunt

Culvert Summary Table - Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1 year	3.85	3.85	400.35	0.95	0.19	1-S2n	0.64	0.69	0.64	0.73	4.45	2.43
2 year	8.55	8.55	400.94	1.54	0.76	1-S2n	0.99	1.04	0.99	0.98	5.51	2.97
5 year	12.00	12.00	401.32	1.92	1.27	1-S2n	1.22	1.24	1.22	1.11	5.96	3.23
10 year	29.00	24.01	403.17	3.64	3.77	7-M2c	2.00	1.74	1.74	1.55	8.29	4.03
25 year	40.00	24.36	403.25	3.71	3.85	7-M2t	2.00	1.74	1.75	1.75	8.36	4.36
50 year	50.00	24.40	403.31	3.71	3.91	7-M2t	2.00	1.75	1.90	1.90	7.91	4.61
100 year	60.00	24.13	403.37	3.66	3.97	4-FFf	2.00	1.74	2.00	2.04	7.68	4.83
200 year	70.00	23.77	403.41	3.59	4.01	4-FFf	2.00	1.73	2.00	2.16	7.57	5.02
500 year	100.00	22.86	403.54	3.42	4.14	4-FFf	2.00	1.70	2.00	2.47	7.28	5.49

Culvert Crossing: 24 inch below fox hunt Proposed

Crossing Summary Table

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
400.35	1 year	3.85	3.85	0.00	1
400.94	2 year	8.55	8.55	0.00	1
401.32	5 year	12.00	12.00	0.00	1
404.22	10 year	29.00	28.32	0.64	22
404.32	25 year	40.00	28.74	11.19	7
404.39	50 year	50.00	28.95	21.03	6
404.44	100 year	60.00	28.81	31.17	5
404.49	200 year	70.00	28.52	41.47	5
404.62	500 year	100.00	27.78	72.21	4
404.20	Overtopping	28.24	28.24	0.00	Overtopping

Culvert Crossing: 24 inch below fox hunt Proposed

Culvert Summary Table - Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1 year	3.85	3.85	400.35	0.95	0.19	1-S2n	0.64	0.69	0.64	0.73	4.45	2.43
2 year	8.55	8.55	400.94	1.54	0.76	1-S2n	0.99	1.04	0.99	0.98	5.51	2.97
5 year	12.00	12.00	401.32	1.92	1.27	1-S2n	1.22	1.24	1.22	1.11	5.96	3.23
10 year	29.00	28.32	404.22	4.55	4.82	7-M2c	2.00	1.83	1.83	1.55	9.39	4.03
25 year	40.00	28.74	404.32	4.65	4.92	7-M2c	2.00	1.84	1.84	1.75	9.50	4.36
50 year	50.00	28.95	404.39	4.70	4.99	7-M2t	2.00	1.85	1.90	1.90	9.39	4.61
100 year	60.00	28.81	404.44	4.66	5.04	4-FFf	2.00	1.84	2.00	2.04	9.17	4.83
200 year	70.00	28.52	404.49	4.60	5.09	4-FFf	2.00	1.84	2.00	2.16	9.08	5.02
500 year	100.00	27.78	404.62	4.43	5.22	4-FFf	2.00	1.82	2.00	2.47	8.84	5.49

Culvert Crossing: Christophers Crossing

Crossing Summary Table

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
396.34	0.00	0.00	0.00	1
397.19	5.70	5.70	0.00	1
397.42	8.70	8.70	0.00	1
397.67	12.00	12.00	0.00	1
397.95	16.00	16.00	0.00	1
398.22	20.00	20.00	0.00	1
398.36	22.00	22.00	0.00	1
399.09	31.10	31.10	0.00	1
399.18	32.00	32.00	0.00	1
399.57	36.00	36.00	0.00	1
400.02	40.00	40.00	0.00	1
401.04	50.00	47.76	2.10	8
401.44	130.00	50.49	79.48	5
401.48	140.00	50.72	89.27	4
401.51	150.00	50.93	99.06	4
401.00	47.47	47.47	0.00	Overtopping

Culvert Crossing: Christophers Crossing

Culvert Summary Table - Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	396.34	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
5.70	5.70	397.19	0.85	0.01	1-S2n	0.34	0.64	0.39	0.84	7.64	2.68
8.70	8.70	397.42	1.08	0.21	1-S2n	0.42	0.80	0.51	0.99	8.28	2.98
12.00	12.00	397.67	1.33	0.43	1-S2n	0.49	0.95	0.61	1.11	8.79	3.23
16.00	16.00	397.95	1.61	0.70	1-S2n	0.56	1.11	0.73	1.24	9.29	3.47
20.00	20.00	398.22	1.88	0.98	1-S2n	0.63	1.26	0.84	1.35	9.69	3.67
22.00	22.00	398.36	2.02	1.13	5-S2n	0.66	1.32	0.89	1.40	9.89	3.76
31.10	31.10	399.09	2.75	2.06	5-S2n	0.80	1.58	1.11	1.59	10.71	4.10
32.00	32.00	399.18	2.84	2.13	5-S2n	0.81	1.61	1.13	1.61	10.78	4.13
36.00	36.00	399.57	3.23	2.43	5-S2n	0.86	1.70	1.21	1.68	11.14	4.25
40.00	40.00	400.02	3.68	2.76	5-S2n	0.92	1.77	1.29	1.75	11.50	4.36
50.00	47.76	401.04	4.70	3.46	5-S2n	1.01	1.86	1.43	1.90	12.27	4.61
130.00	50.49	401.44	5.10	3.73	5-S2n	1.05	1.88	1.47	2.72	12.57	5.86
140.00	50.72	401.48	5.14	3.76	5-S2n	1.05	1.88	1.48	2.80	12.60	5.97
150.00	50.93	401.51	5.17	3.78	5-S2n	1.05	1.89	1.48	2.87	12.62	6.07

APPENDIX E: Drainage Ditch Design

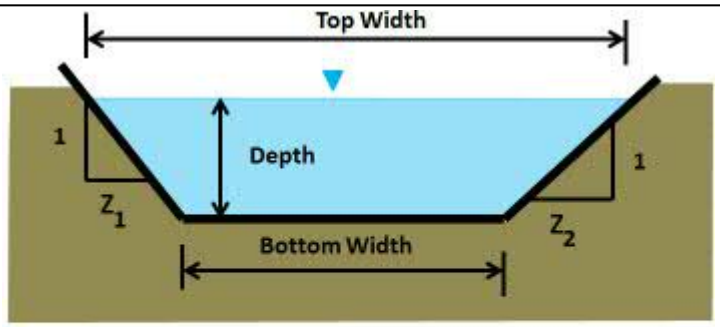
USDA United States Department of Agriculture
Natural Resources Conservation Service

Report Generated 08/02/2024
EFT Version 4.0.8.0

Trapezoidal Channel

Project Name: Fox Hunt Lane
Location: _____
Project Description: _____
Practice: Ditch

Designed by: _____ **Date:**_____
Checked by: _____ **Date:**_____
Approved by: _____ **Date:** _____



$$Q = \frac{1.486}{n} A r^{2/3} s^{1/2}$$

Inputs

Bottom Width : 2.00 ft
Depth of Flow : 0.65 ft
Side Slope 1 : 4.00:1
Side Slope 2 : 4.00:1
Bed Slope : 0.0177 ft/ft
Manning's n : 0.035

Outputs

Top Width : 7.20 ft
Hydraulic Radius : 0.41 ft
Flow Area : 2.99 sq ft
Capacity : 9.26 cfs
Velocity : 3.10 ft/sec
Critical Depth : 0.60 ft

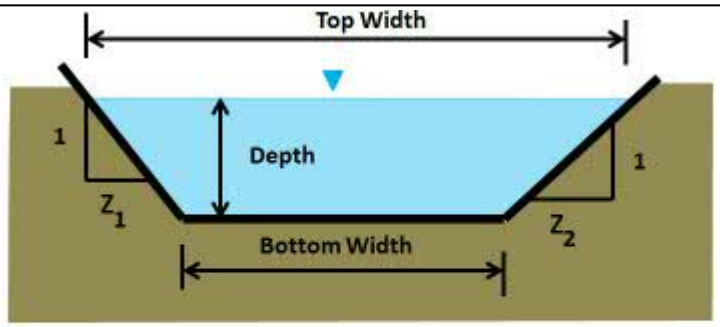
USDA United States Department of Agriculture
Natural Resources Conservation Service

Report Generated 07/31/2024
EFT Version 4.0.8.0

Trapezoidal Channel

Project Name: Fox Hunt Lane Ditch
Location: _____
Project Description: _____
Practice: 10 YR

Designed by: _____ **Date:**_____
Checked by: _____ **Date:**_____
Approved by: _____ **Date:** _____



$$Q = \frac{1.486}{n} A r^{2/3} s^{1/2}$$

Inputs

Bottom Width : 2.00 ft
Depth of Flow : 1.13 ft
Side Slope 1 : 4.00:1
Side Slope 2 : 4.00:1
Bed Slope : 0.0177 ft/ft
Manning's n : 0.035

Outputs

Top Width : 11.04 ft
Hydraulic Radius : 0.65 ft
Flow Area : 7.37 sq ft
Capacity : 31.26 cfs
Velocity : 4.24 ft/sec
Critical Depth : 1.08 ft

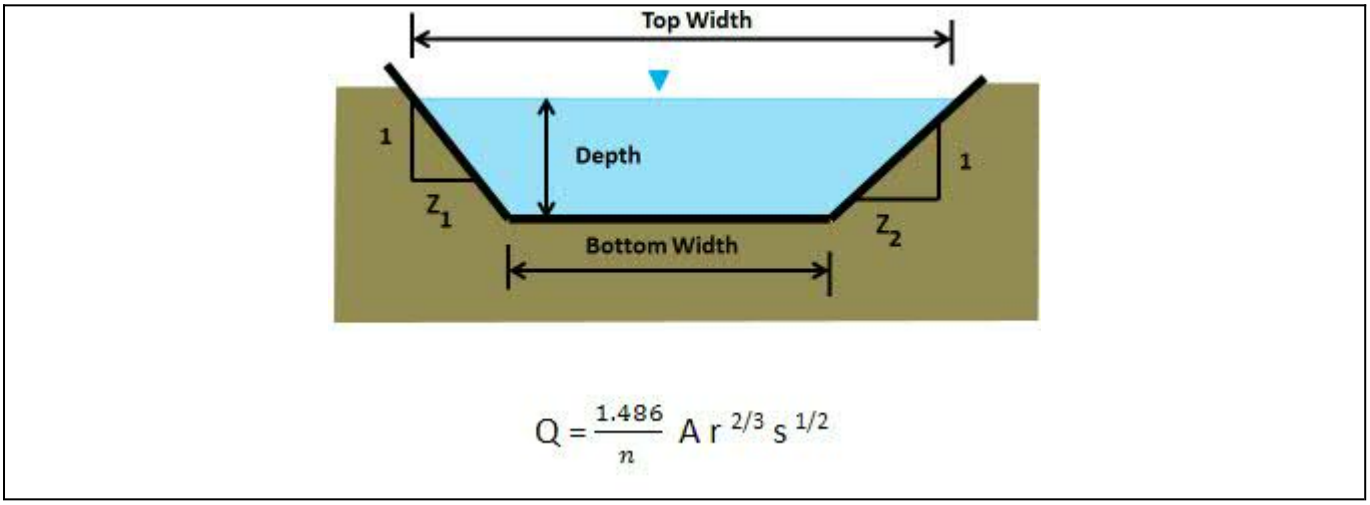
USDA United States Department of Agriculture
Natural Resources Conservation Service

Report Generated 08/05/2024
EFT Version 4.0.8.0

Trapezoidal Channel

Project Name: 10 YR Flow over check dam
Location: Fox Hunt Lane Ditch above Christophers X
Project Description: _____
Practice: _____

Designed by: _____ **Date:**_____
Checked by: _____ **Date:**_____
Approved by: _____ **Date:** _____



$$Q = \frac{1.486}{n} A r^{2/3} s^{1/2}$$

Inputs

Bottom Width : 7.20 ft
Depth of Flow : 0.36 ft
Side Slope 1 : 4.00:1
Side Slope 2 : 4.00:1
Bed Slope : 0.2500 ft/ft
Manning's n : 0.035

Outputs

Top Width : 10.08 ft
Hydraulic Radius : 0.31 ft
Flow Area : 3.11 sq ft
Capacity : 29.98 cfs
Velocity : 9.64 ft/sec
Critical Depth : 0.71 ft

Step 6: Compute Surface Storage Volume

Check Dam Top Width (TW_{CD}):	1.0	feet	
Upstream Check Dam Slope (S_{CD-US}):	0.250	feet/feet	
Downstream Check Dam Slope (S_{CD-DS}):	0.250	feet/feet	
Check Dam Height (H_{CD}):	0.75	feet	
Maximum Storage Length (L_{MAX}):	42	feet	*[H_{CD} /S_L (40 LF MIN.)]*
Storage Length (L_S):	40	feet	
Check Dam Length (L_{CD}):	7	feet	*[2*H_{CD} / S_{CD} + TW_{CD}]*
Check Dam Spacing (CD_S):	47	feet	*[L_S + L_{CD}]*
Number of Cells (F):	4		*[(L/CD_S)]*
Minimum Storage Depth (d_{MIN}):	0.04	feet	*[S_L * (L_{MAX} - L_S)]*

Appendix F: References

- Maryland Department of the Environment, 2000 Maryland Stormwater Design Manual, (October 2000, Revised May 2009)
- Maryland Department of the Environment, 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control
- Maryland Department of the Environment, Maryland Stormwater Management and Erosion & Sediment Control Guidelines for State and Federal Projects, (February 2015)
- Maryland Department of Transportation State Highway Administration, Sediment and Stormwater Guidelines and Procedures, (October 2017)
- Maryland Department of Transportation State Highway Administration, Sediment and Stormwater Current Technical Practices, (June 2018)
- Web Soil Survey for Frederick County, Maryland
- MDE Technical Memo No. 12 – Clarification on Grass Swale Design, (April 2019)
- Frederick County, Frederick County Roads & Streets Design Manual, (2003)