Introduction

The Little Bennett Regional Park is located in northern Montgomery County off of Frederick Road (MD 355) in Clarksburg, MD. The proposed connector trail will run parallel to the westbound lane of Frederick Road and cross over a steep, environmentally sensitive ravine. The purpose of this project is to design a connector trail that will allow park visitors to easily and safely access the future Day Use area from the main campground area. On-site stormwater management through low impact development (LID) retrofit options was utilized to treat stormwater runoff expected to be created from the new trail. Stormwater management treatment was designed to meet the 2000 Maryland Department of the Environmental (MDE), Chapter 5 Environmental Site Design (ESD) criteria goals.

Hydrologic Analysis

Charles P. Johnson & Associates, Inc. (CPJ) completed a hydrologic analysis using table top and visual methods. The site impervious area and drainage area to each facility was delineated using a combination of field run survey performed by CPJ in Winter 2013 and Summer 2014 and Montgomery County GIS data. The project area is located in the Little Bennett Creek watershed and a small portion of the Little Seneca Creek Watershed within a Special Protection Area. The trail project crosses three drainage areas, of which all are classified as Use III-P, Natural Trout Waters.

The total project site across the three drainage areas is 83.94 acres. The proposed total limit of disturbance is 3.71 acres. The trail designed within this area is proposed to drain in an easterly direction into the park property. The project site consists of predominantly ‘C’ soils with some ‘D’ soils within the largest drainage area that encompasses the ravine. The majority of the site is within forested park property and a small portion of the trail nearest the future Day Use Area is within a private property used for agricultural purposes. No recreational facilities currently exist in the area of the park where the trail is proposed to connect the campground to the Day Use Area. Due to the natural hydrologic drainage divisions on site, three study points were identified and the site was divided into three drainage areas. The proposed impervious for each drainage area ranges from 14% to 43% and is entirely the responsibility of Maryland National Capital Park and Planning Commission (MNCPPC) with regard to stormwater management treatment. When calculating the impervious area for the site, the portion of the trail that is raised was assumed to be pervious.

Existing Site Description

The site within the Little Bennett Regional Park is owned by MNCPPC and located on Parcels P999, P100, P426, P380, P195, and P141. The small portion on private property (P020) is owned by Henry Hamm and KG. MNCPPC is currently coordinating with the property owner for the trail project and has initial permissions to construct a new trail on this property. Since there are no recreational facilities currently located in the area of the new trail, no stormwater management measures are present. The forested stream valley that encompasses a degraded stream channel nearest the intersection with Comus Road drains to a first order tributary to Soper Branch. Site constraints include a very limited, linear project area, existing steep slopes greater than 5%, and larger drainage areas that prohibit many low impact stormwater management treatments.

Proposed Retrofit/Restoration Opportunities

The proposed design for the trail includes a non-slip, ADA accessible multi-use trail through several unique ecosystems, such as abandoned field, early, mid and late successional forests and non-tidal wetlands in a stream valley. The trail will provide an essential connection to the future Day Use Area, rest/overlook areas, and environmental education opportunities through interpretative signage. Using the drainage parameters computed and described above and the technical requirements for ESD to the MEP criteria found in the Chapter 5 revision to the 2000 MDE SWM Manual and Montgomery County Department of Permitting Service's Water Resources Technical Policy WRTP-5, CPJ computed the Water Quality (WQ) Volume and ESD Volume treatment requirements for the site. Detailed calculations can be found in the appendix.

Table 4. Hydrologic Analysis Summary

Parameter	Unit	DA 1 Requirement	DA 2 Requirement	DA 3 Requirement
LOD Area (DA)	Acres	0.87	2.09	0.75
Target PE Value	Inches	1.0	1.0	1.0
LOD Impervious Area (IA)	Acres	0.30	0.29	0.27
Target Water Quality Volume (WQv)	CF	1,130	1,320	1,030
Target Environmental Site Design Volume (ESDv)	CF	1,130	1,320	1,030

Stormwater management will be provided through sheet flow to conservation area, a rain garden, pervious pavement, and non-rooftop disconnection. Detailed computations for each facility can be found in the appendix. The proposed design treats a total of 3,665 CF, which is 105.3% of the required ESD volume.

Summary Table			
Drainage Area	**WQv/ESD Required (cf)**	**WQv/ESD Proposed (cf)**	**% Treated**
Drainage Area 1	1,130	1,156	102.3%
Drainage Area 2	1,320	1,423	107.8%
Drainage Area 3	1,030	1,086	105.4%
Total	3,450	3,665	105.3%

Conclusion

The proposed concept will allow the connection between the existing camping area at the Little Bennett Regional Park and future Day Use Area while providing full ESD treatment on-site. The proposed designs for Drainage Areas 1 through 3 provide a treatment volume of 1,156 cf, 1,423 cf, and 1,086 cf respectively which exceeds the required ESD volume for each drainage area.

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STORMWATER MANAGEMENT REQUIREMENTS

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Study Area: DA 1

Site Data:
County: Montgomery
Project Type: SWM Plan
Location: North Fredrick Road

	Parcel Area to Study Point	LOD Area to Study Point
Total Area:	**10.44 AC**	**0.87 AC**
Impervious Area:	**1.62 AC**	**0.30 AC**
Percent Impervious:	**15.5%**	**34.0%**

Soils:

HSG	RCN[1]	Parcel Area (Ac.)	Percent
A [2]	38	0.00	0%
B	55	0.00	0%
C	70	10.44	100%
D	77	0.00	0%

[1] RCN for "woods in good condition" (Table 2-2, TR-55)

[2] Actual RCN for Hydrologic Soil Group 'A' is less than 30, use RCN=38

Determine Water Quality (WQv) Requirements

A. Determine target WQ Volume <u>for Disturbed Area</u>

$$WQv = \frac{P_E * Rv * A}{12}$$

WQv Required = 1,124.94 CF , USE: **1,130 CF**

Where: P_E = 1.00 inches
Rv = 0.05 + (0.009*I) = 0.36
I = 34.0%
A= 0.87 AC

Determine ESD Requirements

Methodology per Montgomery County DPS Water Resources Technical Policy WRTP-5

A. Determine RCN for "woods in good condition" for Site Area

$$RCN_{woods} = \frac{\text{('A' RCN * 'A' Area) + ('B' RCN * 'B' Area) + ('C' RCN * 'C' Area) + ('D' RCN * 'D' Area)}}{\text{Total Area}}$$

RCN_{woods} = **70.00** Use **70**

B. Determine Target P_E <u>based on Parcel Area Characteristics</u>

% I = 15.5%

Use % I = 20.0 % to determine Target P_E.

Determine P_E for each soil group present in the drainage area using % I value and Table 5.3.

HSG	P_E
A	0.00
B	0.00
C	1.00
D	0.00

$$\text{Composite } P_{E} = \frac{\text{('A' } P_E * \text{'A' Area) + ('B' } P_E * \text{'B' Area) + ('C' } P_E * \text{'C' Area) + ('D' } P_E * \text{'D' Area)}}{\text{Total Area}}$$

Composite P_{E} = **1.00 Inches**

C. Determine target ESD Volume <u>for Disturbed Area</u>

$$ESDv = \frac{P_E * Rv * A}{12}$$

ESDv Required = 1,124.94 CF , USE: **1,130 CF**

Where: P_E = 1.00 inches
Rv = 0.05 + (0.009*I) = 0.36
I = 34.0%
A= 0.87 AC

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STORMWATER MANAGEMENT CONCEPT PLAN SUMMARY

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Impervious Area Analysis

Total Disturbed Area	0.87 AC
Total Impervious Area within LOD	0.30 AC

Total Site Percent Impervious (I) = Impervious Area to be Treated/Total Area
I = 34.0%

Target Rainfall Depth (PE) =	1.00"	*Composite PE value previously calculation*
Target RCN (Woods Good Condition) =	70	*Composite RCN value previously calculated*
10 Yr. Safety Storm Intensity (i) =	7.00 in./hr.	*from MSHA Highway Drainage Maunual Table 61.1-403.1*

LOD Area Rv =	0.36	*Rv value perviously calculated*
Required WQv =	1,130 CF	*Required WQv value previously calculated*
Required ESDv =	1,130 CF	*Required ESDv value previously calculated*

Study Area DA 1 Summary Table

Study Area	BMP #	Facility Type	Existing Hydrology			Stormwater Management					
			Drainage Area (ac)	Total Impervious Area (ac)	Percent Impervious	Target Volumes (cf) WQv	ESDv	1 Yr. Volume (Max)	Volume Provided (cf)	Percent WQv Treated	Percent ESDv Treated
DA 1	A2-1	Permeable Pavement	0.10	0.1	100%	340	340	884	688	202.1%	202.1%
DA 1	N3-1	Sheet Flow to Conservation Area	0.07	0.07	100%	247	247	641	247	100.0%	100.0%
DA 1	M7-1	Rain Garden	0.16	0.02	14%	105	188	272	222	212.4%	118.0%
		Total Area to SWM facilities (ac)	0.33	0.19							
		Study Area DA 1 Total (ac)	10.44	1.619							
Total Treatment Volume Provided and Percent of Required Treatment Volume (Study Area DA 1)									**1156**	**102.3%**	**102.3%**

PE Treated = (12*ESDv treated)/(Rv*A) = 1.03"

ESD reequirements have been satisfied. Additional stormwater management through structural practices is not necessary.

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SHEET FLOW TO CONSERVATION AREA - CONCEPT DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **N3-1** Facility Type: Sheet Flow to Conservation Area
Study Area: **DA 1**

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	3116	0.07	100%

Facility Concept Design

Facility Name: **N3-1**
Facility Type: Sheet Flow to Conservation Area

Total Impervious Area = 3,116 SF
I = 100%
Rv = 0.95
C = 0.90

Target WQ Rainfall Depth (P) =	1.00"	
Target WQv =	**247 CF**	*WQv = [P * Rv * A]/12*
Target ESD Rainfall Depth (P_E) =	1.00"	*Composite P_E value calculated for Study Area*
Target ESDv =	**247 CF**	*ESDv = [PE * Rv * A]/12*
1-Year 24-Hour Storm Rainfall Depth =	2.60"	
1-Year 24-Hour Storm Runoff Volume =	**641 CF**	*Using WQv formula with P= Rainfall Depth*

Target ESD Rainfall Depth is equal to 1 inch or less. Therefore, the Total ESDv can be treated if sufficient disconnection length can be provided.

Compute Treatment Volume Provided

Is the disconnection slope less than or equal to 5%? NO

Disconnection slopes greater than 5% require a 2' gravel diaphragm

Sizing Factors

Total Conservation Length =	389 FT
Min Conservation Area Width =	100 FT
Total Conservation Area =	38900 SF
Provided Pe =	1.0
Imervious Area Draining to	3116 SF

Treated Rainfall, P_E = **1.0 Inches** *P_E = (ESDv * 12) / (Rv * A)*

Treatment Volume Provided = **247 CF** *The lesser of the Provided Facility Storage or the 1-Year Storm Runoff Volume*

Adaquate storage volume is provided to treat ESDv.

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PERMEABLE PAVEMENT - CONCEPT DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **A2-1** Facility Type: Permeable Pavement
Study Area: **DA 1**

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	4297	0.1	100%

Facility Concept Design

Facility Name: **A2-1**
Facility Type: Permeable Pavement

Total Impervious Area = 4,297 SF
I = 100%
Rv = 0.95
C = 0.90

Target WQ Rainfall Depth (P) =	1.00"	
Target WQv =	**340 CF**	*WQv = [P * Rv * A]/12*
Target ESD Rainfall Depth (P_E) =	1.00"	*Composite P_E value calculated for Study Area*
Target ESDv =	**340 CF**	*ESDv = [PE * Rv * A]/12*
1-Year 24-Hour Storm Rainfall Depth =	2.60"	
1-Year 24-Hour Storm Runoff Volume =	**884 CF**	*Using WQv formula with P= Rainfall Depth*

Required ESDv is less than 1 Yr. runoff volume. Therefore, the Total ESDv can be treated.

Compute Treatment Volume Provided

Facility Dimensions

Pavement Area =	4297 FT	
Subbase Depth =	12.0 Inches	
Equivalent ESDv/sf =	0.16	*Determined using Table 1 from the MDE ESD Process & Computations Suppliment dated July 2010*

Provided ESDv Storage = Pavement Area * Equivalent ESDv/sf
= **688 CF**

Treated Rainfall, P_E = **2.0 Inches** *P_E = (ESDv * 12) / (Rv * A)*

Adaquate storage volume is provided to treat ESDv.

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RAIN GARDEN FACILITY - PRELIMINARY DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **M7-1** Facility Type: Rain Garden
Study Area: **DA 1**

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	1005	0.02	14%
Open Space/Woods	5995	0.14	86%
Total Drainage Area	**7000**	**0.16**	100%

Facility Preliminary Design

Facility Name: **M7-1**
Facility Type: Rain Garden

Drainage Area (DA) =	7,000 SF	Target WQ Rainfall Depth (P) =	1.00"	
Total Impervious Area =	1,005 SF	Target WQv =	**105 CF**	*WQv = [P * Rv * A]/12*
I =	14%	Target ESD Rainfall Depth (P_E) =	1.80"	*Composite P_E value calculated for Study Area*
Rv =	0.18	Target ESDv =	**188 CF**	*ESDv = [PE * Rv * A]/12*
C =	0.34	1-Year 24-Hour Storm Rainfall Depth =	2.60"	
		1-Year 24-Hour Storm Runoff Volume =	**272 CF**	*Using WQv formula with P= Rainfall Depth*

Required ESDv is less than 1 Yr. runoff volume. Therefore, the Total ESDv can be treated.

Compute Treatment Volume Provided

Facility Dimensions

Filter Bed Elevation	660.5
Overflow Crest Elevation	661.0
Top of Embankment Elevation	661.0
Bottom Surface Area (Af)	247 SF
Ponding Depth	6.00 IN
Ponding Storage Provided *	124 CF
Bed Depth *(Mulch & Media)*	1.00 FT
Filter Bed Porosity	0.40

* Ponding Storage Provided calculated as Bottom Surface Area * Ponding Depth

Safety Storm

T_c (min) =	**5**	
i_{10} =	**7.07**	
A_{10} =	**0.16 AC**	
Q_{10} =	**0.39 CFS**	*Q=ciA*
Weir Length =	**4.00 FT**	
$WSEL_{10}$ =	**661.10**	

Compute Safety Storm WSEL using Weir Equation***
WSEL = ESD WSEL + (Q/3.1*LW)2/3
****Note: Safety storm WSEL must be less than top of dam*

Provided Facility Storage = Ponding Storage + Filter Bed Storage
= 222 CF

Treatment Volume Provided = **222 CF** *The lesser of the Provided Facility Storage or the 1-Year Storm Runoff Volume*
Treated Rainfall, P_E = **2.1 Inches** *P_E = (ESDv * 12) / (Rv * A)*

Adaquate storage volume is provided to treat ESDv.

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STORMWATER MANAGEMENT REQUIREMENTS

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Study Area: DA 2

Site Data: County: Montgomery
Project Type: SWM Plan
Location: North Fredrick Road

	Parcel Area to Study Point	LOD Area to Study Point
Total Area:	**55.54 AC**	**2.09 AC**
Impervious Area:	**1.63 AC**	**0.29 AC**
Percent Impervious:	**2.9%**	**13.7%**

Soils:

HSG	RCN[1]	Parcel Area (Ac.)	Percent
A [2]	38	0.00	0%
B	55	0.00	0%
C	70	43.33	78%
D	77	12.21	22%

[1] RCN for "woods in good condition" (Table 2-2, TR-55)

[2] Actual RCN for Hydrologic Soil Group 'A' is less than 30, use RCN=38

Determine Water Quality (WQv) Requirements

A. Determine target WQ Volume <u>for Disturbed Area</u>

$$WQv = \frac{P_E * Rv * A}{12}$$

WQv Required = 1,313.70 CF , USE: **1,320 CF**

Where: P_E = 1.00 inches
Rv = 0.05 + (0.009*I) = 0.17
I = 13.7%
A= 2.09 AC

Determine ESD Requirements

Methodology per Montgomery County DPS Water Resources Technical Policy WRTP-5

A. Determine RCN for "woods in good condition" for Site Area

$$RCN_{woods} = \frac{('A' RCN * 'A' Area) + ('B' RCN * 'B' Area) + ('C' RCN * 'C' Area) + ('D' RCN * 'D' Area)}{Total\ Area}$$

RCN_{woods} = **71.54** Use **72**

B. Determine Target P_E <u>based on Parcel Area Characteristics</u>

% I = 2.9%

Use % I = 3.0 % to determine Target P_E.

Determine P_E for each soil group present in the drainage area using % I value and Table 5.3.

HSG	P_E
A	0.00
B	0.00
C	1.00
D	1.00

$$Composite\ P_E = \frac{('A' P_E * 'A' Area) + ('B' P_E * 'B' Area) + ('C' P_E * 'C' Area) + ('D' P_E * 'D' Area)}{Total\ Area}$$

Composite P_E = **1.00 Inches**

C. Determine target ESD Volume <u>for Disturbed Area</u>

$$ESDv = \frac{P_E * Rv * A}{12}$$

ESDv Required = 1,313.70 CF , USE: **1,320 CF**

Where: P_E = 1.00 inches
Rv = 0.05 + (0.009*I) = 0.17
I = 13.7%
A= 2.09 AC

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STORMWATER MANAGEMENT CONCEPT PLAN SUMMARY

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Impervious Area Analysis

Total Disturbed Area	2.09 AC
Total Impervious Area within LOD	0.29 AC

Total Site Percent Impervious (I) = Impervious Area to be Treated/Total Area
I = 13.7%

Target Rainfall Depth (PE) =	1.00"	*Composite PE value previously calculation*
Target RCN (Woods Good Condition) =	72	*Composite RCN value previously calculated*
10 Yr. Safety Storm Intensity (i) =	7.00 in./hr.	*from MSHA Highway Drainage Maunual Table 61.1-403.1*

LOD Area Rv =	0.17	*Rv value perviously calculated*
Required WQv =	1,320 CF	*Required WQv value previously calculated*
Required ESDv =	1,320 CF	*Required ESDv value previously calculated*

Study Area DA 2 Summary Table

Study Area	BMP #	Facility Type	Existing Hydrology			Stormwater Management					
			Drainage Area (ac)	Total Impervious Area (ac)	Percent Impervious	Target Volumes (cf) WQv	ESDv	1 Yr. Volume (Max)	Volume Provided (cf)	Percent WQv Treated	Percent ESDv Treated
DA 2	N3-2	Sheet Flow to Conservation Area	0.14	0.14	100%	482	482	1254	482	100.0%	100.0%
DA 2	A2-2	Permeable Pavement	0.14	0.14	100%	466	466	1211	941	202.1%	202.1%
		Total Area to SWM facilities (ac)	0.28	0.28							
		Study Area DA 2 Total (ac)	55.54	1.63							
Total Treatment Volume Provided and Percent of Required Treatment Volume (Study Area DA 2)									**1423**	**107.8%**	**107.8%**

PE Treated = (12*ESDv treated)/(Rv*A) = 1.08"

ESD reequirements have been satisfied. Additional stormwater management through structural practices is not necessary.

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SHEET FLOW TO CONSERVATION AREA - CONCEPT DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **N3-2** Facility Type: Sheet Flow to Conservation Area
Study Area: **DA 2**

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	6093	0.14	100%

Facility Concept Design

Facility Name: **N3-2**
Facility Type: Sheet Flow to Conservation Area

Total Impervious Area = 6,093 SF
I = 100%
Rv = 0.95
C = 0.90

Target WQ Rainfall Depth (P) =	1.00"	
Target WQv =	**482 CF**	*WQv = [P * Rv * A]/12*
Target ESD Rainfall Depth (P_E) =	1.00"	*Composite P_E value calculated for Study Area*
Target ESDv =	**482 CF**	*ESDv = [PE * Rv * A]/12*
1-Year 24-Hour Storm Rainfall Depth =	2.60"	
1-Year 24-Hour Storm Runoff Volume =	**1,254 CF**	*Using WQv formula with P= Rainfall Depth*

Target ESD Rainfall Depth is equal to 1 inch or less. Therefore, the Total ESDv can be treated if sufficient disconnection length can be provided.

Compute Treatment Volume Provided

Is the disconnection slope less than or equal to 5%? NO

Disconnection slopes greater than 5% require a 2' gravel diaphragm

Sizing Factors

Total Conservation Length =	762 FT
Min Conservation Area Width =	100 FT
Total Conservation Area =	76200 SF
Provided Pe =	1.0
Imervious Area Draining to	6093 SF

Treated Rainfall, P_E = **1.0 Inches** *P_E = (ESDv * 12) / (Rv * A)*

Treatment Volume Provided = **482 CF** *The lesser of the Provided Facility Storage or the 1-Year Storm Runoff Volume*

Adaquate storage volume is provided to treat ESDv.

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PERMEABLE PAVEMENT - CONCEPT DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **A2-2** Facility Type: Permeable Pavement
Study Area: **DA 2**

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	5882	0.14	100%

Facility Concept Design

Facility Name: **A2-2**
Facility Type: Permeable Pavement

Total Impervious Area = 5,882 SF
I = 100%
Rv = 0.95
C = 0.90

Target WQ Rainfall Depth (P) =	1.00"	
Target WQv =	**466 CF**	*WQv = [P * Rv * A]/12*
Target ESD Rainfall Depth (P_E) =	1.00"	*Composite P_E value calculated for Study Area*
Target ESDv =	**466 CF**	*ESDv = [PE * Rv * A]/12*
1-Year 24-Hour Storm Rainfall Depth =	2.60"	
1-Year 24-Hour Storm Runoff Volume =	**1,211 CF**	*Using WQv formula with P= Rainfall Depth*

Required ESDv is less than 1 Yr. runoff volume. Therefore, the Total ESDv can be treated.

Compute Treatment Volume Provided

Facility Dimensions

Pavement Area =	5882 SF	
Subbase Depth =	12.0 Inches	
Equivalent ESDv/sf =	0.16	*Determined using Table 1 from the MDE ESD Process & Computations Suppliment dated July 2010*

Provided ESDv Storage = Pavement Area * Equivalent ESDv/sf
= **941 CF**

Treated Rainfall, P_E = **2.0 Inches** *P_E = (ESDv * 12) / (Rv * A)*

Adaquate storage volume is provided to treat ESDv.

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STORMWATER MANAGEMENT REQUIREMENTS

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Study Area: DA 3

Site Data:
County: Montgomery
Project Type: SWM Plan
Location: North Fredrick Road

	Parcel Area to Study Point	LOD Area to Study Point
Total Area:	**17.96 AC**	**0.75 AC**
Impervious Area:	**1.30 AC**	**0.27 AC**
Percent Impervious:	**7.2%**	**36.4%**

Soils:

HSG	RCN[1]	Parcel Area (Ac.)	Percent
A [2]	38	0.00	0%
B	55	0.00	0%
C	70	17.96	100%
D	77	0.00	0%

[1] RCN for "woods in good condition" (Table 2-2, TR-55)

[2] Actual RCN for Hydrologic Soil Group 'A' is less than 30, use RCN=38

Determine Water Quality (WQv) Requirements

A. Determine target WQ Volume <u>for Disturbed Area</u>

$$WQv = \frac{P_E * Rv * A}{12}$$

WQv Required = 1,024.20 CF , USE: **1,030 CF**

Where: P_E = 1.00 inches
Rv = 0.05 + (0.009*I) = 0.38
I = 36.4%
A= 0.75 AC

Determine ESD Requirements

Methodology per Montgomery County DPS Water Resources Technical Policy WRTP-5

A. Determine RCN for "woods in good condition" for Site Area

$$RCN_{woods} = \frac{\text{('A' RCN * 'A' Area) + ('B' RCN * 'B' Area) + ('C' RCN * 'C' Area) + ('D' RCN * 'D' Area)}}{\text{Total Area}}$$

RCN_{woods} = **70.00** Use **70**

B. Determine Target P_E <u>based on Parcel Area Characteristics</u>

% I = 7.2%

Use % I = 8.0 % to determine Target P_E.

Determine P_E for each soil group present in the drainage area using % I value and Table 5.3.

HSG	P_E
A	0.00
B	0.00
C	1.00
D	0.00

$$\text{Composite } P_{E} = \frac{\text{('A' } P_E * \text{'A' Area) + ('B' } P_E * \text{'B' Area) + ('C' } P_E * \text{'C' Area) + ('D' } P_E * \text{'D' Area)}}{\text{Total Area}}$$

Composite P_{E} = **1.00 Inches**

C. Determine target ESD Volume <u>for Disturbed Area</u>

$$ESDv = \frac{P_E * Rv * A}{12}$$

ESDv Required = 1,024.20 CF , USE: **1,030 CF**

Where: P_E = 1.00 inches
Rv = 0.05 + (0.009*I) = 0.38
I = 36.4%
A= 0.75 AC

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STORMWATER MANAGEMENT CONCEPT PLAN SUMMARY

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Impervious Area Analysis

Total Disturbed Area	0.75 AC
Total Impervious Area within LOD	0.27 AC

Total Site Percent Impervious (I) = Impervious Area to be Treated/Total Area
I = 36.4%

Target Rainfall Depth (PE) =	1.00"	*Composite PE value previously calculation*
Target RCN (Woods Good Condition) =	70	*Composite RCN value previously calculated*
10 Yr. Safety Storm Intensity (i) =	7.00 in./hr.	*from MSHA Highway Drainage Maunual Table 61.1-403.1*

LOD Area Rv =	0.38	*Rv value perviously calculated*
Required WQv =	1,030 CF	*Required WQv value previously calculated*
Required ESDv =	1,030 CF	*Required ESDv value previously calculated*

Study Area DA 3 Summary Table

Study Area	BMP #	Facility Type	Existing Hydrology			Stormwater Management					
			Drainage Area (ac)	Total Impervious Area (ac)	Percent Impervious	Target Volumes (cf) WQv	ESDv	1 Yr. Volume (Max)	Volume Provided (cf)	Percent WQv Treated	Percent ESDv Treated
DA 3	N2-1	Non-Rooftop Disconnection	0.06	0.06	100%	199	199	517	199	100.0%	100.0%
DA 3	A2-3	Permeable Pavement	0.13	0.13	100%	439	439	1141	887	202.1%	202.1%
		Total Area to SWM facilities (ac)	0.19	0.19							
		Study Area DA 3 Total (ac)	17.96	1.3							
Subtotal Treatment Volume Provided and Percent of Required Treatment Volume (Study Area DA 3)									**1086**	**105.4%**	**105.4%**

PE Treated = (12*ESDv treated)/(Rv*A) = 1.06"

ESD requirements have been satisfied, additional SWM through structural practices is not required.

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NON-ROOFTOP DISCONNECTION - CONCEPT DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **N2-1** Facility Type: Non-Rooftop Disconnectior
Study Area: **DA 3**

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	2514	0.06	100%

Facility Concept Design

Facility Name: **N2-1**
Facility Type: Non-Rooftop Disconnection

Total Impervious Area = 2,514 SF
I = 100%
Rv = 0.95
C = 0.90

Target WQ Rainfall Depth (P) =	1.00"	
Target WQv =	**199 CF**	*WQv = [P * Rv * A]/12*
Target ESD Rainfall Depth (P_E) =	1.00"	*Composite P_E value calculated for Study Area*
Target ESDv =	**199 CF**	*ESDv = [PE * Rv * A]/12*
1-Year 24-Hour Storm Rainfall Depth =	2.60"	
1-Year 24-Hour Storm Runoff Volume =	**517 CF**	*Using WQv formula with P= Rainfall Depth*

Target ESD Rainfall Depth is equal to 1 inch or less. Therefore, the Total ESDv can be treated if sufficient disconnection length can be provided.

Compute Treatment Volume Provided

Facility Dimensions
Max Contribution Lenth = 18 FT
Max Disconnection Length = 18 FT

Is the disconnection slope less than or equal to 5%? YES

Treated Rainfall, P_E = **1.0 Inches** *P_E = (ESDv * 12) / (Rv * A)*
Treatment Volume Provided = **199 CF** *The lesser of the Provided Facility Storage or the 1-Year Storm Runoff Volume*

Adaquate storage volume is provided to treat ESDv.

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PERMEABLE PAVEMENT - CONCEPT DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **A2-3** Facility Type: Permeable Pavement
Study Area: **DA 3**

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	5542	0.13	100%

Facility Concept Design

Facility Name: **A2-3**
Facility Type: Permeable Pavement

Total Impervious Area = 5,542 SF
I = 100%
Rv = 0.95
C = 0.90

Target WQ Rainfall Depth (P) =	1.00"	
Target WQv =	**439 CF**	*WQv = [P * Rv * A]/12*
Target ESD Rainfall Depth (P_E) =	1.00"	*Composite P_E value calculated for Study Area*
Target ESDv =	**439 CF**	*ESDv = [PE * Rv * A]/12*
1-Year 24-Hour Storm Rainfall Depth =	2.60"	
1-Year 24-Hour Storm Runoff Volume =	**1,141 CF**	*Using WQv formula with P= Rainfall Depth*

Required ESDv is less than 1 Yr. runoff volume. Therefore, the Total ESDv can be treated.

Compute Treatment Volume Provided

Facility Dimensions

Pavement Area =	5542 FT	
Subbase Depth =	12.0 Inches	
Equivalent ESDv/sf =	0.16	*Determined using Table 1 from the MDE ESD Process & Computations Suppliment dated July 2010*

Provided ESDv Storage = Pavement Area * Equivalent ESDv/sf
= **887 CF**

Treated Rainfall, P_E = **2.0 Inches** *P_E = (ESDv * 12) / (Rv * A)*

Adaquate storage volume is provided to treat ESDv.

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MICRO-BIORETENTION FACILITY - CONCEPT DESIGN

Project Name: Little Bennet Trail
Project No.: 42-520 Date: 5/8/2015 By: KMO

Facility Summary

Facility Name: **M6-1** Facility Type: Micro-Bioretention
Study Area: **NA**

NOTE: this facility is not required to meet stormwater management requirements for the proposed trail. This facility is proposed to provide additional ms4 treatment.

Hydrology Summary			
Land Use	Area (sf)	Area (ac)	%
Impervious Area	8564	0.2	49%
Open Space/Woods	8876	0.2	51%
Total Drainage Area	**17440**	**0.4**	100%

Facility Concept Design

Facility Name: **M6-1**
Facility Type: Micro-Bioretention

Drainage Area (DA) =	17,440 SF	Target WQ Rainfall Depth (P) =	1.00"	
Total Impervious Area =	8,564 SF	Target WQv =	**715 CF**	*WQv = [P * Rv * A]/12*
I =	49%	Target ESD Rainfall Depth (P_E) =	1.00"	*Composite P_E value calculated for Study Area*
Rv =	0.49	Target ESDv =	**715 CF**	*ESDv = [PE * Rv * A]/12*
C =	0.57	1-Year 24-Hour Storm Rainfall Depth =	2.60"	
		1-Year 24-Hour Storm Runoff Volume =	**1,859 CF**	*Using WQv formula with P= Rainfall Depth*

Required ESDv is less than 1 Yr. runoff volume. Therefore, the Total ESDv can be treated.

Compute Treatment Volume Provided

Facility Dimensions

Filter Bed Elevation	650.0	
Overflow Crest Elevation	651.0	
Top of Embankment Elevation	652.0	*0.74' of Freeboard is provided*
Bottom Surface Area (Af)	834 SF	
Ponding Depth	1.00 FT	
Ponding Storage Provided	834 CF	
Bed Depth *(Media & Sand)*	3.25 FT	
Filter Bed Porosity	0.40	
Additional Stone Storage Area	00 SF	*Applicable if facility is an enhanced filter*
Additional Stone Storage Depth	0.00 FT	*Applicable if facility is an enhanced filter*
Additional Stone Storage Porosi	0.40	

Safety Storm

T_c (min) =	**5**	
i_{10} =	**7.07**	
A_{10} =	**0.40 AC**	
Q_{10} =	**1.61 CFS**	*Q=ciA*
Weir Length =	**3.93 FT**	*15 " Diam. Nyloplast Str.*
$WSEL_{10}$ =	**651.26**	

Compute Safety Storm WSEL using Weir Equation***
WSEL = ESD WSEL + (Q/3.1*LW)2/3
****Note: Safety storm WSEL must be less than top of dam*

Provided Facility Storage = Ponding Storage + Filter Bed Storage + Additional Stone Storage
= 1,918 CF

Treatment Volume Provided = **1,859 CF** *The lesser of the Provided Facility Storage or the 1-Year Storm Runoff Volume*
Treated Rainfall, P_E = **2.6 Inches** $P_E = (ESDv * 12) / (Rv * A)$

Adaquate storage volume is provided to treat ESDv.