Water Street Road

Prioritization Ranking:	17
Planning Level Cost Estimate:	$ 161,520.65
Estimated Cost/Impervious Acre	$ 60,332.44

General BMP Information:		
Structure Location:	Water Street Road and Greenbrier Lane	
ADC Map:	4449, H3 (2008)	
Northing/Easting:	661,230.426/1,220,142.522	
NPDES Watershed:	Israel Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool ED (P-1)	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	23.34	
Total Impervious Area (ac):	2.93	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	16945	
Total Treated Drainage Area (ac):	23.34	
Total Treated Impervious Area (ac):	2.93	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	189.54	207.70
TP (lbs/yr):	12.12	17.25
TSS (lbs/yr):	7143.17	17666.26

Existing conditions for Water Street Road

Site map for Water Street Road

EXISTING SITE CONDITIONS

Water Street Road and Greenbrier Lane were investigated during site visits to identify opportunities to treat untreated impervious area. The drainage area for BMP A as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 23.34 acres. The drainage area is shown in the location map above. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from Water Street Road or Greenbrier Lane. There are no other obvious site constraints such as utilities or steep slopes. MOT is required for this BMP.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: MOT, Acquisition of Easement	

PROPOSED RETROFIT

There is no existing SWM at this location. The proposed retrofit for Water Street Road is a micropool ED (P-1). It will provide quantity and quality management for 23.34 acres including 2.93 acres of impervious area. The existing inlet (Inlet #3) will be modified to act as a control structure for the retrofit.

WATER STREET ROAD

Storm Water Management Retrofit Evaluation					
Report Date:	10/6/2015	**Design Approval:**	Not Available	**Maintenance Owner:**	N/A
Structure No:	BMP A	**Year Constructed:**	Not Available	**Inspection Date:**	5/5/2015
Structure Name:	Water Street Road	**NPDES Watershed:**	Israel Creek	**Inspection Team:**	ND, CF
Location:	Water Street Road and Greenbrier Lane	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	4/30/2015 (0.14")
ADC Map:	4449, H3 (2008)	**Land-River Segment:**	PM4_3341_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	661,230.426/1,220,142.522	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Micropool ED (P-1)	
BMP Classification:			Stormwater Treatment (ST) Practice	
Management Type:			Quantity/Quality	
Total Drainage Area (acres):			23.34	
Total Impervious Area within Drainage Area (acres):			2.93	
WQv Required:			16945 cu. ft.	0.389 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		16945 cu. ft.	0.389 ac-ft
Total Treated Drainage Area (acres):			23.34	
Total Treated Impervious Area within Drainage Area (acres):			2.93	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		1.59	
Total Nitrogen:			38.32%	
Total Phosphorus:			60.23%	
Sediment:			76.65%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		189.54	207.70
TP (lbs/yr):			12.12	17.25
TSS (lbs/yr):			7143.17	17666.26
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 161,520.65**

WATER STREET ROAD

Existing Site Conditions:

Water Street Road and Greenbrier Lane were investigated during site visits to identify opportunities to treat untreated impervious area. The drainage area for BMP A as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 23.34 acres and an impervious area of 2.93 acres. The drainage area is shown in the location map below (**Figure 1**).

General Observations:

The site visit was conducted on May 5th, 2015. **Figure 2** shows the location of photos taken during the visit.

Flow from the north side of Greenbrier Lane flows west via a grass ditch (**Photo 1**). Flow from the south side of Greenbrier Lane flows west via a grass ditch to an inlet (Inlet #1) which outfalls across Greenbrier Lane (**Photos 1 and 2**). Flow from Water Street Road flows north via a grass ditch to an inlet (Inlet #2) which outfalls across Greenbrier Lane (**Photo 3**).

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site via Water Street Road or Greenbrier Lane. There are overhead utilities along the east side of Water Street Road. According to the County's parcel layer in GIS, this site is on open space. Easements at this location should be evaluated further in final design. MOT is required at this site.

Proposed Retrofit:

There is no existing SWM at this location. Based on the results of a GIS desktop analysis and site visit, it was determined that the impervious area along Greenbrier Lane drains to the proposed location for BMP A (**Photo 4**). Therefore, the most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP A is a micropool ED (P-1). The proposed retrofit will provide quantity and quality management for 23.34 acres including 2.93 acres of impervious area. The existing inlet (Inlet #3) will be modified to act as a control structure for the retrofit (**Photo 5**).

Step 1: Watershed Factors

BMP A is located in Frederick County's Israel Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP A due to the downstream coldwater conditions. For the retrofit of BMP A, 100% of the WQv can be stored within the proposed BMP (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream Israel creek.

Step 2: Terrain Factors

BMP A is not located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for proposed design of BMP A.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation two (2) feet below the existing ground elevation (based on information available). There is adequate space for the proposed retrofit within the existing open space. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area for a micropool ED is 10 acres. The proposed drainage area for BMP A is 23.34 acres and composed of A and B soils. The likelihood of BMP A receiving hotspot runoff is low as they are part of a residential community.

The land use within the drainage area to the BMP is not ultra-urban. Proposing new BMPs are feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP A is located to the north of Greenbrier Lane and the east of Water Street Road and has high visibility. BMP A is in close proximity to the house on Greenbrier Lane. There will be a loss of existing shrubs with installation of this facility. Micropool ED tend to have medium maintenance requirements, medium community acceptance, low construction costs relative to the drainage area, and provide medium habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP A include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Flood Insurance Map FM24021C0315D indicates that the BMP is within the FEMA 100-year floodplain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is not mapped as a wetland, nor is an in-stream facility.

Figure 1: BMP Location Map – Existing Conditions

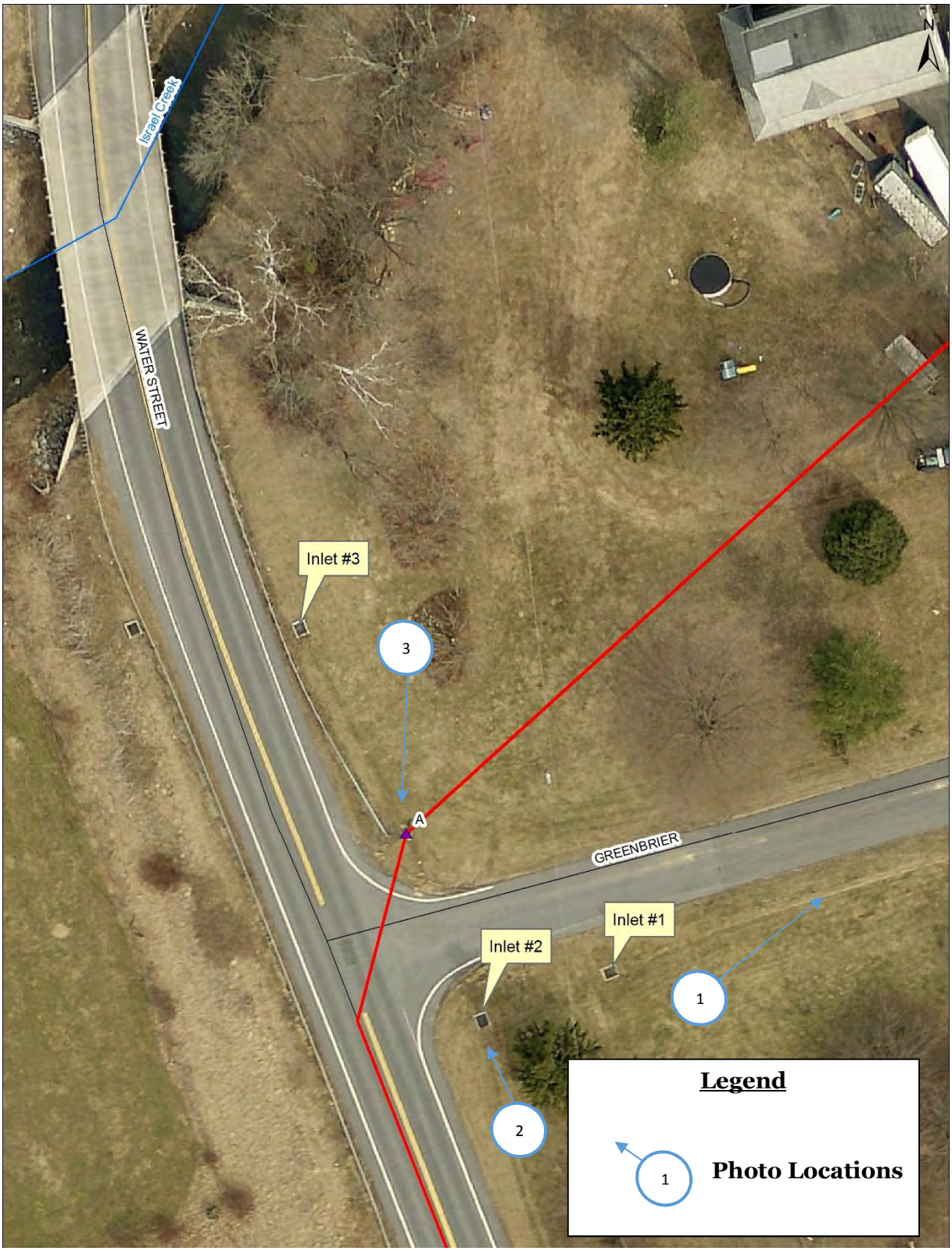


Figure 2: Photo Locations

Photo 1: Grass ditches along Greenbrier Lane facing west

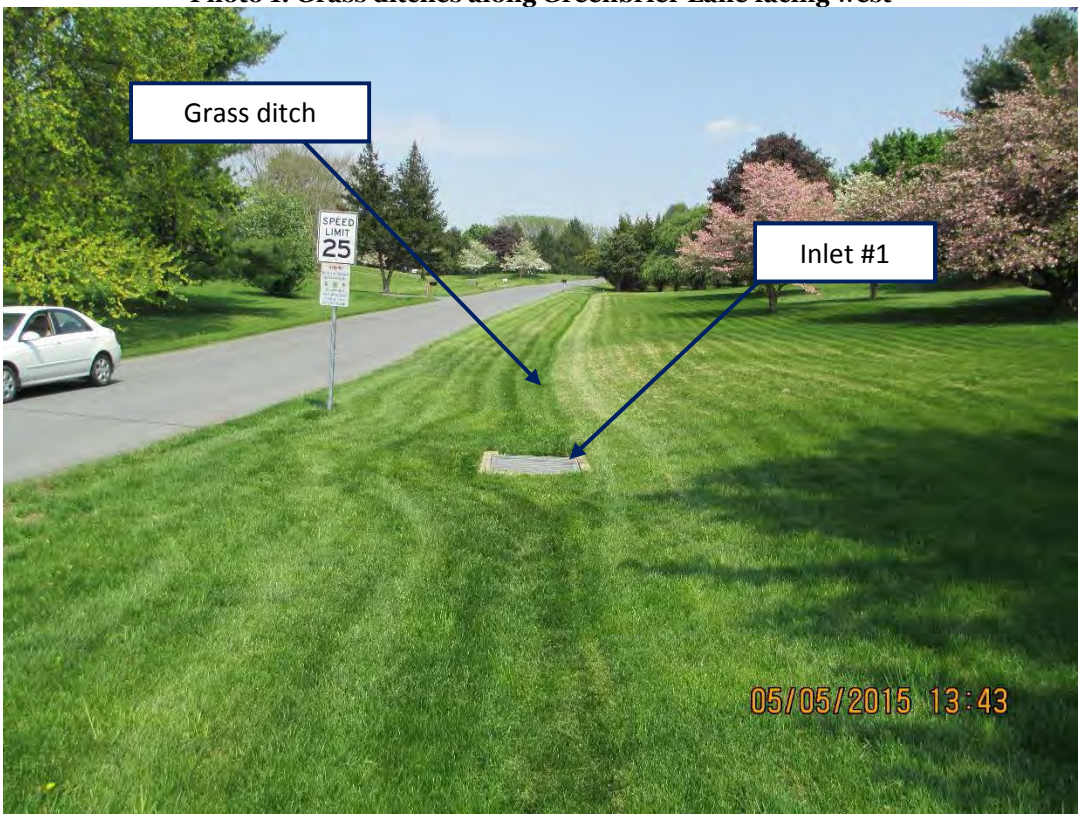


Photo 2: Grass ditch on south side of Greenbrier Lane facing east

Photo 3: Grass ditch along Water Street Road facing southeast

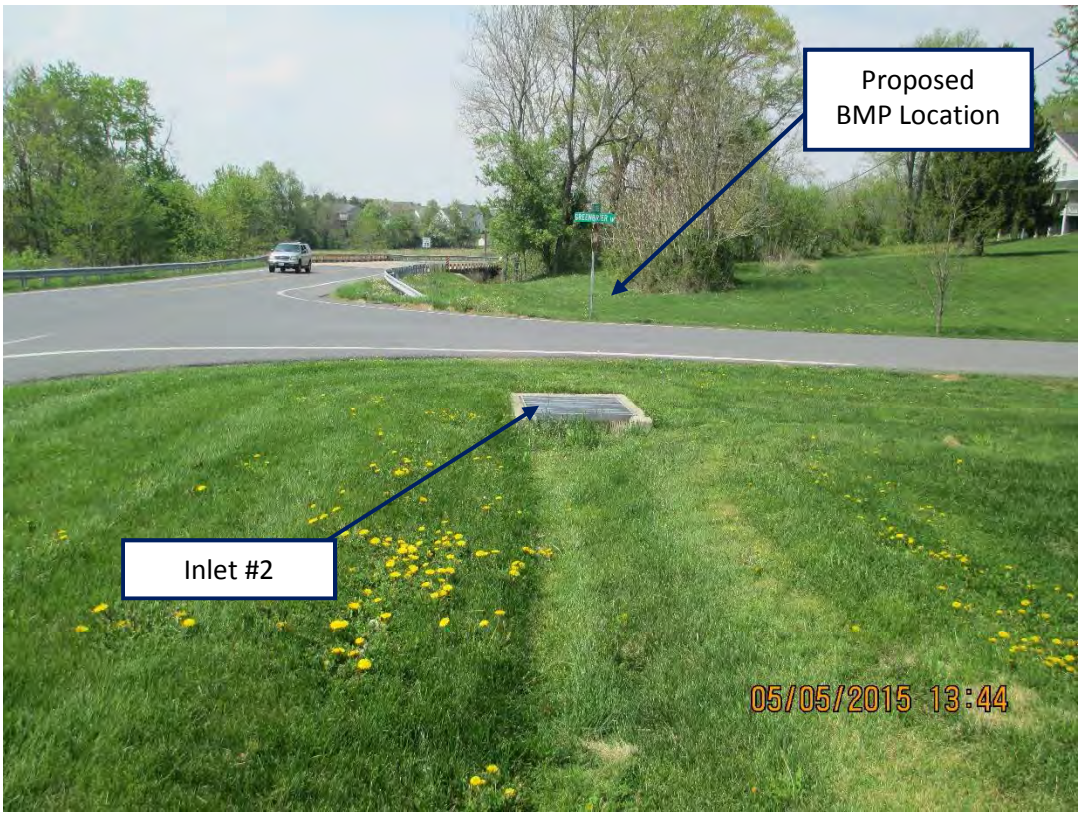


Photo 4: Proposed BMP location facing north

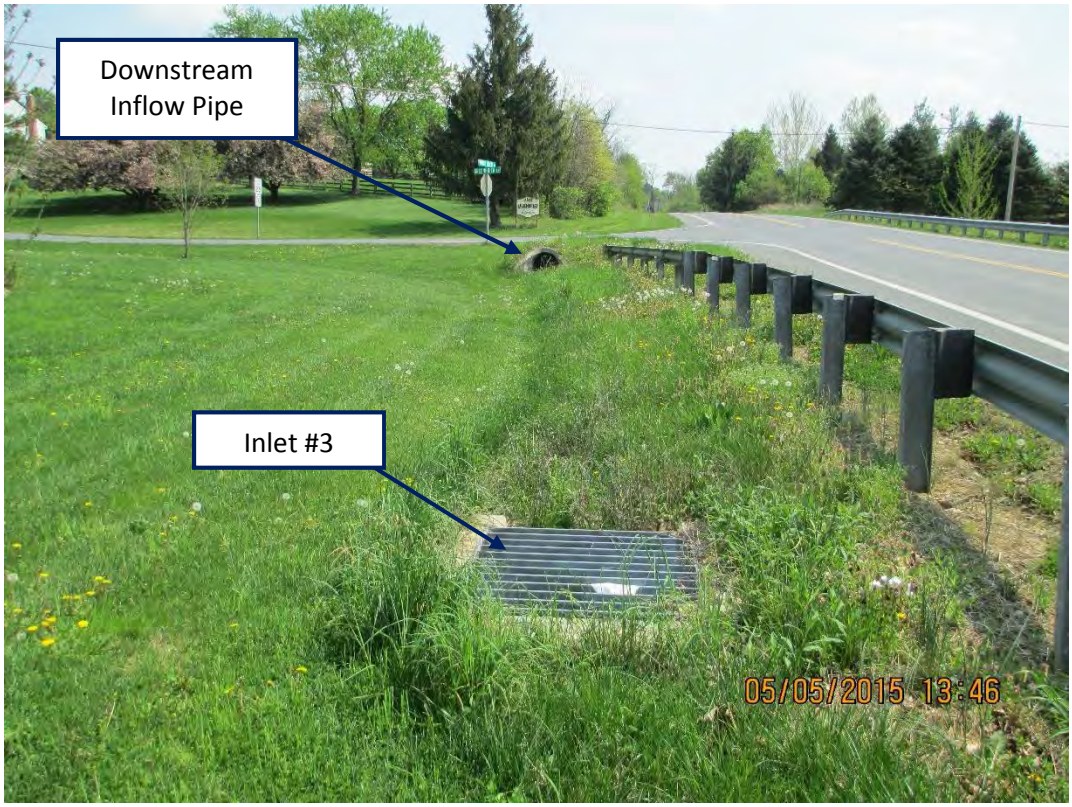
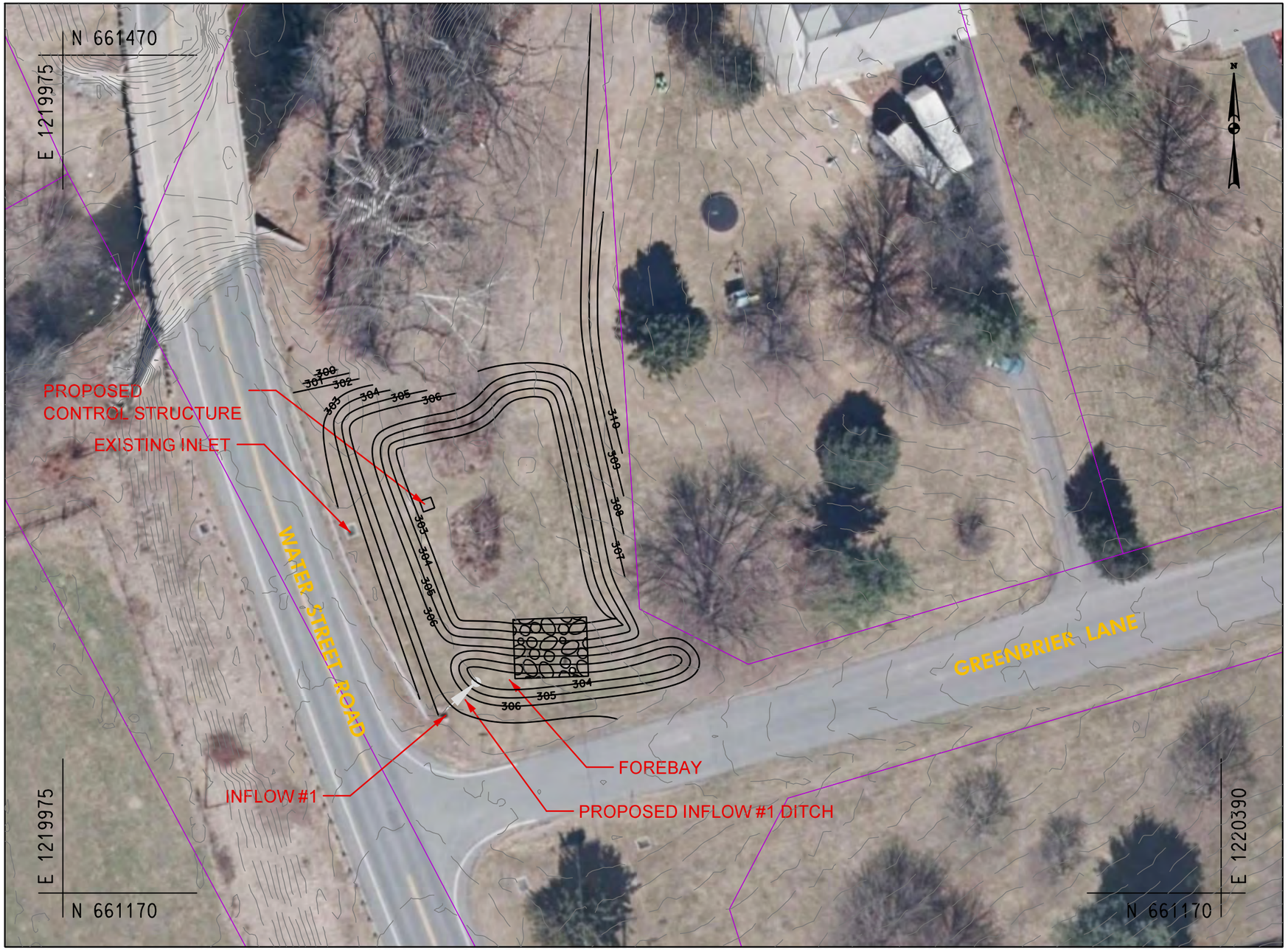


Photo 5: Inflow and Outflow facing south



GENERAL BMP INFORMATION - BMP C	
BMP TYPE:	MICROPOOL ED (P-1)
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	23.34
TOTAL IMPERVIOUS AREA (ACRES):	2.93
WQv REQUIRED (CU. FT):	16945
WQv REQUIRED (AC. FT):	0.389
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	16945
TOTAL TREATED DA (ACRES):	23.34
TOTAL TREATED IMPERVIOUS AREA (ACRES):	2.93

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: vhamsher -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

WATER STREET ROAD

SCALE 1" = 40' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF - SHEET NO. - OF

PLOTTED: Wednesday, June 07, 2017 AT 09:29 AM
FILE: \\catoctrl\Projects\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_WaterStreet.dgn

WinTR-55 Current Data Description

--- Identification Data ---

User: vhamsher
Project: Untreated Impervious Area
SubTitle: Water Street Road
State: Maryland
County: Frederick NOAA_C
Filename: <new file>

Date: 10/6/2015
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
BMP A		Outlet	23.34	65	.256

Total area: 23.34 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.42	4.45	5.34	6.69	7.88	9.22	2.81

Storm Data Source: Wicomico East NOAA_D County, MD (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

vhamsher

Untreated Impervious Area
Water Street Road
Frederick NOAA_C County, Maryland

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period ANALYSIS: (cfs)	10-Yr (cfs)	100-Yr (cfs)
SUBAREAS			
BMP A	17.67	52.85	140.84
REACHES			
OUTLET	17.67	52.85	140.84

vhamsher

Untreated Impervious Area
Water Street Road
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)
BMP A							
SHEET	100	0.0200	0.150				0.158
CHANNEL	1760					5.000	0.098
					Time of Concentration		.256

vhamsher

Untreated Impervious Area
Water Street Road
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
BMP A	Open space; grass cover > 75%	(good)	A	.17	39
	Open space; grass cover > 75%	(good)	B	20.24	61
	Paved parking lots, roofs, driveways		B	2.08	98
	Paved; open ditches (w/right-of-way)		B	.85	89
	Total Area / Weighted Curve Number			23.34	65
				=====	==

MICROPOOL ED DESIGN (P-1): WATER STREET ROAD

This spreadsheet is for **design level calculations** of Micropool ED

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2011)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project: **SWM BMP Retrofit Assessment** Engineer:

Location: **Frederick County, MD** Date: **10/6/2015**

Watershed: **Lower Monocacy River** As Built:

Drainage Area: **23.34 (Total)** Acres 0.036 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **2.93** Acres **I =** 0.126

= 12.6 %

Soil Type: **A, B**

RCN Existing : **0** **Existing tc =** **0.00** hr

RCN Post Development : **65** **Post-D tc =** **0.26** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.163

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (1.0" for Eastern Rainfall Zone, 0.9" for Western Rainfall zone)

1" selected per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 12.6 %

$WQ_{V(I)}$ = 0.317 ac-ft = 13808 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.389 ac-ft = 16944.84 cu.ft

Water quality treatment required =	**16945**	**cu.ft**	**=**	**0.3890**	ac-ft
WQv provided by other practices =	**0**	**cu.ft**	**=**	**0.0000**	ac-ft
Net water quality treatment required =	**16945**	**cu.ft**	**=**	**0.3890**	ac-ft
Sediment Forebay Volume Required=	**1694**	**cu.ft**	**=**	**0.0389**	ac-ft
WQv in pond =	**15250**	**cu.ft**	**=**	**0.3501**	ac-ft
Elevation at the Top of WQv in pond =	**304.00**	**ft**			

Forebay Volume = 0.1" runoff

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	8472
II	50% of WQv is in micropool	8472
III	1/3 of WQv is in micropool & forebay	3954
IV	1/3 of WQv is in micropool & forebay	3954

***source: SHA SWM Workshop, April 30, 2003**

Micropool storage volume required = **3954** **cu.ft** **=** **0.0908** **ac-ft**

Extended Detention Storage= **3954** cu.ft = Dead Storage Volume cu.ft

Extended Detention Elevation= **303.96** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice

Hence, WQrr = **0.05** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

Assume h_o = **0.04** ft *Will change based on pond volume

Ao = 0.05 sf

Determine the required orifice diameter (d_o)

Do = 0.25 ft = **3.0** inches.

Step 2: Compute Recharge Volume (Rev)

$$\text{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

	HSG	Drainage Area (Acres)	Percentage (%)
	A	**0.17**	1
23.34	B	**23.17**	99
	C	**0.00**	0
	D	**0.00**	0
	Total	**23.34**	OK: sum of the areas matches site Area

Composite S: 0.2609 Use 26.09 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.083 ac-ft = **3602** cu.ft

Rev in Pond= **1908**

El of Rev= **303.47** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **0.764** Acres = 33295 sf

The Rev requirement may be met by:

a) treating 0.083 ac-ft using structural method,

b) treating 0.764 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	SWM BMP Retrofit Assessment	Engineer:	VLH
Location:	Frederick County, MD	Date:	10/6/2015
Watershed:	Lower Monocacy River		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
3650.3	**303.0**	0.08	0.00	0.00	0.00	0.00
4571.6	**304.0**	0.10	1.00	0.09	0.09	4102.31
5561.6	**305.0**	0.13	1.00	0.12	0.21	9160.81
6606.4	**306.0**	0.15	1.00	0.14	0.35	15237.31

No. of valid row entries= 4

BMP #394 - SWM Detention Pond

Prioritization Ranking:	18
Planning Level Cost Estimate:	$ 1,249,088.50
Estimated Cost/Impervious Acre	$ 106,054.00

General BMP Information:		
Structure Location:	Inspiration Avenue	
ADC Map:	4449, D6 (2008)	
Northing/Easting:	655,310.75/1,212,003.33	
NPDES Watershed:	Israel Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Wet Extended Detention Pond (P-3)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	39.45	
Total Impervious Area (ac):	12.01	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	46396	
Total Treated Drainage Area (ac):	39.45	
Total Treated Impervious Area (ac):	12.01	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	319.33	187.73
TP (lbs/yr):	28.09	13.18
TSS (lbs/yr):	17569.43	11383.11

Existing conditions for BMP #394

Site map for BMP #394

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #394 has been identified as a dry pond. The facility was constructed north of Stauffer Road and east of Inspiration Avenue. The Urban BMP Database from the County indicates that the original design for BMP #394 provides management for quantity and that the total treatment area for the BMP is 37.94 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 39.45 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out from a sidewalk between residences along Inspiration Avenue. According to the County's parcel layer in GIS, BMP #394 was constructed on property owned by the Discover Homeowners Association to be dedicated to a park. MOT will be required to notify residents living in the surrounding area that may utilize Inspiration Ave.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Acquisition of Easements, MOT	

PROPOSED RETROFIT

The proposed retrofit for BMP #394 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 39.45 acres including 12.01 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating approximately 2 feet below the existing BMP bottom elevation for extended detention as shown in the Concept Plans. As part of the final design, the condition of the existing CMP riser structure should be evaluated and will likely need to be replaced with a concrete structure if necessary.

BMP # 394 – DISCOVERY SUBDIVISION – SWM DETENTION POND #1

Storm Water Management Retrofit Evaluation					
Report Date:	7/13/2015	**Design Approval:**	12/5/1975	**Maintenance Owner:**	Discovery H.O.A.
Structure No:	394	**Year Constructed:**	Not Available	**Inspection Date:**	6/10/2015
Structure Name:	Discovery Subdivision - SWM Detention Pond #1	**NPDES Watershed:**	Israel Creek	**Inspection Team:**	ND, GL
Location:	Inspiration Avenue	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/8/2015 (0.38")
ADC Map:	4449, D6 (2008)	**Land-River Segment:**	PM4_3341_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	655,310.75/1,212,003.33	**Stream Use:**	IV_P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	Dry Pond		Wet Extended Detention Pond (P-3)	
BMP Classification:	N/A		Stormwater Treatment (ST) Practice	
Management Type:	Quantity		Quality/Quantity	
Total Drainage Area (acres):	37.94		39.45	
Total Impervious Area within Drainage Area (acres):	Unknown		12.01	
WQv Required:	Unknown		46396 cu. ft.	1.065 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes	
Adequate ROW (Y/N):	Yes		Yes	
Adequate Access (Y/N):	Yes		Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	Unknown	0	46396 cu. ft.	1.065 ac-ft
Total Treated Drainage Area (acres):	37.94	0	39.45	
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	12.01	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.06	
Total Nitrogen:			35.53%	
Total Phosphorus:			55.83%	
Sediment:			71.06%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		319.33	187.73
TP (lbs/yr):	0		28.09	13.18
TSS (lbs/yr):	0		17569.43	11383.11

Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):	**$ 1,249,088.50**

BMP # 394 – DISCOVERY SUBDIVISION – SWM DETENTION POND #1

Existing Site Conditions:

SWM Era: Pre-1985

According to Frederick County's Urban BMP Database, BMP #394 has been identified as a dry pond. The facility was constructed north of Stauffer Road and east of Inspiration Avenue as shown in the BMP Location map (**Figure 1**). The Urban BMP Database from the County indicates that the original design for BMP #394 provides management for quantity and that the total treatment area for the BMP is 37.94 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 39.45 acres. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. The Urban BMP Database lists a 24" CMP barrel as the facility control structure. The majority of land use is residential.

General Observations:

A site visit was conducted on June 10th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has two inflow points per the site visit. Both inflows are via open sections. According to observations in the field, Inflow #1 is a grass channel from the southwest **(Photo 1)**. It is fully covered by grass that has been mowed and appears to be in good condition.

Inflow #2 is sheet flow from the northwest **(Photo 2)**. It is fully covered by grass that has been mowed and appears to be in good condition.

Pretreatment:

This facility does not have a forebay or pretreatment section.

Control Structure and Spillways:

According to the Urban BMP Database, the control structure for this facility is a 24" CMP barrel. However, based on observations made in the field, it was determined that the control structure for this facility is an 18" CMP riser with a 12" CMP low flow trash rack, a 29" CMP concentric trash rack, and a 12" CMP principal spillway **(Photo 3)**. The control structure appears to be in good condition and clear of sediment and debris.

This facility does not have an emergency spillway.

Embankment:

A fill embankment is present between the dry pond and principal spillway outlet to the north and east of the pond **(Photo 4)**. The embankment is fully covered by grass that has been mowed and appears to be in good condition. The embankment to the north of BMP #394 separates BMP #394 from BMP #8 **(Photo 2)**. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

According to observations in the field, the 12" CMP principal spillway outlets the BMP east of the riser and is in good condition **(Photo 5)**. The outflow continues southwest to Israel Creek. Riprap outfall protection is present at the outfall of the principal spillway **(Photo 6)**. The principal spillway is clear and appears to be in good condition.

Overall BMP:

BMP is functioning as designed with no problem areas identified **(Photo 7)**.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out from a sidewalk between residences along Inspiration Avenue **(Photo 8)**. According to the County's parcel layer in GIS, BMP #394 was constructed on property owned by the Discover Homeowners Association to be dedicated to a park. Access to the BMP from Inspiration Avenue is via

the 20' stormwater easement. Easements at this location should be evaluated further in final design. MOT will be required to notify residents living in the surrounding area that may utilize Inspiration Avenue.

Proposed Retrofit:

BMP #394 was originally designed as a dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #394 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 39.45 acres including 12.01 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 2 feet below the existing BMP bottom elevation for extended detention as shown in the **Concept Plans**. As part of the final design, the condition of the existing CMP riser structure should be evaluated and replaced with a concrete structure if necessary.

Step 1: Watershed Factors

BMP #394 is located in Frederick County's Israel Creek which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #394 due to downstream coldwater conditions. For the retrofit of BMP #394, 100% of the WQv can be treated within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream Israel Creek.

Step 2: Terrain Factors

BMP #394 is located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are special terrain factors and/or constraints that must be considered for retrofit design to BMP #394. Additional geotechnical investigation will be required during the final design and the proposed retrofit may need to be lined if karst geology is identified.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to lack of plans. Replacement and modification of the CMP riser structure is recommended. Since the downstream channel is in stable condition, there are no erosion or safety concerns and additional water quantity management is not required. There is adequate space for the proposed retrofit within the existing BMP boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a wet extended detention pond is 25 acres. The proposed drainage area to BMP #394 is 39.45 acres and is composed of B soils. The likelihood of BMP #394 receiving hotspot runoff is low as it is located within a residential community. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban.

Step 5: Community and Environmental Factors

BMP #394 is located north of Stauffer Road and east of Inspiration Avenue and has moderate visibility. Wet extended detention ponds tend to have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide high habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #394 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will not be required. Review of FEMA Flood Insurance Map FM24021C0303D indicates that the BMP is not within the FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is not mapped as a wetland. Frederick County's Stream GIS layer indicates BMP #394 is not an in-stream facility; therefore, it does not require additional environmental factor and permitting consideration for final design.

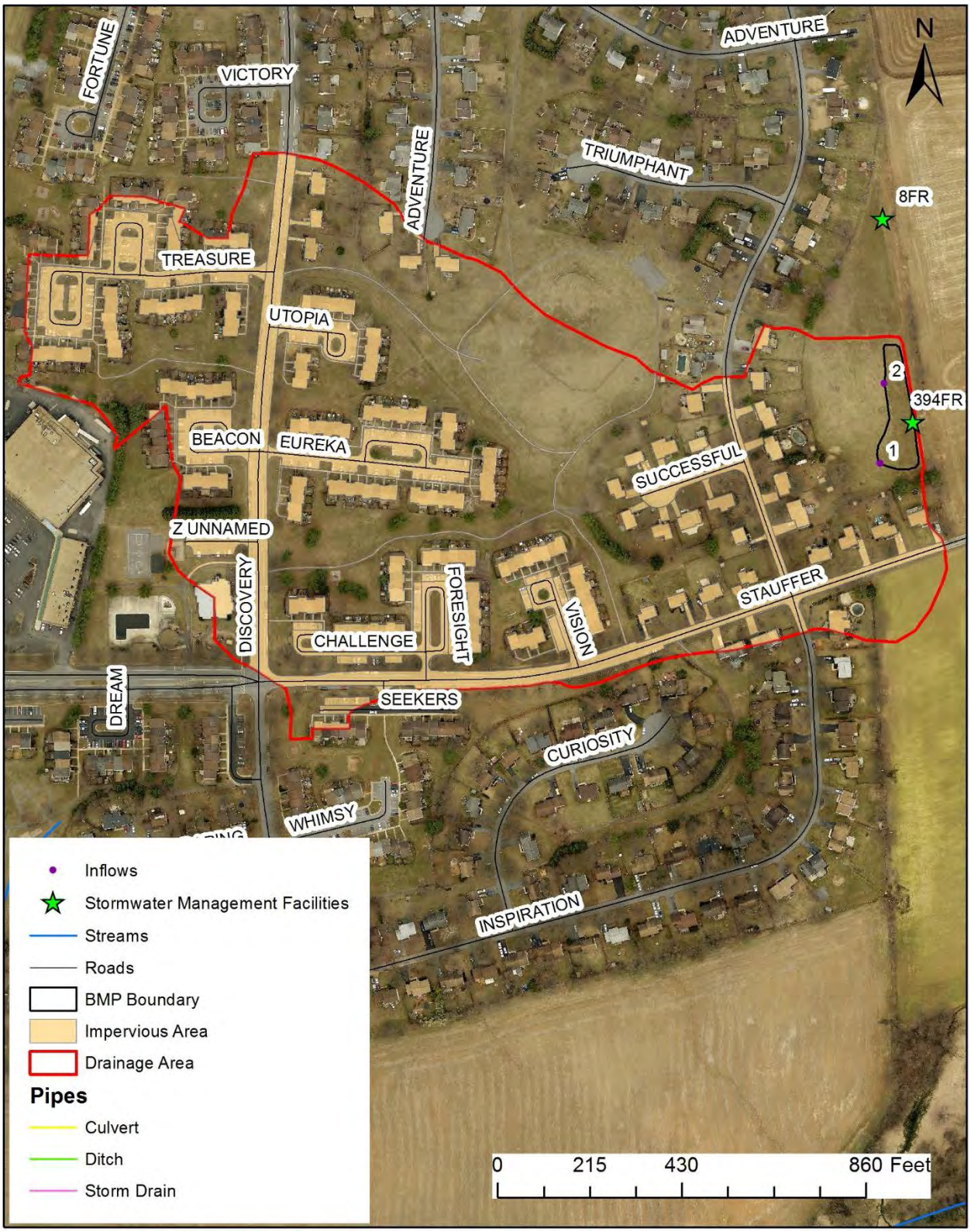


Figure 1: BMP Location Map – Existing Conditions

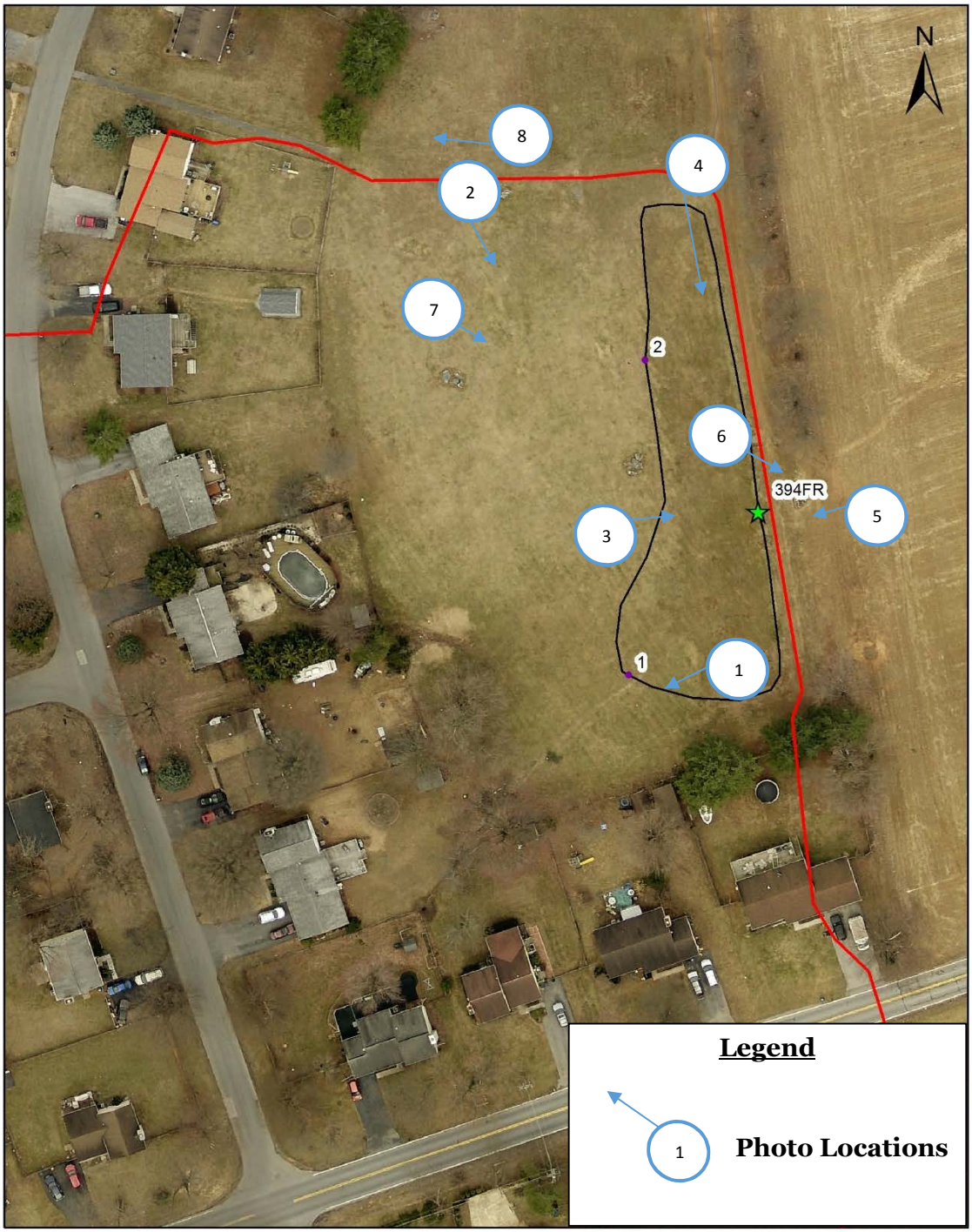


Figure 2: Photo Locations

Photo 1: Inflow #1 facing southwest

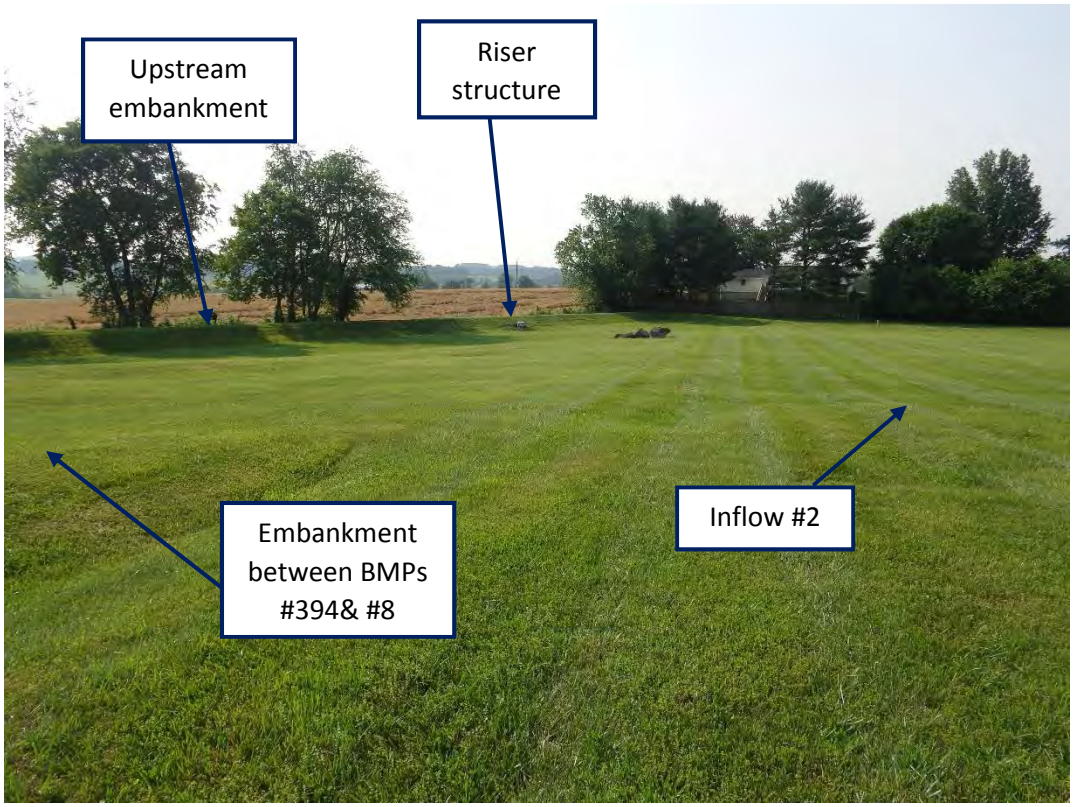


Photo 2: Inflow #2 facing southeast

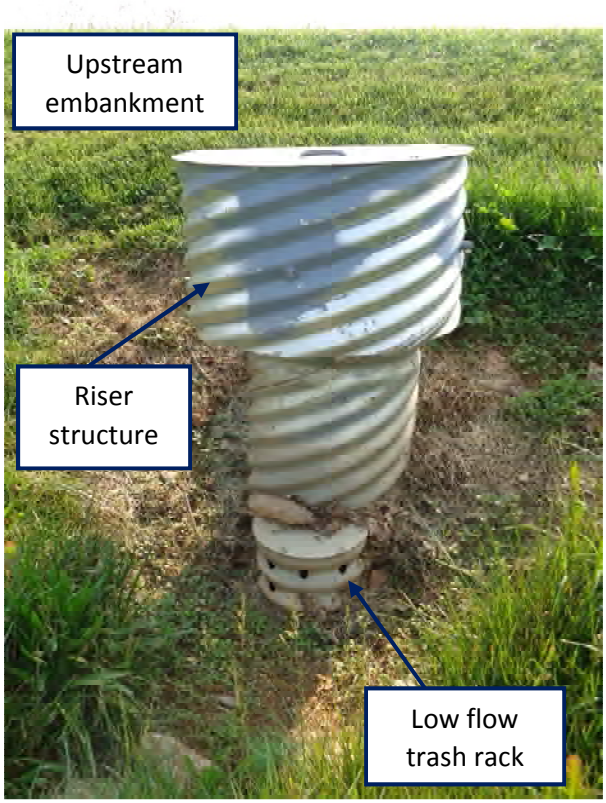


Photo 3: Riser Structure facing east

Photo 4: Embankment facing south

Photo 5: Principal Spillway facing west

Photo 6: Downstream condition facing east

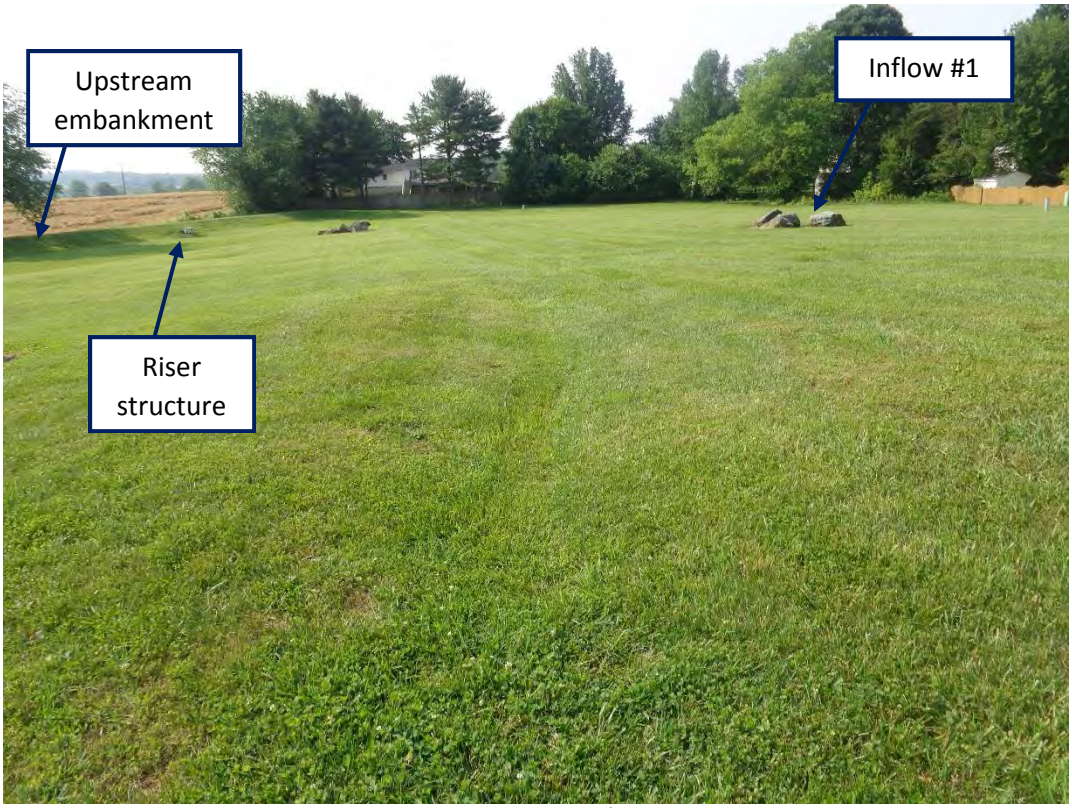


Photo 7: Overall BMP facing southeast

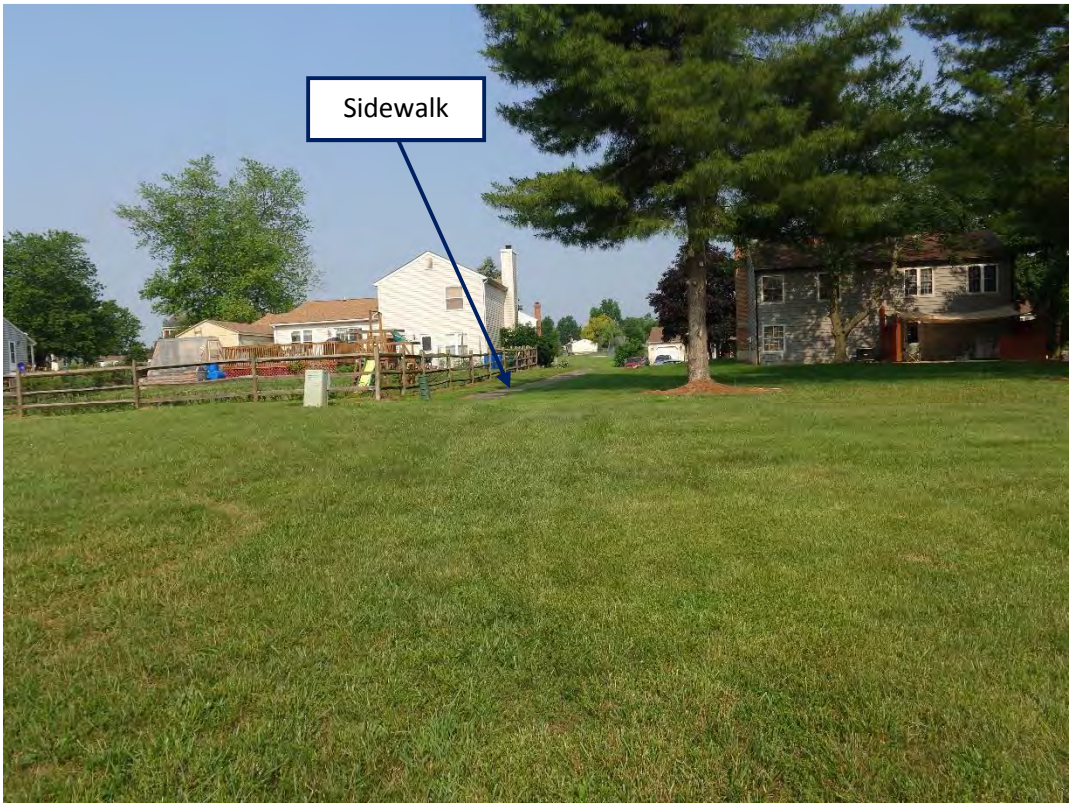
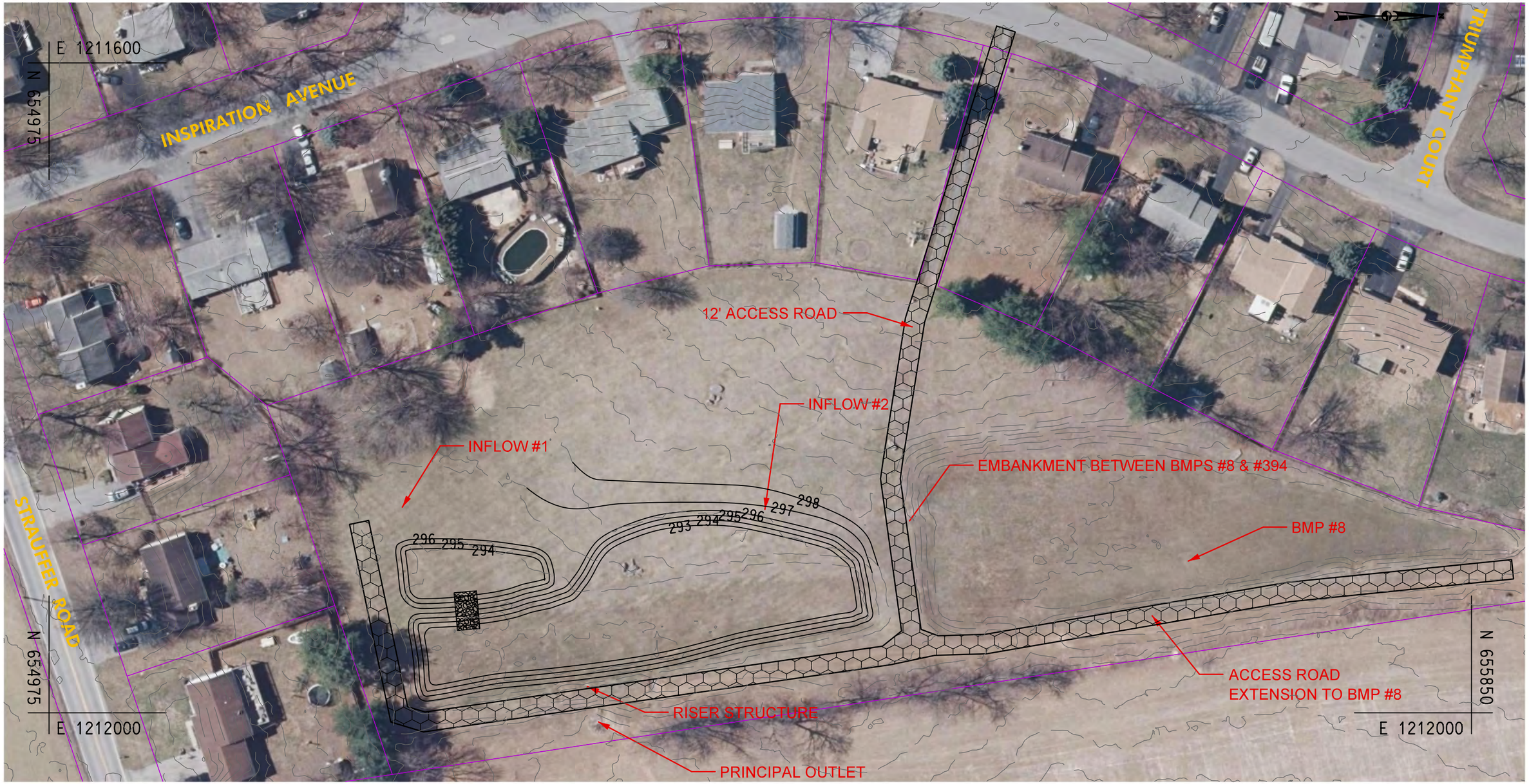


Photo 8: Access Route facing west



GENERAL BMP INFORMATION	
BMP TYPE:	WET EXTENDED DETENTION POND (P-3)
MANAGEMENT TYPE:	STORMWATER TREATMENT (ST) PRACTICE
TOTAL DA (ACRES):	39.45
TOTAL IMPERVIOUS AREA (ACRES):	12.01
WQv REQUIRED (CU. FT):	46396
WQv REQUIRED (AC. FT):	1.065
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	46396
TOTAL TREATED DA (ACRES):	39.45
TOTAL TREATED IMPERVIOUS AREA (ACRES):	12.01

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #394 – DISCOVERY SUBDIVISION – SWM POND #1

SCALE 1" = 60' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. – OF SHEET NO. OF

PLOTTED: Wednesday, June 07, 2017 AT 09:42 AM
FILE: \\catocdr\Projects\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSWM-P000_BMP394.dgn

BY: vhamsher -

WET EXTENDED DETENTION POND DESIGN (P-3): BMP 394

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Assessment**	Engineer:	**GEL**
Location:	**Frederick County, MD**	Date:	**7/13/2015**
Watershed:	**Israel Creek**	As Built:	**-**

Drainage Area: **39.45** Acres 0.062 square miles

(Total)

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **12.01** Acres **I =** 0.304

= 30.4 %

Soil Type: **B**

RCN Existing : **-** **Existing tc =** **-** hr **Unknown per Frederick County's Urban BMP Database**

RCN Post Development : **-** **Post-D tc =** **-** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.324

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)

Step 1(c): Compute WQv

Water quality required for I = 30.4 %

$WQ_{V(I)}$ = 1.065 ac-ft = 46396 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.658 ac-ft = 28640.7 cu.ft

Water quality treatment required =	**46396**	**cu.ft =**	**1.0651**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**46396**	**cu.ft =**	**1.0651**	ac-ft	
Sediment Forebay Volume Required=	**4640**	**cu.ft =**	**0.1065**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**41757**	**cu.ft =**	**0.9586**	ac-ft	
Elevation at the Top of WQv in pond =	**295.60**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	23198
II	50% of WQv is in micropool	23198
III	1/3 of WQV is in micropool & forebay	10826
IV	1/3 of WQV is in micropool & forebay	10826

***source: SHA SWM Workshop, April 30, 2003**

Micropool storage volume required = **10826** **cu.ft =** **0.2485** **ac-ft**

Extended Detention Storage= **10826** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **293.75** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.13** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_o = \frac{WQrr}{4.81\sqrt{h_o}}$$

Assume h_o = **1.85** ft *Will change based on pond volume

Ao = 0.02 sf

Determine the required orifice diameter (d_o)

$$D_o = \sqrt{\frac{4\ A_o}{}}$$

Do = 0.16 ft = **1.9** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**0.00**	0
B	**39.45**	100
C	**0.00**	0
D	**0.00**	0
Total	**39.45**	OK: sum of the areas matches site Area

Composite S: 0.2600 Use 26.00 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.277 ac-ft = **12063** cu.ft

Rev in Pond= **7423**

El of Rev= **293.51** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **3.123** Acres = 136019 sf

The Rev requirement may be met by:

a) treating 0.277 ac-ft using structural method,

b) treating 3.123 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Assessment	Engineer:	GEL
Location:	Frederick County, MD	Date:	7/13/2015
Watershed:	Israel Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
13575.0	**293.0**	0.31	0.00	0.00	0.00	0.00
15482.0	**294.0**	0.36	1.00	0.33	0.33	14518.06
17439.0	**295.0**	0.40	1.00	0.38	0.71	30968.86
19449.0	**296.0**	0.45	1.00	0.42	1.13	49403.72
		0.00	0.00	0.00	0.00	0.00

No. of valid row entries= 4

BMP #353 - 84 LUMBER COMPANY - BMP B

Prioritization Ranking:	19
Planning Level Cost Estimate:	$ 26,180.00
Estimated Cost/Impervious Acre	$ 87,242.50

General BMP Information:		
Structure Location:	4484 Quad County Court	
ADC Map:	4690, C3 (2008)	
Northing/Easting:	615666.28/1,263,504.90	
NPDES Watershed:	Upper Bush Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Grass Swale (M-8)	
Management Type:	Quality	
Total Drainage Area (ac):	0.94	
Total Impervious Area (ac):	0.81	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	1513	
Total Treated Drainage Area (ac):	0.51	
Total Treated Impervious Area (ac):	0.44	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	15.38	9.98
TP (lbs/yr):	1.66	0.78
TSS (lbs/yr):	766.54	496.64

Existing conditions for BMP #353

Site map for BMP #353 - BMP B

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #353 has been identified as an extended detention dry pond. The facility was constructed north of Mill Bottom Road and west of Quad County Court. The BMP Database from the County indicates that the original design for BMP #353 provides management for quantity and quality and that the total treatment area for the BMP is 16.18 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 17.76 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out from a grass road accessible from Quad County Court. According to the County's parcel layer in GIS, BMP #353 was constructed on private property. Maintenance of traffic (MOT) will be required to notify owners of the property. Easements must be evaluated at this site.

Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There are five BMPs proposed at this site: one retrofit and four new BMPs. The proposed new BMP for BMP B is a grass swale (M-8). BMP B is proposed on the east side of the property to provide quality management for 0.94 acres including 0.81 acres of impervious area as shown in the Concept Plans. The Project Summary Sheets for the BMP #353 retrofit and BMPs A, C, and D are included separately in Appendix E with a prioritization ranking of 44, 34, 38, and 33 respectively.

BMP # 353 – 84 LUMBER COMPANY @ MT. AIRY – ED POND

Storm Water Management Retrofit Evaluation					
Report Date:	6/30/2015	**Design Approval:**	10/31/2000	**Maintenance Owner:**	84 Lumber Company
Structure No:	353	**Year Constructed:**	5/10/2006	**Inspection Date:**	6/23/2015
Structure Name:	84 Lumber Company @ Mt. Airy - ED Pond	**NPDES Watershed:**	Upper Bush Creek	**Inspection Team:**	ND, GL
Location:	4484 Quad County Court	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/20/2015 (1.41")
ADC Map:	4690, C3 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	615666.28/1,263,504.90	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Extended Detention Dry Pond		Micropool Extended Detention (P-1)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity/Quality		Quality/Quantity		
Total Drainage Area (acres):	16.18		8.11		
Total Impervious Area within Drainage Area (acres):	Unknown		4.62		
WQv Required:	Unknown		16565	cu. ft.	0.380 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	No		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	16565	cu. ft.	0.380 ac-ft
Total Treated Drainage Area (acres):	16.18	0	8.11		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	4.62		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		0.99		
Total Nitrogen:			34.82%		
Total Phosphorus:			54.72%		
Sediment:			69.65%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		71.00		46.08
TP (lbs/yr):	0		8.38		3.93
TSS (lbs/yr):	0		4498.18		2914.34

Projected Retrofit Cost:	**$ 487,047.00**

BMP # 353 – 84 LUMBER COMPANY @ MT. AIRY – ED POND

Storm Water Management Retrofit Evaluation					
Report Date:	6/30/2015	**Design Approval:**	10/31/2000	**Maintenance Owner:**	84 Lumber Company
Structure No:	353 - BMP A	**Year Constructed:**	5/10/2006	**Inspection Date:**	6/23/2015
Structure Name:	84 Lumber Company @ Mt. Airy - ED Pond	**NPDES Watershed:**	Upper Bush Creek	**Inspection Team:**	ND, GL
Location:	4484 Quad County Court	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/20/2015 (1.41")
ADC Map:	4690, C3 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	615666.28/1,263,504.90	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Bioswale (M-8)	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quality	
Total Drainage Area (acres):			2.27	
Total Impervious Area within Drainage Area (acres):			1.60	
WQv Required:			5639 cu. ft.	0.129 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		5639 cu. ft.	0.129 ac-ft
Total Treated Drainage Area (acres):			2.27	
Total Treated Impervious Area within Drainage Area (acres):			1.60	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		0.97	
Total Nitrogen:			59.20%	
Total Phosphorus:			69.25%	
Sediment:			74.21%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		35.40	22.97
TP (lbs/yr):			3.46	1.62
TSS (lbs/yr):			1580.83	1024.21

Projected Retrofit Cost:	**$ 122,650.00**

BMP # 353 – 84 LUMBER COMPANY @ MT. AIRY – ED POND

Storm Water Management Retrofit Evaluation					
Report Date:	6/30/2015	**Design Approval:**	10/31/2000	**Maintenance Owner:**	84 Lumber Company
Structure No:	353 - BMP B	**Year Constructed:**	5/10/2006	**Inspection Date:**	6/23/2015
Structure Name:	84 Lumber Company @ Mt. Airy - ED Pond	**NPDES Watershed:**	Upper Bush Creek	**Inspection Team:**	ND, GL
Location:	4484 Quad County Court	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/20/2015 (1.41")
ADC Map:	4690, C3 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	615666.28/1,263,504.90	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Grass Swale (M-8)	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quality	
Total Drainage Area (acres):			0.94	
Total Impervious Area within Drainage Area (acres):			0.81	
WQv Required:			2801 cu. ft.	0.064 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			No	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		1513 cu. ft.	0.035 ac-ft
Total Treated Drainage Area (acres):			0.51	
Total Treated Impervious Area within Drainage Area (acres):			0.44	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		0.95	
Total Nitrogen:			58.97%	
Total Phosphorus:			68.98%	
Sediment:			73.92%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		15.38	9.98
TP (lbs/yr):			1.66	0.78
TSS (lbs/yr):			766.54	496.64

Projected Retrofit Cost:	**$ 26,180.00**

BMP # 353 – 84 LUMBER COMPANY @ MT. AIRY – ED POND

Storm Water Management Retrofit Evaluation					
Report Date:	6/30/2015	**Design Approval:**	10/31/2000	**Maintenance Owner:**	84 Lumber Company
Structure No:	353 - BMP C	**Year Constructed:**	5/10/2006	**Inspection Date:**	6/23/2015
Structure Name:	84 Lumber Company @ Mt. Airy - ED Pond	**NPDES Watershed:**	Upper Bush Creek	**Inspection Team:**	ND, GL
Location:	4484 Quad County Court	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/20/2015 (1.41")
ADC Map:	4690, C3 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	615666.28/1,263,504.90	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Bioswale (M-8)	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quality	
Total Drainage Area (acres):			2.03	
Total Impervious Area within Drainage Area (acres):			1.80	
WQv Required:			6249 cu. ft.	0.143 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		6249 cu. ft.	0.143 ac-ft
Total Treated Drainage Area (acres):			2.03	
Total Treated Impervious Area within Drainage Area (acres):			1.8	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		0.95	
Total Nitrogen:			58.95%	
Total Phosphorus:			68.96%	
Sediment:			73.90%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		33.46	21.71
TP (lbs/yr):			3.67	1.72
TSS (lbs/yr):			1694.17	1097.64

Projected Retrofit Cost:	**$ 137,610.00**

BMP # 353 – 84 LUMBER COMPANY @ MT. AIRY – ED POND

Storm Water Management Retrofit Evaluation					
Report Date:	6/30/2015	**Design Approval:**	10/31/2000	**Maintenance Owner:**	84 Lumber Company
Structure No:	353 - BMP D	**Year Constructed:**	5/10/2006	**Inspection Date:**	6/23/2015
Structure Name:	84 Lumber Company @ Mt. Airy - ED Pond	**NPDES Watershed:**	Upper Bush Creek	**Inspection Team:**	ND, GL
Location:	4484 Quad County Court	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/20/2015 (1.41")
ADC Map:	4690, C3 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	615666.28/1,263,504.90	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Bioswale (M-8)	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quality	
Total Drainage Area (acres):			4.41	
Total Impervious Area within Drainage Area (acres):			2.62	
WQv Required:			9360 cu. ft.	0.215 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		9360 cu. ft.	0.215 ac-ft
Total Treated Drainage Area (acres):			4.41	
Total Treated Impervious Area within Drainage Area (acres):			2.62	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		0.98	
Total Nitrogen:			59.50%	
Total Phosphorus:			69.60%	
Sediment:			74.59%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		66.54	43.18
TP (lbs/yr):			5.97	2.80
TSS (lbs/yr):			2704.01	1751.91

Projected Retrofit Cost:	**$ 203,896.00**

BMP #353 – 84 LUMBER COMPANY @ MT. AIRY – ED POND

Existing Site Conditions:

SWM Era: 1985-2002

According to Frederick County's Urban BMP Database, BMP #353 has been identified as an extended detention dry pond. The facility was constructed north of Mill Bottom Road and west of Quad County Court as shown in the BMP Location map (**Figure 1**). The BMP Database from the County indicates that the original design for BMP #353 provides management for quantity and quality and that the total treatment area for the BMP is 16.18 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 17.76 acres, including 11.45 acres of impervious area. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. The facility has one inflow per the GIS pipes layer: a 36" PVC pipe from the south. The Urban BMP Database indicates that the facility has the following features: a 3" extended detention orifice and a 24" CMP riser. The majority of land use is industrial.

General Observations:

A site visit was conducted on June 23rd, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has three inflow points. Inflow #1 is a grass and riprap ditch from the north that conveys flow from the north side of the facility **(Photo 1)**. The channel is overgrown with vegetation.

Inflow #2 is 36" PVC pipe from the south which flows into a concrete energy dissipater **(Photo 2)**. A 6" low flow orifice is located at the bottom of the concrete energy dissipater **(Photo 3)**. During the site visit, water was flowing through the PVC pipe, concrete energy dissipater, and the low flow orifice. Riprap, algae, ponding, and accumulated sediment were present in the energy dissipater. Below the outfall of the low flow orifice is riprap which is overgrown with vegetation **(Photo 4)**.

Inflow #3 is a riprap ditch from the south which flows along the concrete structure for Inflow #2 **(Photo 5)**. The riprap ditch is overgrown with vegetation.

Pretreatment:

The concrete energy dissipater at Inflow #2 is acting as a forebay for that inflow. The structure appears to be in good condition, but has algae, riprap, and accumulated sediment in the structure.

Control Structure and Spillways:

According to the Urban BMP Database and observations in the field, the control structure for this facility is a 24" CMP riser, a 3" extended detention orifice, and an 18" principal spillway **(Photos 6 and 7)**. The riser and principal spillway are covered in a black protective coating. The extended detention orifice has a trash rack on it. The riser and extended detention orifice appear to be in good condition.

The emergency spillway is located on the west side of the dry pond **(Photo 8)**. It is lined with riprap and has some overgrown vegetation but is otherwise in good condition.

Embankment:

An embankment is present between the pond and principal outlet to the west of the pond **(Photo 9)**. Vegetation on the embankment is slightly overgrown and some animal burrows were present on the embankment but it is otherwise in good condition. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

According to measurements taken in the field and the Urban BMP Database, the principal spillway is an 18" CMP that outlets the BMP southwest of the riser **(Photo 10)**. The CMP is covered in a black protective coating. There is not positive drainage to the outflow channel resulting in ponding water at the outfall. The downstream area has riprap that is covered in vegetation and

debris and is overgrown with vegetation. The downstream banks are highly eroded **(Photo 11)**. The downstream area is in poor condition.

Overall BMP:

The BMP is overgrown with vegetation **(Photo 12)**. Inflows #1 and #3 are also over grown with vegetation. There is evidence of animal burrows on the embankment and erosion on the banks downstream of the principal spillway. Minor problems are observed, however, BMP is functioning as designed with no critical parameters but with some problem conditions.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out from a grass road accessible from Quad County Court. According to the County's parcel layer in GIS, BMP #353 was constructed on private property. Maintenance of traffic (MOT) will be required to notify owners of the property. Easements and maintenance agreements must be further evaluated at final design.

Proposed Retrofit:

The footprint of the existing facility cannot be expanded to provide additional water quality volume treatment due to steep slopes surrounding the BMP; therefore, the full water quality volume required cannot be provided for BMP #353. The proposed retrofit option reduces the drainage area to BMP #353 by installing four new BMPs (BMP A, B, C, and D) upstream.

BMP #353 was originally designed as an extended detention dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #353 is a micropool extended detention (P-1). The proposed retrofit will provide quantity and quality management for 8.11 acres including 4.62 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating four feet below the existing BMP footprint to provide extended detention as shown in the **Concept Plans**. The riser structure may need to be relocated towards the west side of the pond if the excavation impacts the existing principal spillway.

In addition, four micro-scale and ESD practices are proposed upstream of the micropool extended detention pond. BMP A is a bioswale proposed on the south side of the property to provide quality management for 2.27 acres including 1.60 acres of impervious area. BMP B is a grass swale proposed on the east side of the property to provide quality management for 0.94 acres including 0.81 acres of impervious area. BMP C is a bioswale proposed in the middle of the property to provide quality management for 2.03 acres including 1.80 acres of impervious area. BMP D is a bioswale proposed on the north side of the property to provide quality management for 4.41 acres including 2.62 acres of impervious area. The proposed BMP drainage areas are as shown in **Figure 3**. The four micro-scale BMPs are shown in the **Concept Plans**.

Step 1: Watershed Factors

BMP #353 is located in Frederick County's Upper Bush Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #353 due to its location within the wellhead protection area and downstream coldwater conditions. For the retrofit of BMP #353, 100% of the WQv can be stored within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream stream. The pond is located in an area composed of B soils. The final design may consider lining the pond to minimize the potential for contaminants infiltrating into the soil in this wellhead protection area.

Step 2: Terrain Factors

BMP #353 is not located in a region of Frederick County that is prone to karst geology. Therefore, there are no special terrain factors and/or constraints that must be considered for retrofit design to BMP #353.

Step 3: Stormwater Treatment Suitability

For the retrofit of BMP #353, 100% of the WQv for the reduced drainage area can be provided within the existing BMP footprint. Since the downstream channel is not in stable condition and actively eroding, it is recommended that additional

water quantity management and downstream channel protection by evaluated during final design. There is adequate space for the proposed retrofit within the BMP footprint. The concept design level calculations for the proposed retrofit are provided in Appendix E.

The proposed micro-scale practices BMP A, C, and D meet all of the bioswale criteria providing 1" of rainfall (P_E). There is adequate space for the BMPs within the existing site boundary. There are no safety concerns with the use of bioswales. The concept level calculations for the proposed retrofit are included in **Appendix E**.

The proposed micro-scale practice BMP B does not meet all of the grass swale criteria to provide the full 1" of rainfall (P_E) because the site constraints limit the length of the swale. There is adequate space for the BMP within the existing site boundary. There are no safety concerns with the use of grass swales. The concept level calculations for the proposed retrofit are included in **Appendix E**.

Step 4: Physical Feasibility Factors

The proposed drainage area to BMP #353 is 8.11 acres, which is less than the required 10 acre minimum drainage area requirement for a micropool extended detention facility. Based on the feasibility analysis, it is likely that the water supply to the facility will be adequate to support a permanent pool. A formal water balance analysis should be conducted during final design to verify the drainage area is adequate. The likelihood of BMP #353 receiving hotspot runoff is moderate as it is located near an industrial site. Hence, minimum separation from the water table is not required as long as pretreatment to remove hydrocarbons, trace metals, and toxicants is provided. The land use within the drainage area to the BMP is not ultra-urban.

Bioswales in series are proposed for BMPs A, C, and D. Bioswales in series utilize strategically placed inlets to sub-divide the total drainage area to an individual bioswale cell. The inlets divert treated stormwater into a stormdrain system to bypass downstream bioswale cells, allowing the facility to comply with the maximum 1 acre drainage area requirements. BMPs A, C, and D will require 3, 2, and 5 cells, respectively based on the proposed drainage areas. The proposed underdrains and stormdrain system of the bioswales can outlet to the existing conveyance ditches surrounding the site. Additional investigation on the outlet locations should be conducted during final design. The longitudinal slope at the proposed BMPs is less than or equal to 4%. Installing bioswales upstream of the proposed BMP retrofit is feasible per the preliminary assessment of physical factors.

The maximum drainage area for a grass swale is 1 acre. The drainage area to BMP B is less than 1 acre. The longitudinal slope at the proposed BMP B location is less than or equal to 4%. Installing a grass swale upstream of the proposed BMP retrofit is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP #353 is located west of Quad County Court and has low visibility. Micropool extended detention ponds tend to have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide high habitat quality. Bioswales and grass swales have low maintenance requirements, high community acceptance, low construction cost relative to the drainage area, and provide little habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #353 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

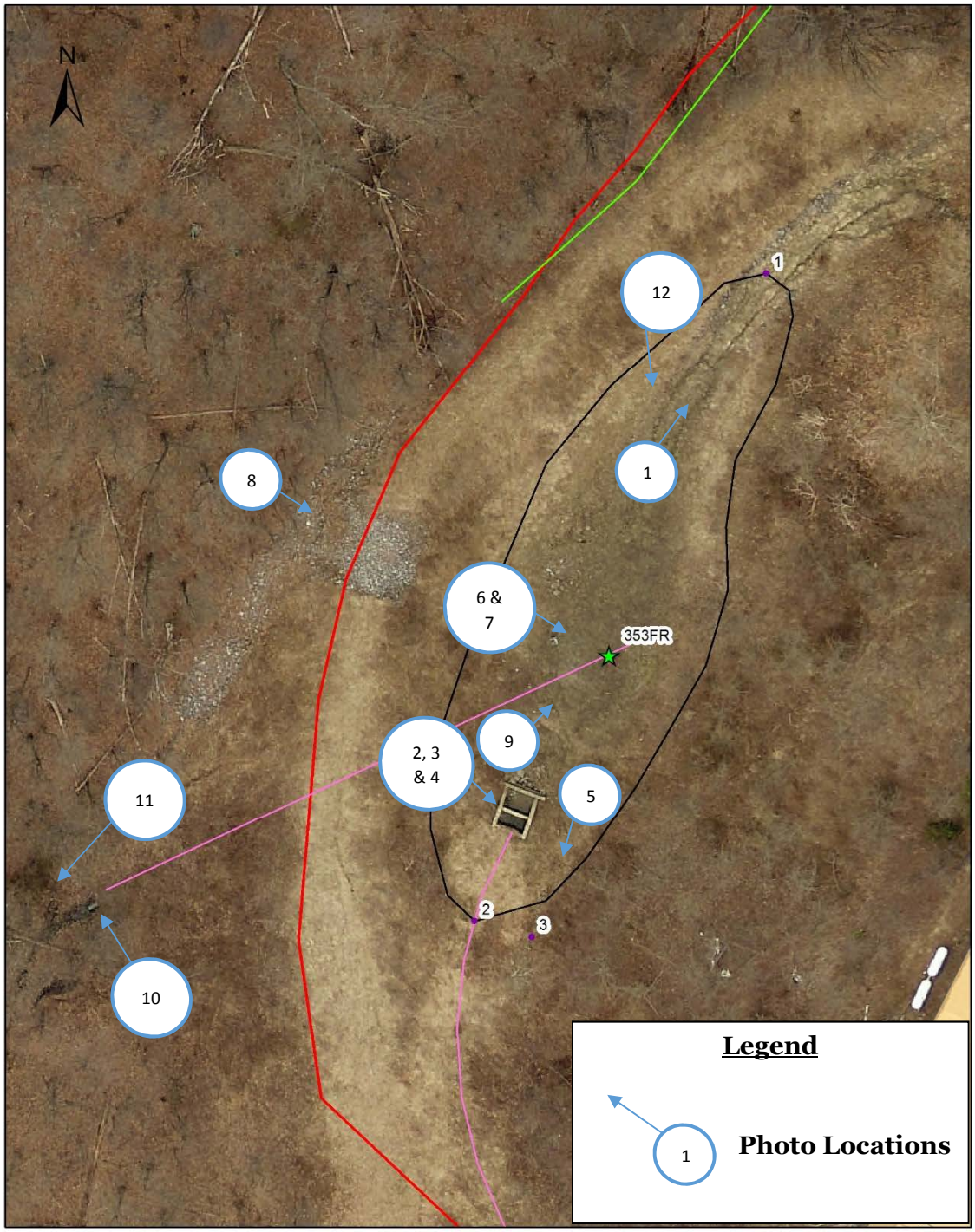


Figure 2: Photo Locations

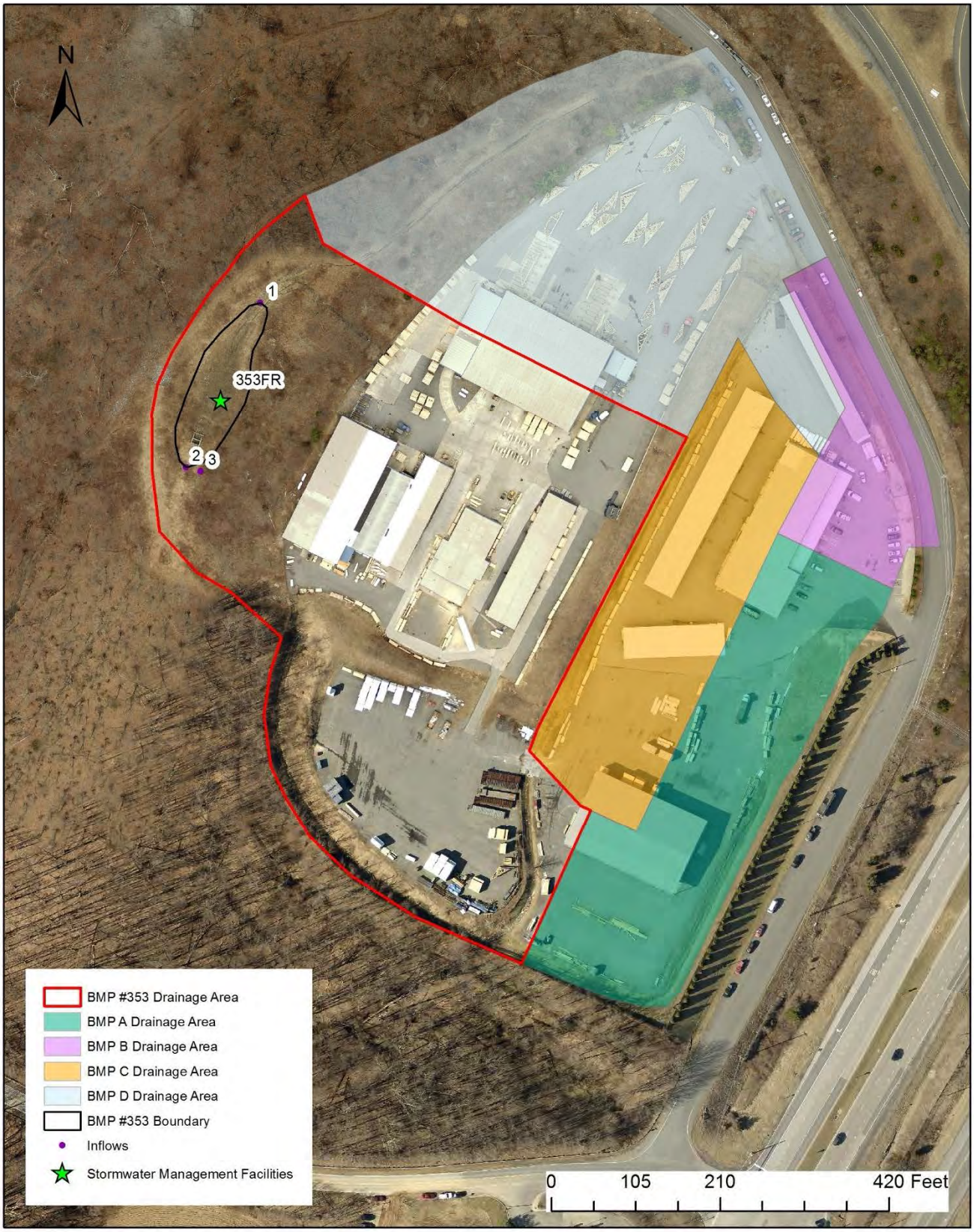


Figure 3: Proposed BMP Drainage Areas

Photo 1: Inflow #1 facing northeast

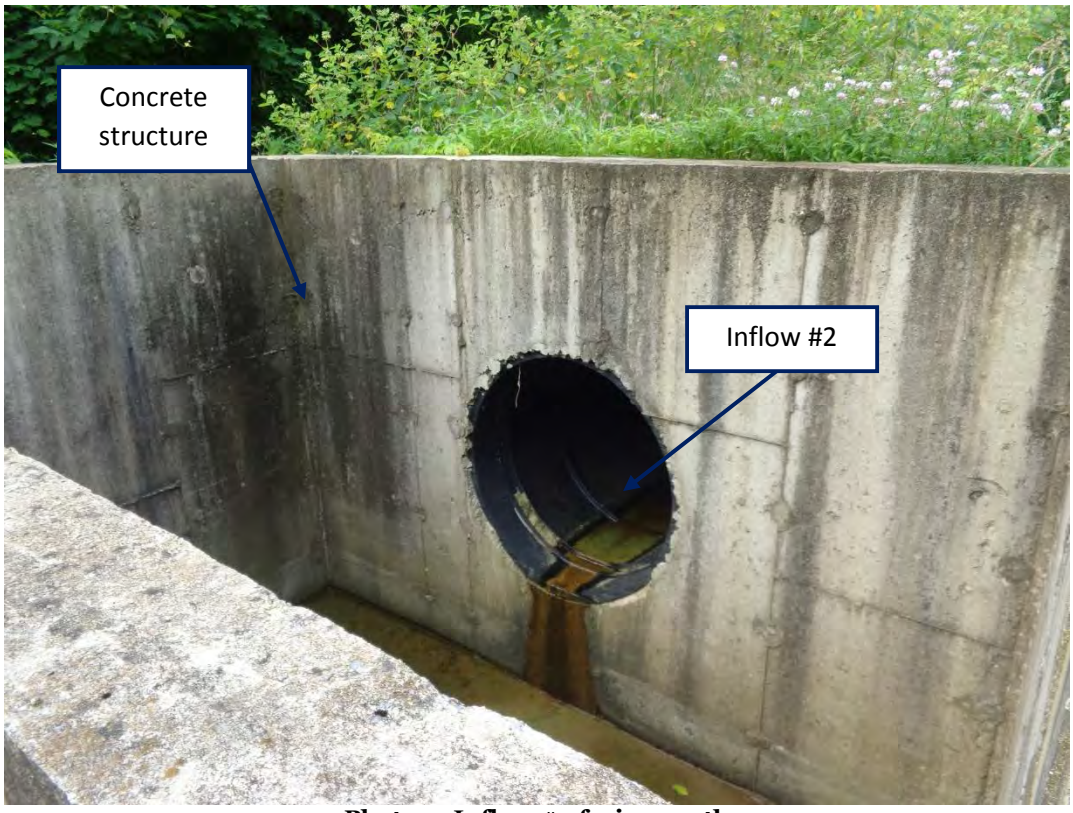


Photo 2: Inflow #2 facing south

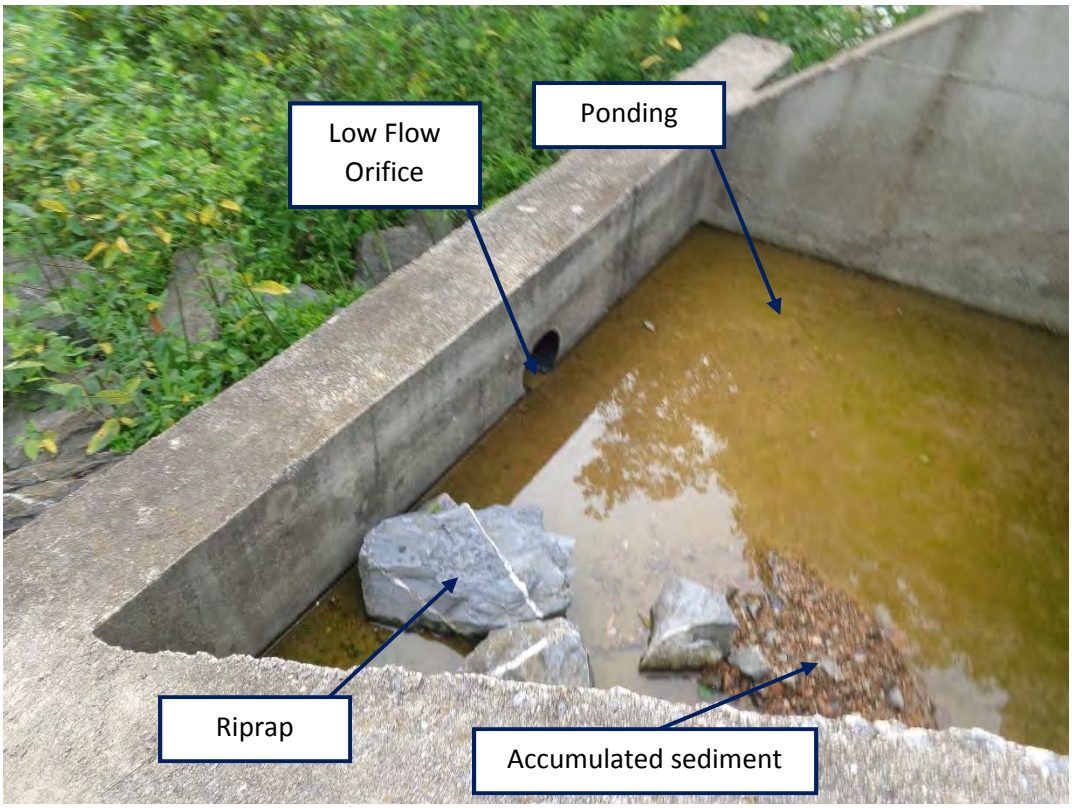


Photo 3: Inflow #2 facing east

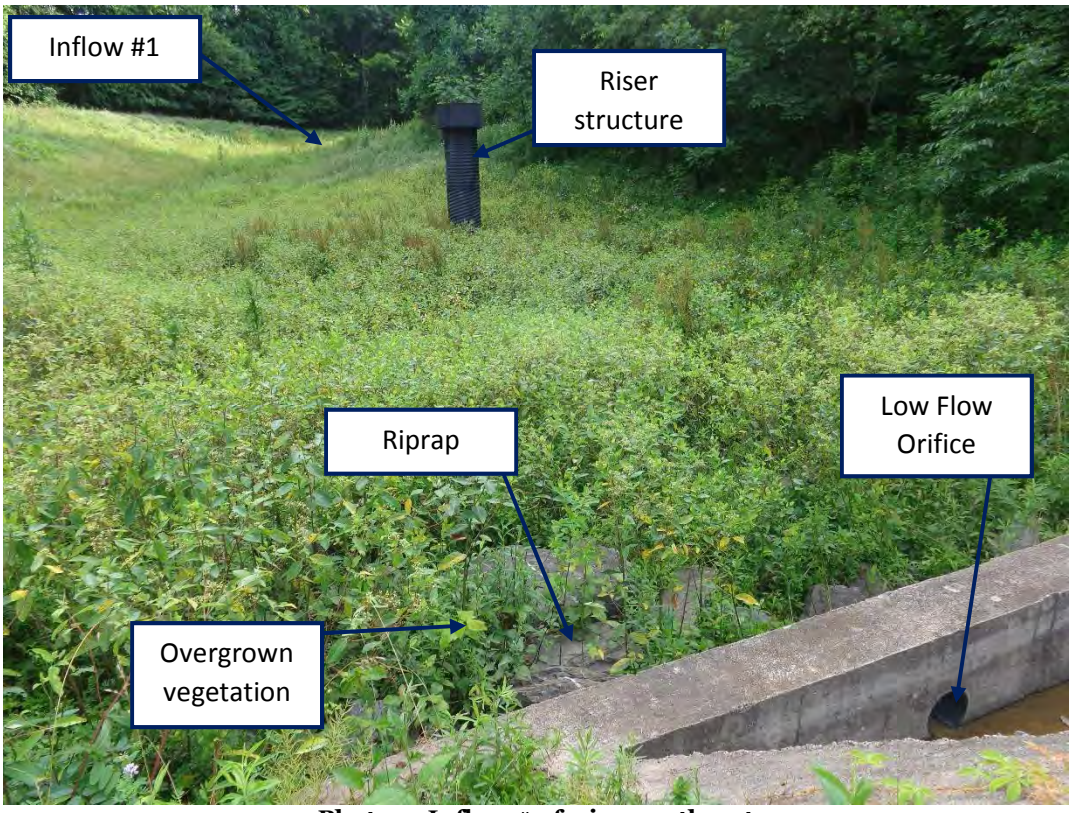


Photo 4: Inflow #2 facing northeast

Photo 5: Inflow #3 facing south

Photo 6: Riser structure facing east

Photo 7: Extended detention orifice facing east

Photo 8: Emergency spillway facing southeast

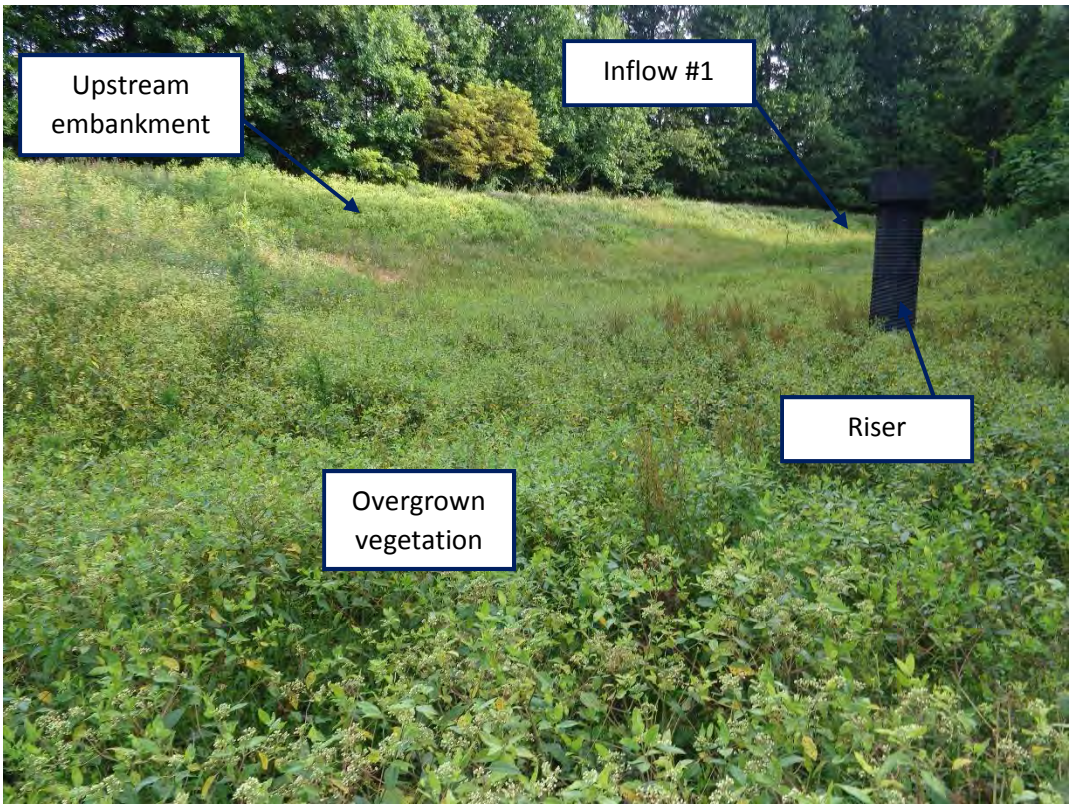


Photo 9: Upstream embankment facing north

Photo 10: Principal spillway outlet facing north

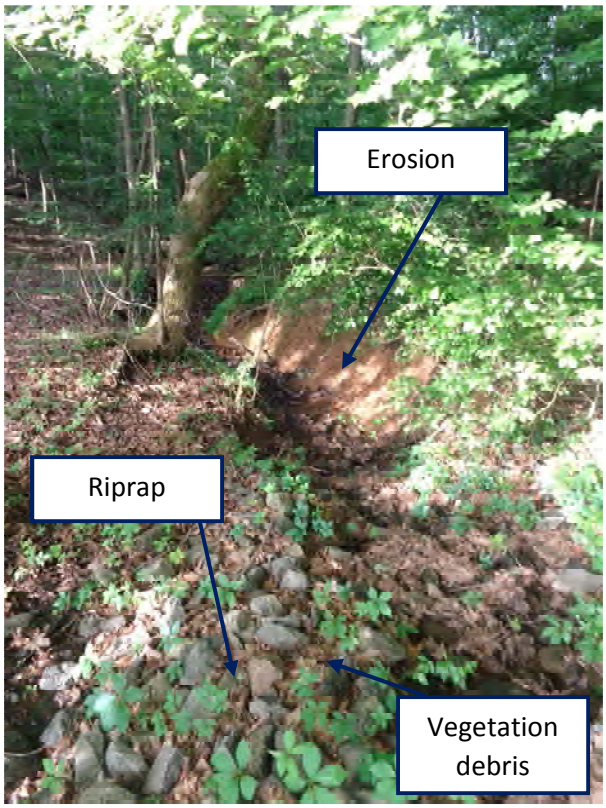


Photo 11: Downstream of outfall facing southwest

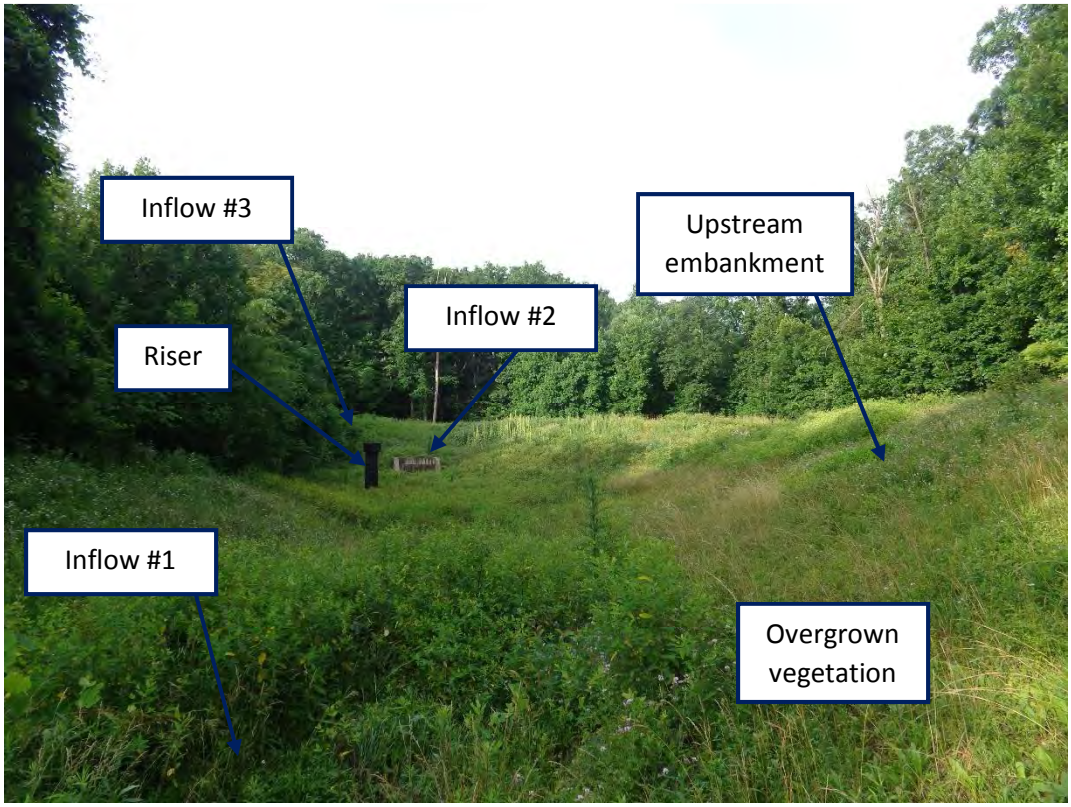


Photo 12: Overall BMP facing south

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndnskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #353 – LOCATION MAP

SCALE 1" = 100' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

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SHEET NO. OF

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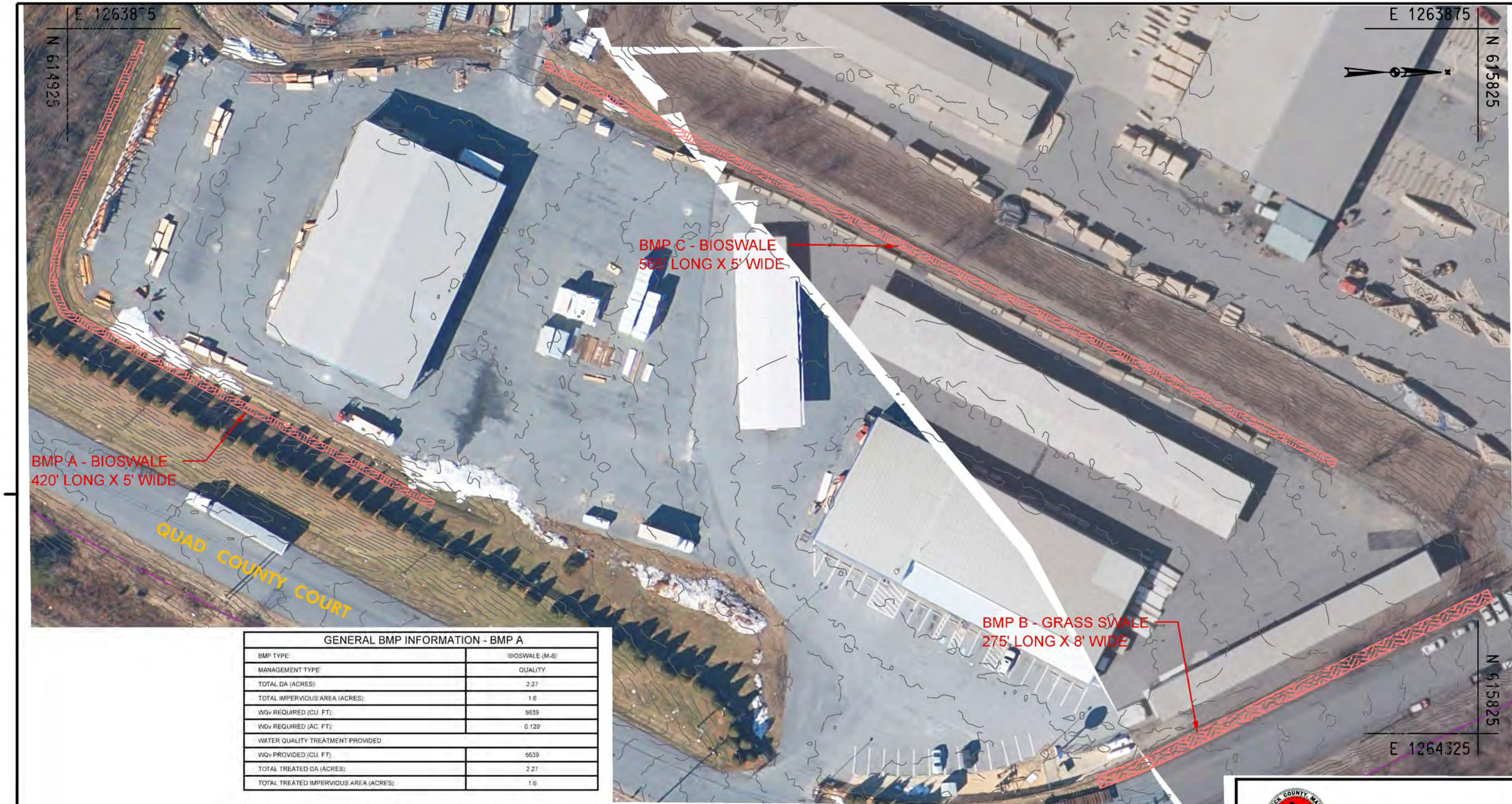

GENERAL BMP INFORMATION - BMP A	
BMP TYPE:	BIOSWALE (M-8)
MANAGEMENT TYPE:	QUALITY
TOTAL DA (ACRES):	2.27
TOTAL IMPERVIOUS AREA (ACRES):	1.6
WQv REQUIRED (CU. FT):	5639
WQv REQUIRED (AC. FT):	0.129
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	5639
TOTAL TREATED DA (ACRES):	2.27
TOTAL TREATED IMPERVIOUS AREA (ACRES):	1.6

GENERAL BMP INFORMATION - BMP B	
BMP TYPE:	GRASS SWALE (M-8)
MANAGEMENT TYPE:	QUALITY
TOTAL DA (ACRES):	0.94
TOTAL IMPERVIOUS AREA (ACRES):	0.81
WQv REQUIRED (CU. FT):	2801
WQv REQUIRED (AC. FT):	0.064
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	1513
TOTAL TREATED DA (ACRES):	0.51
TOTAL TREATED IMPERVIOUS AREA (ACRES):	0.44

GENERAL BMP INFORMATION - BMP C	
BMP TYPE:	BIOSWALE (M-8)
MANAGEMENT TYPE:	QUALITY
TOTAL DA (ACRES):	2.03
TOTAL IMPERVIOUS AREA (ACRES):	1.8
WQv REQUIRED (CU. FT):	6249
WQv REQUIRED (AC. FT):	0.143
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	6249
TOTAL TREATED DA (ACRES):	2.03
TOTAL TREATED IMPERVIOUS AREA (ACRES):	1.8

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndriskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #353 : BMP A, BMP B, & BMP C

SCALE 1" = 60' ADVERTISED DATE <AD DATE> CONTRACT NO.

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DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

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GENERAL BMP INFORMATION - BMP D	
BMP TYPE:	BIOSWALE (M-8)
MANAGEMENT TYPE:	QUALITY
TOTAL DA (ACRES):	4.41
TOTAL IMPERVIOUS AREA (ACRES):	2.62
WQv REQUIRED (CU. FT):	9360
WQv REQUIRED (AC. FT):	0.215
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	9360
TOTAL TREATED DA (ACRES):	4.41
TOTAL TREATED IMPERVIOUS AREA (ACRES):	2.62

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410 265 9500
FAX: 410 265 8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #353: BMP D

SCALE 1" = 80' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

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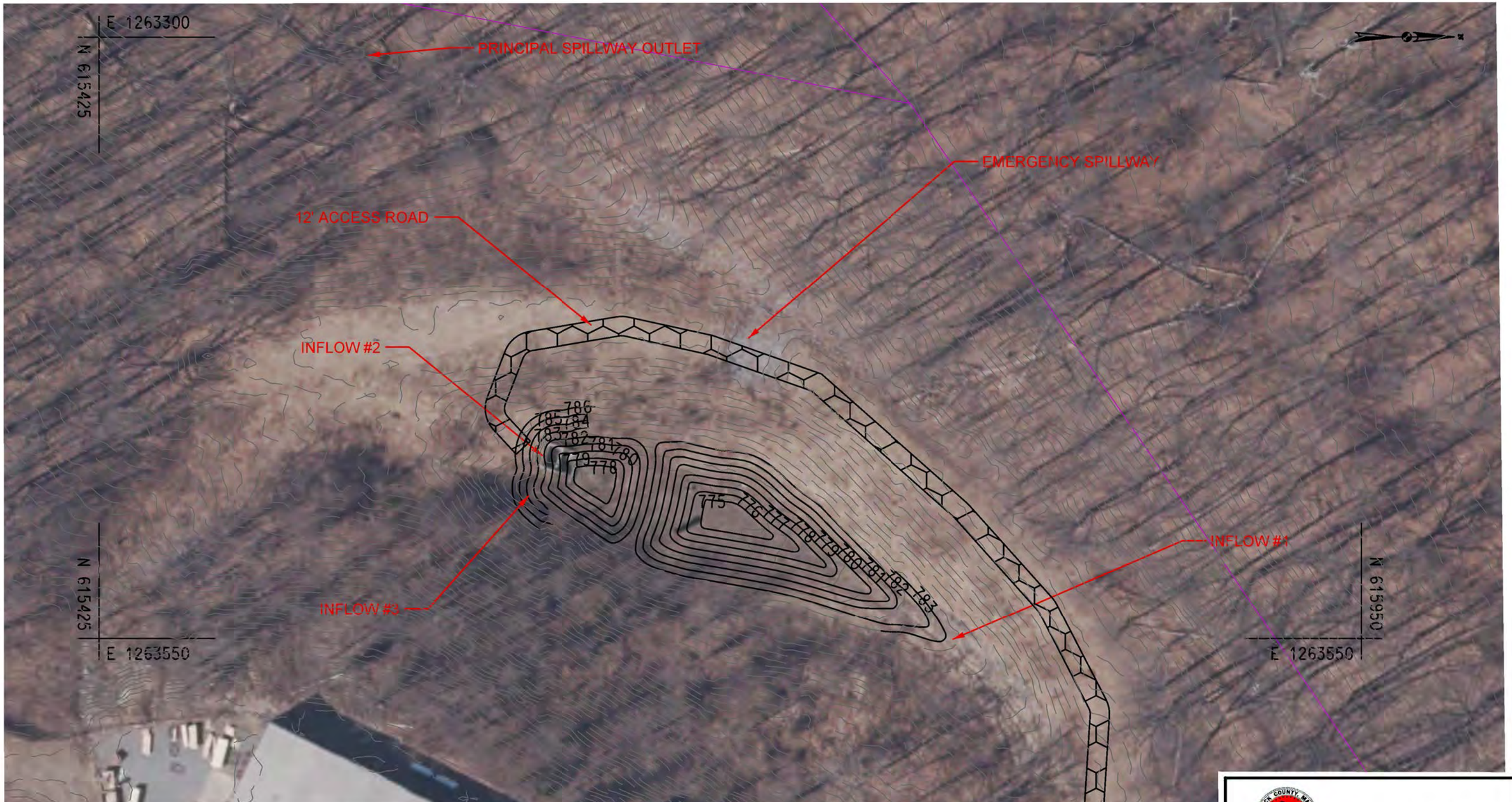

LEGEND

PARCEL BOUNDARY

GENERAL BMP INFORMATION - BMP 353	
BMP TYPE:	MICROPOOL EXTENDED DETENTION (P-1)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	8.11
TOTAL IMPERVIOUS AREA (ACRES):	4.62
WQv REQUIRED (CU. FT):	16565
WQv REQUIRED (AC. FT):	0.38
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	16565
TOTAL TREATED DA (ACRES):	8.11
TOTAL TREATED IMPERVIOUS AREA (ACRES):	4.62

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndriskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #353 – 84 LUMBER COMPANY MT. AIRY – ED POND

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

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MICROPOOL EXTENDED DETENTION DESIGN (P-1): BMP 353

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Evaluate and Address at Final Design

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**6/30/2015**
Watershed:	**Upper Bush Creek**	As Built:	**5/10/2006**

Drainage Area: **8.11** **(Total)** Acres 0.013 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **4.62** Acres **I =** 0.570

= 57.0 %

Soil Type:

RCN Existing : **91** **Existing tc =** **0.30** hr

RCN Post Development : **91** **Post-D tc =** **0.30** hr

Per Frederick County's Urban BMP Database

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): *Compute volumetric Runoff Coefficient(Rv)*

Rv =0.05+(0.009)I= 0.563

Step 1(b): *Rainfall Zone*

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)
1" per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): *Compute WQv*

Water quality required for I = 57.0 %

$WQ_{V(I)}$ = 0.380 ac-ft = 16565 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.135 ac-ft = 5887.86 cu.ft

Water quality treatment required =	**16565**	**cu.ft =**	**0.3803**	ac-ft	
WQv provided by other practices =		**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**16565**	**cu.ft =**	**0.3803**	ac-ft	
Sediment Forebay Volume Required=	**1657**	**cu.ft =**	**0.0380**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**14909**	**cu.ft =**	**0.3423**	ac-ft	
Elevation at the Top of WQv in pond =	**782.02**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	8283
II	50% of WQv is in micropool	8283
III	1/3 of WQv is in micropool & forebay	3865
IV	1/3 of WQv is in micropool & forebay	3865
***source: SHA SWM Workshop, April 30, 2003**		

Micropool storage volume required = **3865** **cu.ft =** **0.0887** **ac-ft**

Extended Detention Storage= **3865** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **778.66** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.04** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_O = \frac{WQrr}{4.81\sqrt{h_O}}$$

Assume h_o = **3.36** ft *Will change based on pond volume

Ao = 0.01 sf

Determine the required orifice diameter (d_o)

$$D_O = \sqrt{\frac{4\ A_O}{\pi}}$$

Do = 0.08 ft = **1.0** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ v = \frac{(S)(Rv)(A)}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**1.50**	19
B	**2.74**	34
C	**3.86**	48
D	**0.00**	0
Total	**8.10**	OK: sum of the areas matches site Area

Composite S: 0.2203 Use 22.03 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.084 ac-ft = **3649** cu.ft

Rev in Pond= **1992**

El of Rev= **777.53** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **1.018** Acres = 44329 sf

The Rev requirement may be met by:

a) treating 0.084 ac-ft using structural method,

b) treating 1.018 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	6/30/2015
Watershed:	Upper Bush Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
288.0	**775.0**	0.01	0.00	0.00	0.00	0.00
632.0	**776.0**	0.01	1.00	0.01	0.01	448.88
1070.0	**777.0**	0.02	1.00	0.02	0.03	1290.32
1577.0	**778.0**	0.04	1.00	0.03	0.06	2605.66
2257.0	**779.0**	0.05	1.00	0.04	0.10	4512.53
2994.0	**780.0**	0.07	1.00	0.06	0.16	7129.36
3793.0	**781.0**	0.09	1.00	0.08	0.24	10515.00
4829.0	**782.0**	0.11	1.00	0.10	0.34	14815.58
7782.0	**783.0**	0.18	1.00	0.14	0.48	21062.65

No. of valid row entries= 9

Project: **Lower Monocacy Watershed Assessment** Bio-Swale Rev. 12-10-2014 **BMP:** **BMP 353- BMP A**

Preliminary Design:

	Cell with automated formula
	Cell for user input

Location: Frederick County, Maryland **Sta.**
Watershed: Lower Monocacy River **Stream Use:** IV

This spreadsheet is for 100 % ESDv storage with equally spaced check dams with upstream depths of 0 feet.

See Maryland Department of Environment (MDE), 2000 Maryland Stormwater Management Design Manual Volumes I & II for referenced equations, acronyms, and definitions.

Site Area (A): 2.270 ac 0.004 sqm

Measured Impervious Area:

Total Impervious Area = 1.600 ac

Percent Impervious (I) = 0.705 I =Total Impervious Area/Site Area
= 70%

Volumetric Runoff Coefficient (Rv) = 0.05+(0.009)I Eq. Ref. Vol. I, Sec. 2.0, Table 2.1
= 0.68

Soil Type: A, B

RCN Post Development : 91 **tc =** 0.300 hr **Per Frederick County's Urban BMP Database**

Step 1: WQv Computations for the WQv Practice

Step 1(a): *P_E and Q_E for the Site*

P_E required for the Water Quality (in) = 1
WQv Runoff Depth, Q_E (in)= 0.68 **Q_E = WQv P_E X R_V**
Ref. Vol. I, Sec. 2.2
WQ Runoff Volume, WQv (cf) = 5,639 **WQv (cf)= $(P_E)(R_V)(A)/12$**

Step 2: Compute Recharge Volume (Rev)

$$Rev = \frac{(S)(Rv)(A)}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Percentage (%)
A	7%
B	93%
C	0%
D	0%

Composite S: 0.27 Use 27% of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.035 ac-ft = 1514 cft

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = 0.43 ac = 18706 sf

Stone Pit Dimensions
Length (ft) = 50.00
Width (ft) = 10.00
Depth (ft) = 5.00

Recharge provided by a stone pit of 50 ft x 10 ft x 5 ft **which has volume of =** 2500 cft OK

Step 3: Bio-Swale ESDv Peak Discharge

Q_E = (P)(Rv) = 0.68 watershed inches Eq. Ref. Vol. II, Appendix D.10

RCN for WQv = $\frac{1000}{[10+5P+10Q_E-10\sqrt{(Q_E^2+1.25Q_EP)}]}$ = **97** Eq. Ref. Vol. II, Appendix D.10

Initial Abstraction = I_a =(200/CN)-2 = 0.07

I_a/P_E = 0.10

Unit Peak Discharge = q_u = 676 csm/in (Figure D.11.1)

WQv Peak Flow =Q_{ESD} = (q_u csm/in)*(A mi^2)*(Q_E in) = 1.64 cfs

Step 4: Inflow velocity

Riprap outlet protection provided to provide safe conveyance from the inlet outfall to the BMP.

Step 5: Treatment

Step 5(a) *Compute the Required Filter Bed Area: (Af)*

Minimum Filter Bed Area = A_f =	1,978	sft	**2% of contributing drainage are**a.
Minimum Filter Media Depth =	18	in	
Design Filter Bed Depth (d_f) =	26	in	**18" BSM Layer + 4" Coarse Sand Layer+4" Stone**
=	2.2	ft	

Filter Media Type:	Bioretention Soil Mix, Coarse Sand and Stone layer		
Coefficient of Permeability (k) =	2.000	ft/day	
Filter Bed Drain Time (t_f) =	2	days =	48 hours

Step 5(b) *Design the Filter Chamber*

Setting Width (w)=	5.0	ft	
Minimum Filter Bed Length =	395.5	ft	
Design Filter Bed Length (l)=	420.0	ft	
Provided A_f =	2,100.00	sft	**[Provided Af is > than required Af of 1978 sft]**
Use a Filter Chamber 5.0 ft by	420.0	ft	

Step 5(c) *Design Temporary Surface Storage ($V_{temp\ SS}$) above Filter Media*

$V_{temp\ SS}$ = WQv -Rev= **3,139** cft **(When Rev provided upstream of the BMP)**

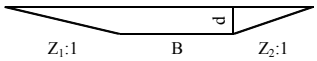
Check Dam Height at downstream end = d =	1	ft	
Height of water at upstream end= d_u =	0	ft	
Median height = h_f =	0.5	ft	
Width of swale bottom = W =	5.0	ft	
Side Slope Z1=	3	:1	
Side Slope Z2=	3	:1	
Slope of filter bed=	0.020	ft/ft	
Total Length of Swale = L_s =	445.0	ft	
Length of permanent ponding per full cells= L_p =	50	ft	
Number of full cells = N =	7		
Length of each Check dam (3:1 side slope) = L_c =	8	ft	(d) x (3) x (2) + 2 (2' top width of check dam)
Partial Cell Required	Yes		Yes if (Ls - N x Lc - Lc) - (Lp x N) > 0
Number of check dams = Ndams =	8		
Length of Partial Cell = L_{pu}	39	ft	(Ls - Lc x (Ndams-1) - N x Lp)
Check Dam Height at downstream end of partial cell= dp =	0.78	ft	Slope x Lpu
Storage in partial Cell	115	cft	V= $(d^2L_{pu}(Z_1+Z_2)+(3bdL_{pu})/6$
Storage per full cell = WQv =	175	cft	V= $(d^2L_p(Z_1+Z_2)+(3bdL)/6$
Length of filter media in partial cell = Lpar =	39.0	ft	
Area of filter media in partial cell = Apar =	195.0	cft	
Area of filter media per full cell = A_{cf} =	272.1	sft	(Provided Af - Lpar x W) / N
Length of filter media per full cell = L_{cf} =	54.4	ft	Acf / W
Total Filter Surface Area Provided = SAt =	2100.0	sft	Lcf x W + Lpar x W
Surface Storage provided = V_{SS} =	1,340	cft	V_{SS} = WQv X N + Storage in Partial Cell

Step 5(d) *Design Storage (Vmedia) of Filter Media*

Volume of filter media per full cell = Vmedia =	4550.0	cft	
Media Storage provided WQv Provided(media)	1,820	cft	Vmedia X 0.40
Total of WQv Provided =	5,660	cft	WQ_V Provided =Vmedia + V_{SS}+ Rev
Drain time of each cell (t_f) =	1.1	days	tf=(ESDprovided)(df)/[(k)(hf+d_f)(SAt)]

Step 6: Check Design for WQv and 10-year event velocity

Bio-Swale Typical Section:



Z_1, Z_2 = Side Slopes
B = Bottom width
d = Depth of the flow in inches
S = Longitudinal channel slope

Z_1 = **3**	B =	**5.00**	ft	Z_2 = **3**	S =	**0.020**	ft/ft

Manning's Equation = $V = (1.49*A*R^{2/3}*S^{1/2})/n$
Manning's n = 0.207-0.0145*d
Manning's n for flow depth is > 12"= **0.040** reference for "n" value: P.1-2-B-6 of SHA Highway Drainage Manual

Step 6(a) *WQv Velocity Check*
WQv Peak Flow = Q_{ESD} = **1.64** cfs
The permissible WQv velocity= **1.0** fps

d (in)	Z_1	B	Z_2	n	A (sf)	R (ft)	R^(2/3)	A*R^(2/3)	Q (cfs)	Q_{ESD} (cfs)	V (fps)	WP (ft)
4.6	**3**	**5.0**	**3**	**0.140**	**2.35**	**0.32**	**0.465**	**1.093**	**1.64**	**1.64**	**0.70**	**7.42**

Selected d = 4.6 in (from above table)

Computed Velocity
$V = Q_{ESD}/A$ = 0.70 fps <= 1fps OK

Step 7: Check for Bio-Swale Criteria ***Ref. Vol. I, ch 5, pg 5.109***

A. Bio-Swale bottom width 5.0 ft is between 2.0 ft to 8.0 ft OK.
B. Bio-Swale side slopes (Z1=3.0:1 and Z2=3.0:1) is 3:1 or flatter, OK.
C. Bio-Swale slope (2.0%) is less than or equal to 4.000% OK.
D. Flow velocity for WQv runoff from (0.70 fps) is less than or equal to 1.00 fps OK.
E. Bio-Swale filter area 2100 sft is greater than or equal to 2% of contributing impervious area 1978 sft OK.
F. 7 full cells 50' long and 1 partial cells with a length of 39; 5' wide with 3:1 side slopes provided with total storage of 5660cft.
G. Filter media with length of 54' at downstream end of each full cell provided and 39' of filter media at downstream end of partial cell.
H. Recharge provided by a stone pit of 50 ft x 10 ft x 5 ft
I. The 10 year WSE is 14" below the edge of shoulder.

Step 8: Summary

Total Area	2.270	ac
Total Impervious Area	1.600	ac
Treatment Claimed	1.600	ac impervious area
Target PE	1.00	in
Treated PE	1.00	in
WQv Required	5,639	cft
Total WQv Provided	5,660	cft

Project: **Lower Monocacy Watershed Assessment** GrassSwale Rev. 12/17/2014-2014 **BMP:** 353- BMP B
Standard No. **ESD Type:** M-8

Preliminary Design:

Sta.

Location: Frederick County, Maryland
Watershed: Upper Bush Creek **Stream Use:** IV-P

See Maryland Department of Environment (MDE), 2000 Maryland Stormwater Management Design Manual Volumes I & II for referenced equations, acronyms, and definitions.

	Cell with automated formula
	Cell for user input

Drainage Area: 0.940 ac 0.00147 sqm

Measured Impervious Area:

Total Impervious Area = 0.810 ac
Impervious Area Along Length of Grass Swale = 0.810 ac

Percent Impervious (I) = 0.862 I =Total Impervious Area/Site Area
= 86.2%
Rv =0.05+(0.009)I= 0.826 Eq. Ref. Vol. I, Sec. 2.0, Table 2.1

RCN Post Development : 91 **tc =** 0.300 hr **Per Frederick County's Urban BMP Database**

Step 1: Rainfall Zone and Recharge Volume (Rev)

Step 1(a): *Compute Composite S*

	Area (Acres)	%	Soil Specific Recharge Factor (s)
Soil Type A	0.94	100%	0.38
Soil Type B	0	0%	0.26
Soil Type C		0%	0.13
Soil Type D	0	0%	0.07

Composite S: 0.380 Use 38.00% of site imperviousness

Step 1(b): *Rainfall Zone*

Rainfall Zone: Min P_E required (in)= 1 Per MDE's Accounting Guidance, Accounting for Stormwater Wasteload Allocations, and Impervious Area Treated (2014)

Step 1(c): *Compute Recharge using Percent Volume Method*

Rev Required = [(S)(Rv)(A)]/12 = 0.025 ac-ft = 1070 cft

Step 2: Grass-Swale Water Quality Peak Discharge and Velocity

$Q_a = (P)(Rv) =$ 0.83 watershed inches — Eq. Ref. Vol. II, Appendix D.10

RCN for ESDv = $\frac{1000}{[10+5P+10Q_a-10\sqrt{(Q_a^2+1.25Q_aP)}]}$ = **98** — Eq. Ref. Vol. II, Appendix D.10

Initial Abstraction = I_a =(200/CN)-2 = 0.03

I_a/P = 0.10

Unit Peak Discharge = q_u = 676 csm/in (Figure D.11.1)

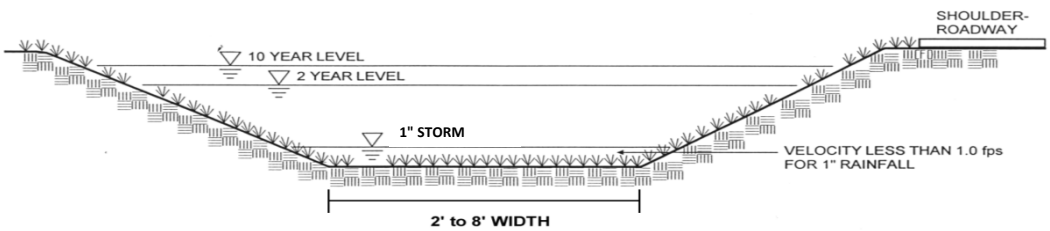
WQv Peak Flow = Q_w = (q_u csm/in)*(A mi^2)*(q_a in) = 0.820 cfs

Criteria for the Grass-Swale — Ref. Vol. I, ch 5, pg 5.109

The WQv is obtained if a grass-swale meets the following criteria:

A. The bottom width shall be 2 feet minimum and 8 feet maximum,
B. The side slopes shall be 3:1 or flatter,
C. The channel slope shall be less than or equal to 4.0%, and
D. The maximum flow depth of the grass swale for ESDv flow is 4 inches or less
E. The maximum flow velocity for runoff from the one-inch rainfall shall be less than or equal to 1.0 fps (see Appendix D.10 for methodology to compute flowrate),
F. The maximum flow velocity for runoff from the ten-year design event shall be non erosive,
G. Minimum required filter bed area (A_f) is 2% of contributing drainage area. (Ref. Vol. I, ch 5, pg 5.109)

Typical of Top of GRass-Swale



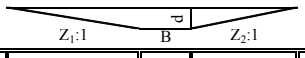
Slope of Channel S = 0.040 ft/ft
Length of Channel L= 275 ft

Z_1 = **3**	B =	**8.00**	ft	Z_2 = **3**	S =	**0.040**	ft/ft

Bottom area = **2200.0** sf

Bottom Area Check: **> 2% of Drainage Area - Bottom Area OK**

Step 3: Solve Manning's equation



d (in)	Z_1	B	Z_2	n	A (sf)	R (ft)	R^(2/3)	A*R^(2/3)	Q (cfs)	Qw (cfs)	V (fps)	WP (ft)
1.5	3	8.0	3	0.150	1.05	0.12	0.242	0.253	0.50	0.82	0.48	8.8
2.0	**3**	**8.0**	**3**	**0.150**	**1.42**	**0.16**	**0.290**	**0.411**	0.82	**0.82**	**0.58**	**9.05**
2.5	3	8.0	3	0.150	1.80	0.19	0.334	0.600	1.19	0.82	0.66	9.3

Selected d = 2.0 in (from above table) — ok

Computed Velocity
V = Qw/A = 0.58 fps <= 1 fps OK

Step 4: Check for Grass-Swale Criteria

A. Grass-Swale bottom width (8.0') greater than or is equal to 2.0' and less than or equal to 8.0', OK.
B. Grass-Swale side slopes (Z1=3:1 and Z2=3:1) is 3:1 or flatter, OK.
C. Grass-Swale slope (4.000%) is less than or equal to 4.000%, OK.
D. Grass-Swale flow depth (2.000 inches) is less than or equal to 4 inches, OK.
E. Flow velocity for runoff from the one-inch rainfall (0.58 fps) is less than or equal to 1.00 fps, OK.
F. Grass-Swale Bottom area (2200.000 sft) is greater than or equal to 2% of contributing Drainage area (0.940 ac), OK.
G. Recharge of 1070cft provided if all the above conditions are met

Step 5: Summary

Total Area	0.940	ac	
Total Impervious Area	0.810	ac	
Treatment Claimed	0.435	ac impervious area	
Pe claimed	0.54	in	=10 in*(Af/DA) or 2.60 in whichever is less
ESDv volume claimed	1513	cft	
Recharge Volume Provided	1070	cft	

Project: **Lower Monocacy Watershed Assessment** Bio-Swale Rev. 12-10-2014 **BMP:** **BMP 353- BMP C**

Preliminary Design:

	Cell with automated formula
	Cell for user input

Location: Frederick County, Maryland **Sta.**
Watershed: Lower Monocacy River **Stream Use:** IV

This spreadsheet is for 100 % ESDv storage with equally spaced check dams with upstream depths of 0 feet.

See Maryland Department of Environment (MDE), 2000 Maryland Stormwater Management Design Manual Volumes I & II for referenced equations, acronyms, and definitions.

Site Area (A): 2.030 ac 0.003 sqm

Measured Impervious Area:

Total Impervious Area = 1.800 ac

Percent Impervious (I) = 0.887 I =Total Impervious Area/Site Area
= 89%

Volumetric Runoff Coefficient (Rv) = 0.05+(0.009)I Eq. Ref. Vol. I, Sec. 2.0, Table 2.1
= 0.85

Soil Type: A

RCN Post Development : 91 **tc =** 0.300 hr **Per Frederick County's Urban BMP Database**

Step 1: WQv Computations for the WQv Practice

Step 1(a): *P_E and Q_E for the Site*

P_E required for the Water Quality (in) = 1
WQv Runoff Depth, Q_E (in)= 0.85 **Q_E = WQv P_E X R_V**
Ref. Vol. I, Sec. 2.2
WQ Runoff Volume, WQv (cf) = 6,249 **WQv (cf)= $(P_E)(R_V)(A)/12$**

Step 2: Compute Recharge Volume (Rev)

$$Rev = \frac{(S)(Rv)(A)}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Percentage (%)
A	100%
B	0%
C	0%
D	0%

Composite S: 0.38 Use 38% of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.055 ac-ft = 2375 cft

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = 0.68 ac = 29795 sf

Stone Pit Dimensions
Length (ft) = 100.00
Width (ft) = 5.00
Depth (ft) = 5.00

Recharge provided by a stone pit of 100 ft x 5 ft x 5 ft **which has volume of =** 2500 cft OK

Step 3: Bio-Swale ESDv Peak Discharge

Q_E = (P)(Rv) = 0.85 watershed inches Eq. Ref. Vol. II, Appendix D.10

RCN for WQv = $\frac{1000}{[10+5P+10Q_E-10\sqrt{(Q_E^2+1.25Q_EP)}]}$ = **99** Eq. Ref. Vol. II, Appendix D.10

Initial Abstraction = I_a =(200/CN)-2 = 0.03

I_a/P_E = 0.10

Unit Peak Discharge = q_u = 676 csm/in (Figure D.11.1)

WQv Peak Flow =Q_{ESD} = (q_u csm/in)*(A mi^2)*(Q_E in) = 1.82 cfs

Step 4: Inflow velocity

Riprap outlet protection provided to provide safe conveyance from the inlet outfall to the BMP.

Step 5: Treatment

Step 5(a) *Compute the Required Filter Bed Area: (Af)*

Minimum Filter Bed Area = A_f =	1,769	sft	**2% of contributing drainage are**a.
Minimum Filter Media Depth =	18	in	
Design Filter Bed Depth (d_f) =	26	in	**18" BSM Layer + 4" Coarse Sand Layer+4" Stone**
=	2.2	ft	

Filter Media Type:	Bioretention Soil Mix, Coarse Sand and Stone layer		
Coefficient of Permeability (k) =	2.000	ft/day	
Filter Bed Drain Time (t_f) =	2	days =	48 hours

Step 5(b) *Design the Filter Chamber*

Setting Width (w)=	5.0	ft	
Minimum Filter Bed Length =	353.7	ft	
Design Filter Bed Length (l)=	565.0	ft	
Provided A_f =	2,825.00	sft	**[Provided Af is > than required Af of 1769 sft]**

Use a Filter Chamber	5.0	ft by	565.0	ft

Step 5(c) *Design Temporary Surface Storage ($V_{temp\ SS}$) above Filter Media*

$V_{temp\ SS}$ = WQv -Rev=	**3,749**	cft	**(When Rev provided upstream of the BMP)**

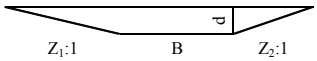
Check Dam Height at downstream end = d =	1	ft	
Height of water at upstream end= d_u =	0	ft	
Median height = h_f =	0.5	ft	
Width of swale bottom = W =	5.0	ft	
Side Slope Z1=	4	:1	
Side Slope Z2=	4	:1	
Slope of filter bed=	0.020	ft/ft	
Total Length of Swale = L_s =	565.0	ft	
Length of permanent ponding per full cells= L_p =	50	ft	
Number of full cells = N =	9		
Length of each Check dam (3:1 side slope) = L_c =	8	ft	(d) x (3) x (2) + 2 (2' top width of check dam)
Partial Cell Required	Yes		Yes if (Ls - N x Lc - Lc) - (Lp x N) > 0
Number of check dams = Ndams =	10		
Length of Partial Cell = L_{pu}	43	ft	(Ls - Lc x (Ndams-1) - N x Lp)
Check Dam Height at downstream end of partial cell= dp =	0.86	ft	Slope x Lpu
Storage in partial Cell	150	cft	V= $(d^2L_{pu}(Z_1+Z_2)+(3bdL_{pu})/6$
Storage per full cell = WQv =	192	cft	V= $(d^2L_p(Z_1+Z_2)+(3bdL)/6$
Length of filter media in partial cell = Lpar =	43.0	ft	
Area of filter media in partial cell = Apar =	215.0	cft	
Area of filter media per full cell = A_{cf} =	290.0	sft	(Provided Af - Lpar x W) / N
Length of filter media per full cell = L_{cf} =	58.0	ft	Acf / W
Total Filter Surface Area Provided = SAt =	2825.0	sft	Lcf x W + Lpar x W
Surface Storage provided = V_{SS} =	1,875	cft	V_{SS} = WQv X N + Storage in Partial Cell

Step 5(d) *Design Storage (Vmedia) of Filter Media*

Volume of filter media per full cell = Vmedia =		6120.8	cft	
Media Storage provided	WQv Provided(media)	2,448	cft	Vmedia X 0.40
Total of WQv Provided =		6,823	cft	WQ_V Provided =Vmedia + V_{SS}+ Rev
Drain time of each cell (t_f) =		1.0	days	tf=(ESDprovided)(df)/[(k)(hf+d_f)(SAt)]

Step 6: Check Design for WQv and 10-year event velocity

Bio-Swale Typical Section:



Z_1, Z_2 = Side Slopes
B = Bottom width
d = Depth of the flow in inches
S = Longitudinal channel slope

Z_1 =	**4**	B =	**5.00**	ft	Z_2 = **4**	S = **0.020**	ft/ft

Manning's Equation = $V = (1.49*A*R^{2/3}*S^{1/2})/n$
Manning's n = 0.207-0.0145*d
Manning's n for flow depth is > 12"= **0.040** reference for "n" value: P.1-2-B-6 of SHA Highway Drainage Manual

Step 6(a) *WQv Velocity Check*
WQv Peak Flow = Q_{ESD} = **1.82** cfs
The permissible WQv velocity= **1.0** fps

d (in)	Z_1	B	Z_2	n	A (sf)	R (ft)	R^(2/3)	A*R^(2/3)	Q (cfs)	Q_{ESD} (cfs)	V (fps)	WP (ft)
4.7	**4**	**5.0**	**4**	**0.139**	**2.57**	**0.31**	**0.461**	**1.184**	**1.82**	**1.82**	**0.71**	**8.23**

Selected d = 4.7 in (from above table)

Computed Velocity
$V = Q_{ESD}/A$ = 0.71 fps <= 1fps OK

Step 7: Check for Bio-Swale Criteria ***Ref. Vol. I, ch 5, pg 5.109***

A. Bio-Swale bottom width 5.0 ft is between 2.0 ft to 8.0 ft OK.
B. Bio-Swale side slopes (Z1=4.0:1 and Z2=4.0:1) is 3:1 or flatter, OK.
C. Bio-Swale slope (2.0%) is less than or equal to 4.000% OK.
D. Flow velocity for WQv runoff from (0.71 fps) is less than or equal to 1.00 fps OK.
E. Bio-Swale filter area 2825 sft is greater than or equal to 2% of contributing impervious area 1769 sft OK.
F. 9 full cells 50' long and 1 partial cells with a length of 43; 5' wide with 4:1 side slopes provided with total storage of 6823cft.
G. Filter media with length of 58' at downstream end of each full cell provided and 43' of filter media at downstream end of partial cell.
H. Recharge provided by a stone pit of 100 ft x 5 ft x 5 ft
I. The 10 year WSE is 14" below the edge of shoulder.

Step 8: Summary

Total Area	2.030	ac
Total Impervious Area	1.800	ac
Treatment Claimed	1.800	ac impervious area
Target PE	1.00	in
Treated PE	1.09	in
WQv Required	6,249	cft
Total WQv Provided	6,823	cft

Project: **Lower Monocacy Watershed Assessment** Bio-Swale Rev. 12-10-2014 **BMP:** **BMP 353- BMP D**

Preliminary Design:

	Cell with automated formula
	Cell for user input

Location: Frederick County, Maryland **Sta.**
Watershed: Lower Monocacy River **Stream Use:** IV

This spreadsheet is for 100 % ESDv storage with equally spaced check dams with upstream depths of 0 feet.

See Maryland Department of Environment (MDE), 2000 Maryland Stormwater Management Design Manual Volumes I & II for referenced equations, acronyms, and definitions.

Site Area (A): 4.410 ac 0.007 sqm

Measured Impervious Area:

Total Impervious Area = 2.620 ac

Percent Impervious (I) = 0.594 I =Total Impervious Area/Site Area
= 59%

Volumetric Runoff Coefficient (Rv) = 0.05+(0.009)I Eq. Ref. Vol. I, Sec. 2.0, Table 2.1
= 0.58

Soil Type: A, B, C

RCN Post Development : 91 **tc =** 0.300 hr **Per Frederick County's Urban BMP Database**

Step 1: WQv Computations for the WQv Practice

Step 1(a): *P_E and Q_E for the Site*

P_E required for the Water Quality (in) = 1
WQv Runoff Depth, Q_E (in)= 0.58 **Q_E = WQv P_E X R_V**
Ref. Vol. I, Sec. 2.2
WQ Runoff Volume, WQv (cf) = 9,360 **WQv (cf)= (P_E)(R_V)(A)/12**

Step 2: Compute Recharge Volume (Rev)

$$Rev = \frac{(S)(Rv)(A)}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Percentage (%)
A	22%
B	32%
C	46%
D	0%

Composite S: 0.23 Use 23% of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.049 ac-ft = 2121 cft

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = 0.59 ac = 25861 sf

Stone Pit Dimensions
Length (ft) = 150.00
Width (ft) = 8.00
Depth (ft) = 5.00

Recharge provided by a stone pit of 150 ft x 8 ft x 5 ft **which has volume of =** 6000 cft OK

Step 3: Bio-Swale ESDv Peak Discharge

Q_E = (P)(Rv) = 0.58 watershed inches Eq. Ref. Vol. II, Appendix D.10

RCN for WQv = $\frac{1000}{[10+5P+10Q_E-10\sqrt{(Q_E^2+1.25Q_EP)}]}$ = **95** Eq. Ref. Vol. II, Appendix D.10

Initial Abstraction = I_a =(200/CN)-2 = 0.10

I_a/P_E = 0.10

Unit Peak Discharge = q_u = 676 csm/in (Figure D.11.1)

WQv Peak Flow =Q_{ESD} = (q_u csm/in)*(A mi^2)*(Q_E in) = 2.72 cfs

Step 4: Inflow velocity

Riprap outlet protection provided to provide safe conveyance from the inlet outfall to the BMP.

Step 5: Treatment

Step 5(a) *Compute the Required Filter Bed Area: (Af)*

Minimum Filter Bed Area = A_f =	3,842	sft	**2% of contributing drainage are**a.
Minimum Filter Media Depth =	18	in	
Design Filter Bed Depth (d_f) =	26	in	**18" BSM Layer + 4" Coarse Sand Layer+4" Stone**
=	2.2	ft	

Filter Media Type:	Bioretention Soil Mix, Coarse Sand and Stone layer		
Coefficient of Permeability (k) =	2.000	ft/day	
Filter Bed Drain Time (t_f) =	2	days =	48 hours

Step 5(b) *Design the Filter Chamber*

Setting Width (w)=	8.0	ft	
Minimum Filter Bed Length =	480.2	ft	
Design Filter Bed Length (l)=	481.0	ft	
Provided A_f =	3,848.00	sft	**[Provided Af is > than required Af of 3842 sft]**
Use a Filter Chamber 8.0 ft by	481.0	ft	

Step 5(c) *Design Temporary Surface Storage ($V_{temp\ SS}$) above Filter Media*

$V_{temp\ SS}$ = WQv -Rev= **3,360** cft **(When Rev provided upstream of the BMP)**

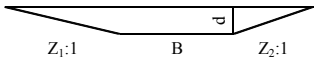
Check Dam Height at downstream end = d =	1	ft	
Height of water at upstream end= d_u =	0	ft	
Median height = h_f =	0.5	ft	
Width of swale bottom = W =	8.0	ft	
Side Slope Z1=	3	:1	
Side Slope Z2=	3	:1	
Slope of filter bed=	0.040	ft/ft	
Total Length of Swale = L_s =	481.0	ft	
Length of permanent ponding per full cells= L_p =	25	ft	
Number of full cells = N =	13		
Length of each Check dam (3:1 side slope) = L_c =	8	ft	(d) x (3) x (2) + 2 (2' top width of check dam)
Partial Cell Required	Yes		Yes if (Ls - N x Lc - Lc) - (Lp x N) > 0
Number of check dams = Ndams =	14		
Length of Partial Cell = L_{pu}	52	ft	(Ls - Lc x (Ndams-1) - N x Lp)
Check Dam Height at downstream end of partial cell= dp =	2.08	ft	Slope x Lpu
Storage in partial Cell	485	cft	V= $(d^2L_{pu}(Z_1+Z_2)+(3bdL_{pu})/6$
Storage per full cell = WQv =	125	cft	V= $(d^2L_p(Z_1+Z_2)+(3bdL)/6$
Length of filter media in partial cell = Lpar =	34.4	ft	
Area of filter media in partial cell = Apar =	274.9	cft	
Area of filter media per full cell = A_{cf} =	274.9	sft	(Provided Af - Lpar x W) / N
Length of filter media per full cell = L_{cf} =	34.4	ft	Acf / W
Total Filter Surface Area Provided = SAt =	3848.0	sft	Lcf x W + Lpar x W
Surface Storage provided = V_{SS} =	2,110	cft	V_{SS} = WQv X N + Storage in Partial Cell

Step 5(d) *Design Storage (Vmedia) of Filter Media*

Volume of filter media per full cell = Vmedia =	8337.3	cft	
Media Storage provided WQv Provided(media)	3,335	cft	Vmedia X 0.40
Total of WQv Provided =	11,445	cft	WQ_V Provided =Vmedia + V_{SS}+ Rev
Drain time of each cell (t_f) =	1.2	days	tf=(ESDprovided)(df)/[(k)(hf+d_f)(SAt)]

Step 6: Check Design for WQv and 10-year event velocity

Bio-Swale Typical Section:



Z_1, Z_2 = Side Slopes
B = Bottom width
d = Depth of the flow in inches
S = Longitudinal channel slope

Z_1 = **3**	B =	**8.00**	ft	Z_2 = **3**	S =	**0.040**	ft/ft

Manning's Equation = $V = (1.49*A*R^{2/3}*S^{1/2})/n$
Manning's n = 0.207-0.0145*d
Manning's n for flow depth is > 12"= **0.040** reference for "n" value: P.1-2-B-6 of SHA Highway Drainage Manual

Step 6(a) *WQv Velocity Check*
WQv Peak Flow = Q_{ESD} = **2.72** cfs
The permissible WQv velocity= **1.0** fps

d (in)	Z_1	B	Z_2	n	A (sf)	R (ft)	R^(2/3)	A*R^(2/3)	Q (cfs)	Q_{ESD} (cfs)	V (fps)	WP (ft)
4.0	**3**	**8.0**	**3**	**0.148**	**3.03**	**0.30**	**0.447**	**1.355**	**2.72**	**2.72**	**0.90**	**10.13**

Selected d = 4.0 in (from above table)

Computed Velocity
$V = Q_{ESD}/A$ = 0.90 fps <= 1fps OK

Step 7: Check for Bio-Swale Criteria ***Ref. Vol. I, ch 5, pg 5.109***

A. Bio-Swale bottom width 8.0 ft is between 2.0 ft to 8.0 ft OK.
B. Bio-Swale side slopes (Z1=3.0:1 and Z2=3.0:1) is 3:1 or flatter, OK.
C. Bio-Swale slope (4.0%) is less than or equal to 4.000% OK.
D. Flow velocity for WQv runoff from (0.90 fps) is less than or equal to 1.00 fps OK.
E. Bio-Swale filter area 3848 sft is greater than or equal to 2% of contributing impervious area 3842 sft OK.
F. 13 full cells 25' long and 1 partial cells with a length of 52; 8' wide with 3:1 side slopes provided with total storage of 11445cft.
G. Filter media with length of 34' at downstream end of each full cell provided and 34' of filter media at downstream end of partial cell.
H. Recharge provided by a stone pit of 150 ft x 8 ft x 5 ft
I. The 10 year WSE is 14" below the edge of shoulder.

Step 8: Summary

Total Area	4.410	ac
Total Impervious Area	2.620	ac
Treatment Claimed	2.620	ac impervious area
Target PE	1.00	in
Treated PE	1.22	in
WQv Required	9,360	cft
Total WQv Provided	11,445	cft

BA102: Pine Cliff Park - BMP B

Prioritization Ranking:	20
Planning Level Cost Estimate:	$ 328,515.00
Estimated Cost/Impervious Acre	$ 104,950.03

General BMP Information:		
Structure Location:	Pinecliff Park Road	
ADC Map:	4567, A8 (2008)	
Nothing/Easting:	627,916.874/1,206,558.402	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Stream Restoration	
Management Type:	Quality	
Total Drainage Area (ac):	N/A	
Total Impervious Area (ac):	N/A	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	N/A	
Total Treated Drainage Area (ac):	N/A	
Total Treated Impervious Area (ac):	3.3	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	24.75	-
TP (lbs/yr):	22.44	-
TSS (lbs/yr):	14817.00	-

Existing conditions for BMP B

Site map for BMPs A and B

EXISTING SITE CONDITIONS

Pinecliff Park encompasses approximately 50 acres along the east bank of the Monocacy River. The property is located off Pinecliff Park Road as shown in the site map above. The park has five baseball fields, picnicking areas, boat access to the river, playgrounds, and winter sledding and ice skating. Runoff from the lawn, fields, and parking areas drains directly into several small streams then into the river. No stormwater management controls currently exist at this facility.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site via Pinecliff Park Road. According to the County's parcel layer in GIS, this site is owned by Parks and Recreation. Underground water lines beneath the stream and along the east side of the park were being upgraded in early 2006. A detailed utility investigation will need to be conducted during the design phase.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Utilities, MOT	

PROPOSED RETROFIT

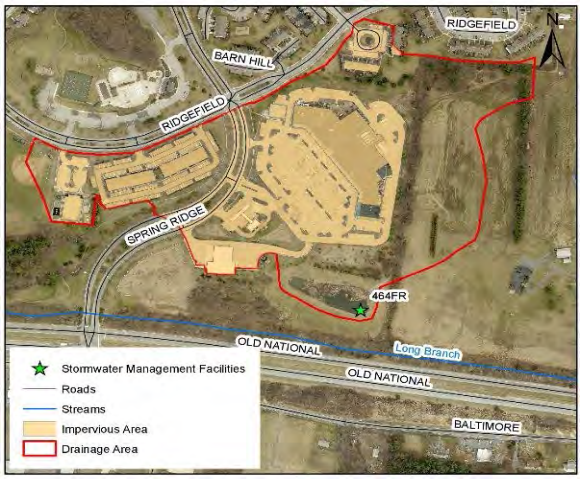
There are two new BMPs proposed at this location. BMP B is a stream restoration for 330 linear feet of stream along an unnamed tributary of the Monocacy River. The Project Summary Sheet for the new grass swale (BMP A), Assessment, and Concept Plan is included separately in Appendix E with a prioritization ranking of 12.

BMP # 464 – SPRING RIDGE – POND #9

Prioritization Ranking:	21
Planning Level Cost Estimate:	$ 1,324,130.50
Estimated Cost/Impervious Acre	$ 105,950.56

General BMP Information:		
Structure Location:	Spring Ridge Parkway and MD. RT. 144	
ADC Map:	4567, E7 (2008)	
Northing/Easting:	630,456.33/1,214,633.59	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Wet Extended Detention Pond (P-3)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	30.25	
Total Impervious Area (ac):	12.73	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	47079	
Total Treated Drainage Area (ac):	30.25	
Total Treated Impervious Area (ac):	12.73	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	253.11	92.60
TP (lbs/yr):	25.79	12.10
TSS (lbs/yr):	20642.75	13374.30

Existing conditions for BMP #464



Site map for BMP #464

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #464 has been identified as an extended detention dry pond. The facility was constructed north of Old National Pike and east of Spring Ridge Parkway. The BMP Database from the County indicates that the original design for BMP #464 provides management for quantity and quality and that the total treatment area for the BMP is 25.2 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 30.25 acres (including 12.73 acres of impervious area). The majority of land use is commercial with some residential areas.

ANTICIPATED SITE CONSTRAINTS

According to the design plans, the site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from a commercial parking lot to the north of the BMP that leads to the northwest side of the BMP or the fire station parking lot. The BMP is located in a SWM easement on a parcel allocated to open space per the Parcel GIS layer provided by Frederick County.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: NONE	

PROPOSED RETROFIT

The proposed retrofit for BMP #464 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 30.25 acres including 12.73 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating approximately 1 foot below the existing BMP bottom elevation for extended detention as shown in the Concept Plans.

BMP # 464 – SPRING RIDGE – POND #9

Storm Water Management Retrofit Evaluation					
Report Date:	6/1/2015	**Design Approval:**	2/7/1990	**Maintenance Owner:**	Richard A. Gremmell
Structure No:	464	**Year Constructed:**	10/1/1990	**Inspection Date:**	5/8/2015
Structure Name:	Spring Ridge - Pond #9	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, CF
Location:	Spring Ridge Parkway and MD. RT. 144	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	5/6/2015 (0.05")
ADC Map:	4567, E7 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	630,456.33/1,214,633.59	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Extended Detention Dry Pond		Wet Extended Detention Pond (P-3)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity/Quality		Quality/Quantity		
Total Drainage Area (acres):	25.2		30.25		
Total Impervious Area within Drainage Area (acres):	Unknown		12.73		
WQv Required:	Unknown		47079	cu. ft.	1.081 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	Yes		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	47079	cu. ft.	1.081 ac-ft
Total Treated Drainage Area (acres):	25.2	0	30.25		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	12.73		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.02		
Total Nitrogen:			35.13%		
Total Phosphorus:			55.20%		
Sediment:			70.26%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		253.11		92.60
TP (lbs/yr):	0		25.79		12.10
TSS (lbs/yr):	0		20642.75		13374.30
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):					**$ 1,324,130.50**

BMP # 464 – SPRING RIDGE – POND #9

Existing Site Conditions:

SWM Era: 1985-2002

According to Frederick County's Urban BMP Database, BMP #464 has been identified as an extended detention dry pond. The facility was constructed north of Old National Pike and east of Spring Ridge Parkway as shown in the BMP Location map (**Figure 1**). The BMP Database from the County indicates that the original design for BMP #464 provides management for quantity and quality and that the total treatment area for the BMP is 25.2 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 30.25 acres (including 12.73 acres of impervious area). Figure 1 shows the drainage area for the facility. Design plans were available for this BMP, and show that the facility has the following features: two inflows into the facility- a 42" RCP from the north and riprap channel from the north, one 9" low flow orifice, one 5" extended detention orifice, a 36" CMP riser, and a 24" CMP principal spillway. The majority of land use is commercial with some residential areas. A stormwater management report was not available.

General Observations:

A site visit was conducted on May 8th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has five inflow points. Four inflows (Inflows #1, #3, #4, and #5) are in closed sections. According to the Urban BMP Database, Inflow #1 is a 15" HDPE storm drain that conveys flow from the fire station to the west into the forebay which is not on the design plans. The crown of Inflow #1 was submerged at least 6" and surrounded by excess vegetation during the site visit; therefore, the size and material of the storm drain could not be verified in the field **(Photo 1)**.

Inflow #2 does not appear on the design plans or in the Urban BMP Database but was observed in the field. Inflow #2 is a riprap channel from the north and enters the BMP east of the forebay **(Photo 2)**. At Inflow #2, excess vegetation was growing in the riprap channel. According to the Urban BMP Database and the design plans, Inflow #3 is a 42" RCP that enters the BMP from the northeast of the forebay and immediately adjacent to Inflow #2 **(Photo 3)**. At Inflow #3 excess vegetation, ponding water, and debris was observed near the outflow and ponding and sediment accumulation occurs in the pipe.

Inflow #4 does not appear on the design plans or in the Urban BMP Database but was observed in the field. Inflow #4 is a riprap channel from the north that enters the BMP east of the forebay **(Photo 4)**. Ponding and accumulated sediment was observed at Inflow #4 because the channel is not graded for positive drainage into the facility.

Inflow #5 does not appear on the design plans but does appear in the Urban BMP Database. Inflow #5 is a riprap channel that enters the northeast side of the BMP **(Photos 5 and 6)**. A tributary riprap channel joins the riprap channel for Inflow #5 from the west before Inflow #5 enters the BMP **(Photo 7)**. Overall, the inflows require maintenance to remedy the ponding water, excess vegetation, accumulated sediment, stability, and accessibility of the inflows.

Pretreatment:

This facility has a forebay that is not included in the design plans on the west side of the BMP **(Photo 8)**. Only Inflow #1 enters the forebay. Per the design plans, flow from the west side of the BMP flows to the east side of the BMP via a pilot channel **(Photo 9)**. Erosion of the pilot channel has occurred. The forebay condition is moderate because of accumulated sediment, excess vegetation, and ponding water.

Control Structure and Spillways:

According to the Urban BMP Database and design plans provided by Frederick County, the control structure for this facility has a 5" extended detention orifice, a 9" low flow orifice, a 36" riser, and a 24" principal spillway. The riser is constructed of CMP with a concentric trash rack and anti-vortex device **(Photo 10)**. The principal spillway flows from the southeast of the BMP toward Long Branch Creek **(Photo 11)**. The orifices and riser were not accessible during the site visit due to ponding water. The exterior of the riser structure appeared to be in good condition. Standing water was visible even though this BMP is classified as an extended detention dry pond, so it can be assumed that the orifices are clogged.

This BMP does not have an emergency spillway.

Embankment:

A fill embankment is present between the dry detention pond and principal outlet to the south and east of the pond **(Photo 12)**. The embankment is in good condition. Per the design plan, the embankment has a cutoff trench.

Outflow:

The 24" CMP principal spillway outlets the BMP south of the riser and is in good condition. However, the outflow has ponding water, accumulated sediment, and erosion **(Photo 13)**. The outflow continues south to Long Branch Creek.

Overall BMP:

Excess vegetation is present at Inflows #1, #2, #3, and #5. Ponding water of a depth of nearly one foot is present in the forebay and detention pond **(Photo 14)**. Erosion of channels has occurred at the pilot channel between the forebay and detention pond as well as at the outflow. Moderate problems were observed, however, the BMP is functioning as designed with no critical parameters but with some problem conditions. BMP performance is being compromised.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

According to the design plans, the site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from a commercial parking lot to the north of the BMP that leads to the northwest side of the BMP or the fire station parking lot. The BMP is located in a SWM easement on a parcel allocated to open space per the Parcel GIS layer provided by Frederick County. Easements at this location should be evaluated further in final design.

Proposed Retrofit:

BMP #464 was originally designed as an extended detention dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #464 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 30.25 acres including 12.73 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 1 foot below the existing BMP bottom elevation for extended detention as shown in the **Concept Plans**.

Additional Retrofit Opportunities:

As part of the final design, the condition of the existing CMP riser structure should be evaluated to determine if it should be replaced with a concrete riser structure.

Step 1: Watershed Factors

BMP #464 is located in Frederick County's Lower Linganore Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #464 due to the downstream coldwater conditions. For the retrofit of BMP #464, 100% of the WQv can be treated within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek.

Step 2: Terrain Factors

BMP #464 is not located in in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for retrofit design to BMP #464.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. Per the Pipes GIS layer provided by Frederick County, the invert elevation of Inflow #1 at the forebay is 345'. This Inflow may need to be modified so that the pipe

is not submerged in the proposed forebay. Field verification of the Inflow #1 invert elevation at the pond is recommended. The invert elevation of the existing principal spillway outlet is 342.5' per the Pipes GIS layer and the design plans. Since the downstream channel is in stable condition, there are no erosion or safety concerns and additional water quantity management is not required. There is adequate space for the proposed retrofit within the existing stormwater management (SWM) easement. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a wet extended detention pond is 25 acres. The proposed drainage area to BMP #464 is 30.23 acres and is composed of A, B, C, and D soils. The likelihood of BMP #464 receiving hotspot runoff is moderate since a gas station is located within the residential area. Hence, minimum separation from the water table may be required. The land use within the drainage area commercial and residential; therefore, the drainage to the BMP is not ultra-urban.

Step 5: Community and Environmental Factors

BMP #464 is located south of the shopping center off of Spring Ridge Parkway and has moderate visibility due to trees around the parking lot. Wet extended detention ponds tend to have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide high habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #464 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Flood Insurance Map FM24021C0313D indicates that the BMP is not within the FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is mapped as a wetland.

Figure 1: BMP Location Map – Existing Conditions

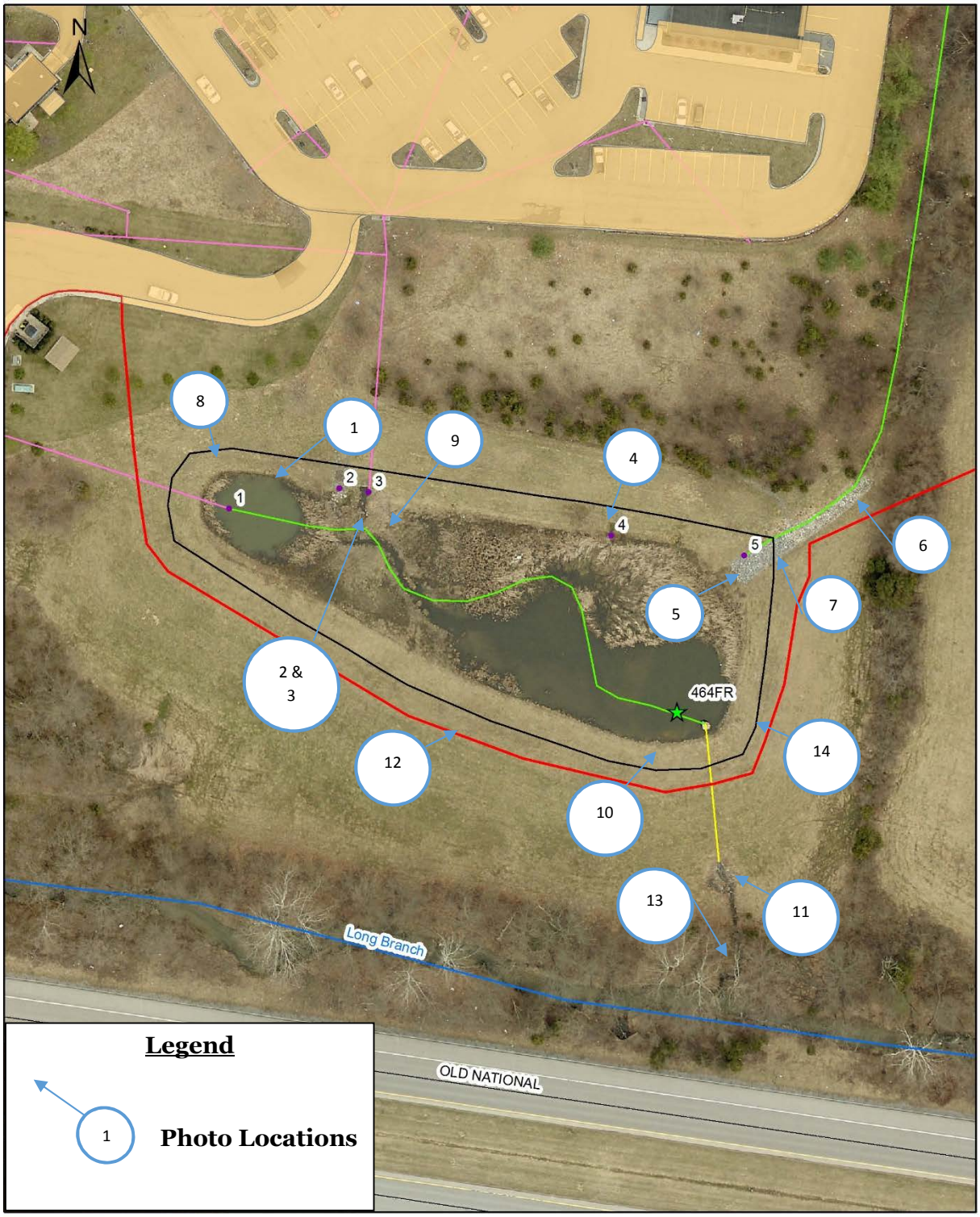


Figure 2: Photo Locations

Photo 1: Inflow #1 and forebay facing southwest

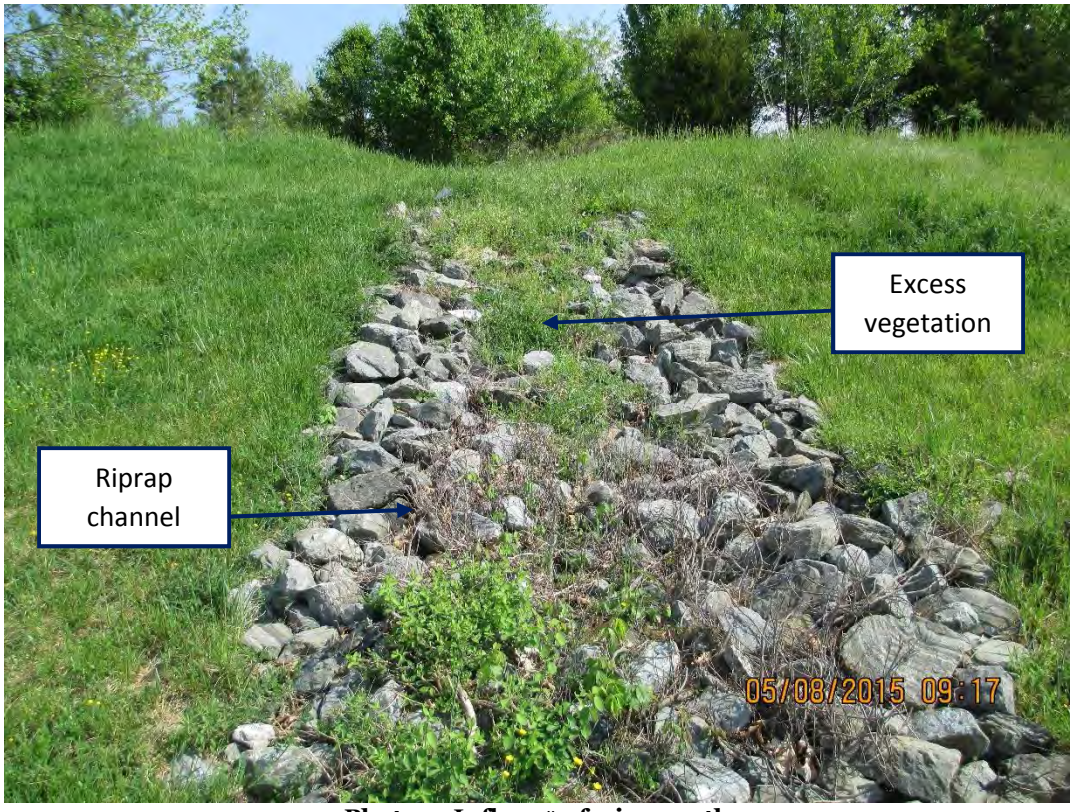


Photo 2: Inflow #2 facing north

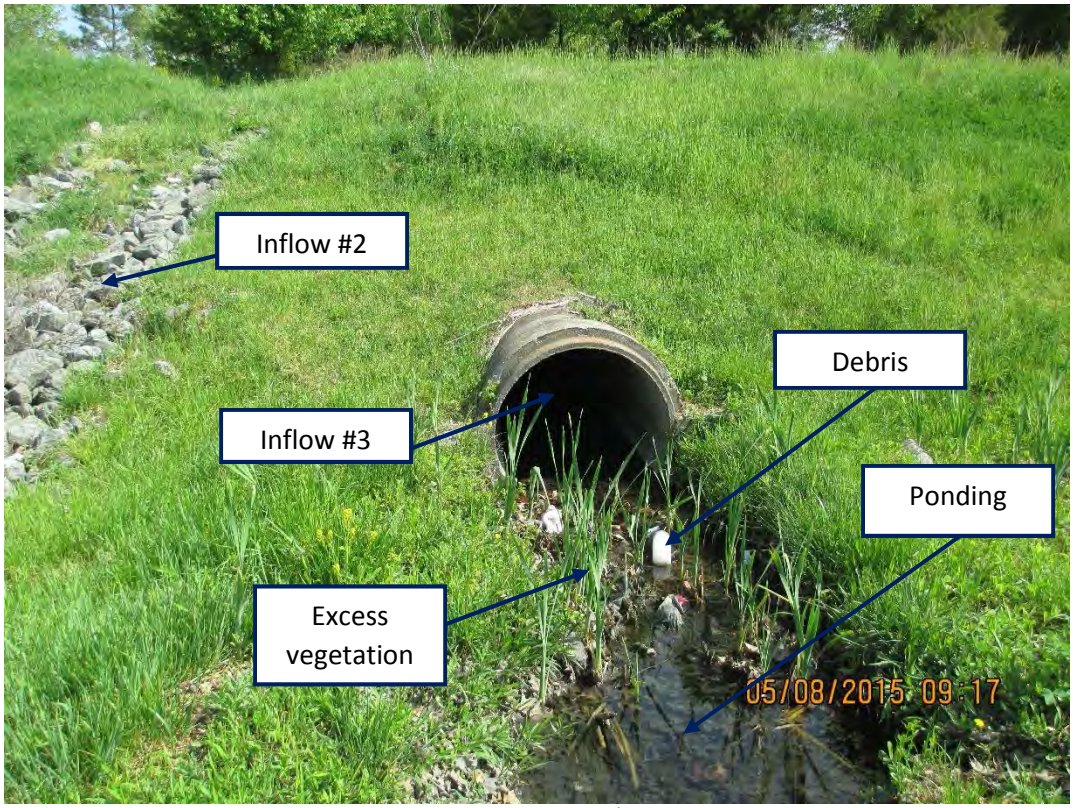


Photo 3: Inflow #3 facing north

Photo 4: Inflow #4 facing south

Photo 5: Inflow #5 facing northeast

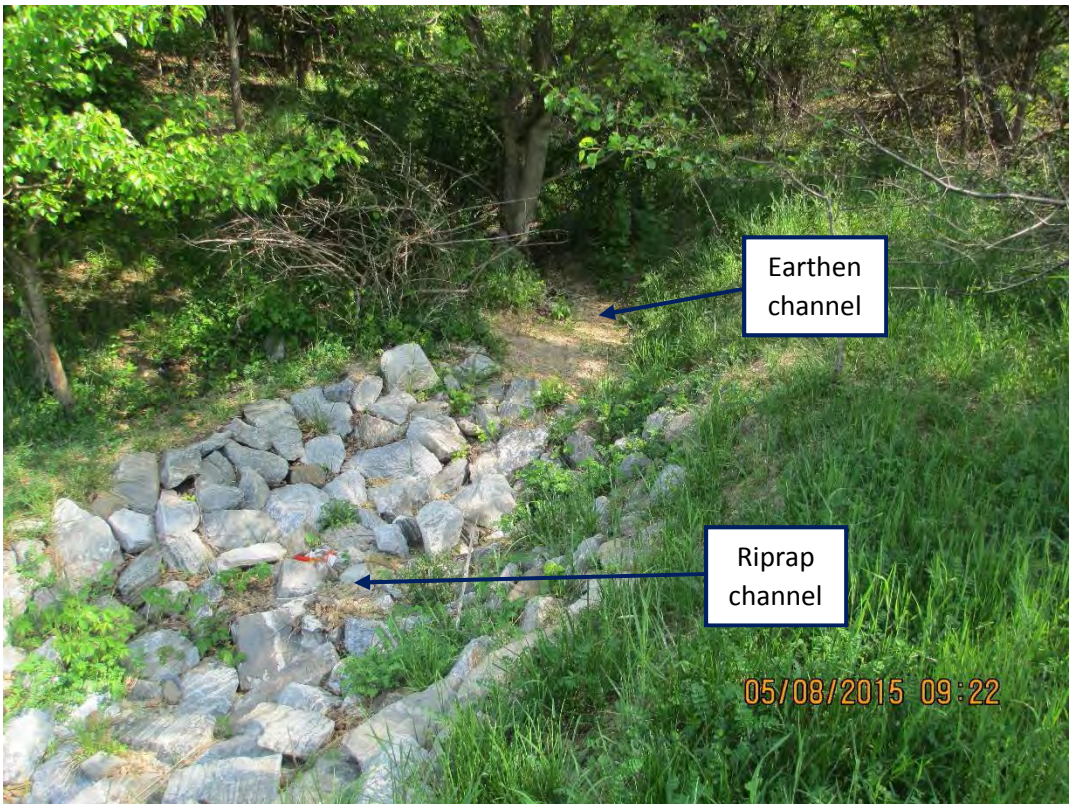


Photo 6: Inflow #5 facing north

Photo 7: Inflow #5 facing northwest

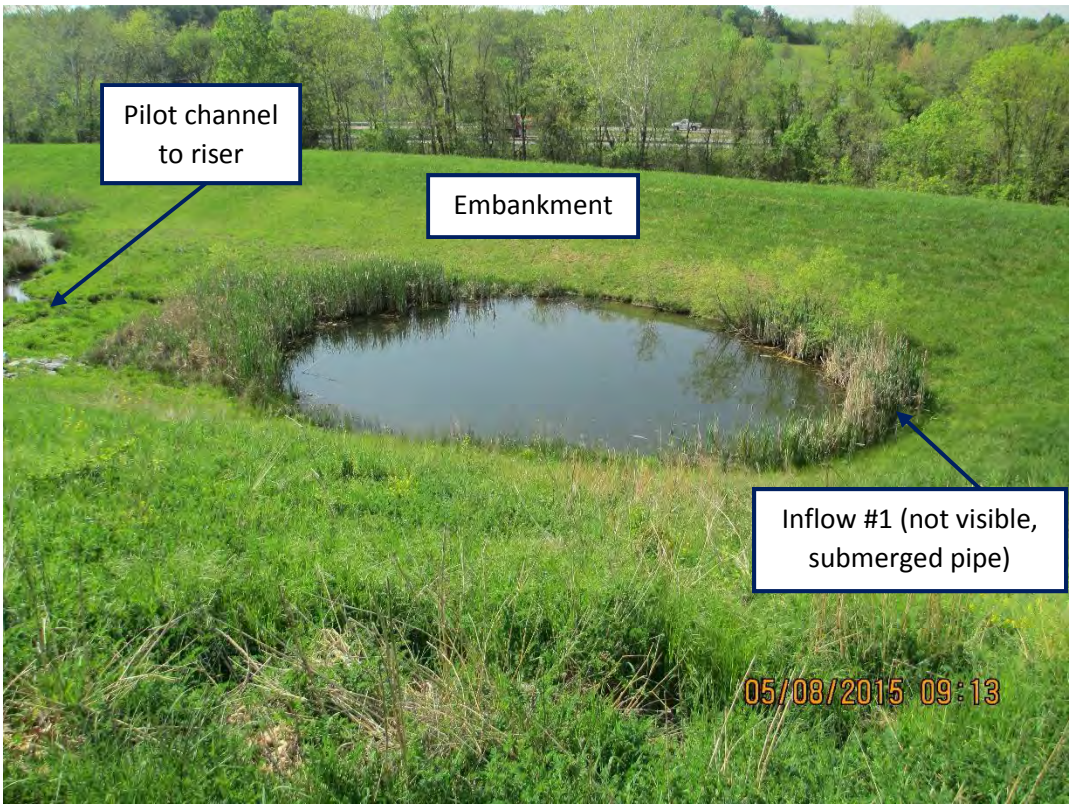


Photo 8: Forebay facing southeast

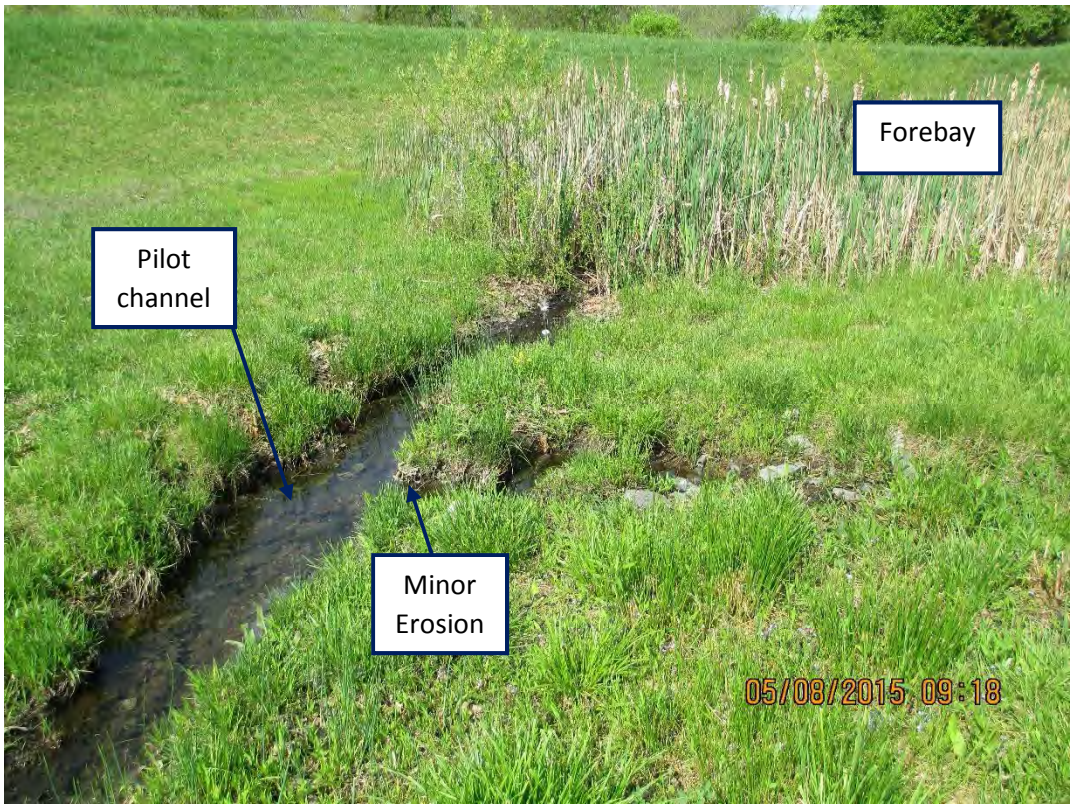


Photo 9: Pilot channel facing southwest

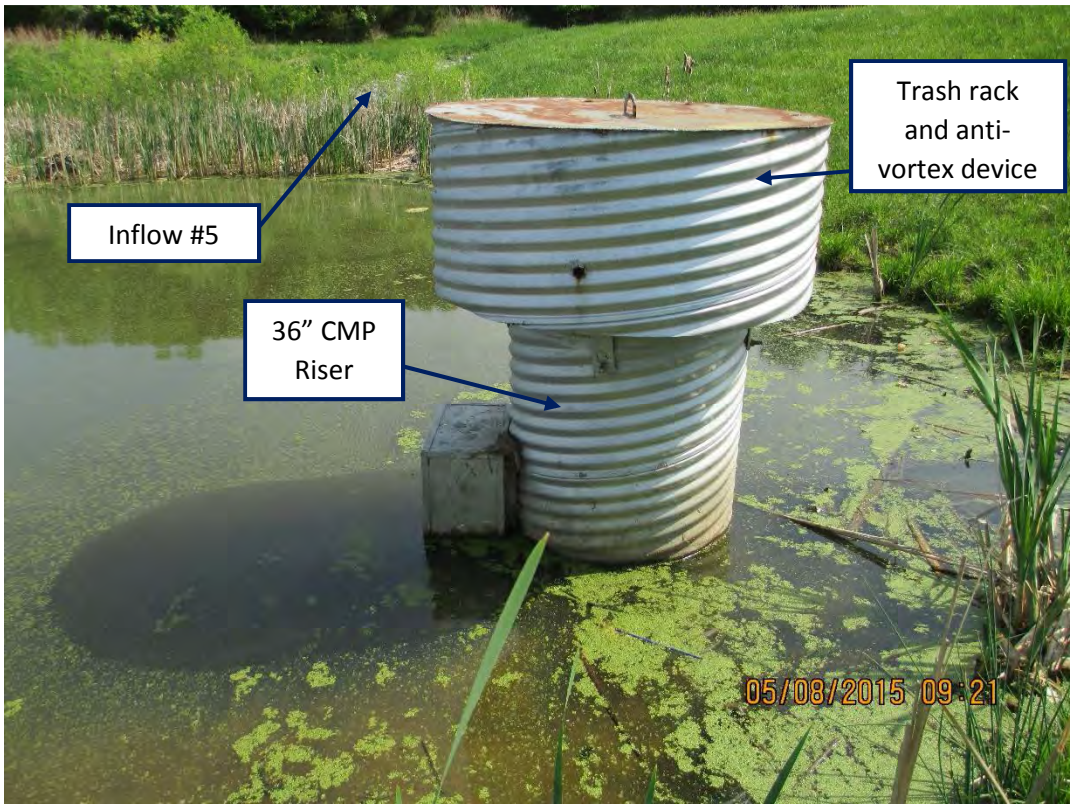


Photo 10: Riser facing north

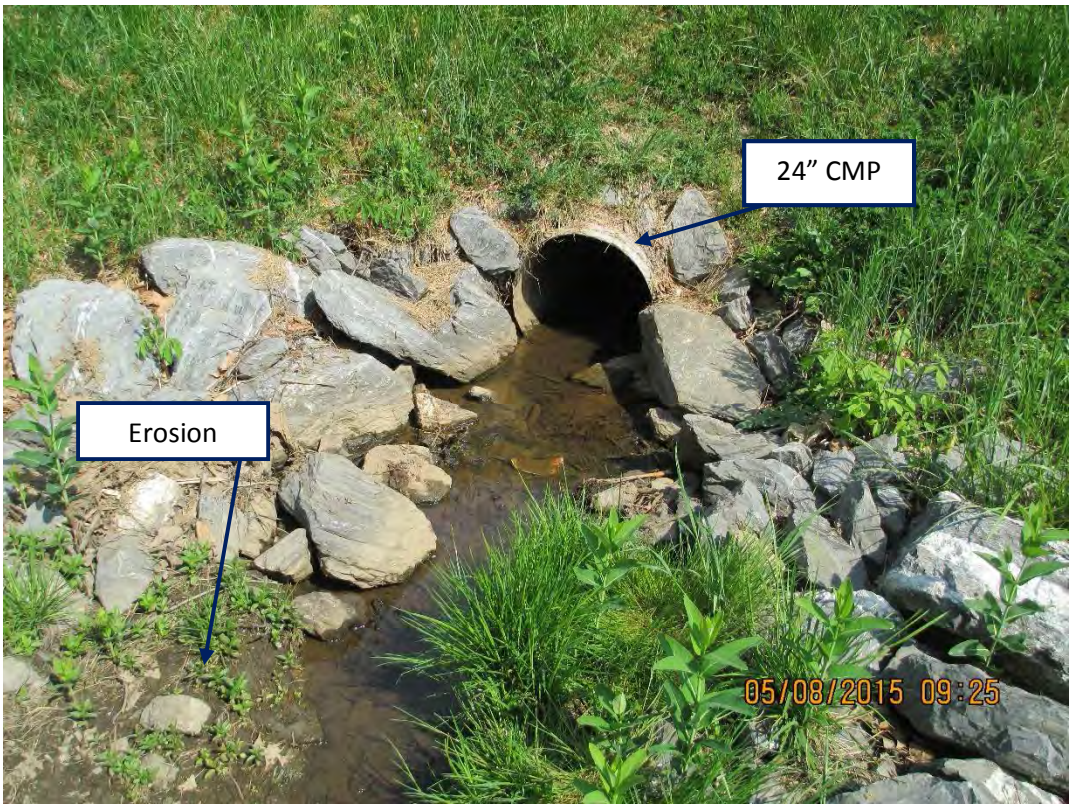


Photo 11: Principal outlet facing north

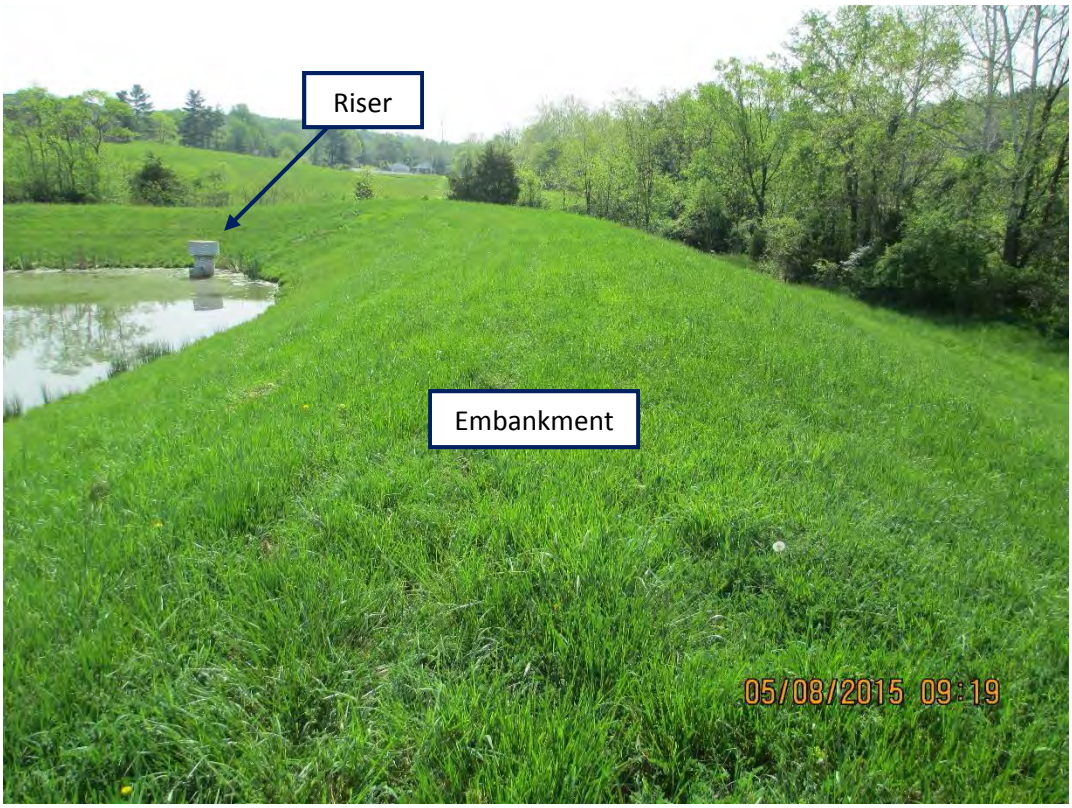


Photo 12: Embankment facing east

Photo 13: Downstream of outlet facing north

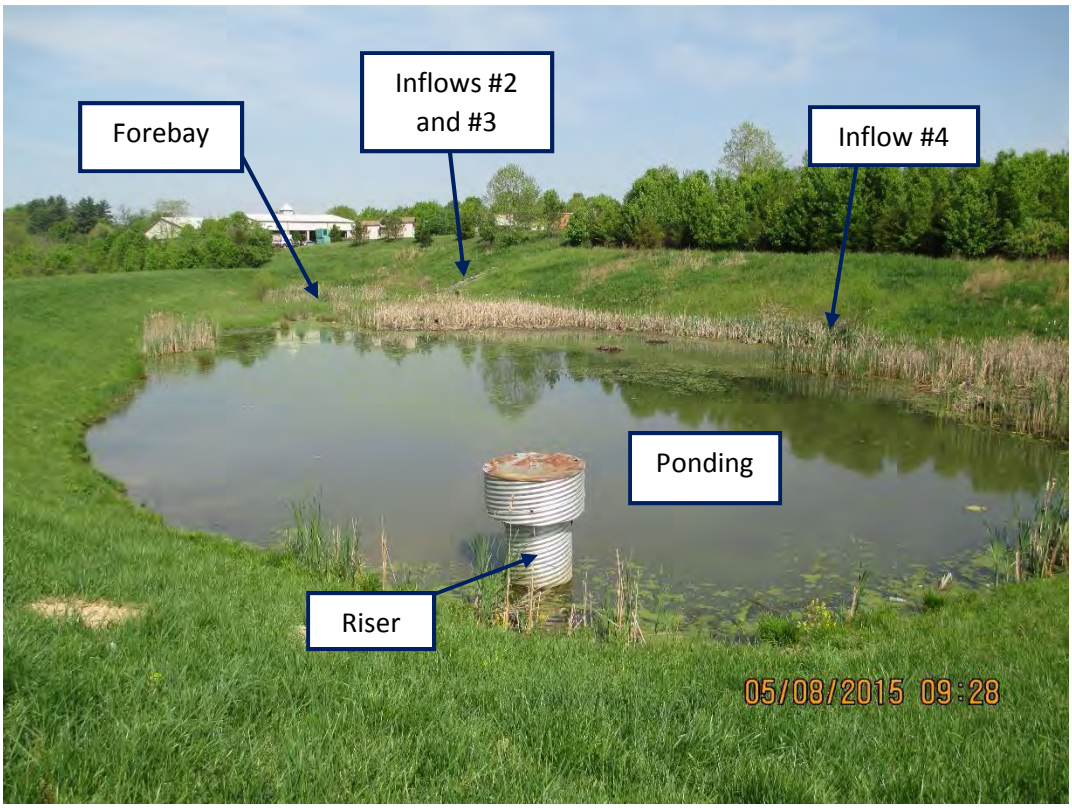
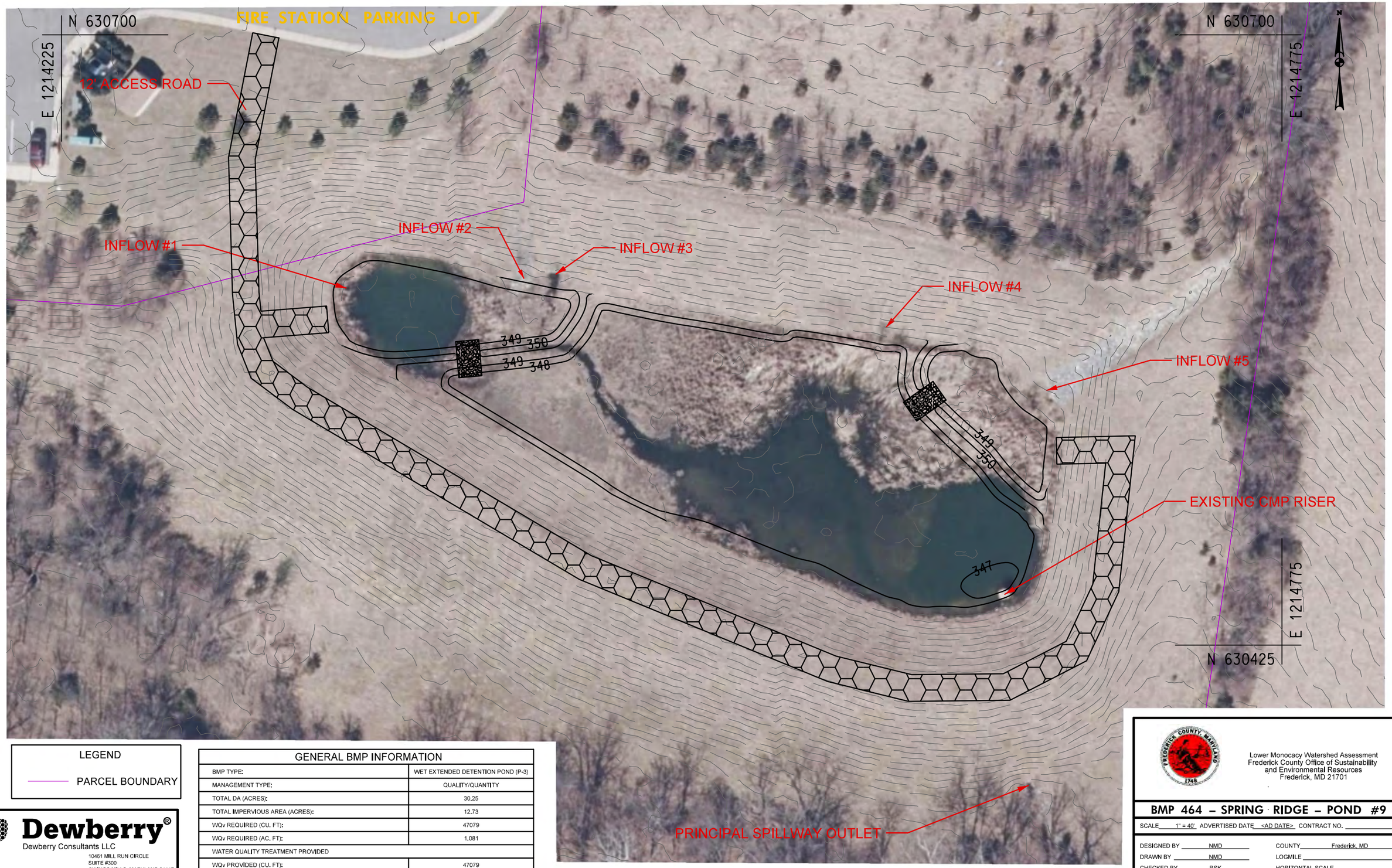


Photo 14: Overall BMP facing northwest



LEGEND

PARCEL BOUNDARY

GENERAL BMP INFORMATION	
BMP TYPE:	WET EXTENDED DETENTION POND (P-3)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	30.25
TOTAL IMPERVIOUS AREA (ACRES):	12.73
WQv REQUIRED (CU. FT):	47079
WQv REQUIRED (AC. FT):	1.081
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	47079
TOTAL TREATED DA (ACRES):	30.25
TOTAL TREATED IMPERVIOUS AREA (ACRES):	12.73

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: vhamsher -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP 464 – SPRING RIDGE – POND #9

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO. _____

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF - SHEET NO. - OF

PLOTTED: Wednesday, June 07, 2017 AT 11:22 AM
FILE: \\catoctn\Projects\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP464.dgn

WET EXTENDED DETENTION POND DESIGN (P-3): BMP 464

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Channel Protection Volume (CPv)	**Yes**	
4	Overbank Flood Protection Volume(Qp)	**Yes**	10-year peak control
5	Extreme Flood Volume(Qf)	**Yes**	See POI **#**

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**9/13/2015**
Watershed:	**Lower Linganore Creek**	As Built:	**10/1/1990**

Drainage Area: **30.25** **(Total)** Acres 0.047 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **12.73** Acres **I =** 0.421

= 42.1 %

Soil Type: **A, B, C, D**

RCN Existing : **93** **Existing tc =** **0.20** hr

RCN Post Development : **93** **Post-D tc =** **0.20** hr

Per Frederick County's Urban BMP Database

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): *Compute volumetric Runoff Coefficient(Rv)*

Rv =0.05+(0.009)I= 0.429

Step 1(b): *Rainfall Zone*

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)

1" per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): *Compute WQv*

Water quality required for I = 42.1 %

$WQ_{V(I)}$ = 1.081 ac-ft = 47079 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.504 ac-ft = 21961.5 cu.ft

Water quality treatment required =	**47079**	**cu.ft =**	**1.0808**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**47079**	**cu.ft =**	**1.0808**	ac-ft	
Sediment Forebay Volume Required=	**4708**	**cu.ft =**	**0.1081**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**42371**	**cu.ft =**	**0.9727**	ac-ft	
Elevation at the Top of WQv in pond =	**349.73**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_v distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	23539
II	50% of WQv is in micropool	23539
III	1/3 of WQv is in micropool & forebay	10985
IV	1/3 of WQv is in micropool & forebay	10985

*source: SHA SWM Workshop, April 30, 2003

Micropool storage volume required = **10985** **cu.ft =** **0.2522** **ac-ft**

Extended Detention Storage= **10985** cu.ft = Dead Storage Volume cu.ft

Extended Detention Elevation= **348.38** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice

Hence, WQrr = **0.13** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_O = \frac{WQrr}{4.81\sqrt{h_O}}$$

Assume h_o = **1.35** ft *Will change based on pond volume

Ao = 0.02 sf

Determine the required orifice diameter (d_o)

$$D_O = \sqrt{\frac{4\ A_O}{\pi}}$$

Do = 0.17 ft = **2.0** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ v = \frac{(S)(Rv)(A)}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**0.43**	1
B	**16.53**	55
C	**3.86**	13
D	**9.43**	31
Total	**30.25**	OK: sum of the areas matches site Area

Composite S: 0.1859 Use 18.59 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.201 ac-ft = **8751** cu.ft

Rev in Pond= **4043**

El of Rev= **347.58** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **2.366** Acres = 103077 sf

The Rev requirement may be met by:

a) treating 0.201 ac-ft using structural method,

b) treating 2.366 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	9/13/2015
Watershed:	Lower Linganore Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
280.0	**347.0**	0.01	0.00	0.00	0.00	0.00
18377.0	**348.0**	0.42	1.00	0.16	0.16	6975.13
20625.0	**349.0**	0.47	1.00	0.45	0.61	26465.32
23652.0	**350.0**	0.54	1.00	0.51	1.12	48586.56
		0.00	0.00	0.00	0.00	0.00

No. of valid row entries= 4

BMP #346 -HOLLY HILLS – SWM POND #2

Prioritization Ranking:	22
Planning Level Cost Estimate:	$ 631,873.00
Estimated Cost/Impervious Acre	$ 109,781.45

General BMP Information:		
Structure Location:	Broadmoor Terrace North/Ijamsville Road	
ADC Map:	4567, J9 (2008)	
Northing/Easting:	625,677.66/1,220,628.90	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Wet Extended Detention Pond (P-3)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	35.10	
Total Impervious Area (ac):	5.98	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	25907	
Total Treated Drainage Area (ac):	35.1	
Total Treated Impervious Area (ac):	5.98	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	276.56	101.17
TP (lbs/yr):	19.43	9.12
TSS (lbs/yr):	14653.84	9494.12

Existing conditions for BMP #346

Site map for BMP #346

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #346 has been identified as an extended detention dry pond and vegetative filter. The facility was constructed east of Ijamsville Road and north of Vista Ridge Court in Ijamsville. The BMP Database from the County indicates that the original design for BMP #346 provides management for quality and quantity and that the total treatment area for the BMP is 36 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 35.10 acres including 5.98 acres of impervious area. The majority of land use is within the drainage area is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from Ijamsville Road, Broadmoor Crossing, and Broadmoor Terrace. According to the County's parcel layer in GIS, BMP #346 was constructed in open space within a stormwater management, drainage, and access easement. MOT will be required to notify residents who utilize Ijamsville Road, Broadmoor Xing, and Broadmoor Terrace.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: MOT	

PROPOSED RETROFIT

The proposed retrofit for BMP #346 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 35.10 acres including 5.98 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating 1 foot below the existing pond to provide extended detention as shown in the Concept Plans.

BMP # 346 – HOLLY HILLS – SWM POND #2

Storm Water Management Retrofit Evaluation					
Report Date:	8/25/2015	**Design Approval:**	2/22/1994	**Maintenance Owner:**	Richmarr Holly Hills, Inc.
Structure No:	346	**Year Constructed:**	2/27/1997	**Inspection Date:**	6/11/2015
Structure Name:	Holly Hills - SWM Pond #2	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, GL
Location:	Broadmoor Terrace North/Ijamsville Road	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/8/2015 (0.38")
ADC Map:	4567, J9 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	625,677.66/1,220,628.90	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Extended Detention Dry Pond & Vegetative Filter		Wet Extended Detention Pond (P-3)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity/Quality		Quality/Quantity		
Total Drainage Area (acres):	36		35.10		
Total Impervious Area within Drainage Area (acres):	Unknown		5.98		
WQv Required:	Unknown		25907	cu. ft.	0.595 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	Yes		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	25907	cu. ft.	0.595 ac-ft
Total Treated Drainage Area (acres):	36	0	35.1		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	5.98		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.19		
Total Nitrogen:			36.49%		
Total Phosphorus:			57.34%		
Sediment:			72.98%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		276.56		101.17
TP (lbs/yr):	0		19.43		9.12
TSS (lbs/yr):	0		14653.84		9494.12
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):					**$ 631,873.00**

BMP # 346 – HOLLY HILLS – SWM POND #2

Existing Site Conditions:

SWM Era: 1985-2002

According to Frederick County's Urban BMP Database, BMP #346 has been identified as an extended detention dry pond and vegetative filter. A vegetative filter is a wide, flat grass shoulder or a trapezoidal grass swale conveying drainage to the pond. The facility was constructed east of Ijamsville Road and north of Vista Ridge Court in Ijamsville as shown in the BMP Location map (**Figure 1**). The BMP Database from the County indicates that the original design for BMP #346 provides management for quality and quantity and that the total treatment area for the BMP is 36 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 35.10 acres including 5.98 acres of impervious area. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. The Urban BMP Database indicates that the facility has the following features: a 4" extended detention orifice, 2'-6" weir, and a CMP outfall. The majority of land use is within the drainage area is residential.

General Observations:

A site visit was conducted on June 11th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has unmapped storm drain inflows. Inflow #1 is an unmapped 24" RCP storm drain with an end section and rip rap channel south of the BMP **(Photo 1)**. This storm drain conveys drainage from Vista Ridge Court into the BMP. Inflow #1 is in good condition, with overgrown vegetation and accumulated debris in the downstream rip rap channel **(Photo 2)**.

Inflow #2 is a channel east of the BMP that conveys drainage from the surrounding residential areas which drain via an unmapped closed system. The exact locations of additional storm drain inflows to BMP #346 are unknown. Storm drain outlets could not be located due to dense vegetation east of the BMP.

Control Structure and Spillways:

Outflow from the extended detention dry pond is controlled via a concrete riser with a 4" extended detention orifice and 2'-6" rectangular orifice within the concrete riser **(Photo 3).** The low flow orifice had water flowing through it during the site visit **(Photo 4).** In addition, the rectangular orifice with trash rack was blocked with vegetation and tree debris **(Photo 4).** There is some evidence of corrosion on the trash rack, but overall the riser and trash rack appear to be in good condition despite the vegetation blockage **(Photo 5).**

This facility includes an emergency spillway southwest of the control **(Photo 6).** The emergency spillway appears to be in good condition.

Embankment:

A fill embankment is present along the west side of the facility over the principal spillway **(Photo 7).** Both the upstream and downstream sides of the embankment are mowed. However, there is woody vegetation growing within 15 feet of the upstream and downstream sides of the embankment. Overall the embankment is in good condition. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

The Urban BMP Database indicates the extended detention dry pond outlets via a CMP barrel. The principal spillway has evidence of corrosion within the concrete riser structure **(Photo 8).** The area downstream of the principal spillway is overgrown with vegetation **(Photo 9).** Outflow from the CMP principal spillway drains into a culvert under Ijamsville Road that outlets to an unnamed creek per the aerial imagery.

Overall BMP:

Overall, the BMP is not functioning as designed due to ponding water and the blocked weir at the concrete riser structure. The remaining unmapped storm drain inflows could not be located due to overgrown vegetation around the pond. The control structure requires maintenance to clear the debris blockage. Landscaping plans were not available for this BMP; therefore, it is unknown if the vegetation within the BMP is planted. Moderate problems are observed, and the facility is not functioning as designed with no critical parameters but with some problem conditions. BMP performance is being compromised.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from Ijamsville Road, Broadmoor Crossing, and Broadmoor Terrace. According to the County's parcel layer in GIS, BMP #346 was constructed in open space within a stormwater management, drainage, and access easement. Easements at this location should be evaluated further in final design. MOT will be required to notify residents who utilize Ijamsville Road, Broadmoor Xing, and Broadmoor Terrace**.**

Proposed Retrofit:

BMP #346 was originally designed as an extended detention dry pond & vegetative filter. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #346 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 35.10 acres including 5.98 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating 1 foot below the existing pond to provide extended detention as shown in the **Concept Plans**. The surrounding land use is residential and the proposed wet extended detention pond has a depth of 3', therefore, a fence surrounding the facility is recommended.

Step 1: Watershed Factors

BMP #346 is located in Frederick County's Lower Linganore Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #346 due to the downstream coldwater stream conditions. For the retrofit of BMP #346, 100% of the WQv can be treated within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek designated as a Use IV-P Stream.

Step 2: Terrain Factors

BMP #346 is not located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for retrofit design for BMP #346.

Step 3: Stormwater Treatment Suitability

The proposed retrofit maintains the existing permanent p0ol elevation (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. Maintenance to remove the debris from the existing control structure is required. The invert elevation of the existing control structure is unknown due to unavailability of plans. There is adequate space for the proposed retrofit within the existing BMP boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a wet extended detention pond is 25 acres. The proposed drainage area to BMP #346 is 35.10 acres and is composed of B and D soils. The likelihood of BMP #346 receiving hotspot runoff is low as it is located within a residential community. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban. Retrofitting the existing BMP into a wet extended detention pond is feasible at this location per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP #346 is located east of Ijamsville Road and north of Vista Ridge Court and has high visibility. Wet extended detention ponds tend to have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide high habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #346 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

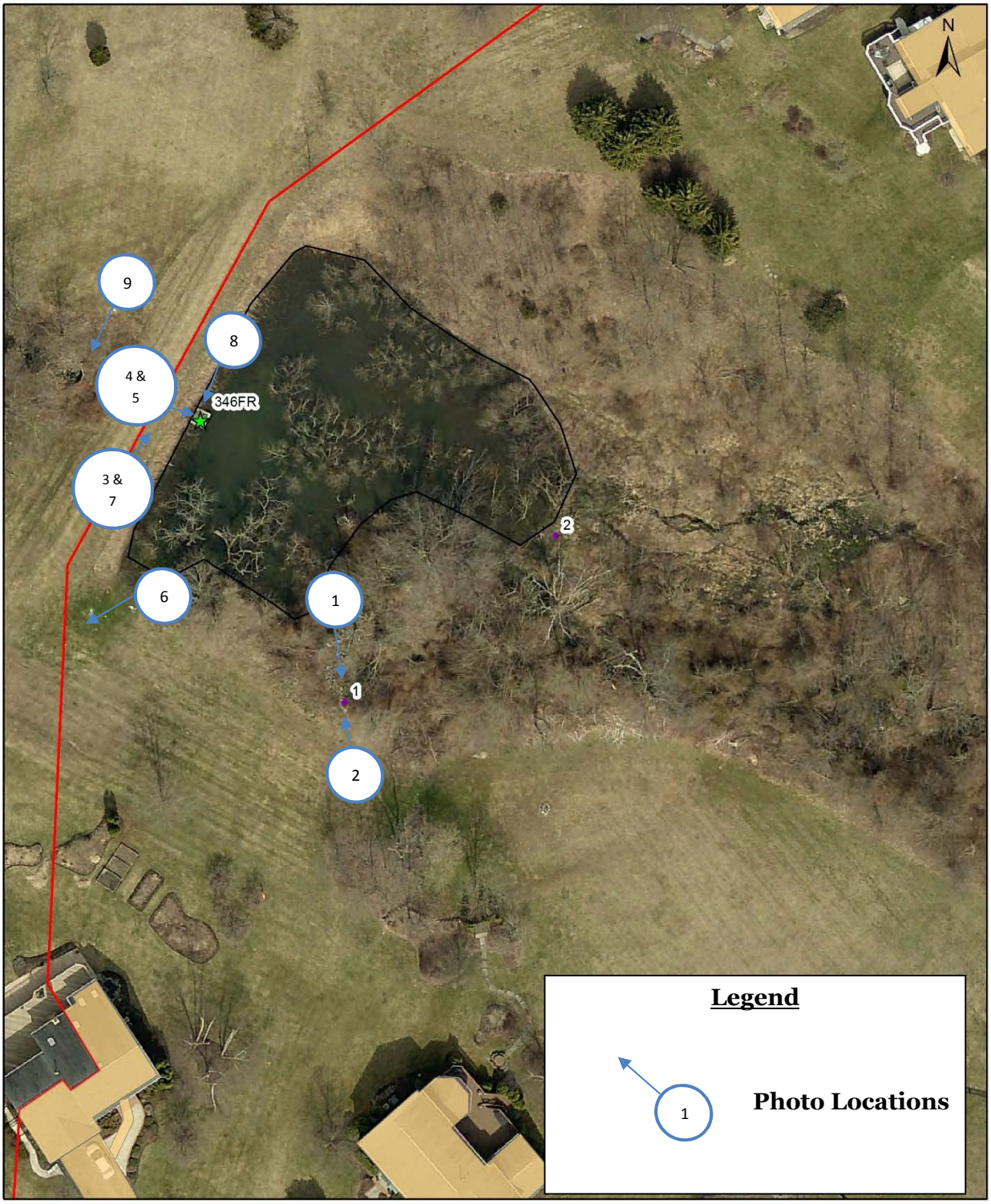


Figure 2: Photo Locations

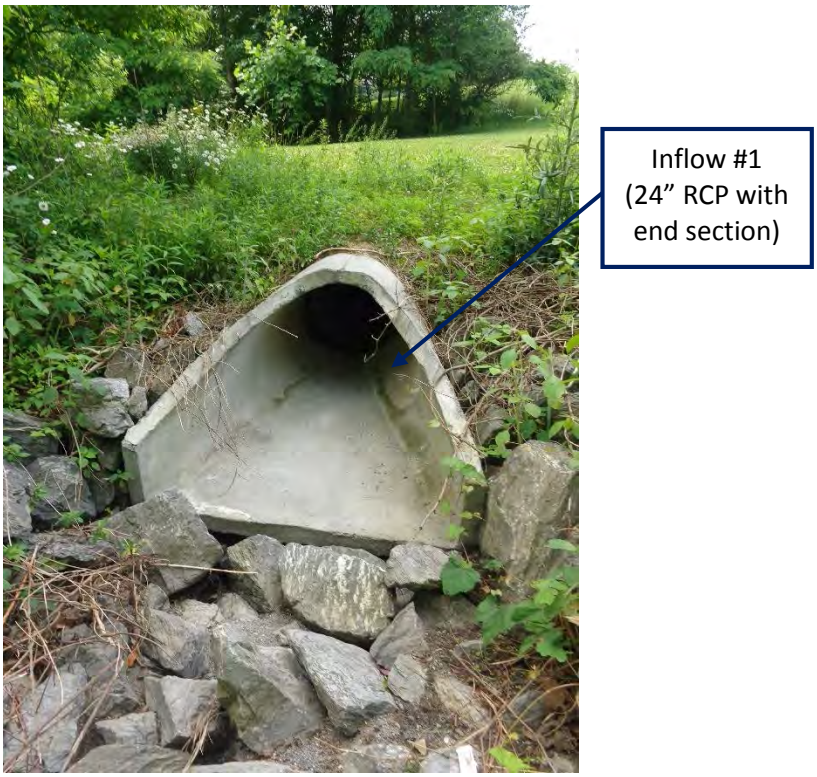


Photo 1: Inflows #1 facing southwest

Photo 2: Downstream of Inflow #1 facing northwest

Photo 3: Concrete Riser facing northeast

Photo 4: Interior of Concrete Riser facing east

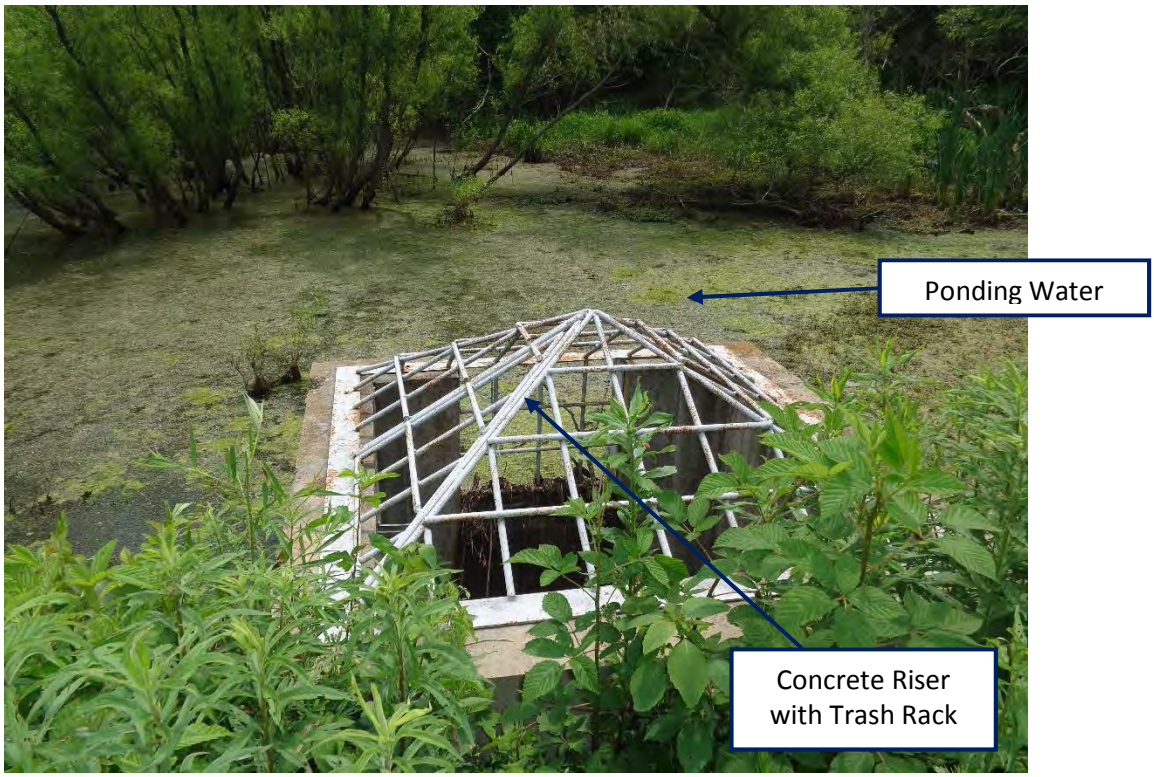


Photo 5: Overall BMP facing east

Photo 6: Emergency Spillway facing southwest

Photo 7: Fill Embankment facing northeast

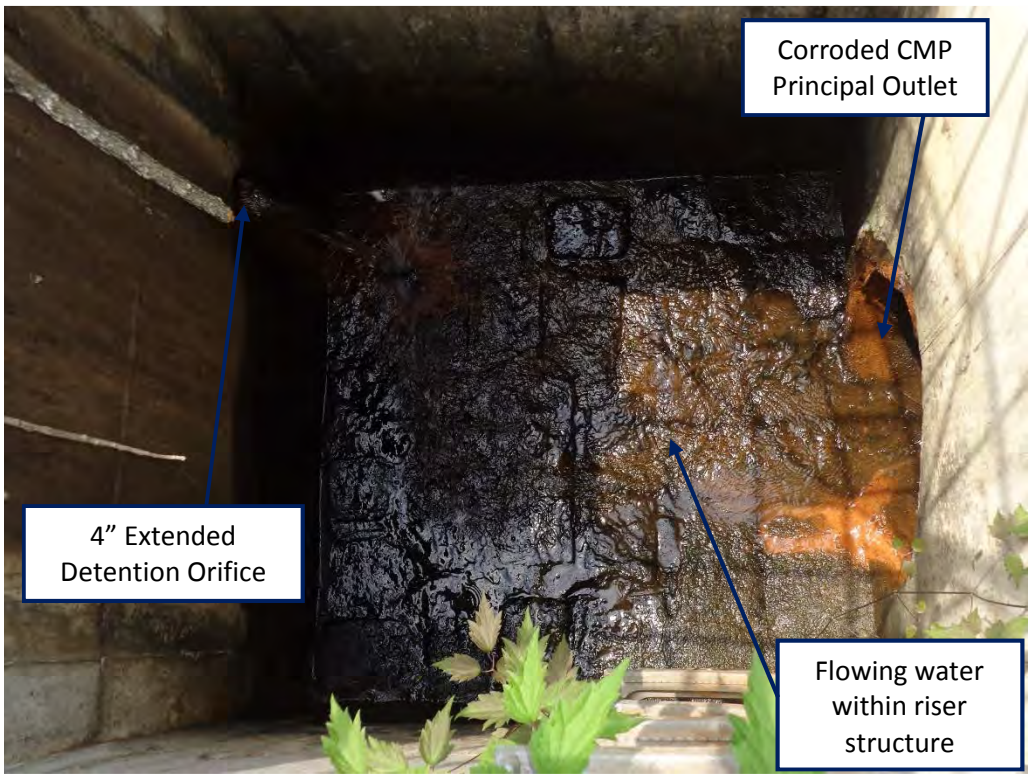


Photo 8: Interior of Concrete Riser facing south

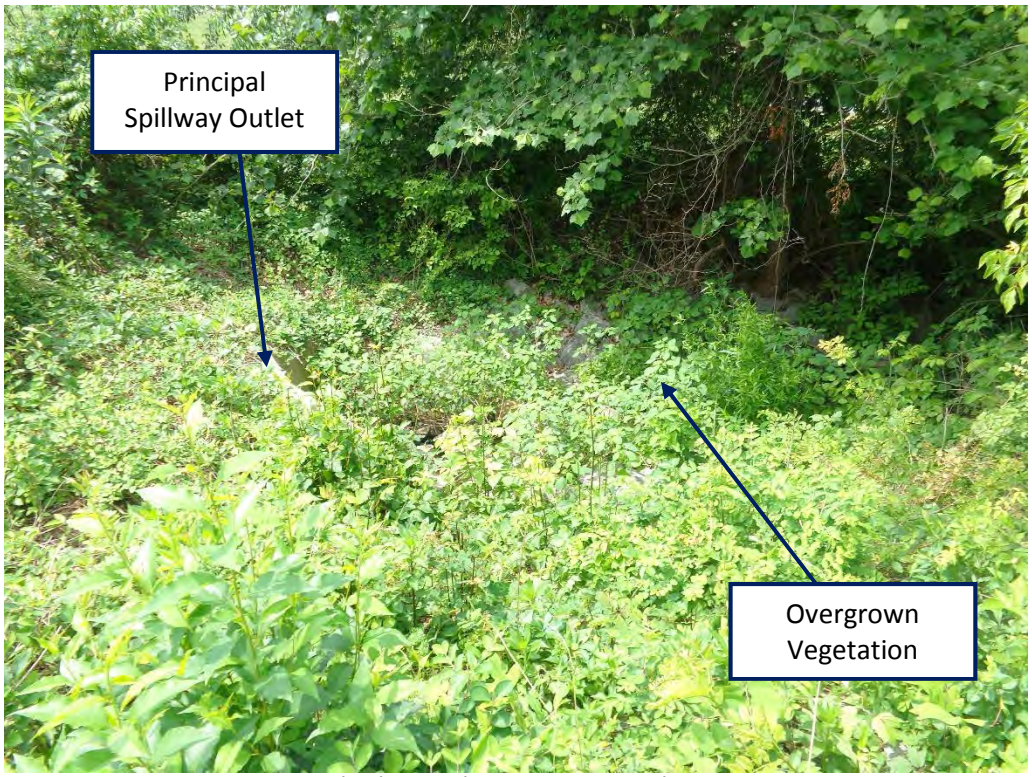


Photo 9: Principal Spillway Outlet facing southwest

GENERAL BMP INFORMATION	
BMP TYPE:	WET EXTENDED DETENTION POND (P-3)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	35.1
TOTAL IMPERVIOUS AREA (ACRES):	5.98
WQv REQUIRED (CU. FT):	25907
WQv REQUIRED (AC. FT):	0.595
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	25907
TOTAL TREATED DA (ACRES):	35.1
TOTAL TREATED IMPERVIOUS AREA (ACRES):	5.98

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndriskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #346 – HOLLY HILLS – SWM POND #2

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. - OF ##
SHEET NO. OF

PLOTTED: Tuesday, June 20, 2017 AT 01:08 PM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP346.dgn

WET EXTENDED DETENTION POND DESIGN (P-3): BMP 346

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**9/3/2015**
Watershed:	**Lower Linganore Creek**	As Built:	**2/27/1997**

Drainage Area: **35.10** **(Total)** Acres 0.055 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **5.98** Acres **I =** 0.170

= 17.0 %

Soil Type: **B, D**

RCN Existing : **70** **Existing tc =** **0.30** hr

RCN Post Development : **70** **Post-D tc =** **0.30** hr

Per Frederick County's Urban BMP Database

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.203

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)
1" per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 17.0 %

$WQ_{V(I)}$ = 0.595 ac-ft = 25907 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.585 ac-ft = 25482.6 cu.ft

Water quality treatment required =	**25907**	**cu.ft**	**=**	**0.5947**	ac-ft
WQv provided by other practices =	**0**	**cu.ft**	**=**	**0.0000**	ac-ft
Net water quality treatment required =	**25907**	**cu.ft**	**=**	**0.5947**	ac-ft
Sediment Forebay Volume Required=	**2591**	**cu.ft**	**=**	**0.0595**	ac-ft
WQv in pond =	**23316**	**cu.ft**	**=**	**0.5353**	ac-ft
Elevation at the Top of WQv in pond =	**450.61**	**ft**			

Forebay Volume = 0.1" runoff

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	12954
II	50% of WQv is in micropool	12954
III	1/3 of WQv is in micropool & forebay	6045
IV	1/3 of WQv is in micropool & forebay	6045

***source: SHA SWM Workshop, April 30, 2003**

Micropool storage volume required = **6045** **cu.ft** **=** **0.1388** **ac-ft**

Extended Detention Storage= **6045** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **448.76** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.07** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_o = \frac{WQrr}{4.81\sqrt{h_o}}$$

Assume h_o = **1.85** ft *Will change based on pond volume

Ao = 0.01 sf

Determine the required orifice diameter (d_o)

$$D_o = \sqrt{\frac{4\ A_o}{}}$$

Do = 0.12 ft = **1.4** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**0.00**	0
B	**20.22**	58
C	**0.00**	0
D	**14.88**	42
Total	**35.10**	OK: sum of the areas matches site Area

Composite S: 0.1795 Use 17.95 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.107 ac-ft = **4649** cu.ft

Rev in Pond= **2058**

El of Rev= **448.26** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **1.073** Acres = 46745 sf

The Rev requirement may be met by:

a) treating 0.107 ac-ft using structural method,

b) treating 1.073 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	9/3/2015
Watershed:	Lower Linganore Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
7482.0	**448.0**	0.17	0.00	0.00	0.00	0.00
8572.0	**449.0**	0.20	1.00	0.18	0.18	8020.83
9725.0	**450.0**	0.22	1.00	0.21	0.39	17163.26
10943.0	**451.0**	0.25	1.00	0.24	0.63	27491.28

No. of valid row entries= 4

BMP #227 -THE FAIRWAYS AT HOLLY HILLS, POND #3

Prioritization Ranking:	23
Planning Level Cost Estimate:	$ 1,081,135.00
Estimated Cost/Impervious Acre	$ 107,354.86

General BMP Information:		
Structure Location:	To left off Mahogany Ct. at Ijamsville Road	
ADC Map:	4567, J10 (2008)	
Northing/Easting:	623,507.49/1,220,999.70	
NPDES Watershed:	Lower Bush Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Wet Extended Detention Pond (P-3)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	39.40	
Total Impervious Area (ac):	10.30	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	40801	
Total Treated Drainage Area (ac):	39.40	
Total Treated Impervious Area (ac):	10.30	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	315.56	204.78
TP (lbs/yr):	26.03	12.21
TSS (lbs/yr):	13314.59	8626.44

Existing conditions for BMP #227

Site map for BMP #227

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #227 has been identified as an extended detention dry pond. The facility was constructed north of Mahogany Run and east of Ijamsville Road. The BMP Database from the County indicates that the original design for BMP #227 provides management for quantity and quality and that the total treatment area for the BMP is 39.7 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 39.40 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from Ijamsville Road or a sidewalk off the north side of Mahogany Run. According to the County's parcel layer in GIS, BMP #227 was constructed on open space dedicated to a stormwater management easement and access to the BMP from Ijamsville Road is via a stormwater management easement. MOT will be required to notify residents who utilize Ijamsville Road.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: MOT	

PROPOSED RETROFIT

The proposed retrofit for BMP #227 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 39.40 acres including 10.30 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating approximately 2 foot below the existing BMP bottom elevation for extended detention as shown in the Concept Plans.

BMP # 227 – THE FAIRWAYS AT HOLLY HILLS, POND #3

Storm Water Management Retrofit Evaluation					
Report Date:	8/25/2015	**Design Approval:**	9/6/1995	**Maintenance Owner:**	HollyHills HOA - c/o: Richmarr Holly Hills Inc.
Structure No:	227	**Year Constructed:**	10/1/1997	**Inspection Date:**	6/11/2015
Structure Name:	The Fairways at Holly Hills, Pond #3	**NPDES Watershed:**	Lower Bush Creek	**Inspection Team:**	ND, GL
Location:	To left off Mahogany Ct. at Ijamsville Road	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/8/2015 (0.38")
ADC Map:	4567, J10 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	623,507.49/1,220,999.70	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Extended Detention Dry Pond		Wet Extended Detention Pond (P-3)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity/Quality		Quality/Quantity		
Total Drainage Area (acres):	39.7		39.40		
Total Impervious Area within Drainage Area (acres):	Unknown		10.30		
WQv Required:	Unknown		40801	cu. ft.	0.937 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	No		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	40801	cu. ft.	0.937 ac-ft
Total Treated Drainage Area (acres):	39.7	0	39.40		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	10.30		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.09		
Total Nitrogen:			35.75%		
Total Phosphorus:			56.18%		
Sediment:			71.51%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		315.56		204.78
TP (lbs/yr):	0		26.03		12.21
TSS (lbs/yr):	0		13314.59		8626.44
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):					**$ 1,081,135.00**

BMP # 227 – THE FAIRWAYS AT HOLLY HILLS, POND #3

Existing Site Conditions:

SWM Era: 1985-2002

According to Frederick County's Urban BMP Database, BMP #227 has been identified as an extended detention dry pond. The facility was constructed north of Mahogany Run and east of Ijamsville Road as shown in the BMP Location map **(Figure 1)**. The BMP Database from the County indicates that the original design for BMP #227 provides management for quantity and quality and that the total treatment area for the BMP is 39.7 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 39.40 acres. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. According the GIS Pipes layer provided by the County, this facility has one inflow: a mapped 36" CMP from the south. The Urban BMP Database states the control structures for the facility are a 4" PVC orifice, a 1.5' weir, and a 27" RCP barrel. This BMP is an in-stream facility. The majority of land use is residential.

General Observations:

A site visit was conducted on June 11th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has six inflow points which all come from closed sections. According to field observations, Inflow #1 is a 10" plastic storm drain from the south that is unmapped on the GIS Pipes layer provided by the County **(Photo 1)**. Inflow #1 appears to be in good condition. Inflow #2 is a 36" CMP with an end section from the south **(Photo 2)**. Flow from Inflow #2 combines with Inflow #1 in a riprap channel **(Photo 3 and 4)**. The riprap channel is overgrown with vegetation, but otherwise, Inflow #2 is in good condition. Inflow #3 is a 15" CMP from the north that is unmapped on the GIS Pipes layer **(Photo 5)**. Inflow #3 flows into a riprap channel that is overgrown with cattails. Inflow #4 is an unmapped 8" PVC pipe from the north that drains to a grass channel. There is accumulated sediment, excess vegetation, and riprap outfall protection is not installed to provide outfall stability and positive drainage **(Photo 6)**. Inflow #5 is an unmapped 8" PVC pipe from the northeast that drains to a grass channel **(Photos 7 and 8)**. This inflow is not graded to provide positive drainage into the facility, causing approximately 5" of ponding. Inflow #6 is an unnamed stream with dense vegetation present in the stream channel **(Photos 4 and 8)**. The stream was dry at the time of the site visit.

Pretreatment:

This facility does not have a forebay or pretreatment section.

Control Structure and Spillways:

The control structure is as reported in the Urban BMP database except that the low flow orifice is a vertical perforated pipe that was measured to be 5" instead of 4" and the weir is a 1.5' x 1.5' rectangular orifice **(Photo 12, 13, 14, and 15)**. The control structure is in good condition.

The emergency spillway is located on the south side of the embankment and appears to be in good condition **(Photo 16).**

Embankment:

A fill embankment is present between the dry detention pond and principal outlet on the southwest side of the facility. The embankment is fully covered by grass and has been mowed **(Photo 16).** Overall the embankment appears to be in good condition. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

The principal spillway of the dry pond is an unmapped 27" RCP **(Photo 17)**. Flow travels from east to west through the RCP. After the flow exits the principal spillway on the downstream side of the embankment, it flows into a riprap channel towards Ijamsville Road. The flow then enters a culvert that goes under Ijamsville Road and outfalls into a pond on private property.

The riprap channel between the principal spillway and Ijamsville Road is overgrown with vegetation **(Photo 18)**. Erosion has occurred near the outfall of the principal spillway and there is 2" of ponding at the outfall of the principal spillway **(Photo 17)**.

Overall BMP:

Sediment accumulation, overgrown vegetation, and ponding are present at several inflows. Minor problems were observed, however, the BMP is functioning as designed with no critical parameters but with some problem conditions.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from Ijamsville Road or a sidewalk off the north side of Mahogany Run. According to the County's parcel layer in GIS, BMP #227 was constructed on open space dedicated to a stormwater management easement and access to the BMP from Ijamsville Road is via a stormwater management easement. Easements at this location should be evaluated further in final design. MOT will be required to notify residents who utilize Ijamsville Road.

Proposed Retrofit:

BMP #227 was originally designed as an extended detention dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #227 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 39.40 acres including 10.30 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 2 feet below the existing BMP bottom elevation for extended detention as shown in the **Concept Plans**.

Step 1: Watershed Factors

BMP #227 is located in Frederick County's Lower Bush Creek which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #227 due to the downstream coldwater conditions. For the retrofit of BMP #227, 100% of the WQv can be stored within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek.

Step 2: Terrain Factors

BMP #227 is not located in in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for retrofit design to BMP #227.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to the unavailability of plans. Since the downstream channel is in stable condition, there are no erosion or safety concerns and additional water quantity management is not required. There is adequate space for the proposed retrofit within the existing stormwater management easement. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a wet extended detention pond is 25 acres. The proposed drainage area to BMP #227 is 39.40 acres and is composed of B and C soils. The likelihood of BMP #227 receiving hotspot runoff is low as it is located within a residential community. The land use within the drainage area to the BMP is not ultra-urban.

Step 5: Community and Environmental Factors

BMP #227 is located east of Ijamsville Road and north of Mahogany Run and has high visibility. Wet extended detention ponds tend to have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide high habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #227 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Flood Insurance Map FM24021C0315D indicates that the BMP is not within the FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is not mapped as a wetland. Frederick County's Stream GIS layer indicates BMP #227 is an in-stream facility; therefore, it requires additional environmental factor and permitting consideration for final design.

Figure 1: BMP Location Map – Existing Conditions

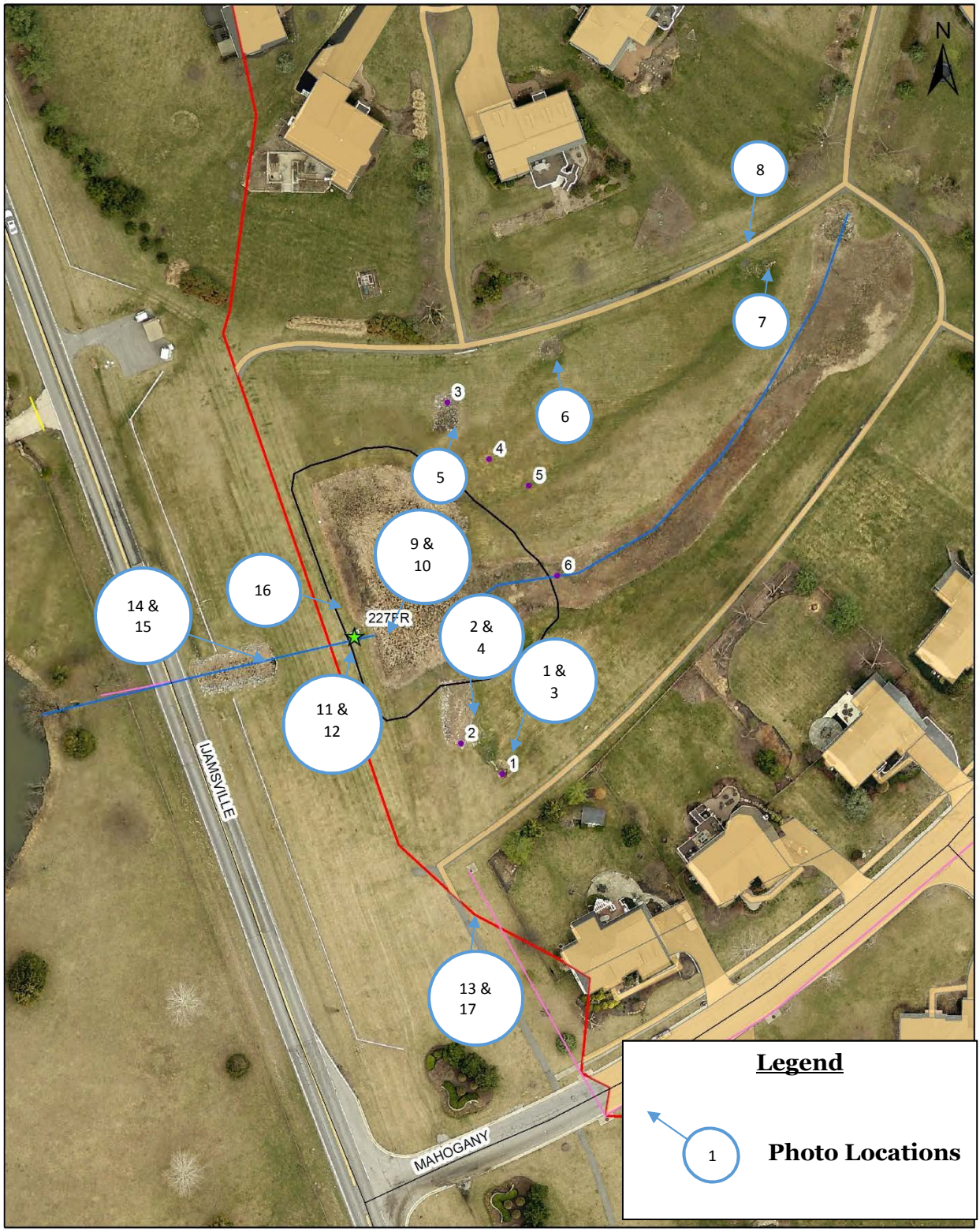


Figure 2: Photo Locations

Photo 1: Inflow #1 facing south

Photo 2: Inflow #2 facing south

Photo 3: Riprap channel from Inflow #1 facing northwest

Photo 4: Riprap channel from Inflows #1 and #2 facing north

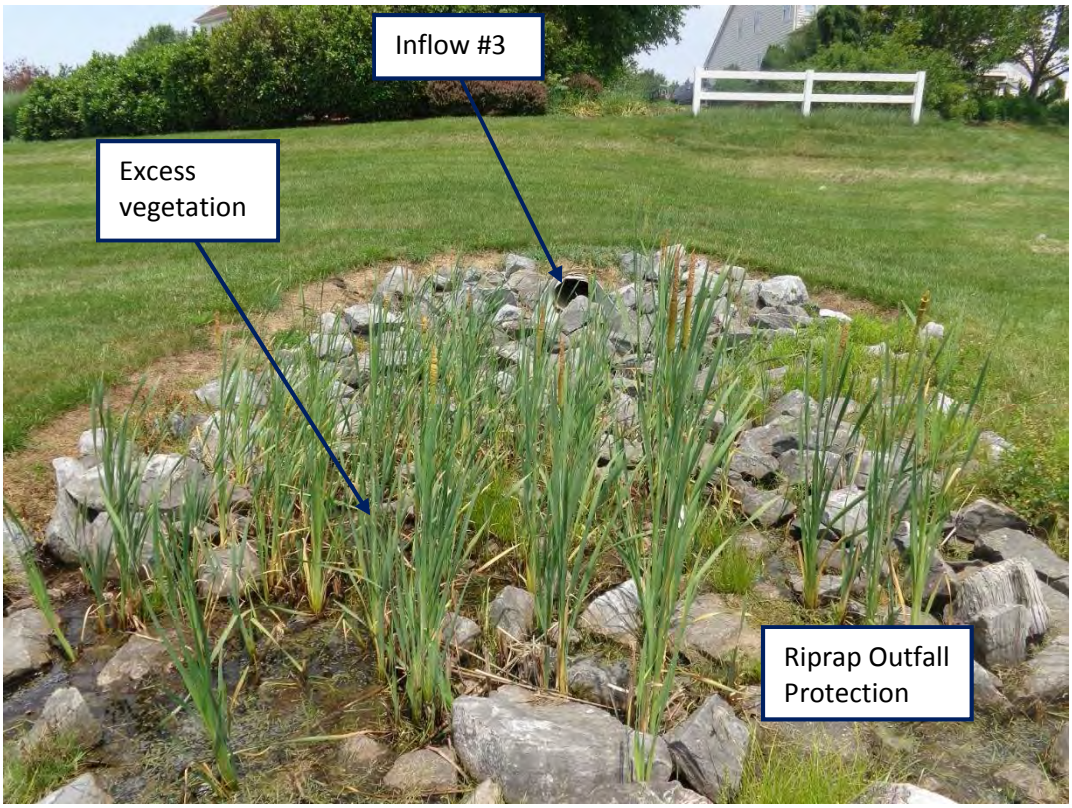


Photo 5: Inflow #3 facing north

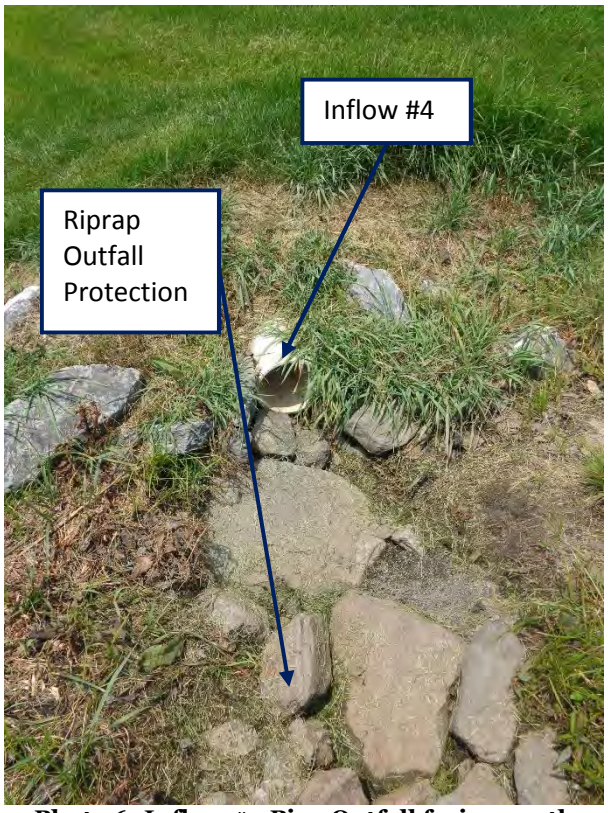


Photo 6: Inflow #4 Pipe Outfall facing north

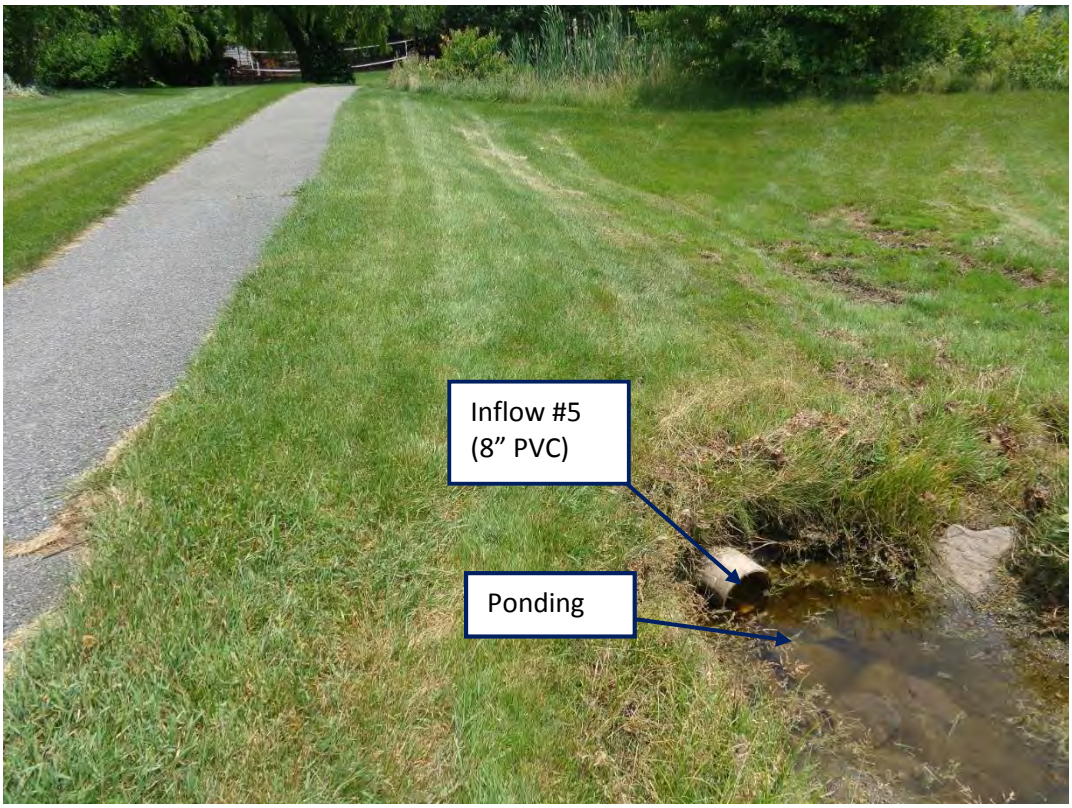


Photo 7: Inflow #5 Pipe Outfall facing east

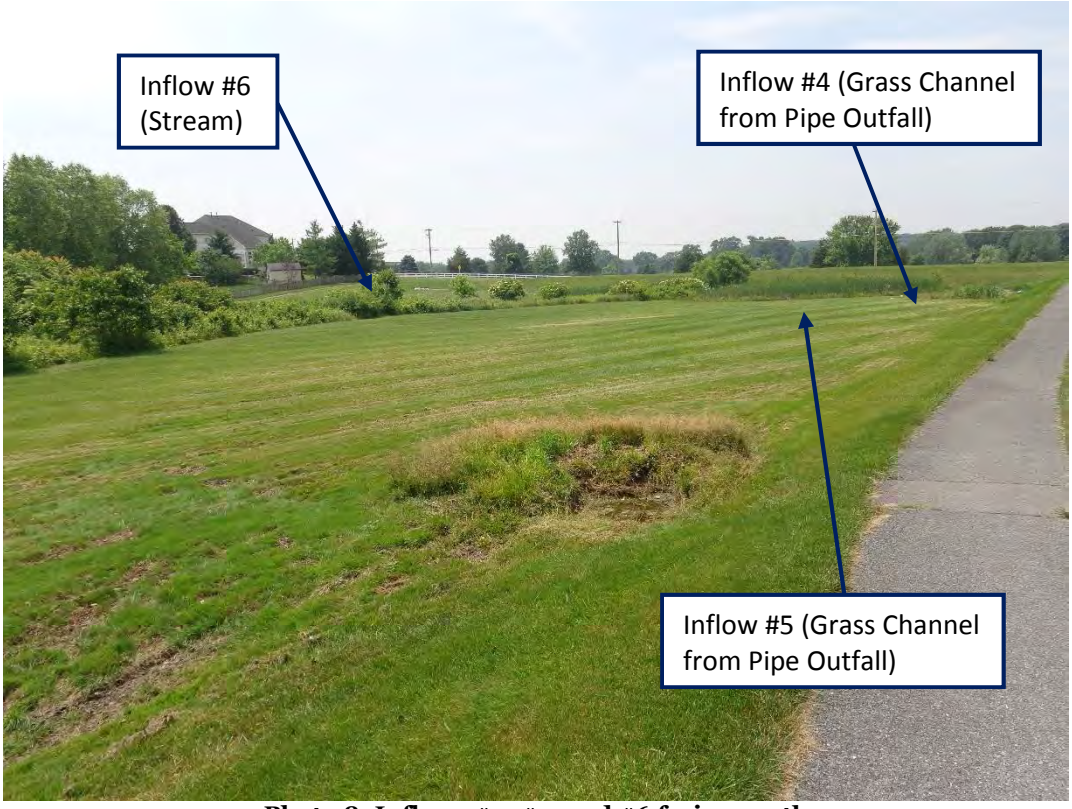


Photo 8: Inflows #4, #5, and #6 facing south

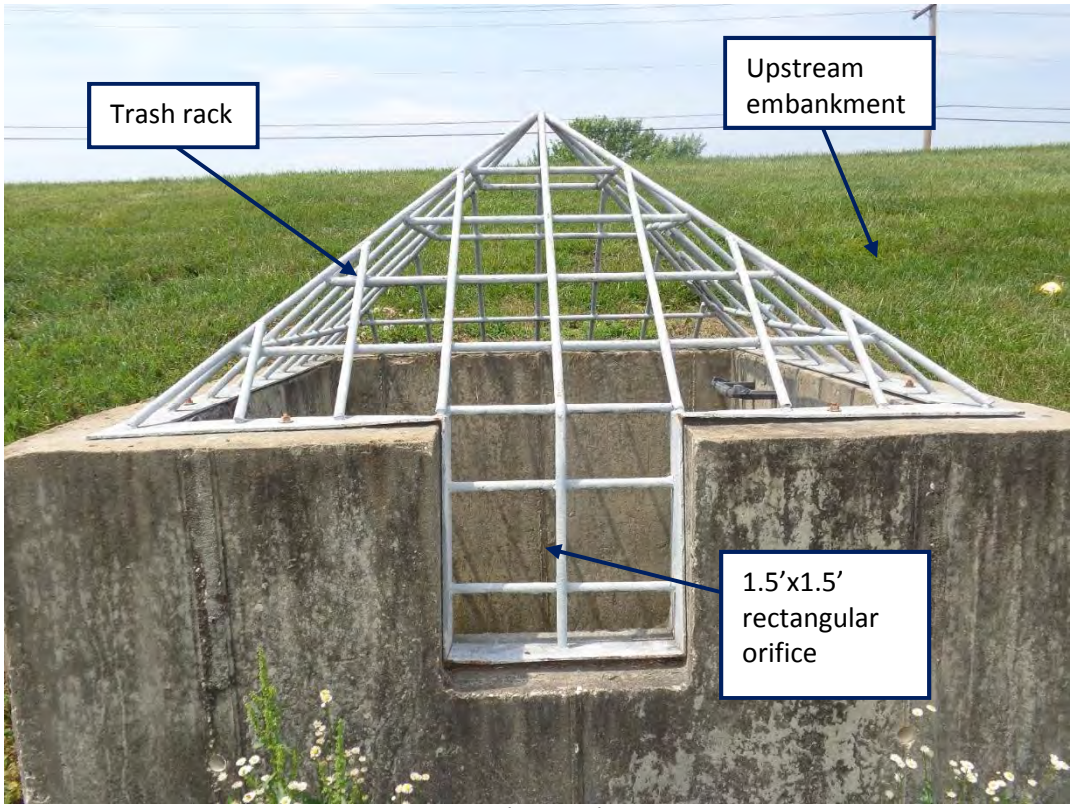


Photo 9: Riser facing west

Photo 10: Inside riser facing west

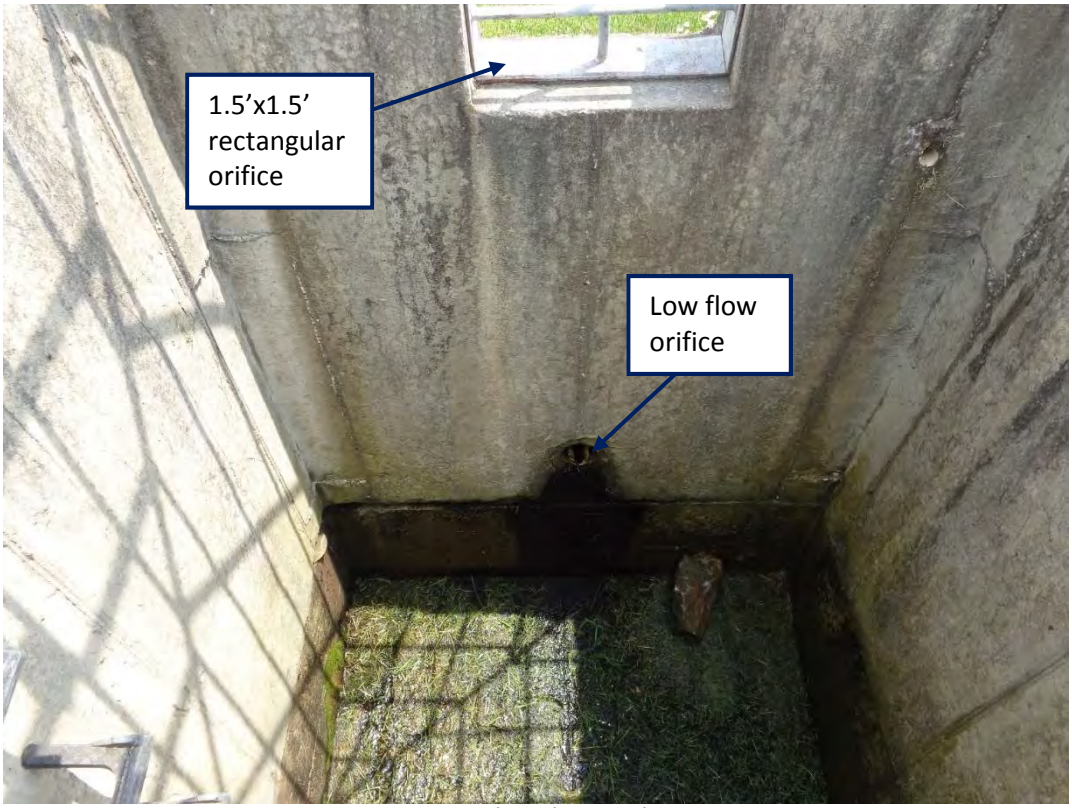


Photo 11: Inside riser facing east

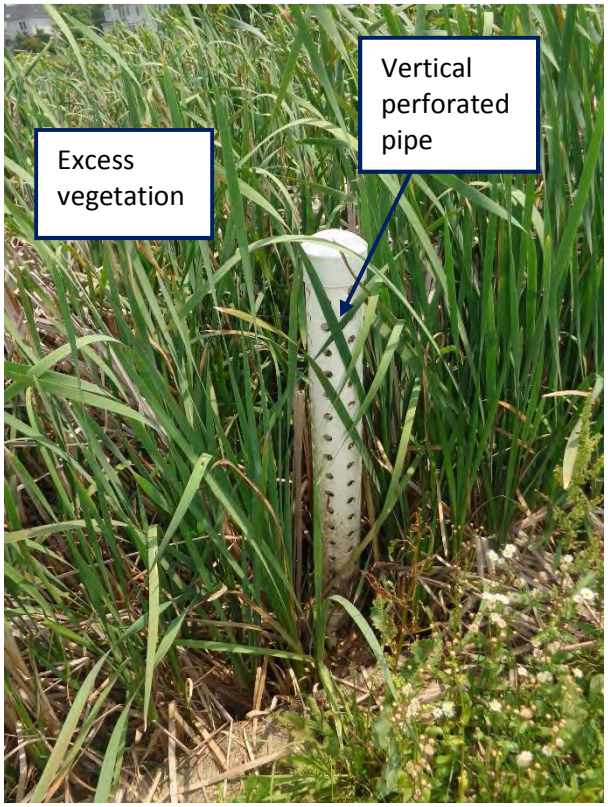


Photo 12: Vertical pipe facing east

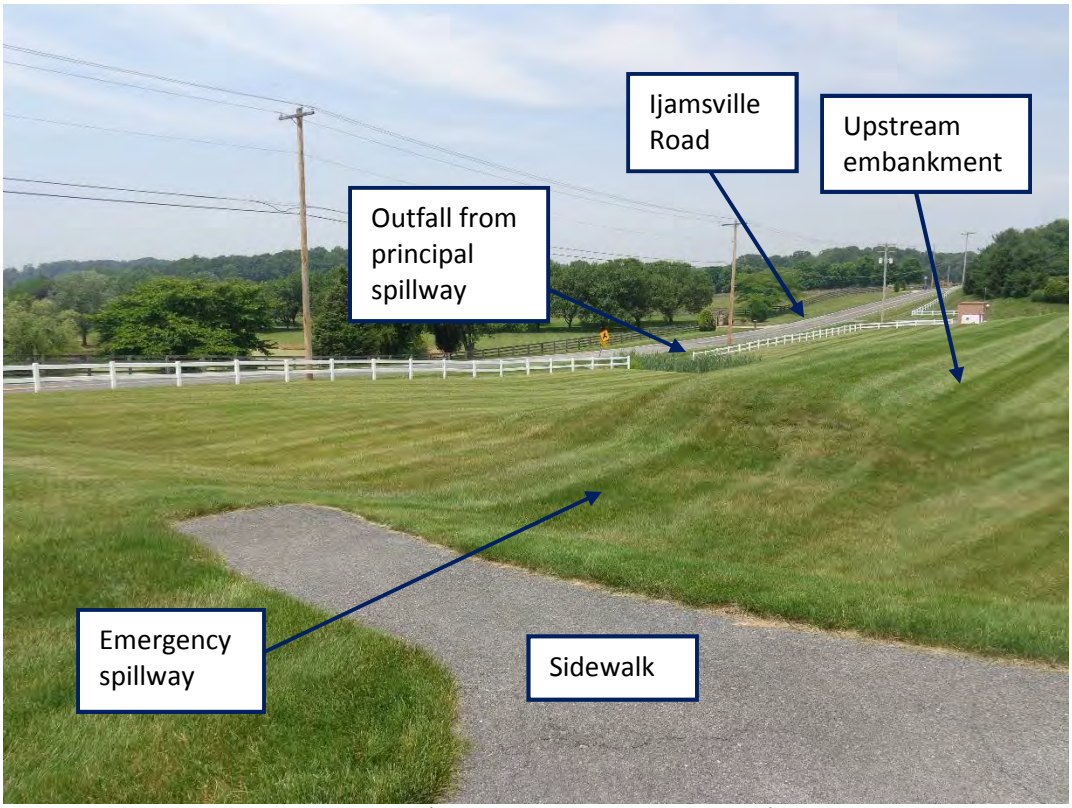


Photo 13: Emergency spillway and embankment facing northwest

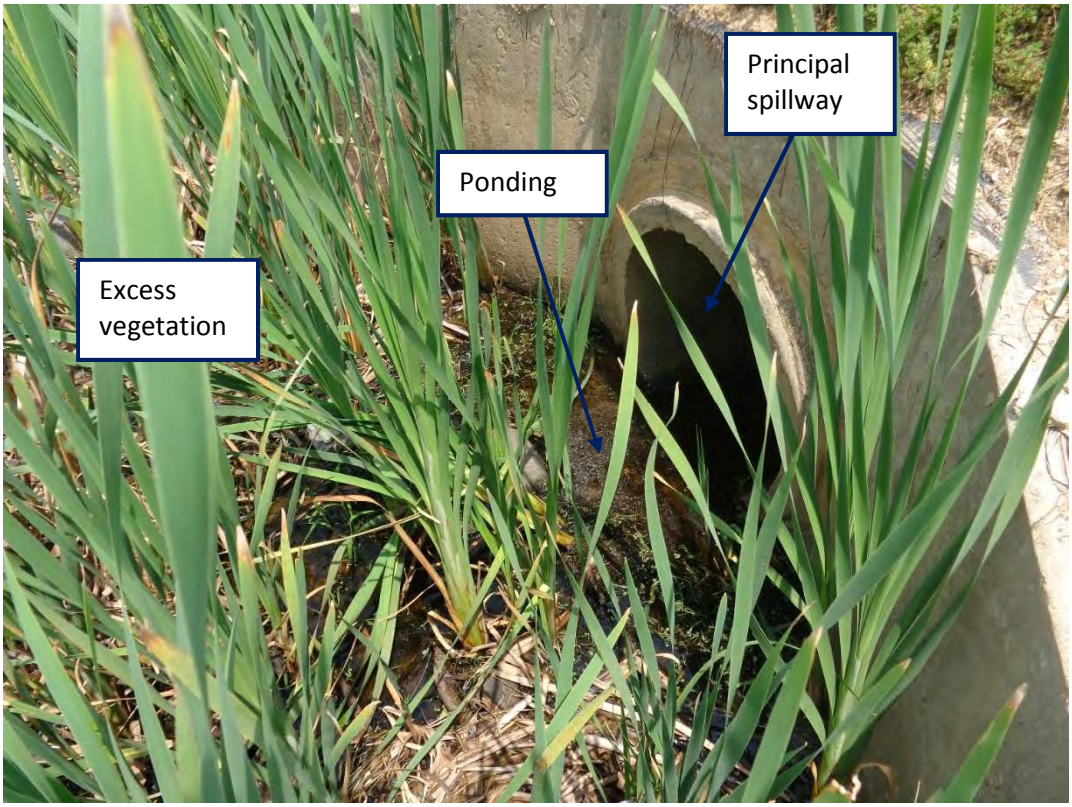


Photo 14: Principal spillway facing east

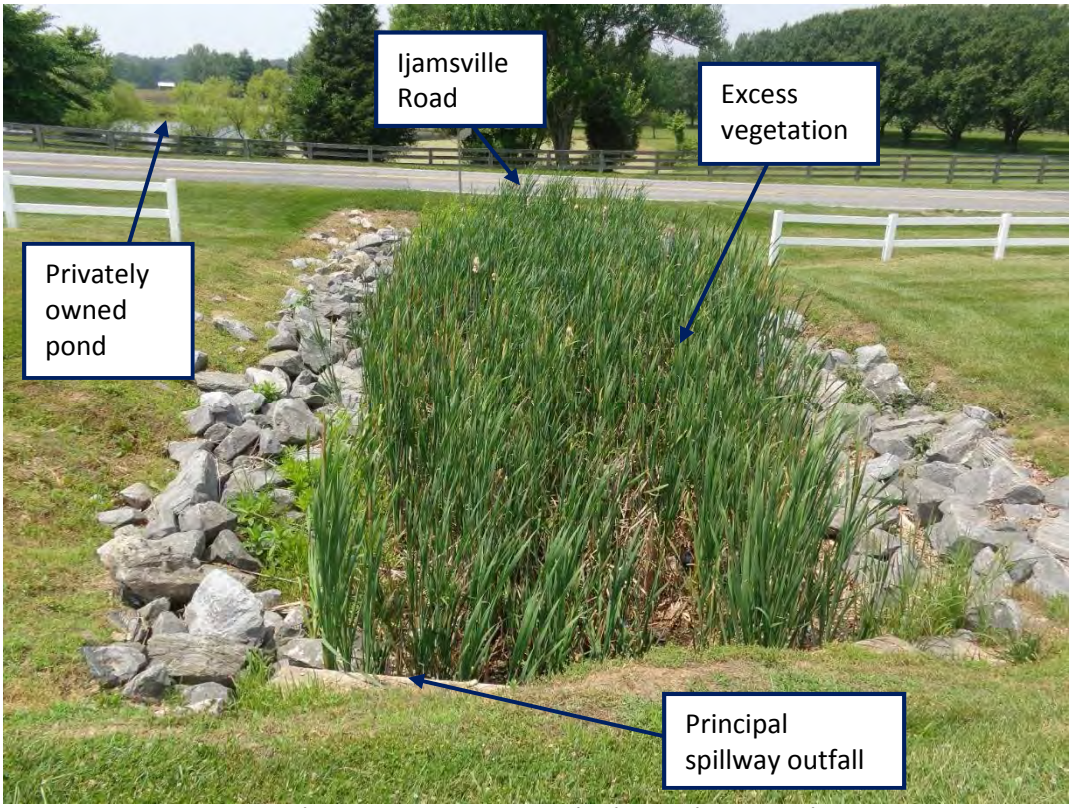


Photo 15: Riprap channel from principal spillway facing west

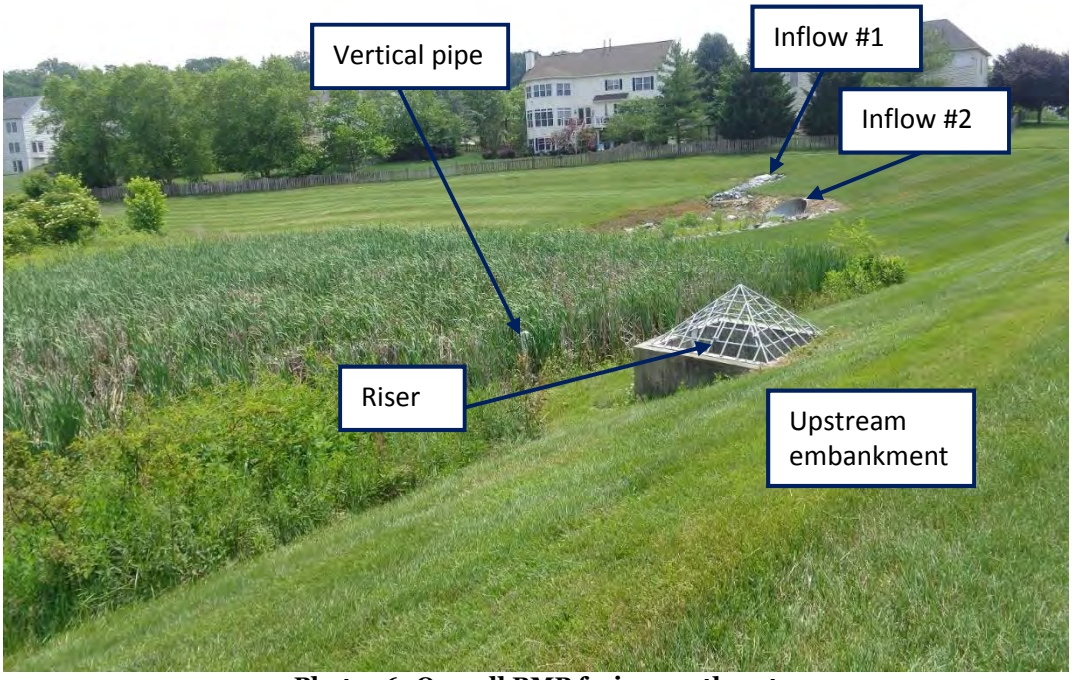


Photo 16: Overall BMP facing southeast

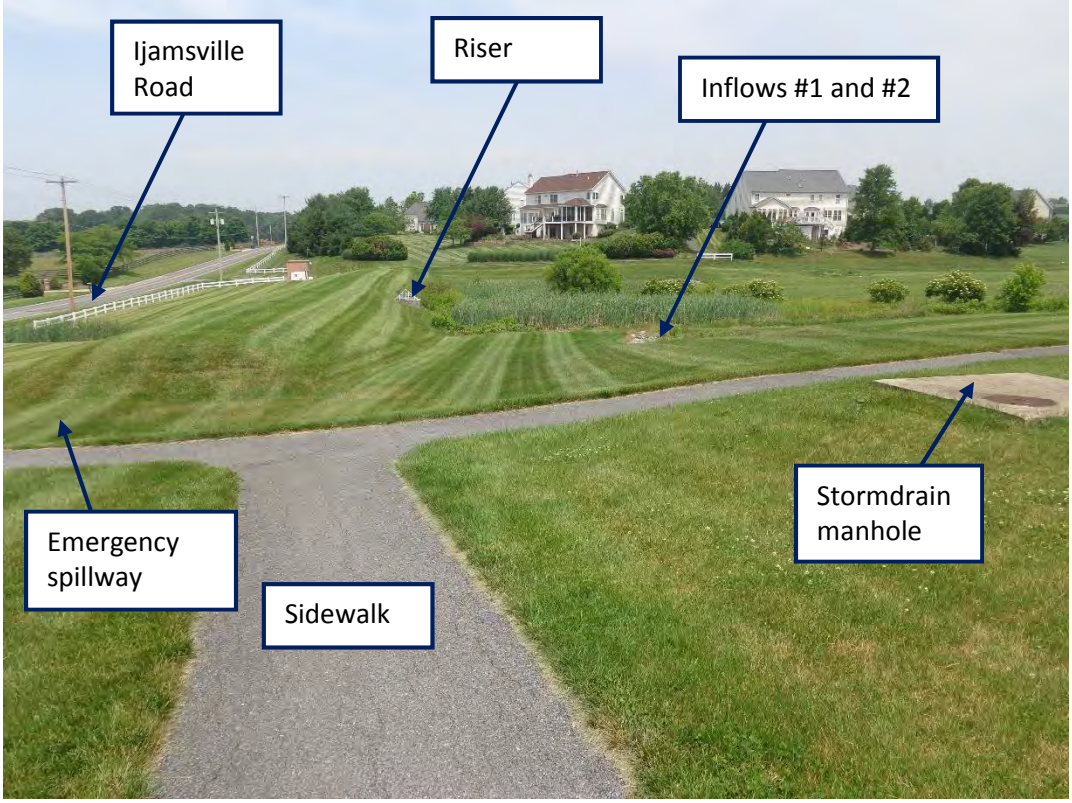
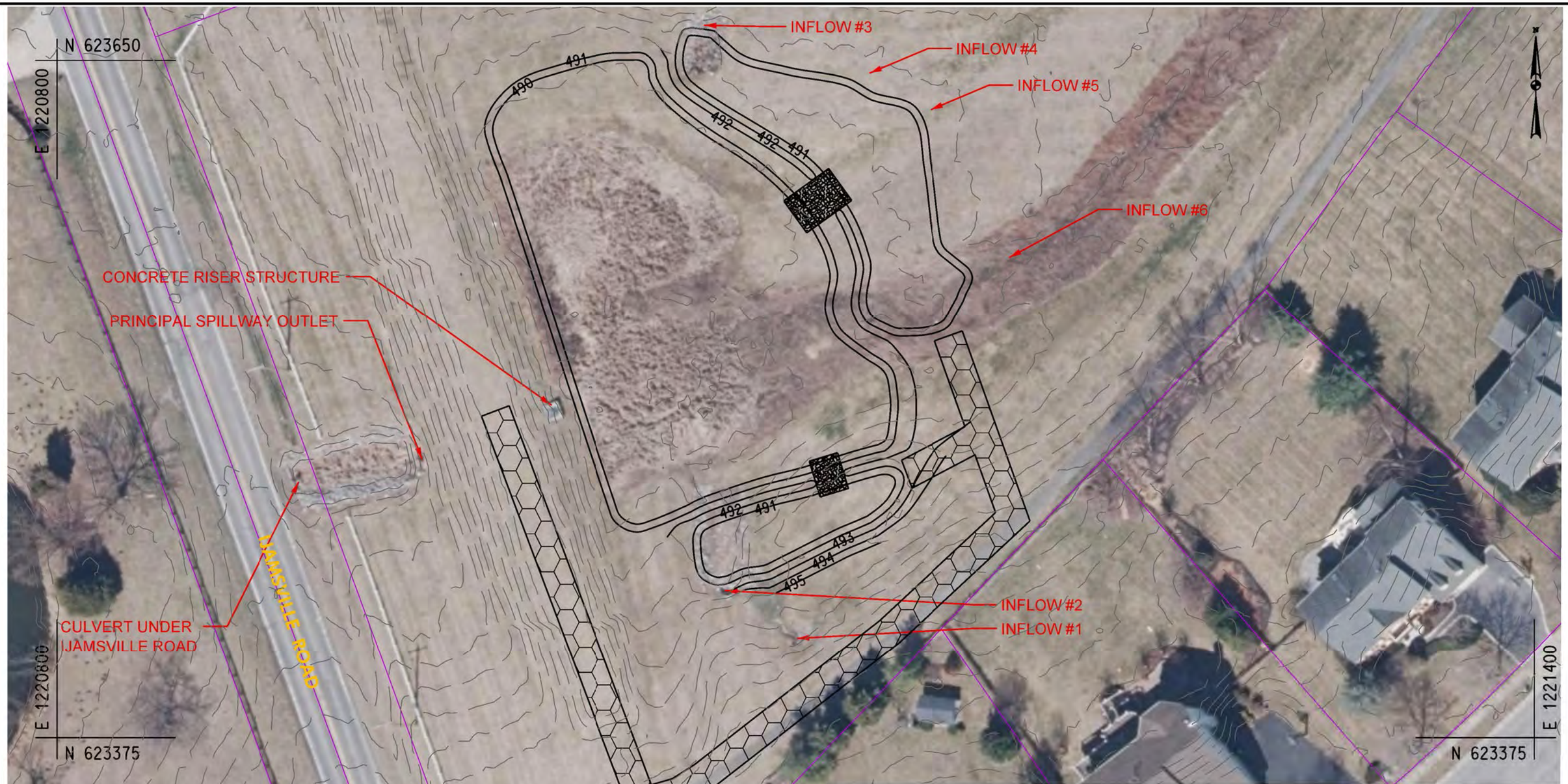


Photo 17: Overall BMP facing north



GENERAL BMP INFORMATION	
BMP TYPE:	WET EXTENDED DETENTION POND (P-3)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	39.4
TOTAL IMPERVIOUS AREA (ACRES):	10.3
WQv REQUIRED (CU. FT):	40801
WQv REQUIRED (AC. FT):	0.937
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	40801
TOTAL TREATED DA (ACRES):	39.4
TOTAL TREATED IMPERVIOUS AREA (ACRES):	10.3

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410 265 9500
FAX: 410 265 8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #227 – FAIRWAY AT HOLLY HILLS, POND #3

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO. _____

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. – OF SHEET NO. OF

BY: ndriskill -

PLOTTED: Tuesday, June 20, 2017 AT 01:21 PM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP227.dgn

WET EXTENDED DETENTION POND DESIGN (P-3): BMP 227

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**9/17/2015**
Watershed:	**Lower Bush Creek**	As Built:	**10/1/1997**

Drainage Area: **39.40** **(Total)** Acres 0.062 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **10.30** Acres **I =** 0.261

= 26.1 %

Soil Type: **B, C**

RCN Existing : **70** **Existing tc =** **0.30** hr

RCN Post Development : **70** **Post-D tc =** **0.30** hr

Per Frederick County's Urban BMP Database

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.285

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)
1" per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 26.1 %

$WQ_{V(I)}$ = 0.937 ac-ft = 40801 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.657 ac-ft = 28604.4 cu.ft

Water quality treatment required =	**40801**	**cu.ft =**	**0.9367**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**40801**	**cu.ft =**	**0.9367**	ac-ft	
Sediment Forebay Volume Required=	**4080**	**cu.ft =**	**0.0937**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**36721**	**cu.ft =**	**0.8430**	ac-ft	
Elevation at the Top of WQv in pond =	**491.82**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	20400
II	50% of WQv is in micropool	20400
III	1/3 of WQv is in micropool & forebay	9520
IV	1/3 of WQv is in micropool & forebay	9520

***source: SHA SWM Workshop, April 30, 2003**

Micropool storage volume required = **9520** **cu.ft =** **0.2186** **ac-ft**

Extended Detention Storage= **9520** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **490.52** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.11** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_o = \frac{WQrr}{4.81\sqrt{h_o}}$$

Assume h_o = **1.30** ft *Will change based on pond volume

Ao = 0.02 sf

Determine the required orifice diameter (d_o)

$$D_o = \sqrt{\frac{4\ A_o}{}}$$

Do = 0.16 ft = **1.9** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**0.00**	0
B	**38.07**	97
C	**1.33**	3
D	**0.00**	0
Total	**39.40**	OK: sum of the areas matches site Area

Composite S: 0.2556 Use 25.56 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.239 ac-ft = **10429** cu.ft

Rev in Pond= **6349**

El of Rev= **490.33** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **2.633** Acres = 114684 sf

The Rev requirement may be met by:

a) treating 0.239 ac-ft using structural method,

b) treating 2.633 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	9/17/2015
Watershed:	Lower Bush Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
18006.0	**490.0**	0.41	0.00	0.00	0.00	0.00
19966.0	**491.0**	0.46	1.00	0.44	0.44	18977.56
24030.0	**492.0**	0.55	1.00	0.50	0.94	40944.21
		0.00	0.00	0.00	0.00	0.00

No. of valid row entries= 3

BMP #412 – GEORGIA-PACIFIC CORPORATION – SWM ED

Prioritization Ranking:	24
Planning Level Cost Estimate:	$ 1,469,869.50
Estimated Cost/Impervious Acre	$ 106,218.17

General BMP Information:		
Structure Location:	Geoffery Way	
ADC Map:	4686, C4 (2008)	
Northing/Easting:	613,958.89/1,192,860.09	
NPDES Watershed:	Monocacy Direct Southwest	
MDE 8 Digit Watershed:	Lower Monocacy River	
Proposed BMP Retrofit General Information:		
BMP Type:	Wet Extended Detention Pond (P-3)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	33.64	
Total Impervious Area (ac):	14.07	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	52072	
Total Treated Drainage Area (ac):	33.64	
Total Treated Impervious Area (ac):	14.07	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	281.22	182.49
TP (lbs/yr):	28.57	13.40
TSS (lbs/yr):	15063.95	9759.83

Existing conditions for BMP #412

Site map for BMP #412

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #412 has been identified as an extended detention dry pond. The facility was constructed south of Geoffrey Way and east of Buckeystown Pike. The Urban BMP Database from the County indicates that the original design for BMP #412 provides management for quantity and quality and that the total treatment area for the BMP is 41.43 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 33.64 acres, including 14.07 acres of impervious area. The majority of land use is industrial.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out from the paved lot of the industrial site. According to the County's parcel layer in GIS, BMP #412 was constructed on private property. MOT will be required to notify property owners of the industrial site. Access to the BMP requires crossing railroad tracks.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: Acquisition of Easements, MOT	

PROPOSED RETROFIT

The proposed retrofit for BMP #412 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 33.64 acres including 14.07 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating approximately 1 foot below the existing BMP footprint to provide extended detention as shown in the Concept Plans.

BMP # 412 – GEORGIA-PACIFIC CORPORATION – SWM ED POND #1

Storm Water Management Retrofit Evaluation

Report Date:	7/1/2015	**Design Approval:**	3/18/1996	**Maintenance Owner:**	Georgia-Pacific, Inc.
Structure No:	412	**Year Constructed:**	6/12/1997	**Inspection Date:**	6/24/2015
Structure Name:	Georgia-Pacific Corporation - SWM ED Pond #1	**NPDES Watershed:**	Monocacy Direct Southwest	**Inspection Team:**	GL, VH
Location:	Geoffery Way	**MDE 8 Digit Name/#:**	Lower Monocacy River	**Last Significant Rainfall:**	6/23/2015 (0.35")
ADC Map:	4686, C4 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	613,958.89/1,192,860.09	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description

	Existing Condition		Proposed Condition	
General BMP Information				
BMP Type:	Extended Detention Dry Pond		Wet Extended Detention Pond (P-3)	
BMP Classification:	N/A		Stormwater Treatment (ST) Practice	
Management Type:	Quantity/Quality		Quality/Quantity	
Total Drainage Area (acres):	41.43		33.64	
Total Impervious Area within Drainage Area (acres):	Unknown		14.07	
WQv Required:	Unknown		52072 cu. ft.	1.195 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes	
Adequate ROW (Y/N):	Yes		Yes	
Adequate Access (Y/N):	No		Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	Unknown	0	52072 cu. ft.	1.195 ac-ft
Total Treated Drainage Area (acres):	41.43	0	33.64	
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	14.07	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.02	
Total Nitrogen:			35.13%	
Total Phosphorus:			55.20%	
Sediment:			70.26%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		281.22	182.49
TP (lbs/yr):	0		28.57	13.40
TSS (lbs/yr):	0		15,063.95	9,759.83
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 1,469,869.50**

BMP #412 – GEORGIA-PACIFIC CORPORATION – SWM ED POND #1

Existing Site Conditions:

SWM Era: 1985-2002

According to Frederick County's Urban BMP Database, BMP #412 has been identified as an extended detention dry pond. The facility was constructed south of Geoffrey Way and east of Buckeystown Pike as shown in the BMP Location map (**Figure 1**). The Urban BMP Database from the County indicates that the original design for BMP #412 provides management for quantity and quality and that the total treatment area for the BMP is 41.43 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 33.64 acres, including 14.07 acres of impervious area. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. The facility has the following features per the GIS Pipes layer provided by Frederick County: two inflows - a 27" RCP from the northeast and two 36" RCP parallel storm drains from the north, and a 24" principal spillway. According to the Urban BMP Database provided by Frederick County, the facility's control structure is a 36" riser with a 3" extended detention orifice and a 1' square orifice. The majority of land use is industrial.

General Observations:

A site visit was conducted on June 24th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has two inflow points. Inflow #1 is a 27" RCP with an end wall from the northeast which flows under the railroad tracks **(Photo 1)**. At the outfall of Inflow #1 there is ponding water and overgrown vegetation **(Photo 2)**.

Inflow #2 is two 36" RCP storm drains **(Photo 3)** with an end wall which conveys flow from a grass ditch under the railroad tracks **(Photo 4)**. There was an animal burrow near the end wall on the northeast side of the railroad tracks **(Photo 5)**. The riprap outfall protection is overgrown with vegetation on the southwest side of the railroad tracks **(Photo 5)**. Otherwise, Inflow #2 appears to be in good condition.

Pretreatment:

This facility does not contain pretreatment or forebays.

Control Structure and Spillways:

According to the Urban BMP Database, the control structure for this facility is a 36" CMP riser with a 3" extended detention orifice and a 1' square orifice **(Photo 6)**. The riser structure could not be accessed due to ponding water, but it appears to be in good condition.

This facility does not have an emergency spillway.

Embankment:

A fill embankment is present between the pond and principal outlet to the south and west of the pond **(Photo 6).** The embankment is not mowed but does not have any trees. The embankment appears to be in good condition. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

According to measurements taken in the field and the GIS Pipes layer, the principal spillway is a 24" CMP that outlets the BMP from the south of the pond to an agricultural field **(Photo 7)**. The outfall is in poor condition due to ponding and accumulated sediment in the downstream channel. The area is also overgrown with vegetation.

Overall BMP:

This BMP is overgrown with vegetation. Ponding is present at the outfall of the principal spillway and Inflow #1. Minor problems were observed, however, the BMP is functioning as designed with no critical parameters but with some problem conditions.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out from the paved lot of the industrial site. According to the County's parcel layer in GIS, BMP #412 was constructed on private property. Easements at this locations should be evaluated further in final design. MOT will be required to notify property owners of the industrial site. Access to the BMP requires crossing railroad tracks.

Proposed Retrofit:

BMP #412 was originally designed as an extended detention dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #412 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 33.64 acres including 14.07 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 1 foot below the existing BMP footprint to provide extended detention as shown in the **Concept Plans**. The proposed retrofit drainage area excludes drainage and impervious area treated by other BMPs. As part of the final design, the condition of the existing CMP riser structure should be replaced with a concrete structure.

Additional Retrofit Opportunities:

In final design, retrofit of upstream BMP #341 can be considered or the drainage area to BMP #341 can be incorporated into the retrofit design of BMP #412.

Step 1: Watershed Factors

BMP #412 is located in Frederick County's Monocacy Direct Southwest watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #412. For the retrofit of BMP #412, 100% of the WQv can be treated within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in Kiln Run downstream of the BMP.

Step 2: Terrain Factors

BMP #412 is located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are special terrain factors and/or constraints that must be considered for retrofit design to BMP #412. Additional geotechnical investigation will be required during the final design and the proposed pond may need to be lined if karst geology is identified.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to the unavailability of plans. There is adequate space for the retrofit within the existing BMP boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a wet extended detention pond is 25 acres. The proposed drainage area to BMP #412 is 33.64 acres and is composed of A and B soils. The likelihood of BMP #412 receiving hotspot runoff is moderate as it is located within an industrial area. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban.

Step 5: Community and Environmental Factors

BMP #412 is located east of Buckeystown Pike on the Georgia Pacific property and has moderate visibility. Wet extended detention ponds tend to have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide high habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #412 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

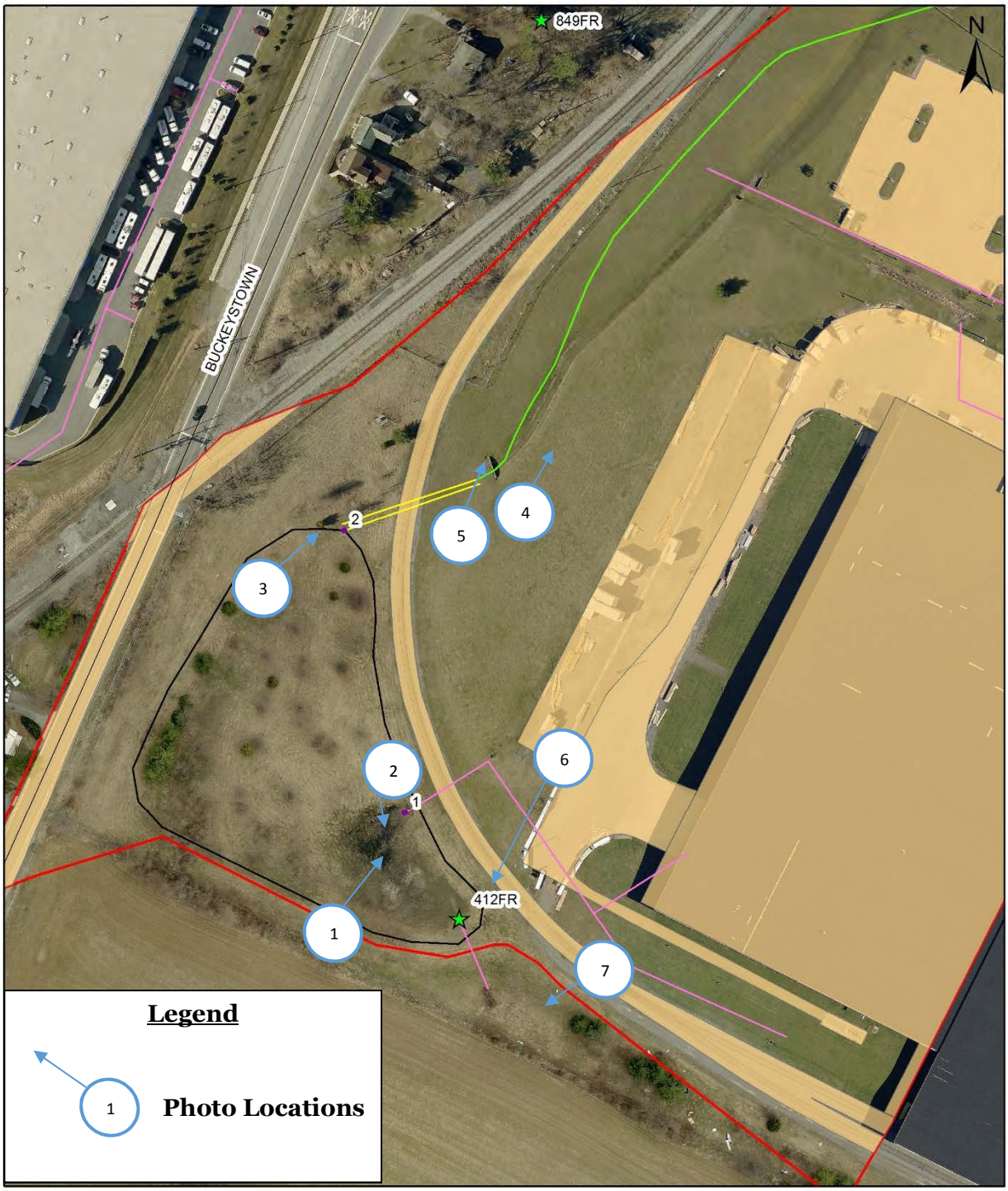


Figure 2: Photo Locations

Photo 1: Inflow #1 facing northeast

Photo 2: Inflow #1 facing southwest

Photo 3: Inflow #2 facing northeast

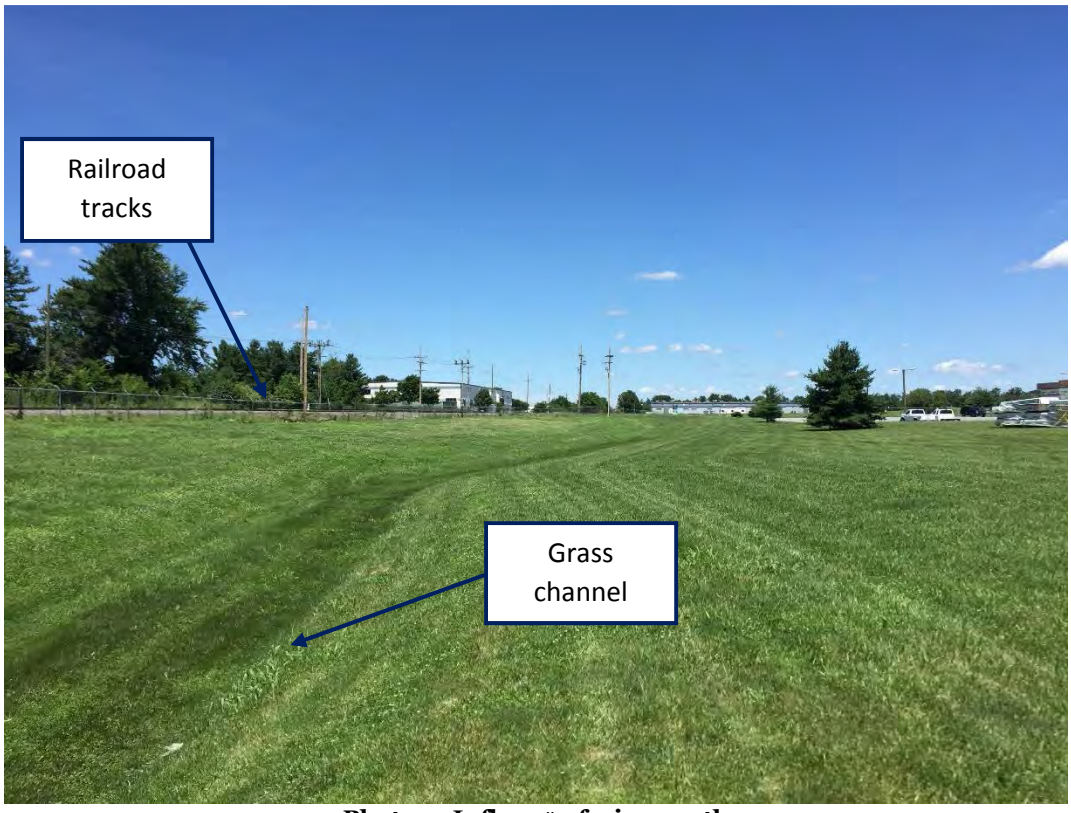


Photo 4: Inflow #2 facing north

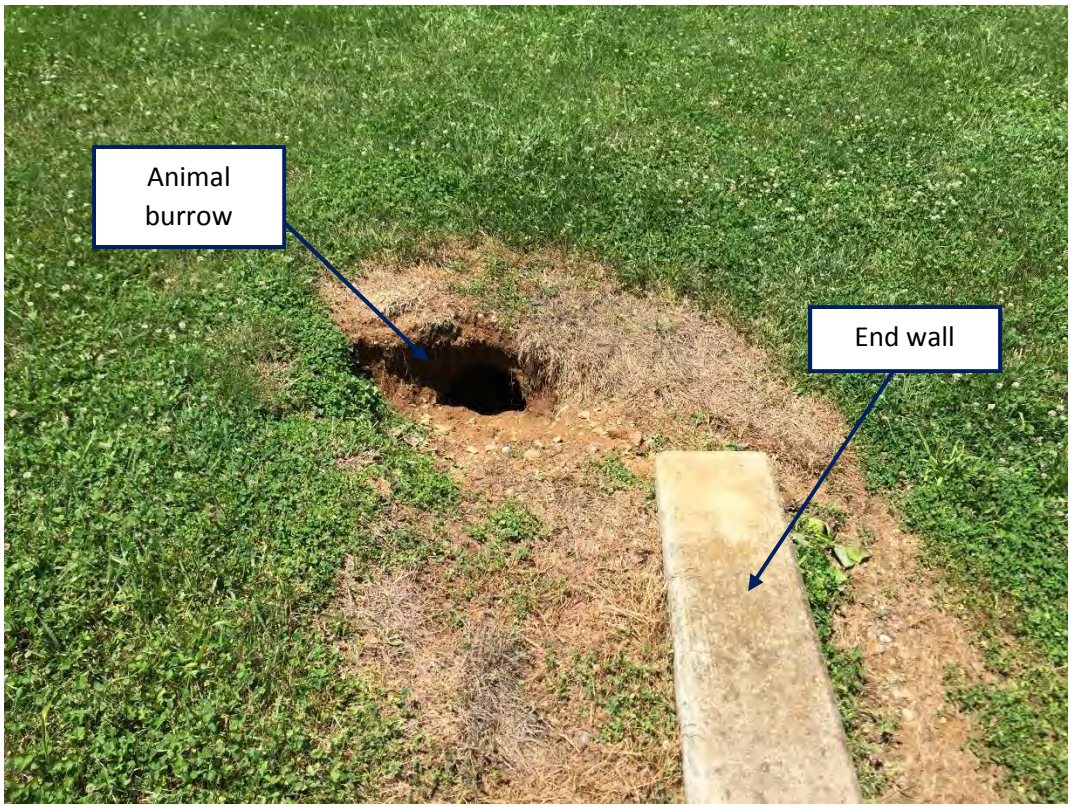


Photo 5: Inflow #2 facing north

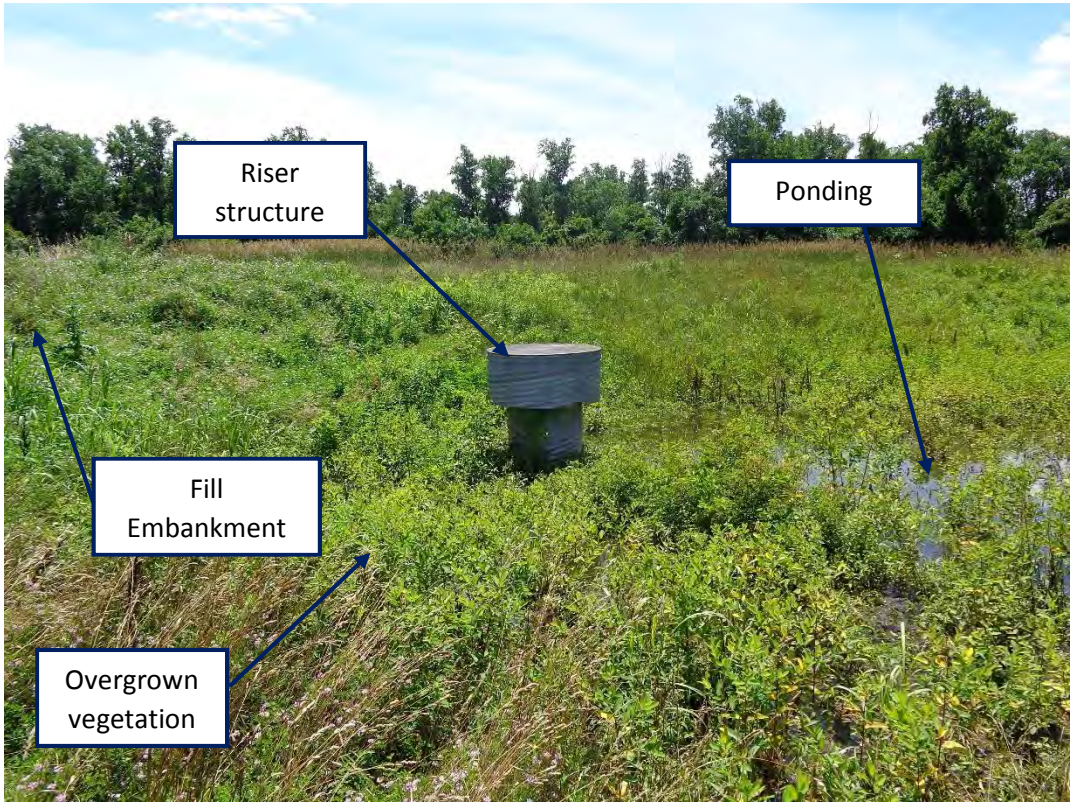


Photo 6: Riser structure facing south

Photo 7: Principal spillway facing northwest

LEGEND

PARCEL BOUNDARY

GENERAL BMP INFORMATION	
BMP TYPE:	WET EXTENDED DETENTION POND (P-3)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	33.64
TOTAL IMPERVIOUS AREA (ACRES):	14.07
WQv REQUIRED (CU. FT):	52072
WQv REQUIRED (AC. FT):	1.195
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	52072
TOTAL TREATED DA (ACRES):	33.64
TOTAL TREATED IMPERVIOUS AREA (ACRES):	14.07

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: vhamsher -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #412 – GEORGIA-PACIFIC CORPORATION – SWM ED POND #1

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. OF

SHEET NO. OF

PLOTTED: Wednesday, June 07, 2017 AT 01:37 PM
FILE: \\catoctfr\Projects\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP412.dgn

WET EXTENDED DETENTION POND DESIGN (P-3): BMP 412

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**9/23/2015**
Watershed:	**Monocacy Direct Southwest**	As Built:	**6/12/1997**

Drainage Area: **33.64** **(Total)** Acres 0.053 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **14.07** Acres **I =** 0.418

= 41.8 %

Soil Type: **A, B**

RCN Existing : **80** **Existing tc =** **0.20** hr

RCN Post Development : **80** **Post-D tc =** **0.20** hr

Per Frederick County's Urban BMP Database

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.426

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)

1" per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 41.8 %

$WQ_{V(I)}$ = 1.195 ac-ft = 52072 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.561 ac-ft = 24422.64 cu.ft

Water quality treatment required =	**52072**	**cu.ft =**	**1.1954**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**52072**	**cu.ft =**	**1.1954**	ac-ft	
Sediment Forebay Volume Required=	**5207**	**cu.ft =**	**0.1195**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**46865**	**cu.ft =**	**1.0759**	ac-ft	
Elevation at the Top of WQv in pond =	**262.00**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	26036
II	50% of WQv is in micropool	26036
III	1/3 of WQv is in micropool & forebay	12150
IV	1/3 of WQv is in micropool & forebay	12150

***source: SHA SWM Workshop, April 30, 2003**

Micropool storage volume required = **12150** **cu.ft =** **0.2789** **ac-ft**

Extended Detention Storage=	**12150**	cu.ft	= Dead Storage Volume	cu.ft
Extended Detention Elevation=	**260.55**	ft	= Dead Storage El =	orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice

Hence, WQrr = **0.14** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_o = \frac{WQrr}{4.81\sqrt{h_o}}$$

Assume h_o = **1.45** ft *Will change based on pond volume

Ao = 0.02 sf

Determine the required orifice diameter (d_o)

$$D_o = \sqrt{\frac{4\ A_o}{}}$$

Do = 0.18 ft = **2.1** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

1334950.504

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**4.46**	13
B	**29.18**	87
C	**0.00**	0
D	**0.00**	0
Total	**33.64**	OK: sum of the areas matches site Area

Composite S: 0.2759 Use 27.59 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.330 ac-ft = **14367** cu.ft

Rev in Pond= **9160**

El of Rev= **260.41** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **3.882** Acres = 169101 sf

The Rev requirement may be met by:

a) treating 0.330 ac-ft using structural method,

b) treating 3.882 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	9/23/2015
Watershed:	Monocacy Direct Southwest		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
21452.0	**260.0**	0.49	0.00	0.00	0.00	0.00
23473.0	**261.0**	0.54	1.00	0.52	0.52	22454.92
25550.0	**262.0**	0.59	1.00	0.56	1.08	46959.08
		0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00

No. of valid row entries= 3

McKaig Road

Prioritization Ranking:	25
Planning Level Cost Estimate:	$ 201,080.00
Estimated Cost/Impervious Acre	$ 109,450.05

General BMP Information:		
Structure Location:	McKaig Road	
ADC Map:	4450, A9 (2008)	
Northing/Easting:	618,533.136/1,208,375.427	
NPDES Watershed:	Israel Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Regenerative Step Pool Conveyance	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	20.37	
Total Impervious Area (ac):	2.98	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	13433	
Total Treated Drainage Area (ac):	20.37	
Total Treated Impervious Area (ac):	2.00	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	289.87	170.41
TP (lbs/yr):	14.42	6.77
TSS (lbs/yr):	7241.12	4691.47

Existing conditions for McKaig Road

Site map for McKaig Road

EXISTING SITE CONDITIONS

McKaig Road was investigated during site visits to identify opportunities to treat untreated impervious area. The drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the drainage area to the culvert under McKaig Road is 20.37 acres, including 2.98 acres of impervious area. The drainage area is shown in the location map above. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from McKaig Road. There are no other obvious site constraints such as utilities or steep slopes. Maintenance of Traffic (MOT) is required for this BMP.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: Acquisition of Easements, MOT	

PROPOSED RETROFIT

There is no existing SWM at this location. The most appropriate option for restoration at this location to treat untreated impervious area is a new regenerative step pool conveyance below the culvert outfall under McKaig Road. Proposed BMP A will include five 22' cascades and five 25' cobble riffles, with a total length of 235 feet. BMP A will provide quality management for 20.37 acres including 2 acres of impervious area. In addition, rip rap stabilization is recommended in the ditch on the northwest side of McKaig Road.

MCKAIG ROAD

Storm Water Management Retrofit Evaluation					
Report Date:	10/6/2015	**Design Approval:**	Not Available	**Maintenance Owner:**	N/A
Structure No:	BMP A	**Year Constructed:**	Not Available	**Inspection Date:**	5/5/2015
Structure Name:	McKaig Road	**NPDES Watershed:**	Israel Creek	**Inspection Team:**	ND, CF
Location:	McKaig Road	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	4/30/2015 (0.14")
ADC Map:	4450, A9 (2008)	**Land-River Segment:**	PM4_3341_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	618,533.136/1,208,375.427	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Regenerative Step Pool Conveyance	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quantity/Quality	
Total Drainage Area (acres):			20.37	
Total Impervious Area within Drainage Area (acres):			2.98	
WQv Required:			13433 cu. ft.	0.308 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		13433 cu. ft.	0.308 ac-ft
Total Treated Drainage Area (acres):			20.37	
Total Treated Impervious Area within Drainage Area (acres):			2.00	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		1.85	
Total Nitrogen:			66.57%	
Total Phosphorus:			77.81%	
Sediment:			83.51%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		289.87	170.41
TP (lbs/yr):			14.42	6.77
TSS (lbs/yr):			7241.12	4691.47
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 201,080.00**

MCKAIG ROAD

Existing Site Conditions:

McKaig Road was investigated during site visits to identify opportunities to treat untreated impervious area. The drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the drainage area to the culvert under McKaig Road is 20.37 acres, including 2.98 acres of impervious area. Figure 1 shows the drainage area for the facility.

General Observations:

The site visit was conducted on May 5th, 2015. **Figure 2** shows the location of photos taken during the visit.

Runoff from Allview Drive drains west towards McKaig Road via concrete channels **(Photo 1)** prior to entering a storm drain on the northeast side of McKaig Road and Allview Drive intersection. In addition, runoff from McKaig Road, south of Allview Drive, collects in a ditch and drains to a storm drain on the southeast side of the intersection of McKaig Road and Allview Drive **(Photo 2)**. Both storm drains combine at an inlet which outlets on the northwest side of the intersection of McKaig Road and Allview Drive on private property **(Photo 3)**. Flow is then conveyed via a driveway culvert and ditch along the west side of McKaig Road **(Photo 4)**. There is some erosion in this ditch. Flow from the northeast side of McKaig Road is collected in a ditch and is conveyed beneath McKaig Road via a cross culvert. The area in the vicinity of the culvert outlet is in poor condition due to erosion **(Photo 5)**.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site via McKaig Road. According to the County's parcel layer in GIS, this site is on private property and an easement will be required. Easements at this location should be evaluated further in final design. Maintenance of traffic (MOT) is required at this site.

Proposed Retrofit:

There is no existing SWM at this location. The most appropriate option for restoration at this location to treat untreated impervious area is a new regenerative step pool conveyance below the culvert outfall under McKaig Road. Proposed BMP A will include five 22' cascades and five 25' cobble riffles, with a total regenerative step pool conveyance length of 235 feet. BMP A will provide quality management for 20.37 acres including 2 acres of impervious area as shown in the **Concept Plans**. In addition, rip rap stabilization is recommended in the ditch on the northwest side of McKaig Road.

Additional Retrofit Opportunities:

In final design, outfall stabilization for impervious area credit can be explored for this site to treat additional impervious area.

Step 1: Watershed Factors

BMP A is located in Frederick County's Israel Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are no special watershed factors and/or constraints that must be considered.

Step 2: Terrain Factors

BMP A is not located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for proposed design of BMP A.

Step 3: Stormwater Treatment Suitability

For BMP A, a regenerative step pool conveyance is feasible below the existing culvert outfall. BMP A is proposed on private property and will require an easement. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The maximum drainage area for a regenerative step pool conveyance is 30 acres. The proposed drainage area for BMP A is 20.37 acres and is composed of B and C soils. The likelihood of BMP A receiving hotspot runoff is low as it is located within a residential area. Proposing a new BMP is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

Proposed BMP A is located below the existing culvert outfall west of McKaig Road and has moderate visibility. Regenerative step pool conveyances tend to have low maintenance requirements, medium community acceptance, and medium cost relative to the drainage area with medium habitat quality in comparison with other BMP selections.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP A include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

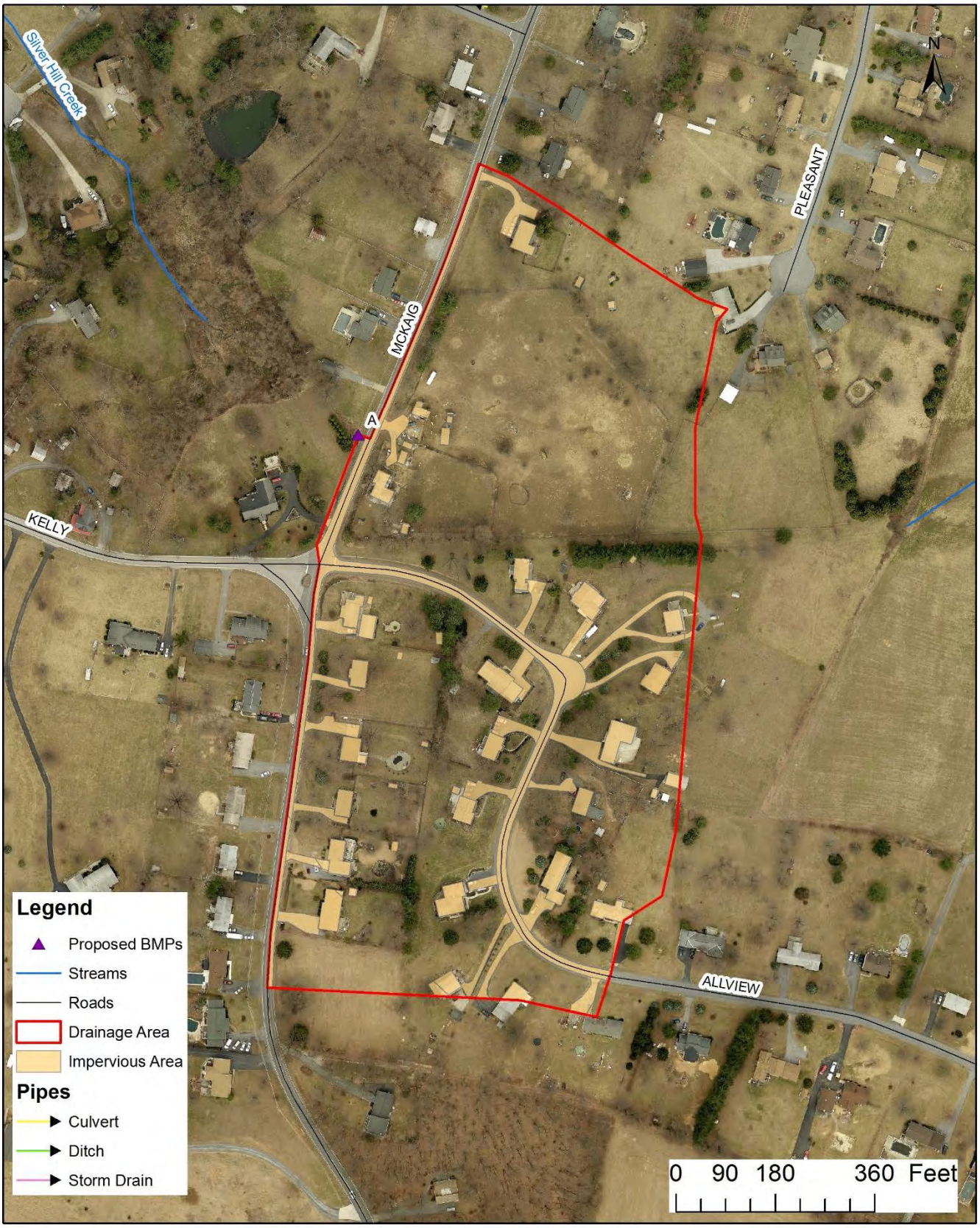


Figure 1: BMP Location Map – Existing Conditions

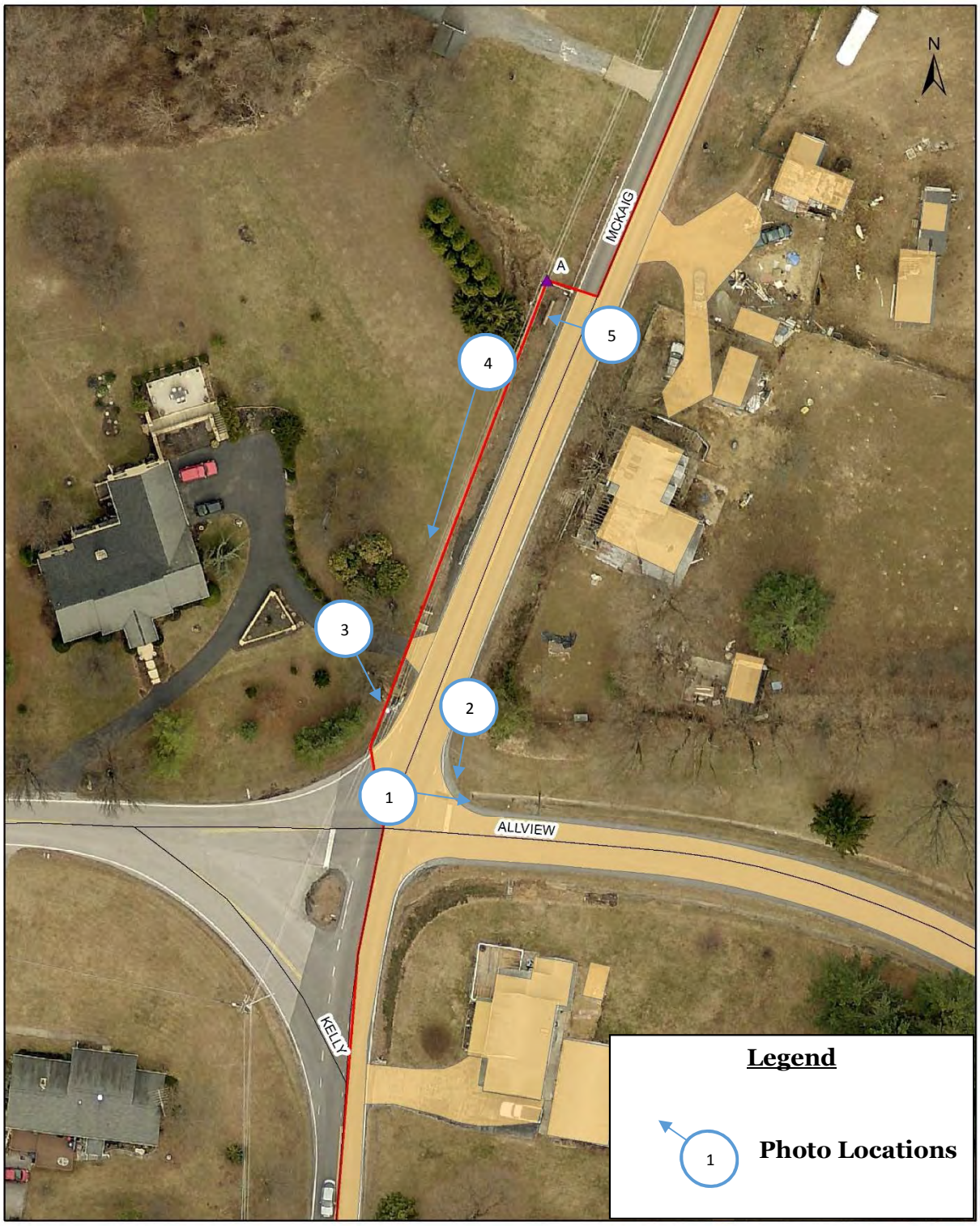


Figure 2: Photo Locations

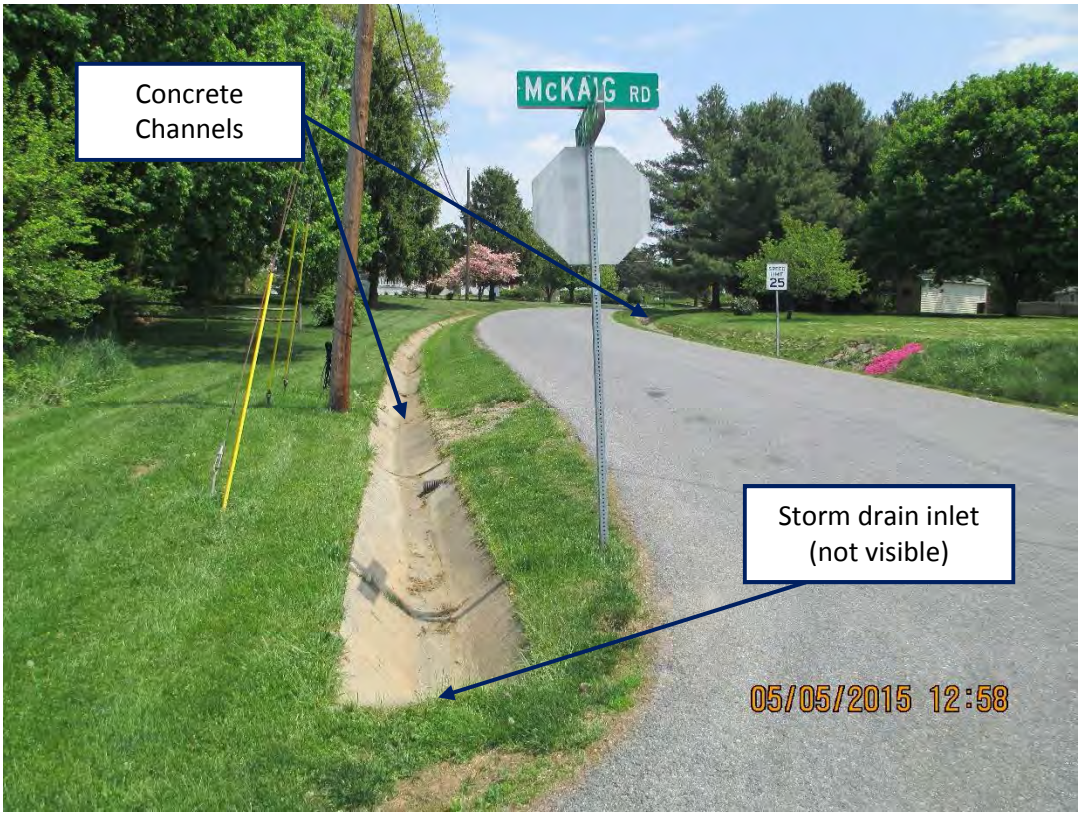


Photo 1: Intersection of McKaig Road and Allview Drive facing east

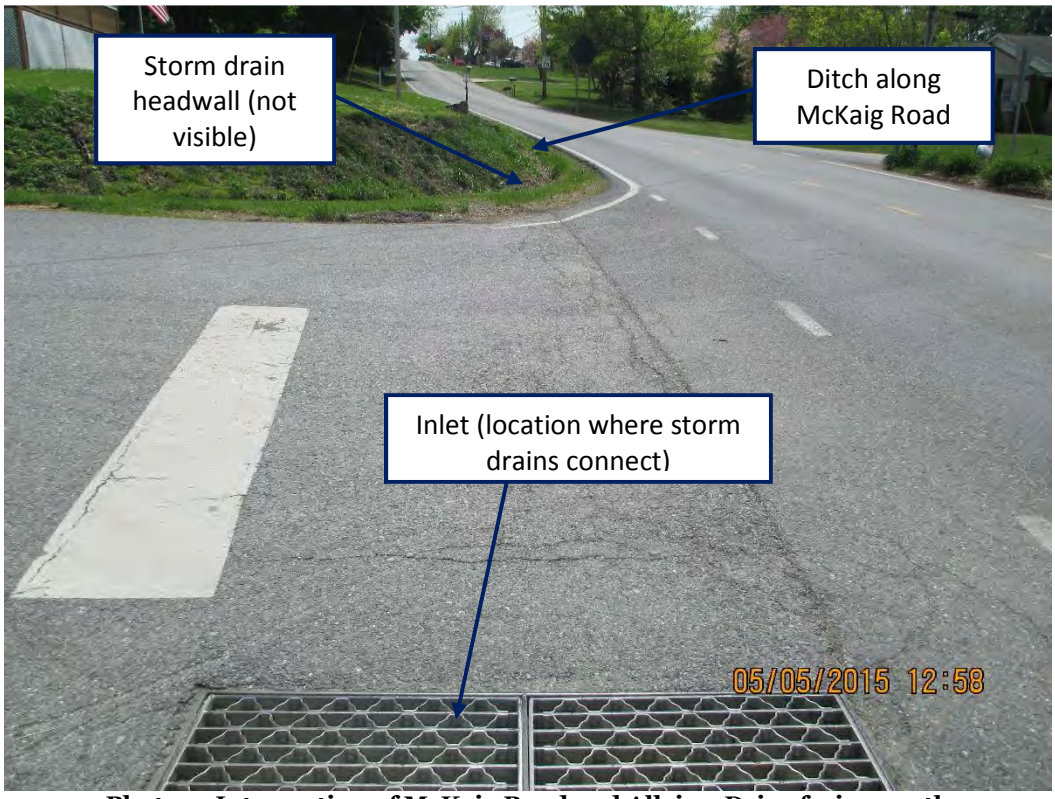


Photo 2: Intersection of McKaig Road and Allview Drive facing south

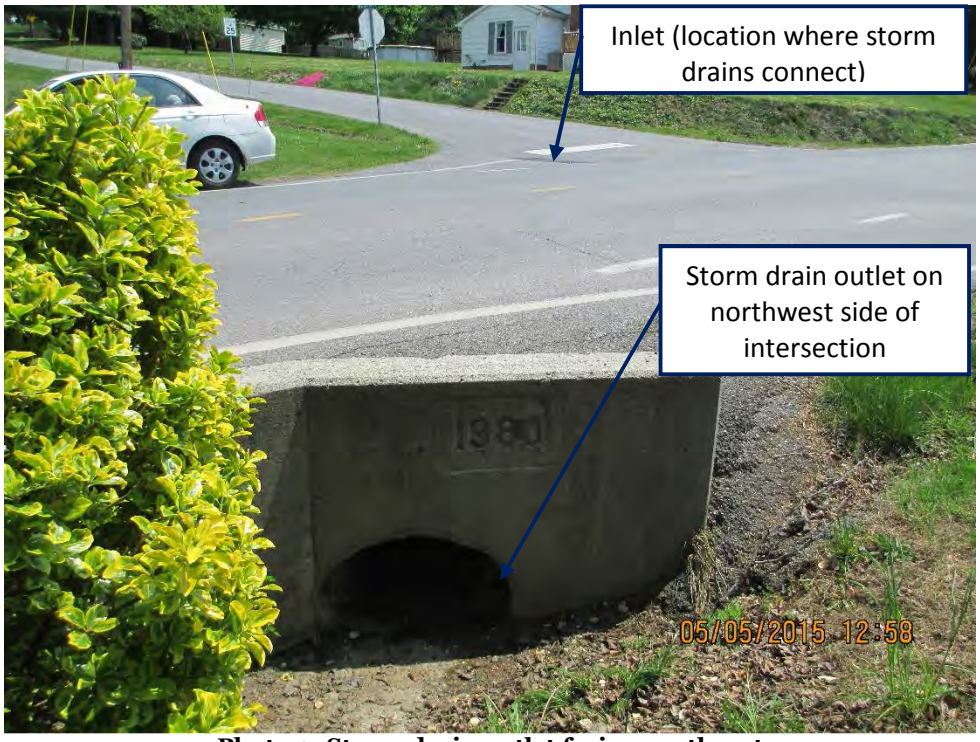


Photo 3: Storm drain outlet facing southeast

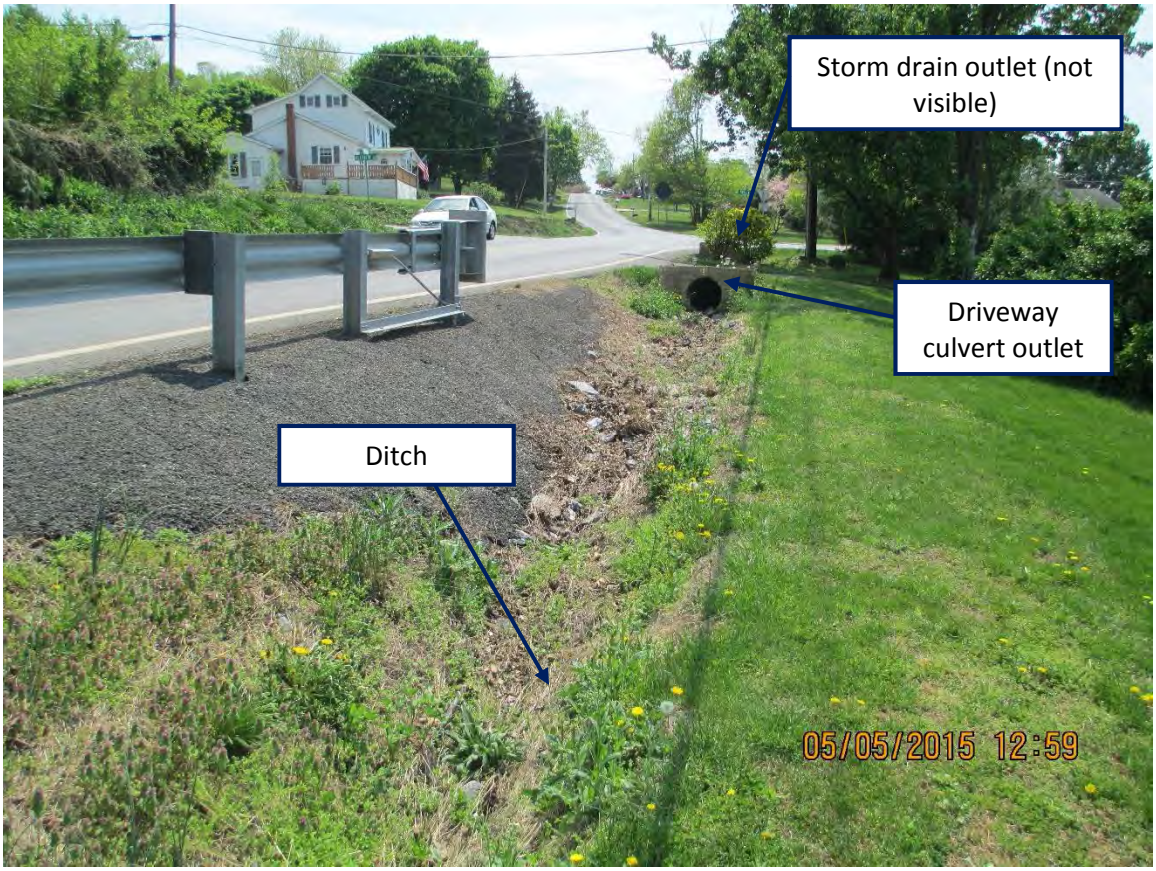


Photo 4: Ditch west of McKaig Road facing southwest

Photo 5: Culvert downstream channel facing west

GENERAL BMP INFORMATION - BMP A	
BMP TYPE:	REGENERATIVE STEP POOL CONVEYANCE
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	20.37
TOTAL IMPERVIOUS AREA (ACRES):	2.98
WQv REQUIRED (CU. FT):	13433
WQv REQUIRED (AC. FT):	0.308
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	13433
TOTAL TREATED DA (ACRES):	20.37
TOTAL TREATED IMPERVIOUS AREA (ACRES):	2.00

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndnskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

MCKAIG ROAD – BMP A

SCALE 1" = 40' ADVERTISED DATE <TO BID DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. - OF SHEET NO. OF

PLOTTED: Friday, June 23, 2017 AT 06:26 PM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_McKaig.dgn

SPSC Design Calculations - Riffle

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **McKaig Road - BMP A** Engineer: **NMD**
Plan Number: Date: **10/6/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	20.37	acres	9.5	9.5
C-Factor:	0.76		0.76	0.76
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	145.60	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.1	ft/ft	Note: Start with 5%			
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1			
Design Depth (D) =	1.4	ft				Adequate
W =	20	ft	8 ft (min.)			-
d50 (Cobble) =	0.75	ft	Note: Start with 0.5			
Area (A) =	2WD / 3		=	18.67	SF	
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$		=	0.921		
n =	D^(1/6) / (21.6*log(D/d50)+14)			=	0.053	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	156.33	cfs	Adequate

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)				
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)		
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)		
=	8.37	ft/s			Supercritical Flow C = 0.86
Vmax =	Q / A	=	8.37	ft/s	Adequate
Fr =	V / ((g*D)^(1/2))		=	1.247	

Step C: Check Actual

dw =	1.400	ft	Note: Use Solver to make Q(act.) = Q(design)			
Wa =	20.00	ft				
A (act.) =	18.67	SF				
Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	0.921		
n(act.) =	dw^(1/6) / (21.6*log(dw/d50)+14)			=	0.053	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	156.33	cfs	Adequate

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	8.37	ft/s				Supercritical Flow C = 0.86
V (act.) =	Q (act.) / A(act.)		=	8.37	ft/s	Adequate
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	1.25		

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	2.2391	=	2.24	ft	MIN. REQUIRED DEPTH

IV. Water Quality Computations

Site Drainage Area (SA) =	20.37	acres
Contr. Imp. Area (IA) =	2.98	acres
Length Total (L Design) =	125	ft

Rv =	0.05+[0.009*((IA/SA)*100)]	=	0.182	
WQv =	(Rv*SA / 12) * 43560	=	13,433	CF

df (pool) =	2	ft	2.0 ft (min.)
df (riffle) =	2	ft	
df (average) =	2	ft	
Wsand =	10	ft	4 ft (min.)
Lsand =	125	ft	Length along project
Af (provided) =	1250	SF	
k =	3.5		
hf =	2.24	ft	
tf =	1.67	days	

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	1214	SF

-

Adequate

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

SPSC Design Calculations - Cascade

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **BMP #309 - BMP A** Engineer: **VLH**
Plan Number: Date: **9/28/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	20.37	acres	9.5	9.5
C-Factor:	0.76		0.76	0.76
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	145.60	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.1	ft/ft	Note: Start with 5%				
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1				
Design Depth (D) =	1.4	ft					Adequate
W =	22	ft	8 ft (min.)				-
d50 (Boulder) =	1.6	ft	Note: Start with 1.0 (MDSHA Classification)				Class 2
Area (A) =	2WD / 3		=	20.53	SF		
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$			=	0.923		
n =					=	**0.050**	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	183.48	cfs	Adequate

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	12.23	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	17.07	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	12.23	ft/s				Supercritical Flow C = 0.86
Vmax =	Q / A	=	8.94	ft/s		Adequate
Fr =	V / ((g*D)^(1/2))	=	1.33			

Step C: Check Actual

dw =	1.40	ft	Note: Use Solver to make Q(act.) = Q(design)
Wa =	22.00	ft	
A (act.) =	20.53	SF	

Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	0.923		
n(act.) =				=	**0.05**	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	183.48	cfs	Adequate

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	12.23	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	17.07	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	12.23	ft/s				Supercritical Flow C = 0.86
V (act.) =	Q (act.) / A(act.)	=	8.94	ft/s		Adequate
Fr(act.) =	V(act.) / ((g*dw)^(1/2))	=	1.33			

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	2.3899	=	2.39	ft	MIN. REQUIRED DEPTH

IV. Water Quality Requirement

Site Drainage Area (SA) =	20.37	acres
Contr. Imp. Area (IA) =	0.09	acres
Length (Total) =	260	ft
Length (Cascades) =	117	ft

Rv =	0.05+[0.009*((SA/IA)*100)]	=	0.05		
WQv =	(Rv*SA / 12) * 43560	=	3,980	CF	

df (pool) =	1.5	ft	1.5 ft (min.)	
df (riffle) =	1.5	ft		
df (average) =	1.5	ft		
Wsand =	6	ft	4 ft (min.)	-
Lsand =	143	ft		
Af (provided) =	858	SF		
k =	3.5			
hf =	2.39	ft		
tf =	1.67	days		

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	418.35	SF	Adequate

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

5-7: Ballenger Creek Trail, Parking and Loop - BMP A

Prioritization Ranking:	26
Planning Level Cost Estimate:	$ 81,765.75
Estimated Cost/Impervious Acre	$ 110,182.21

General BMP Information:		
Structure Location:	End of Mallard Lane	
ADC Map:	4686, A1 (2008)	
Nothing/Easting:	621,547.302/1,191,949.401	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Bioretention (F-6)	
Management Type:	Quality	
Total Drainage Area (ac):	1.82	
Total Impervious Area (ac):	1.02	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	3662.64	
Total Treated Drainage Area (ac):	1.82	
Total Treated Impervious Area (ac):	1.02	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	27.16	17.63
TP (lbs/yr):	2.37	1.11
TSS (lbs/yr):	1069.00	692.60

Existing conditions for BMP A

Site map for BMPs A, B, and C

EXISTING SITE CONDITIONS

This site is currently open field that is bounded on the north by Ballenger Creek and on the south by a residential community. The site is 90% actively farmed as row crops; the remaining 10% contains trees. There are three storm drain outfalls that drain to this site. No stormwater management controls currently exist at this location. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site via Mallard Lane. According to the County's parcel layer in GIS, this site is an open space dedicated to Frederick County. Utility access may be needed due to overhead power lines.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Utility Approval, Tree Impacts	

PROPOSED RETROFIT

There are three new BMPs proposed at this site. BMP A is a bioretention (F-6) and it will provide quality management for 1.82 acres including 1.02 acres of impervious area. Construction of an access road will be required to provide maintenance access to the facility. The Project Summary Sheet for BMPs B and C are included separately in Appendix E with a prioritization rankings of 27 and 31, respectively.

5-7: BALLENGER CREEK TRAIL, PARKING AND LOOP

Storm Water Management Retrofit Evaluation					
Report Date:	9/18/2015	**Design Approval:**	N/A	**Maintenance Owner:**	N/A
Structure No:	BMP A	**Year Constructed:**	N/A	**Inspection Date:**	6/23/2015
Structure Name:	Ballenger Creek Trail, Parking and Loop	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	VH, GL
Location:	End of Mallard Lane	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/21/2015 (0.10")
ADC Map:	4686, A1 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	621,547.302/1,191,949.401	**Stream Use:**	III-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Bioretention (F-6)	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quality	
Total Drainage Area (acres):			1.82	
Total Impervious Area within Drainage Area (acres):			1.02	
WQv Required:			3662.64 cu. ft.	0.084 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		3662.64 cu. ft.	0.084 ac-ft
Total Treated Drainage Area (acres):			1.82	
Total Treated Impervious Area within Drainage Area (acres):			1.02	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		0.99	
Total Nitrogen:			59.56%	
Total Phosphorus:			69.67%	
Sediment:			74.66%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		27.16	17.63
TP (lbs/yr):			2.37	1.11
TSS (lbs/yr):			1069.00	692.60
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 81,765.75**

Storm Water Management Retrofit Evaluation					
Report Date:	9/18/2015	**Design Approval:**	N/A	**Maintenance Owner:**	N/A
Structure No:	BMP B	**Year Constructed:**	N/A	**Inspection Date:**	6/23/2015
Structure Name:	Ballenger Creek Trail, Parking and Loop	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	VH, GL
Location:	End of Finch Court	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/21/2015 (0.10")
ADC Map:	4686, B1 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	621,291.226/1,190,958.082	**Stream Use:**	III-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Bioretention (F-6)	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quality	
Total Drainage Area (acres):			0.62	
Total Impervious Area within Drainage Area (acres):			0.32	
WQv Required:			1156.146 cu. ft.	0.027 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		1156.146 cu. ft.	0.027 ac-ft
Total Treated Drainage Area (acres):			0.62	
Total Treated Impervious Area within Drainage Area (acres):			0.32	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		1.01	
Total Nitrogen:			59.95%	
Total Phosphorus:			70.14%	
Sediment:			75.17%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		9.17	5.95
TP (lbs/yr):			0.77	0.36
TSS (lbs/yr):			344.92	223.47
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 25,652.00**

Storm Water Management Retrofit Evaluation					
Report Date:	9/18/2015	**Design Approval:**	N/A	**Maintenance Owner:**	N/A
Structure No:	BMP C	**Year Constructed:**	N/A	**Inspection Date:**	6/23/2015
Structure Name:	Ballenger Creek Trail, Parking and Loop	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	VH, GL
Location:	North of Robin Drive, south of Ballenger Creek	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/21/2015 (0.10")
ADC Map:	4686, B1 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	621,039.490/1,191,114.332	**Stream Use:**	III-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Surface Sand Filter (F-1)	
BMP Classification:			Stormwater Treatment (ST) Practice	
Management Type:			Quantity/Quality	
Total Drainage Area (acres):			11.02	
Total Impervious Area within Drainage Area (acres):			2.60	
WQv Required:			10494.248 cu. ft.	0.241 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		10494.248 cu. ft.	0.241 ac-ft
Total Treated Drainage Area (acres):			11.02	
Total Treated Impervious Area within Drainage Area (acres):			2.60	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		1.11	
Total Nitrogen:			35.91%	
Total Phosphorus:			56.44%	
Sediment:			71.83%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		87.76	56.95
TP (lbs/yr):			6.95	3.26
TSS (lbs/yr):			3528.91	2286.36
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 214,500.00**

5-7: BALLENGER CREEK TRAIL, PARKING AND LOOP

The Ballenger Creek Trail, Parking, and Loop was previously identified as Site No. 5-7 in *An Assessment of Stormwater Management Retrofit and Stream Restoration Opportunities in Ballenger Creek Watershed, Frederick County, Maryland* (hereafter referred to as the Ballenger R/R Report) developed by Versar, Inc. (August 2005). This project was selected for re-evaluation because the site was included in the untreated impervious area evaluation completed for the *Lower and Middle Mainstem of Ballenger Creek Stormwater Master Plan (SWMP)* as a potential location for a retrofit/restoration project but the SWMP did not include a feasibility concept.

Versar's proposed actions for the Ballenger Creek Trail, Parking, and Loop included incorporation of low impact development (LID) techniques to capture and treat stormwater runoff using infiltration and plant uptake. Three off-line bioretention cells were proposed, one at each of the existing storm drain outfalls. Dewberry has evaluated the previous recommendations and conducted a GIS desktop analysis and site visit and identified the most cost-effective retrofit/restoration approach for the site as described in detail below. All three BMPs should be constructed at the same time to reduce costs for mobilization.

Existing Site Conditions:

This site is currently open field that is bounded on the north by Ballenger Creek and on the south by a residential community. The site is 90% actively farmed as row crops; the remaining 10% contains trees. There are three storm drain outfalls that drain to this site: an 18" RCP (**Photos 1 and 2**) from Mallard Lane (Outfall #1), a 15" RCP (**Photos 3 and 4**) from Finch Court (Outfall #2), and a 30" RCP (**Photo 5**) from Robin Drive (Outfall #3). There is vegetation and debris below all outfalls and Outfalls #1 and #2 are 50-90% blocked. There is woody vegetation surrounding Outfall #3. There is a concrete control structure downstream of Outflow #3 (**Photo 6**). There is sediment, debris, and heavy woody vegetation around the control structure and in the outflow channel (**Photo 7**). No stormwater management controls currently exist at this location.

A site visit was conducted on June 23rd, 2015. **Figure 2** shows the location of photos taken during the visit.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site via Mallard Lane, Finch Court, and Robin Drive. According to the County's parcel layer in GIS, this site is an open space dedicated to Frederick County. Easements at this location should be evaluated further in final design. MOT is required to notify residents living in the surrounding area. Utility access may be needed due to overhead power lines.

Proposed Retrofit:

Based on the results of a GIS desktop analysis and site visit, it was determined that a bioretention should be installed at Outfalls #1 and #2 and a surface sand filter installed at Outfall #3.

BMPs A, B, and C are new BMPs proposed to treat the untreated impervious area on this site. For BMP A, the most appropriate BMP options fall under the infiltration and filtering systems BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed practice type for BMP A is a bioretention (F-6). It will provide quality management for 1.82 acres including 1.02 acres of impervious area. The proposed BMP is located at Outfall #1 at the end of Mallard Lane.

For BMP B, the most appropriate BMP options fall under the infiltration and filtering systems BMP groups groups (as listed in Table 3). Based on the results of the screening process described below, the proposed practice type for BMP B is a bioretention (F-6). It will provide quality management for 0.62 acres including 0.32 acres of impervious area. The proposed BMP is located at Outfall #2 at the end of Finch Court.

For BMP C, the most appropriate BMP options fall under the infiltration and filtering systems BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed practice type for BMP C is a surface sand filter (F-1). It will provide quality management for 11.02 acres including 2.60 acres of impervious area. The proposed BMP is located north of Robin Drive at Outfall #3. There is an existing concrete control structure below Outfall #3 which should be removed as part of the retrofit.

Additional Retrofit Opportunities:

In final design, access from Robin Drive can be evaluated for all three facilities, BMP A, BMP B and BMP C. Proposed access from Mallard Lane for BMP A may cause impacts to the residential properties. Proposed access from Finch Court for BMP B may cause residential concerns due to tree loss. The orientation of BMP C can be evaluated during final design in order to minimize impacts to the active farmland adjacent to the facility.

Step 1: Watershed Factors

BMPS A, B, and C are located in Frederick County's Ballenger Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use III-P. The BMP is not located within a Frederick County designated wellhead protection area. There are no special watershed factors and/or constraints that must be considered for retrofit design for BMPs A, B, and C.

Step 2: Terrain Factors

BMPs A, B, and C are located in a region of Frederick County that is prone to karst geology. Therefore, special terrain factors and/or constraints must be considered for retrofit design and include geotechnical testing, maximum ponding depths, and/or poly or clay liner requirements.

Step 3: Stormwater Treatment Suitability

For BMPs A, B, and C, 100% of the WQv can be provided within the proposed BMP. There is adequate space for each BMP within the open space parcel at each outfall. There are no safety concerns associated with the use of bioretentions or pocket sand filters. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The maximum drainage area for a bioretention is 5 acres. The proposed drainage areas for BMP A and BMP B are 1.82 acres and 0.62 acres, respectively. The maximum drainage area requirement for a surface sand filter is 10 acres, however, the drainage area can be larger in some instances. The drainage area for BMP C is 11.02 acres. The drainage areas to all the BMPs are composed of B soils. The likelihood of BMPs A, B, and C receiving hotspot runoff is low as they are part of a residential community. The land use within the drainage area to the BMP is not ultra-urban. Proposing new BMPs are feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP A is located off Mallard Lane and BMP B is located off of Finch Court and have high visibility. Bioretentions tend to have medium maintenance requirements, medium community acceptance, medium construction costs relative to the drainage area, and provide low habitat quality. BMP C is located north of Robin Drive and south of Ballenger Creek and has high visibility. Surface sand filters tend to have medium maintenance requirements, medium community acceptance, high construction costs relative to the drainage area, and provide low habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMPs A, B, and C include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Floodplain GIS Data indicates that the BMPs are within FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMPs are mapped as a wetland, however, are not an in-stream facility.

Figure 1: BMP Location Map – Existing Conditions

Figure 2: Photo Locations

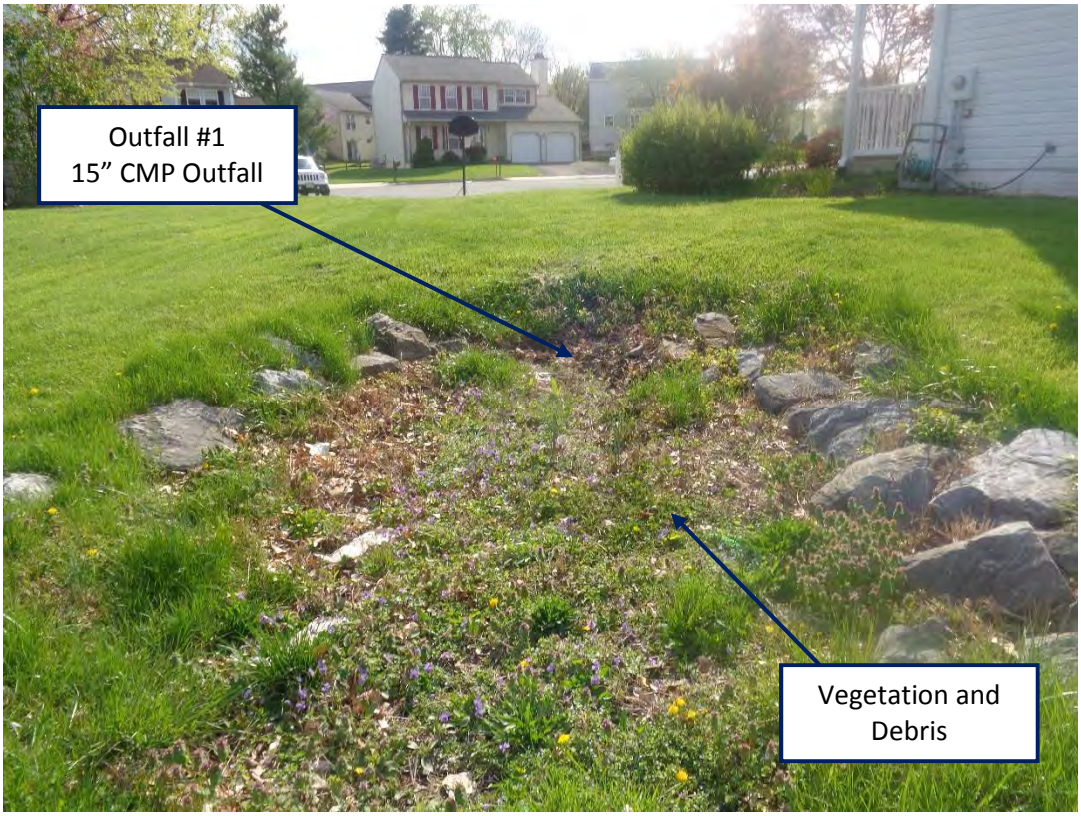


Photo 1: Outfall #1 facing southwest

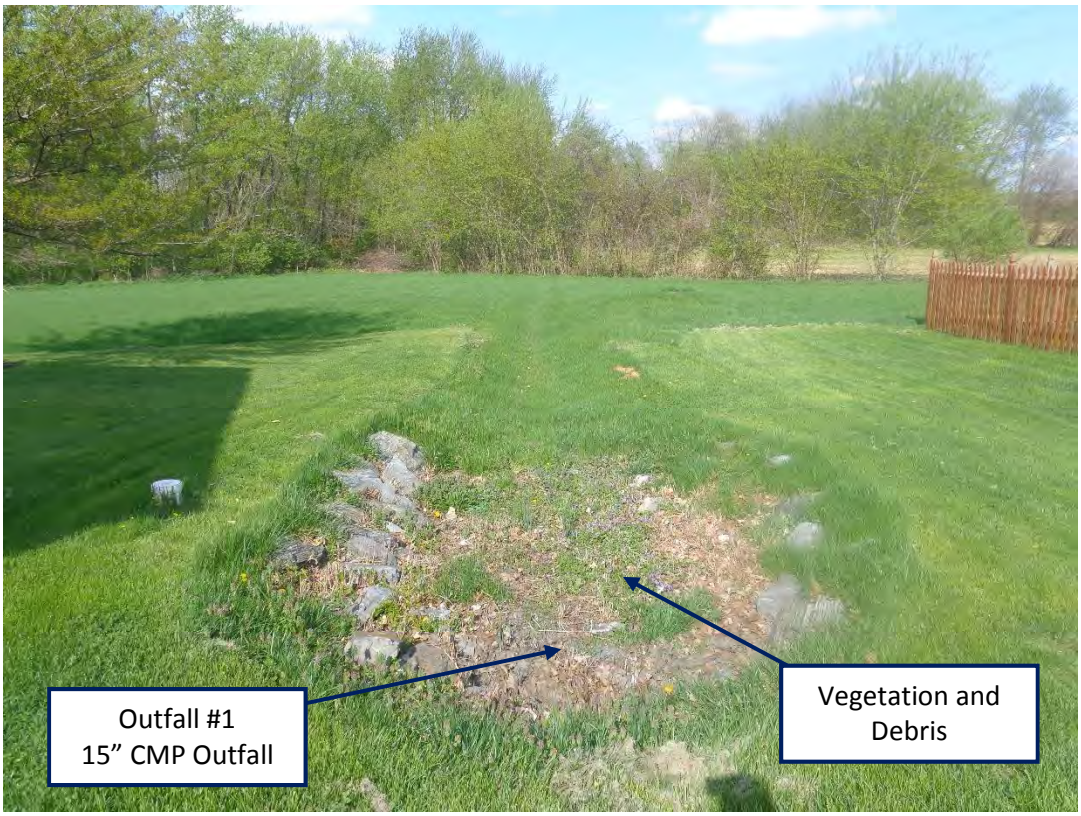


Photo 2: Downstream Outfall #1 facing northeast

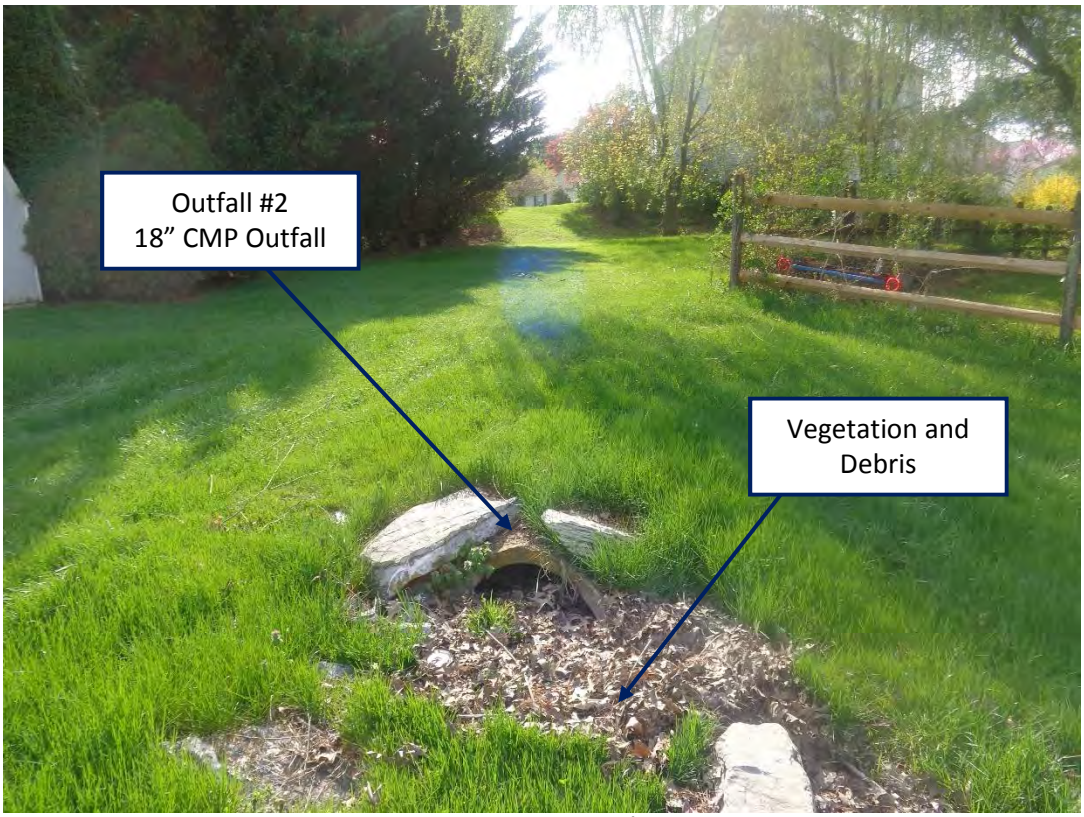


Photo 3: Outfall #2 facing west

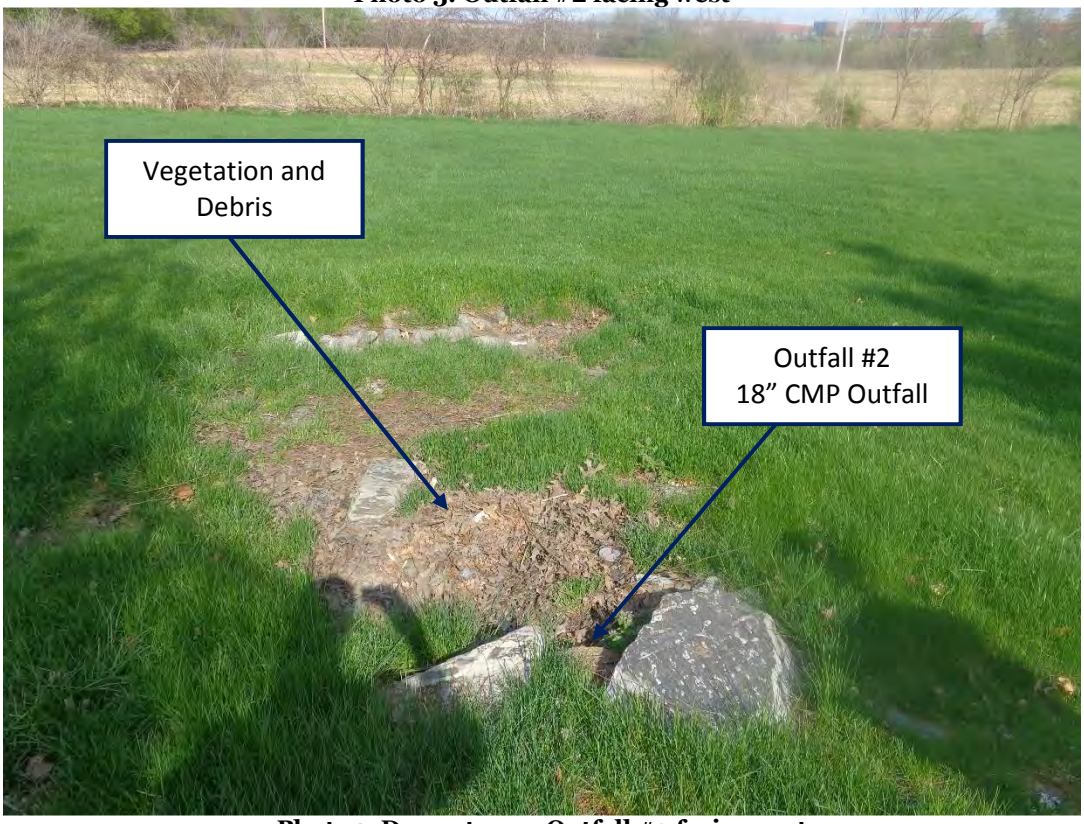
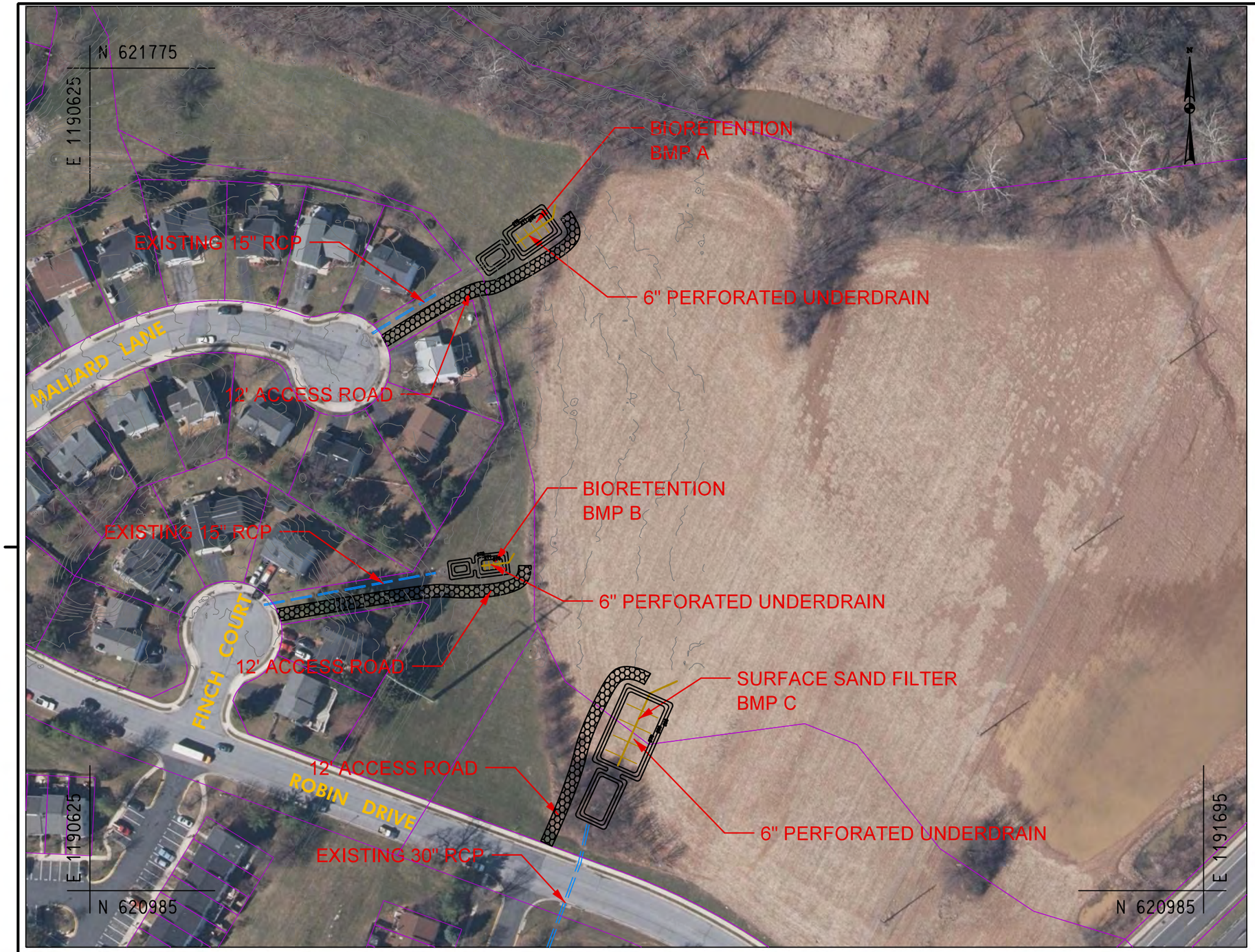


Photo4: Downstream Outfall #2 facing east

Photo 5: Outfall #3 facing southeast

Photo 6: Concrete control structure facing southeast

Photo 7: Outfall #3 channel facing north



GENERAL BMP INFORMATION - BMP A	
BMP TYPE:	BIORETENTION (F-6)
MANAGEMENT TYPE:	QUALITY
TOTAL DA (ACRES):	1.82
TOTAL IMPERVIOUS AREA (ACRES):	1.02
WQv REQUIRED (CU. FT):	3662.64
WQv REQUIRED (AC. FT):	0.084
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	3662.64
TOTAL TREATED DA (ACRES):	1.82
TOTAL TREATED IMPERVIOUS AREA (ACRES):	1.02

GENERAL BMP INFORMATION - BMP B	
BMP TYPE:	BIORETENTION (F-6)
MANAGEMENT TYPE:	QUALITY
TOTAL DA (ACRES):	0.62
TOTAL IMPERVIOUS AREA (ACRES):	0.32
WQv REQUIRED (CU. FT):	1156.146
WQv REQUIRED (AC. FT):	0.027
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	1156.146
TOTAL TREATED DA (ACRES):	0.62
TOTAL TREATED IMPERVIOUS AREA (ACRES):	0.32

GENERAL BMP INFORMATION - BMP C	
BMP TYPE:	SURFACE SAND FILTER (F-1)
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	11.02
TOTAL IMPERVIOUS AREA (ACRES):	2.6
WQv REQUIRED (CU. FT):	10494.248
WQv REQUIRED (AC. FT):	0.241
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	10494.248
TOTAL TREATED DA (ACRES):	11.02
TOTAL TREATED IMPERVIOUS AREA (ACRES):	2.6

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: vhamsher -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BALLENGER CREEK TRAIL, PARKING AND LOOP - BMPS A, B, & C

SCALE 1" = 100' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF - SHEET NO. - OF

PLOTTED: Wednesday, June 07, 2017 AT 02:42 PM
FILE: \\catoctfr\Projects\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSWM-P000_BALL-11.dgn

Project: **Ballenger Creek Trail, Parking** Bioretention (F-6)
BMP A
Preliminary Design:

Location: Frederick, Maryland
Watershed: **Stream Use:**

Site Area: 1.82 ac 0.00284 sqm

Measured Impervious Area: 1.02 ac
New Impervious Area = 0 ac
Redevelopment Area = 0 ac
Impervious Area Decrease = 0 ac

Impervious Area Needs to be Treated =
100% of New Impervious Area + 20% of Redevelopment Area
= - 80% of Net Impervious Area Decrease
= 1.02 ac

I = 0.560
= 56.04 %

Soil Type: B

RCN Post Development : - **tc =** 0.1 hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.554

Step 1(b): Rainfall Zone

Rainfall Zone: Western Rainfall zone with Rainfall (P)= 1 "

Step 1(c): Compute WQv

Water quality required for I = 56%

$WQ_{V(I)}$ = 0.084 ac-ft = 3663 cft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.030 ac-ft = 1321.32 cft

Water quality treatment required = 3662.6414 cft = 0.0841 ac-ft

Step 1(d): Water Quality Discharge

a. Runoff Volume = $Q_a = P*R_v$ = 0.5544 in

b. CN for W_Q storm = 94.86 (from page D.10.1 2000 MDE Stormwater Management Manual)

c. Initial Abstraction = I_a =(200/CN)-2 = 0.11

d. I_a/P = 0.11

e. Unit Peak Discharge = q_u = 972.5 csm/in (Figure D.11.1)

f. Water Quality Peak Flow = Q_w = (q_u csm/in)*(A mi^2)*(q_a in) = 1.53 cfs

Step 2: Pretreatment Volume $\left(A_s = \frac{Q_0}{W} \times E'\right)$

Step 2(a) Compute Pretreatment Volume: (25% of WQ_v)

Minimum Required V_p = 915.66 cft

Step 2(b) Compute Sedimentation Basin Minimum Surface Area: (A_{sf})

A_{sf} = (0.066)(WQv), if I<=75%
= 241.73 sft

Step 2(c) Design the Sedimentation Basin

Design Width (w) = 10 ft
Design Length (l) = 20 ft

Required Depth = 4.6 ft
Design Depth (d) = 1.5 ft

	Stage - Storage Data for Forebay					
Stage (ft)	Elevation (ft)	Area (sft)	Avg Area (sft)	Incr. (cft)	Storage (cft)	(ac-ft)
0.00	270.00	200.00			0.0	0
			249.50	249.5		
1.00	271.00	299.00			249.5	0.00573
			357.50	357.5		
2.00	272.00	416.00			607.0	0.01393

Use a Sedimentation Chamber 10 ft by 20 ft by 1.5 ft = 607.0 cft
(with side slopes of 3:1)

Provided Vp = 607.0 cft

Step 3: Treatment

Step 3(a) Compute Storage Volume prior to Filtration (including Pretreatment): (75% of WQ_v)

V_{temp} = 2746.98 cft

Step 3(b) Compute the Required Filter Bed Area: (Af)

$$A_f = (WQ_v)(d_f) \Big/ [k \times (h_f + d_f) \times t_f)]$$

Minimum Filter Bed Depth = 12"

Design Filter Bed Depth (d_f) = 12 "
= 1.00 ft

Filter Media: Bioretention Soil Mix
Coefficient of Permeability (k) = 3.5 ft/day

Filter Bed Drain Time (t_f) = 1.67 days

Design Temporary Ponding Height above the Filter Bed (t_p) = 2.25 ft

Design Average Height of Water above the Filter Bed (h_f) = 1.125 ft

A_f = 294.88 sft

Step 3(c) Design the Filter Chamber

Setting Width = 22 ft

Required Length = 13.4 ft
Design Length = 36 ft

Use a Filter Chamber 22 ft by 36 ft

Stage - Storage Data for Sand Filter								
Stage	Elevation	Area	Average Area	Incr. Storage	Total Storage		Storage Above Dead Storage	
(ft)	(ft)	(sft)	(sft)	(cft)	(cft)	(ac-ft)	(ac-ft)	(cft)
0.00	268.00	792.00			0.0	0.0000	0.0000	0.00
			883.50	883.5				
1.00	269.00	975.00			883.5	0.0203	0.0203	883.50
			1075.50	1075.5				
2.00	270.00	1176.00			1959.0	0.0450	0.0450	1958.99

$$V_{treatment} = (\boldsymbol{t_p} \times \boldsymbol{l} \times \boldsymbol{b}) + (\boldsymbol{d_f} \times \boldsymbol{l} \times \boldsymbol{b} \times 0.4)$$
$$= 2275.792223 \text{ cft}$$

Step 4: Check

$V_{temp} = V_p + V_{treatment} =$ 2882.79 cft

Required Vtemp = 2746.98 cft

Desgin Criteria Satisfication: Yes

Step 5: Compute Recharge Volume (Rev)

Step 5(a) : Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (ac)	Percentage (%)
A	0	0
B	1.82	100
C	0.00	0
D	0	0
Total	1.82	

Composite S: 0.2600 Use 26.00 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.022 ac-ft = 952 cft

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = 0.265 ac = 11552 sf

Recharge volume is included in the water quality volume.

The Rev requirement may be met by a) treating 0.017 ac-ft using structural method, b) treating 0.200 acres using non-structural methods, or c) a combination of both or it is part of WQv volume if not treated separately.

Project: **Ballenger Creek Trail, Parking** Bioretention (F-6)
BMP B
Preliminary Design:

Location: Frederick, Maryland
Watershed: **Stream Use:**

Site Area: 0.61 ac 0.00095 sqm

Measured Impervious Area: 0.32 ac
New Impervious Area = 0 ac
Redevelopment Area = 0 ac
Impervious Area Decrease = 0 ac

Impervious Area Needs to be Treated =
100% of New Impervious Area + 20% of Redevelopment Area
= - 80% of Net Impervious Area Decrease
= 0.32 ac

I = 0.525
= 52.46 %

Soil Type: B

RCN Post Development : - **tc =** 0.1 hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.522

Step 1(b): Rainfall Zone

Rainfall Zone: Western Rainfall zone with Rainfall (P)= 1 "

Step 1(c): Compute WQv

Water quality required for I = 52%

$WQ_{V(I)}$ = 0.027 ac-ft = 1156 cft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.010 ac-ft = 442.86 cft

Water quality treatment required = 1156.146 cft = 0.0265 ac-ft

Step 1(d): Water Quality Discharge

a. Runoff Volume = Q_a = P*R_v = 0.52213 in

b. CN for W_Q storm = 94.32 (from page D.10.1 2000 MDE Stormwater Management Manual)

c. Initial Abstraction = I_a =(200/CN)-2 = 0.12

d. I_a/P = 0.12

e. Unit Peak Discharge = q_u = 972.5 csm/in (Figure D.11.1)

f. Water Quality Peak Flow = Q_w = (q_u csm/in)*(A mi^2)*(q_a in) = 0.48 cfs

Step 2: Pretreatment Volume $\left(A_s = \frac{Q_0}{W} \times E'\right)$

Step 2(a) Compute Pretreatment Volume: (25% of WQ_v)

Minimum Required V_p = 289.04 cft

Step 2(b) Compute Sedimentation Basin Minimum Surface Area: (A_{sf})

A_{sf} = (0.066)(WQv), if I<=75%
= 76.31 sft

Step 2(c) Design the Sedimentation Basin

Design Width (w) = 6 ft
Design Length (l) = 12 ft

Required Depth = 4.0 ft
Design Depth (d) = 1.5 ft

	Stage - Storage Data for Forebay					
Stage (ft)	Elevation (ft)	Area (sft)	Avg Area (sft)	Incr. (cft)	Storage (cft)	(ac-ft)
0.00	270.00	72.00			0.0	0
			103.50	103.5		
1.00	271.00	135.00			103.5	0.00238
			175.50	175.5		
2.00	272.00	216.00			279.0	0.0064

Use a Sedimentation Chamber 6 ft by 12 ft by 1.5 ft = 279.0 cft
(with side slopes of 3:1)

Provided Vp = 279.0 cft

Step 3: Treatment

Step 3(a) Compute Storage Volume prior to Filtration (including Pretreatment): (75% of WQ_v)

V_{temp} = 867.11 cft

Step 3(b) Compute the Required Filter Bed Area: (Af)

$$A_f = (WQ_v)(d_f) \Big/ [k \times (h_f + d_f) \times t_f)]$$

Minimum Filter Bed Depth = 12"

Design Filter Bed Depth (d_f) = 12 "
= 1.00 ft

Filter Media: Bioretention Soil Mix
Coefficient of Permeability (k) = 3.5 ft/day

Filter Bed Drain Time (t_f) = 1.67 days

Design Temporary Ponding Height above the Filter Bed (t_p) = 2.25 ft

Design Average Height of Water above the Filter Bed (h_f) = 1.125 ft

A_f = 93.08 sft

Step 3(c) Design the Filter Chamber

Setting Width = 10 ft

Required Length = 9.3 ft
Design Length = 20 ft

Use a Filter Chamber 10 ft by 20 ft

Stage - Storage Data for Sand Filter								
Stage	Elevation	Area	Average Area	Incr. Storage	Total Storage		Storage Above Dead Storage	
(ft)	(ft)	(sft)	(sft)	(cft)	(cft)	(ac-ft)	(ac-ft)	(cft)
0.00	268.00	200.00			0.0	0.0000	0.0000	0.00
			249.50	249.5				
1.00	269.00	299.00			249.5	0.0057	0.0057	249.50
			357.50	357.5				
2.00	270.00	416.00			607.0	0.0139	0.0139	607.00

$$V_{treatment} = (\boldsymbol{t_p} \times \boldsymbol{l} \times \boldsymbol{b}) + (\boldsymbol{d_f} \times \boldsymbol{l} \times \boldsymbol{b} \times 0.4)$$
$$= 686.9975902 \text{ cft}$$

Step 4: Check

$V_{temp} = V_p + V_{treatment} =$ 966.00 cft

Required Vtemp = 867.11 cft

Desgin Criteria Satisfication: Yes

Step 5: Compute Recharge Volume (Rev)

Step 5(a) : Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (ac)	Percentage (%)
A	0	0
B	0.61	100
C	0.00	0
D	0	0
Total	0.61	

Composite S: 0.2600 Use 26.00 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.007 ac-ft = 301 cft

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = 0.083 ac = 3624 sf

Recharge volume is included in the water quality volume.

The Rev requirement may be met by a) treating 0.017 ac-ft using structural method, b) treating 0.200 acres using non-structural methods, or c) a combination of both or it is part of WQv volume if not treated separately.

Project: **Ballenger Creek Trail, Parking - BMP C** Surface Sand Filter (F-1)

Preliminary Design:

Location: Frederick County, Maryland
Watershed: Lower Monocacy River **Stream Use:** III-P

Site Area: 11.02 ac 0.01722 sqm

Measured Impervious Area: 2.6 ac
I = 0.236
= 23.59 %

Soil Type: B

RCN Post Development : - **tc =** 0.1 hr Minimum Tc

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.262

Step 1(b): Rainfall Zone

Rainfall Zone: Western Rainfall zone with Rainfall (P)= 1 inch

Per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 24%

$WQ_{V(I)}$ = 0.241 ac-ft = 10494 cft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.184 ac-ft = 8000.52 cft

Water quality treatment required = 10494.248 cft = 0.2409 ac-ft

Step 1(d): Water Quality Discharge

a. Runoff Volume = Q_a = P*R_v = 0.26234 in

b. CN for W_Q storm = 88.30 (from page D.10.1 2000 MDE Stormwater Management Manual)

c. Initial Abstraction = I_a =(200/CN)-2 = 0.26

d. I_a/P = 0.26

e. Unit Peak Discharge = q_u = 965 csm/in (Figure D.11.1)

f. Water Quality Peak Flow = Q_w = (q_u csm/in)*(A mi^2)*(q_a in) = 4.36 cfs

Step 2: Pretreatment Volume

$$\left(A_s = \frac{Q_0}{W} \times E'\right)$$

Step 2(a) Compute Pretreatment Volume: (25% of WQ_v)

Minimum Required V_p = 2623.56 cft

Step 2(b) Compute Sedimentation Basin Minimum Surface Area: (A_{sf})

A_{sf} = (0.066)(WQv), if I<=75%
= 692.62 sft

Step 2(c) Design the Sedimentation Basin

Design Width (w) = 20 ft Suggested Length to Width Ratio = 2:1
Design Length (l) = 40 ft

Required Depth = 3.3 ft
Design Depth (d) = 2 ft Maximum Depth = 2'

	Stage - Storage Data for Forebay					
Stage (ft)	Elevation (ft)	Area (sft)	Avg Area (sft)	Incr. (cft)	Storage (cft)	(ac-ft)
0.00	268.00	800.00			0.0	0
			894.50	894.5		
1.00	269.00	989.00			894.5	0.02053
			1092.50	1092.5		
2.00	270.00	1196.00			1987.0	0.04562

Use a Sedimentation Chamber (with side slopes of 3:1) 20 ft by 40 ft by 2 ft = 1987.0 cft

Provided Vp = 1987.0 cft

Step 3: Treatment

Step 3(a) Compute Storage Volume prior to Filtration (including Pretreatment): (75% of WQ_v)

V_{temp} = 7870.69 cft

Step 3(b) Compute the Required Filter Bed Area: (Af)

$$A_f = (WQ_v)(d_f) \Big/ [k \times (h_f + d_f) \times t_f)]$$

Minimum Filter Bed Depth = 12"

Design Filter Bed Depth (d_f) = 18 "
= 1.50 ft

Filter Media: SHA Bioretention Soil Mix
Coefficient of Permeability (k) = 2 ft/day

Filter Bed Drain Time (t_f) = 2 days

Design Temporary Ponding Height above the Filter Bed (t_p) = 2 ft

Design Average Height of Water above the Filter Bed (h_f) = 1 ft

A_f = 1574.14 sft

Step 3(c) Design the Filter Chamber

Setting Width = 38 ft

Required Length = 41.4 ft
Design Length = 70 ft

Use a Filter Chamber 38 ft by 70 ft

Stage - Storage Data for Sand Filter								
Stage	Elevation	Area	Average Area	Incr. Storage	Total Storage		Storage Above Dead Storage	
(ft)	(ft)	(sft)	(sft)	(cft)	(cft)	(ac-ft)	(ac-ft)	(cft)
0.00	268.00	2660.00			0.0	0.0000	0.0000	0.00
			2826.50	2826.5				
1.00	269.00	2993.00			2826.5	0.0649	0.0649	2826.49
			3168.50	3168.5				
2.00	270.00	3344.00			5995.0	0.1376	0.1376	5994.98

$$V_{treatment} = (t_p \times l \times b) + (d_f \times l \times b \times 0.4)$$
$$= 17606.93644 \text{ cft}$$

Step 4: Check

$V_{temp} = V_p + V_{treatment} =$ 7981.98 cft

Required Vtemp = 7870.69 cft

Design Criteria Satisfaction: Yes

Step 5: Compute Recharge Volume (Rev)

Step 5(a) : Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

$$Rev = \frac{(S)(Rv)(A)}{12}$$

HSG	Drainage Area (ac)	Percentage (%)
A	0	0
B	11.02	100
C	0.00	0
D	0	0
Total	11.02	OK: sum of the areas matches site Area

Composite S: 0.2600 Use 26.00 of site imperviousness

Step 5(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.063 ac-ft = 2729 cft

Step 5(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = 0.676 ac = 29446 sf

Recharge volume is included in the water quality volume.

The Rev requirement may be met by a) treating 0.063 ac-ft using structural method, b) treating 0.676 acres using non-structural methods, or c) a combination of both or it is part of WQv volume if not treated separately.

5-7: Ballenger Creek Trail, Parking and Loop - BMP B

Prioritization Ranking:	27
Planning Level Cost Estimate:	$ 25,652.00
Estimated Cost/Impervious Acre	$ 175,850.31

General BMP Information:		
Structure Location:	End of Finch Court	
ADC Map:	4686, B1 (2008)	
Nothing/Easting:	621,291.226/1,190,958.082	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Bioretention (F-6)	
Management Type:	Quality	
Total Drainage Area (ac):	0.62	
Total Impervious Area (ac):	0.32	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	1156.146	
Total Treated Drainage Area (ac):	0.62	
Total Treated Impervious Area (ac):	0.32	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	9.17	5.95
TP (lbs/yr):	0.77	0.36
TSS (lbs/yr):	344.92	223.47

Existing conditions for BMP B

Site map for BMPs A, B, and C

EXISTING SITE CONDITIONS

This site is currently open field that is bounded on the north by Ballenger Creek and on the south by a residential community. The site is 90% actively farmed as row crops; the remaining 10% contains trees. There are three storm drain outfalls that drain to this site. No stormwater management controls currently exist at this location. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site via Finch Court. According to the County's parcel layer in GIS, this site is an open space dedicated to Frederick County. Utility access may be needed due to overhead power lines.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Utility Approval, Tree Impacts	

PROPOSED RETROFIT

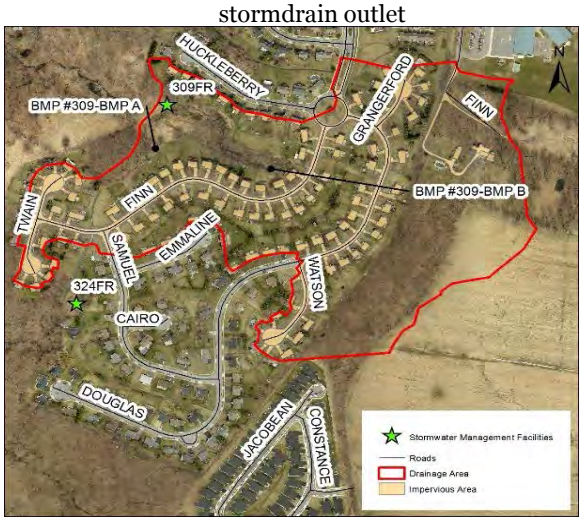
There are three new BMPs proposed at this site. BMP B is a bioretention (F-6) and it will provide quality management for 0.62 acres including 0.32 acres of impervious area. Construction of an access road will be required to provide maintenance access to the facility. The BMP A Project Summary Sheet, Assessment, and Concept Plan is included separately in Appendix E with a prioritization ranking of 26. The BMP C Project Summary Sheet is included separetely in Appendix E with a prioritization ranking of 31.

LL216: BMP #309 - Summerfield Pond No. 1 (EDSD) - BMP B

Prioritization Ranking:	28
Planning Level Cost Estimate:	$ 204,050.00
Estimated Cost/Impervious Acre	$ 110,935.05

General BMP Information:		
Structure Location:	Huckleberry Way	
ADC Map:	4568, C8 (2008)	
Nothing/Easting:	632,218.729/1,228,161.938	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Regenerative Step Pool Conveyance	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	33.10	
Total Impervious Area (ac):	5.90	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	25283	
Total Treated Drainage Area (ac):	10.11	
Total Treated Impervious Area (ac):	2.00	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	149.32	54.63
TP (lbs/yr):	8.19	3.84
TSS (lbs/yr):	5283.01	3422.83

Eroded inflow channel downstream of BMP B stormdrain outlet



Site map for BMP #309 - BMP B

EXISTING SITE CONDITIONS

BMP #309 was designed as an extended detention dry pond. The facility was constructed south of Huckleberry Way and west of Finn Drive as shown in the site map above. According to Frederick County's Urban BMP Database the drainage area for this BMP is 44.9 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 50.55 acres. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

According to the plans, access is available via a 30' storm drain and stormwater management easement that connects the south end of the embankment to Finn Drive. There are no other obvious site constraints such as utilities or steep slopes.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: Acquisition of Easements, MOT, Tree Impacts	

PROPOSED RETROFIT

There are three BMPs proposed at this location: one retrofit and two new BMPs. The proposed new BMP B is a 380 foot long regenerative step pool conveyance. It will provide quantity and quality management for 9.50 acres including 2 acres of impervious area. The Project Summary Sheets for the BMP #309 retrofit and new BMP A are included separately in Appendix E with a prioritization ranking of 32 and 29, respectively.

LL216: BMP # 309 – SUMMERFIELD POND NO. 1

Storm Water Management Retrofit Evaluation					
Report Date:	9/15/2015	**Design Approval:**	10/31/1988	**Maintenance Owner:**	Lake Linganore Association, Inc.
Structure No:	BMP #309	**Year Constructed:**	6/18/1996	**Inspection Date:**	5/20/2015
Structure Name:	Summerfield Pond No. 1	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, GL
Location:	Huckleberry Way	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	5/19/2015 (0.14")
ADC Map:	4568, C8 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	632,218.729/1,228,161.938	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Extended Detention Dry Pond		Wet Extended Detention Pond (P-3)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity/Quality		Quantity/Quality		
Total Drainage Area (acres):	44.09		50.55		
Total Impervious Area within Drainage Area (acres):	Unknown		10.01		
WQv Required:	Unknown		41877	cu. ft.	0.961 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	No		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	25126	cu. ft.	0.577 ac-ft
Total Treated Drainage Area (acres):	44.09	0	30.94		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	6.01		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.15		
Total Nitrogen:			36.21%		
Total Phosphorus:			56.90%		
Sediment:			72.41%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		244.26		89.36
TP (lbs/yr):	0		17.97		8.43
TSS (lbs/yr):	0		13669.16		8856.16
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):					**$ 630,998.50**

Storm Water Management Retrofit Evaluation					
Report Date:	9/15/2015	**Design Approval:**	10/31/1988	**Maintenance Owner:**	Lake Linganore Association, Inc.
Structure No:	BMP #309 - A	**Year Constructed:**	6/18/1996	**Inspection Date:**	5/20/2015
Structure Name:	Summerfield Pond No. 1	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, GL
Location:	Huckleberry Way	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	5/19/2015 (0.14")
ADC Map:	4568, C8 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	632,218.729/1,228,161.938	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	Extended Detention Dry Pond		Regenerative Step Pool Conveyance	
BMP Classification:	N/A		Runoff Reduction (RR) Practice	
Management Type:	Quantity/Quality		Quantity/Quality	
Total Drainage Area (acres):	44.09		9.50	
Total Impervious Area within Drainage Area (acres):	Unknown		3.33	
WQv Required:	Unknown		12603 cu. ft.	0.289 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes	
Adequate ROW (Y/N):	Yes		Yes	
Adequate Access (Y/N):	No		Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	Unknown	0	12603 cu. ft.	0.289 ac-ft
Total Treated Drainage Area (acres):	44.09	0	9.50	
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	2.00	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.73	
Total Nitrogen:			66.21%	
Total Phosphorus:			77.38%	
Sediment:			83.02%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		138.05	50.50
TP (lbs/yr):	0		7.78	3.65
TSS (lbs/yr):	0		5016.41	3250.10
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 204,050.00**

Storm Water Management Retrofit Evaluation					
Report Date:	9/15/2015	**Design Approval:**	10/31/1988	**Maintenance Owner:**	Lake Linganore Association, Inc.
Structure No:	BMP #309 - B	**Year Constructed:**	6/18/1996	**Inspection Date:**	5/20/2015
Structure Name:	Summerfield Pond No. 1	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, GL
Location:	Huckleberry Way	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	5/19/2015 (0.14")
ADC Map:	4568, C8 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	632,218.729/1,228,161.938	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	Extended Detention Dry Pond		Regenerative Step Pool Conveyance	
BMP Classification:	N/A		Runoff Reduction (RR) Practice	
Management Type:	Quantity/Quality		Quantity/Quality	
Total Drainage Area (acres):	44.09		33.10	
Total Impervious Area within Drainage Area (acres):	Unknown		5.90	
WQv Required:	Unknown		25283 cu. ft.	0.580 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes	
Adequate ROW (Y/N):	Yes		Yes	
Adequate Access (Y/N):	No		Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	Unknown	0	25283 cu. ft.	0.580 ac-ft
Total Treated Drainage Area (acres):	44.09	0	10.11	
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	2.00	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		2.50	
Total Nitrogen:			67.70%	
Total Phosphorus:			78.81%	
Sediment:			84.90%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		149.32	54.63
TP (lbs/yr):	0		8.19	3.84
TSS (lbs/yr):	0		5283.01	3422.83
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 204,050.00**

LL216: BMP # 309 – SUMMERFIELD POND NO. 1

Summerfield – LID 2 was previously identified as Project ID LL216 in *An Assessment of Stormwater Management Retrofit and Stream Restoration Opportunities in Linganore Creek Watershed, Frederick County, Maryland* (hereafter referred to as the Linganore R/R Report) developed by Versar, Inc. (July 2006). This project location was selected for re-evaluation because a GIS desktop analysis determined that the majority of the area drains to an existing, pre-2002 BMP which has a higher amount of impervious area draining to it.

Versar's proposed actions included retrofitting structure BMP #309 (ED dry pond) control structure to meet MD2000 standards and three bioretention cells. Dewberry has evaluated the previous recommendations and conducted a GIS desktop analysis and site visit and identified the most cost-effective retrofit/restoration approach for the site as described in detail below. Dewberry's proposed retrofit includes retrofitting existing BMP #309 from an extended detention dry pond to a wet extended detention pond and proposing two new regenerative step pool conveyances (BMPs A and B).

Existing Site Conditions:

SWM Era: 1985-2002

According to Frederick County's Urban BMP Database, BMP #309 has been identified as an extended detention dry pond. The facility was constructed south of Huckleberry Way and west of Finn Drive as shown in the BMP Location map (**Figure 1**). The BMP Database from the County indicates that the original design for BMP #309 provides management for quantity and quality and that the total treatment area for the BMP is 44.9 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 50.55 acres. Figure 1 shows the drainage area for the facility. Design plans were available for this BMP, and show that the facility has the following features: three inflows into the facility- a 21" RCP from the southwest (Inflow #1), a 24" CMP from the east (Inflow #2), and a 27" RCP from the southeast (Inflow #3), one 6" ductile iron low flow orifice, a 42" CMP riser, and a 30" CMP principal spillway. The majority of land use is residential with some forested areas.

General Observations:

A site visit was conducted on May 20th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has three inflow points which are all from closed section. Inflow #1 is a 21" RCP that discharges to a riprap channel from the southwest and flows into BMP #309 **(Photo 1)**. Inflow #1 has major erosion, visible geotextile, and large amounts of tree debris **(Photos 2, 3, and 4)**. Inflow #2 is a 24" CMP that discharges to a riprap channel from the east between two residences and combines with Inflow #3. The pipe leading to the riprap channel was not visible due to tree growth. Inflow #2 has ponding water, accumulated debris, tree growth at the inlet, and erosion at a pedestrian path **(Photo 5)**. The condition of the CMP pipe is unknown due to standing water and accumulated debris at Inflow #2. A previously constructed wooden pedestrian bridge over the channel for Inflow #2 has failed due to the erosion **(Photo 6)**. Inflow #3 is a 27" RCP that discharges to a riprap channel that conveys flow from the southeast to combine with Inflow #2 **(Photo 7)**. The concrete pipe and riprap channel is located between two residences. Inflow #3 has tree growth in the riprap channel and ponding water. The inflows require some maintenance as debris and vegetation is inhibiting positive drainage.

Control Structure and Spillways:

According to the Urban BMP Database and design plans provided by Frederick County, the control structure for this facility is a 42" riser with a 30" CMP barrel and 6" low flow orifice. The riser is constructed of CMP with a concentric trash rack and anti-vortex device **(Photo 8)**. The low flow orifice was not visible during the site visit due to accumulated sediment. Flowing water could be heard within the riser structure. The riser structure was in good condition. The principal spillway for the BMP is via a 24" CMP as measured in the field. Water was flowing out of the principal spillway during the site visit.

The 20' by 20' emergency spillway is located on the south end of the embankment between the dry detention pond and the principal outlet **(Photo 9)**. The emergency spillway appears to be in good condition except for a few trees growing in the embankment area.

Embankment:

A fill embankment is present between the dry detention pond and principal outlet**.** The embankment is fully covered by grass but also has some small tree stumps located on both sides of the embankment **(Photo 10)**. Overall the embankment appears to be in good condition. According to the design plans, a cut-off trench was installed.

Outflow:

The 24" principal spillway outlets the BMP west of the riser **(Photo 11)**. During the site visit, water was flowing from the outflow. The outfall had some ponding water but is otherwise is in stable condition **(Photo 12)**.

Overall BMP:

Excess vegetation is present at Inflows #2 and #3. Large amounts of vegetation debris are in the rip-rap channels of Inflows #1 and #2. Flowing water occurs at Inflow #3 and the outflow, however 0.14" of rain fell the day before. Erosion at Inflow #2 has caused a pedestrian bridge to fail. Moderate problems are observed, however, the BMP is functioning as designed with no critical parameters but with some problem conditions. BMP performance is being compromised.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site from two locations along Finn Drive. According to the plans, access is available via a 30' storm drain and stormwater management easement that connects the south end of the embankment to Finn Drive **(Photo 13)**. Easements at this location must be evaluated further at final design. A second access location is the short paved path between two residences directly east of the facility.

Proposed Retrofit:

Based on the results of a GIS desktop analysis and site visit, it was determined that the entire impervious area drains to BMP #309. Due to site constraints (such as steep topography and limited area), the full water quality volume required cannot be provided within the BMP #309 retrofit. Therefore, the most cost-effective retrofit option is to retrofit BMP #309 to treat as much as possible and install two new BMPs (BMP A and BMP B) below the three storm drain outfalls to provide the remaining water quality treatment.

BMP #309 was originally designed as an extended detention dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #309 is a wet extended detention pond (P-3). The proposed retrofit will provide quantity and quality management for 50.55 acres including 10.01 acres of impervious area.

The most appropriate options for the new BMPs are two regenerative step pool conveyances below the three pipe outfalls. BMP A will provide quality management for 9.50 acres including 2 acres of impervious area as shown in the **Concept Plans**. Proposed BMP A will include five 14' cascades and five 25' cobble riffles, with a total regenerative step pool conveyance length of 195 feet. BMP B will provide quality management for 10.11 acres including 2 acres of impervious area as shown in the **Concept Plans**. Proposed BMP B will include five 26' cascades and five 50' cobble riffles, with a total regenerative step pool conveyance length of 380 feet.

Additional Retrofit Opportunities:

In final design, BMP #309 outfall modifications should be evaluated to determine if modifications will make the area more stable. In addition, the regenerative step pool conveyance lengths should be evaluated to determine if the length should extend further towards the BMP #309 wet pool.

Step 1: Watershed Factors

BMP #309 is located in Frederick County's Ballenger Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #309 due to the downstream coldwater conditions. For the retrofit of BMP #309, 100% of the WQv can be treated within the existing BMP footprint in nearby open space (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek.

Step 2: Terrain Factors

BMP #309 is located in a region of Frederick County that is not prone to karst geology. Therefore, no special terrain factors and/or constraints must be considered for retrofit design.

Step 3: Stormwater Treatment Suitability

The existing BMP provides quantity management for the 2-, 10-, and 100-year storms. For the retrofit of BMP #309, 33% of the WQv can be provided within the existing BMP bottom and the downstream channel is in good condition. Therefore, there are no safety concerns and additional water quantity management is not required. There is adequate space for the proposed retrofit within the open space parcel. The concept design level calculations for the proposed retrofit are provided in Appendix E.

For BMPs A and B, a regenerative step pool conveyance is feasible below the existing storm drain outfalls. There is adequate space for BMP A within the existing SWM easement. BMP B is proposed on private property and will require an easement (**Photo 20**). The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a wet extended detention pond is 25 acres. The proposed drainage area to BMP #309 is 50.55 acres and is composed of A and C soils. The likelihood of BMP #309 receiving hotspot runoff is low as it is located within a residential community. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban. Retrofitting the existing BMP into a wet pond is feasible at this location per the preliminary assessment of physical factors.

The maximum drainage area for a regenerative step pool conveyance is 30 acres, however the drainage area can be larger in some instances. The proposed drainage area for BMP A is 9.50 acres and is composed of C soils. The proposed drainage area for BMP B is 10.11 acres and is composed of A soils. The likelihood of BMPs A and B receiving hotspot runoff is low as it is located within a residential area. Proposing a new BMP is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP #309 is located to the south of Huckleberry Way and west of Finn Drive Court and has high visibility. Wet extended detention ponds tend to have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide high habitat quality.

BMPs A and B are located below the existing storm drain outfalls south of BMP #309 and have visibility. Regenerative step pool conveyances tend to have low maintenance requirements, medium community acceptance, and medium cost relative to the drainage area with medium habitat quality in comparison with other BMP selections. Existing Inflow #2 and proposed BMP B are shown within a private parcel per available GIS data; therefore, the need for easements from the private property owner must be evaluated at final design.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #309 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

Figure 2: Photo Locations

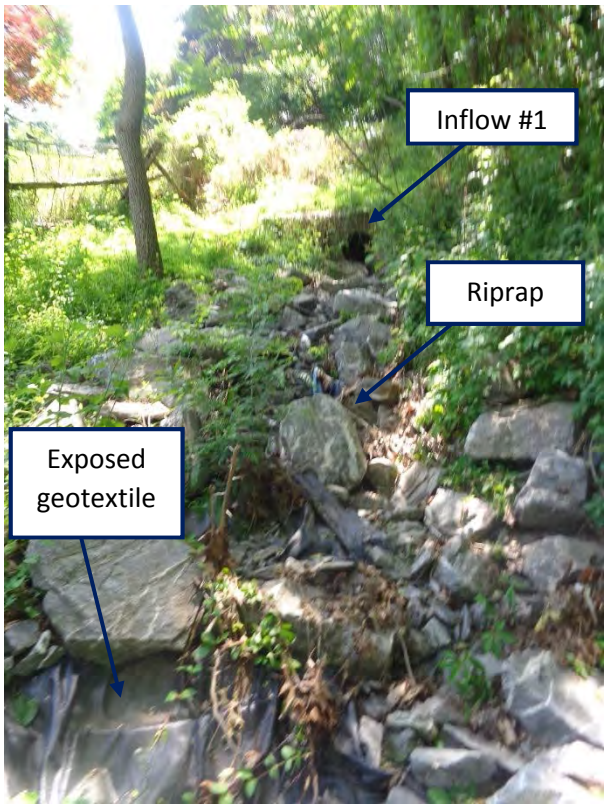


Photo 1: Inflow #1 from the northeast

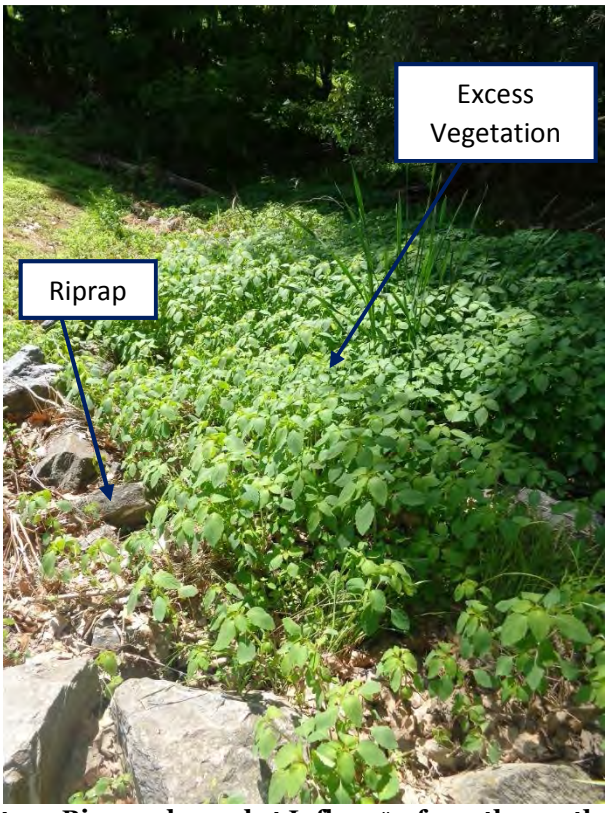


Photo 2: Riprap channel at Inflow # 1 from the southwest

Photo 3: Inflow #1 channel from the southwest

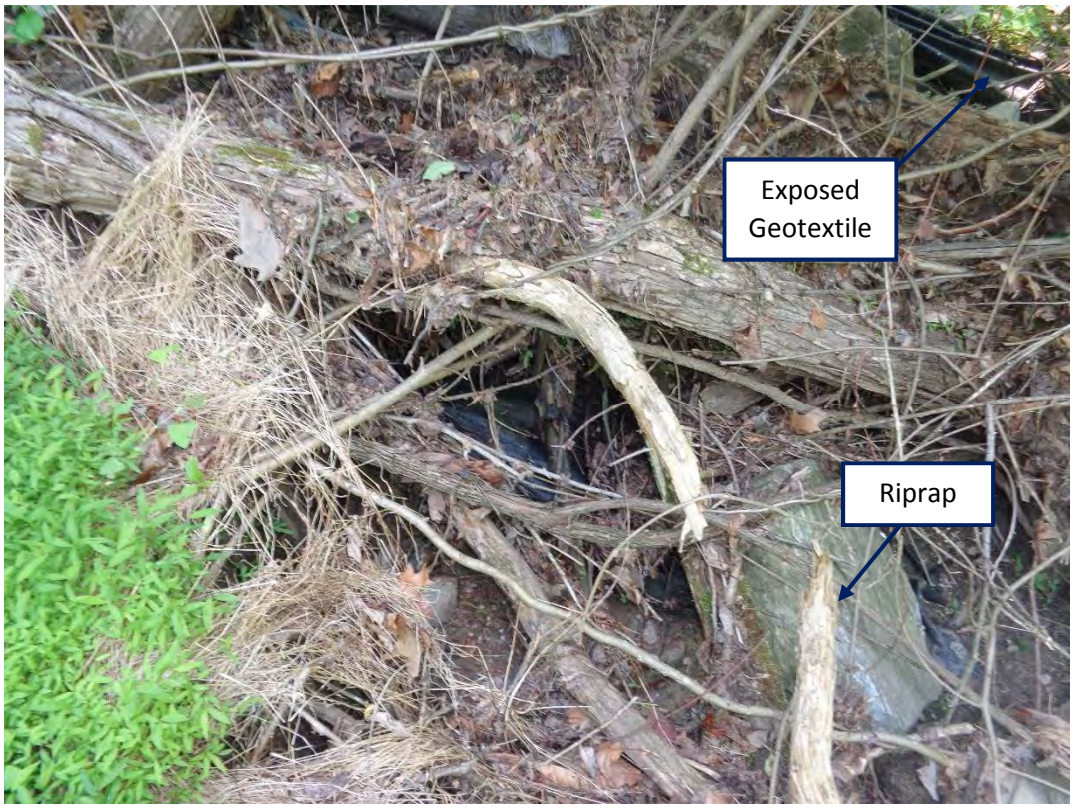


Photo 4: Tree Debris at Inflow #1 from the northeast

Photo 5: Inflow #2 from the west

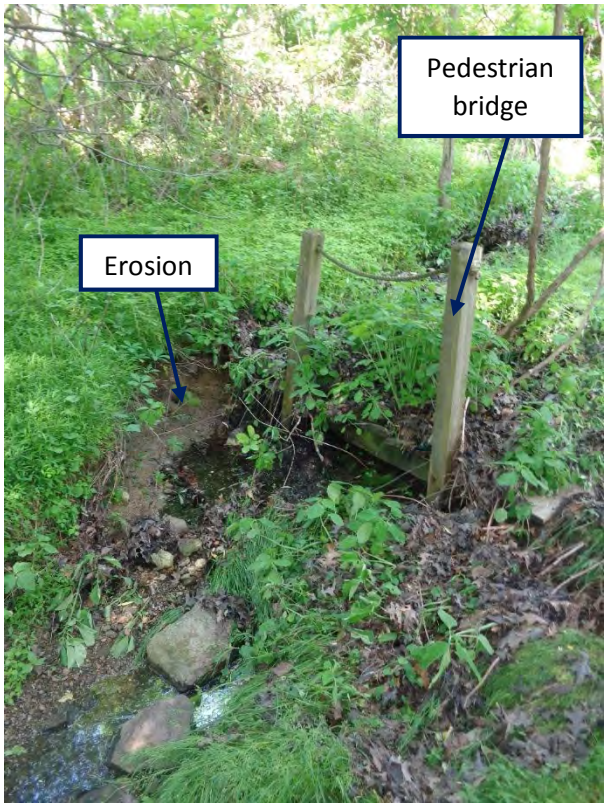


Photo 6: Inflow #2 from the southwest

Photo 7: Inflow #3 from the southwest

Photo 8: Riser from the southwest

Photo 9: Emergency Spillway from the north

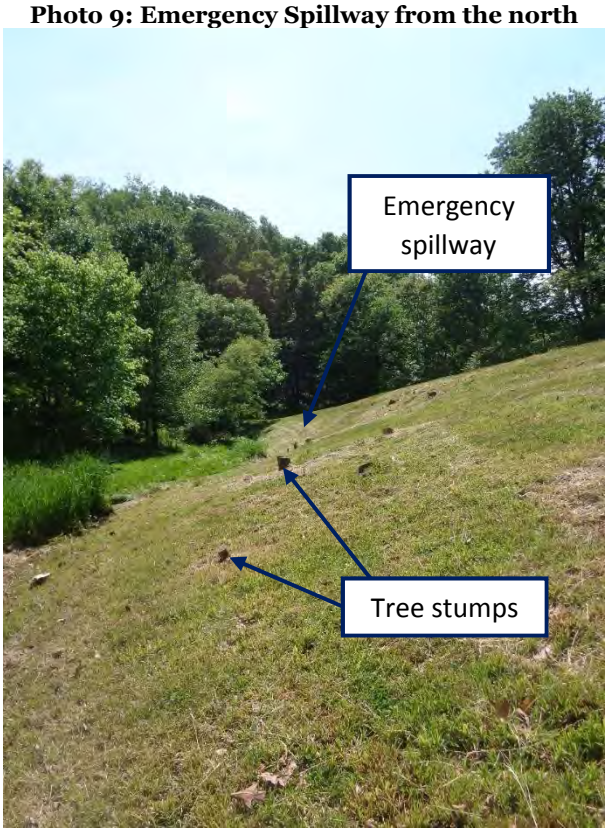


Photo 10: Upstream Embankment from the south

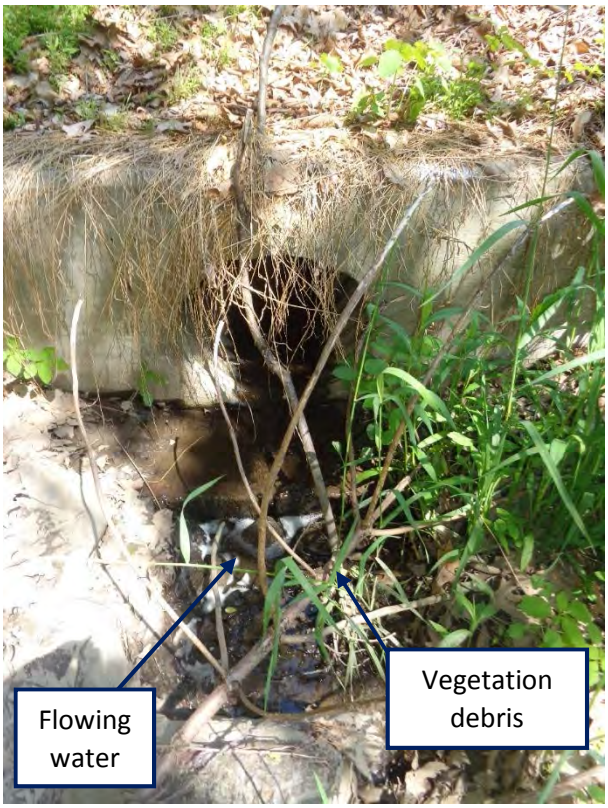


Photo 11: Outfall from the west

Photo 12: Downstream of Outfall from the east

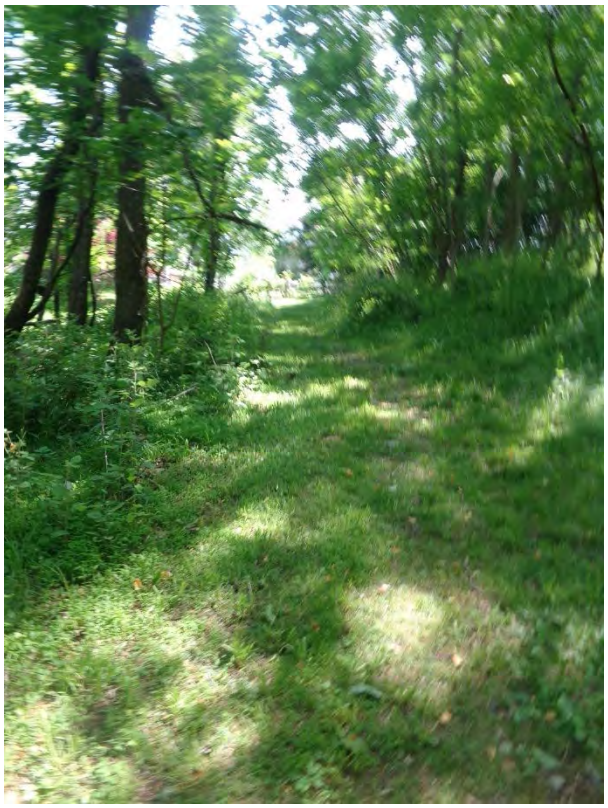


Photo 13: Access route from Finn Drive from the northeast

GENERAL BMP INFORMATION	
BMP TYPE:	WET EXTENDED DETENTION POND (P-3)
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	50.55
TOTAL IMPERVIOUS AREA (ACRES):	10.01
WQv REQUIRED (CU. FT):	41877
WQv REQUIRED (AC. FT):	0.961
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	25126
TOTAL TREATED DA (ACRES):	30.94
TOTAL TREATED IMPERVIOUS AREA (ACRES):	6.01

GENERAL BMP INFORMATION - BMP A	
BMP TYPE:	REGENERATIVE STEP POOL CONVEYANCE
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	9.5
TOTAL IMPERVIOUS AREA (ACRES):	3.33
WQv REQUIRED (CU. FT):	12603
WQv REQUIRED (AC. FT):	0.289
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	12603
TOTAL TREATED DA (ACRES):	9.5
TOTAL TREATED IMPERVIOUS AREA (ACRES):	2

GENERAL BMP INFORMATION - BMP B	
BMP TYPE:	REGENERATIVE STEP POOL CONVEYANCE
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	33.1
TOTAL IMPERVIOUS AREA (ACRES):	5.9
WQv REQUIRED (CU. FT):	25283
WQv REQUIRED (AC. FT):	0.58
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	25283
TOTAL TREATED DA (ACRES):	10.11
TOTAL TREATED IMPERVIOUS AREA (ACRES):	2

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #309 - SUMMERFIELD POND NO. 1

SCALE 1" = 100' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. – OF SHEET NO. OF

BY: ndriskill -

PLOTTED: Wednesday, June 21, 2017 AT 10:14 AM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP309.dgn

EXTENDED DETENTION WET POND DESIGN (P-2): BMP #309

This spreadsheet is for **design level calculations** of Extended Detention Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2011)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project: **SWM BMP Retrofit Assessment** Engineer:

Location: **Frederick County, MD** Date: **9/14/2015**

Watershed: **Lower Monocacy River** As Built:

Drainage Area: **50.55 (Total)** Acres 0.079 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **10.01** Acres **I =** 0.198

= 19.8 %

Soil Type: **A, B, C**

RCN Existing : **0** **Existing tc =** **0.00** hr

RCN Post Development : **72** **Post-D tc =** **0.70** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.228

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (1.0" for Eastern Rainfall Zone, 0.9" for Western Rainfall zone)
1" selected per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 19.8 %

$WQ_{V(I)}$ = 0.961 ac-ft = 41877 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.843 ac-ft = 36699.3 cu.ft

Water quality treatment required =	**41877**	**cu.ft**	**=**	**0.9614**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft**	**=**	**0.0000**	ac-ft	
Net water quality treatment required =	**41877**	**cu.ft**	**=**	**0.9614**	ac-ft	
Sediment Forebay Volume Required=	**4188**	**cu.ft**	**=**	**0.0961**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**37689**	**cu.ft**	**=**	**0.8652**	ac-ft	
Elevation at the Top of WQv in pond =	**412.84**	**ft**				

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	20939
II	50% of WQv is in micropool	20939
III	1/3 of WQV is in micropool & forebay	9771
IV	1/3 of WQV is in micropool & forebay	9771

***source: SHA SWM Workshop, April 30, 2003**

Micropool storage volume required = **9771** **cu.ft** **=** **0.2243** **ac-ft**

Extended Detention Storage= **9771** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **412.84** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.11** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr
2.78

With WQv, determine the required orifice area (Ao) for extended detention design:

Assume h_o = **0.00** ft *Will change based on pond volume

Ao = #DIV/0! sf

Determine the required orifice diameter (d_o)

Do = #DIV/0! ft = **#DIV/0!** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

	HSG	Drainage Area (Acres)	Percentage (%)
	A	**4.42**	9
50.55	B	**28.54**	56
	C	**17.60**	35
	D	**0.00**	0
	Total	**50.55**	OK: sum of the areas matches site Area

Composite S: 0.2252 Use 22.52 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.217 ac-ft = **9432** cu.ft

Rev in Pond= **5244**

El of Rev= **1.53** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **2.255** Acres = 98206 sf

The Rev requirement may be met by:

a) treating 0.217 ac-ft using structural method,

b) treating 2.255 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	SWM BMP Retrofit Assessment	Engineer:	VLH
Location:	Frederick County, MD	Date:	9/14/2015
Watershed:	Lower Monocacy River		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
4344.3	**411.0**	0.10	0.00	0.00	0.00	0.00
5394.0	**412.0**	0.12	1.00	0.11	0.11	4859.68
6515.3	**413.0**	0.15	1.00	0.14	0.25	10805.48
7699.9	**414.0**	0.18	1.00	0.16	0.41	17904.82
8946.5	**415.0**	0.21	1.00	0.19	0.60	26220.23
10256.5	**416.0**	0.24	1.00	0.22	0.82	35814.31
0.0	**0.0**	0.00	0.00	0.00	0.00	0.00
0.0	**0.0**	0.00	0.00	0.00	0.00	0.00
0.0	**0.0**	0.00	0.00	0.00	0.00	0.00
0.0	**0.0**	0.00	0.00	0.00	0.00	0.00
0.0	**0.0**	0.00	0.00	0.00	0.00	0.00

No. of valid row entries= 6

SPSC Design Calculations - Riffle

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **BMP #309 - BMP A** Engineer: **VLH**
Plan Number: Date: **9/28/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	9.5	acres	9.5	9.5
C-Factor:	0.72		0.72	0.72
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	64.33	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.05	ft/ft	Note: Start with 5%				
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1				
Design Depth (D) =	1.6	ft					**Adequate**
W =	10	ft	8 ft (min.)				**-**
d50 (Cobble) =	0.75	ft	Note: Start with 0.5				
Area (A) =	2WD / 3		=	10.67	SF		
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$			=	0.999		
n =	D^(1/6) / (21.6*log(D/d50)+14)				=	0.051	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	69.29	cfs	**Adequate**

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	11.69	ft/s				**Subcritical Flow C = 1.2**
Vmax =	Q / A	=	6.50	ft/s		**Adequate**
Fr =	V / ((g*D)^(1/2))		=	0.905		

Step C: Check Actual

dw =	1.60	ft	Note: Use Solver to make Q(act.) = Q(design)				
Wa =	10.00	ft					
A (act.) =	10.67	SF					
Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$			=	0.999		
n(act.) =	dw^(1/6) / (21.6*log(dw/d50)+14)				=	0.051	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	69.29	cfs	**Adequate**

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	8.37	ft/s				**Supercritical Flow C = 0.86**
V (act.) =	Q (act.) / A(act.)		=	6.50	ft/s	**Adequate**
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	0.91		

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	2.0053	=	2.01	ft	**MIN. REQUIRED DEPTH**

IV. Water Quality Computations

Site Drainage Area (SA) =	9.5	acres
Contr. Imp. Area (IA) =	3.33	acres
Length Total (L Design) =	125	ft

Rv =	0.05+[0.009*((IA/SA)*100)]	=	0.365	
WQv =	(Rv*SA / 12) * 43560	=	12,603	CF

df (pool) =	2	ft	2.0 ft (min.)	
df (riffle) =	2	ft		
df (average) =	2	ft		
Wsand =	10	ft	4 ft (min.)	-
Lsand =	125	ft	Length along project	
Af (provided) =	1250	SF		
k =	3.5			
hf =	2.01	ft		
tf =	1.67	days		

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	1081	SF	**Adequate**

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

SPSC Design Calculations - Cascade

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **BMP #309 - BMP A**
Plan Number:

Engineer: **VLH**
Date: **9/28/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	9.5	acres	9.5	9.5
C-Factor:	0.72		0.72	0.72
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	64.33	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.5	ft/ft	Note: Start with 5%				
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1				
Design Depth (D) =	1.4	ft					Adequate
W =	14	ft	8 ft (min.)				-
d50 (Boulder) =	4.5	ft	Note: Start with 1.0 (MDSHA Classification)				Type 2
Area (A) =	2WD / 3		=	13.07	SF		
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$			=	0.909		
n =					=	**0.050**	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	258.39	cfs	Adequate

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	20.51	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	28.62	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	20.51	ft/s				Supercritical Flow C = 0.86
Vmax =	Q / A	=	19.77	ft/s		Adequate
Fr =	V / ((g*D)^(1/2))		=	2.95		

Step C: Check Actual

dw =	1.40	ft	Note: Use Solver to make Q(act.) = Q(design)			
Wa =	14.00	ft				
A (act.) =	13.07	SF				
Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	0.909		
n(act.) =				=	**0.05**	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	258.39	cfs	Adequate
Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	20.51	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	28.62	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	20.51	ft/s				Supercritical Flow C = 0.86
V (act.) =	Q (act.) / A(act.)		=	19.77	ft/s	Adequate
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	2.95		

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	7.2219	=	3.00	ft	MAXIMUM of 3.0 FT

IV. Water Quality Requirement

Site Drainage Area (SA) =	9.5	acres
Contr. Imp. Area (IA) =	0.09	acres
Length (Total) =	260	ft
Length (Cascades) =	117	ft

Rv =	0.05+[0.009*((SA/IA)*100)]	=	0.06	
WQv =	(Rv*SA / 12) * 43560	=	2,007	CF

df (pool) =	1.5	ft	1.5 ft (min.)
df (riffle) =	1.5	ft	
df (average) =	1.5	ft	
Wsand =	6	ft	4 ft (min.)
Lsand =	143	ft	
Af (provided) =	858	SF	
k =	3.5		
hf =	3.00	ft	
tf =	1.67	days	

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	228.91	SF

-

Adequate

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

SPSC Design Calculations - Riffle

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **BMP #309 - BMP B** Engineer: **VLH**
Plan Number: Date: **9/28/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	33.1	acres	33.1	33.1
C-Factor:	0.72		0.72	0.72
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	**224.14**	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.05	ft/ft	Note: Start with 5%				
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1				
Design Depth (D) =	2	ft					**Adequate**
W =	24	ft	8 ft (min.)				-
d50 (Cobble) =	0.75	ft	Note: Start with 0.5				
Area (A) =	2WD / 3		=	32.00	SF		
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$		=	1.309			
n =	D^(1/6) / (21.6*log(D/d50)+14)			=	0.048		
Qmax =			=	263.71	cfs		**Adequate**

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)				
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)		
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)		
=	8.37	ft/s			**Supercritical Flow C = 0.86**
Vmax =	Q / A	=	8.24	ft/s	**Adequate**
Fr =	V / ((g*D)^(1/2))		=	1.027	

Step C: Check Actual

dw =	2.00	ft	Note: Use Solver to make Q(act.) = Q(design)				
Wa =	24.00	ft					
A (act.) =	32.00	SF					
Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	1.309			
n(act.) =	dw^(1/6) / (21.6*log(dw/d50)+14)			=	0.048		
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	263.71	cfs		**Adequate**

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	8.37	ft/s				**Supercritical Flow C = 0.86**
V (act.) =	Q (act.) / A(act.)		=	8.24	ft/s	**Adequate**
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	1.03		

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	2.8046	=	2.80	ft	**MIN. REQUIRED DEPTH**

IV. Water Quality Computations

Site Drainage Area (SA) =	33.1	acres
Contr. Imp. Area (IA) =	5.90	acres
Length Total (L Design) =	240	ft

Rv =	0.05+[0.009*((IA/SA)*100)]	=	0.210	
WQv =	(Rv*SA / 12) * 43560	=	25,283	CF

df (pool) =	2	ft	2.0 ft (min.)
df (riffle) =	2	ft	
df (average) =	2	ft	
Wsand =	12	ft	4 ft (min.)
Lsand =	240	ft	Length along project
Af (provided) =	2880	SF	
k =	3.5		
hf =	2.80	ft	
tf =	1.67	days	

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	2523	SF

-

Adequate

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

SPSC Design Calculations - Cascade

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **BMP #309 - BMP B**
Plan Number:

Engineer: **VLH**
Date: **9/28/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	33.1	acres	33.1	33.1
C-Factor:	0.72		0.72	0.72
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	224.14	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

	Design Slope (S) =	0.5	ft/ft	Note: Start with 5%			
	Side Slope Ratio =	5	:1	Range from 10:1 to 5:1			
	Design Depth (D) =	1	ft				**Adequate**
26	W =	26	ft	8 ft (min.)			**-**
	d50 (Boulder) =	3.0	ft	Note: Start with 1.0 (MDSHA Classification)			**NOT a Standard Size**
	Area (A) =	2WD / 3		=	17.33	SF	
	Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$		=	0.664		
	n =				=	**0.050**	
	Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	278.00	cfs	**Adequate**

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)				
=	16.75	ft/s	C = 0.86 (Prevailing Supercritical Flow)		
=	23.37	ft/s	C = 1.2 (Prevailing Subcritical Flow)		
=	16.75	ft/s			**Supercritical Flow C = 0.86**
Vmax =	Q / A	=	16.04	ft/s	**Adequate**
Fr =	V / ((g*D)^(1/2))		=	2.83	

Step C: Check Actual

dw =	1.00	ft	Note: Use Solver to make Q(act.) = Q(design)
Wa =	26.00	ft	
A (act.) =	17.33	SF	

Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	0.664	
n(act.) =			=	**0.05**	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	278.00	cfs

Adequate

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)				
=	16.75	ft/s	C = 0.86 (Prevailing Supercritical Flow)		
=	23.37	ft/s	C = 1.2 (Prevailing Subcritical Flow)		
=	16.75	ft/s			**Supercritical Flow C = 0.86**
V (act.) =	Q (act.) / A(act.)	=	16.04	ft/s	**Adequate**
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	2.83	

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	4.7444	=	3.00	ft

MAXIMUM of 3.0 FT

IV. Water Quality Requirement

Site Drainage Area (SA) =	33.1	acres
Contr. Imp. Area (IA) =	0.09	acres
Length (Total) =	260	ft
Length (Cascades) =	117	ft

Rv =	0.05+[0.009*((SA/IA)*100)]	=	0.05	
WQv =	(Rv*SA / 12) * 43560	=	6,290	CF

df (pool) =	1.5	ft	1.5 ft (min.)
df (riffle) =	1.5	ft	
df (average) =	1.5	ft	
Wsand =	6	ft	4 ft (min.)
Lsand =	143	ft	
Af (provided) =	858	SF	
k =	3.5		
hf =	3.00	ft	
tf =	1.67	days	

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	717.47	SF

-

Adequate

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

LL216: BMP #309 - Summerfield Pond No. 1 (EDSD) - BMP A

Prioritization Ranking:	29
Planning Level Cost Estimate:	$ 204,050.00
Estimated Cost/Impervious Acre	$ 110,935.05

General BMP Information:		
Structure Location:	Huckleberry Way	
ADC Map:	4568, C8 (2008)	
Nothing/Easting:	632,218.729/1,228,161.938	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Regenerative Step Pool Conveyance	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	9.50	
Total Impervious Area (ac):	3.33	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	12603	
Total Treated Drainage Area (ac):	9.50	
Total Treated Impervious Area (ac):	2.00	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	138.05	50.50
TP (lbs/yr):	7.78	3.65
TSS (lbs/yr):	5016.41	3250.10

Existing conditions for BMP #309 - BMP A

Site map for BMP #309 - BMP A

EXISTING SITE CONDITIONS

BMP #309 was designed as an extended detention dry pond. The facility was constructed south of Huckleberry Way and west of Finn Drive as shown in the site map above. According to Frederick County's Urban BMP Database the drainage area for this BMP is 44.9 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 50.55 acres. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

According to the plans, access is available via a 30' storm drain and stormwater management easement that connects the south end of the embankment to Finn Drive. There are no other obvious site constraints such as utilities or steep slopes.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: Acquisition of Easements, MOT, Tree Impacts	

PROPOSED RETROFIT

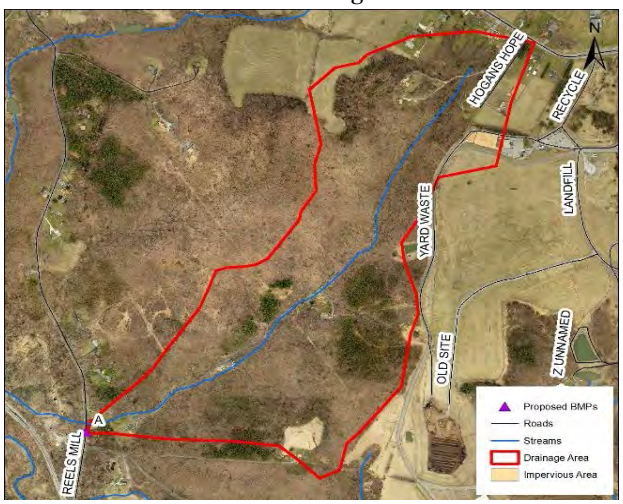
There are three BMPs proposed at this location: one retrofit and two new BMPs. The proposed new BMP A is a 195 foot long regenerative step pool conveyance. It will provide quantity and quality management for 9.50 acres including 2 acres of impervious area. The Project Summary Sheets for the BMP #309 retrofit and new BMP B are included separately in Appendix E with a prioritization ranking of 32 and 28, respectively.

Reels Mill

Prioritization Ranking:	30
Planning Level Cost Estimate:	$ 400,180.00
Estimated Cost/Impervious Acre	$ 104,500.03

General BMP Information:		
Structure Location:	Reels Mill Road	
ADC Map:	4687, A2 (2008)	
Northing/Easting:	618,533.136/1,208,375.427	
NPDES Watershed:	Lower Bush Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Stream Restoration	
Management Type:	Quality	
Total Drainage Area (ac):	186.47	
Total Impervious Area (ac):	3.64	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	N/A	
Total Treated Drainage Area (ac):	186.47	
Total Treated Impervious Area (ac):	4.00	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	30.00	-
TP (lbs/yr):	27.20	-
TSS (lbs/yr):	17960.00	-

Existing conditions for Reels Mill



Site map for Reels Mill

EXISTING SITE CONDITIONS

There is no existing SWM at this location. BMP A is a proposed stream restoration for 400 linear feet of stream along an unnamed tributary of Bush Creek. The length for the stream restoration was calculated using the County's GIS stream layer. Stream restoration is recommended upstream and downstream of the cross culvert under Reels Mill Road to improve the hydrologic, hydraulic, geomorphic, water quality, and biological condition of the degraded urban stream.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from Reels Mill Road. There are no other obvious site constraints such as utilities or steep slopes. Maintenance of Traffic (MOT) is required for this BMP. The stream is located on private property per available GIS data.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There is no existing SWM at this location. BMP A is a proposed stream restoration for 400 linear feet of stream along an unnamed tributary of Bush Creek. The length for the stream restoration was calculated using the County's GIS stream layer. Stream restoration is recommended upstream and downstream of the cross culvert under Reels Mill Road to improve the hydrologic, hydraulic, geomorphic, water quality, and biological condition of the degraded urban stream.

REELS MILL ROAD

Storm Water Management Retrofit Evaluation					
Report Date:	10/5/2015	**Design Approval:**	Not Available	**Maintenance Owner:**	N/A
Structure No:	BMP A	**Year Constructed:**	Not Available	**Inspection Date:**	8/25/2015
Structure Name:	Reels Mill	**NPDES Watershed:**	Lower Bush Creek	**Inspection Team:**	ND, JS, GL
Location:	Reels Mill Road	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	8/20/2015 (0.12")
ADC Map:	4687, A2 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	618,533.136/1,208,375.427	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Stream Restoration	
BMP Classification:			N/A	
Management Type:			Quality	
Total Drainage Area (acres):			186.47	
Total Impervious Area within Drainage Area (acres):			3.64	
WQv Required:			N/A cu. ft.	N/A
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		N/A cu. ft.	N/A
Total Treated Drainage Area (acres):			186.47	
Total Treated Impervious Area within Drainage Area (acres):			4.00	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		N/A	
Total Nitrogen:			-	
Total Phosphorus:			-	
Sediment:			-	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		30.00	-
TP (lbs/yr):			27.20	-
TSS (lbs/yr):			17960.00	-
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 400,180.00**

REELS MILL ROAD

Existing Site Conditions:

An unnamed tributary of Bush Creek crosses Reels Mill Road as shown in the location map below (**Figure 1**). The County provided information about an existing flooding issue at this location due to significant sedimentation in the culvert. The existing CMP cross culvert is half full of displaced gravel (**Photo 1**) and is blocking the stream's flow through the culvert. There is also displaced gravel upstream (**Photos 2 and 3**) and downstream of the culvert (**Photos 4 and 5**). The mapped stream GIS shapefile received by the County does not match the actual stream location found in the field.

A site visit was conducted on August 25th, 2015. **Figure 2** shows the location of photos taken during the visit. The stream was dry during the site visit.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site via Reels Mill Road. According to the County's parcel layer in GIS, this site is on private property and an easement will be required. Easements must be evaluated further at this location during final design. Maintenance of traffic (MOT) is required at this site.

Proposed Retrofit:

There is no existing SWM at this location. BMP A is a proposed stream restoration for 400 linear feet of stream along an unnamed tributary of Bush Creek. The length for the stream restoration was calculated using the County's GIS stream layer. Stream restoration is recommended upstream and downstream of the cross culvert under Reels Mill Road to improve the hydrologic, hydraulic, geomorphic, water quality, and biological condition of the degraded urban stream. Proposed retrofit BMP A includes a 4 impervious acre credit per the *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (2014*) as shown in the **Concept Plans**. The stream restoration limits shown on the Concept Plan are 200 feet upstream and 200 feet downstream of the culvert under Reels Mill Road. These limits are defined by the rock vane structures shown on the Concept Plan.

Replacing the culvert under Reels Mill Road is recommended to prevent flooding in this area. A drastic change in slope is present between the 10% slope upstream of the road to 1% slope in the vicinity of the cross culvert. Therefore, there is a reduction in velocity that causes the deposition of natural stone and sediment in the stream. Topographic survey will be required for final design recommendations due to the drastic slope change. Per the Frederick County Streets and Roads Design Manual, culverts under road crossings are required to convey the 25-year storm. Per the feasibility design, a 54" RCP and two overflow 48" RCP culverts are required to meet the 25-year storm criteria. In addition, the culvert should be cleaned frequently to maintain the culvert opening.

Additional Retrofit Opportunities:

It is recommended that a detailed stream assessment and geomorphological assessment be performed in final design to determine the full extent of stream restoration required and the proposed stream restoration limits. In addition, any swale modifications to the roadside channels along Reels Mill Road should be evaluated during final design. In final design, walking upstream to determine the source of sediment once access is granted by property owners is recommended.

Step 1: Watershed Factors

BMP A is located in Frederick County's Lower Bush watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. Since the project does not include retrofitting the existing BMP, there are no special watershed factors and/or constraints that must be considered.

Step 2: Terrain Factors

BMP A is not located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for proposed design of BMP A.

Step 3: Stormwater Treatment Suitability

For the retrofit of BMP A, stream restoration is recommended. Stream restoration to stabilize and improve the condition of the stream is feasible east and west of the cross culvert on Reels Mill Road. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The existing stream channel shows signs of degradation upstream and downstream of the cross culvert. A detailed geomorphological assessment should be completed during final design to identify any physical constraints.

Step 5: Community and Environmental Factors

BMP A is located to east and west of the cross culvert on Reels Mill Road and has high visibility. Stream restoration is an alternative retrofit proposed to improve the condition of this unnamed stream in the area. Residents may be receptive to this stream restoration on private property since the streambanks are eroding and impacting their property. Coordination with property owners and easement acquisition should be evaluated during final design.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP A include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Flood Insurance Map FM24021C0315D indicates that the BMP is not within FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is not mapped as a wetland, but is an in-stream facility.

Figure 1: BMP Location Map – Existing Conditions

Figure 2: Photo Locations

Photo 1: Displaced gravel inside cross culvert facing west

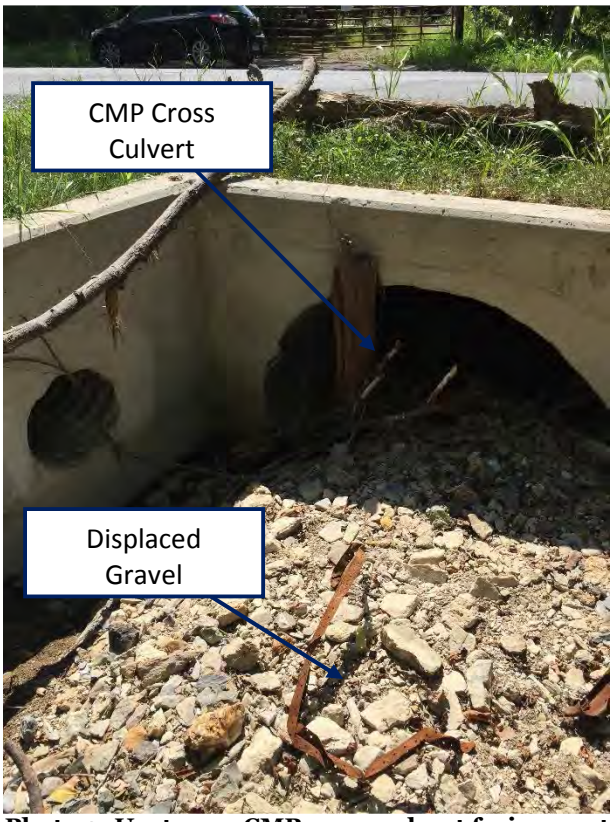


Photo 2: Upstream CMP cross culvert facing west

Photo 3: Upstream channel facing east

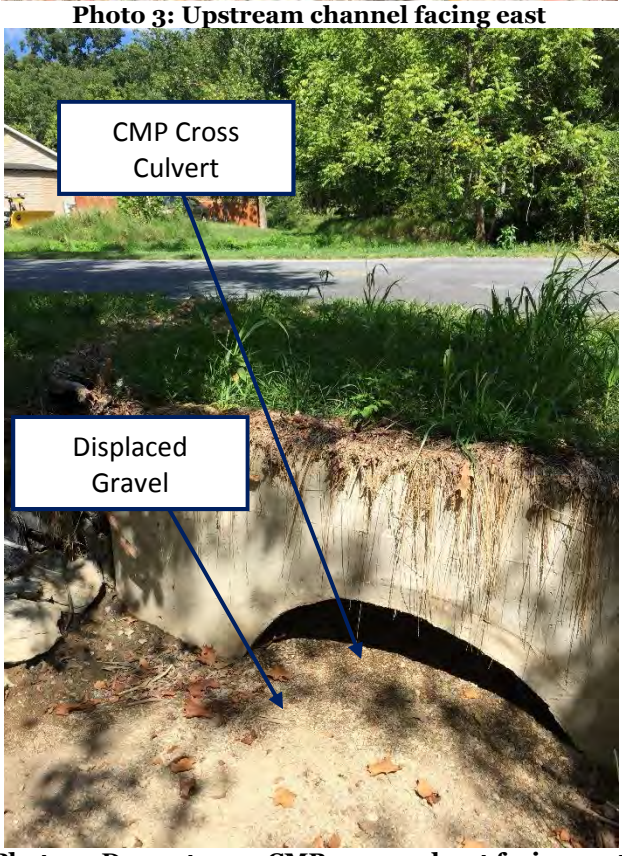


Photo 4: Downstream CMP cross culvert facing east

Photo 5: Downstream channel facing west

GENERAL BMP INFORMATION	
BMP TYPE:	STREAM RESTORATION
MANAGEMENT TYPE:	QUALITY
TOTAL DA (ACRES):	186.47
TOTAL IMPERVIOUS AREA (ACRES):	3.64
WQv REQUIRED (CU. FT):	N/A
WQv REQUIRED (AC. FT):	N/A
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	N/A
TOTAL TREATED DA (ACRES):	186.47
TOTAL TREATED IMPERVIOUS AREA (ACRES):	4.00

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

REELS MILL

SCALE 1" = 100' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF SHEET NO. OF

PLOTTED: Thursday, June 22, 2017 AT 02:20 PM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_ReelsMill.dgn

BY: ndriskill -

STREAM RESTORATION: REELS MILL - BMP A

This spreadsheet is for **design level calculations for stream restoration**

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects (Schueler and Stack 2014)

SWM BMP Retrofit Assessment

Note: Blue cells in this sheet are user entries

Design Parameters:

Project:	**SWM BMP Retrofit Assessment**	Engineer:	**VLH**
Location:	**Frederick County, MD**	Date:	**10/5/2015**
Watershed:	**Lower Mocacy**	As Built:	
Proposed Stream Restoration Location:		Reels Mill Road	
Proposed Stream Restoration (Linear Feet):	**400**		

Practice	Impervious Acre Equivalent (ac/LF)	Impervious Acre Credit
Stream Restoration	0.01	4

	Edge-of-Stream Pollutant Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr)			Estimated Pollutant Reduction (lbs/year)		
Practice	**TN**	**TP**	**TSS (Non-Coastal Plain)**	**TN**	**TP**	**TSS**
Stream Restoration	0.075	0.068	44.9	30	27.2	17960

*The calculations above are appropriate for the planning level. Final conceptual design should reference the procedures outlined in Schueler and Stack (2014).

WinTR-55 Current Data Description

--- Identification Data ---

User: vhamsher
Project: Lower Monocacy River
SubTitle: Untreated Impervious Area
State: Maryland
County: Frederick NOAA_C
Filename: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\Tech\Untreated Impervious Area\Re

Date: 10/23/2015
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Reels Mill	Culvert	Outlet	186.46	68	0.498

Total area: 186.46 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.07	3.9	4.64	5.77	6.79	7.95	2.54

Storm Data Source: Frederick NOAA_C County, MD (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

vhamsher

Lower Monocacy River
Untreated Impervious Area
Frederick NOAA_C County, Maryland

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period ANALYSIS: (cfs)	10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)	1-Yr (cfs)
SUBAREAS						
Reels Mill	90.17	255.72	395.17	531.71	690.90	47.39
REACHES						
OUTLET	90.17	255.72	395.17	531.71	690.90	47.39

vhamsher

Lower Monocacy River
Untreated Impervious Area
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)
Reels Mill							
SHEET	100	0.0200	0.150				0.167
CHANNEL	5950					5.000	0.331
					Time of Concentration		0.498

vhamsher

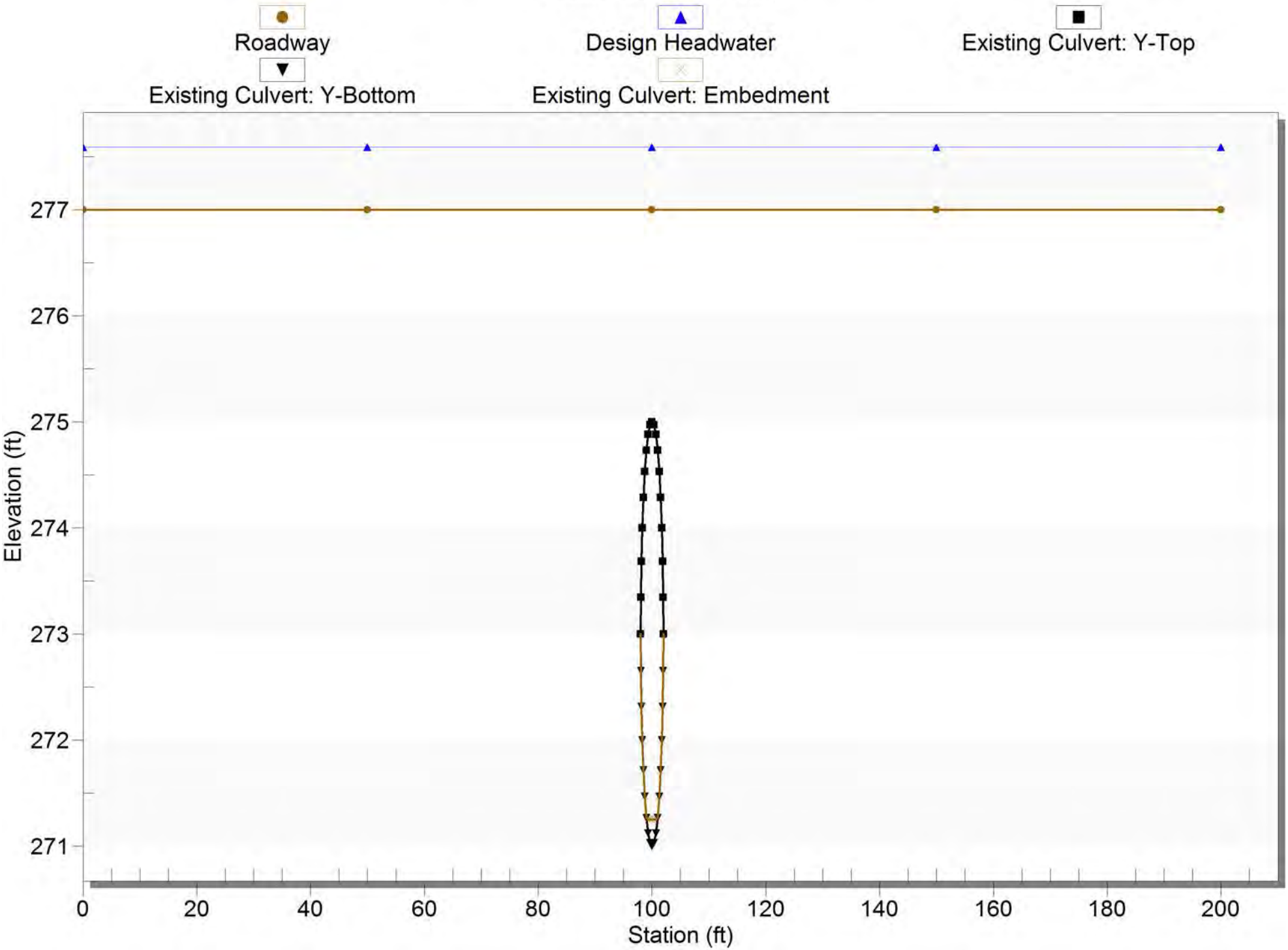
Lower Monocacy River
Untreated Impervious Area
Frederick NOAA_C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Reels Mill	Open space; grass cover > 75%	(good)	B	10	61
	Open space; grass cover > 75%	(good)	C	10	74
	Paved parking lots, roofs, driveways		B	1.213	98
	Paved parking lots, roofs, driveways		C	1.213	98
	Paved parking lots, roofs, driveways		D	1.213	98
	Woods	(good)	B	62.57	55
	Woods	(good)	C	18.75	70
	Woods	(good)	D	81.5	77
	Total Area / Weighted Curve Number			186.46	68
				======	==

Crossing: Existing Conditions

Front View (Not to scale)



Crossing Properties

Name: Existing Conditions

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	0.00	cfs
Design Flow	395.17	cfs
Maximum Flow	690.90	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	8.00	ft
Side Slope (H:V)	3.00	_:1
Channel Slope	0.1000	ft/ft
Manning's n (channel)	0.0400	
Channel Invert Elevation	270.50	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Irregular	
Irregular Shape	Define...	
Roadway Surface	Paved	
Top Width	20.00	ft

Culvert Properties

Existing Culvert

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Existing Culvert	
Shape	Circular	
Material	Corrugated Steel	
Diameter	4.00	ft
Embedment Depth	3.00	in
Manning's n (Top/Sides)	0.0240	
Manning's n (Bottom)	0.0350	
Inlet Type	Conventional	
Inlet Edge Condition	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	ft
Inlet Elevation	271.00	ft
Outlet Station	35.00	ft
Outlet Elevation	270.50	ft
Number of Barrels	1	

HY-8 Analysis Results

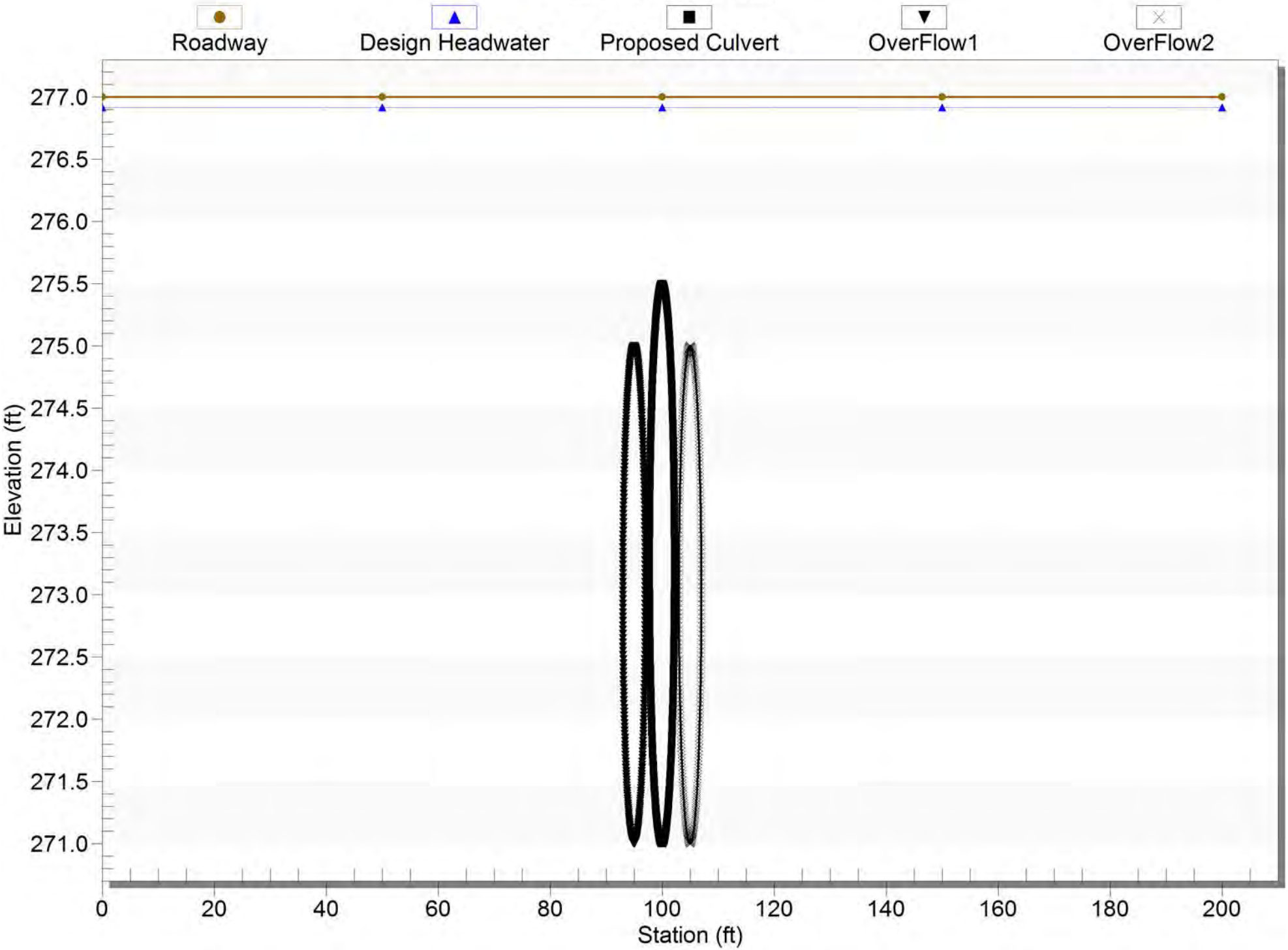
Culvert Summary Table - Existing Culvert

Culvert Crossing: Existing Conditions

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	271.25	0.00	0.0*	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
69.09	69.09	275.16	3.50	3.91	2-M2c	2.59	2.34	2.34	0.78	8.36	8.57
138.18	114.28	277.12	5.73	5.87	7-M2c	3.75	3.04	3.05	1.14	10.66	10.60
207.27	116.81	277.28	5.87	6.03	7-M2c	3.75	3.06	3.08	1.42	10.81	11.93
276.36	118.83	277.41	5.98	6.16	7-M2c	3.75	3.08	3.10	1.65	10.93	12.95
345.45	120.55	277.52	6.10	6.27	7-M2c	3.75	3.10	3.12	1.85	11.03	13.79
395.17	121.70	277.59	6.18	6.34	7-M2c	3.75	3.11	3.13	1.98	11.10	14.31
483.63	123.55	277.71	6.30	6.46	7-M2c	3.75	3.13	3.15	2.19	11.21	15.13
552.72	124.89	277.79	6.39	6.54	7-M2c	3.75	3.15	3.17	2.34	11.29	15.69
621.81	126.17	277.87	6.47	6.62	7-M2c	3.75	3.16	3.18	2.48	11.36	16.20
690.90	127.39	277.95	6.56	6.70	7-M2c	3.75	3.17	3.19	2.62	11.43	16.66

Crossing: Proposed Conditions

Front View (Not to scale)



Crossing Properties

Name: Proposed Conditions

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	0.00	cfs
Design Flow	395.17	cfs
Maximum Flow	690.90	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	8.00	ft
Side Slope (H:V)	3.00	_:1
Channel Slope	0.1000	ft/ft
Manning's n (channel)	0.0400	
Channel Invert Elevation	270.50	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Irregular	
Irregular Shape	Define...	
Roadway Surface	Paved	
Top Width	20.00	ft

Culvert Properties

Proposed Culvert
OverFlow1
OverFlow2

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Proposed Culvert	
Shape	Circular	
Material	Concrete	
Diameter	4.50	ft
Embedment Depth	0.00	in
Manning's n	0.0130	
Inlet Type	Conventional	
Inlet Edge Condition	Beveled Edge (1.5:1)	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	ft
Inlet Elevation	271.00	ft
Outlet Station	35.00	ft
Outlet Elevation	270.50	ft
Number of Barrels	1	

Crossing Properties

Name: Proposed Conditions

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	0.00	cfs
Design Flow	395.17	cfs
Maximum Flow	690.90	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	8.00	ft
Side Slope (H:V)	3.00	_:1
Channel Slope	0.1000	ft/ft
Manning's n (channel)	0.0400	
Channel Invert Elevation	270.50	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Irregular	
Irregular Shape	Define...	
Roadway Surface	Paved	
Top Width	20.00	ft

Culvert Properties

Proposed Culvert
OverFlow1
OverFlow2

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	OverFlow1	
Shape	Circular	
Material	Concrete	
Diameter	4.00	ft
Embedment Depth	0.00	in
Manning's n	0.0130	
Inlet Type	Conventional	
Inlet Edge Condition	Beveled Edge (1:1)	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	ft
Inlet Elevation	271.00	ft
Outlet Station	35.00	ft
Outlet Elevation	270.50	ft
Number of Barrels	1	

Crossing Properties

Name: Proposed Conditions

Parameter	Value	Units
DISCHARGE DATA		
Minimum Flow	0.00	cfs
Design Flow	395.17	cfs
Maximum Flow	690.90	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	8.00	ft
Side Slope (H:V)	3.00	_:1
Channel Slope	0.1000	ft/ft
Manning's n (channel)	0.0400	
Channel Invert Elevation	270.50	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Irregular	
Irregular Shape	Define...	
Roadway Surface	Paved	
Top Width	20.00	ft

Culvert Properties

Proposed Culvert
OverFlow1
OverFlow2

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	OverFlow2	
Shape	Circular	
Material	Concrete	
Diameter	4.00	ft
Embedment Depth	0.00	in
Manning's n	0.0130	
Inlet Type	Conventional	
Inlet Edge Condition	Beveled Edge (1:1)	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.00	ft
Inlet Elevation	271.00	ft
Outlet Station	35.00	ft
Outlet Elevation	270.50	ft
Number of Barrels	1	

HY-8 Analysis Results

Culvert Summary Table - Proposed Culvert

Culvert Crossing: Proposed Conditions

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	271.00	0.00	0.0*	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
69.09	24.48	272.88	1.88	0.28	1-S2n	0.97	1.40	1.07	0.78	8.36	8.57
138.18	49.63	273.84	2.84	0.64	1-S2n	1.40	2.03	1.60	1.14	9.76	10.60
207.27	74.49	274.61	3.61	0.92	1-S2n	1.73	2.51	2.03	1.42	10.72	11.93
276.36	102.15	275.37	4.37	1.15	1-S2n	2.07	2.96	2.44	1.65	11.62	12.95
345.45	132.06	276.22	5.22	1.35	5-S2n	2.41	3.37	2.84	1.85	12.53	13.79
395.17	153.99	276.92	5.92	1.48	5-S2n	2.65	3.63	3.11	1.98	13.15	14.31
483.63	163.21	277.23	6.23	1.69	5-S2n	2.76	3.71	3.20	2.19	13.49	15.13
552.72	166.68	277.36	6.36	1.84	5-S2n	2.80	3.74	3.25	2.34	13.57	15.69
621.81	169.61	277.46	6.46	1.98	5-S2n	2.83	3.77	3.28	2.48	13.66	16.20
690.90	172.26	277.56	6.56	2.12	5-S2n	2.86	3.79	3.32	2.62	13.74	16.66

HY-8 Analysis Results

Culvert Summary Table - OverFlow1

Culvert Crossing: Proposed Conditions

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	271.00	0.00	0.0*	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
69.09	22.32	272.88	1.88	0.28	1-S2n	0.96	1.38	1.06	0.78	8.32	8.57
138.18	44.27	273.84	2.84	0.64	1-S2n	1.37	1.99	1.57	1.14	9.67	10.60
207.27	66.39	274.61	3.61	0.92	1-S2n	1.72	2.46	1.99	1.42	10.66	11.93
276.36	87.13	275.37	4.36	1.15	5-S2n	2.02	2.83	2.33	1.65	11.45	12.95
345.45	106.72	276.22	5.22	1.35	5-S2n	2.28	3.12	2.64	1.85	12.17	13.79
395.17	120.47	276.92	5.92	1.48	5-S2n	2.47	3.29	2.82	1.98	12.72	14.31
483.63	126.22	277.23	6.23	1.69	5-S2n	2.55	3.35	2.91	2.19	12.92	15.13
552.72	128.38	277.36	6.36	1.84	5-S2n	2.58	3.37	2.94	2.34	13.00	15.69
621.81	130.20	277.46	6.46	1.98	5-S2n	2.61	3.39	2.96	2.48	13.07	16.20
690.90	131.85	277.56	6.56	2.12	5-S2n	2.63	3.40	2.99	2.62	13.13	16.66

HY-8 Analysis Results

Culvert Summary Table - OverFlow2

Culvert Crossing: Proposed Conditions

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	271.00	0.00	0.0*	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
69.09	22.32	272.88	1.88	0.28	1-S2n	0.96	1.38	1.06	0.78	8.32	8.57
138.18	44.27	273.84	2.84	0.64	1-S2n	1.37	1.99	1.57	1.14	9.67	10.60
207.27	66.39	274.61	3.61	0.92	1-S2n	1.72	2.46	1.99	1.42	10.66	11.93
276.36	87.13	275.37	4.36	1.15	5-S2n	2.02	2.83	2.33	1.65	11.45	12.95
345.45	106.72	276.22	5.22	1.35	5-S2n	2.28	3.12	2.64	1.85	12.17	13.79
395.17	120.47	276.92	5.92	1.48	5-S2n	2.47	3.29	2.82	1.98	12.72	14.31
483.63	126.22	277.23	6.23	1.69	5-S2n	2.55	3.35	2.91	2.19	12.92	15.13
552.72	128.38	277.36	6.36	1.84	5-S2n	2.58	3.37	2.94	2.34	13.00	15.69
621.81	130.20	277.46	6.46	1.98	5-S2n	2.61	3.39	2.96	2.48	13.07	16.20
690.90	131.85	277.56	6.56	2.12	5-S2n	2.63	3.40	2.99	2.62	13.13	16.66

5-7: Ballenger Creek Trail, Parking and Loop - BMP C

Prioritization Ranking:	31
Planning Level Cost Estimate:	$ 214,500.00
Estimated Cost/Impervious Acre	$ 93,507.73

General BMP Information:		
Structure Location:	North of Robin Drive, south of Ballenger Creek	
ADC Map:	4686, B1 (2008)	
Nothing/Easting:	621,039.490/1,191,114.332	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Surface Sand Filter (F-1)	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	11.02	
Total Impervious Area (ac):	2.60	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	10494.248	
Total Treated Drainage Area (ac):	11.02	
Total Treated Impervious Area (ac):	2.60	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	87.76	56.95
TP (lbs/yr):	6.95	3.26
TSS (lbs/yr):	3528.91	2286.36

Existing conditions for BMP C

Site map for BMPs A, B, and C

EXISTING SITE CONDITIONS

This site is currently open field that is bounded on the north by Ballenger Creek and on the south by a residential community. The site is 90% actively farmed as row crops; the remaining 10% contains trees. There are three storm drain outfalls that drain to this site. No stormwater management controls currently exist at this location. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance of traffic (MOT) and hauling material in and out of the site via Robin Drive. According to the County's parcel layer in GIS, this site is an open space dedicated to Frederick County. Utility access may be needed due to overhead power lines.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Utility Approval, Tree Impacts	

PROPOSED RETROFIT

There are three new BMPs proposed at this site. BMP C is a surface sand filter (F-1) and it will provide quantity and quality management for 11.02 acres including 2.60 acres of impervious area. Construction of an access road will be required to provide maintenance access to the facility. The BMP A Project Summary Sheet, Assessment, and Concept Plan is included separately in Appendix E with a prioritization ranking of 26. The BMP B Project Summary Sheet is included separetely in Appendix E with a prioritization ranking of 27.

LL216: BMP #309 - Summerfield Pond No. 1 (EDSD)

Prioritization Ranking:	32
Planning Level Cost Estimate:	$ 630,998.50
Estimated Cost/Impervious Acre	$ 109,087.95

General BMP Information:		
Structure Location:	Huckleberry Way	
ADC Map:	4568, C8 (2008)	
Nothing/Easting:	632,218.729/1,228,161.938	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Wet Extended Detention Pond (P-3)	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	50.55	
Total Impervious Area (ac):	9.23	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	25126	
Total Treated Drainage Area (ac):	30.94	
Total Treated Impervious Area (ac):	6.01	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	244.26	89.36
TP (lbs/yr):	17.97	8.43
TSS (lbs/yr):	13669.16	8856.16

Existing conditions for BMP #309

Site map for BMP #309

EXISTING SITE CONDITIONS

BMP #309 was designed as an extended detention dry pond. The facility was constructed south of Huckleberry Way and west of Finn Drive as shown in the site map above. According to Frederick County's Urban BMP Database the drainage area for this BMP is 44.9 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 50.55 acres. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

According to the plans, access is available via a 30' storm drain and stormwater management easement that connects the south end of the embankment to Finn Drive. There are no other obvious site constraints such as utilities or steep slopes.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: Acquisition of Easements, MOT, Tree Impacts	

PROPOSED RETROFIT

There are three BMPs proposed at this location: one retrofit and two new BMPs. The proposed retrofit for BMP #309 is a wet extended detention pond (P-3). It will provide quantity and quality management for 50.55 acres including 7.23 acres of impervious area. The retrofit will include grading within the footprint of the existing BMP and construction of an access road to provide maintenance access to the control structure. The Project Summary Sheets for the new BMPs A and B are included separately in Appendix E with a prioritization ranking of 29 and 28, respectively.

BMP #353 - 84 LUMBER COMPANY - BMP D

Prioritization Ranking:	33
Planning Level Cost Estimate:	$ 203,896.00
Estimated Cost/Impervious Acre	$ 84,929.81

General BMP Information:		
Structure Location:	4484 Quad County Court	
ADC Map:	4690, C3 (2008)	
Northing/Easting:	615666.28/1,263,504.90	
NPDES Watershed:	Upper Bush Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Bioswale (M-8)	
Management Type:	Quality	
Total Drainage Area (ac):	4.41	
Total Impervious Area (ac):	2.62	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	9360	
Total Treated Drainage Area (ac):	4.41	
Total Treated Impervious Area (ac):	2.62	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	66.54	43.18
TP (lbs/yr):	5.97	2.80
TSS (lbs/yr):	2704.01	1751.91

Existing conditions for BMP #353

Site map for BMP #353 - BMP D

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #353 has been identified as an extended detention dry pond. The facility was constructed north of Mill Bottom Road and west of Quad County Court. The BMP Database from the County indicates that the original design for BMP #353 provides management for quantity and quality and that the total treatment area for the BMP is 16.18 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 17.76 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out from a grass road accessible from Quad County Court. According to the County's parcel layer in GIS, BMP #353 was constructed on private property. Maintenance of traffic (MOT) will be required to notify owners of the property. Easements must be evaluated at this site.

Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There are five BMPs proposed at this site: one retrofit and four new BMPs. The proposed new BMP for BMP D is a bioswale (M-8). BMP D is proposed on the north side of the property to provide quality management for 4.41 acres including 2.62 acres of impervious area as shown in the Concept Plans. The Project Summary Sheets for the BMP #353 retrofit and BMPs A, B, and C are included separately in Appendix E with a prioritization ranking of 44, 34, 19, and 38 respectively.

BMP #353 - 84 LUMBER COMPANY - BMP A

Prioritization Ranking:	34
Planning Level Cost Estimate:	$ 122,650.00
Estimated Cost/Impervious Acre	$ 88,293.81

General BMP Information:		
Structure Location:	4484 Quad County Court	
ADC Map:	4690, C3 (2008)	
Northing/Easting:	615666.28/1,263,504.90	
NPDES Watershed:	Upper Bush Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Bioswale (M-8)	
Management Type:	Quality	
Total Drainage Area (ac):	2.27	
Total Impervious Area (ac):	1.60	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	5639	
Total Treated Drainage Area (ac):	2.27	
Total Treated Impervious Area (ac):	1.60	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	35.40	22.97
TP (lbs/yr):	3.46	1.62
TSS (lbs/yr):	1580.83	1024.21

Existing conditions for BMP #353

Site map for BMP #353 - BMP A

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #353 has been identified as an extended detention dry pond. The facility was constructed north of Mill Bottom Road and west of Quad County Court. The BMP Database from the County indicates that the original design for BMP #353 provides management for quantity and quality and that the total treatment area for the BMP is 16.18 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 17.76 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out from a grass road accessible from Quad County Court. According to the County's parcel layer in GIS, BMP #353 was constructed on private property. Maintenance of traffic (MOT) will be required to notify owners of the property. Easements must be evaluated at this site.

Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There are five BMPs proposed at this site: one retrofit and four new BMPs.The proposed new BMP for BMP A is a bioswale (M-8). BMP A is proposed on the south side of the property to provide quality management for 2.27 acres including 1.60 acres of impervious area as shown in the Concept Plans. The Project Summary Sheets for the BMP #353 retrofit and BMPs B, C, and D are included separately in Appendix E with a prioritization ranking of 44, 19, 38, and 33 respectively.

Prioritization Ranking:	35
Planning Level Cost Estimate:	$ 577,478.00
Estimated Cost/Impervious Acre	$ 109,871.92

BMP #8 - SWM Detention Pond

General BMP Information:		
Structure Location:	Inspiration Avenue	
ADC Map:	4449, D6 (2008)	
Northing/Easting:	655,780.63/1,211,908.52	
NPDES Watershed:	Israel Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool Extended Detention (P-1)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	23.58	
Total Impervious Area (ac):	5.48	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	22183	
Total Treated Drainage Area (ac):	23.58	
Total Treated Impervious Area (ac):	5.48	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	187.61	110.29
TP (lbs/yr):	14.76	6.93
TSS (lbs/yr):	9068.95	5875.71

Existing conditions for BMP #8

Site map for BMP #8

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #8 has been identified as a dry pond. The facility was constructed north of Stauffer Road and west of Inspiration Ave. The Urban BMP Database from the County indicates that the original design for BMP #8 provides management for quantity and that the total treatment area for the BMP is 41.17 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 23.54 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from Inspiration Avenue. According to the County's parcel layer in GIS, BMP #8 was constructed on property owned by the Discover Homeowners Association to be dedicated to a park. Maintenance of Traffic (MOT) will be required to notify residents living in the surrounding area that may utilize Inspiration Avenue.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Acquisition of Easements, MOT	

PROPOSED RETROFIT

The proposed retrofit for BMP #8 is a micropool extended detention (P-1). The proposed retrofit will provide quantity and quality management for 23.58 acres including 5.48 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating approximately 2 feet below the existing BMP bottom to provide extended detention as shown in the Concept Plans.

BMP # 8 – DISCOVERY SUBDIVISION –SWM DETENTION POND #2

Storm Water Management Retrofit Evaluation					
Report Date:	7/2/2015	**Design Approval:**	12/5/1975	**Maintenance Owner:**	Discovery Homeowners Association
Structure No:	8	**Year Constructed:**	Not Available	**Inspection Date:**	6/10/2015
Structure Name:	Discovery Subdivision - SWM Detention Pond #2	**NPDES Watershed:**	Israel Creek	**Inspection Team:**	ND, GL
Location:	Inspiration Avenue	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/8/2015 (0.38")
ADC Map:	4449, D6 (2008)	**Land-River Segment:**	PM4_3341_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	655,780.63/1,211,908.52	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	Dry Pond		Micropool Extended Detention (P-1)	
BMP Classification:	N/A		Stormwater Treatment (ST) Practice	
Management Type:	Quantity		Quality/Quantity	
Total Drainage Area (acres):	41.17		23.58	
Total Impervious Area within Drainage Area (acres):	Unknown		5.48	
WQv Required:	Unknown		22183 cu. ft.	0.509 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes	
Adequate ROW (Y/N):	Yes		Yes	
Adequate Access (Y/N):	Yes		Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	Unknown	0	22183 cu. ft.	0.509 ac-ft
Total Treated Drainage Area (acres):	41.17	0	23.58	
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	5.48	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.11	
Total Nitrogen:			35.93%	
Total Phosphorus:			56.46%	
Sediment:			71.86%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		187.61	110.29
TP (lbs/yr):	0		14.76	6.93
TSS (lbs/yr):	0		9068.95	5875.71

Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):	**$ 577,478.00**

BMP #8 – DISCOVERY SUBDIVISION – SWM DETENTION POND #2

Existing Site Conditions:

SWM Era: Pre-1985

According to Frederick County's Urban BMP Database, BMP #8 has been identified as a dry pond. The facility was constructed north of Stauffer Road and west of Inspiration Ave as shown in the BMP Location map (**Figure 1**). The Urban BMP Database from the County indicates that the original design for BMP #8 provides management for quantity and that the total treatment area for the BMP is 41.17 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 23.54 acres. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. According to the Urban BMP Database provided by Frederick County, the facility's control structure is a 24" CMP barrel. The majority of land use is residential.

General Observations:

A site visit was conducted on June 10th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has two inflow points based on the site visit. According to measurements taken in the field, Inflow #1 is a 42" CMP with an end section from the north that flows into a riprap channel **(Photo 1)**. Flow enters the CMP via a storm drain located near a private fence **(Photo 2)**. Accumulated sediment and riprap are located inside the CMP, but overall the CMP pipes appear to be in good condition. Underground utilities are located above the outfall of Inflow #1.

Inflow #2 is sheet flow from the area west of the facility **(Photo 3)**. The area is fully covered by mowed grass and appears to be in good condition.

Pretreatment:

This facility does not have a forebay or pretreatment area.

Control Structure and Spillways:

According to the Urban BMP Database, the control structure for this facility is a 24" CMP principal spillway. However, based on observation in the field, it was determined that the control structure for this facility is an 18" CMP riser with a 12" low flow orifice and trash rack, a 29" CMP concentric trash rack, and a 12" CMP principal spillway **(Photo 4)**. Overall, the riser structure is in good condition. The grass embankment around the riser is in poor condition, lacking vegetation and showing signs of erosion.

The emergency spillway of the facility is located in the southeast corner of the pond and appears to be in good condition **(Photo 5)**.

Embankment:

A fill embankment is present between the pond and principal spillway outlet to the south and east of the pond. The embankment to the south of BMP #8 separates BMP #8 from BMP #394 **(Photo 6)**. An animal burrow was observed on the downstream side of the embankment above the principal spillway **(Photo 7)**. The downstream embankment is overgrown with vegetation **(Photo 8)**. Otherwise, the embankment stability appears to be in good condition. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

According to measurements taken in the field, the 12" CMP principal spillway with end wall outlets the BMP east of the riser into an agricultural field **(Photo 9)**. Riprap is located at the outfall of the principal spillway. The outfall channel is stable. Sediment has accumulated inside the principal spillway. There is erosion and an animal burrow on the embankment around the endwall.

Overall BMP:

Inflow #1 has accumulated sediment. The downstream embankment is overgrown with vegetation, has an animal burrow, and has erosion. Minor problems are observed, however, BMP is functioning as designed with no critical parameters but with some problem conditions **(Photo 10).**

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site from Inspiration Avenue. According to the County's parcel layer in GIS, BMP #8 was constructed on property owned by the Discover Homeowners Association to be dedicated to a park. Access to the BMP from Inspiration Avenue is via the 20' stormwater easement. Easements at this location must be further evaluated at final design. Maintenance of traffic (MOT) will be required to notify residents living in the surrounding area that may utilize Inspiration Avenue.

Proposed Retrofit:

BMP #8 was originally designed as a dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #8 is a micropool extended detention (P-1). The proposed retrofit will provide quantity and quality management for 23.58 acres including 5.48 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 2 feet below the existing BMP bottom to provide extended detention as shown in the **Concept Plans**.

As part of the final design, the location of the riser structure should be relocated further south away from the forebay to limit short circuiting within the facility from Inflow #1. A manhole should be installed at the location of the existing riser structure to connect the proposed riser structure to the existing principal spillway to limit impacts to the embankment and existing principal spillway outlet.

Additional Retrofit Opportunities:

In final design, the proposed grading can be revised to increase the pond depth and reduce the size of the BMP footprint. If the pond depth is increased in final design, a fence will be needed since the facility is within a residential area and the safe water depth will be exceeded. Decreasing the BMP footprint in final design is an alternative to explore for this area so that additional room is available on the land dedicated to the park. Easements at this area must be evaluated at final design.

As an additional alternative, two separate BMPs #394 and #8 could be combined into a single facility. If this alternative is explored, then quantity management at the outfalls must be maintained so that the discharge quantity does not increase on the private property downstream of the outfalls.

Step 1: Watershed Factors

BMP #8 is located in Frederick County's Israel Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #8 due to the downstream coldwater conditions. For the retrofit of BMP #8, 100% of the WQv can be treated within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream Israel Creek.

Step 2: Terrain Factors

BMP #8 is located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are special terrain factors and/or constraints that must be considered for retrofit design to BMP #8. Additional geotechnical investigation will be required during the final design and the proposed retrofit may need to be lined if karst geology is identified.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is

unknown due to the unavailability of plans. Since the downstream channel is in stable condition, there are no erosion or safety concerns and additional water quantity management is not required. There is adequate space for the proposed retrofit within the existing BMP boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a micropool extended detention is 10 acres. The proposed drainage area to BMP #8 is 23.58 acres and is composed of A and B soils. The likelihood of BMP #8 receiving hotspot runoff is low as it is located within a residential community. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban.

Step 5: Community and Environmental Factors

BMP #8 is located north of Stauffer Road and east of Triumphant Court and has moderate visibility. Micropool extended detention ponds tend to have medium maintenance requirements, medium community acceptance, low construction costs relative to the drainage area, and provide medium habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #8 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Flood Insurance Map 24021C0303D indicates that the BMP is not within the FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is mapped as a wetland.

Figure 1: BMP Location Map – Existing Conditions

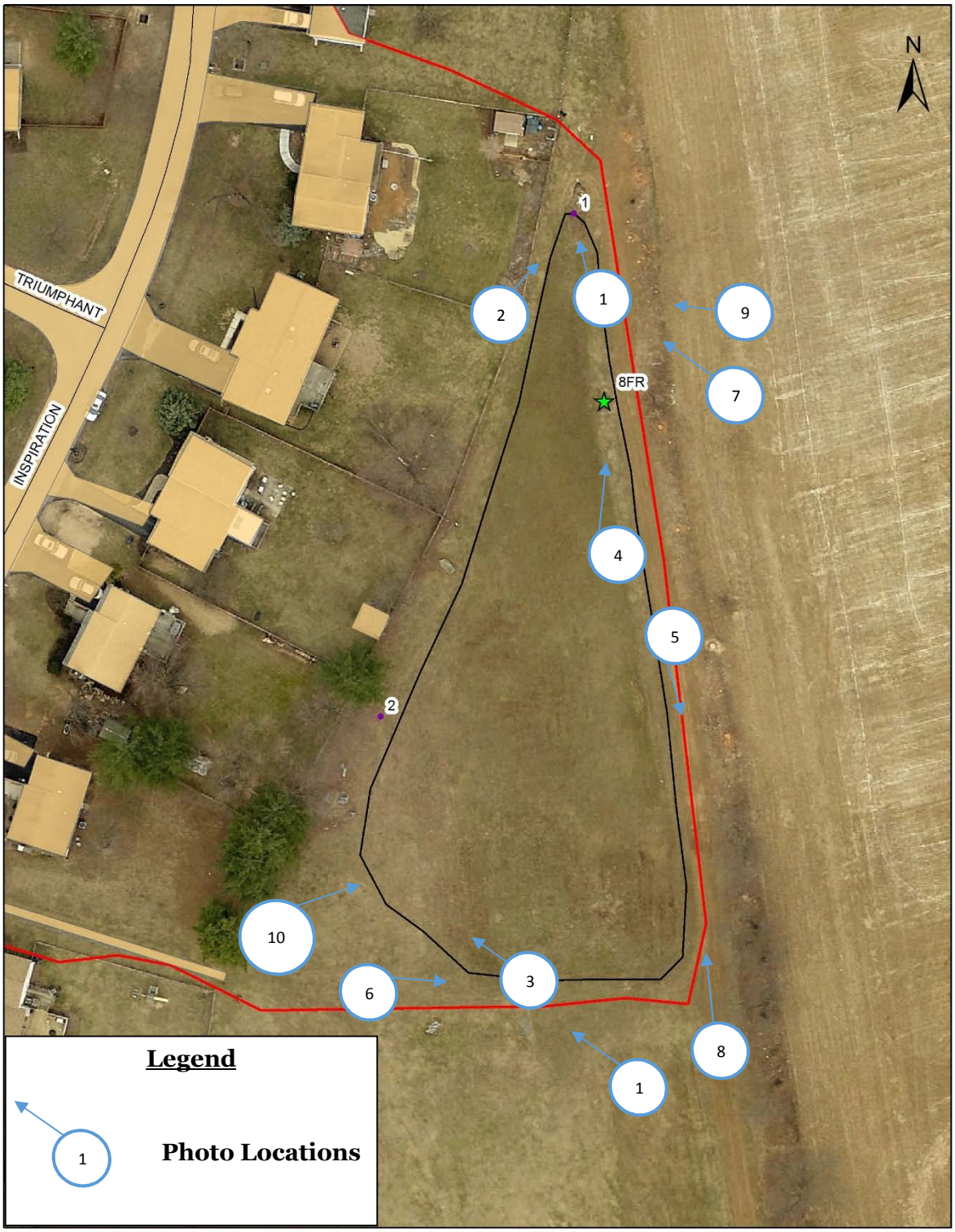


Figure 2: Photo Locations

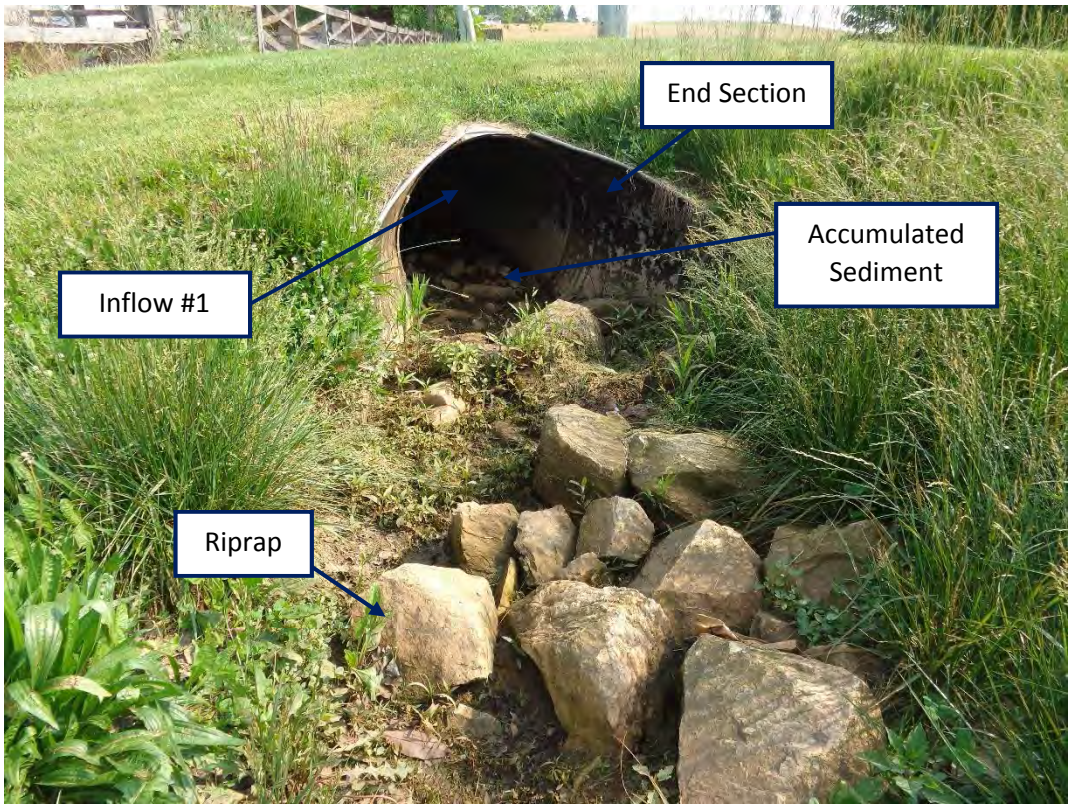


Photo 1: Inflow #1 facing north

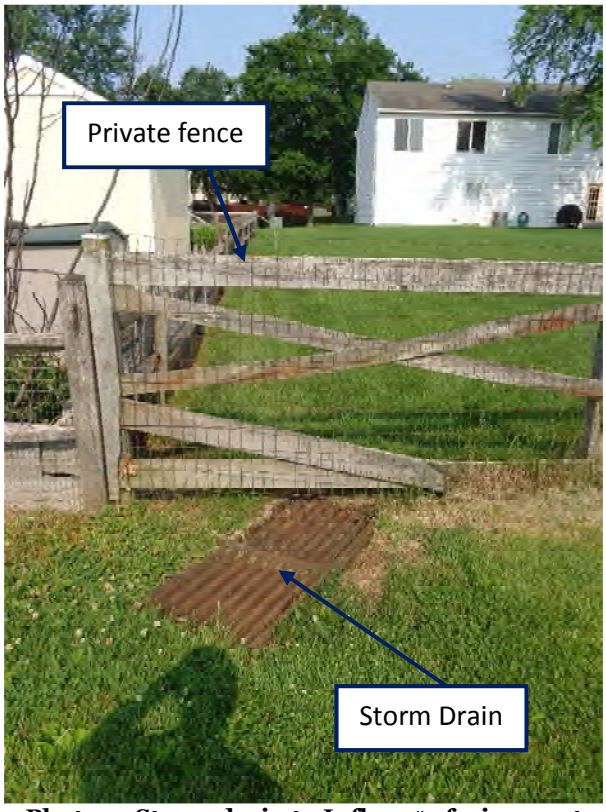


Photo 2: Storm drain to Inflow #1 facing west

Photo 3: Inflow #2 facing west

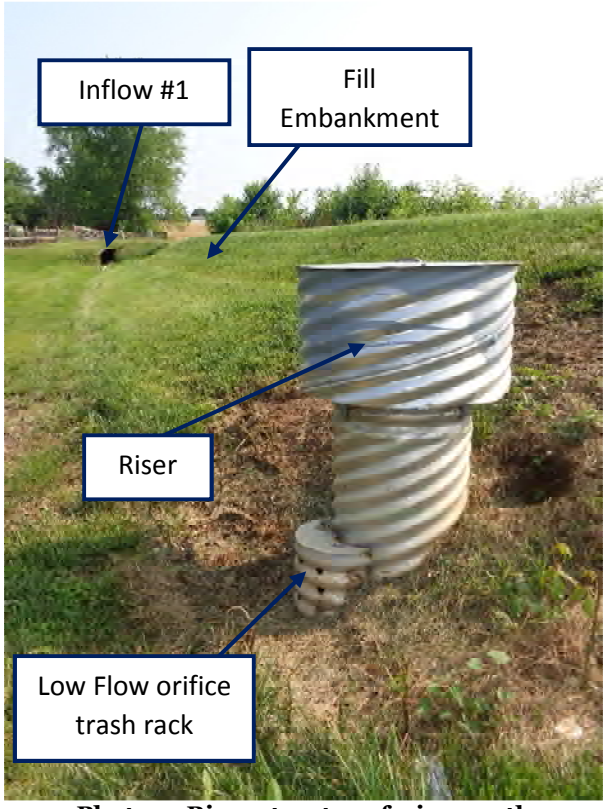


Photo 4: Riser structure facing north

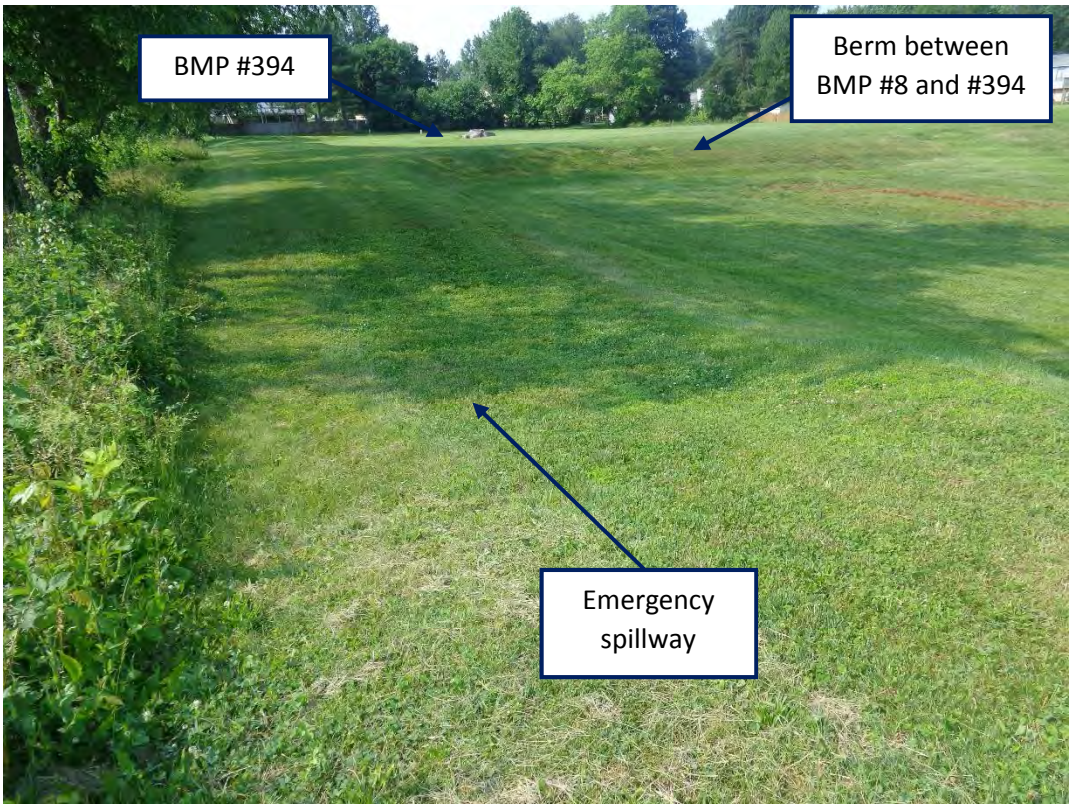


Photo 5: Emergency spillway facing south

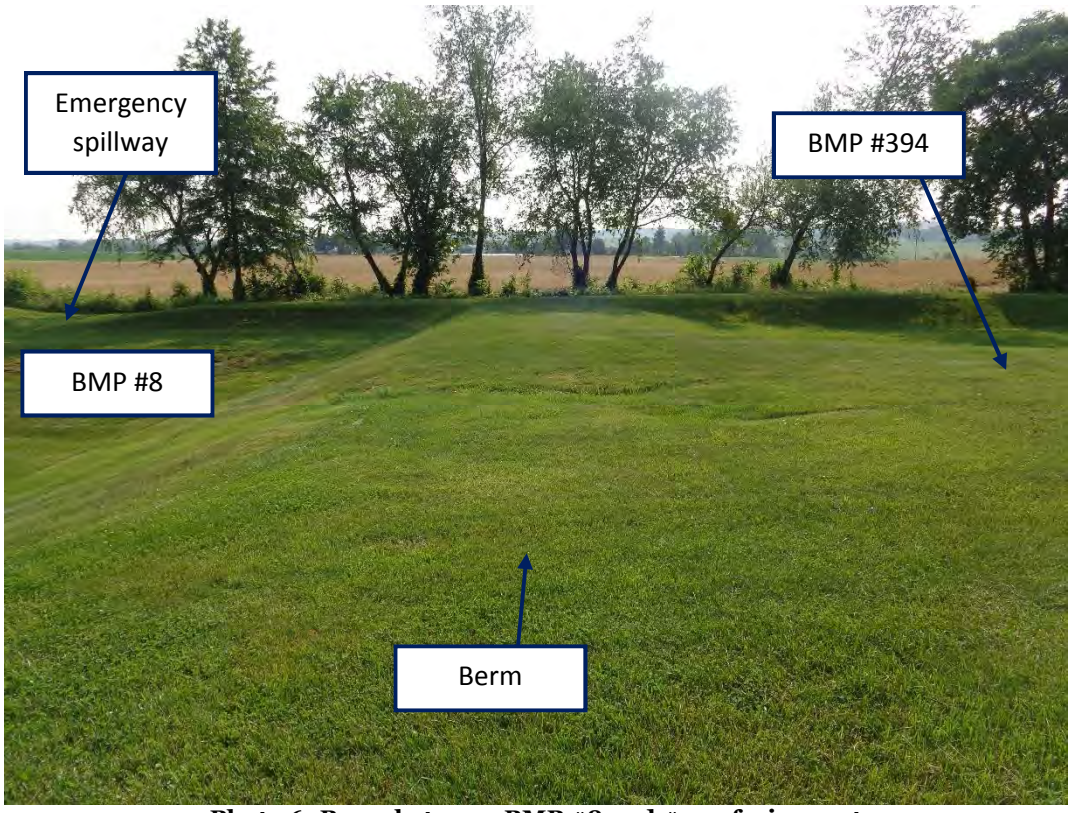


Photo 6: Berm between BMP #8 and #394 facing east

Photo 7: Downstream embankment facing west

Photo 8: Downstream embankment facing north

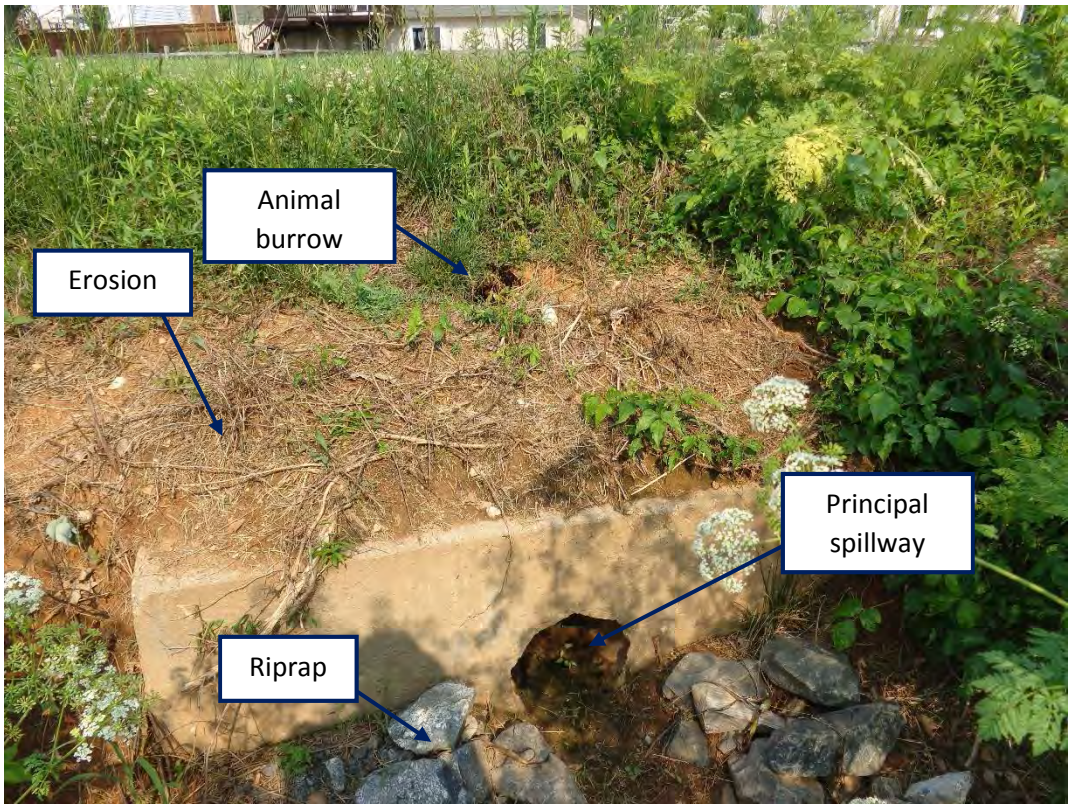


Photo 9: Principal spillway facing west

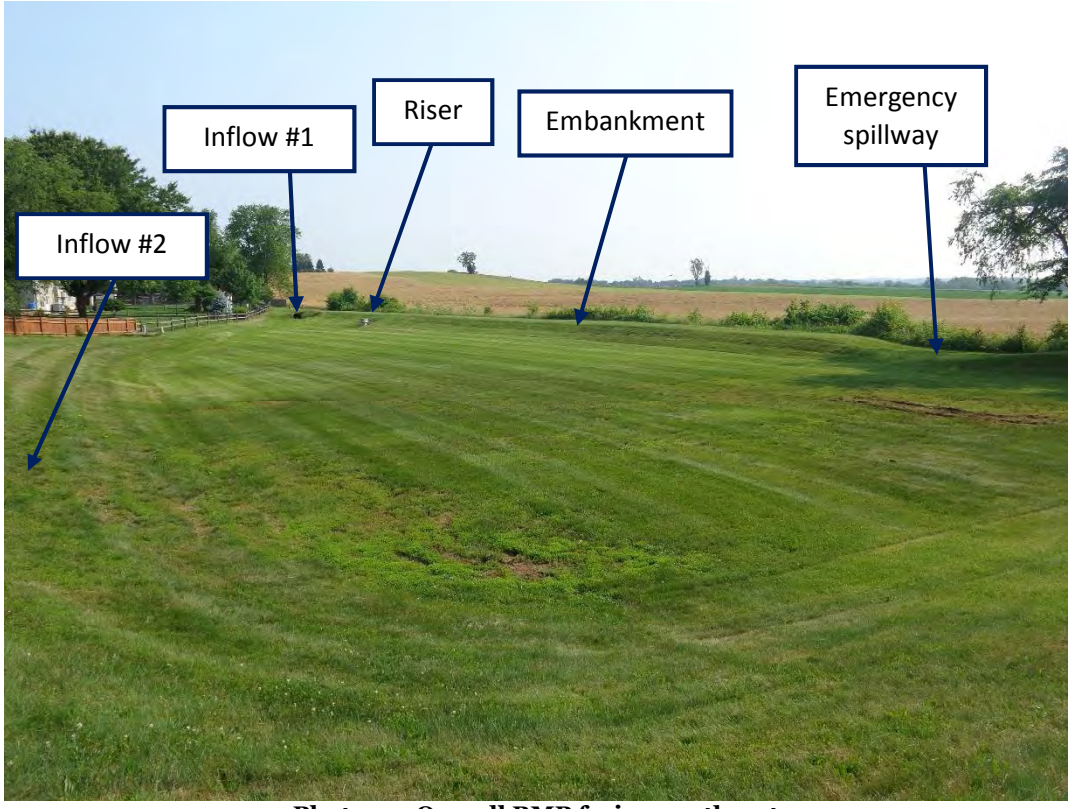
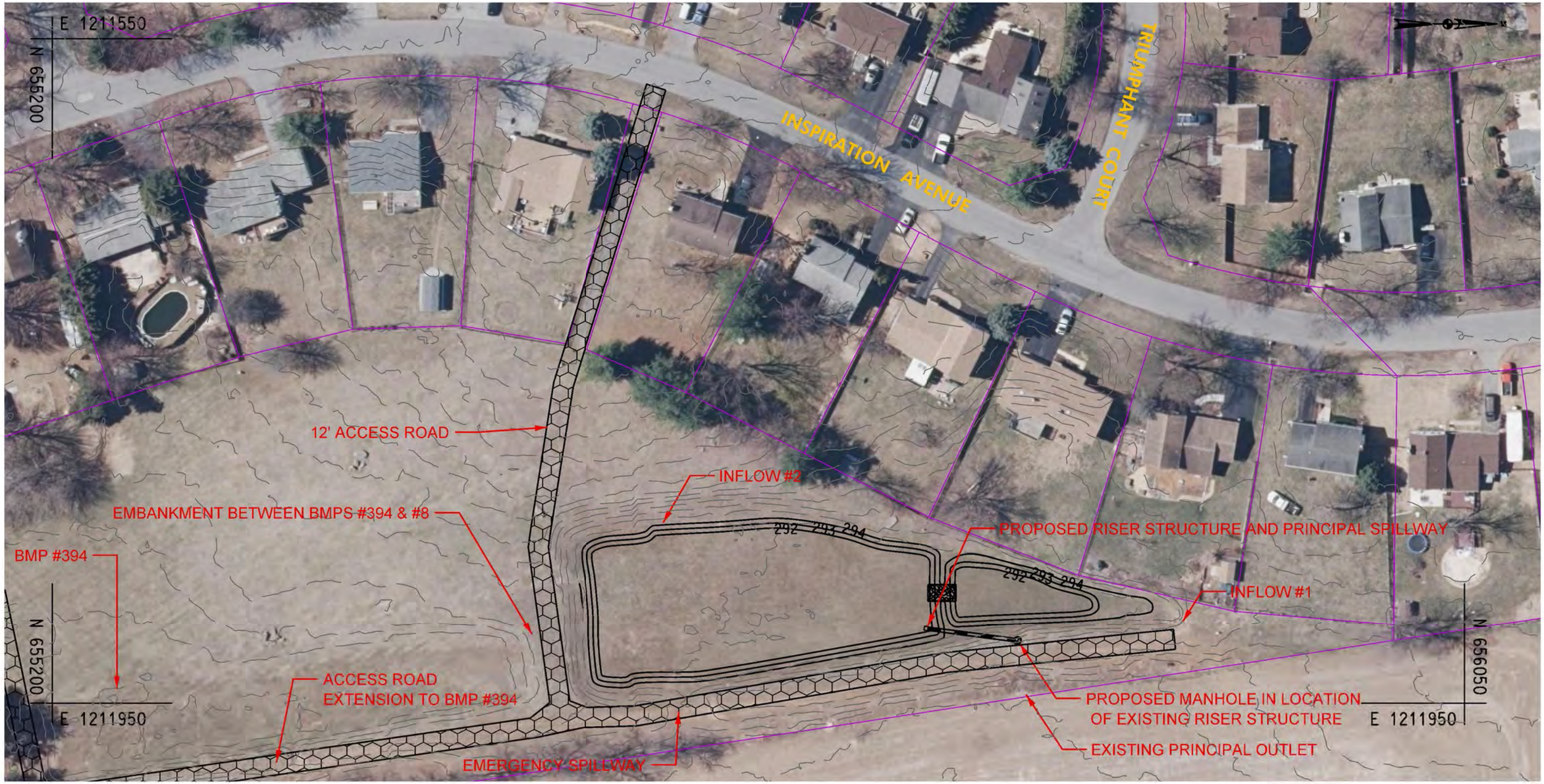


Photo 10: Overall BMP facing northeast



GENERAL BMP INFORMATION	
BMP TYPE:	MICROPOOL EXTENDED DETENTION (P-1)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	23.58
TOTAL IMPERVIOUS AREA (ACRES):	5.48
WQv REQUIRED (CU. FT):	22183
WQv REQUIRED (AC. FT):	0.509
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	22183
TOTAL TREATED DA (ACRES):	23.58
TOTAL TREATED IMPERVIOUS AREA (ACRES):	5.48

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #8 – DISCOVERY SUBDIVISION – SWM POND #2

SCALE 1" = 60' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. – OF SHEET NO. OF

PLOTTED: Wednesday, June 21, 2017 AT 11:37 AM
FILE: \\catocdn\Projects\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP8.dgn

BY: ndriskill -

MICROPOOL EXTENDED DETENTION DESIGN (P-1): BMP 8

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**9/17/2015**
Watershed:	**Lower Linganore Creek**	As Built:	**-**

Drainage Area: **23.58 (Total)** Acres 0.037 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **5.48** Acres **I =** 0.232

= 23.2 %

Soil Type: **A, B**

RCN Existing : **-** **Existing tc =** **-** hr **Unknown per Frederick County's Urban BMP Database**

RCN Post Development : **-** **Post-D tc =** **-** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.259

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)

1" per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 23.2 %

$WQ_{v(I)}$ = 0.509 ac-ft = 22183 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.393 ac-ft = 17119.08 cu.ft

Water quality treatment required =	**22183**	**cu.ft**	**=**	**0.5092**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft**	**=**	**0.0000**	ac-ft	
Net water quality treatment required =	**22183**	**cu.ft**	**=**	**0.5092**	ac-ft	
Sediment Forebay Volume Required=	**2218**	**cu.ft**	**=**	**0.0509**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**19964**	**cu.ft**	**=**	**0.4583**	ac-ft	
Elevation at the Top of WQv in pond =	**293.70**	**ft**				

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	11091
II	50% of WQv is in micropool	11091
III	1/3 of WQv is in micropool & forebay	5176
IV	1/3 of WQv is in micropool & forebay	5176

*source: SHA SWM Workshop, April 30, 2003

Micropool storage volume required = **5176** **cu.ft** **=** **0.1188** **ac-ft**

Extended Detention Storage= **5176** cu.ft = Dead Storage Volume cu.ft

Extended Detention Elevation= **292.34** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice

Hence, WQrr = **0.06** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_o = \frac{WQrr}{4.81\sqrt{h_o}}$$

Assume h_o = **1.36** ft *Will change based on pond volume

Ao = 0.01 sf

Determine the required orifice diameter (d_o)

$$D_o = \sqrt{\frac{4\ A_o}{}}$$

Do = 0.12 ft = **1.4** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**0.17**	1
B	**23.37**	99
C	**0.00**	0
D	**0.00**	0
Total	**23.54**	OK: sum of the areas matches site Area

Composite S: 0.2609 Use 26.09 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.133 ac-ft = **5787** cu.ft

Rev in Pond= **3568**

El of Rev= **292.23** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **1.430** Acres = 62271 sf

The Rev requirement may be met by:

a) treating 0.133 ac-ft using structural method,

b) treating 1.430 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	9/17/2015
Watershed:	Lower Linganore Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
14527.0	**292.0**	0.33	0.00	0.00	0.00	0.00
16156.0	**293.0**	0.37	1.00	0.35	0.35	15334.29
17851.0	**294.0**	0.41	1.00	0.39	0.74	32330.74
		0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00

No. of valid row entries= 3

HR103: New Market Elementary/Middle School

Prioritization Ranking:	36
Planning Level Cost Estimate:	$ 493,680.00
Estimated Cost/Impervious Acre	$ 107,979.19

General BMP Information:		
Structure Location:	125 W. Main Street	
ADC Map:	4568, F9 (2008)	
Nothing/Easting:	626,032.763/1,233,823.694	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool ED (P-1)	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	12.57	
Total Impervious Area (ac):	4.8	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	17963	
Total Treated Drainage Area (ac):	12.57	
Total Treated Impervious Area (ac):	4.8	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	103.94	38.03
TP (lbs/yr):	10.12	4.75
TSS (lbs/yr):	8052.26	5217.01

Existing conditions for BMP A

Site map for BMP A

EXISTING SITE CONDITIONS

BMP A was designed as a SWM pond. The facility was constructed in the northwest corner of New Market Middle School located at 125 W. Main Street as shown in the site map above. This facility is not in Frederick County's Urban BMP Database. The drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 12.57 acres and includes. The land use is institutional.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from the New Market Middle School parking lot located at 125 W. Main Street. There are no other obvious site constraints such as utilities or steep slopes. Maintenance of Traffic (MOT) will be required for access from the school parking lot.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: Tree Impacts, MOT	

PROPOSED RETROFIT

The proposed retrofit for BMP A is a micropool ED (P-1). It will provide quality management for 12.57 acres including 4.80 acres of impervious area. The retrofit will include grading within the footprint of the existing BMP and construction of an access road to provide maintenance access to the control structure.

HR103: NEW MARKET ELEMENTARY/MIDDLE SCHOOL

Storm Water Management Retrofit Evaluation					
Report Date:	9/16/2015	**Design Approval:**	7/7/1977	**Maintenance Owner:**	FCPS
Structure No:		**Year Constructed:**	N/A	**Inspection Date:**	7/7/2015
Structure Name:	New Market Elementary/Middle School	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, GL
Location:	125 W. Main Street	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/28/2015 (0.19")
ADC Map:	4568, F9 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	626,032.763/1,233,823.694	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	Extended Detention Dry Pond		Micropool ED (P-1)	
BMP Classification:	N/A		Stormwater Treatment (ST) Practice	
Management Type:			Quantity/Quality	
Total Drainage Area (acres):			12.57	
Total Impervious Area within Drainage Area (acres):			4.80	
WQv Required:			17963 cu. ft.	0.412 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	N/A	0	17963 cu. ft.	0.412 ac-ft
Total Treated Drainage Area (acres):	N/A	0	12.57	
Total Treated Impervious Area within Drainage Area (acres):	N/A	0	4.8	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.03	
Total Nitrogen:			35.23%	
Total Phosphorus:			55.36%	
Sediment:			70.46%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		103.94	38.03
TP (lbs/yr):	0		10.12	4.75
TSS (lbs/yr):	0		8052.26	5217.01
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 493,680.00**

HR103: NEW MARKET ELEMENTARY/MIDDLE SCHOOL

New Market Elementary and New Market Middle Schools were previously identified as Project ID HR103 and HR102 respectively in *An Assessment of Stormwater Management Retrofit and Stream Restoration Opportunities in Linganore Creek Watershed, Frederick County, Maryland* (hereafter referred to as the Linganore R/R Report) developed by Versar, Inc. (July 2006). This project location was selected for re-evaluation because it is located on Frederick County Public School (FCPS) properties and the County has previously completed restoration efforts at this location.

Versar's proposed actions for New Market Elementary school included constructing rain gardens adjacent to a number of paved areas, installing an infiltration trench in the parking lots, building an off-line bioretention, and constructing a detention micro-berm. The proposed actions for New Market Middle School included retrofitting the control structure of the existing stormwater management facility to MD2000 standards, incorporating multi-cell bioretention cells within the facility, building rain gardens adjacent to paved areas, installing an infiltration trench in the parking lot, and reforesting unused open space. Dewberry has evaluated the previous recommendations and conducted a GIS desktop analysis and site visit and identified the most cost-effective retrofit/restoration approach for the site as described in detail below.

Existing Site Conditions:

SWM ERA: pre-1985

According to the design plans provided by the County, an existing extended detention dry pond has been identified. The facility was constructed in the northwest corner of New Market Middle School located at 125 W. Main Street as shown in the BMP Location map **(Figure 1)**. The facility is not in the Frederick County Urban BMP Database. The drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 12.57 acres. **Figure 1** shows the drainage area for the facility. According to the design plans, this facility has the following features: an existing storm drain inflow with a concrete headwall from the east, a 10' grassed emergency spillway, and a 12" ALCMP outlet pipe with a concrete endwall and trash rack. The majority of land use is institutional.

General Observations:

A site visit was conducted on July 7th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has five inflow points. Inflow #1 conveys water into the facility from the south via a 12" plastic pipe (**Photo 1**). There is some erosion in the inflow channel downstream of the riprap outfall protection. Inflow #2 conveys water into the facility from the southeast via an 18" RCP (**Photo 2**). Inflow #2 is half submerged in water and there is vegetation in the inflow channel. Inflow #3 drains water into the facility from the southeast via an 18" CMP (**Photo 3**). The inflow pipe does not have an end section and is damaged. Inflow #4 drains water into the facility from the east via a 12" plastic pipe cross culvert under the paved sidewalk (**Photo 4**). The pipe is exposed due to inadequate cover and there is some sediment and debris below the inflow (**Photo 5**). Inflow #5 drains water into the facility from the northeast via a 12" plastic pipe cross culvert under the paved sidewalk (**Photo 6**). There is some vegetation in the upstream inflow channel and debris in the downstream inflow channel (**Photos 6 & 7**).

Control Structure and Spillways:

The control structure for this facility is a 12" ALCMP outlet pipe with a concrete end wall and trash rack **(Photo 8)**. There is overgrown vegetation and debris is blocking almost 100% of the control structure.

Embankment:

A fill embankment is present between the pond and principal outlet. The upstream side of the embankment is covered by grass that has been mowed and is in good condition **(Photo 9)**. There is woody vegetation within 15' of the embankment. According to design plans, a core trench was installed.

Outflow:

The facility outfalls to the west via a 12" ALCMP (**Photo 10**). There is overgrown vegetation and debris in the outflow channel and an orange discharge in the outflow pipe which is concluded to be a naturally-occurring ferrous bacteria. A fire hydrant is present approximately 10' northeast of the outfall (**Photo 11**).

Overall BMP:

There is some erosion downstream of Inflow #1 and Inflow #2 is half submerged in water with vegetation in the inflow channel. Inflow #3 pipe is damaged. Inflow #4 pipe is exposed and there is some sediment and debris below the inflow. Vegetation is present in the upstream inflow channel for Inflow #5 and debris in the downstream inflow channel. There is woody vegetation within 15' of the fill embankment. Overgrown vegetation and debris are blocking the control structure. There is overgrown vegetation and debris in the outflow channel and an orange discharge in the outflow pipe which is concluded to be a naturally-occurring ferrous bacteria. A fire hydrant is present approximately 10' northeast of the outfall. The BMP is overgrown with vegetation and invasive species (**Photo 12**). Moderate problems are observed, however, the BMP is functioning as designed with no critical parameters but with some problem conditions. BMP performance is being compromised.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site from the New Market Middle School parking lot located at 125 W. Main Street. BMP A is owned by FCPS, and maintenance of traffic (MOT) is required because access will be obtained from the school parking lot. Stormwater management easements must be evaluated at final design.

Proposed Retrofit:

Based on the results of a GIS desktop analysis and site visit, it was determined that the majority of impervious area on the two school sites drains to the existing stormwater management facility which was designed in 1977 per the available plans from FCPS. Therefore, the most cost-effective retrofit/restoration approach is to assess the option of retrofitting the existing stormwater management facility to meet the current water quality volume standards to provide treatment for one inch of runoff.

BMP A was originally designed as an extended detention dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP A is a micropool ED (P-1). The proposed retrofit will provide quantity and quality management for 12.57 acres including 4.80 acres of impervious area. A grass ditch will need to be graded between existing Inflow #4 and Inflow #5 in order to redirect flow to the proposed forebay.

Additional Retrofit Opportunities:

The outfall for the roof drains for the New Market Middle School could not be determined in the field. Upon final design, further investigation will be needed. The drainage areas for BMP A was assumed based on the information found on the plans received from the County and from the field investigation. The assumption was made that the roof drains for the building drain to the existing SWM facility. If the roof drains do not drain to the existing SWM facility, 2.05 acres of impervious area from sidewalks and parking lots drain the facility.

Step 1: Watershed Factors

BMP A is located in Frederick County's Ballenger Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP A due to the downstream coldwater conditions. For the retrofit of BMP A, 100% of the WQv can be stored by expanding the BMP footprint in nearby open space (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream Cherry Run creek.

Step 2: Terrain Factors

BMP A is not located in a region of Frederick County that is prone to karst geology. Therefore, no special terrain factors and/or constraints must be considered for retrofit design.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to the unavailability of plans. There is adequate space for the proposed retrofit within the existing BMP boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a micropool ED is 10 acres. The proposed drainage area to BMP A is 12.57 acres and is composed of B, and C soils. The likelihood of BMP A receiving hotspot runoff is low as it is located within an institutional area. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban. Retrofitting the existing BMP into a wet pond is feasible at this location per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP A is located in the northwest corner of New Market Middle School at 125 W. Main Street and has high visibility. Micropool ED tend to have medium maintenance requirements, medium community acceptance, low construction costs relative to the drainage area, and provide medium habitat quality. Coordination with the principal of the school will be required in final design since the proposed retrofit will remove trees and vegetation in the event that information needs to be communicated to parents at the school.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP A include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

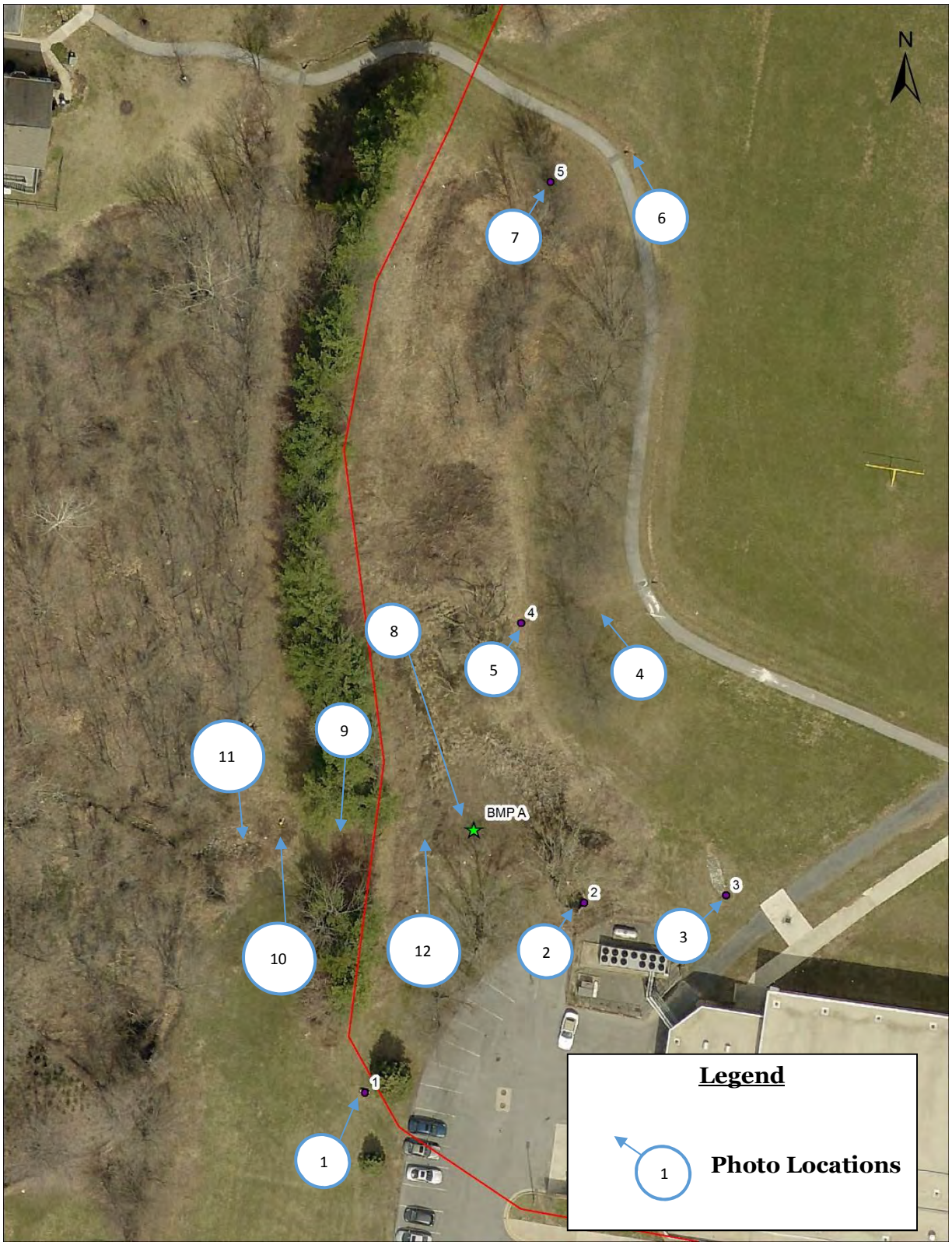


Figure 2: Photo Locations

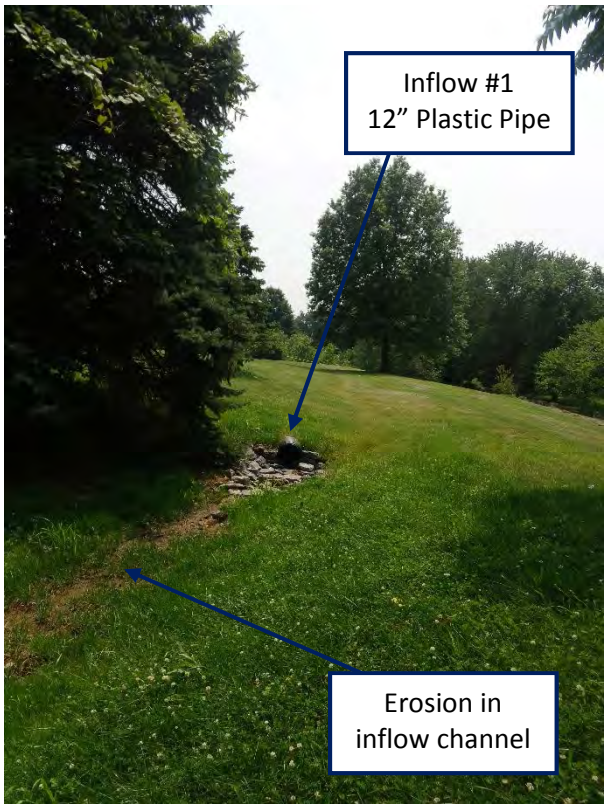


Photo 1: Inflow #1 facing south

Photo 2: Inflow #2 facing southeast

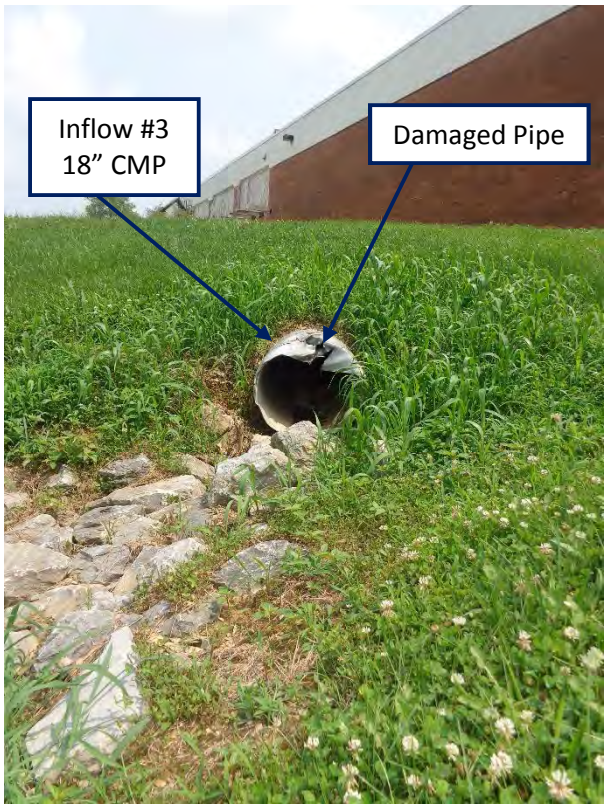


Photo 3: Inflow #3 facing southeast

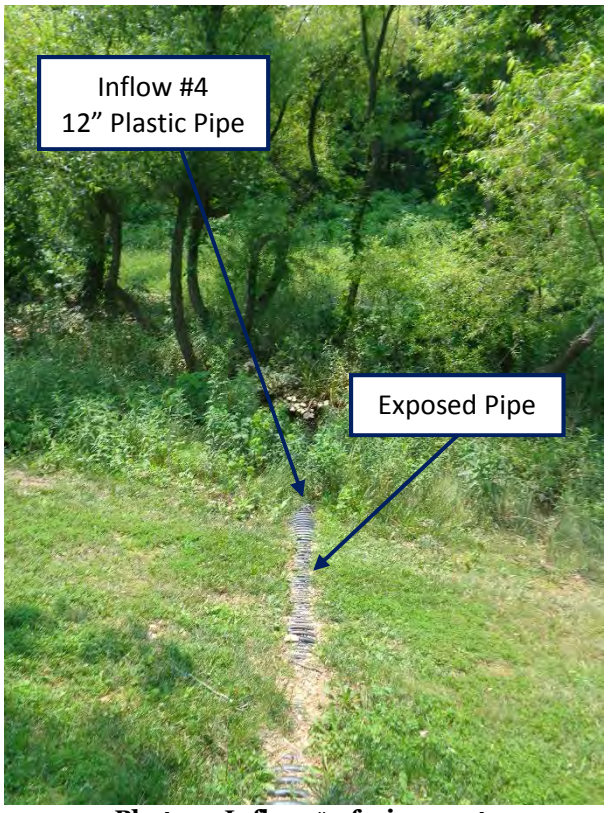


Photo 4: Inflow #4 facing west

Photo 5: Inflow #4 facing west

Photo 6: Upstream Inflow #5 facing southwest

Photo 7: Downstream Inflow #5 facing southwest

Photo 8: Control structure facing west

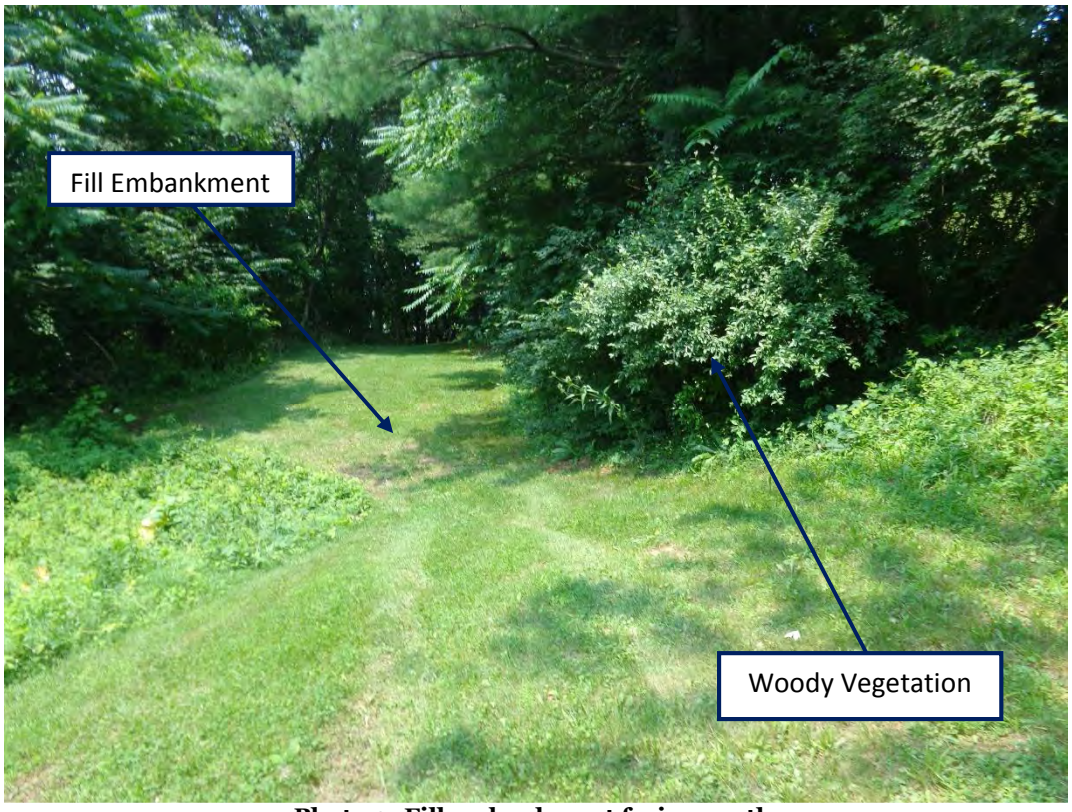


Photo 9: Fill embankment facing south

Photo 10: Outflow pipe facing east

Photo 11: Fire hydrant 10' northeast of outfall facing north

Photo 12: Overall BMP facing north

GENERAL BMP INFORMATION	
BMP TYPE:	MICROPOOL ED (P-1)
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	12.57
TOTAL IMPERVIOUS AREA (ACRES):	4.8
WQv REQUIRED (CU. FT):	17963
WQv REQUIRED (AC. FT):	0.412
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	17963
TOTAL TREATED DA (ACRES):	12.57
TOTAL TREATED IMPERVIOUS AREA (ACRES):	4.8

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndriskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

NEW MARKET ELEMENTARY/MIDDLE SCHOOL

SCALE 1" = 100' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF - SHEET NO. - OF -

PLOTTED: Wednesday, June 21, 2017 AT 11:43 AM
FILE: \\catocbn\Projects\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_NewMarketElem.dgn

WinTR-55 Current Data Description

--- Identification Data ---

User: vhamsher
Project: SWM BMP Retrofit Assessment
SubTitle: New Market Elementary/Middle School
State: Maryland
County: Frederick NOAA_C
Filename: <new file>

Date: 9/17/2015
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
New Market	BMP A	Outlet	12.57	76	0.1

Total area: 12.57 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.42	4.45	5.34	6.69	7.88	9.22	2.81

Storm Data Source: Wicomico East NOAA_D County, MD (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

vhamsher SWM BMP Retrofit Assessment
New Market Elementary/Middle School
Frederick NOAA_C County, Maryland

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period ANALYSIS: (cfs)	10-Yr (cfs)	100-Yr (cfs)
SUBAREAS			
New Market	24.91	54.64	119.79
REACHES			
OUTLET	24.91	54.64	119.79

SWM BMP Retrofit Assessment
New Market Elementary/Middle School
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)
New Market							
SHEET	100	0.0200	0.000				
SHALLOW	326	0.0500	0.050				
CHANNEL	541					8.000	0.019
					Time of Concentration		0.1

SWM BMP Retrofit Assessment
New Market Elementary/Middle School
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
New Market	Open space; grass cover > 75%	(good)	B	6.81	61
	Open space; grass cover > 75%	(good)	C	.96	74
	Paved parking lots, roofs, driveways		B	4.8	98
	Total Area / Weighted Curve Number			12.57	76
				=====	==

MICROPOOL ED DESIGN (P-1): NEW MARKET ELEMENTARY/MIDDLE SCHOOL

This spreadsheet is for **design level calculations** of Micropool ED

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2011)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project: **SWM BMP Retrofit Assessment** Engineer:

Location: **Frederick County, MD** Date: **9/17/2015**

Watershed: **Lower Monocacy River** As Built:

Drainage Area: **12.57** Acres 0.020 square miles

(Total)

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **4.80** Acres **I =** 0.382

= 38.2 %

Soil Type: **B, C**

RCN Existing : **0** **Existing tc =** **0.00** hr

RCN Post Development : **76** **Post-D tc =** **0.10** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.394

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (1.0" for Eastern Rainfall Zone, 0.9" for Western Rainfall zone)
1" selected per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 38.2 %

$WQ_{V(I)}$ = 0.412 ac-ft = 17963 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.210 ac-ft = 9125.82 cu.ft

Water quality treatment required =	**17963**	**cu.ft =**	**0.4124**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**17963**	**cu.ft =**	**0.4124**	ac-ft	
Sediment Forebay Volume Required=	**1796**	**cu.ft =**	**0.0412**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**16167**	**cu.ft =**	**0.3711**	ac-ft	
Elevation at the Top of WQv in pond =	**509.00**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	8981
II	50% of WQv is in micropool	8981
III	1/3 of WQv is in micropool & forebay	4191
IV	1/3 of WQv is in micropool & forebay	4191
*source: SHA SWM Workshop, April 30, 2003		

Micropool storage volume required = **4191** **cu.ft =** **0.0962** **ac-ft**

Extended Detention Storage= **4191** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **508.37** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.05** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

Assume h_o = **0.63** ft *Will change based on pond volume

Ao = 0.01 sf

Determine the required orifice diameter (d_o)

Do = 0.13 ft = **1.5** inches.

Step 2: Compute Recharge Volume (Rev)

$$\text{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

	HSG	Drainage Area (Acres)	Percentage (%)
	A	**0.00**	0
12.56	B	**11.60**	92
	C	**0.96**	8
	D	**0.00**	0
	Total	**12.56**	OK: sum of the areas matches site Area

Composite S: 0.2501 Use 25.01 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.103 ac-ft = **4492** cu.ft

Rev in Pond= **2696**

El of Rev= **508.24** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **1.200** Acres = 52285 sf

The Rev requirement may be met by:

a) treating 0.103 ac-ft using structural method,

b) treating 1.200 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	SWM BMP Retrofit Assessment	Engineer:	VLH
Location:	Frederick County, MD	Date:	9/17/2015
Watershed:	Lower Monocacy River		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
10655.3	**508.0**	0.24	0.00	0.00	0.00	0.00
12117.9	**509.0**	0.28	1.00	0.26	0.26	11378.73
13641.2	**510.0**	0.31	1.00	0.30	0.56	24250.76

No. of valid row entries= 3

Steamboat Way Subdivision - BMP A

Prioritization Ranking:	37
Planning Level Cost Estimate:	$ 80,630.00
Estimated Cost/Impervious Acre	$ 123,062.63

General BMP Information:		
Structure Location:	North of Illinois Court, west of Steamboat Way	
ADC Map:	4568, C6 (2008)	
Northing/Easting:	633,554.010/1,229,212.199	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Regenerative Step Pool Conveyance	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	6.24	
Total Impervious Area (ac):	0.8	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	3746	
Total Treated Drainage Area (ac):	6.24	
Total Treated Impervious Area (ac):	0.80	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	83.90	30.69
TP (lbs/yr):	4.02	1.88
TSS (lbs/yr):	2503.09	1621.74

Existing conditions for Steamboat Way Subdivion - BMP A

Site map for Steamboat Way Subdivision - BMP A

EXISTING SITE CONDITIONS

The subdivisions at Illinois Court and Steamboat Way were investigated during site visits to identify opportunities to treat untreated impervious area. The drainage area for BMP A, as digitized in GIS using the contours created from Digital Elevation Models (DEM) provided by the County, shows the BMP is treating 6.24 acres. The drainage area is shown in the location map above. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from Illinois Court. There are no other obvious site constraints such as utilities or steep slopes. Maintenance of traffic (MOT) is required for this BMP.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There is no existing SWM at this location. The most appropriate BMP options for untreated impervious area are step pool conveyances below each of the storm drain outfalls in the subdivisions. Two step pool conveyances are proposed at this location (BMPs A and B). Proposed BMP A will include four 8' cascades and four 10' cobble riffles. BMP A will provide quality management for 6.24 acres including 0.80 acres of impervious area. The Project Summary Sheet for BMP B is included separately in Appendix E with a prioritization ranking of 45.

STEAMBOAT WAY SUBDIVISION

Storm Water Management Retrofit Evaluation

Report Date:	10/7/2015	**Design Approval:**	Not Available	**Maintenance Owner:**	N/A
Structure No:	BMP A	**Year Constructed:**	Not Available	**Inspection Date:**	5/5/2015
Structure Name:	Steamboat Way Subdivision	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, CF
Location:	North of Illinois Court, west of Steamboat Way	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	4/30/2015 (0.14")
ADC Map:	4568, C6 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	633,554.010/1,229,212.199	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description

	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Regenerative Step Pool Conveyance	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quantity/Quality	
Total Drainage Area (acres):			6.24	
Total Impervious Area within Drainage Area (acres):			0.80	
WQv Required:			3746 cu. ft.	0.086 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		3746 cu. ft.	0.086 ac-ft
Total Treated Drainage Area (acres):			6.24	
Total Treated Impervious Area within Drainage Area (acres):			0.80	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		1.29	
Total Nitrogen:			63.37%	
Total Phosphorus:			74.13%	
Sediment:			79.46%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		83.90	30.69
TP (lbs/yr):			4.02	1.88
TSS (lbs/yr):			2503.09	1621.74
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 80,630.00**

Storm Water Management Retrofit Evaluation					
Report Date:	10/7/2015	**Design Approval:**	Not Available	**Maintenance Owner:**	N/A
Structure No:	BMP B	**Year Constructed:**	Not Available	**Inspection Date:**	5/5/2015
Structure Name:	Steamboat Way Subdivision	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, CF
Location:	Northwest corner of Steamboat Way	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	4/30/2015 (0.14")
ADC Map:	**4568,** C6 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	633,759.013/1,229,176.912	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	No Existing SWM Facility		Regenerative Step Pool Conveyance	
BMP Classification:			Runoff Reduction (RR) Practice	
Management Type:			Quantity/Quality	
Total Drainage Area (acres):			3.63	
Total Impervious Area within Drainage Area (acres):			1.77	
WQv Required:			6441 cu. ft.	0.148 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):			Yes	
Adequate ROW (Y/N):			Yes	
Adequate Access (Y/N):			Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	No Existing SWM Facility		6441 cu. ft.	0.148 ac-ft
Total Treated Drainage Area (acres):			3.63	
Total Treated Impervious Area within Drainage Area (acres):			1.77	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	No Existing SWM Facility		1.00	
Total Nitrogen:			59.81%	
Total Phosphorus:			69.97%	
Sediment:			74.98%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	No Existing SWM Facility		53.00	19.39
TP (lbs/yr):			4.31	2.02
TSS (lbs/yr):			2933.30	1900.46
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 177,193.50**

STEAMBOAT WAY SUBDIVISION

Existing Site Conditions:

The subdivisions at Illinois Court and Steamboat Way were investigated during site visits to identify opportunities to treat untreated impervious area. The drainage areas for BMP A and BMP B, as digitized in GIS using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMPs are treating 6.24 acres and 3.63 acres, respectively. **Figure 1** shows the drainage areas for BMP A and BMP B.

General Observations:

The site visit was conducted on May 5th, 2015. **Figure 2** shows the location of photos taken during the visit.

Runoff from Illinois Court drains into a storm drain system and outfalls to the north of the subdivision via a 30" ALCMP (**Photo 1**). There was a small amount of water in the outfall pipe. The outfall drains to the northwest via a rip-rap channel (**Photo 2**) which ultimately drains to an unnamed creek. There is some vegetation and trees in the outflow channel. There is sediment deposition below the outfall which is preventing positive drainage from the pipe.

Runoff from Steamboat Way drains into a storm drain system and outfalls to the northwest of the subdivision via a 15" ALCMP. The 15" ALCMP is buried under rip-rap and was not able to be located in the field (**Photo 3**). The outfall drains to the west via a rip-rap channel (**Photo 4**) which ultimately drains to an unnamed creek. There is vegetation, trees, and heavy debris in the outflow channel.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The sites can be accessed for maintenance and hauling material in and out of the site via Illinois Court or Steamboat Way. According to the County's parcel layer in GIS, the sites are located within a storm drain easement. Easements at this location must be further evaluated at final design. Maintenance of traffic (MOT) is required to notify residents living in the surrounding area.

Proposed Retrofit:

There is no existing SWM at this location. The most appropriate BMP options for untreated impervious area are regenerative step pool conveyances below each of the storm drain outfalls in the subdivisions. Proposed BMP A will include four 8' cascades and four 10' cobble riffles. BMP A will provide quality management for 6.24 acres including 0.80 acres of impervious area as shown in the **Concept Plans**. Proposed BMP B will include three 8' cascades and three 10' cobble riffles. BMP B will provide quality management for 3.63 acres including 1.77 acres of impervious area as shown in the **Concept Plans**.

Additional Retrofit Opportunities:

Outfall stabilization for impervious area credit may be evaluated for this area at final design. In final design, a permanent access road should be provided to each facility after acquiring easements.

Step 1: Watershed Factors

BMPs A and B are located in Frederick County's Lower Linganore Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are no special watershed factors and/or constraints that must be considered.

Step 2: Terrain Factors

BMPs A and B are not located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for proposed design of BMPs A and B.

Step 3: Stormwater Treatment Suitability

For BMPs A and B, a regenerative step pool conveyance is feasible below the existing storm drain outfall. BMPs A and B are proposed within a storm drain easement. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The maximum drainage area for a regenerative step pool conveyance is 30 acres. The proposed drainage area for BMP A is 6.24 acres and is composed of B and C soils. The proposed drainage area for BMP B is 3.63 acres and is composed of B and C soils. The likelihood of BMPs A and B receiving hotspot runoff is low as it is located within a residential area. Proposing new BMPs are feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

Proposed BMPs A and B are located below the existing storm drain outfalls west of the Steamboat Way subdivision and have moderate visibility. Regenerative step pool conveyances tend to have low maintenance requirements, medium community acceptance, and medium cost relative to the drainage area with medium habitat quality in comparison with other BMP selections. Property ownership and easements at this location must be further evaluated at final design.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMPs A and B include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

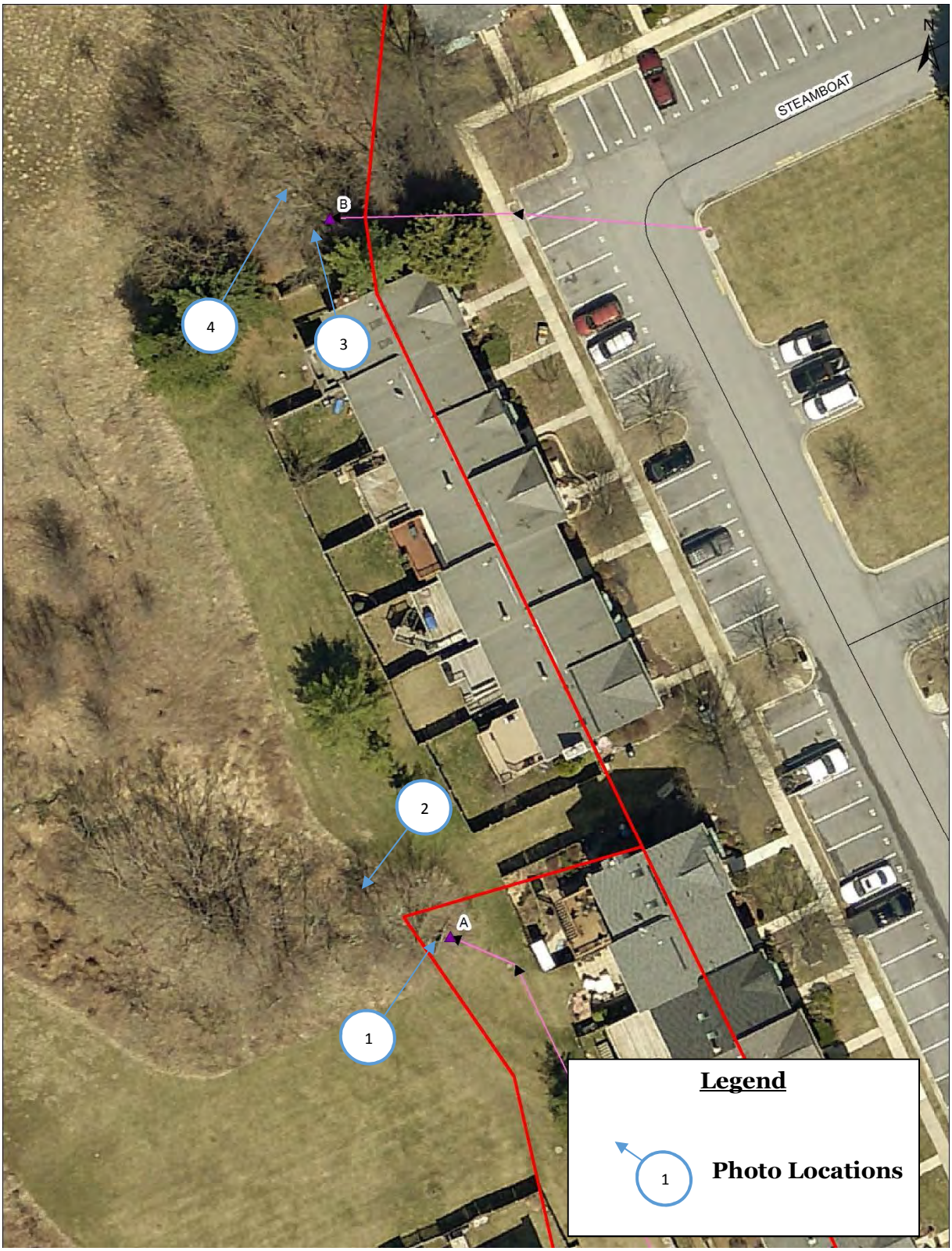


Figure 2: Photo Locations

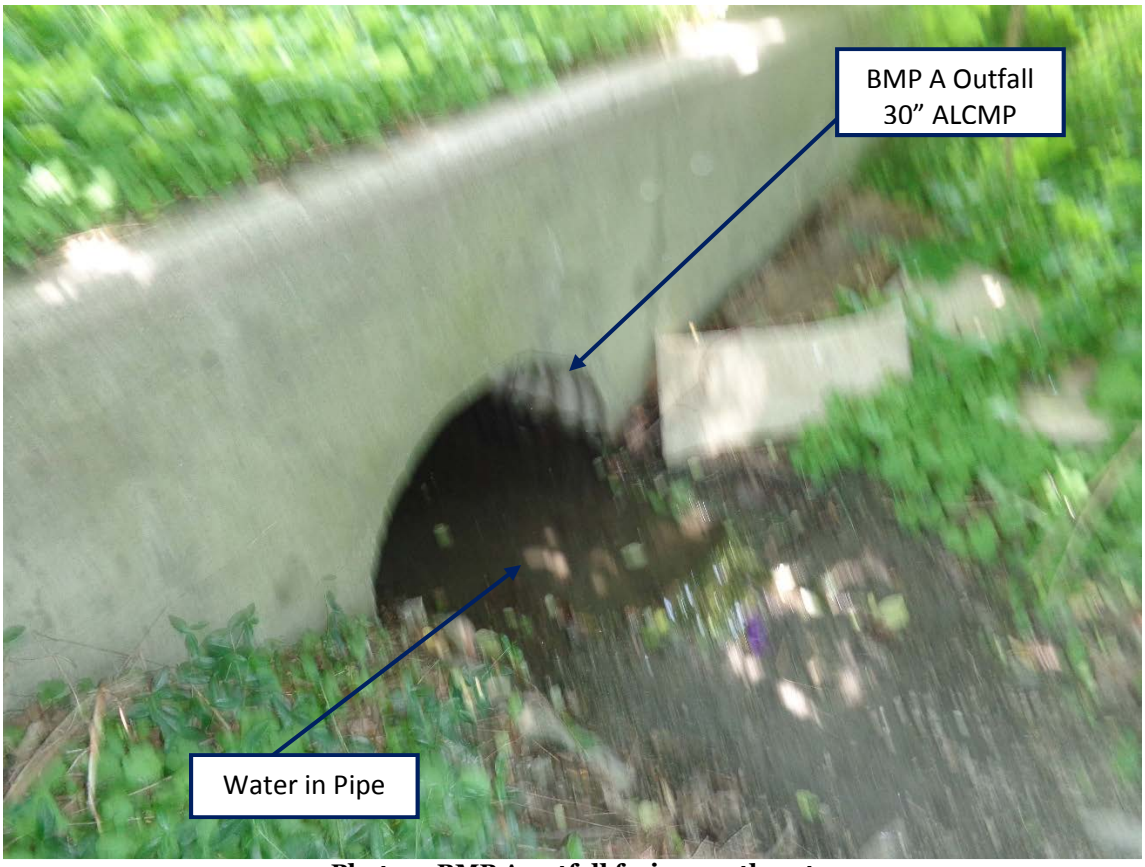


Photo 1: BMP A outfall facing southeast

Photo 2: BMP A downstream channel facing southwest

Photo 3: BMP B outfall facing east

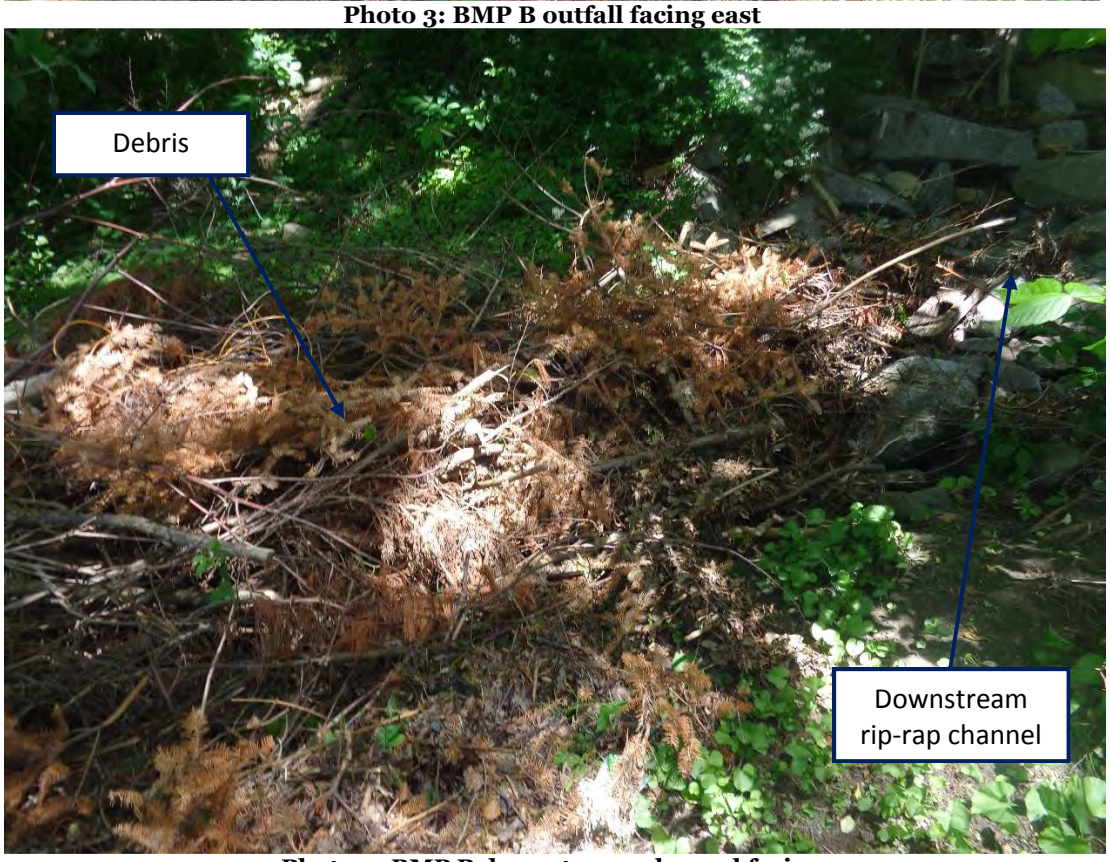
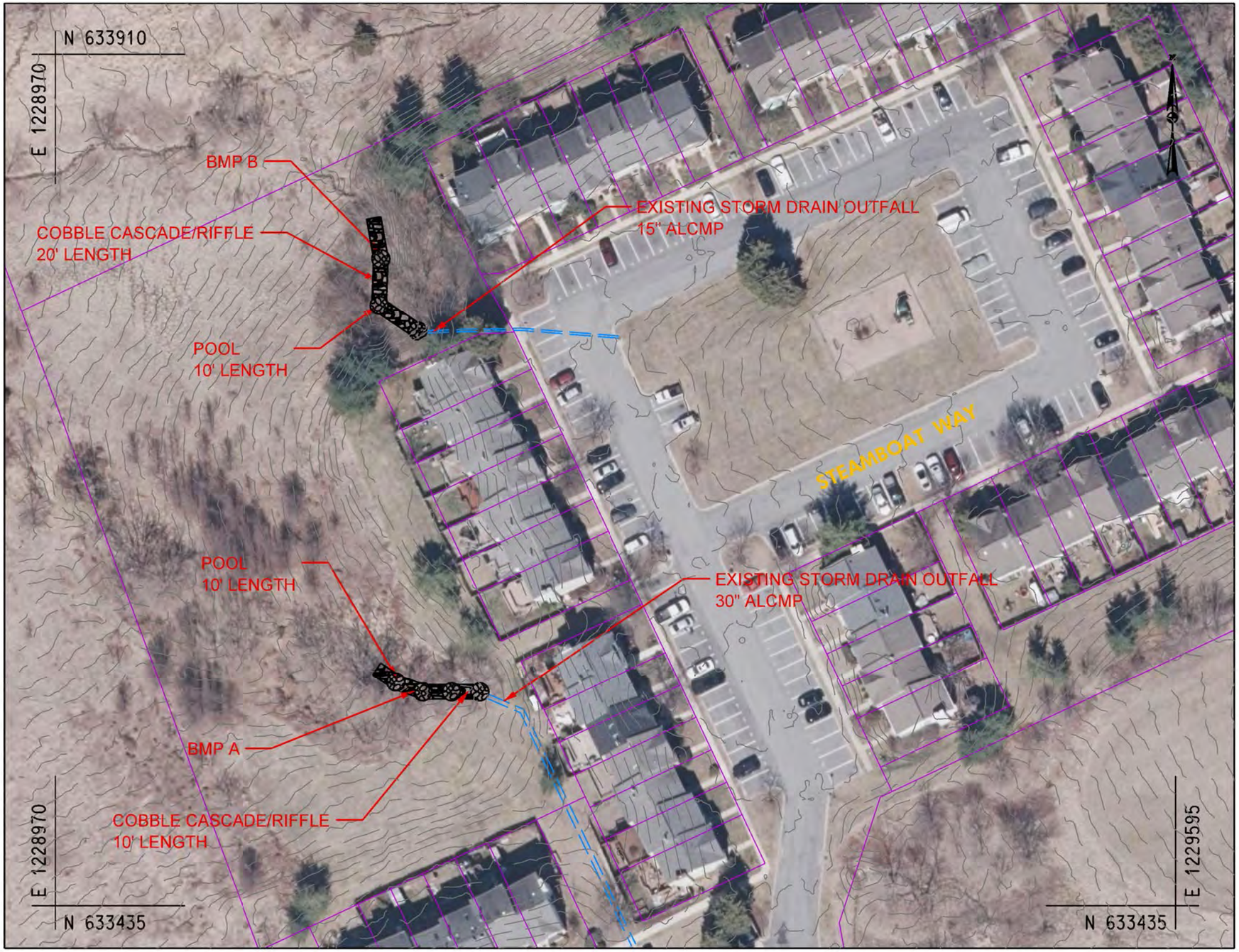


Photo 4: BMP B downstream channel facing



GENERAL BMP INFORMATION - BMP A	
BMP TYPE:	REGENERATIVE STEP POOL CONVEYANCE
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	6.24
TOTAL IMPERVIOUS AREA (ACRES):	0.80
WQv REQUIRED (CU. FT):	3746
WQv REQUIRED (AC. FT):	0.086
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	3746
TOTAL TREATED DA (ACRES):	6.24
TOTAL TREATED IMPERVIOUS AREA (ACRES):	0.80

GENERAL BMP INFORMATION - BMP B	
BMP TYPE:	REGENERATIVE STEP POOL CONVEYANCE
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	3.63
TOTAL IMPERVIOUS AREA (ACRES):	1.77
WQv REQUIRED (CU. FT):	5441
WQv REQUIRED (AC. FT):	0.148
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	5441
TOTAL TREATED DA (ACRES):	3.63
TOTAL TREATED IMPERVIOUS AREA (ACRES):	1.77

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

STEAMBOAT WAY SUBDIVISION

SCALE 1" = 60' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF - SHEET NO. - OF -

BY: ndriskill -

PLOTTED: Wednesday, June 21, 2017 AT 02:55 PM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_SteamboatSub.dgn

SPSC Design Calculations - Riffle

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **Steamboat Way Subdivision - BMP A** Engineer: **VLH**
Plan Number: Date: **10/7/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	6.24	acres	6.24	6.24
C-Factor:	0.87		0.87	0.87
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	51.06	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.05	ft/ft	Note: Start with 5%			
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1			
Design Depth (D) =	1.6	ft				Adequate
W =	8	ft	8 ft (min.)			-
d50 (Cobble) =	0.75	ft	Note: Start with 0.5			
Area (A) =	2WD / 3		=	8.53	SF	
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$		=	0.964		
n =	D^(1/6) / (21.6*log(D/d50)+14)			=	0.051	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	54.14	cfs	Adequate

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)				
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)		
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)		
=	11.69	ft/s			Subcritical Flow C = 1.2
Vmax =	Q / A	=	6.35	ft/s	Adequate
Fr =	V / ((g*D)^(1/2))		=	0.884	

Step C: Check Actual

dw =	1.600	ft	Note: Use Solver to make Q(act.) = Q(design)			
Wa =	8.00	ft				
A (act.) =	8.53	SF				
Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	0.964		
n(act.) =	dw^(1/6) / (21.6*log(dw/d50)+14)			=	0.051	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	54.14	cfs	Adequate

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	8.37	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	11.69	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	8.37	ft/s				Supercritical Flow C = 0.86
V (act.) =	Q (act.) / A(act.)		=	6.35	ft/s	Adequate
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	0.88		

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	1.9751	=	1.98	ft	MIN. REQUIRED DEPTH

IV. Water Quality Computations

Site Drainage Area (SA) =	6.24	acres
Contr. Imp. Area (IA) =	0.80	acres
Length Total (L Design) =	40	ft

Rv =	0.05+[0.009*((IA/SA)*100)]	=	0.165	
WQv =	(Rv*SA / 12) * 43560	=	3,746	CF

df (pool) =	2	ft	2.0 ft (min.)	
df (riffle) =	2	ft		
df (average) =	2	ft		
Wsand =	8	ft	4 ft (min.)	-
Lsand =	40	ft	Length along project	
Af (provided) =	320	SF		
k =	3.5			
hf =	1.98	ft		
tf =	1.67	days		

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	319	SF	**Adequate**

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

SPSC Design Calculations - Cascade

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **Steamboat Way Subdivision - BMP A** Engineer: **VLH**
Plan Number: Date: **10/7/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	6.24	acres	6.24	6.24
C-Factor:	0.87		0.87	0.87
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	51.06	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.05	ft/ft	Note: Start with 5%				
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1				
Design Depth (D) =	1.6	ft					Adequate
W =	10	ft	8 ft (min.)				-
d50 (Boulder) =	1.5	ft	Note: Start with 1.0 (MDSHA Classification)				NOT a Standard Size
Area (A) =	2WD / 3		=	10.67	SF		
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$			=	0.999		
n =					=	**0.050**	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	71.01	cfs	Adequate

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	11.84	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	16.53	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	16.53	ft/s				Subcritical Flow C = 1.2
Vmax =	Q / A	=	6.66	ft/s		Adequate
Fr =	V / ((g*D)^(1/2))	=	0.93			

Step C: Check Actual

dw =	1.60	ft	Note: Use Solver to make Q(act.) = Q(design)
Wa =	10.00	ft	
A (act.) =	10.67	SF	

Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	0.999		
n(act.) =				=	**0.05**	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	71.01	cfs	Adequate

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	11.84	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	16.53	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	16.53	ft/s				Subcritical Flow C = 1.2
V (act.) =	Q (act.) / A(act.)		=	6.66	ft/s	Adequate
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	0.93		

III. Sizing Required Pool Depth

hf (cascade) = dw + ($V(act)^2$ / 2g) - 0.25	=	2.0381	=	2.04	ft	MIN. REQUIRED DEPTH

IV. Water Quality Requirement

Site Drainage Area (SA) =	6.24	acres
Contr. Imp. Area (IA) =	0.09	acres
Length (Total) =	260	ft
Length (Cascades) =	117	ft

Rv =	0.05+[0.009*((SA/IA)*100)]	=	0.06		
WQv =	(Rv*SA / 12) * 43560	=	1,415	CF	

df (pool) =	1.5	ft	1.5 ft (min.)
df (riffle) =	1.5	ft	
df (average) =	1.5	ft	
Wsand =	6	ft	4 ft (min.)
Lsand =	143	ft	
Af (provided) =	858	SF	
k =	3.5		
hf =	2.04	ft	
tf =	1.67	days	

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	139.54	SF		Adequate

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

SPSC Design Calculations - Riffle

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **Steamboat Way Subdivision - BMP B** Engineer: **VLH**
Plan Number: Date: **10/7/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	3.63	acres	3.63	3.63
C-Factor:	0.81		0.81	0.81
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	27.65	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.05	ft/ft	Note: Start with 5%				
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1				
Design Depth (D) =	1.2	ft					**Adequate**
W =	8	ft	8 ft (min.)				**-**
d50 (Cobble) =	0.5	ft	Note: Start with 0.5				
Area (A) =	2WD / 3		=	6.40	SF		
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$			=	0.755		
n =	D^(1/6) / (21.6*log(D/d50)+14)				=	0.046	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	38.09	cfs	**Adequate**

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	6.84	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	9.54	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	9.54	ft/s				**Subcritical Flow C = 1.2**
Vmax =	Q / A	=	5.95	ft/s		**Adequate**
Fr =	V / ((g*D)^(1/2))		=	0.957		

Step C: Check Actual

dw =	1.200	ft	Note: Use Solver to make Q(act.) = Q(design)				
Wa =	8.00	ft					
A (act.) =	6.40	SF					
Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$			=	0.755		
n(act.) =	dw^(1/6) / (21.6*log(dw/d50)+14)				=	0.046	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	38.09	cfs	**Adequate**

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)						
=	6.84	ft/s	C = 0.86 (Prevailing Supercritical Flow)				
=	9.54	ft/s	C = 1.2 (Prevailing Subcritical Flow)				
=	6.84	ft/s					**Supercritical Flow C = 0.86**
V (act.) =	Q (act.) / A(act.)		=	5.95	ft/s		**Adequate**
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	0.96			

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	1.4999	=	1.50	ft	**MINIMUM of 1.5 FT**

IV. Water Quality Computations

Site Drainage Area (SA) =	3.63	acres
Contr. Imp. Area (IA) =	1.77	acres
Length Total (L Design) =	60	ft

Rv =	0.05+[0.009*((IA/SA)*100)]	=	0.489	
WQv =	(Rv*SA / 12) * 43560	=	6,441	CF

df (pool) =	2	ft	2.0 ft (min.)	
df (riffle) =	2	ft		
df (average) =	2	ft		
Wsand =	8	ft	4 ft (min.)	-
Lsand =	60	ft	Length along project	
Af (provided) =	480	SF		
k =	3.5			
hf =	1.50	ft		
tf =	1.67	days		

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	472	SF	**Adequate**

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

SPSC Design Calculations - Cascade

Refer to "Regenerative Step Pool Storm Conveyance (SPSC) - Design Guidelines [Revision 5: Dec. 2012]"

Plan Name: **Steamboat Way Subdivision - BMP B** Engineer: **VLH**
Plan Number: Date: **10/7/2015**

I. Calculate Design Q (Flow)

	100-YR		10-YR	1-YR
Drainage Area:	3.63	acres	3.63	3.63
C-Factor:	0.81		0.81	0.81
I (Return Period):	9.5	in/hr	7	4.4
CF	0.99		1.00	1.00
Q design = Flow = CF*C*I*DA =	27.65	cfs		

II. Sizing Conveyance Channel

Step A: Channel Dimensions

Design Slope (S) =	0.05	ft/ft	Note: Start with 5%				
Side Slope Ratio =	5	:1	Range from 10:1 to 5:1				
Design Depth (D) =	1	ft					Adequate
W =	10	ft	8 ft (min.)				-
d50 (Boulder) =	1.5	ft	Note: Start with 1.0 (MDSHA Classification)				NOT a Standard Size
Area (A) =	2WD / 3		=	6.67	SF		
Hydraulic Radius (Rh) =	$2W^2D / (3W^2 + 8D^2)$			=	0.649		
n =					=	**0.050**	
Qmax =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)			=	33.31	cfs	Adequate

Step B: Check Maximum Allowable Velocity

g =	32.2	ft/s^2
ys =	185	lb/ft^3
yw =	62.4	lb/ft^3

Max. Allowable Velocity =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	11.84	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	16.53	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	16.53	ft/s				Subcritical Flow C = 1.2
Vmax =	Q / A	=	5.00	ft/s		Adequate
Fr =	V / ((g*D)^(1/2))	=	0.88			

Step C: Check Actual

dw =	1.00	ft	Note: Use Solver to make Q(act.) = Q(design)
Wa =	10.00	ft	
A (act.) =	6.67	SF	

Rh (act.) =	$2Wa^2dw / (3Wa^2 + 8dw^2)$		=	0.649		
n(act.) =				=	**0.05**	
Q (act.) =	(1.49 / n)*A*Rh^(2/3)*S^(1/2)		=	33.31	cfs	Adequate

Max. Allowable Velocity (act.) =	C * [2*g* ((ys-yw)/yw)]^(1/2) * d50^(1/2)					
=	11.84	ft/s	C = 0.86 (Prevailing Supercritical Flow)			
=	16.53	ft/s	C = 1.2 (Prevailing Subcritical Flow)			
=	16.53	ft/s				Subcritical Flow C = 1.2
V (act.) =	Q (act.) / A(act.)		=	5.00	ft/s	Adequate
Fr(act.) =	V(act.) / ((g*dw)^(1/2))		=	0.88		

III. Sizing Required Pool Depth

hf (cascade) = dw + $(V(act)^2 / 2g)$ - 0.25	=	1.1377	=	1.50	ft	MINIMUM of 1.5 FT

IV. Water Quality Requirement

Site Drainage Area (SA) =	3.63	acres
Contr. Imp. Area (IA) =	0.09	acres
Length (Total) =	260	ft
Length (Cascades) =	117	ft

Rv =	0.05+[0.009*((SA/IA)*100)]	=	0.07	
WQv =	(Rv*SA / 12) * 43560	=	942	CF

df (pool) =	1.5	ft	1.5 ft (min.)	
df (riffle) =	1.5	ft		
df (average) =	1.5	ft		
Wsand =	6	ft	4 ft (min.)	-
Lsand =	143	ft		
Af (provided) =	858	SF		
k =	3.5			
hf =	1.50	ft		
tf =	1.67	days		

Af (required) =	[WQv * df] / [k*(hf+df)*tf]	=	80.55	SF	Adequate

Q(design) :	Design Flow
S :	Design Slope
W :	Design Top Width
D :	Design Depth
d50 :	Mean Spherical Diameter
A :	Design Cross Sectional Area
Rh :	Design Hydraulic Area
n :	Design Roughness Coefficient
g :	Specific Gravity
ys :	Density of Stone
yw :	Density of Water
C :	Coefficient of Flow
Vmax :	Maximum Velocity
Fr :	Froude Number based on Design Values
dw :	Normal Depth of Flow
Wa :	Actual Top Width at Normal Depth
A(act.) :	Actual Cross Sectional Area at Normal Depth
Rh(act.) :	Actual Hydraulic Area
n(act.) :	Actual Roughness Coefficient
V(act.) :	Actual Velocity
Fr(act.) :	Froude Number based on Actual Values
hf :	Minimum Depth of Pool

BMP #353 - 84 LUMBER COMPANY - BMP C

Prioritization Ranking:	38
Planning Level Cost Estimate:	$ 137,610.00
Estimated Cost/Impervious Acre	$ 86,794.50

General BMP Information:		
Structure Location:	4484 Quad County Court	
ADC Map:	4690, C3 (2008)	
Northing/Easting:	615666.28/1,263,504.90	
NPDES Watershed:	Upper Bush Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Bioswale (M-8)	
Management Type:	Quality	
Total Drainage Area (ac):	2.03	
Total Impervious Area (ac):	1.80	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	6249	
Total Treated Drainage Area (ac):	2.03	
Total Treated Impervious Area (ac):	1.8	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	33.46	21.71
TP (lbs/yr):	3.67	1.72
TSS (lbs/yr):	1694.17	1097.64

Existing conditions for BMP #353

Site map for BMP #353 - BMP C

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #353 has been identified as an extended detention dry pond. The facility was constructed north of Mill Bottom Road and west of Quad County Court. The BMP Database from the County indicates that the original design for BMP #353 provides management for quantity and quality and that the total treatment area for the BMP is 16.18 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 17.76 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out from a grass road accessible from Quad County Court. According to the County's parcel layer in GIS, BMP #353 was constructed on private property. Maintenance of traffic (MOT) will be required to notify owners of the property. Easements must be evaluated at this site.

Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There are five BMPs proposed at this site: one retrofit and four new BMPs. The proposed new BMP for BMP C is a bioswale (M-8). BMP C is proposed in the middle of the property to provide quality management for 2.03 acres including 1.80 acres of impervious area as shown in the Concept Plans. The Project Summary Sheets for the BMP #353 retrofit and BMPs A, B, and D are included separately in Appendix E with a prioritization ranking of 44, 34, 19, and 33 respectively.

BMP #580 - HYATT PARK, LOT 2A

Prioritization Ranking:	39
Planning Level Cost Estimate:	$ 113,850.00
Estimated Cost/Impervious Acre	$ 107,931.89

General BMP Information:		
Structure Location:	To Rt. off cul-de-sac turn to left & out in back.	
ADC Map:	4568, D6 (2008)	
Northing/Easting:	591,143.00/1,222,569.00	
NPDES Watershed:	Bennett Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Pocket Sand Filter (F-5)	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	3.67	
Total Impervious Area (ac):	1.32	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	4979	
Total Treated Drainage Area (ac):	3.67	
Total Treated Impervious Area (ac):	1.32	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	28.02	18.18
TP (lbs/yr):	2.76	1.29
TSS (lbs/yr):	1449.43	939.07

Existing conditions for BMP #580

Site map for BMP #580

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #580 has been identified as a dry pond. The facility was constructed southwest of the end of Tyler Place. The BMP Database from the County indicates that the original design for BMP #580 provides management for quantity and that the total treatment area for the BMP is 5.50 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 3.67 acres. The majority of the land use is commercial.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out from an overgrown path along the ditch of Inflow #1 from Tyler Court. The owners of the nearby commercial business will need to be notified by MOT. Easements must be acquired.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

The proposed retrofit for BMP #580 is a pocket sand filter (F-5). The proposed retrofit will provide quantity and quality management for 3.67 acres including 1.32 acres of impervious area as shown in the Concept Plans.

BMP # 580 – HYATT PARK, LOT 2A

Storm Water Management Retrofit Evaluation					
Report Date:	8/4/2015	**Design Approval:**	3/15/1982	**Maintenance Owner:**	Nelson Tyler
Structure No:	580	**Year Constructed:**	Not Available	**Inspection Date:**	7/7/2015
Structure Name:	Hyatt Park, Lot 2A	**NPDES Watershed:**	Bennett Creek	**Inspection Team:**	ND, GL
Location:	To Rt. off cul-de-sac turn to left & out in back.	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	7/6/2015 (0.03")
ADC Map:	4807, K4 (2008)	**Land-River Segment:**	PM4_4040_4410	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	591,143.00/1,222,569.00	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Dry Pond		Pocket Sand Filter (F-5)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity		Quantity/Quality		
Total Drainage Area (acres):	5.5		3.67		
Total Impervious Area within Drainage Area (acres):	Unknown		1.32		
WQv Required:	Unknown		4979	cu. ft.	0.114 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	No		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	4979	cu. ft.	0.114 ac-ft
Total Treated Drainage Area (acres):	5.5	0	3.67		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	1.32		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.04		
Total Nitrogen:			35.29%		
Total Phosphorus:			55.45%		
Sediment:			70.57%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		28.02		18.18
TP (lbs/yr):	0		2.76		1.29
TSS (lbs/yr):	0		1449.43		939.07
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):					**$ 113,850.00**

BMP # 580 – HYATT PARK, LOT 2A

Existing Site Conditions:

SWM Era: Pre-1985

According to Frederick County's Urban BMP Database, BMP #580 has been identified as a dry pond. The facility was constructed southwest of the end of Tyler Place as shown in the BMP Location map (**Figure 1**). The BMP Database from the County indicates that the original design for BMP #580 provides management for quantity and that the total treatment area for the BMP is 5.50 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 3.67 acres. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were not available for this BMP. The Urban BMP Database indicates the facility control structures is a 30" CMP riser with an 8" low flow orifice and a 21" principal spillway. The majority of the land use is commercial.

General Observations:

A site visit was conducted on July 7th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has two inflow points. Both inflows are via open section. According to observations in the field, Inflow #1 is a CMP with an end section from the north **(Photo 1)**. The CMP is in good condition and flows into a vegetated and riprap ditch **(Photo 2)**. There is accumulated sediment in the CMP and excess vegetation and debris in the ditch.

Inflow #2 is sheet flow from the northeast over a mowed hillside **(Photo 3)**. There is dense vegetation on the downstream side of the hills, but Inflow #2 appears to be in good condition.

Pretreatment:

This facility does not have a forebay or pretreatment section.

Control Structure and Spillways:

According to the Urban BMP Database and observations in the field, the control structure for this facility is a 30" CMP riser with an 8" low flow orifice and a 21" principal spillway. The riser structure and trash rack are displaced which may be impacting performance **(Photo 4).** The black coating on the CMP riser is chipping off. There is accumulated sediment and mud around the riser **(Photo 5).** The low flow orifice was not visible during the site visit due to accumulated sediment**.**

There is an emergency spillway located to the south of the pond and is in poor condition. There is debris and vegetation blocking the emergency spillway and signs of erosion **(Photo 6).**

Embankment:

A fill embankment is present between the pond and principal outlet to the southwest of the pond. Many large trees are growing on both the upstream and downstream sides of the embankment and erosion is present **(Photos 6 and 7)**. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

According to observations in the field, the 21" CMP principal spillway outlets the BMP southwest of the riser and it is in poor condition **(Photo 8)**. There is a large tree growing over the principal spillway pipe. The outfall of the principal spillway is corroded and there is ponding water **(Photo 9)**. The downstream condition has erosion and debris and is in poor condition **(Photo 10)**.

Overall BMP:

There is approximately 2" of ponding in the basin of the BMP, but this could be due to a recent storm event. There is erosion, trees, and debris at the basin, embankment, and outfall of the BMP **(Photo 11).** There is accumulated sediment blocking the low flow orifice and the riser and trash rack are displaced **(Photo 12)**. Moderate problems are observed; however, the BMP is functioning as designed with no critical parameters with problem conditions. BMP performance is being compromised. Maintenance of the BMP should be scheduled.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out from an overgrown path along the ditch of Inflow #1 from Tyler Court. This access will lead to the northwest side of the BMP. The owners of the nearby commercial business will need to be notified about maintenance of traffic (MOT). Easements at this location must be evaluated further in final design.

Proposed Retrofit:

BMP #580 was originally designed as a dry pond. The most appropriate BMP retrofit options fall under the filtering BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #580 is a pocket sand filter (F-5). The proposed retrofit will provide quantity and quality management for 3.67 acres including 1.32 acres of impervious area as shown in the **Concept Plans**.

Additional Retrofit Opportunities:

The addition of impervious area from neighboring commercial area can be evaluated at final design to determine if additional area can be treated with this BMP #580 retrofit.

Step 1: Watershed Factors

BMP #580 is located in Frederick County's Bennett Creek which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #580 due to the downstream cold water condition. Evaluation for stream warming is recommended during final design.

Step 2: Terrain Factors

BMP #580 is not located in in a region of Frederick County that is prone to karst geology per the geology GIS layer provided by Frederick County. Therefore, there are no special terrain factors and/or constraints that must be considered for retrofit design to BMP #580.

Step 3: Stormwater Treatment Suitability

For the retrofit of BMP #580, 100% of the WQv can be provided within the existing BMP footprint. There is adequate space below the existing inflow pipe near the south end of Tyler Court. There are no safety concerns associated with the use of pocket sand filters. There is adequate space for the proposed retrofit within the existing parcel boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The maximum drainage area requirement for a pocket sand filter is 5 acres. The proposed drainage area to BMP #580 is 3.67 acres and is composed of B and D soils. The likelihood of BMP #580 receiving hotspot runoff is low as it is located within this commercial area. Two (2) feet minimum separation from the water table is required. The elevation difference between the inflow and outflow for BMP #580 under existing conditions is 3' based on GIS data available, indicating installation of an underdrain is feasible. The land use within the drainage area to the BMP is not ultra-urban. Retrofitting the existing BMP into a pocket sand filter is feasible at this location per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP #580 is located southwest of Tyler Court and has low visibility. Pocket sand filters tend to have medium maintenance requirements, medium community acceptance, and medium cost relative to the drainage area with low habitat quality in comparison with other BMP selections.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #580 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Flood Insurance Map FM24021C0465D indicates that the BMP is not within the FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is mapped as a wetland. Frederick County's Stream GIS layer indicates BMP #580 is not an in-stream facility.

Figure 1: BMP Location Map – Existing Conditions

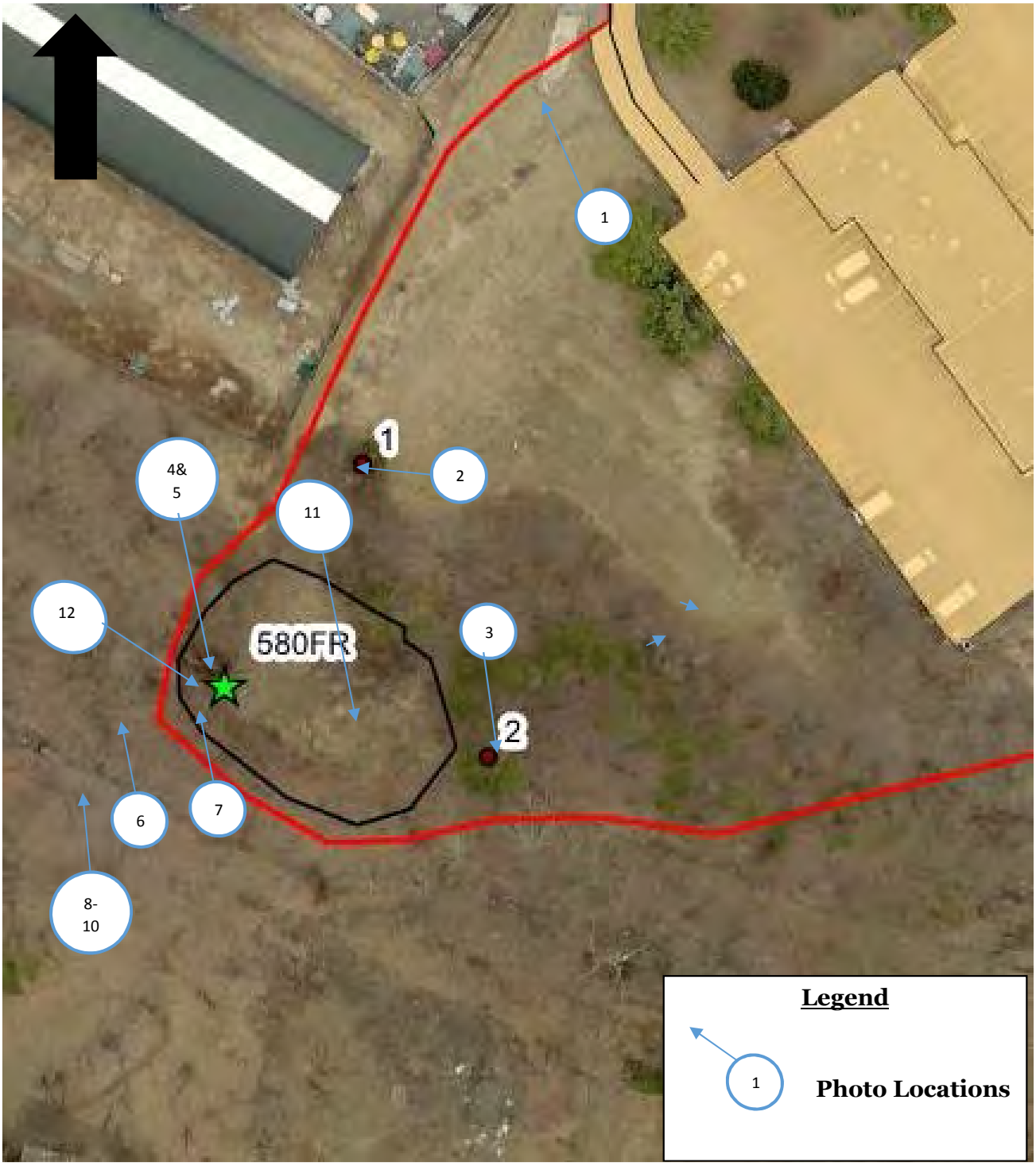


Figure 2: Photo Locations

Photo 1: Inflow #1 facing northeast

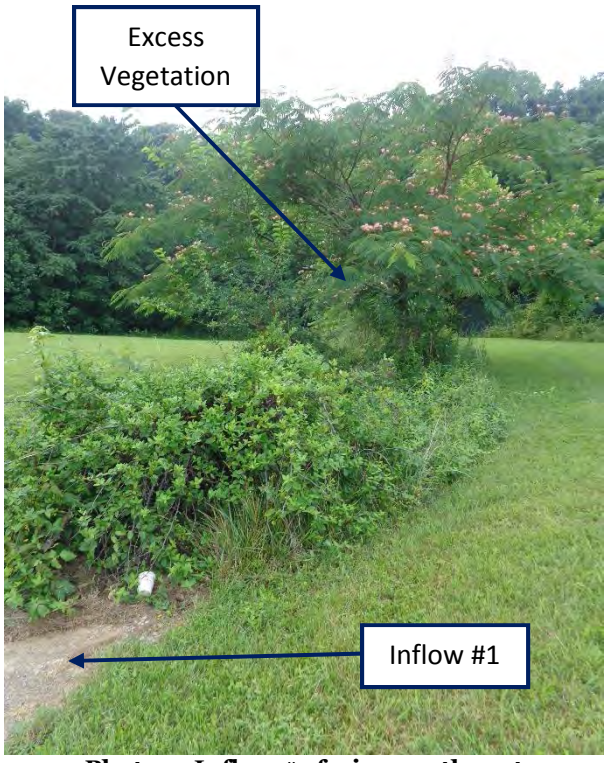


Photo 2: Inflow #1 facing southwest

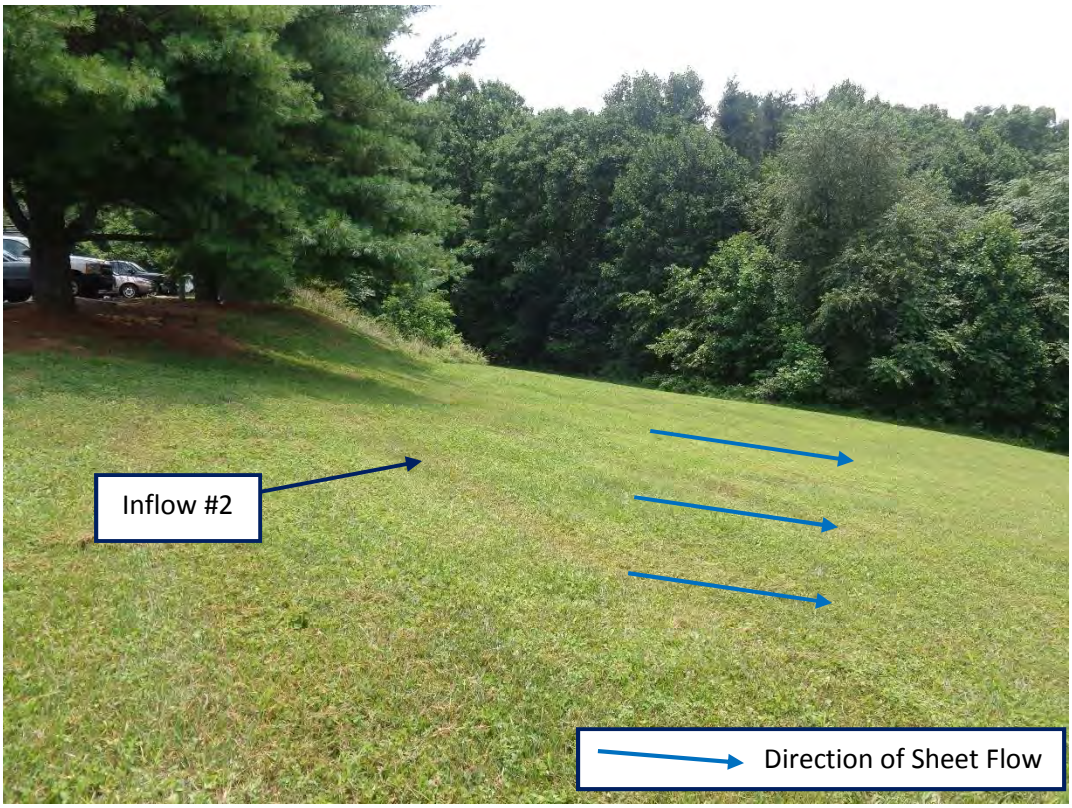


Photo 3: Inflow #2 facing east

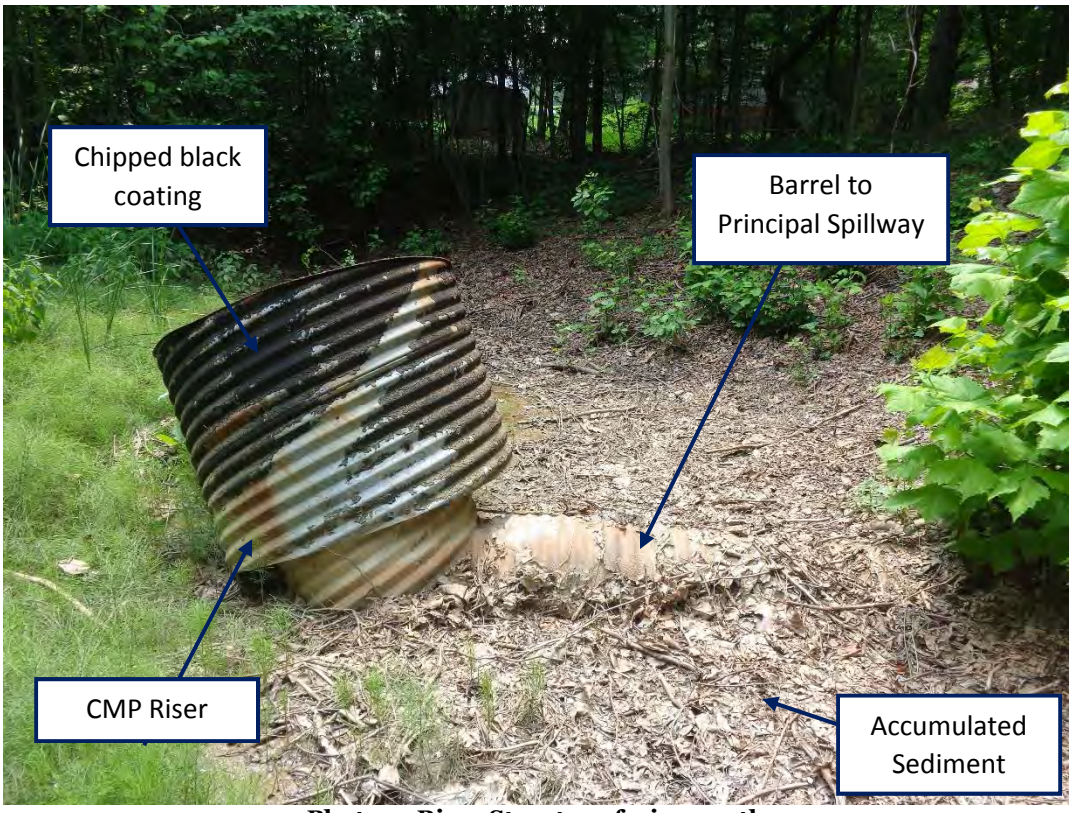


Photo 4: Riser Structure facing south

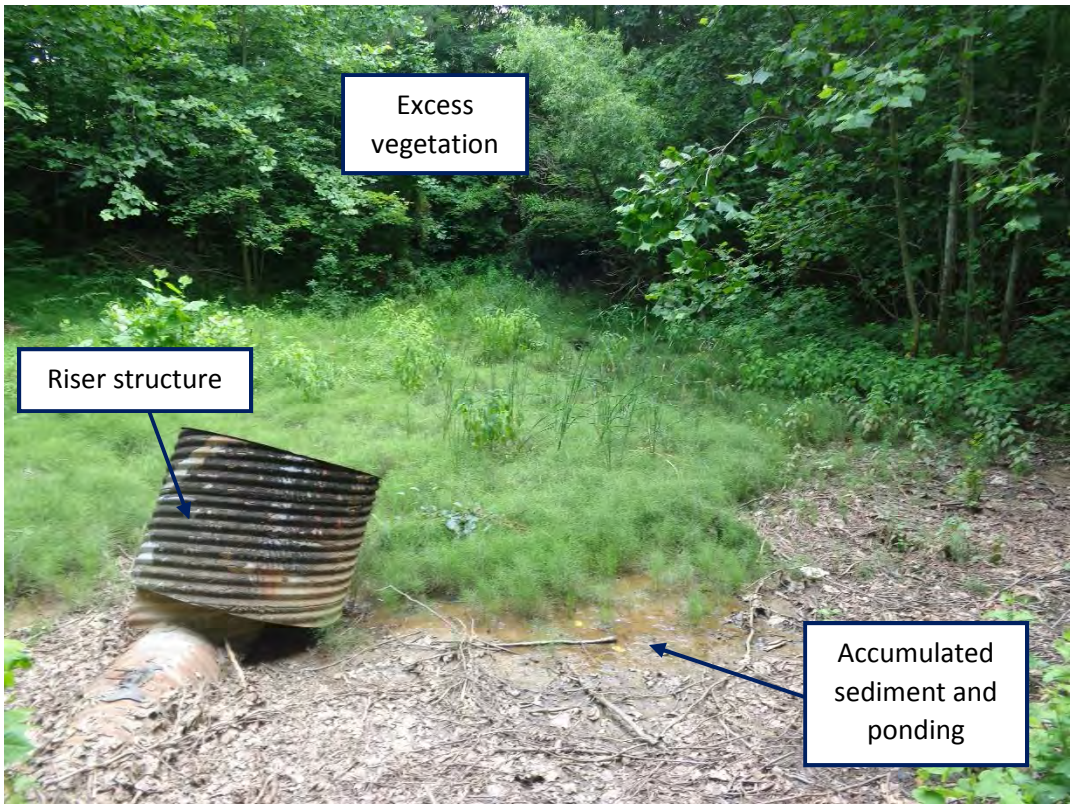


Photo 5: BMP basin facing northeast

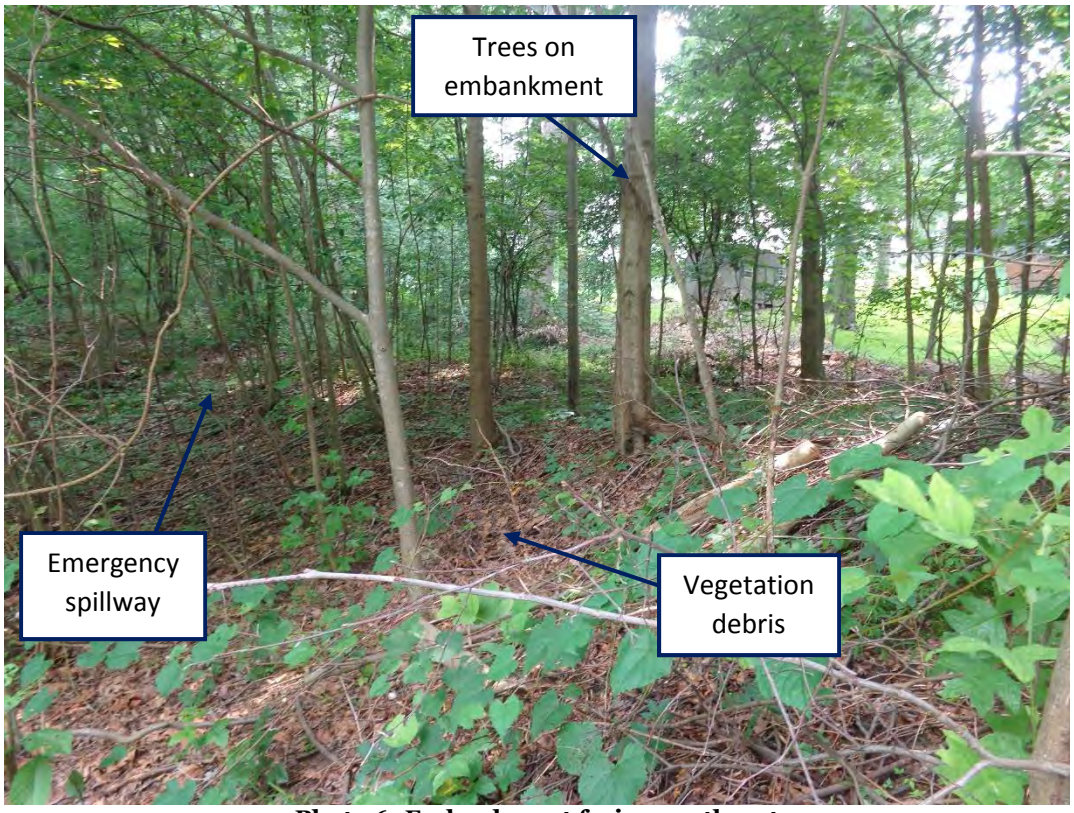


Photo 6: Embankment facing southeast

Photo 7: Embankment facing west

Photo 8: Principal Spillway facing north

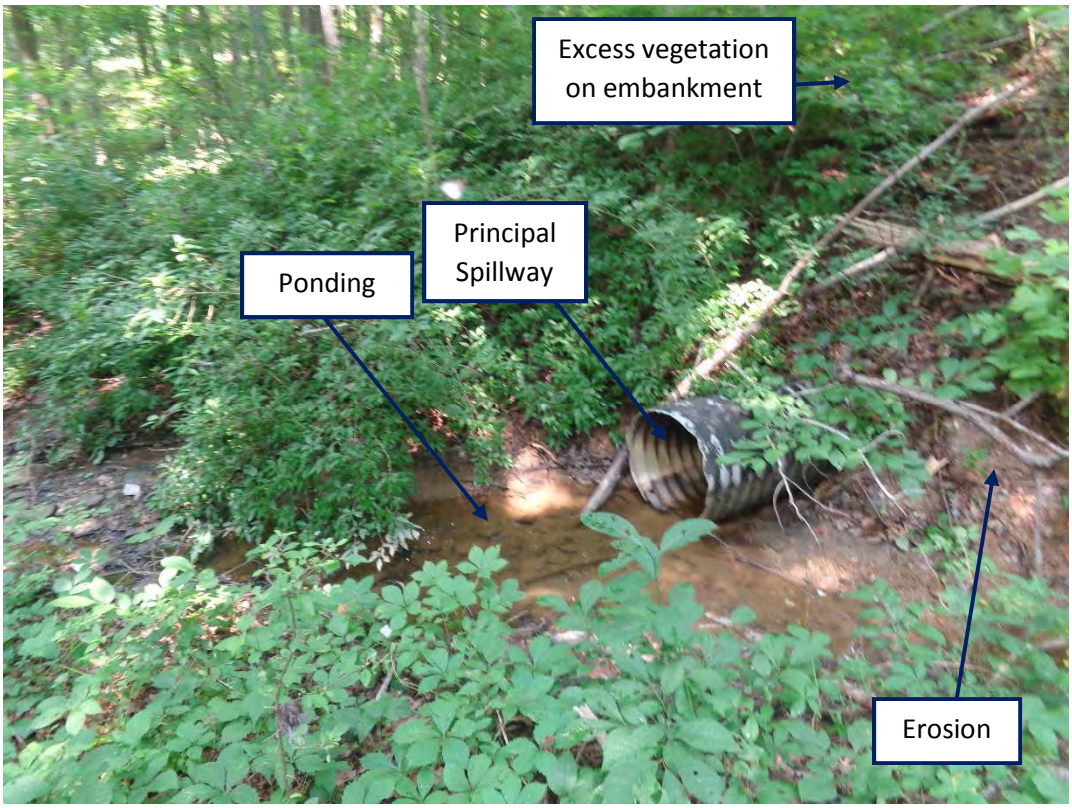


Photo 9: Principal Spillway facing west

Photo 10: Downstream condition facing west

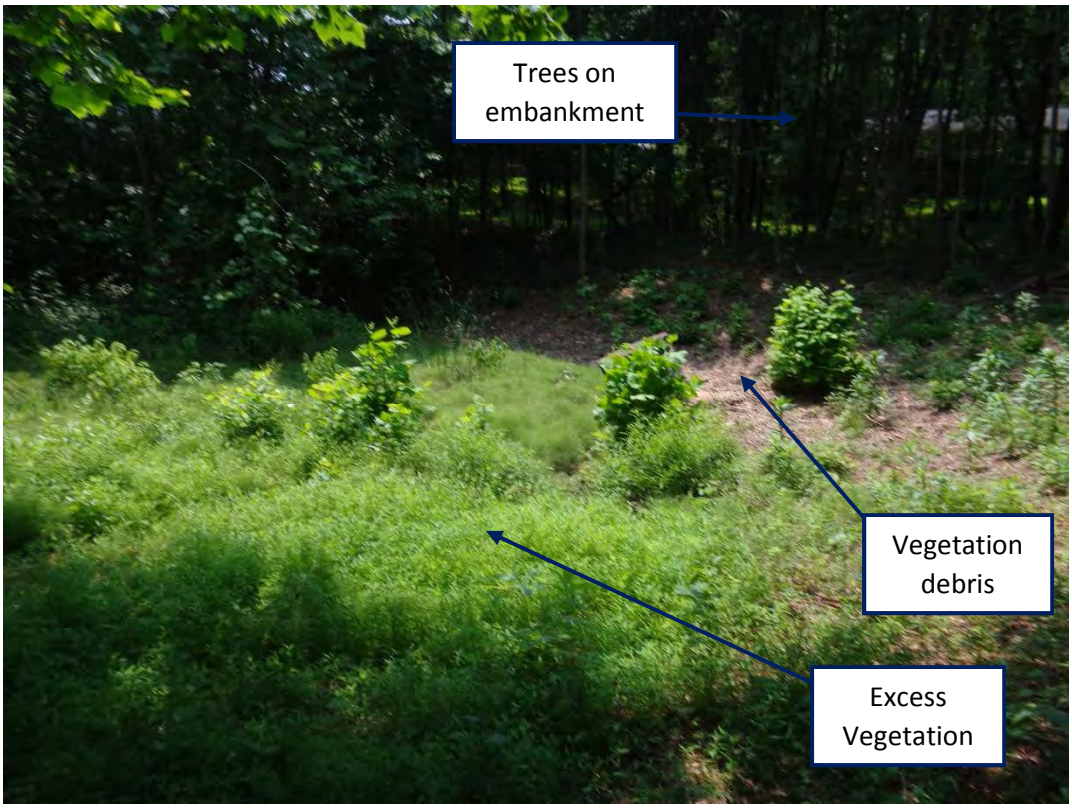


Photo 11: BMP basin facing southeast

GENERAL BMP INFORMATION	
BMP TYPE:	POCKET SAND FILTER (F-5)
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	3.67
TOTAL IMPERVIOUS AREA (ACRES):	1.32
WQv REQUIRED (CU. FT):	4979
WQv REQUIRED (AC. FT):	0.114
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	4979
TOTAL TREATED DA (ACRES):	3.67
TOTAL TREATED IMPERVIOUS AREA (ACRES):	1.32

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #580 – HYATT PARK, LOT 2A

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. - OF - SHEET NO. - OF -

BY: ndriskill -

PLOTTED: Wednesday, June 21, 2017 AT 03:09 PM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP580.dgn

Project: **BMP 580** Pocket Sand Filter (F-5)

Preliminary Design:

Location: Frederick County, Maryland
Watershed: Lower Monocacy River **Stream Use:** IV

Site Area: 3.67 ac 0.00573 sqm

Measured Impervious Area: 1.32 ac
I = 0.360
= 35.97 %

Soil Type: B & D

RCN Post Development : 74 **tc =** 0.2 hr Per Frederick County's Urban BMP Database

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.374

Step 1(b): Rainfall Zone

Rainfall Zone: Western Rainfall zone with Rainfall (P)= 1 inch

Per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 36%

$WQ_{V(I)}$ = 0.114 ac-ft = 4979 cft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.061 ac-ft = 2664.42 cft

Water quality treatment required = 4978.5061 cft = 0.1143 ac-ft

Step 1(d): Water Quality Discharge

a. Runoff Volume = Q_a = P*R_v = 0.37371 in

b. CN for W_Q storm = 91.35 (from page D.10.1 2000 MDE Stormwater Management Manual)

c. Initial Abstraction = I_a =(200/CN)-2 = 0.19

d. I_a/P = 0.19

e. Unit Peak Discharge = q_u = 783 csm/in (Figure D.11.1)

f. Water Quality Peak Flow = Q_w = (q_u csm/in)*(A mi^2)*(q_a in) = 1.68 cfs

Step 2: Pretreatment Volume

$$\left(A_s = \frac{Q_0}{W} \times E'\right)$$

Step 2(a) Compute Pretreatment Volume: (25% of WQ_v)

Minimum Required V_p = 1244.63 cft

Step 2(b) Compute Sedimentation Basin Minimum Surface Area: (A_{sf})

A_{sf} = (0.066)(WQv), if I<=75%
= 328.58 sft

Step 2(c) Design the Sedimentation Basin

Design Width (w) = 18 ft Suggested Length to Width Ratio = 2:1
Design Length (l) = 36 ft

Required Depth = 1.9 ft
Design Depth (d) = 2 ft Maximum Depth = 2'

	Stage - Storage Data for Forebay					
Stage (ft)	Elevation (ft)	Area (sft)	Avg Area (sft)	Incr. (cft)	Storage (cft)	(ac-ft)
0.00	532.00	780.00			0.0	0
			977.50	977.5		
1.00	533.00	1175.00			977.5	0.02244
			1407.50	1407.5		
2.00	534.00	1640.00			2385.0	0.05475

Use a Sedimentation Chamber (with side slopes of 3:1) 18 ft by 36 ft by 2 ft = 2385.0 cft

Provided Vp = 2385.0 cft

Step 3: Treatment

Step 3(a) Compute Storage Volume prior to Filtration (including Pretreatment): (75% of WQ_v)

V_{temp} = 3733.88 cft

Step 3(b) Compute the Required Filter Bed Area: (Af)

$$A_f = (WQ_v)(d_f) \Big/ [k \times (h_f + d_f) \times t_f)]$$

Minimum Filter Bed Depth = 12"

Design Filter Bed Depth (d_f) = 18 "
= 1.50 ft

Filter Media: SHA Bioretention Soil Mix
Coefficient of Permeability (k) = 2 ft/day

Filter Bed Drain Time (t_f) = 2 days

Design Temporary Ponding Height above the Filter Bed (t_p) = 2 ft

Design Average Height of Water above the Filter Bed (h_f) = 1 ft

A_f = 746.78 sft

Step 3(c) Design the Filter Chamber

Setting Width = 26 ft

Required Length = 28.7 ft
Design Length = 52 ft

Use a Filter Chamber 26 ft by 52 ft

Stage - Storage Data for Sand Filter								
Stage	Elevation	Area	Average Area	Incr. Storage	Total Storage		Storage Above Dead Storage	
(ft)	(ft)	(sft)	(sft)	(cft)	(cft)	(ac-ft)	(ac-ft)	(cft)
0.00	532.00	1345.00			0.0	0.0000	0.0000	0.00
			1597.50	1597.5				
1.00	533.00	1850.00			1597.5	0.0367	0.0367	1597.49
			2136.50	2136.5				
2.00	534.00	2423.00			3734.0	0.0857	0.0857	3733.99

$$V_{treatment} = (t_p \times l \times b) + (d_f \times l \times b \times 0.4)$$
$$= 4345.185176 \text{ cft}$$

Step 4: Check

$V_{total} = V_p + V_{treatment} =$ 6118.99 cft

Required Vtotal = 4978.51 cft

Design Criteria Satisfaction: Yes

Step 5: Compute Recharge Volume (Rev)

Step 5(a) : Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

$$Rev = \frac{(S)(Rv)(A)}{12}$$

HSG	Drainage Area (ac)	Percentage (%)
A	0.00	0
B	1.41	38
C	0.00	0
D	2.26	62
Total	3.67	OK: sum of the areas matches site Area

Composite S: 0.1430 Use 14.30 of site imperviousness

Step 5(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.016 ac-ft = 712 cft

Step 5(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = 0.189 ac = 8222 sf

Recharge volume is included in the water quality volume.

The Rev requirement may be met by a) treating 0.016 ac-ft using structural method, b) treating 0.189 acres using non-structural methods, or c) a combination of both or it is part of WQv volume if not treated separately.

BMP #403 -GLADE TOWNE CONDOMINIUMS

Prioritization Ranking:	40
Planning Level Cost Estimate:	$ 290,911.50
Estimated Cost/Impervious Acre	$ 113,093.76

General BMP Information:		
Structure Location:	Chapel Place	
ADC Map:	4449, F3 (2008)	
Northing/Easting:	662,170.33/1,215,999.27	
NPDES Watershed:	Israel Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool Extended Detention (P-1)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	6.49	
Total Impervious Area (ac):	2.79	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	10293	
Total Treated Drainage Area (ac):	6.49	
Total Treated Impervious Area (ac):	2.79	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	54.43	32.00
TP (lbs/yr):	5.60	2.63
TSS (lbs/yr):	3581.62	2320.51

Existing conditions for BMP #403

Site map for BMP #403

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #403 has been identified as a dry pond. The facility was constructed northwest of the intersection of Chapel Place and Chapel Court in Walkersville . The BMP Database from the County indicates that the original design for BMP #403 provides management for quantity and that the total treatment area for the BMP is 6.30 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 6.49 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from Chapel Place via Glade Boulevard. According to the County's parcel layer in GIS, BMP #403 was constructed on private property owned by Frederick County Developers, Inc. and access to the BMP from Chapel Court is via private property. Maintenance of traffic (MOT) will be required to notify residents who utilize Glade Towne Condominiums or Chapel Place.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Acquisition of Easements, MOT	

PROPOSED RETROFIT

The proposed retrofit for BMP #403 is a micropool extended detention pond (P-1). The proposed retrofit will provide quantity and quality management for 6.49 acres including 2.79 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating approximately 2 feet below the existing BMP bottom to provide extended detention as shown in the Concept Plans.

BMP # 403 – GLADE TOWNE CONDOMINIUMS

Storm Water Management Retrofit Evaluation					
Report Date:	8/24/2015	**Design Approval:**	6/5/1981	**Maintenance Owner:**	Clagett Management C/O Jan Allen
Structure No:	403	**Year Constructed:**	Not Available	**Inspection Date:**	6/10/2015
Structure Name:	Glade Towne - Condominiums	**NPDES Watershed:**	Israel Creek	**Inspection Team:**	ND, GL
Location:	Chapel Place	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/8/2015 (0.38")
ADC Map:	4449, F3 (2008)	**Land-River Segment:**	PM4_3341_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	662,170.33/1,215,999.27	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Dry Pond		Micropool Extended Detention (P-1)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity		Quality/Quantity		
Total Drainage Area (acres):	6.3		6.49		
Total Impervious Area within Drainage Area (acres):	Unknown		2.79		
WQv Required:	Unknown		10293	cu. ft.	0.236 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	Yes		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	10293	cu. ft.	0.236 ac-ft
Total Treated Drainage Area (acres):	6.3	0	6.49		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	2.79		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.02		
Total Nitrogen:			35.09%		
Total Phosphorus:			55.14%		
Sediment:			70.19%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		54.43		32.00
TP (lbs/yr):	0		5.60		2.63
TSS (lbs/yr):	0		3581.62		2320.51
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):					**$ 290,911.50**

BMP # 403 – GLADE TOWNE CONDOMINIUMS

Existing Site Conditions:

SWM Era: Pre-1985

According to Frederick County's Urban BMP Database, BMP #403 has been identified as a dry pond. The facility was constructed northwest of the intersection of Chapel Place and Chapel Court in Walkersville as shown in the BMP Location map (**Figure 1**). The BMP Database from the County indicates that the original design for BMP #403 provides management for quantity and that the total treatment area for the BMP is 6.30 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 6.49 acres. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. The Urban BMP Database states the BMP control structures is a 36" CMP riser with a 6" low flow orifice and a 24" principal spillway. The majority of land use is residential.

General Observations:

A site visit was conducted on June 10th, 2015. **Figure 2** shows the location of photos taken during the visit. The BMP was surrounded by a fence with a locked gate at the time of the site visit; therefore, the assessment was completed from outside the fence.

Inflow:

The facility has two inflow points. Inflow #1 is an unmapped storm drain of unknown material and size that conveys flow from Glade Towne Condominiums (**Photo 1**). Inflow #1 appears to be in good condition, but grass appears to be inhibiting positive drainage into the facility. Inflow #2 is a curb cut from the parking lot conveying sheet flow from the parking lot southwest of the BMP (**Photos 1 & 2**). Inflow #2 appears to be in good condition, but grass is also inhibiting positive drainage into the facility at this location.

Control Structure and Spillways:

The control structure for this BMP is a 36" concrete riser with a CMP trash rack and a 6" extended detention orifice (**Photo 3**). The control structure could not be accessed due to a fence surrounding the facility, but it appears to be in good condition. There is no emergency spillway for this BMP.

Embankment:

A fill embankment for the facility is present around the northwest, northeast, and southeast sides of the facility (**Photos 4 & 5**). The embankment appears to be in good condition. Since design plans were not available, it could not be determined if a cutoff trench or impermeable core were present.

Outflow:

Outflow from the facility is through a 24" RCP barrel. The principal spillway is under the fill embankment on the northeast side of the facility and outlets into a storm drain system east of the facility (**Photo 6**). The outfall appears to be in good condition, and the storm drain system flows east under Chapel Place.

Overall BMP:

The BMP is functioning as designed with no problem conditions identified.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site from Chapel Place via Glade Boulevard. According to the County's parcel layer in GIS, BMP #403 was constructed on private property owned by Frederick County Developers, Inc. and access to the BMP from Chapel Court is via private property. Easements at this location must be evaluated further in final design. Maintenance of traffic (MOT) will be required to notify residents who utilize Glade Towne Condominiums or Chapel Place.

Proposed Retrofit:

BMP #403 was originally designed a dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Filtering practices are not feasible at this location because there is not the required elevation drop between the invert elevation of Inflow #1 and the riser structure for installation of an underdrain. In addition, there is not an opportunity to raise the invert elevation of Inflow #1 due to the upstream stormdrain structure invert elevations. Therefore, based on the site constraints and results of the screening process described below, the proposed retrofit for BMP #403 is a micropool extended detention pond (P-1). The proposed retrofit will provide quantity and quality management for 6.49 acres including 2.79 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 2 feet below the existing BMP bottom to provide extended detention as shown in the **Concept Plans**. The principal spillway invert elevation at the riser structure should be verified during final design to ensure that the extended detention water surface elevation is higher than the principal spillway invert.

Step 1: Watershed Factors

BMP #403 is located in Israel Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area, however the northwest portion of the drainage area is in the designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #403 due to the downstream coldwater conditions. For the retrofit of BMP #403, 100% of the WQv can be treated within the existing BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek.

Step 2: Terrain Factors

BMP #403 is located in a region of Frederick County that is prone to karst geology per the Geology layer provided by Frederick County. Therefore, there are special terrain factors and/or constraints that must be considered, such as lining the BMP with impermeable liner, for retrofit design for BMP #403. Additional geotechnical investigation will be required during the final design and the proposed pond may need to be lined if karst geology is identified.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to the unavailability of plans. There is adequate space for the proposed retrofit within the existing BMP footprint assuming an easement existing for access. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a micropool extended detention is 10 acres. The proposed drainage area to BMP #403 is 6.49 acres and is composed of B soils. An adequate water balance should be conducted during final design to verify the drainage area is adequate. The likelihood of BMP #403 receiving hotspot runoff is low as it is located within a residential community. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban. Retrofitting the existing BMP into a micropool extended detention is feasible at this location per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP #403 is located northwest of the intersection of Chapel Court and Chapel Place and has high visibility. Micropool extended detention ponds tend to have medium maintenance requirements, medium community acceptance, low construction costs relative to the drainage area, and provide medium habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #403 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

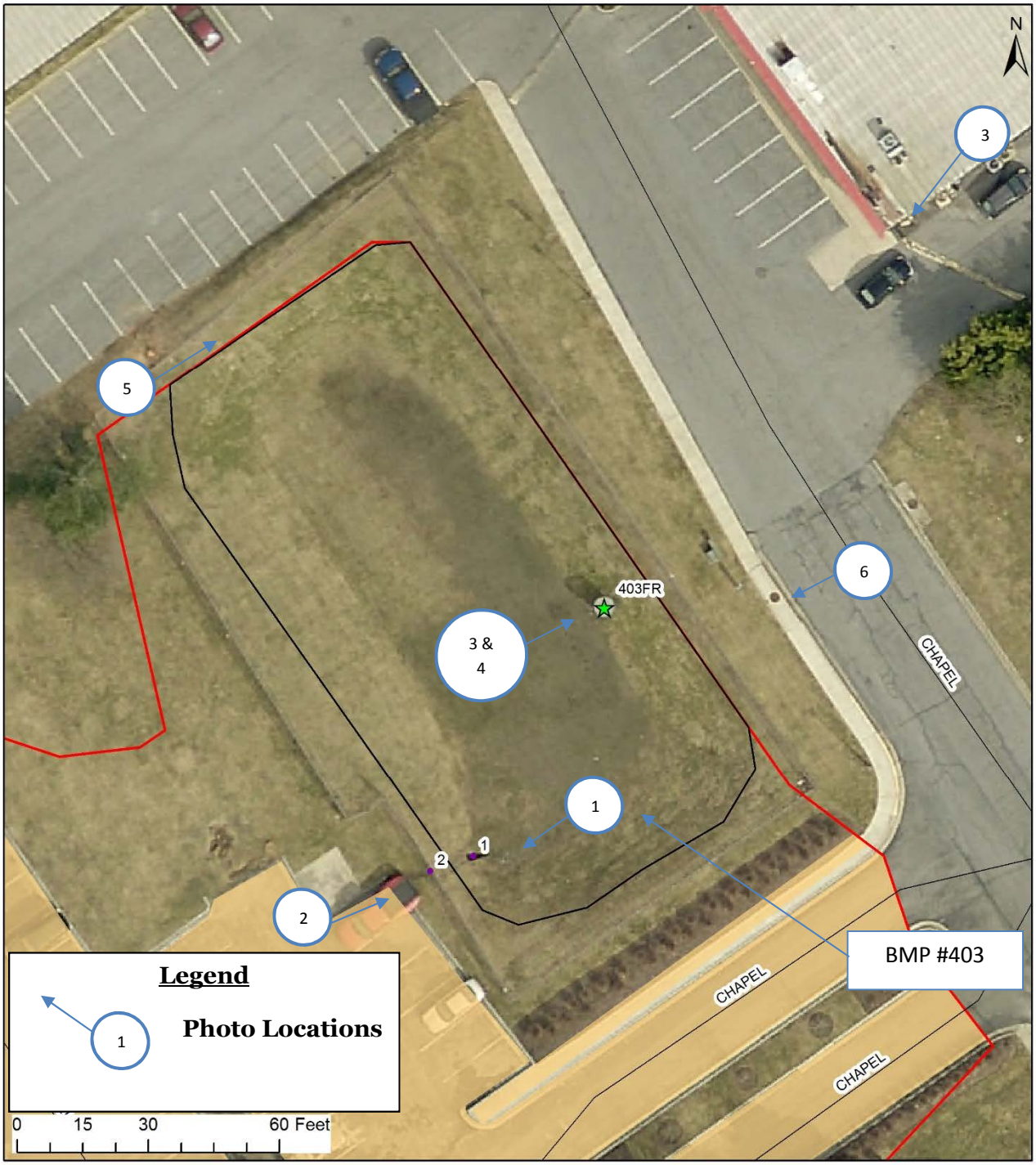


Figure 2: Photo Locations

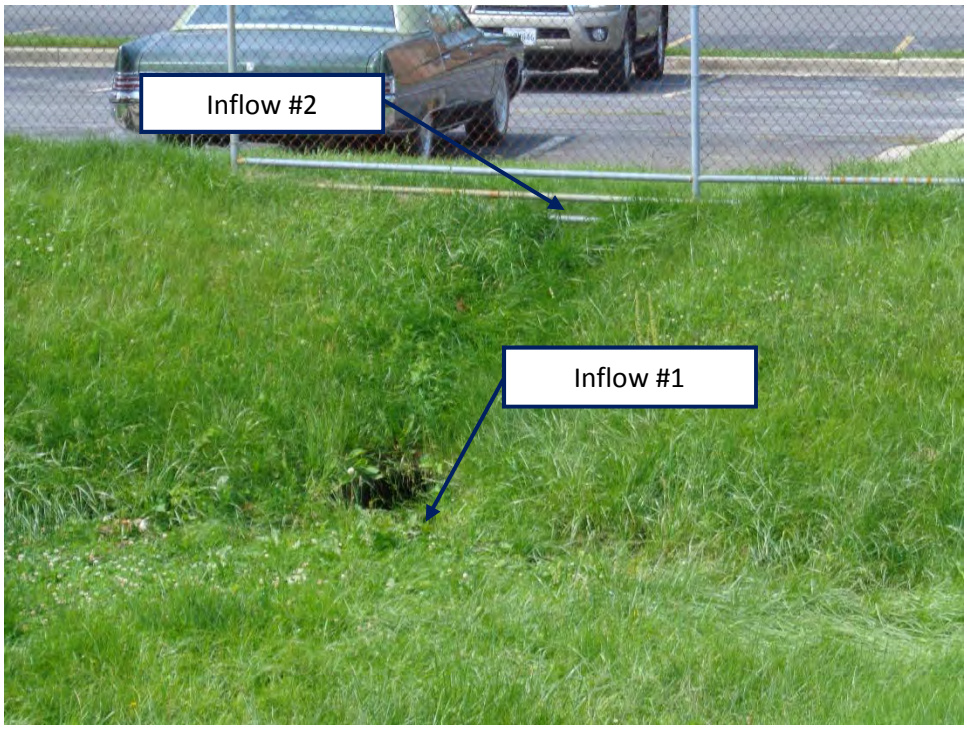


Photo 1: Inflow #1 and #2 to the facility facing southwest

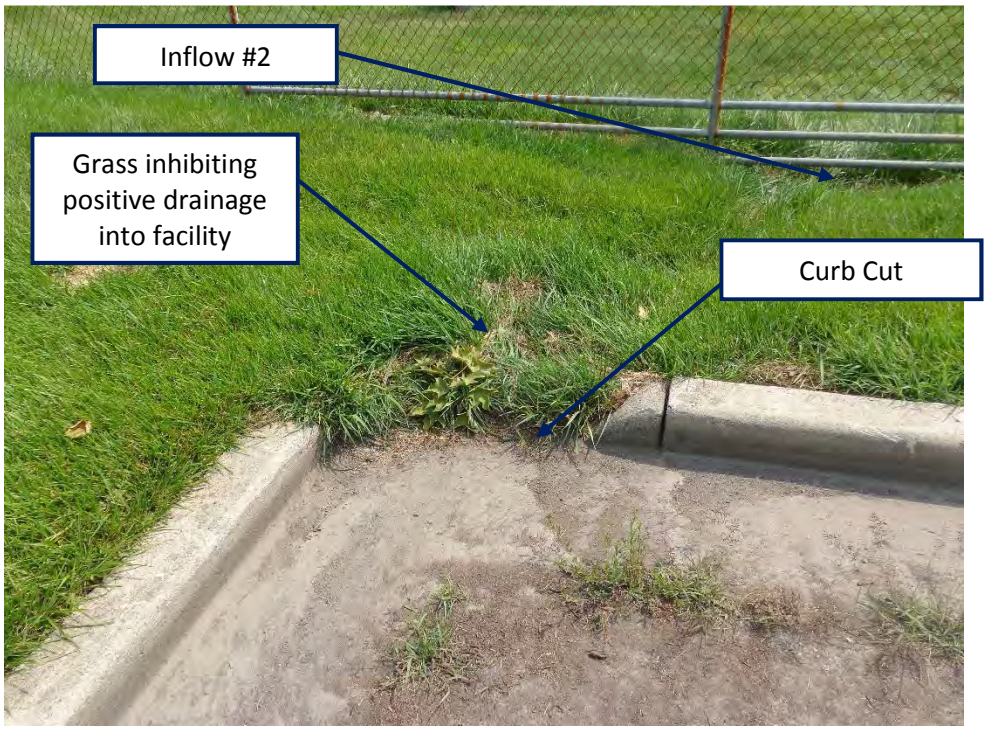


Photo 2: Inflow #2 facing northeast

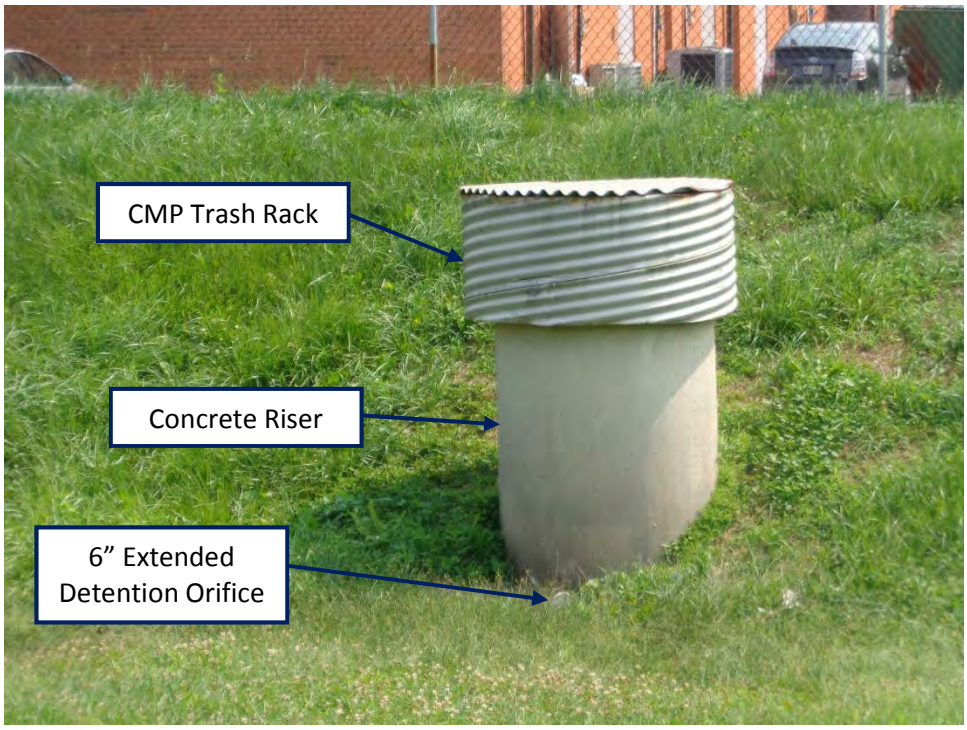


Photo 3: Control Structure facing northeast

Photo 4: Embankment facing northeast

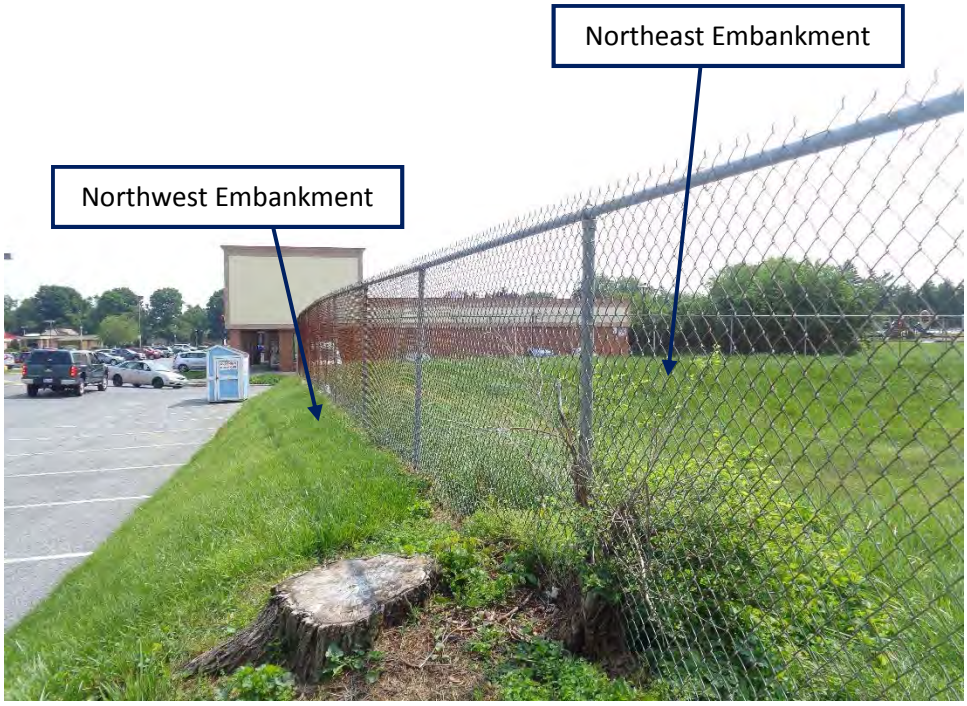
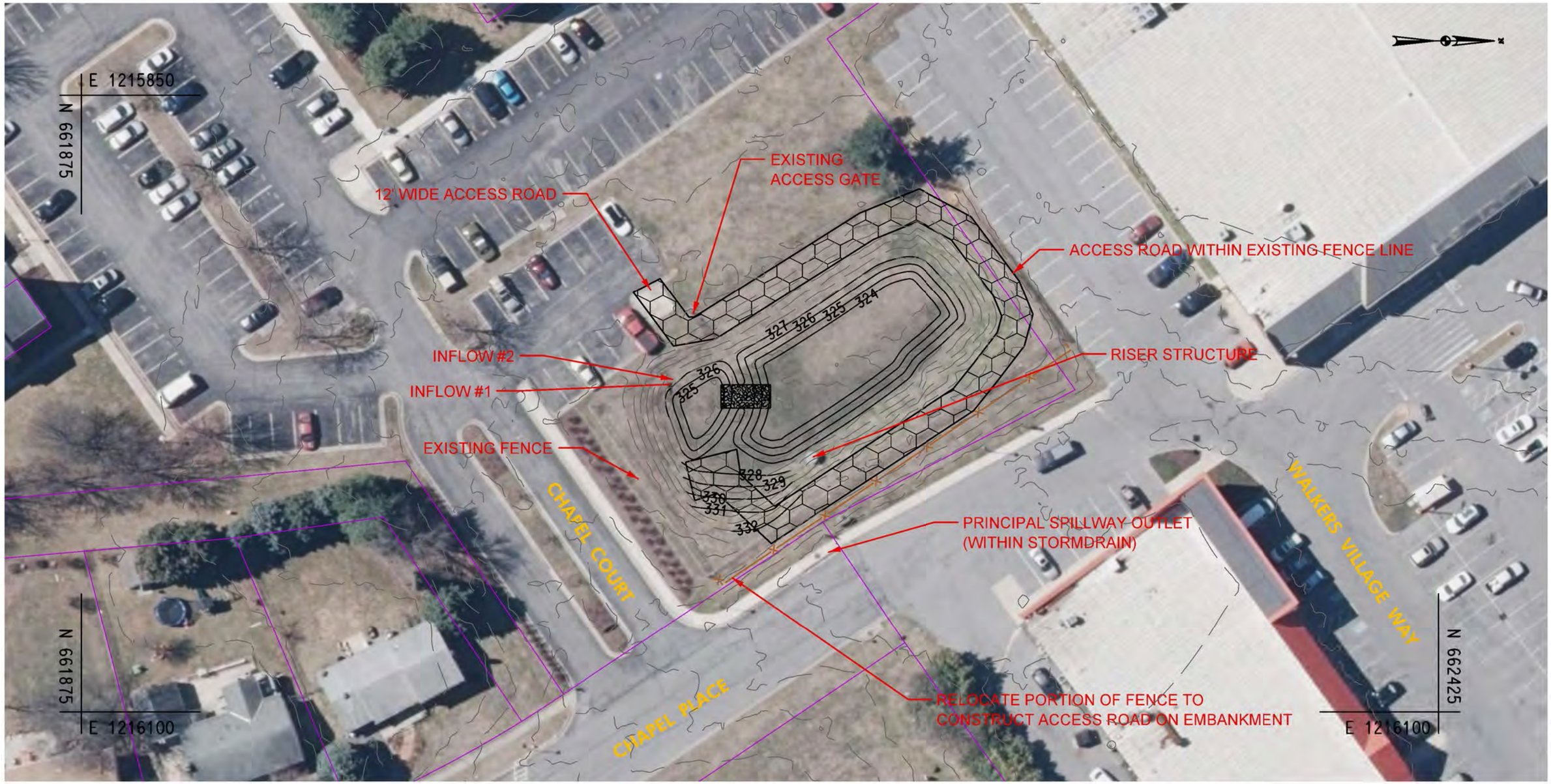


Photo 5: Embankment facing northeast

Photo 6: Principal Spillway Outlet facing southwest



GENERAL BMP INFORMATION	
BMP TYPE:	MICROPOOL EXTENDED DETENTION (P-1)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	6.49
TOTAL IMPERVIOUS AREA (ACRES):	2.79
WQv REQUIRED (CU. FT):	10293
WQv REQUIRED (AC. FT):	0.236
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	10293
TOTAL TREATED DA (ACRES):	6.49
TOTAL TREATED IMPERVIOUS AREA (ACRES):	2.79

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndnskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #403 – GLADE TOWNE – CONDOMINIUMS

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. - OF SHEET NO. OF

PLOTTED: Wednesday, June 21, 2017 AT 04:02 PM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP403.dgn

MICROPOOL EXTENDED DETENTION DESIGN (P-1): BMP 403

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**8/6/2015**
Watershed:	**Israel Creek**	As Built:	**-**

Drainage Area: **6.49** **(Total)** Acres 0.010 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **2.79** Acres **I =** 0.430

= 43.0 %

Soil Type: **B**

RCN Existing : **87** **Existing tc =** **0.20** hr **Per Frederick County's Urban BMP Database**

RCN Post Development : **87** **Post-D tc =** **0.20** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.437

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)

1" per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 43.0 %

$WQ_{V(I)}$ = 0.236 ac-ft = 10293 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.108 ac-ft = 4711.74 cu.ft

Water quality treatment required =	**10293**	**cu.ft =**	**0.2363**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**10293**	**cu.ft =**	**0.2363**	ac-ft	
Sediment Forebay Volume Required=	**1029**	**cu.ft =**	**0.0236**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**9264**	**cu.ft =**	**0.2127**	ac-ft	
Elevation at the Top of WQv in pond =	**326.95**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	5146
II	50% of WQv is in micropool	5146
III	1/3 of WQv is in micropool & forebay	2402
IV	1/3 of WQv is in micropool & forebay	2402

*source: SHA SWM Workshop, April 30, 2003

Micropool storage volume required = **2402** **cu.ft =** **0.0551** **ac-ft**

Extended Detention Storage= **2402** cu.ft = Dead Storage Volume cu.ft

Extended Detention Elevation= **324.98** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice

Hence, WQrr = **0.03** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_o = \frac{WQrr}{4.81\sqrt{h_o}}$$

Assume h_o = **1.97** ft *Will change based on pond volume

Ao = 0.00 sf

Determine the required orifice diameter (d_o)

$$D_o = \sqrt{\frac{4\ A_o}{}}$$

Do = 0.07 ft = **0.9** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**0.00**	0
B	**6.46**	100
C	**0.00**	0
D	**0.00**	0
Total	**6.46**	OK: sum of the areas matches site Area

Composite S: 0.2600 Use 26.00 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.061 ac-ft = **2676** cu.ft

Rev in Pond= **1647**

El of Rev= **324.67** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **0.725** Acres = 31598 sf

The Rev requirement may be met by:

a) treating 0.061 ac-ft using structural method,

b) treating 0.725 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	8/6/2015
Watershed:	Israel Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
2121.0	**324.0**	0.05	0.00	0.00	0.00	0.00
2786.0	**325.0**	0.06	1.00	0.06	0.06	2445.96
3514.0	**326.0**	0.08	1.00	0.07	0.13	5588.92
4302.0	**327.0**	0.10	1.00	0.09	0.22	9490.28
		0.00	0.00	0.00	0.00	0.00

No. of valid row entries= 4

NL105: BMP #468 - WESTWINDS TENNIS PAVILION - PHASE B

Prioritization Ranking:	41
Planning Level Cost Estimate:	$ 582,103.83
Estimated Cost/Impervious Acre	$ 101,591.37

General BMP Information:		
Structure Location:	Wimbledon Court & Crickenberger Road	
ADC Map:	4568, G3 (2008)	
Nothing/Easting:	625,805.185/1,193.488.607	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool ED (P-1)	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	20.14	
Total Impervious Area (ac):	5.88	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	22865	
Total Treated Drainage Area (ac):	20.14	
Total Treated Impervious Area (ac):	5.88	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	162.51	59.45
TP (lbs/yr):	14.04	6.59
TSS (lbs/yr):	10978.61	7112.97

Existing conditions for BMP #468

Site map for BMP #468

EXISTING SITE CONDITIONS

BMP #468 was designed as a extended detention wet pond. The facility was constructed behind the Westwinds Tennis Pavilion, west of Crickenberg Road as shown in the site map above. According to Frederick County's Urban BMP Database the drainage area for this BMP is 23.7 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 20.14 acres. The land use is residential and recreational.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from Gas House Pike. There are no other obvious site constraints such as utilities or steep slopes. Maintenance of traffic (MOT) is required for this BMP.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Acquisition of Easements, MOT, Tree Impacts	

PROPOSED RETROFIT

The proposed retrofit for BMP #468 is a micropool ED (P-1). It will provide quantity and quality management for 20.14 acres including 5.88 acres of impervious area. The retrofit will include grading within the footprint of the existing BMP and construction of an access road to provide maintenance access to the control structure.

NL105: BMP #468 – WESTWINDS TENNIS PAVILION – PHASE B

Storm Water Management Retrofit Evaluation					
Report Date:	10/9/2015	**Design Approval:**	5/20/1992	**Maintenance Owner:**	Lake Linganore Association Inc.
Structure No:	BMP #468	**Year Constructed:**	1/11/1994	**Inspection Date:**	10/8/2015
Structure Name:	Westwinds Tennis Pavilion - Phase B	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	VH, ND
Location:	Wimbledon Court & Crickenberger Road	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	10/4/2015 (0.25")
ADC Map:	4568, G3 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.theweathercollector.com
Northing/Easting:	625,805.185/1,193.488.607	**Stream Use:**	IV-P	**Station:**	US1MDFR0003

BMP Description				
	Existing Condition		**Proposed Condition**	
General BMP Information				
BMP Type:	Extended Detention Wet Pond		Micropool ED (P-1)	
BMP Classification:	N/A		Stormwater Treatment (ST) Practice	
Management Type:	Quantity/Quality		Quantity/Quality	
Total Drainage Area (acres):	23.7		20.14	
Total Impervious Area within Drainage Area (acres):	N/A		5.88	
WQv Required:	N/A		22865 cu. ft.	0.525 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes	
Adequate ROW (Y/N):	Yes		Yes	
Adequate Access (Y/N):	No		Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	Unknown	0	22865 cu. ft.	0.525 ac-ft
Total Treated Drainage Area (acres):	23.7	0	20.14	
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	5.88	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.07	
Total Nitrogen:			35.59%	
Total Phosphorus:			55.92%	
Sediment:			71.18%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		162.51	59.45
TP (lbs/yr):	0		14.04	6.59
TSS (lbs/yr):	0		10978.61	7112.97
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 582,103.83**

NL105: BMP #468 – WESTWINDS TENNIS PAVILION – PHASE B

BMP #468 – Westwinds Tennis Pavilion – Phase B was previously identified as Project ID NL105 in *An Assessment of Stormwater Management Retrofit and Stream Restoration Opportunities in Linganore Creek Watershed, Frederick County, Maryland* (hereafter referred to as the Linganore R/R Report) developed by Versar, Inc. (July 2006). This project location was selected for re-evaluation because the entire area drains to an existing pre-2002 BMP.

Versar's proposed actions included installing a linear rain garden along the back side of the tennis pavilion; reforesting open space; completing a culvert retrofit between parking lots; and installing a rain garden and tree box filter at inlets. Dewberry has evaluated the previous recommendations and conducted a GIS desktop analysis and site visit and identified the most cost-effective retrofit/restoration approach for the site as described in detail below.

Existing Site Conditions:

SWM ERA: 1985-2002

According to Frederick County's Urban BMP Database, BMP #468 has been identified as an extended detention wet pond. The facility was constructed behind the Westwinds Tennis Pavilion, west of Crickenberger Road as shown in the BMP Location map **(Figure 1)**. The BMP Database from the County indicates that the original design for BMP #468 provides management for quantity and quality and that the total treatment area for the BMP is 23.7 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 20.14 acres. Figure 1 shows the drainage area for the facility. According to the Urban BMP Database, this facility has the following features: a 1', 3', and 4' weir and a 48" barrel. Neither design plans nor stormwater management reports were available for this facility. The majority of land use is residential and recreational.

General Observations:

A site visit was conducted on October 8th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has three inflow points. Inflow #1 drains water into the facility from the west via a 15" CMP (**Photo 1**). There is erosion below Inflow #1 which is undermining the structure. There is also overgrown woody vegetation in the downstream inflow channel (**Photo 2**). Inflow #2 drains water into the facility from the west via a 30" CMP (**Photo 3**). Inflow #2 has a concrete headwall and the downstream channel is stabilized with rip-rap gabion baskets (**Photo 4**). There is woody vegetation and debris in the downstream inflow channel and exposed geotextile fabric. Inflow #3 drains water from the south via a rip-rap ditch (**Photo 5**). The majority of the rip-rap has washed to the downstream end of the channel and there is vegetation in the inflow channel. Overall, the CMP structures are in good condition.

Control Structure and Spillways:

The control structure for this facility is concrete riser with trash rack **(Photo 6)**. The riser structure was not accessible in the field due to the water depth and heavy vegetation surrounding the facility. The 1', 3' and 4' weirs were not visible due to the depth of water in the pond.

Embankment:

A fill embankment is present between the wet pond and principal outlet. Design plans were not available to determine whether an impermeable core or cutoff trench were installed. There is woody vegetation growing within 15' of the fill embankment (**Photo 7**).

Outflow:

The facility outflows to the southeast via a 48" ALCMP (**Photos 8 and 9**) and immediately flows into a cross culvert below Crickenberger Road. There is some vegetation in the downstream channel, but otherwise it is in good condition (**Photo 10**). Erosion was not identified at the outfall.

Overall BMP:

Woody vegetation and debris are present in the downstream inflow channels for Inflows #1 and #2. The majority of the rip-rap for Inflow #3 has been washed to the most downstream point. There is woody vegetation growing within 15' of the fill

embankment, as well as, vegetation growing around the perimeter of the BMP and algae growing in the pond (**Photo 11**). There is a hose coming from the swimming pool located south of the BMP (**Photo 12)**. It was unclear what was bring drained. It was repowered to the County for additional information. Minor problems are observed, however, the BMP is functioning as designed with no critical parameters but with some problem conditions.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site from Gas House Pike. BMP #468 is owned by Lake Linganore Association Inc. and easements must be evaluated further at final design. Maintenance of traffic (MOT) is required for this BMP.

Proposed Retrofit:

Based on the results of a GIS desktop analysis and site visit, it was determined that the entire impervious area drains to BMP #468. Therefore, the most cost-effective retrofit option is to retrofit BMP #468 to meet the current water quality volume standards to provide treatment for one inch of runoff.

BMP #468 was originally designed as an extended detention wet pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #468 is a micropool ED (P-1). The proposed retrofit will provide quantity and quality management for 20.14 acres including 5.88 acres of impervious area.

Additional Retrofit Opportunities:

In final design, the alignment of the access road may be modified to limit tree impacts and provide access closer to the pond. Coordination with the residents and Lake Linganore Association Inc. is recommended at final design. In addition, opportunities to add additional impervious area from Crickenberger Road and neighboring homes should be explored at final design to maximize impervious area credit at this location.

Step 1: Watershed Factors

BMP #468 is located in Frederick County's Lower Linganore Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #468 due to the downstream coldwater conditions. For the retrofit of BMP #468, 100% of the WQv can be treated by decreasing the BMP footprint (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek.

Step 2: Terrain Factors

BMP #468 is not located in a region of Frederick County that is prone to karst geology. Therefore, no special terrain factors and/or constraints must be considered for retrofit design.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to the unavailability of plans. There is adequate space for the proposed retrofit within the existing BMP boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a micropool ED is 10 acres. The proposed drainage area to BMP #468 is 20.14 acres and is composed of B, C, and D soils. The likelihood of BMP #468 receiving hotspot runoff is low as it is located within an residential and recreational land use area. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban. Retrofitting the existing BMP into a micropool ED is feasible at this location per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP #468 is located to the north of Wimbledon Court and west of Crickenberger Road and has high visibility. Micropool ED tend to have medium maintenance requirements, medium community acceptance, low construction costs relative to the drainage area, and provide medium habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #468 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Floodplain GIS Data indicates that the BMP is not within FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is mapped as a wetland, but is not an in-stream facility.

Figure 1: BMP Location Map – Existing Conditions

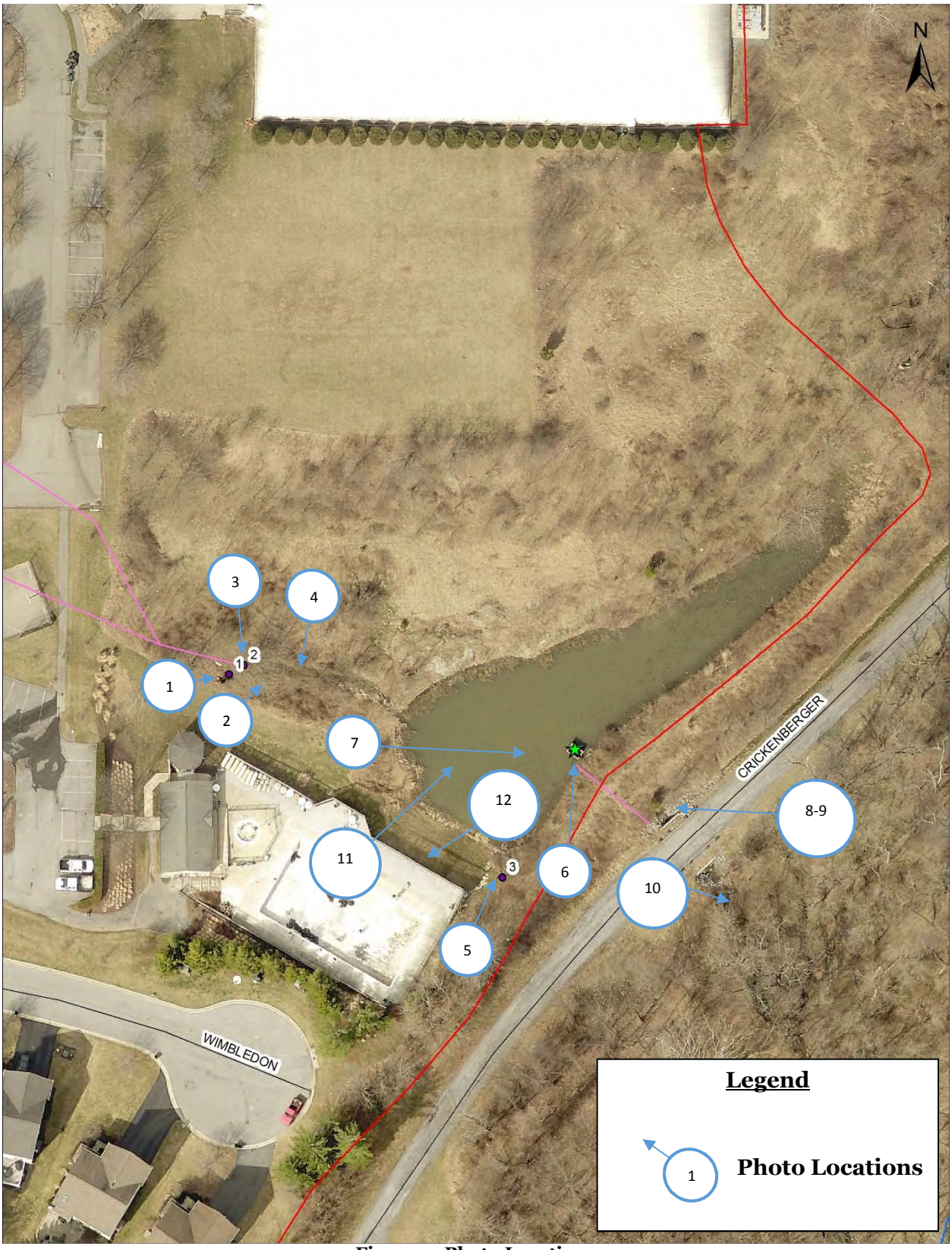


Figure 2: Photo Locations

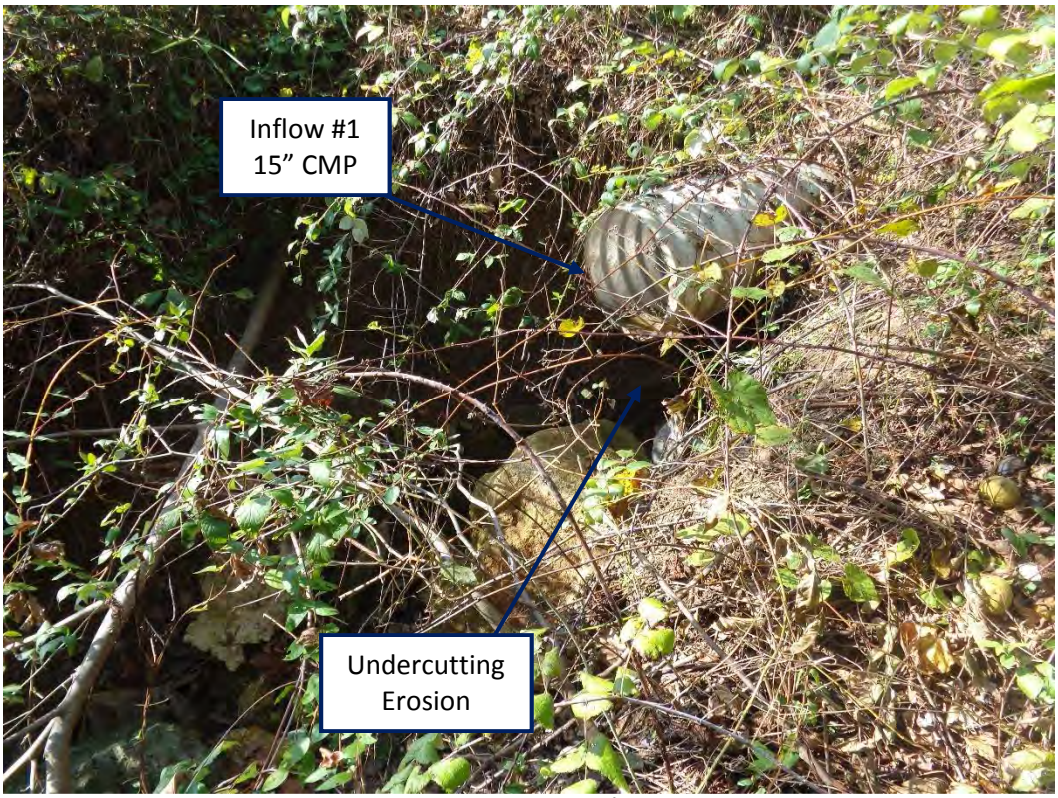


Photo 1: Inflow #1 facing west

Photo 2: Inflow #1 downstream channel facing east

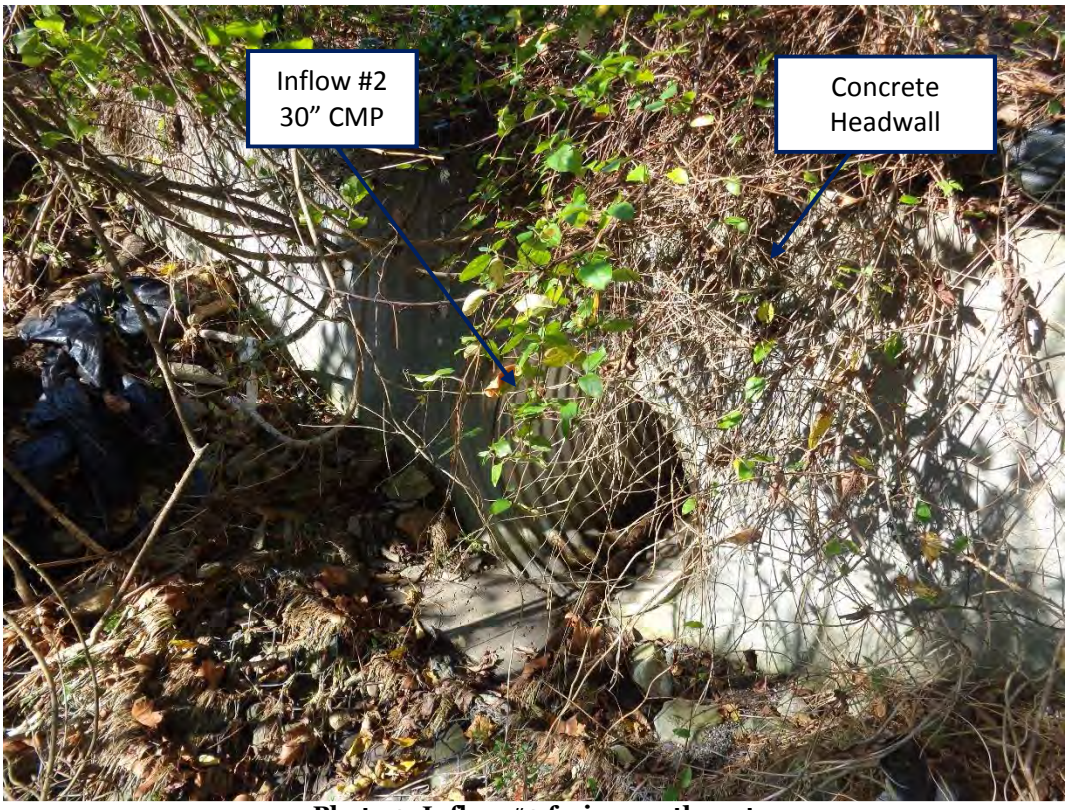


Photo 3: Inflow #2 facing northwest

Photo 4: Inflow #2 downstream channel facing east

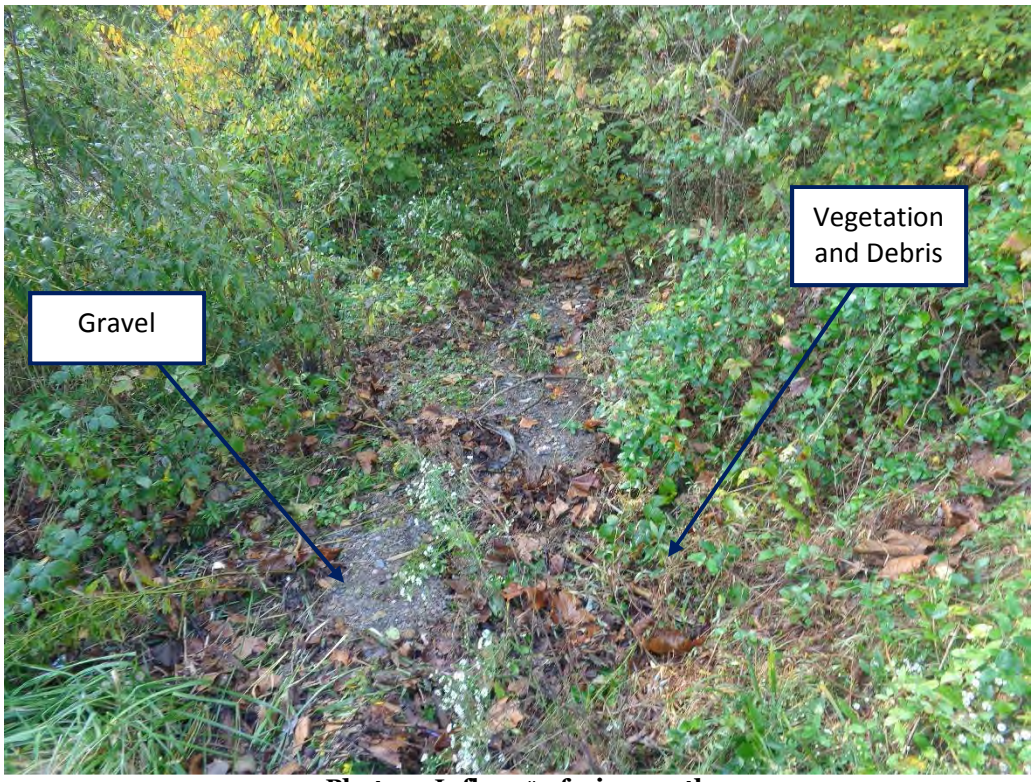


Photo 5: Inflow #3 facing south

Photo 6: Control structure facing northeast

Photo 7: Fill embankment facing east

Photo 8: Outfall facing northwest

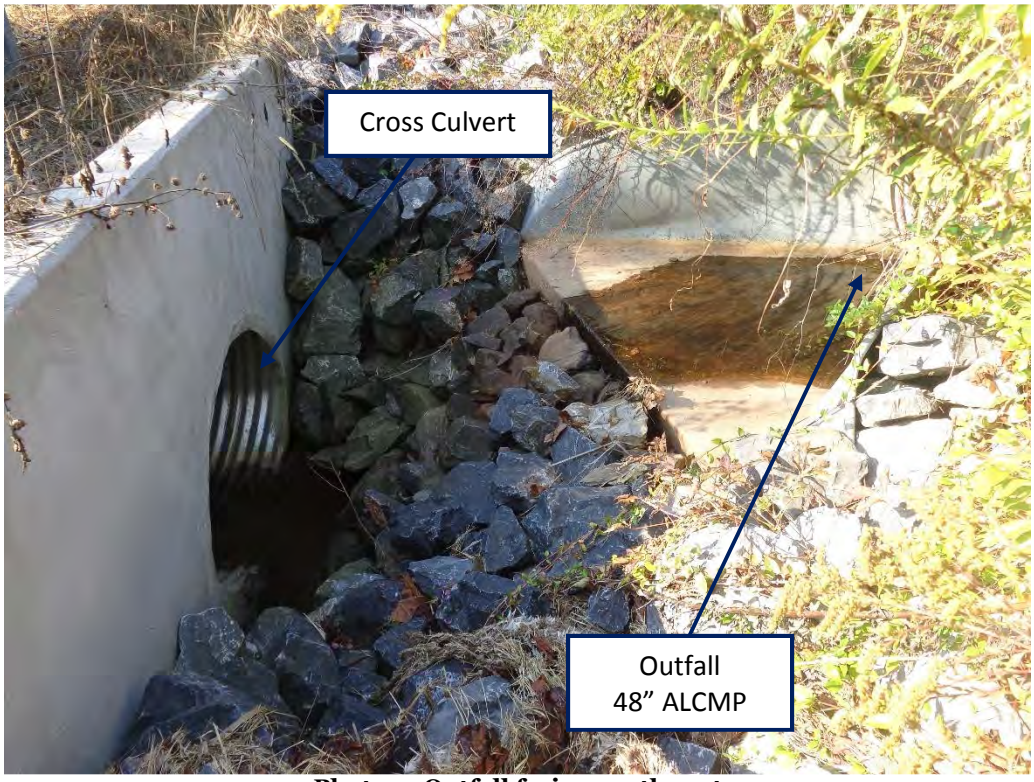


Photo 9: Outfall facing southwest

Photo 10: Outflow channel facing southeast

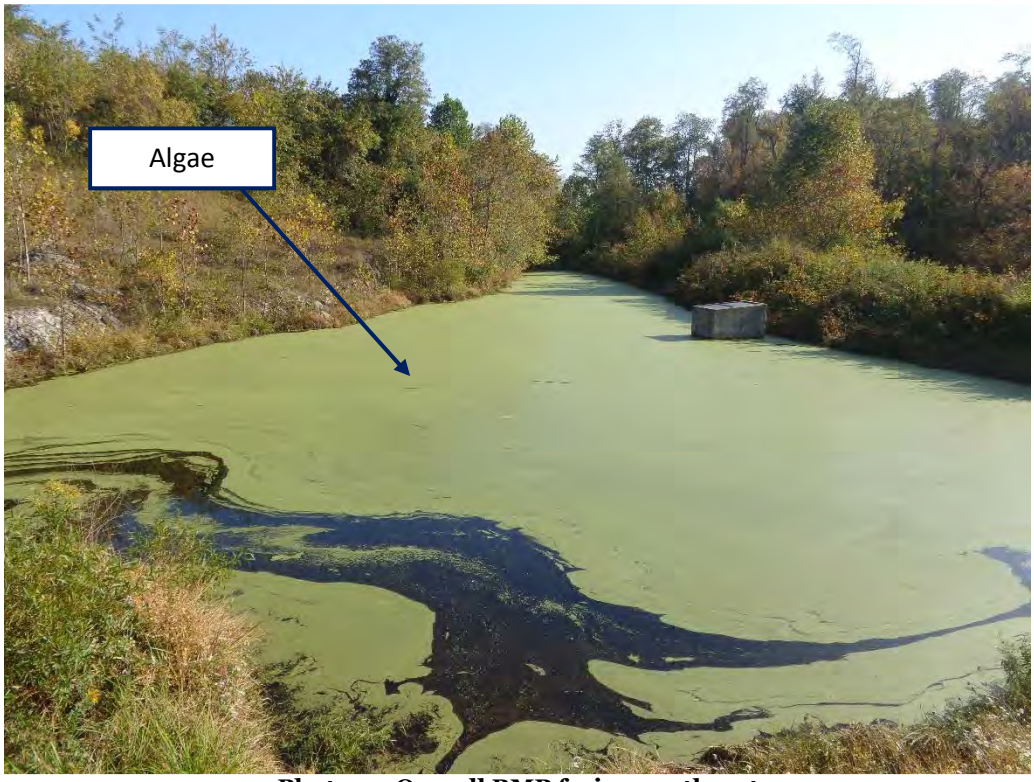
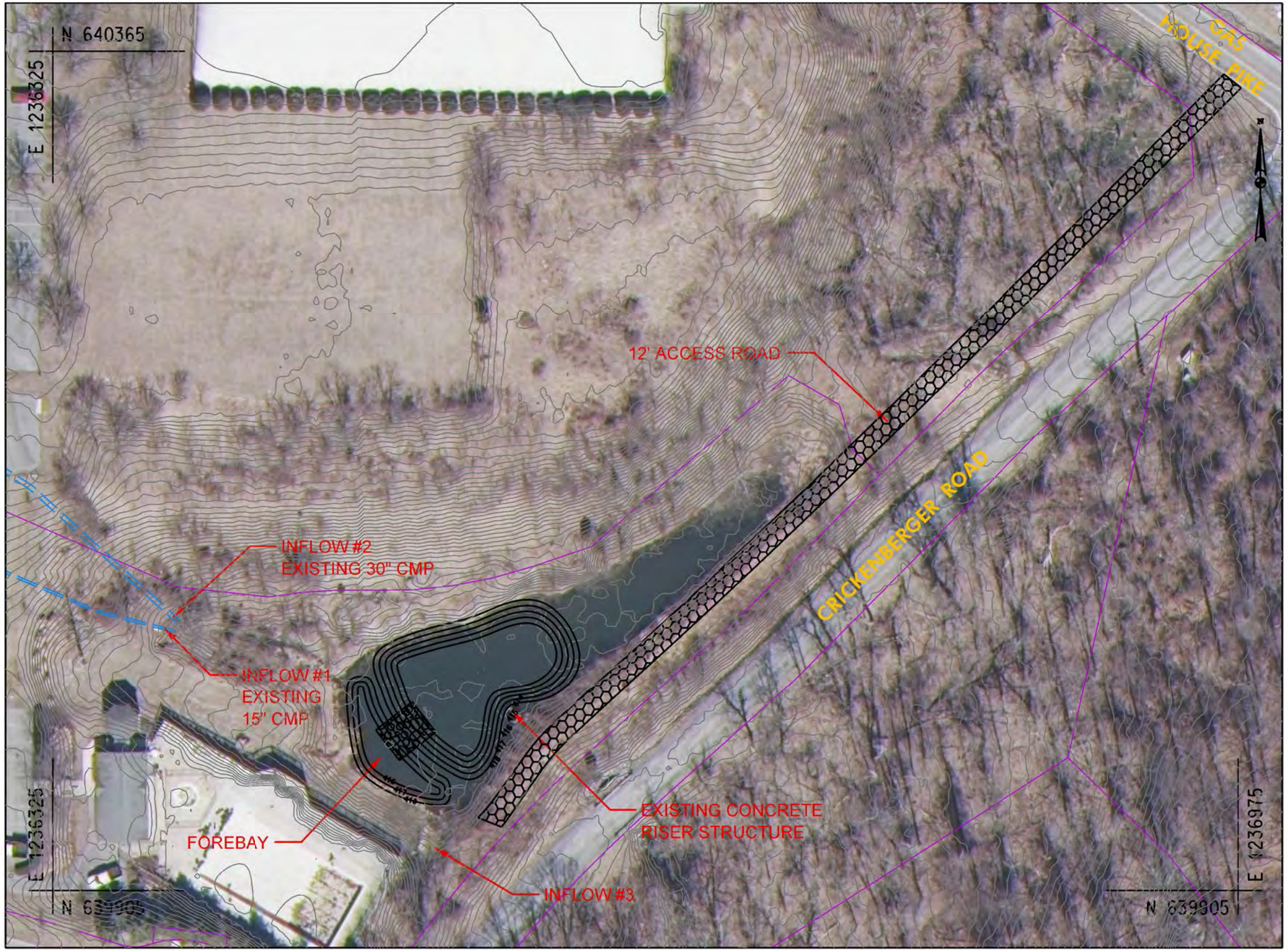


Photo 11: Overall BMP facing northeast

Photo 12: Hose from pool facing southwest



GENERAL BMP INFORMATION	
BMP TYPE:	MICROPOOL ED (P-1)
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	20.14
TOTAL IMPERVIOUS AREA (ACRES):	5.88
WQv REQUIRED (CU. FT):	22865
WQv REQUIRED (AC. FT):	0.525
WATER QUALITY TREATMENT PROVIDED:	
WQv PROVIDED (CU. FT):	22865
TOTAL TREATED DA (ACRES):	20.14
TOTAL TREATED IMPERVIOUS AREA (ACRES):	5.88

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

WESTWINDS TENNIS PAVILION - PHASE B

SCALE 1" = 60' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF SHEET NO. OF

BY: ndriskill -

PLOTTED: Thursday, June 22, 2017 AT 09:19 AM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP468.dgn

MICROPOOL ED DESIGN (P-1): BMP 468 - WESTWINDS TENNIS PAVILION - PHASE B

This spreadsheet is for **design level calculations** of Micropool ED

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2011)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project: **SWM BMP Retrofit Assessment** Engineer:

Location: **Frederick County, MD** Date: **10/12/2015**

Watershed: **Lower Monocacy River** As Built:

Drainage Area: **20.14 (Total)** Acres 0.031 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **5.88** Acres **I =** 0.292

= 29.2 %

Soil Type: **B, C, D**

RCN Existing : **0** **Existing tc =** **0.00** hr

RCN Post Development : **73** **Post-D tc =** **0.30** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.313

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (1.0" for Eastern Rainfall Zone, 0.9" for Western Rainfall zone)
1" selected per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 29.2 %

$WQ_{V(I)}$ = 0.525 ac-ft = 22865 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.336 ac-ft = 14621.64 cu.ft

Water quality treatment required =	**22865**	**cu.ft =**	**0.5249**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**22865**	**cu.ft =**	**0.5249**	ac-ft	
Sediment Forebay Volume Required=	**2287**	**cu.ft =**	**0.0525**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**20579**	**cu.ft =**	**0.4724**	ac-ft	
Elevation at the Top of WQv in pond =	**416.00**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	11433
II	50% of WQv is in micropool	11433
III	1/3 of WQv is in micropool & forebay	5335
IV	1/3 of WQv is in micropool & forebay	5335
*source: SHA SWM Workshop, April 30, 2003		

Micropool storage volume required = **5335** **cu.ft =** **0.1225** **ac-ft**

Extended Detention Storage= **5335** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **415.27** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.06** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

Assume h_o = **0.73** ft *Will change based on pond volume

Ao = 0.02 sf

Determine the required orifice diameter (d_o)

Do = 0.14 ft = **1.7** inches.

Step 2: Compute Recharge Volume (Rev)

$$\text{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

	HSG	Drainage Area (Acres)	Percentage (%)
	A	**0.00**	0
20.14	B	**8.50**	42
	C	**6.67**	33
	D	**4.97**	25
	Total	**20.14**	OK: sum of the areas matches site Area

Composite S: 0.1701 Use 17.01 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.089 ac-ft = **3888** cu.ft

Rev in Pond= **1602**

El of Rev= **414.39** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **1.000** Acres = 43557 sf

The Rev requirement may be met by:

a) treating 0.089 ac-ft using structural method,

b) treating 1.000 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	SWM BMP Retrofit Assessment	Engineer:	VLH
Location:	Frederick County, MD	Date:	10/12/2015
Watershed:	Lower Monocacy River		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
3713.2	**414.0**	0.09	0.00	0.00	0.00	0.00
4476.5	**415.0**	0.10	1.00	0.09	0.09	4088.92
5300.4	**416.0**	0.12	1.00	0.11	0.21	8971.57
6186.4	**417.0**	0.14	1.00	0.13	0.34	14709.26
7132.0	**418.0**	0.16	1.00	0.15	0.49	21362.84

No. of valid row entries= 5

HR101: BMP #600 - Dear Crossing Elementary School (EDSD)

Prioritization Ranking:	42
Planning Level Cost Estimate:	$ 535,848.50
Estimated Cost/Impervious Acre	$ 107,575.55

General BMP Information:		
Structure Location:	Southwest corner of Boyers Mill Road & Finn Drive	
ADC Map:	4568, D6 (2008)	
Nothing/Easting:	632,940.61/1,230,547.35	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool ED (P-1)	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	15.86	
Total Impervious Area (ac):	5.21	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	19900	
Total Treated Drainage Area (ac):	15.86	
Total Treated Impervious Area (ac):	5.21	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	129.23	47.28
TP (lbs/yr):	11.75	5.51
TSS (lbs/yr):	9261.42	6000.41

Existing conditions for BMP #600

Site map for BMP #600

EXISTING SITE CONDITIONS

BMP #600 was designed as a extended detention dry pond. The facility was constructed in the southwest corner of Boyers Mill Road and Finn Drive as shown in the site map above. According to Frederick County's Urban BMP Database the drainage area for this BMP is 14.7 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 15.86 acres. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from Boyers Mill Road. There are no other obvious site constraints such as utilities or steep slopes. MOT is not required for this BMP.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: NONE	

PROPOSED RETROFIT

The proposed retrofit for BMP #600 is a micropool extended detention (P-1). It will provide quantity and quality management for 15.86 acres including 5.21 acres of impervious area. The retrofit will include grading within the footprint of the existing BMP and construction of an access road to provide maintenance access to the control structure.

HR101: BMP #600 – DEER CROSSING ELEMENTARY SCHOOL E.D. POND

Storm Water Management Retrofit Evaluation

Report Date:	9/16/2015	**Design Approval:**	6/27/1996	**Maintenance Owner:**	FCPS - Facilities Services Division
Structure No:	BMP #600	**Year Constructed:**	Not Available	**Inspection Date:**	7/7/2015
Structure Name:	Deer Crossing Elementary School E.D. Pond	**NPDES Watershed:**	Lower Linganore Creek	**Inspection Team:**	ND, GL
Location:	Southwest corner of Boyers Mill Road & Finn Drive	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/28/2015 (0.19")
ADC Map:	4568, D6 (2008)	**Land-River Segment:**	PM1_3710_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	632,940.61/1,230,547.35	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description

	Existing Condition		Proposed Condition	
General BMP Information				
BMP Type:	Extended Detention Dry Pond		Micropool ED (P-1)	
BMP Classification:	N/A		Stormwater Treatment (ST) Practice	
Management Type:	Quantity/Quality		Quantity/Quality	
Total Drainage Area (acres):	14.7		15.86	
Total Impervious Area within Drainage Area (acres):	N/A		5.21	
WQv Required:	N/A		19900 cu. ft.	0.457 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes	
Adequate ROW (Y/N):	Yes		Yes	
Adequate Access (Y/N):	No		Yes	
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**		
WQv Provided:	Unknown	0	19900 cu. ft.	0.457 ac-ft
Total Treated Drainage Area (acres):	14.7	0	15.86	
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	5.21	
Estimated Pollutant Removal Rates				
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.05	
Total Nitrogen:			35.43%	
Total Phosphorus:			55.67%	
Sediment:			70.86%	
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**	**Delivered (Del)**
TN (lbs/yr):	0		129.23	47.28
TP (lbs/yr):	0		11.75	5.51
TSS (lbs/yr):	0		9261.42	6000.41
Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):				**$ 535,848.50**

HR101: BMP #600 – DEER CROSSING ELEMENTARY SCHOOL E.D. POND

Deer Crossing Elementary School was previously identified as Project ID HR101 in *An Assessment of Stormwater Management Retrofit and Stream Restoration Opportunities in Linganore Creek Watershed, Frederick County, Maryland* (hereafter referred to as the Linganore R/R Report) developed by Versar, Inc. (July 2006). This project location was selected for re-evaluation because it is located on a Frederick County Public School (FCPS) property and the County has previously completed some of the recommended restoration efforts.

Versar's proposed actions included upgrading the control structure for BMP #600 to MD2000 standards, reforesting unused grass areas, installing linear bioretention facilities along Finn Drive and the school entrance, placing rain gardens near the basketball court and baseball fields, and creating a detention micro-berm along the southeast margin of the playing fields. Dewberry has evaluated the previous recommendations and conducted a GIS desktop analysis and site visit and identified the most cost-effective retrofit/restoration approach for the site as described in detail below.

Existing Site Conditions:

SWM ERA: 1985-2002

According to Frederick County's Urban BMP Database, BMP #600 has been identified as an extended detention dry pond. The facility was constructed in the southwest corner of Boyers Mill Road and Finn Drive as shown in the BMP Location map **(Figure 1)**. The BMP Database from the County indicates that the original design for BMP #600 provides management for quantity and quality and that the total treatment area for the BMP is 14.7 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 15.86 acres. Figure 1 shows the drainage area for the facility. According to design plans and the Urban BMP Database, this facility has the following features: a 42" RCP inflow, a 10" low flow orifice, and a 10' weir. The majority of land use is residential.

General Observations:

A site visit was conducted on July 7th, 2015. **Figure 2** shows the location of photos taken during the visit.

Inflow:

The facility has two inflow points. Inflow #1 drains water into the facility from the west via a 42" RCP (**Photo 1**). Inflow #1 has a concrete endwall and the pipe is completely submerged. There are cattails growing around Inflow #1. Inflow #2 drains water into the facility from the south via a grass and rip-rap ditch.

Control Structure and Spillways:

The control structure for this facility is a 10' weir with a 10" low flow orifice **(Photo 2)**. The weir was not accessible in the field due to a fence surrounding the facility. There is heavy vegetation and invasive species growing around the weir (**Photo 3**). The water level in the pond is at the top of the weir. Water is not draining from the facility, therefore, the low flow orifice appears to be blocked.

Embankment:

A fill embankment is present between the dry pond and principal spillway outlet. Based on the available design plans, an impermeable core and cutoff trench were installed at the weir. There is woody vegetation growing within 15' of the fill embankment (**Photo 3**).

Outflow:

The facility outflows to the southeast to an unnamed stream (**Photo 4**). There is some algae and sediment in the downstream channel, but otherwise it is in good condition.

Overall BMP:

Inflow #1 and the low flow orifice are completely submerged. There is greater than 3' of standing water in the BMP. There is vegetation and invasive species growing around the perimeter of the BMP (**Photo 5**). Major problems are observed, and the facility is not functioning as designed with several critical parameters with problem conditions. Conditions associated with the

facility have compromised the BMP performance. BMP facility shows signs of impending deterioration with potential for failure. Maintenance should be performed as soon as possible.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site from Finn Drive. BMP #600 is owned by FCPS, and stormwater management easements at this location need to be further evaluated at final design. Maintenance of traffic (MOT) is not required for this BMP.

Proposed Retrofit:

Based on the results of a GIS desktop analysis and site visit, it was determined that the entire impervious area drains to BMP #600. Therefore, the most cost-effective retrofit option is to retrofit BMP #600 to meet the current water quality volume standards to provide treatment for one inch of runoff.

BMP #600 was originally designed as an extended detention dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #600 is a micropool extended detention pond (P-1). The proposed retrofit will provide quantity and quality management for 15.86 acres including 5.21 acres of impervious area. The existing 15" ALCMP storm drain located northeast of the pond, and the CMP cross culvert located northwest of the pond, can be redirected to outfall into the proposed pond to receive additional credit during final design.

Additional Retrofit Opportunities:

In final design, the addition of inlet and a storm drains to direct impervious area from Finn Drive into BMP #600 should be explored to determine if additional impervious area can be treated at this facility.

Step 1: Watershed Factors

BMP #600 is located in Frederick County's Ballenger Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #600 due to the downstream coldwater conditions. For the retrofit of BMP #600, 100% of the WQv can be treated by expanding the BMP footprint in nearby open space (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek.

Step 2: Terrain Factors

BMP #600 is not located in a region of Frederick County that is prone to karst geology. Therefore, no special terrain factors and/or constraints must be considered for retrofit design.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to the unavailability of plans. There is adequate space for the proposed retrofit within the existing BMP boundary. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a micropool ED is 10 acres. The proposed drainage area to BMP #600 is 15.86 acres and is composed of B and C soils. The likelihood of BMP #600 receiving hotspot runoff is low as it is located within an institutional land use area. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban. Retrofitting the existing BMP into a micropool extended detention pond is feasible at this location per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

BMP #600 is located to the south of Finn Drive and the west of Boyers Mill Road and has high visibility. Micropool extended detention ponds tend to have medium maintenance requirements, medium community acceptance, low construction costs relative to the drainage area, and provide medium habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #600 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP will be required. Review of FEMA Floodplain GIS Data indicates that the BMP is not within FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is mapped as a wetland. Frederick County's Stream GIS layer indicates that an unnamed stream begins at the outfall for BMP #600; therefore, it may require additional environmental factor and permitting consideration for final design.

Figure 1: BMP Location Map – Existing Conditions

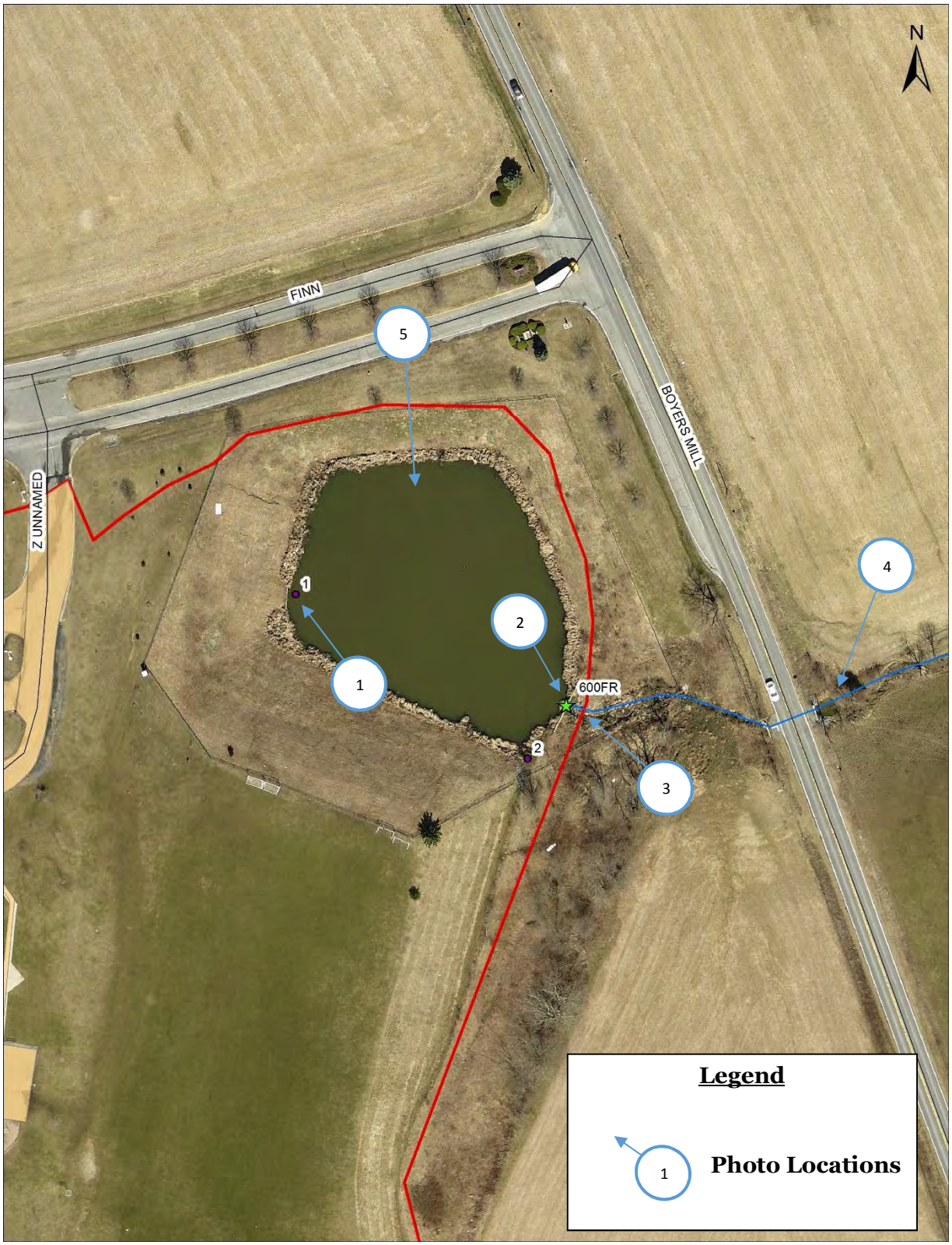


Figure 2: Photo Locations

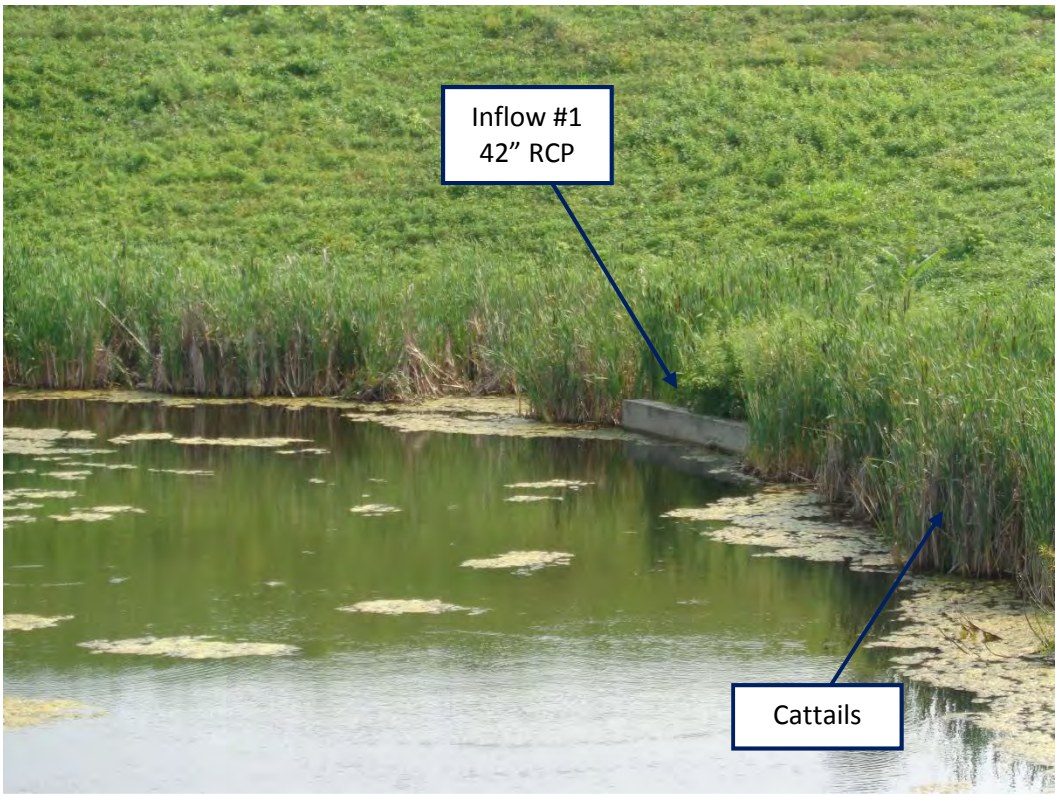


Photo 1: Inflow #1 facing south

Photo 2: Control structure facing southeast

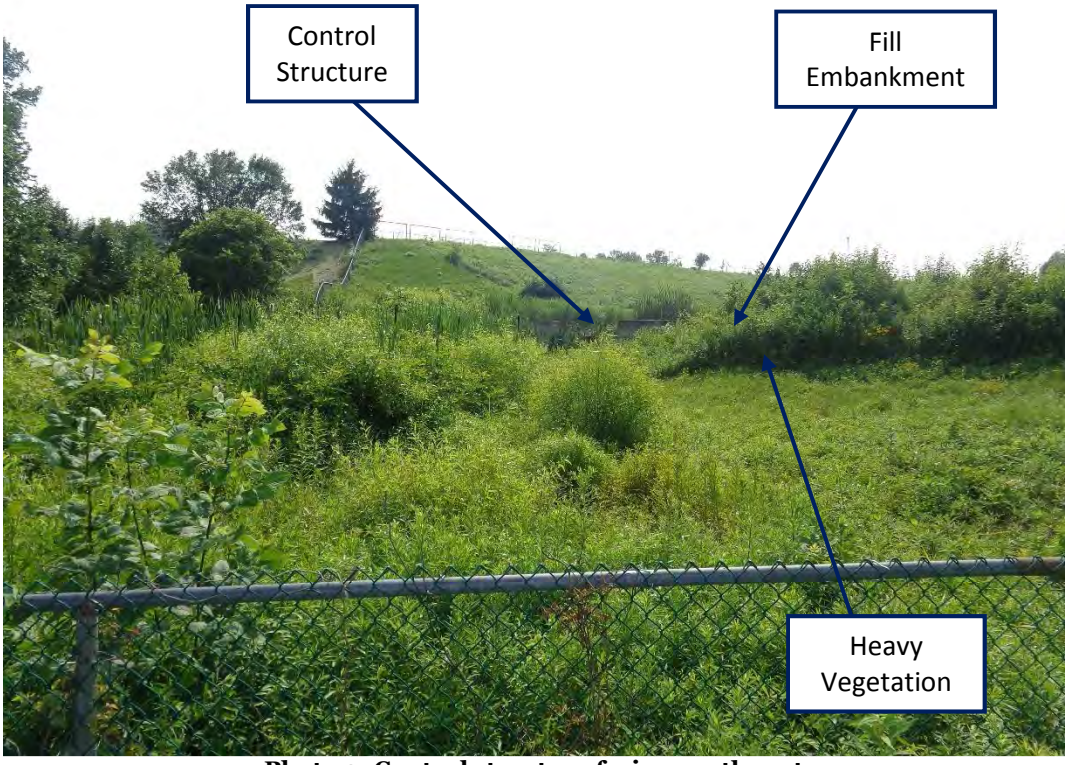
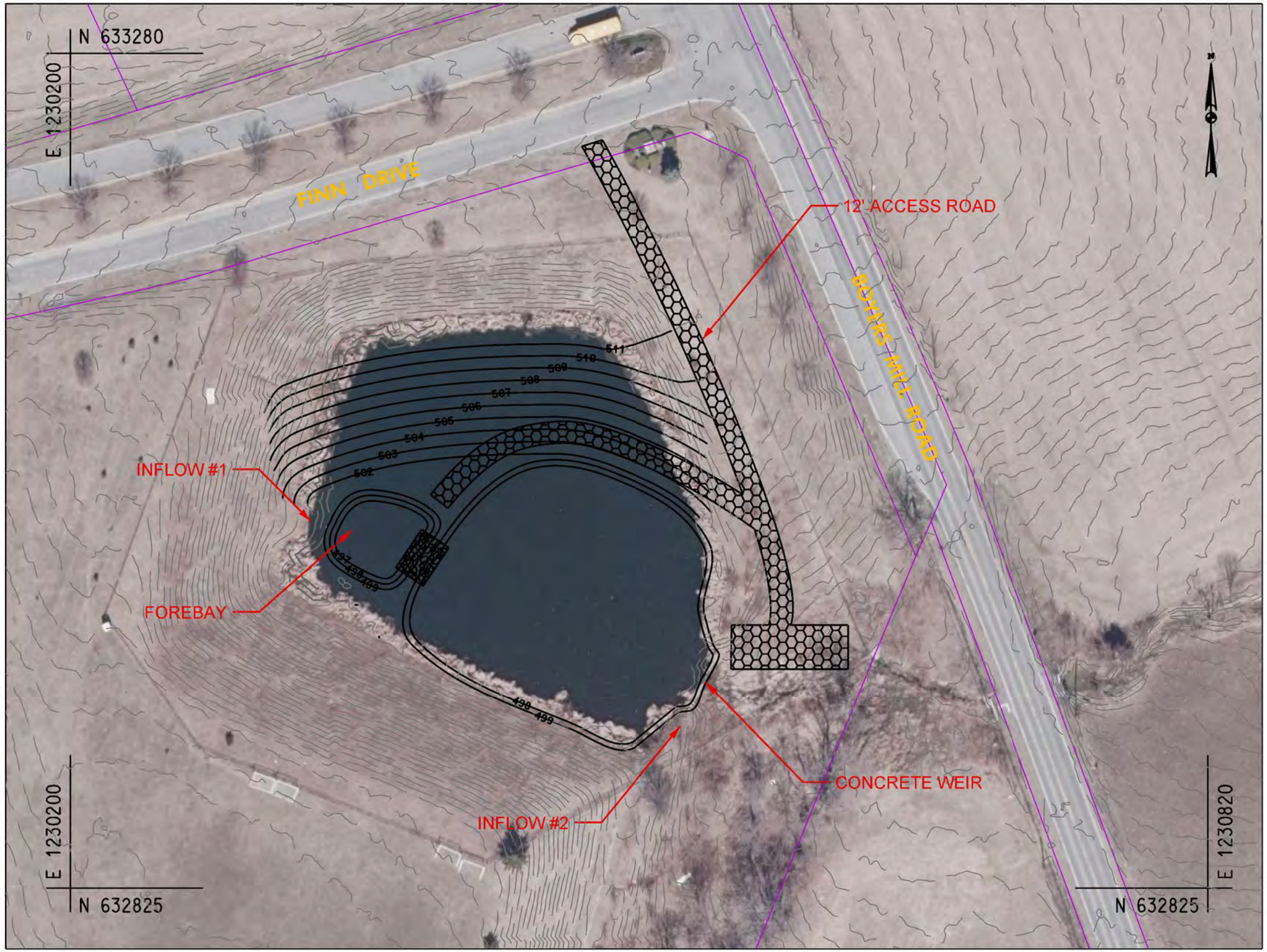


Photo 3: Control structure facing northwest

Photo 4: Outflow unnamed stream facing west

Photo 5: Overall BMP facing south



GENERAL BMP INFORMATION	
BMP TYPE:	MICROPOOL ED (P-1)
MANAGEMENT TYPE:	QUANTITY/QUALITY
TOTAL DA (ACRES):	15.86
TOTAL IMPERVIOUS AREA (ACRES):	5.21
WQv REQUIRED (CU. FT):	19900
WQv REQUIRED (AC. FT):	0.457
WATER QUALITY TREATMENT PROVIDED	
WQv PROVIDED (CU. FT):	19900
TOTAL TREATED DA (ACRES):	15.86
TOTAL TREATED IMPERVIOUS AREA (ACRES):	5.21

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #600 - DEER CROSSING ELEMENTARY SCHOOL E.D. POND

SCALE 1" = 60' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF - SHEET NO. - OF -

PLOTTED: Thursday, June 22, 2017 AT 09:45 AM
FILE: Q:\50064072\50064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP600.dgn

BY: ndriskill -

MICROPOOL ED DESIGN (P-1): BMP 600 - DEER CROSSING ELEMENTARY SCHOOL E.D. POND

This spreadsheet is for **design level calculations** of Micropool ED

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2011)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project: **SWM BMP Retrofit Assessment** Engineer:

Location: **Frederick County, MD** Date: **9/16/2015**

Watershed: **Lower Monocacy River** As Built:

Drainage Area: **15.86** **(Total)** Acres 0.025 square miles

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **5.21** Acres **I =** 0.328

= 32.8 %

Soil Type: **B, C**

RCN Existing : **0** **Existing tc =** **0.00** hr

RCN Post Development : **78** **Post-D tc =** **0.30** hr

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.346

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (1.0" for Eastern Rainfall Zone, 0.9" for Western Rainfall zone)

1" selected per MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 32.8 %

$WQ_{V(I)}$ = 0.457 ac-ft = 19900 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.264 ac-ft = 11514.36 cu.ft

Water quality treatment required =	**19900**	**cu.ft =**	**0.4568**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**19900**	**cu.ft =**	**0.4568**	ac-ft	
Sediment Forebay Volume Required=	**1990**	**cu.ft =**	**0.0457**	ac-ft	Forebay Volume = 0.1" runoff
WQv in pond =	**17910**	**cu.ft =**	**0.4111**	ac-ft	
Elevation at the Top of WQv in pond =	**499.00**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	9950
II	50% of WQv is in micropool	9950
III	1/3 of WQv is in micropool & forebay	4643
IV	1/3 of WQv is in micropool & forebay	4643

***source: SHA SWM Workshop, April 30, 2003**

Micropool storage volume required = **4643** **cu.ft =** **0.1066** **ac-ft**

Extended Detention Storage= **4643** cu.ft = Dead Storage Volume cu.ft

Extended Detention Elevation= **498.25** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice

Hence, WQrr = **0.05** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

Assume h_o = **0.75** ft *Will change based on pond volume

Ao = 0.01 sf

Determine the required orifice diameter (d_o)

Do = 0.13 ft = **1.5** inches.

Step 2: Compute Recharge Volume (Rev)

$$\text{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

	HSG	Drainage Area (Acres)	Percentage (%)
	A	**0.00**	0
15.86	B	**9.95**	63
	C	**5.91**	37
	D	**0.00**	0
	Total	**15.86**	OK: sum of the areas matches site Area

Composite S: 0.2116 Use 21.16 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.097 ac-ft = **4210** cu.ft

Rev in Pond= **2220**

El of Rev= **498.12** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **1.102** Acres = 48012 sf

<u>The Rev requirement may be met by:</u>

a) treating 0.097 ac-ft using structural method,

b) treating 1.102 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	SWM BMP Retrofit Assessment	Engineer:	VLH
Location:	Frederick County, MD	Date:	9/16/2015
Watershed:	Lower Monocacy River		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	TOTAL VOLUME (cu.ft)	
17766.9	**498.0**	0.41	0.00	0.00	0.00	0.00	0.00
19357.5	**499.0**	0.44	1.00	0.43	0.43	18556.51	0.51
							1.17
							2.17
							3.64
							5.54
							7.94
							10.83
							14.07
							17.53
							21.15
							24.91

No. of valid row entries= 2

BMP #395 - Micropool Extended Detention (P-1)

Prioritization Ranking:	43
Planning Level Cost Estimate:	$ 639,496.00
Estimated Cost/Impervious Acre	$ 107,811.06

General BMP Information:		
Structure Location:	Revelation Avenue	
ADC Map:	4449, B7 (2008)	
Northing/Easting:	653,829.00/1,209,607.00	
NPDES Watershed:	Israel Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool Extended Detention (P-1)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	19.06	
Total Impervious Area (ac):	6.16	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	23584	
Total Treated Drainage Area (ac):	19.06	
Total Treated Impervious Area (ac):	6.16	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	155.03	91.14
TP (lbs/yr):	14.00	6.57
TSS (lbs/yr):	8789.93	5694.93

Existing conditions for BMP #395

Site map for BMP #395

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #395 has been identified as a dry pond. The facility was constructed south of Revelation Avenue. The BMP Database from the County indicates that the original design for BMP #395 provides management for quantity and that the total treatment area for the BMP is 10.5 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 19.14 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from a residential parking lot off of Revelation Avenue. Maintenance of traffic (MOT) will be required to notify residents who utilize Revelation Avenue.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	X
Other: Acquisition of Easements, MOT, Tree Impacts	

PROPOSED RETROFIT

The proposed retrofit for BMP #395 is a micropool extended detention pond (P-1). The proposed retrofit will provide quantity and quality management for 19.06 acres including 6.22 acres of impervious area. The concept retrofit plan proposes providing dead storage by excavating approximately 2 feet below the existing BMP bottom elevation for extended detention as shown in the Concept Plans.

BMP # 395 – DISCOVERY SUBDIVISION – REVELATION AVENUE FACILITY

Storm Water Management Retrofit Evaluation					
Report Date:	7/14/2015	**Design Approval:**	11/29/1971	**Maintenance Owner:**	Discovery H.O.A.
Structure No:	395	**Year Constructed:**	7/1/1972	**Inspection Date:**	6/10/2015
Structure Name:	Discovery Subdivision - Revelation Avenue Facility	**NPDES Watershed:**	Israel Creek	**Inspection Team:**	ND, GL
Location:	Revelation Avenue	**MDE 8 Digit Name/#:**	Lower Monocacy River (02140302)	**Last Significant Rainfall:**	6/8/2015 (0.38")
ADC Map:	4449, B7 (2008)	**Land-River Segment:**	PM4_3341_4040	**Rainfall Source:**	www.wunderground.com
Northing/Easting:	653,829.00/1,209,607.00	**Stream Use:**	IV-P	**Station:**	KMDNEWMA2

BMP Description					
	Existing Condition		**Proposed Condition**		
General BMP Information					
BMP Type:	Dry Pond		Micropool Extended Detention (P-1)		
BMP Classification:	N/A		Stormwater Treatment (ST) Practice		
Management Type:	Quantity		Quality/Quantity		
Total Drainage Area (acres):	10.5		19.06		
Total Impervious Area within Drainage Area (acres):	Unknown		6.16		
WQv Required:	Unknown		23584	cu. ft.	0.541 ac-ft
Does Facility Meet MDE 2000 WQv Requirements (Y/N):	No		Yes		
Adequate ROW (Y/N):	Yes		Yes		
Adequate Access (Y/N):	Yes		Yes		
Estimated Treatment Provided	**Per Design**	**Per MDE 2000 Standards**			
WQv Provided:	Unknown	0	23584	cu. ft.	0.541 ac-ft
Total Treated Drainage Area (acres):	10.5	0	19.06		
Total Treated Impervious Area within Drainage Area (acres):	Unknown	0	6.16		
Estimated Pollutant Removal Rates					
Runoff Volume Treated per Impervious Acre (in.)	N/A		1.05		
Total Nitrogen:			35.44%		
Total Phosphorus:			55.69%		
Sediment:			70.88%		
Estimated Pollutant Load Reduction			**Edge of Stream (EOS)**		**Delivered (Del)**
TN (lbs/yr):	0		155.03		91.14
TP (lbs/yr):	0		14.00		6.57
TSS (lbs/yr):	0		8789.93		5694.93

Projected Retrofit Cost (Total Capital Cost = Design + Construction + Contingency):	**$ 639,496.00**

BMP # 395 – DISCOVERY SUBDIVISION – REVELATION AVENUE FACILITY

Existing Site Conditions:

SWM Era: Pre-1985

According to Frederick County's Urban BMP Database, BMP #395 has been identified as a dry pond. The facility was constructed south of Revelation Avenue as shown in the BMP Location map (**Figure 1**). The BMP Database from the County indicates that the original design for BMP #395 provides management for quantity and that the total treatment area for the BMP is 10.5 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 19.06 acres. Figure 1 shows the drainage area for the facility. Neither design plans nor a stormwater management report were available for this BMP. The facility has one inflow per the GIS Stream layer: an unnamed stream from the north. The Urban BMP Database states the facility control structure is a concrete weir with a 12" cast iron pipe. The majority of land use is residential.

General Observations:

A site visit was conducted on June 10th, 2015. **Figure 2** shows the location of photos taken during the visit. There was a fence surrounding the facility; therefore, the assessment was completed from outside of the fence.

Inflow:

The facility has four inflow points. Three inflows (Inflows #1, #2, and #3) are via closed sections. According to observations in the field, Inflow #1 is a 27" RCP with a concrete endwall from the north **(Photo 1)**. There is erosion present around the endwall and approximately 7" of sediment accumulation in the outfall of the RCP.

Inflow #2 is a 6" PVC pipe from the north **(Photo 2)**. It appears to be in good condition.

Inflow #3 is a grass ditch from the north that combines with Inflow #4 before entering the BMP and appears to be in good condition **(Photo 3 and 4).**

Inflow #4 is a grass channel mapped as a stream from the north **(Photo 5)**. At the time of the site visit, there was no water in the grass channel of Inflow #4 and appears to be in good condition**.**

Pretreatment:

This facility does not appear to have any forebays or pretreatment.

Control Structure and Spillways:

The control structure as determined in the field for this facility is a concrete weir with a low flow orifice **(Photo 6)**. The control structure was not accessible due to a fence surrounding the BMP. The low flow orifice appeared to be made of PVC rather than cast iron and was approximately half blocked with accumulated sediment and vegetation debris **(Photo 7)**. Erosion is present around the weir. The structure of the concrete weir appeared to be in good condition. Vegetation and trash were present in the concrete structure. There was also a large amount of vegetation debris at the principal spillway.

This BMP does not have an emergency spillway.

Embankment:

A cut embankment is present between the dry detention pond and principal outlet to the south of the pond **(Photo 8 and 9)**. Trees are growing on the downstream side of the embankment and there is a large amount of vegetation debris on the downstream side of the embankment that was visible from the north of the facility. The embankment was not accessible during the site visit due to a fence surrounding the BMP. Otherwise, the embankment appears to be in good condition.

Outflow:

The principal spillway of the BMP was not accessible during the site visit due to a fence surrounding the BMP and large amounts of vegetation debris **(Photo 6)**.

Overall BMP:

Accumulated sediment is present in Inflow #1. The other inflows appear to be in stable condition. The BMP basin has some trash and vegetation debris **(Photo 11)**. The low flow orifice is half blocked by debris and sediment and there is some erosion around the concrete weir. There are trees growing on the downstream side of the embankment. Moderate problems were observed, however, the BMP is functioning as designed with no critical parameters but with some problem conditions. BMP performance is being compromised.

Access, Right-of-Way, and Maintenance of Traffic (MOT):

The site can be accessed for maintenance and hauling material in and out of the site from a residential parking lot off of Revelation Avenue. According to the County's parcel layer in GIS, BMP #395 was constructed on open space and access to the BMP from Revelation Avenue is via open space. Easements at this location should be evaluated further in final design. Maintenance of traffic (MOT) will be required to notify residents who utilize Revelation Avenue.

Proposed Retrofit:

BMP #395 was originally designed as a dry pond. The most appropriate BMP retrofit options fall under the pond and wetland BMP groups (as listed in Table 3). Based on the results of the screening process described below, the proposed retrofit for BMP #395 is a micropool extended detention pond (P-1). The proposed retrofit will provide quantity and quality management for 19.06 acres including 6.16 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 2 feet below the existing BMP bottom elevation for extended detention as shown in the **Concept Plans**.

The proposed retrofit for this facility maintains use of the existing concrete weir and principal spillway to reduce impacts to the embankment. A riser structure is proposed on the northwest side of the facility adjacent to the forebay weir for Inflows #1 and #2. The proposed riser structure will connect to the existing concrete weir and principal spillway via an RCP and manhole to account for pipe deflection.

Additional Retrofit Opportunities:

The proposed retrofit for this facility maintains the BMP footprint within the open space parcel area. The area downstream of the BMP outfall appears to be active farm land. If an easement is acquired in the land owned by a private resident south of the existing BMP footprint, the size of the BMP footprint could be expanded. In addition, the access road configuration can be revised in final design to minimize tree impacts and avoid existing utilities or fences.

Step 1: Watershed Factors

BMP #395 is located in Frederick County's Israel Creek watershed which is located within the Lower Monocacy River 8-digit watershed (02140302). The Stream Use Designation for the downstream waterbody is Use IV-P. The BMP is not located within a Frederick County designated wellhead protection area. There are special watershed factors and/or constraints that must be considered for retrofit design for BMP #395 due to the downstream coldwater conditions. For the retrofit of BMP #395, 100% of the WQv can be treated by expanding the BMP footprint in nearby open space (with 33% stored in the permanent pool and 67% released over time by extended detention). The storage of this portion of the WQv in the permanent pool is to minimize stream warming in the downstream unnamed creek.

Step 2: Terrain Factors

BMP #395 is located in a region of Frederick County that is prone to karst geology per the Geology GIS layer provided by Frederick County. Therefore, there are special terrain factors and/or constraints that must be considered for retrofit design to BMP #395. Additional geotechnical investigation will be required during the final design and the proposed pond may need to be lined if karst geology is identified.

Step 3: Stormwater Treatment Suitability

The retrofit proposes the permanent pool elevation below the existing pond bottom (based on information available) to avoid major modifications to the fill embankment and maintain freeboard in the facility. The invert elevation of the existing outlet is unknown due to the unavailability of plans. There is adequate space for the proposed retrofit within the existing open space,

but increasing the BMP boundary is required. The concept design level calculations for the proposed retrofit are provided in Appendix E.

Step 4: Physical Feasibility Factors

The minimum drainage area requirement for a micropool extended detention pond is 10 acres. The proposed drainage area to BMP #395 is 19.06 acres and is composed of B soils. The likelihood of BMP #395 receiving hotspot runoff is low as it is located within a residential community. Hence, minimum separation from the water table is not required. The land use within the drainage area to the BMP is not ultra-urban.

Step 5: Community and Environmental Factors

BMP #395 is located south of Revelation Avenue and has moderate visibility. Micropool extended detention ponds tend to have medium maintenance requirements, medium community acceptance, low construction costs relative to the drainage area, and provide medium habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the retrofit of BMP #395 include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit
4) Joint Permit Application (JPA)/General Waterway Construction Permit (GWCP): It is anticipated that a JPA/GWCP may be required. Review of FEMA Flood Insurance Map FM24021C0303D indicates that the BMP is not within the FEMA 100-year flood plain. The Maryland Department of Natural Resources (DNR) wetland layer indicates that the BMP is not mapped as a wetland. Frederick County's Stream GIS layer indicates BMP #395 is an in-stream facility, which requires additional environmental factor and permitting consideration for final design.

Figure 1: BMP Location Map – Existing Conditions

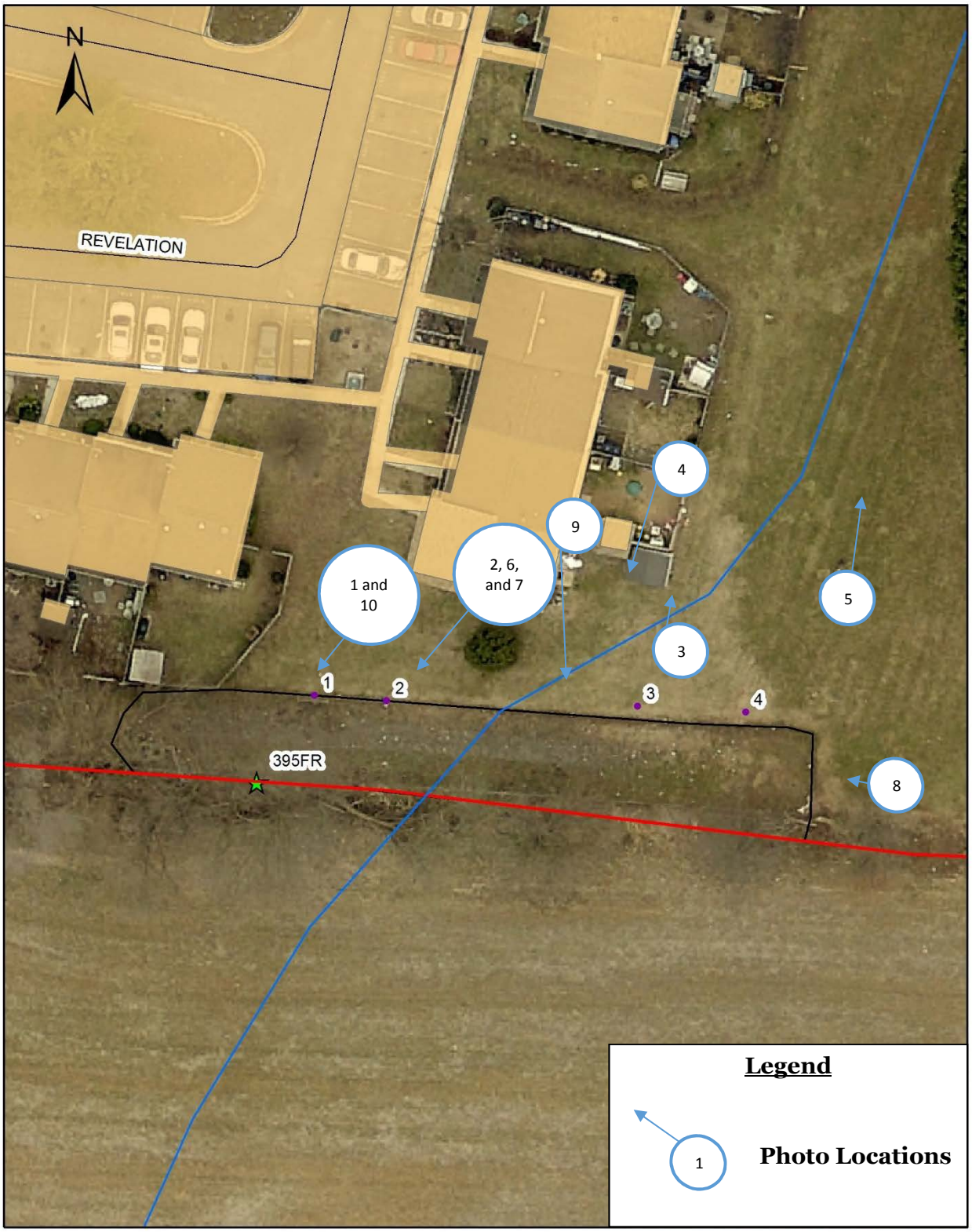


Figure 2: Photo Locations

Photo 1: Inflow #1 facing southwest

Photo 2: Inflow #2 facing west

Photo 3: Inflow #3 facing north

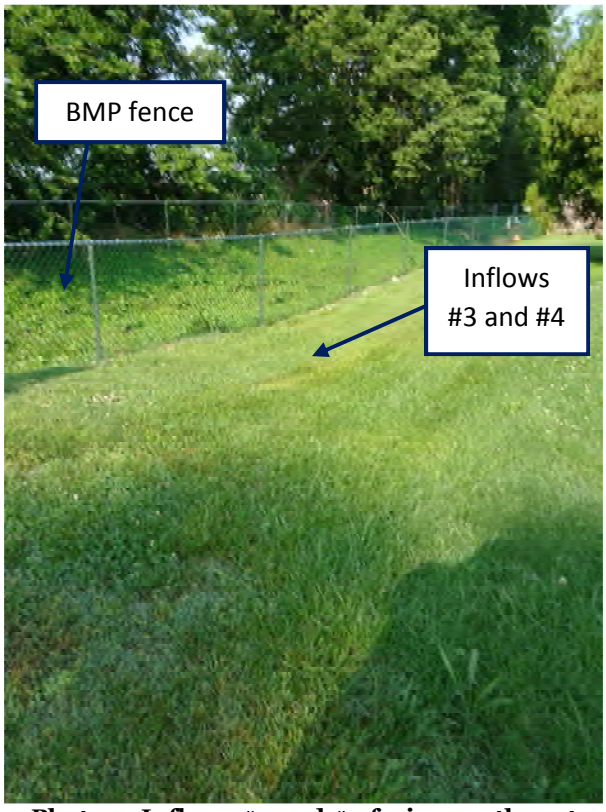


Photo 4: Inflows #3 and #4 facing southwest

Photo 5: Inflow #4 facing north

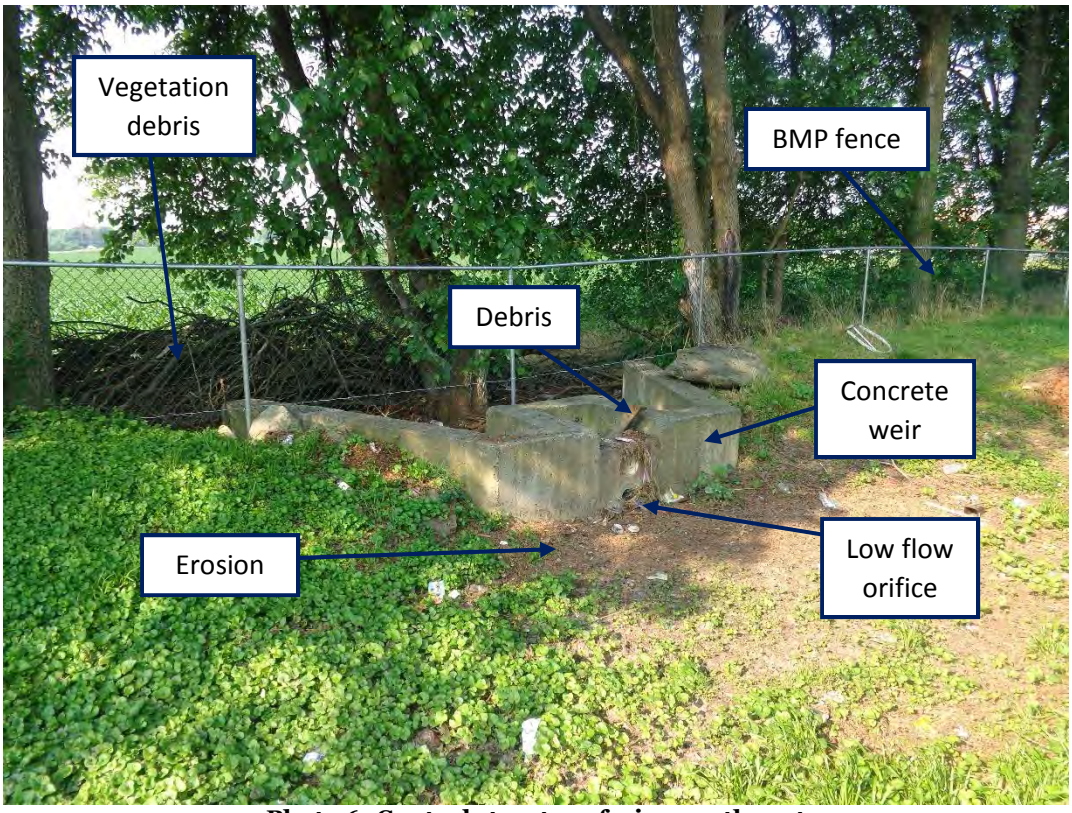


Photo 6: Control structure facing southwest

Photo 7: Low flow orifice facing southwest

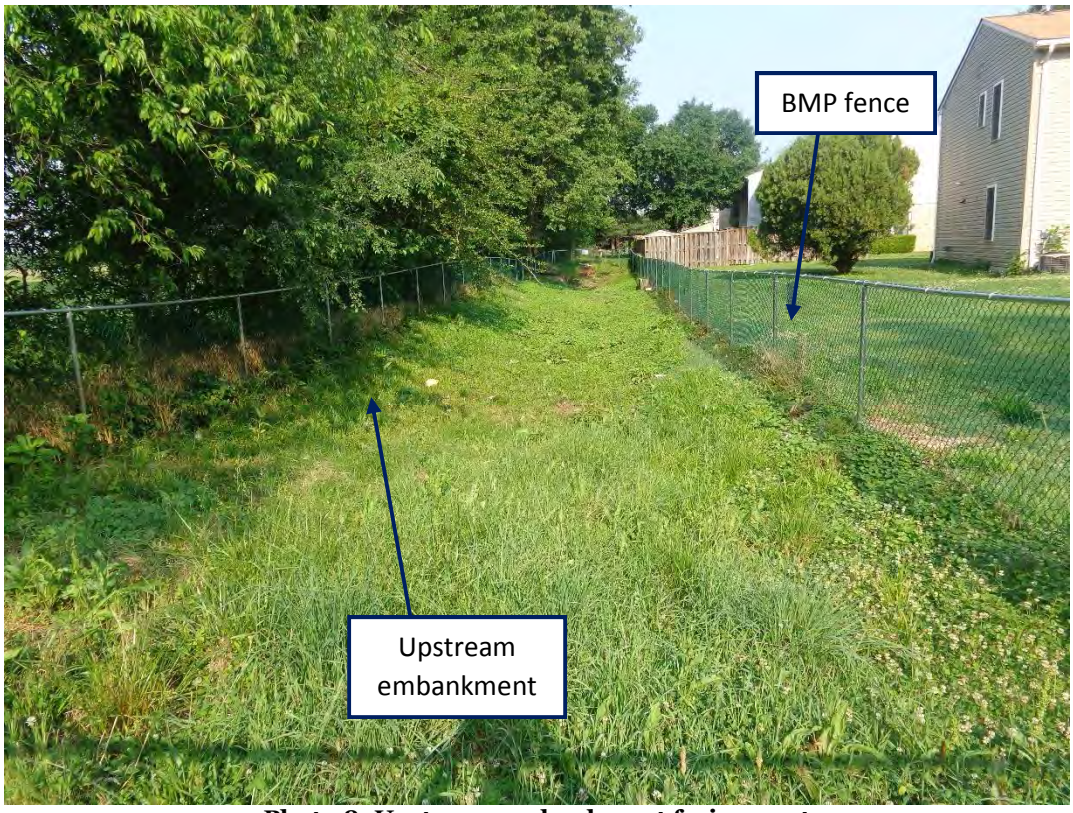


Photo 8: Upstream embankment facing west

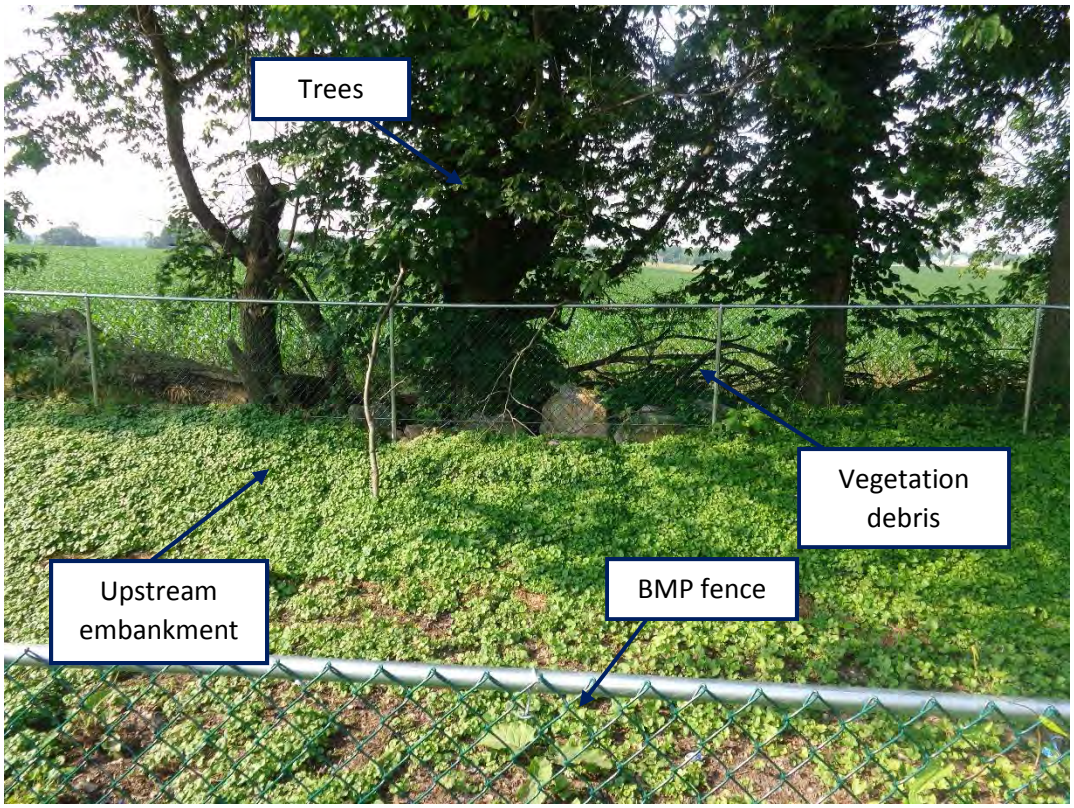


Photo 9: Embankment facing south

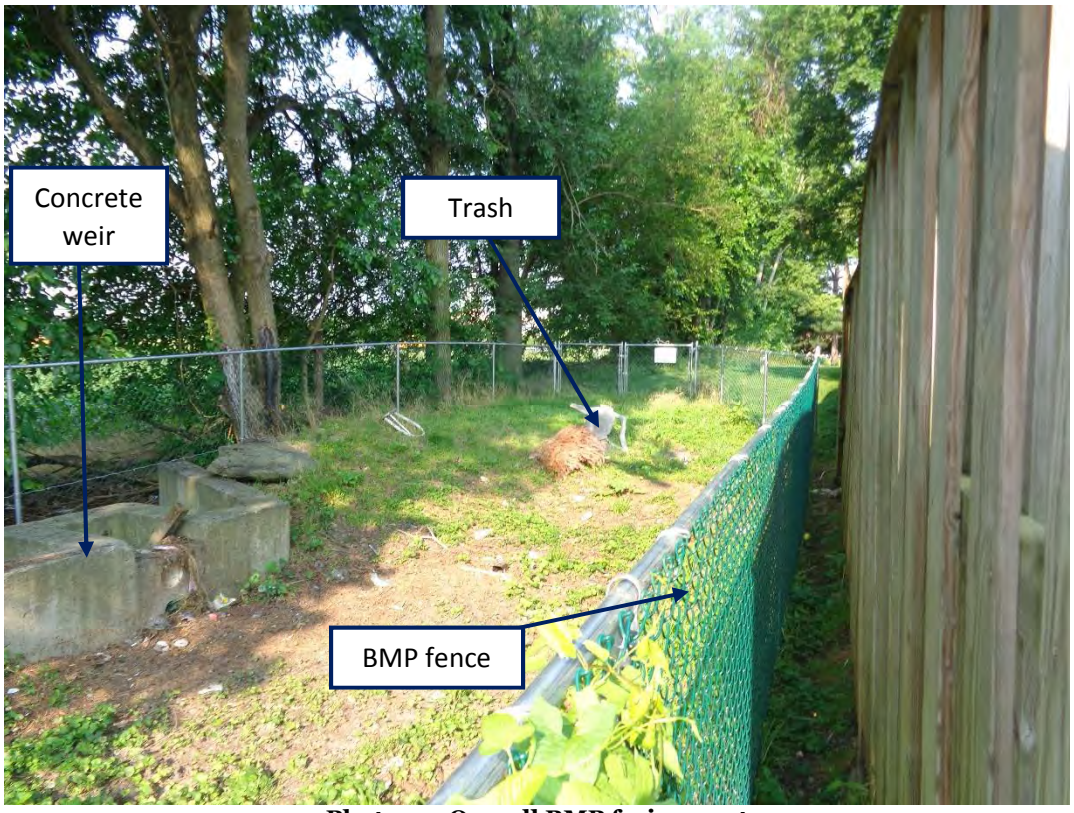
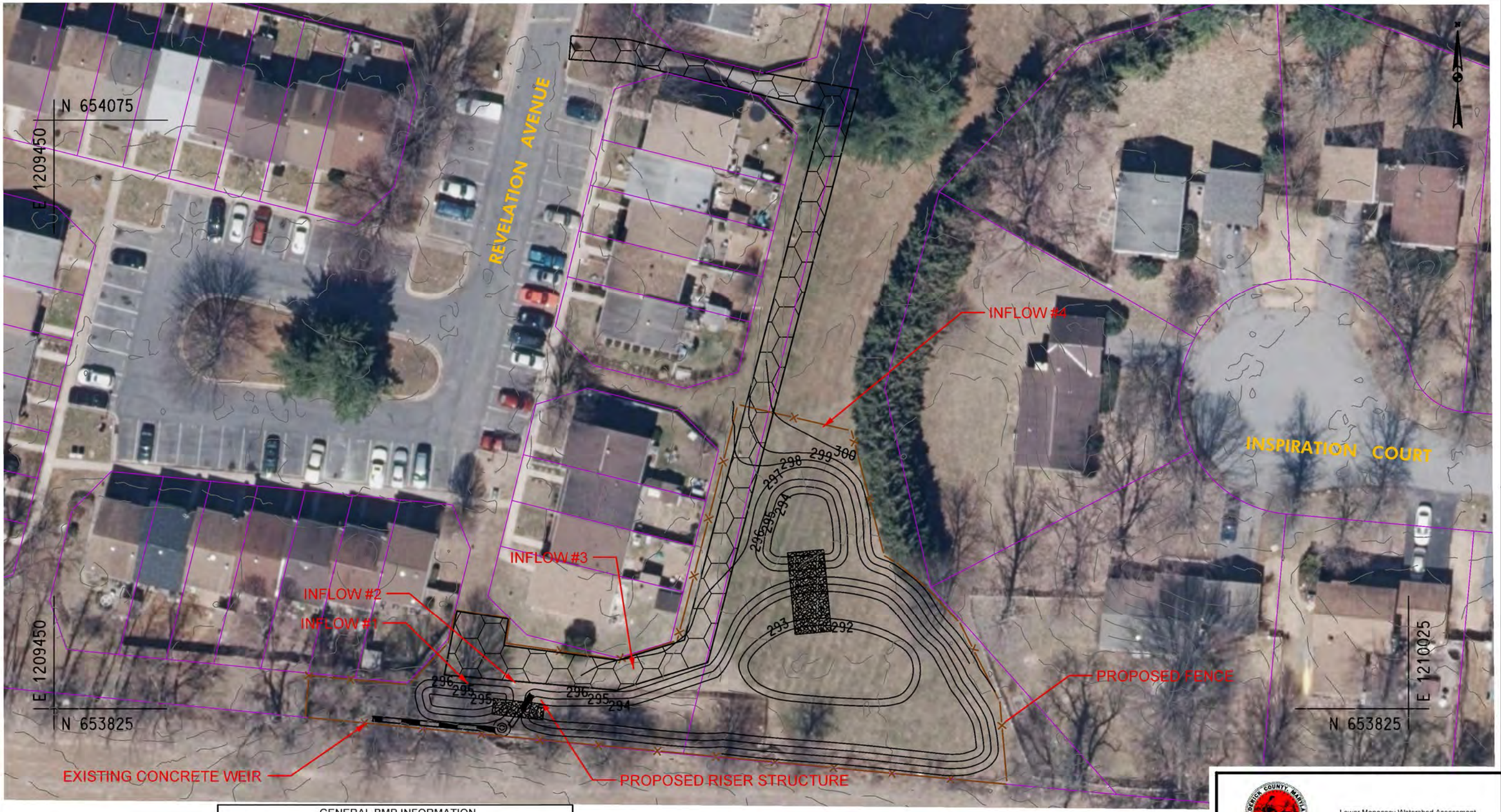


Photo 10: Overall BMP facing west



GENERAL BMP INFORMATION	
BMP TYPE:	MICROPOOL EXTENDED DETENTION (P-1)
MANAGEMENT TYPE:	QUALITY/QUANTITY
TOTAL DA (ACRES):	19.06
TOTAL IMPERVIOUS AREA (ACRES):	6.16
WQ_v REQUIRED (CU. FT):	23584
WQ_v REQUIRED (AC. FT):	0.541
WATER QUALITY TREATMENT PROVIDED	
WQ_v PROVIDED (CU. FT):	23584
TOTAL TREATED DA (ACRES):	19.06
TOTAL TREATED IMPERVIOUS AREA (ACRES):	6.16

LEGEND

PARCEL BOUNDARY

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

BMP #395 – DISCOVERY SUBDIVISION – REVELATION AVENUE FACILITY

SCALE 1" = 40' ADVERTISED DATE <AD DATE> CONTRACT NO.

DESIGNED BY NMD
DRAWN BY NMD
CHECKED BY RSK

COUNTY Frederick, MD
LOGMILE
HORIZONTAL SCALE
VERTICAL SCALE

DRAWING NO. OF SHEET NO. OF

PLOTTED: Thursday, June 22, 2017 AT 02:28 PM
FILE: Q:\60064072\60064076 - Lower Monocacy Watershed Assessment\CAD\Civil\Plan Sheets\pSW-P000_BMP395.dgn

BY: ndriskill -

WET EXTENDED DETENTION POND DESIGN (P-3): BMP 395

This spreadsheet is for **design level calculations** of Wet Pond

Sources for Regulations:

2000 MDE Stormwater Manual Volume I and II

MDE's Accounting Guidance, Accounting of Stormwater Wasteload Allocations, and Impervious Acres Treated (2014)

SWM BMP Retrofit Assessment

Requirement List

Step	Category	Required?	Notes
1	Water Quality Volume (WQv)	**Yes**	Pe=1.0 min
2	Recharge Volume (Rev)	**Yes**	Included in WQv
3	Quantity Management	**Yes**	Maintain Existing Quantity Management

Note: Blue cells in this sheet and "Flows", "Stage-Storage", and "BMP" sheets are user entries

Design Parameters:

Project:	**Lower Monocacy Watershed Assessment**	Engineer:	**NMD**
Location:	**Frederick County, MD**	Date:	**9/15/2015**
Watershed:	**Israel Creek**	As Built:	**7/1/1972**

Drainage Area: **19.06** Acres 0.030 square miles

(Total)

Select Stream Use Classification from drop dowm menu

Stream Use: IV

Measured Impervious Area: **6.16** Acres **I =** 0.323

= 32.3 %

Soil Type:

RCN Existing : **72** **Existing tc =** **0.13** hr

RCN Post Development : **72** **Post-D tc =** **0.13** hr

Per Frederick County's Urban BMP Database

Step 1: WQv Value

$$WQv = \frac{(P)(Rv)(A)}{12}$$

Step 1(a): Compute volumetric Runoff Coefficient(Rv)

Rv =0.05+(0.009)I= 0.341

Step 1(b): Rainfall Zone

Rainfall Zone: P = **1.0** inch (0.9" for Eastern Rainfall Zone, 1.0" for Western Rainfall zone)
1" per MDE's Accounting Guidance, Accounting of Stormwater Allocations, and Impervious Acres Treated (2014)

Step 1(c): Compute WQv

Water quality required for I = 32.3 %

$WQ_{V(I)}$ = 0.541 ac-ft = 23584 cu.ft

Minimum water quality required 0.2 inches per acre of the drainage area,

$WQ_{V(Min)}$ = 0.318 ac-ft = 13837.56 cu.ft

Water quality treatment required =	**23584**	**cu.ft =**	**0.5414**	ac-ft	
WQv provided by other practices =	**0**	**cu.ft =**	**0.0000**	ac-ft	
Net water quality treatment required =	**23584**	**cu.ft =**	**0.5414**	ac-ft	
Sediment Forebay Volume Required=	**2358**	**cu.ft =**	**0.0541**	ac-ft	Forebay Volume =
WQv in pond =	**21226**	**cu.ft =**	**0.4873**	ac-ft	
Elevation at the Top of WQv in pond =	**295.98**	**ft**			

Forebay storage counts toward total WQv requirement.

The Stream Use Classification was used to set WQ_V distribution in forebay, micropool and active storage

Use Classification	Portion of WQv*	WQV in micropool
I	50% of WQv is in micropool	11792
II	50% of WQv is in micropool	11792
III	1/3 of WQv is in micropool & forebay	5503
IV	1/3 of WQv is in micropool & forebay	5503

***source: SHA SWM Workshop, April 30, 2003**

For this case: Use Classification= IV 1/3 of WQv isin micropool & forebay

Micropool storage volume required = **5503** **cu.ft =** **0.1263** **ac-ft**

Extended Detention Storage= **5503** cu.ft = Dead Storage Volume cu.ft
Extended Detention Elevation= **293.87** ft = Dead Storage El = orifice El. From El-Storage

Step 1(d): Water quality release rate

Minimum WQv release time should be **24** -hr drawdown for the portion of WQv in pond above orifice
Hence, WQrr = **0.06** cfs WQrr = Micropool Storage Volume required/24hrs/3600sec/hr

With WQv, determine the required orifice area (Ao) for extended detention design:

$$A_o = \frac{WQrr}{4.81\sqrt{h_o}}$$

Assume h_o = **2.11** ft *Will change based on pond volume

Ao = 0.01 sf

Determine the required orifice diameter (d_o)

$$D_o = \sqrt{\frac{4\ A_o}{}}$$

Do = 0.11 ft = **1.3** inches.

Step 2: Compute Recharge Volume (Rev)

$$\mathrm{Re}\ \boldsymbol{v} = \frac{(\boldsymbol{S})(\boldsymbol{Rv})(\boldsymbol{A})}{12}$$

Step 2(a): Determine Soil Specific Recharge Factor (S) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (s)
A	0.38
B	0.26
C	0.13
D	0.07

HSG	Drainage Area (Acres)	Percentage (%)
A	**0.00**	0
B	**19.06**	100
C	**0.00**	0
D	**0.00**	0
Total	**19.06**	OK: sum of the areas matches site Area

Composite S: 0.2600 Use 26.00 of site imperviousness

Step 2(b): Compute Rev Using Percent Volume Method

Rev = [(S)(Rv)(A)]/12 = 0.141 ac-ft = **6132** cu.ft

Rev in Pond= **3773**

El of Rev= **293.46** ft from El-storage

Step 2(c): Compute Rev Using Percent Area Method

Rev = (S)(Ai) = **1.602** Acres = 69765 sf

The Rev requirement may be met by:

a) treating 0.141 ac-ft using structural method,

b) treating 1.602 acres using non-structural methods, or

c) a combination of both or it is part of WQv volume if not treated separately.

Project:	Lower Monocacy Watershed Assessment	Engineer:	NMD
Location:	Frederick County, MD	Date:	9/15/2015
Watershed:	Israel Creek		

STAGE-STORAGE CALCULATIONS

V = h/3 * [A1 + A2 + SQRT(A1*A2)]

Area (sq.ft)	Elevation (ft)	Area (acres)	Incr. Depth (ft)	Inc. Volume (acre-ft)	TOTAL VOLUME (acre-ft)	(cu.ft)
1472.0	**292.0**	0.03	0.00	0.00	0.00	0.00
2298.0	**293.0**	0.05	1.00	0.04	0.04	1869.73
6412.0	**294.0**	0.15	1.00	0.10	0.14	6052.60
7734.0	**295.0**	0.18	1.00	0.16	0.30	13115.28
8874.0	**296.0**	0.20	1.00	0.19	0.49	21412.75
		0.00				

No. of valid row entries= 5

BMP #353 - 84 LUMBER COMPANY

Prioritization Ranking:	44
Planning Level Cost Estimate:	$ 487,047.00
Estimated Cost/Impervious Acre	$ 110,750.45

General BMP Information:		
Structure Location:	4484 Quad County Court	
ADC Map:	4690, C3 (2008)	
Northing/Easting:	615666.28/1,263,504.90	
NPDES Watershed:	Upper Bush Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Micropool Extended Detention (P-1)	
Management Type:	Quality/Quantity	
Total Drainage Area (ac):	8.11	
Total Impervious Area (ac):	4.62	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	16565	
Total Treated Drainage Area (ac):	8.11	
Total Treated Impervious Area (ac):	4.62	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	71.00	46.08
TP (lbs/yr):	8.38	3.93
TSS (lbs/yr):	4498.18	2914.34

Existing conditions for BMP #353

Site map for BMP #353

EXISTING SITE CONDITIONS

According to Frederick County's Urban BMP Database, BMP #353 has been identified as an extended detention dry pond. The facility was constructed north of Mill Bottom Road and west of Quad County Court. The BMP Database from the County indicates that the original design for BMP #353 provides management for quantity and quality and that the total treatment area for the BMP is 16.18 acres. However, the drainage area as digitized in GIS, using the contours created from Digital Elevation Models (DEM) provided by the County, show the BMP is treating 17.76 acres. The majority of land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out from a grass road accessible from Quad County Court. According to the County's parcel layer in GIS, BMP #353 was constructed on private property. Maintenance of traffic (MOT) will be required to notify owners of the property. Easements must be evaluated at this site.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There are five BMPs proposed at this site: one retrofit and four new BMPs. The proposed retrofit for BMP #353 is a micropool extended detention pond (P-1). The proposed retrofit will provide quantity and quality management for 8.11 acres including 4.62 acres of impervious area. The concept retrofit plan proposes providing permanent storage by excavating approximately 4 feet below the existing BMP bottom to provide extended detention as shown in the Concept Plans. The Project Summary Sheets for BMPs A, B, C, and D are included separately in Appendix E with a prioritization ranking of 34, 19, 38, and 33 respectively.

Steamboat Way Subdivision - BMP B

Prioritization Ranking:	45
Planning Level Cost Estimate:	$ 177,193.50
Estimated Cost/Impervious Acre	$ 110,177.18

General BMP Information:		
Structure Location:	Northwest corner of Steamboat Way	
ADC Map:	4568, C6 (2008)	
Northing/Easting:	633,759.013/1,229,176.912	
NPDES Watershed:	Lower Linganore Creek	
MDE 8 Digit Watershed:	Lower Monocacy River (02140302)	
Proposed BMP Retrofit General Information:		
BMP Type:	Regenerative Step Pool Conveyance	
Management Type:	Quantity/Quality	
Total Drainage Area (ac):	3.63	
Total Impervious Area (ac):	1.77	
Water Quality Treatment Provided:		
WQv Provided (cu.ft.):	6441	
Total Treated Drainage Area (ac):	3.63	
Total Treated Impervious Area (ac):	1.77	
Estimated Nutrient Reductions:	**EOS**	**DEL**
TN (lbs/yr):	53.00	19.39
TP (lbs/yr):	4.31	2.02
TSS (lbs/yr):	2933.30	1900.46

Existing conditions for Steamboat Way Subdivision - BMP B

Site map for Steamboat Way Subdivision - BMP B

EXISTING SITE CONDITIONS

The subdivisions at Illinois Court and Steamboat Way were investigated during site visits to identify opportunities to treat untreated impervious area. The drainage area for BMP B, as digitized in GIS using the contours created from Digital Elevation Models (DEM) provided by the County, shows the BMP is treating 3.63 acres. The drainage area is shown in the location map above. The land use is residential.

ANTICIPATED SITE CONSTRAINTS

The site can be accessed for maintenance and hauling material in and out of the site from Steamboat Way. There are no other obvious site constraints such as utilities or steep slopes. Maintenance of traffic (MOT) is required for this BMP.

Required Permitting	
Frederick County SWM Review:	X
Erosion and Sediment Control (ESC):	X
Grading Permit:	X
Joint Permit Application (JPA)/General Waterway Construction Permit:	
Other: MOT, Acquisition of Easements, Tree Impacts	

PROPOSED RETROFIT

There is no existing SWM at this location. The most appropriate BMP options for untreated impervious area are step pool conveyances below each of the storm drain outfalls in the subdivisions. Proposed BMP B will include three 8' cascades and three 10' cobble riffles. Two step pool conveyances are proposed at this location (BMPs A and B). BMP B will provide quality management for 3.63 acres including 1.77 acres of impervious area. The Project Summary Sheet, Assessment and Concept Plan for BMP A is included separately in Appendix E with a prioritization ranking of 37.

CLOVER HILL SUBDIVISION

Proposed BMP Practice Type:	Grass Swale
Watershed:	Carroll Creek
Description of Site Location:	East of Cloverhill Drive and West of Runnymeade Drive (ADC Grid 4448- B8)
Land Use:	Residential
Inspection Date:	10/8/2015
Inspection Team:	ND, VH
Last Significant Rainfall Date:	10/4/2015 (0.25")
Rainfall Source:	www.theweathercollector.com
Station:	US1MDFR0003

Existing Site Conditions:

The Clover Hill subdivision was investigated during site visits to identify opportunities to treat untreated impervious area. The residential area is shown in the location map below (**Figure 1**).

General Observations:

A site visit was conducted on October 8th, 2015. **Figure 2** shows the location of photos taken during the visit.

The impervious area from Cloverhill Drive, Sunnybrook Drive, Sunnybrook Court, Edgewood Farm Road, Vista Drive, and Runnymeade Drive drains into existing roadside grass ditches. They were all well-maintained and in good condition (**Photos 1-5**).

Access, Right-of-Way, and MOT:

The site can be accessed for maintenance and hauling material in and out of the site from each of the aforementioned roads. According to the County's parcel layer in GIS, there is approximately 12' - 15' of public right-of-way (ROW) from the edge of the road to private property throughout the development. MOT will be required to notify residents of the Clover Hill subdivision.

Proposed Retrofit:

The study area boundary based on parcels of the neighborhood is 66.82 acres, including 12.43 acres of impervious area. There are no existing stormwater management facilities in this development. 6 locations have been identified as potential retrofit opportunities in this area. Additional investigation is required to determine the amount of impervious area that can be treated within this site study area.

Based on the results of the screening process described below, the proposed BMPs throughout the Clover Hill subdivision within the area boundary are a series of grass swales (M-8) to be constructed within the roadside ditches along Cloverhill Drive, Sunnybrook Drive, Sunnybrook Court, Edgewood Farm Road, Vista Drive, and Runnymeade Drive. Drainage areas to each proposed swale should be developed during final design. The proposed retrofit should be constructed to achieve a maximum 4% longitudinal slope with the use of grading and check dams.

We also propose the County to encourage homeowners to install simple BMPs such as rooftop disconnection, rain barrels, and rain gardens through public outreach.

Step 1: Watershed Factors

The Clover Hill subdivision is located in Frederick County's Carroll Creek watershed which is located within the Lower Monocacy 8-digit watershed (02140302). The Stream Use Designation for the downstream unnamed branches is Use III-P. The development is not located within a Frederick County designated wellhead protection area. Since open channels are acceptable practices in cold water streams, there are no special watershed factors and/or constraints that must be considered for grass swale designs within these developments.

Step 2: Terrain Factors

The Clover Hill subdivision is not located in a region of Frederick County that is prone to karst geology. Therefore, there are no special terrain factors and/or constraints that must be considered for design for these developments.

Step 3: Stormwater Treatment Suitability

Based on the GIS desktop analysis it appears the site is suitable for grass swales. There is adequate space along both sides of Cloverhill Drive, Sunnybrook Drive, Sunnybrook Court, Edgewood Farm Road, Vista Drive, and Runnymeade Drive and the existing longitudinal slope based on contours is acceptable for installing the proposed grass swales. The grass swales should be designed to meet the latest MDE grass swale criteria to provide treatment for the full 1" of rainfall (Pe). There are no safety concerns associated with the use of grass swales.

Step 4: Physical Feasibility Factors

The maximum drainage area for a grass swale is 1 acre. The development is composed of B soils. The likelihood of BMPs receiving hotspot runoff is low as it is located within a residential community. The land use within the drainage area to the BMP is not ultra-urban. Installing grass swales at this site is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

Grass swales have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide little habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the design of BMPs at the Clover Hill subdivision include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

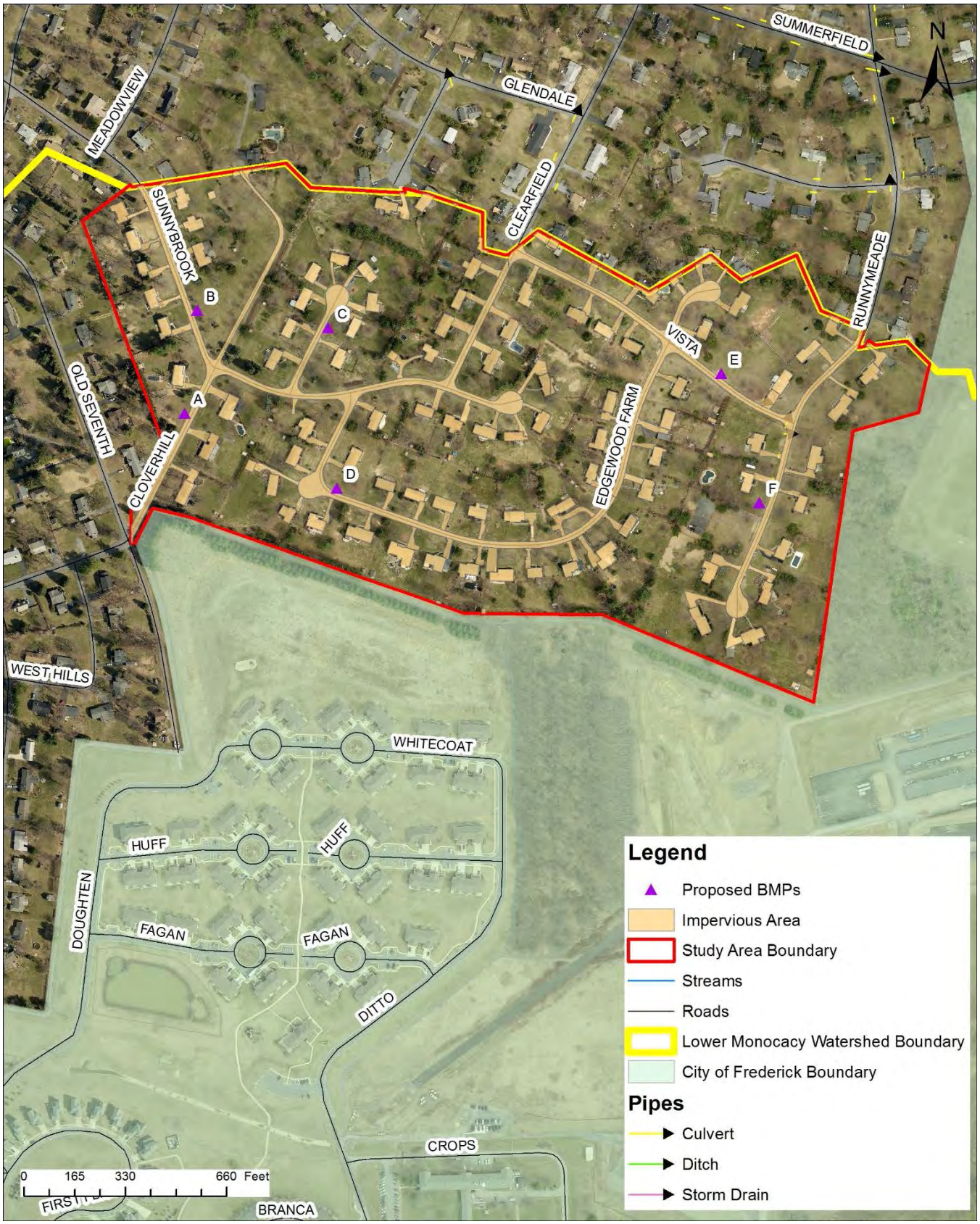


Figure 1: BMP Location Map – Existing Conditions

Figure 2: Photo Locations

Photo 1: Cloverhill Drive facing northeast

Photo 2: Sunnybrook Drive facing southeast

Photo 3: Sunnybrook Court facing northeast

Photo 4: Edgewood Farm Road facing east

Photo 5: Vista Drive facing northwest

Photo 6: Runnymeade Drive facing north

LEGEND

PARCEL BOUNDARY

LOWER MONOCACY WATERSHED BOUNDARY

CITY OF FREDERICK BOUNDARY

GRASS SWALE

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

CLOVER HILL SUBDIVISION

SCALE 1" = 200' ADVERTISED DATE _____ CONTRACT NO. _____

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SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410.265.9500
FAX: 410.265.8875

BY: ndnskill -

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MEADOWBROOK SUBDIVISION

Proposed BMP Practice Type:	Grass Swale
Watershed:	Bennett Creek
Description of Site Location:	East of Mockingbird Drive and West of Browningsville Road (ADC Grid 4688- G8, H8, & H9)
Land Use:	Residential
Inspection Date:	6/23/2015
Inspection Team:	ND, GL
Last Significant Rainfall Date:	6/20/2015 (1.41")
Rainfall Source:	www.wunderground.com
Station:	KMDNEWMA2

Existing Site Conditions:

The Meadowbrook subdivision was investigated during site visits to identify opportunities to treat untreated impervious area. The residential area is shown in the location map below (**Figure 1**).

General Observations:

The site visit was conducted on June 23rd, 2015. **Figure 2** shows the location of photos taken during the visit.

The impervious area from Mockingbird Court, Hummingbird Court, Canary Drive, Meadowlark Drive, Cardinal Lane, Pheasant Run, and Warbler Lane drain into existing roadside grass ditches. They are well-maintained and in good condition (**Photos 1-7**).

Access, Right-of-Way, and MOT:

The site can be accessed for maintenance and hauling material in and out of the site from Mockingbird Court, Hummingbird Court, Canary Drive, Meadowlark Drive, Cardinal Lane, Pheasant Run, and Warbler Lane. According to the County's parcel layer in GIS, there is approximately 12' - 15' of public right-of-way (ROW) from the edge of the road to private property throughout the development. The two culverts located south of the intersection of Pheasant Run and Warbler Lane outfall onto private property. MOT will be required to notify residents of the Meadowbrook subdivision.

Proposed Retrofit:

The study area boundary based on parcels of the neighborhood is 67.77 acres, including 9.61 acres of impervious area. There are no existing stormwater management facilities in this development. 7 locations have been identified as potential retrofit opportunities in this area. Additional investigation is required to determine the amount of impervious area that can be treated within this site study area.

Based on the results of the screening process described below, five of the proposed BMPs throughout the Meadowbrook subdivision are a series of grass swales (M-8) to be constructed within the roadside ditches along Mockingbird Court, Hummingbird Court, Canary Drive, Meadowlark Drive, Cardinal Lane, Pheasant Run, and Warbler Lane. Drainage areas to each proposed swale should be developed during final design. The proposed retrofit should be constructed to achieve a maximum 4% longitudinal slope with the use of grading and check dams.

Alternate options at this location include installing regenerative step pool conveyances at the two storm drain outfalls located south of the intersection of Pheasant Run and Warbler Lane (**Photos 8-11**). We also propose the County to encourage homeowners to install simple BMPs such as rooftop disconnection, rain barrels, and rain gardens through public outreach. The CMP pipes at the proposed regenerative step pool conveyances should be replaced.

Step 1: Watershed Factors

The Meadowbrook subdivision is located in Frederick County's Bennett Creek watershed which is located within the Lower Monocacy 8-digit watershed (02140302). The Stream Use Designation for the downstream unnamed branches is Use IV-P. Mockingbird Court and Canary Drive are located within a Frederick County designated wellhead protection area. Since open channels are acceptable practices in cold water streams and wellhead protection areas as long as hot spot runoff is adequately pretreated, there are no special watershed factors and/or constraints that must be considered for grass swale designs within these developments.

Step 2: Terrain Factors

The Meadowbrook subdivision is not located in a region of Frederick County that is prone to karst geology. Therefore, there are no special terrain factors and/or constraints that must be considered for design for this area.

Step 3: Stormwater Treatment Suitability

Based on the GIS desktop analysis it appears the site is suitable for grass swales. There is adequate space along Mockingbird Court, Hummingbird Court, Canary Drive, Meadowlark Drive, Cardinal Lane, Pheasant Run, and Warbler Lane and the existing longitudinal slope based on contours is acceptable for installing the proposed grass swales. The grass swales should be designed to meet the latest MDE grass swale criteria to provide treatment for the full 1" of rainfall (Pe). There are no safety concerns associated with the use of grass swales.

Step 4: Physical Feasibility Factors

The maximum drainage area for a grass swale is 1 acre. The development is composed of B, C, and D soils. The likelihood of BMPs receiving hotspot runoff is low as it is located within a residential community. The land use within the drainage area to the BMP is not ultra-urban. Proposing a series of grass swales for untreated impervious area is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

Grass swales have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide little habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the design of BMPs at Meadowbrook development include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

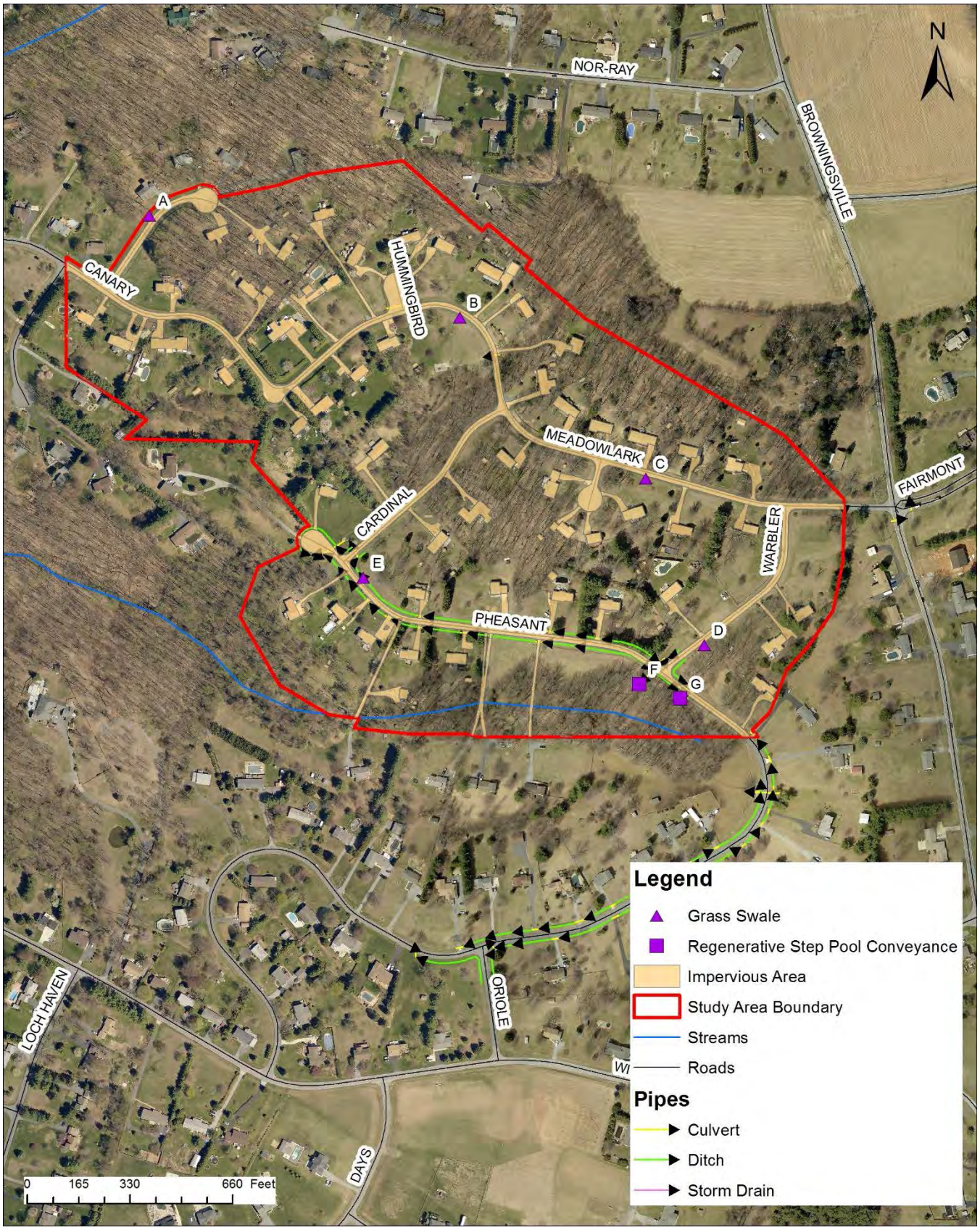

Figure 1: BMP Location Map – Existing Conditions

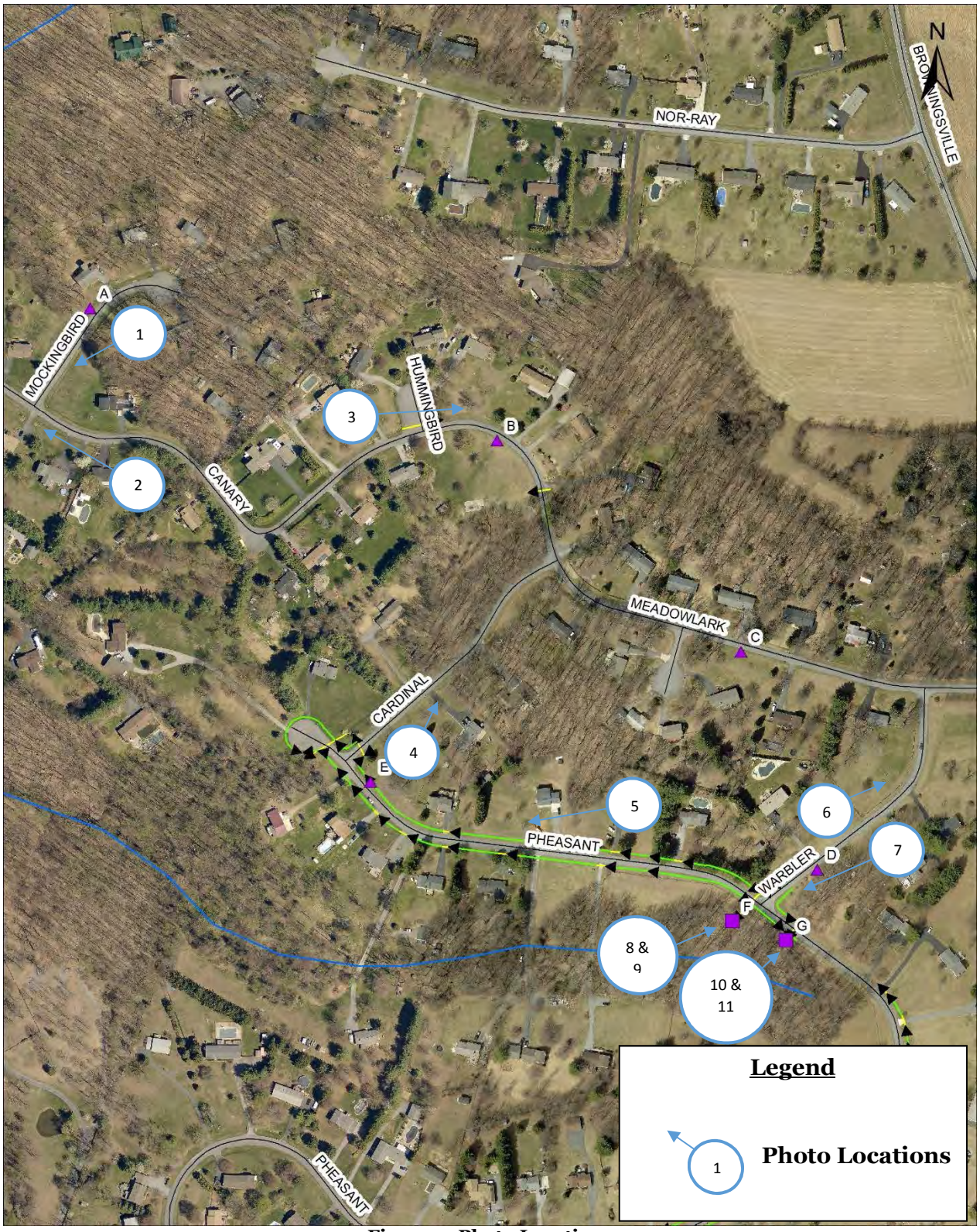

Figure 2: Photo Locations

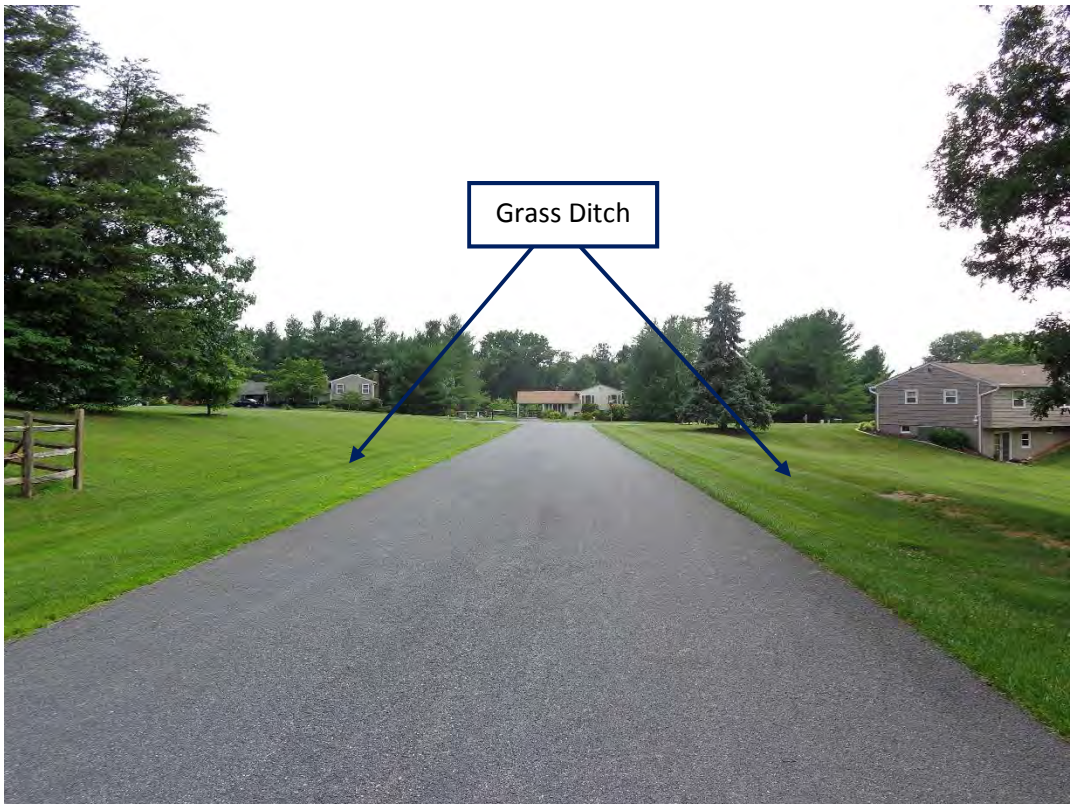

Photo 1: Mockingbird Court facing southwest

Photo 2: Canary Drive facing northwest

Photo 3: Meadowlark Drive facing east

Photo 4: Cardinal Lane facing northeast

Photo 5: Pheasant Run facing west

Photo 6: Warbler Lane facing northeast

Photo 7: Warbler Lane facing southwest

Photo 8: CMP culvert outfall facing northwest

Photo 9: Downstream CMP culvert outfall facing southwest

Photo 10: CMP culvert outfall facing northwest

Photo 11: Downstream CMP culvert outfall facing southwest

LEGEND

- PARCEL BOUNDARY
- PROPOSED CMP REPLACEMENTS
- GRASS SWALE
- STEP POOL CONVEYANCE

Dewberry®
Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
OWINGS MILLS, MARYLAND 21117
PHONE: 410 265 9500
FAX: 410 265 8875

BY: ndriskill -

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability and Environmental Resources
Frederick, MD 21701

MEADOWBROOK SUBDIVISION

SCALE 1" = 200' ADVERTISED DATE _____ CONTRACT NO. _____

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MOLESWORTH HILLS SUBDIVISION

Proposed BMP Practice Type:	Grass Swale
Watershed:	Upper Bush Creek
Description of Site Location:	South of West Oak Drive and East of Bartholows Road (ADC Grid 4689, E3, E4, F4)
Land Use:	Residential
Inspection Date:	6/23/2015
Inspection Team:	ND, GL
Last Significant Rainfall Date:	6/20/2015 (1.41")
Rainfall Source:	www.wunderground.com
Station:	KMDNEWMA2

Existing Site Conditions:

The Molesworth Hills subdivision was investigated during site visits to identify opportunities to treat untreated impervious area. The residential area is shown in the location map below (**Figure 1**).

General Observations:

A site visit was conducted on June 23rd, 2015. **Figure 2** shows the location of photos taken during the visit.

The impervious area from Moxton Drive, Adam Court, Moleston Drive, Roughton Drive, Molesworth Terrace, Davis Court, Molesworth Drive, and Moxley Crest Drive drains into existing roadside grass ditches. They were all well-maintained and in good condition (**Photos 1-5**).

Access, Right-of-Way, and MOT:

The site can be accessed for maintenance and hauling material in and out of the site from Moxton Drive, Adam Court, Moleston Drive, Roughton Drive, Molesworth Terrace, Davis Court, Molesworth Drive, and Moxley Crest Drive. According to the County's parcel layer in GIS, there is approximately 12' - 15' of public right-of-way (ROW) from the edge of the road to private property throughout the development. MOT will be required to notify residents of the Molesworth Hills subdivision.

Proposed Retrofit:

The study area boundary based on parcels of the neighborhood is 138.95 acres, including 19.35 acres of impervious area. There are no existing stormwater management facilities in this development. 8 locations have been identified as potential retrofit opportunities in this area. Additional investigation is required to determine the amount of impervious area that can be treated within this site study area.

Based on the results of the screening process described below, the proposed BMPs throughout Molesworth Hills are a series of grass swales (M-8) within the roadside ditch along Moxton Drive, Adam Court, Moleston Drive, Roughton Drive, Molesworth Terrace, Davis Court, Molesworth Drive, and Moxley Crest Drive. Drainage areas to each proposed swale should be developed during final design. The proposed retrofit should be constructed to achieve a maximum 4% longitudinal slope with the use of grading and check dams.

Alternate options at this location include installing a regenerative step pool conveyance below the culvert outfall located south of Moxton Drive (**Photos 6-8**) to stabilize the erosion at the outfall. We also propose the County to encourage homeowners to install simple BMPs such as rooftop disconnection, rain barrels, and rain gardens through public outreach.

Step 1: Watershed Factors

Molesworth Hills is located in Frederick County's Upper Bush Creek watershed which is located within the Lower Monocacy 8-digit watershed (02140302). The Stream Use Designation for the downstream unnamed branches is Use IV-P. The

development is not located within a Frederick County designated wellhead protection area. There are no special watershed factors and/or constraints that must be considered for retrofit design for the proposed BMPs.

Step 2: Terrain Factors

Molesworth Hills is not located in a region of Frederick County that is prone to karst geology. Therefore, there are no special terrain factors and/or constraints that must be considered for design for this development.

Step 3: Stormwater Treatment Suitability

Based on the GIS desktop analysis it appears the site is suitable for grass swales. There is adequate space along both sides of Moxton Drive, Adam Court, Moleston Drive, Roughton Drive, Molesworth Terrace, Davis Court, Molesworth Drive, and Moxley Crest Drive and the existing longitudinal slope based on contours is acceptable for installing the proposed grass swales. The grass swales should be designed to meet the latest MDE grass swale criteria to provide treatment for the full 1" of rainfall (Pe). There are no safety concerns associated with the use of grass swales.

Step 4: Physical Feasibility Factors

The maximum drainage area for a grass swale is 1 acre. The development is composed of B, and C soils. The likelihood of BMPs receiving hotspot runoff is low as it is located within a residential community. The land use within the drainage area to the BMP is not ultra-urban. Installing grass swales at this site is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

Grass swales have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide little habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the design of BMPs at Molesworth Hills include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

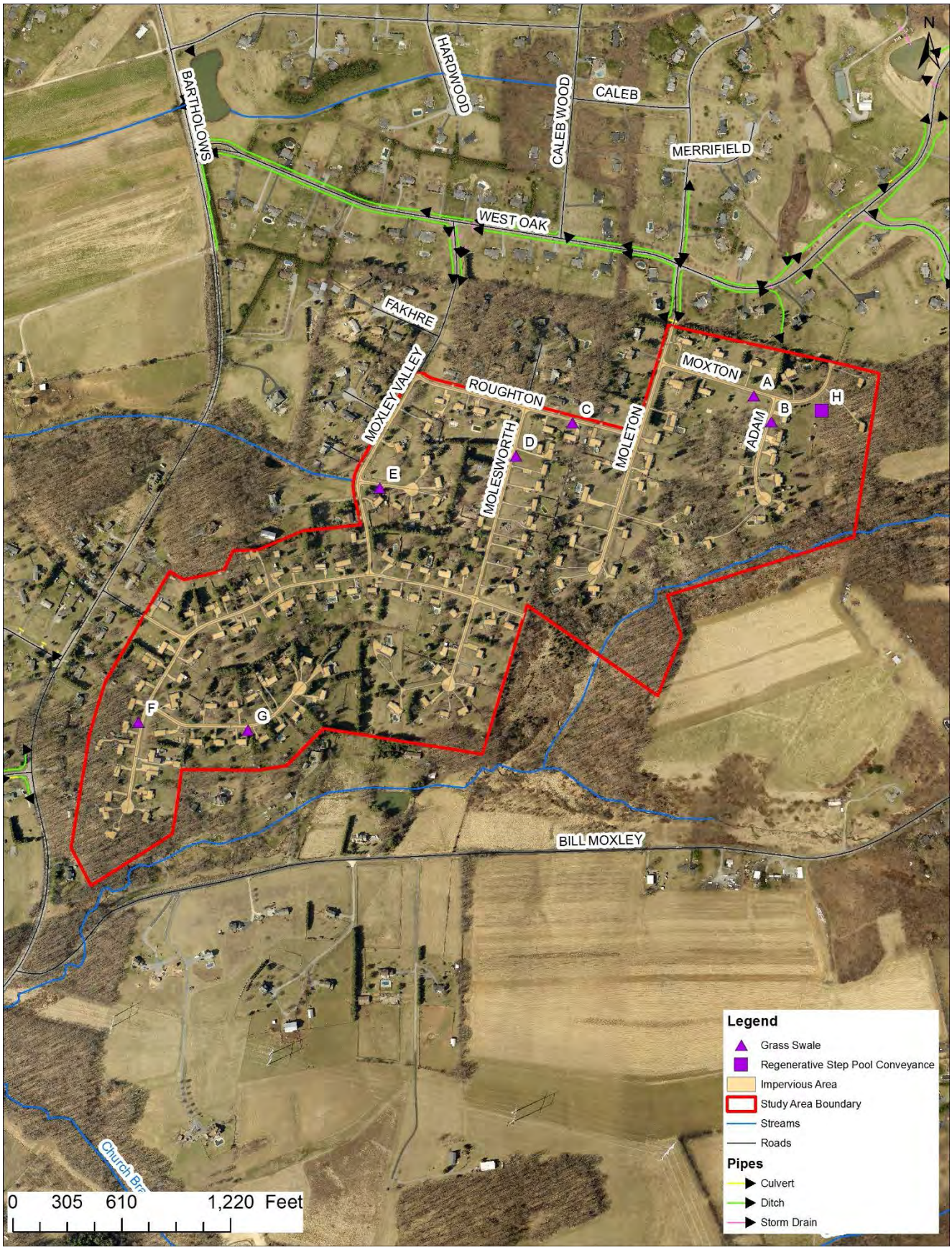


Figure 1: BMP Location Map – Existing Conditions

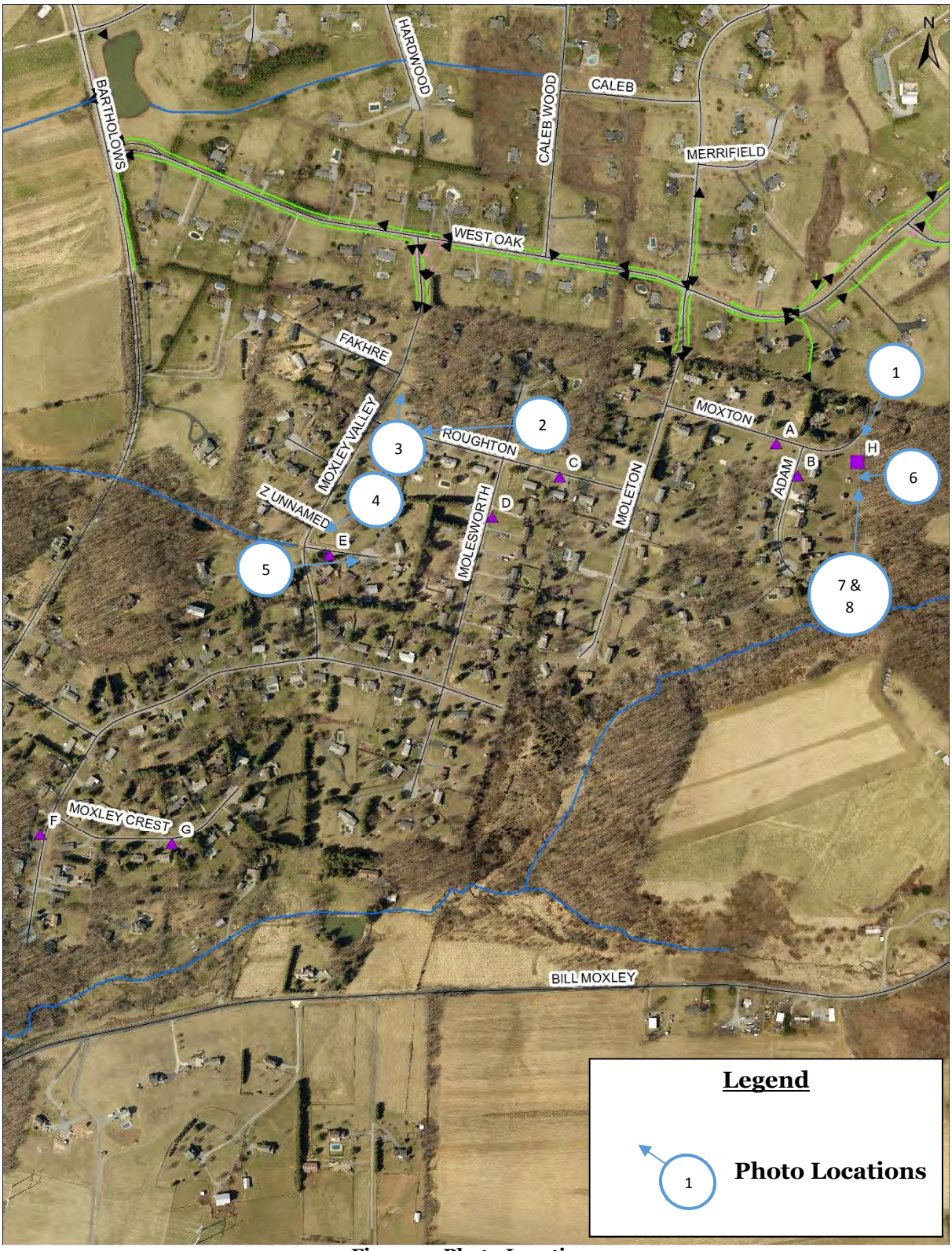


Figure 2: Photo Locations

Photo 1: Moxton Drive facing south

Photo 2: Roughton Drive facing west

Photo 3: Moxley Valley Drive facing northeast

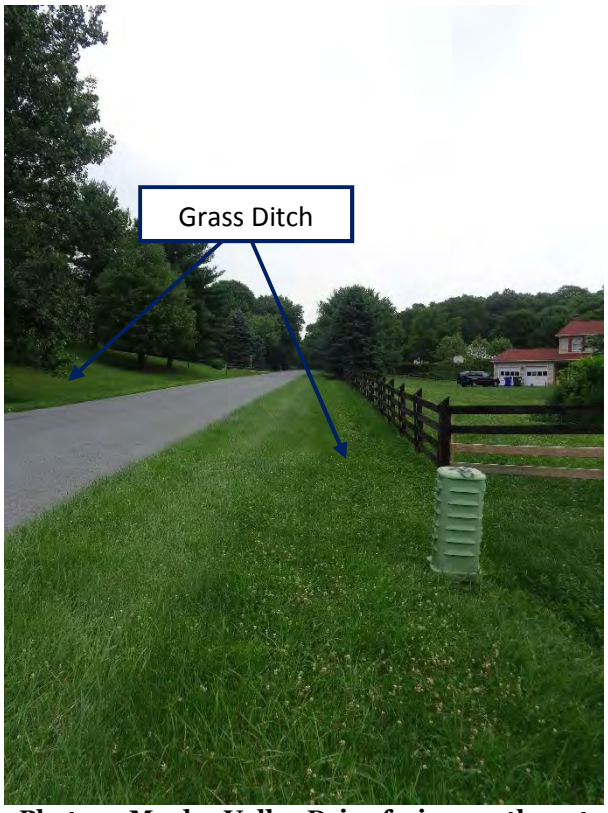


Photo 4: Moxley Valley Drive facing southwest

Photo 5: Davis Court facing east

Photo 6: Cross culvert facing north

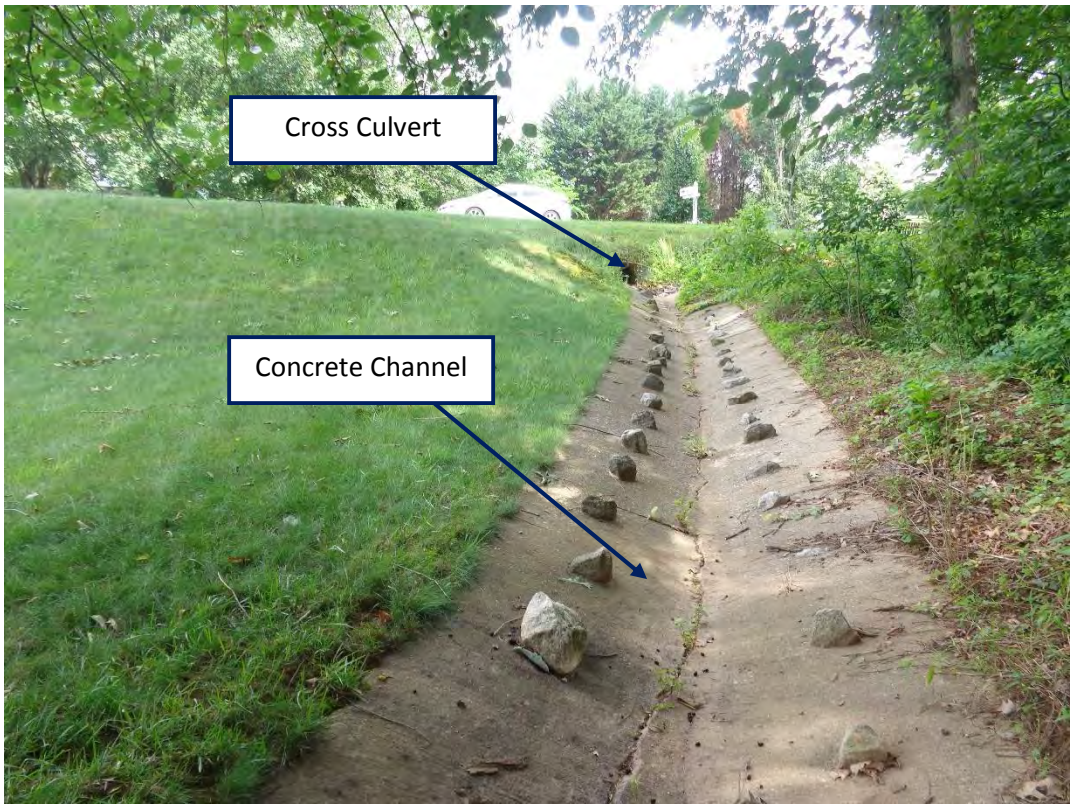
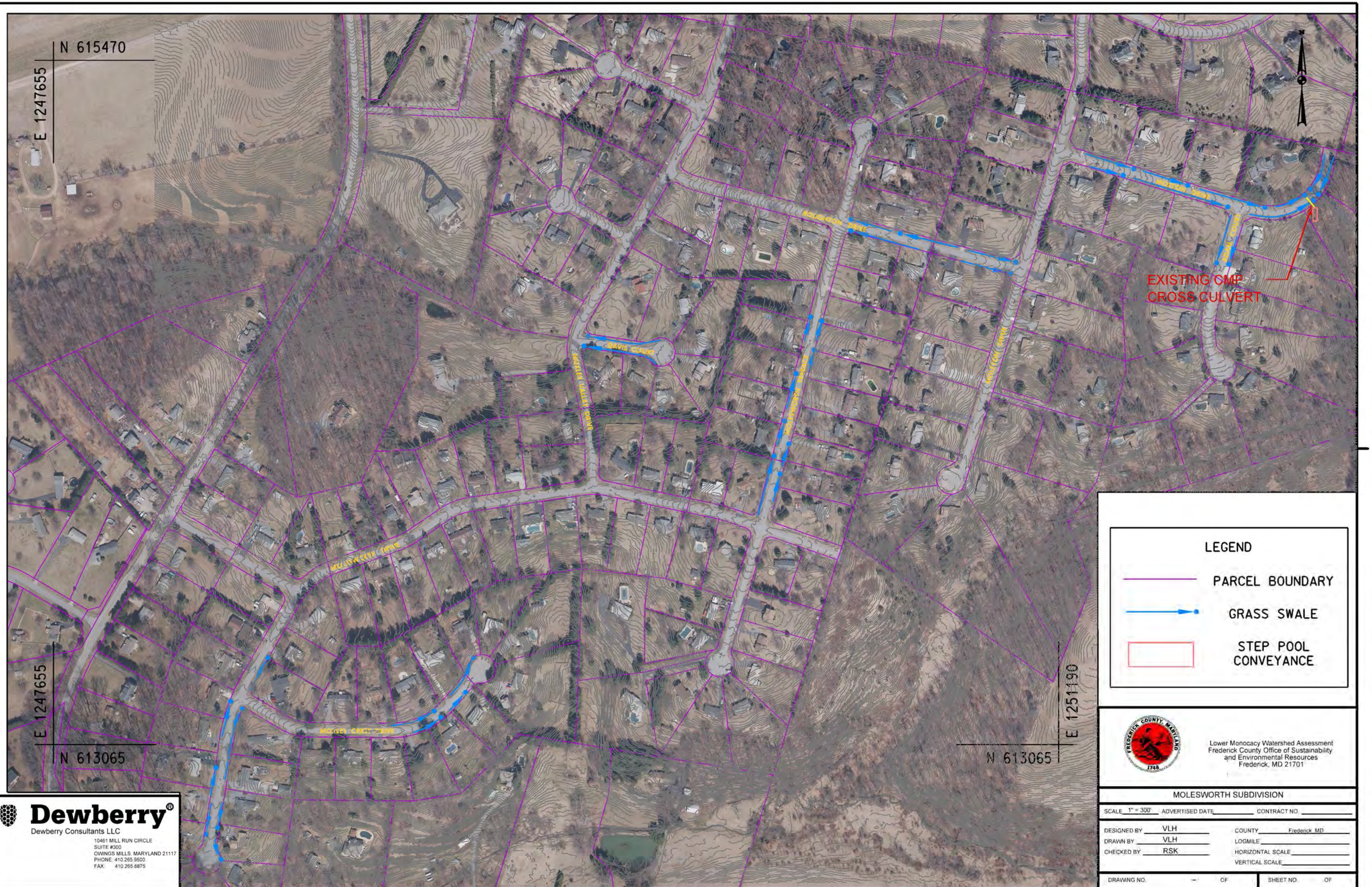


Photo 7: Downstream concrete channel facing north

Photo 8: Erosion in downstream channel facing south



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Dewberry Consultants LLC
10461 MILL RUN CIRCLE
SUITE #300
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FAX: 410.265.8875

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
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Frederick, MD 21701

MOLESWORTH SUBDIVISION

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BY: ndiskill -

ROLLING GREEN SUBDIVISION

Proposed BMP Practice Type:	Grass Swale
Watershed:	Bennett Creek
Description of Site Location:	Regina Drive (ADC Grid 4808, B3)
Land Use:	Residential
Inspection Date:	6/23/2015
Inspection Team:	ND, GL
Last Significant Rainfall Date:	6/20/2015 (1.41")
Rainfall Source:	www.wunderground.com
Station:	KMDNEWMA2

Existing Site Conditions:

Rolling Green was investigated during site visits to identify opportunities to treat untreated impervious area. The residential area is shown in the location map below (**Figure 1**).

General Observations:

The site visit was conducted on June 23rd, 2015. **Figure 2** shows the location of photos taken during the visit.

The impervious area from Regina Drive drains into existing roadside grass ditches. They were all well-maintained and in good condition (**Photos 1-3**).

Access, Right-of-Way, and MOT:

The site can be accessed for maintenance and hauling material in and out of the site from Regina Drive. According to the County's parcel layer in GIS, there is approximately 12' - 15' of public right-of-way (ROW) from the edge of the road to private property throughout the development. MOT will be required to notify residents of the Rolling Green development.

Proposed Retrofit:

The study area boundary based on parcels of the neighborhood is 104.71 acres, including 9.30 acres of impervious area. There are no existing stormwater management facilities in this development. 2 locations have been identified as potential retrofit opportunities in this area. Additional investigation is required to determine the amount of impervious area that can be treated within this site study area.

Based on the results of the screening process described below, the proposed BMPs throughout Rolling Green are a series of grass swales (M-8) to be constructed within the roadside ditch along Regina Drive. Drainage areas to each proposed swale should be developed during final design. The proposed retrofit should be constructed to achieve a maximum 4% longitudinal slope with the use of grading and check dams.

We also propose the County to encourage homeowners to install simple BMPs such as rooftop disconnection, rain barrels, and rain gardens through public outreach.

Step 1: Watershed Factors

Rolling Green is located in Frederick County's Bennett Creek watershed which is located within the Lower Monocacy 8-digit watershed (02140302). The Stream Use Designation for the downstream unnamed branches is Use IV-P. The development is not located within a Frederick County designated wellhead protection area. There are no special watershed factors and/or constraints that must be considered for retrofit design for the proposed BMPs.

Step 2: Terrain Factors

Rolling Green is not located in a region of Frederick County that is prone to karst geology. Therefore, there are no special terrain factors and/or constraints that must be considered for design for this development.

Step 3: Stormwater Treatment Suitability

Based on the GIS desktop analysis it appears the site is suitable for grass swales. There is adequate space along both sides of Regina Drive and the existing longitudinal slope based on contours is acceptable for installing the proposed grass swales. The grass swales should be designed to meet the latest MDE grass swale criteria to provide treatment for the full 1" of rainfall (Pe). There are no safety concerns associated with the use of grass swales.

Step 4: Physical Feasibility Factors

The maximum drainage area for a grass swale is 1 acre. The development is composed of B, and C soils. The likelihood of BMPs receiving hotspot runoff is low as it is located within a residential community. The land use within the drainage area to the BMP is not ultra-urban. Installing grass swales at this site is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

Grass swales have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide little habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the design of BMPs at Rolling Green include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

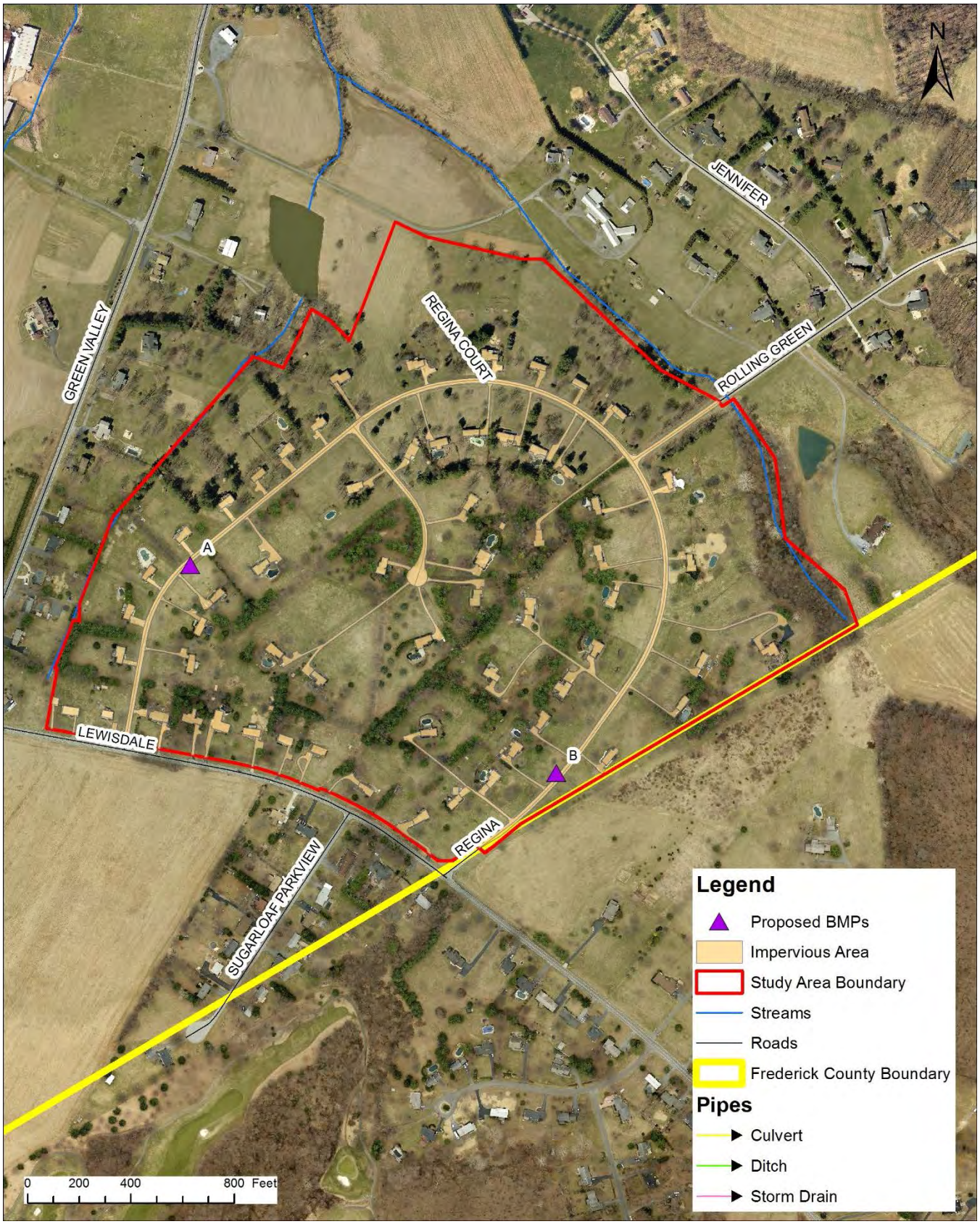

Figure 1: BMP Location Map – Existing Conditions

Figure 2: Photo Locations

Photo 1: Regina Drive facing south

Photo 2: Regina Drive facing southwest

Photo 3: Regina Drive facing northeast

LEGEND

PARCEL BOUNDARY

FREDERICK COUNTY BOUNDARY

GRASS SWALE

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SUITE #300
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Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
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Frederick, MD 21701

ROLLING GREEN SUBDIVISION

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WEST HILLS & CLOVER HILL SUBDIVISION

Proposed BMP Practice Type:	Grass Swale
Watershed:	Carroll Creek
Description of Site Location:	South of Stone Ridge Drive and North of Spout Springs Road (ADC Grid 4447- K8 & K9 and 4448 A8 & A9)
Land Use:	Residential
Inspection Date:	5/5/2015
Inspection Team:	ND, CF
Last Significant Rainfall Date:	5/2/2015 (0.17")
Rainfall Source:	www.wunderground.com
Station:	KMDNEWMA2

Existing Site Conditions:

The West Hills and Clover Hill subdivisions were investigated during site visits to identify opportunities to treat untreated impervious area. The residential area is shown in the location map below (**Figure 1**).

General Observations:

A site visit was conducted on May 5th, 2015 and October 8th, 2015. **Figure 2** shows the location of photos taken during the visit.

The impervious area from Tuscarora Drive, Juniper Drive, Mountainview Drive, Hawthorne Drive, Cloverhill Drive, Spout Spring Road, West Hills Drive, and Old Seventh Street drains into existing roadside grass ditches. They were all well-maintained and in good condition (**Photos 1-5**).

Access, Right-of-Way, and MOT:

The site can be accessed for maintenance and hauling material in and out of the site from each of the aforementioned roads. According to the County's parcel layer in GIS, there is approximately 12' - 15' of public right-of-way (ROW) from the edge of the road to private property throughout the development. MOT will be required to notify residents of the West Hills and Clover Hill subdivisions.

Proposed Retrofit:

The study area boundary based on parcels of the neighborhood is 79.69 acres, including 15.90 acres of impervious area. There are no existing stormwater management facilities in this development. 7 locations have been identified as potential retrofit opportunities in this area. Additional investigation is required to determine the amount of impervious area that can be treated within this site study area.

Based on the results of the screening process described below, the proposed BMPs throughout the West Hills and Clover Hill subdivisions within the area boundary are a series of grass swales (M-8) to be constructed within the roadside ditches along Tuscarora Drive, Juniper Drive, Mountainview Drive, Hawthorne Drive, Cloverhill Drive, Spout Spring Road, West Hills Drive, and Old Seventh Street. Drainage areas to each proposed swale should be developed during final design. The proposed retrofit should be constructed to achieve a maximum 4% longitudinal slope with the use of grading and check dams.

We also propose the County to encourage homeowners to install simple BMPs such as rooftop disconnection, rain barrels, and rain gardens through public outreach.

Step 1: Watershed Factors

The West Hills and Clover Hill subdivisions are located in Frederick County's Carroll Creek watershed which is located within the Lower Monocacy 8-digit watershed (02140302). The Stream Use Designation for the downstream unnamed branches is

Use III-P. The development is not located within a Frederick County designated wellhead protection area. Since open channels are acceptable practices in cold water streams, there are no special watershed factors and/or constraints that must be considered for grass swale designs within these developments.

Step 2: Terrain Factors

The West Hills and Clover Hill subdivisions are not located in a region of Frederick County that is prone to karst geology. Therefore, there are no special terrain factors and/or constraints that must be considered for design for these developments.

Step 3: Stormwater Treatment Suitability

Based on the GIS desktop analysis it appears the site is suitable for grass swales. There is adequate space along both sides of Tuscarora Drive, Juniper Drive, Mountainview Drive, Hawthorne Drive, Cloverhill Drive, Spout Spring Road, West Hills Drive, and Old Seventh Street and the existing longitudinal slope based on contours is acceptable for installing the proposed grass swales. The grass swales should be designed to meet the latest MDE grass swale criteria to provide treatment for the full 1" of rainfall (Pe). There are no safety concerns associated with the use of grass swales.

Step 4: Physical Feasibility Factors

The maximum drainage area for a grass swale is 1 acre. The development is composed of B, and C soils. The likelihood of BMPs receiving hotspot runoff is low as it is located within a residential community. The land use within the drainage area to the BMP is not ultra-urban. Installing grass swales at this site is feasible per the preliminary assessment of physical factors.

Step 5: Community and Environmental Factors

Grass swales have low maintenance requirements, high community acceptance, low construction costs relative to the drainage area, and provide little habitat quality.

Step 6: Location and Permitting Factors

The anticipated permits/reviews required for the design of BMPs at West Hills and Clover Hill include:

1) Frederick County Stormwater Management Review
2) Erosion and Sediment Control (ESC)
3) Grading Permit

Figure 1: BMP Location Map – Existing Conditions

Figure 2: Photo Locations

Photo 1: Tuscarora Drive facing west

Photo 2: Juniper Drive facing north

Photo 3: Mountainview Drive facing southwest

Photo 4: Hawthorne Drive facing south

Photo 5: Cloverhill Drive facing east

LEGEND

PARCEL BOUNDARY

FREDERICK COUNTY BOUNDARY

CITY OF FREDERICK BOUNDARY

GRASS SWALE

Lower Monocacy Watershed Assessment
Frederick County Office of Sustainability
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Frederick, MD 21701

WEST HILLS & CLOVER HILL SUBDIVISION

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FAX: 410.265.8875

BY: ndriskill -

PLOTTED: Friday, June 23, 2017 AT 10:36 AM
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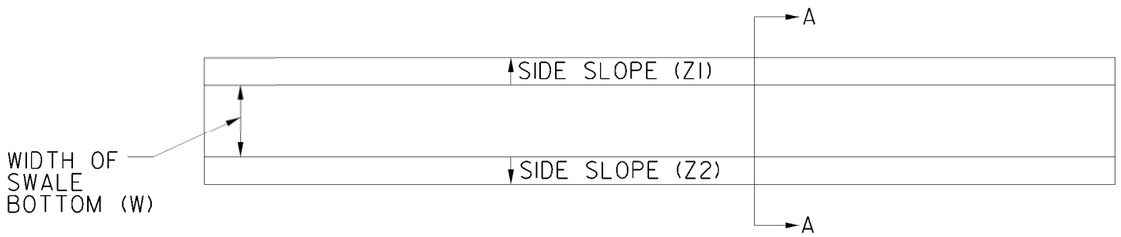
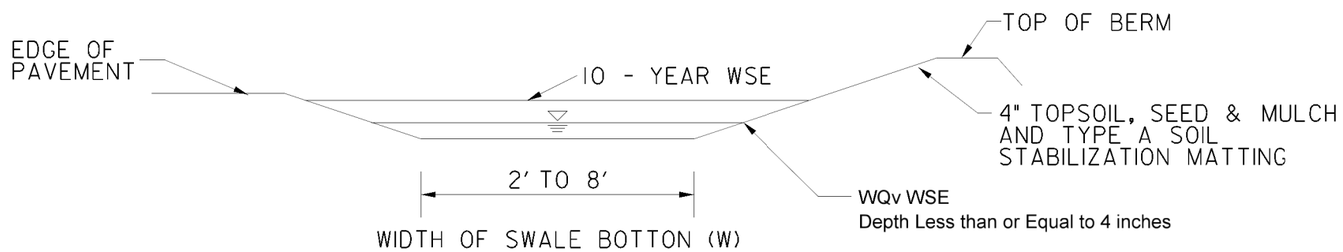


GRASS SWALE PLAN VIEW

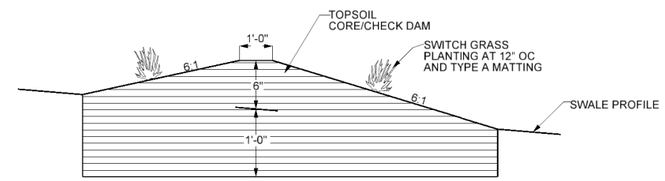
NTS



TYPICAL LAYOUT FOR GRASS SWALE

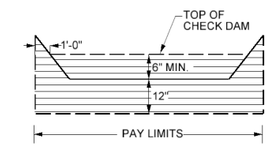
SECTION A-A

NTS



CHECK DAM PROFILE

NOT TO SCALE



CHECK DAM SECTION

NOT TO SCALE

Dewberry®
Dewberry Consultants LLC
3106 LORD BALTIMORE DRIVE
SUITE #110
BALTIMORE, MARYLAND 21244
PHONE: 410.265.9500
FAX: 410.265.8875

County Owned SWM BMP Retrofit Assessment
Frederick County Office of Sustainability
and Environmental Resources
Frederick, MD 21701

TYPICAL GRASS SWALE DETAIL

SCALE 1" = 120' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF SHEET NO. OF

BY: vhamsher -

PLOTTED: Monday, July 13, 2015 AT 11:29 AM
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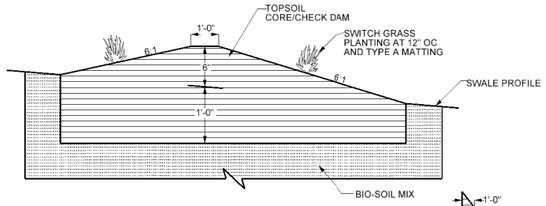

CHECK DAM PROFILE
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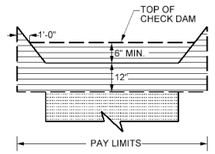

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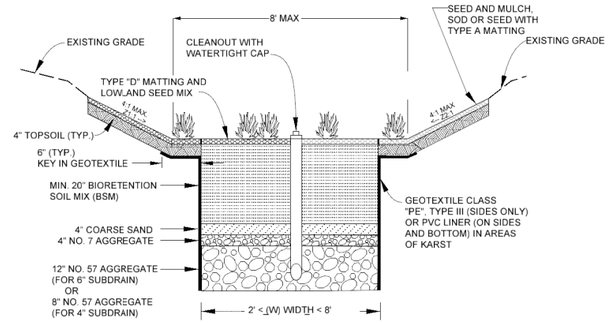
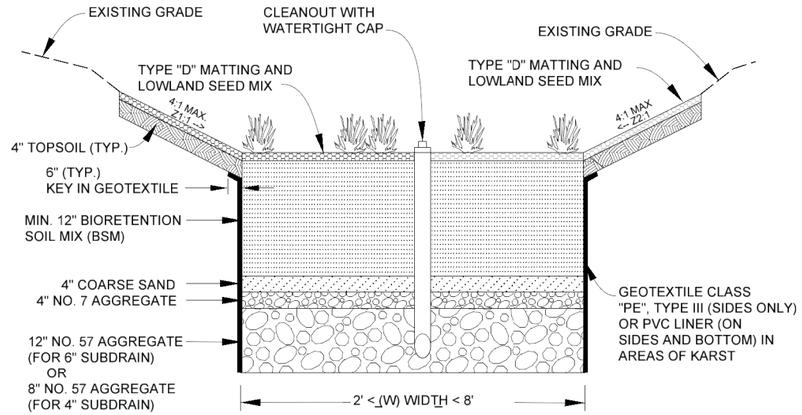


BIO-SWALE SECTION
NOT TO SCALE



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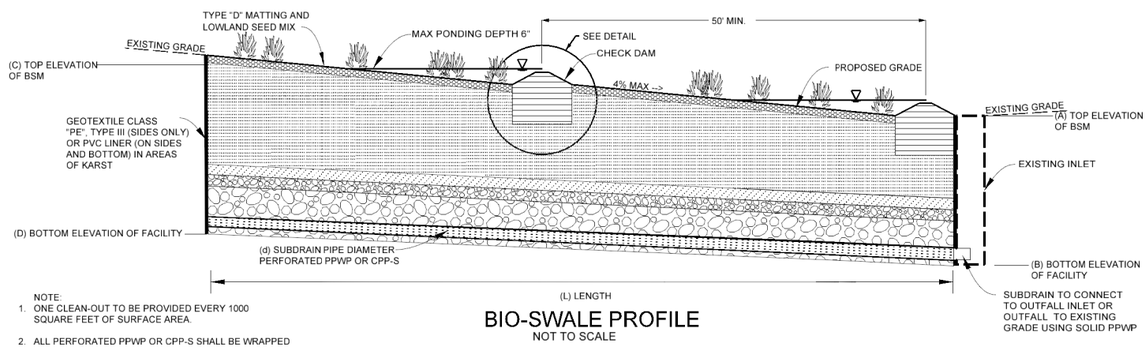
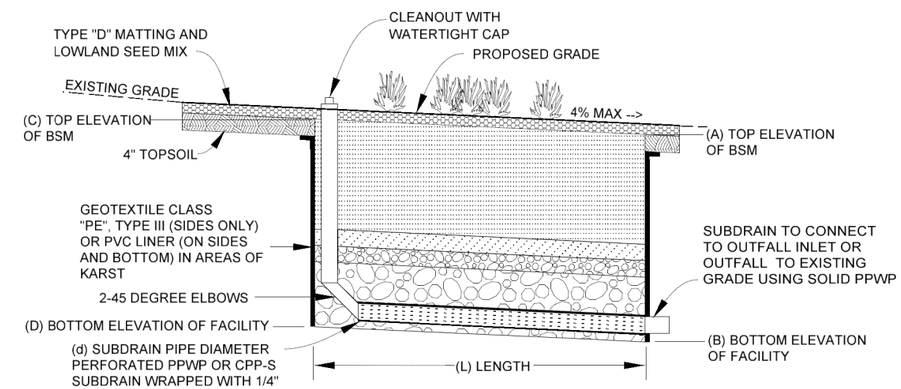


BIO-SWALE PROFILE
NOT TO SCALE

NOTE:
1. ONE CLEAN-OUT TO BE PROVIDED EVERY 1000 SQUARE FEET OF SURFACE AREA.
2. ALL PERFORATED PPWP OR CPP-S SHALL BE WRAPPED WITH 1/4" GALVANIZED HARDWARE CLOTH. THE COST OF THE 1/4" GALVANIZED HARDWARE CLOTH WILL BE INCIDENTAL TO THE COST OF THE PPWP OR CPP-S ITEM.
3. RODENT SCREEN TO BE PROVIDED WHERE SUBDRAIN OUTFALLS TO EXISTING GRADE. COST OF THE RODENT SCREEN IS INCIDENTAL TO THE COST OF THE NON-PERFORATED PPWP OR CPP-S ITEM AS USED FOR THE BMP FACILITY OUTLET.
4. PER SHA SPECIFICATION FOR STORMWATER FILTRATION FACILITIES OR EQUIVALENT.
5. CHECK DAM SPACING TO BE BASED ON CHECK DAM HEIGHTS AND SWALE SLOPE (50' MIN)



BIO-SWALE PROFILE
NOT TO SCALE

NOTE:
1. ONE CLEAN-OUT TO BE PROVIDED EVERY 1000 SQUARE FEET OF SURFACE AREA.
2. ALL PERFORATED PPWP OR CPP-S SHALL BE WRAPPED WITH 1/4" GALVANIZED HARDWARE CLOTH. THE COST OF THE 1/4" GALVANIZED HARDWARE CLOTH WILL BE INCIDENTAL TO THE COST OF THE PPWP OR CPP-S ITEM.
3. RODENT SCREEN TO BE PROVIDED WHERE SUBDRAIN OUTFALLS TO EXISTING GRADE. COST OF THE RODENT SCREEN IS INCIDENTAL TO THE COST OF THE NON-PERFORATED PPWP OR CPP-S ITEM AS USED FOR THE BMP FACILITY OUTLET.
4. PER SHA SPECIFICATION FOR STORMWATER FILTRATION FACILITIES OR EQUIVALENT. AND INSTALLATION.
5. REDUCED BIO-SOIL TO 12".

Dewberry®
Dewberry Consultants LLC
3106 LORD BALTIMORE DRIVE
SUITE #110
BALTIMORE, MARYLAND 21244
PHONE: 410.265.9500
FAX: 410.265.8875

County Owned SWM BMP Retrofit Assessment
Frederick County Office of Sustainability and Environmental Resources
Frederick, MD 21701

TYPICAL BIOSWALE DETAIL

SCALE 1" = 120' ADVERTISED DATE _____ CONTRACT NO. _____

DESIGNED BY VLH
DRAWN BY VLH
CHECKED BY RSK

COUNTY Frederick MD
LOGMILE _____
HORIZONTAL SCALE _____
VERTICAL SCALE _____

DRAWING NO. - OF
SHEET NO. OF

PLOTTED: Wednesday, July 15, 2015 AT 09:06 AM
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BY: vhamsher -

APPENDIX F – PRIORITIZATION INFORMATION FOR PROPOSED PROJECTS

Cost Matrix for Proposed Projects

BMP Site	Proposed Practice Type	Cost															TOTAL SCORE (Max = 75)
		Overall Planning Level Costs			Cost/Pound of Nitrogen Removed			Cost/Pound of Phosphorus Removed			Cost/Pound of Sediment Removed			Cost/Impervious Acre Treated			
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
BMP #41	Wet Extended Detention Pond (P-3)	2	1	2	5	1	5	5	1	5	5	1	5	8	1	8	**25**
BMP #42	Wet Extended Detention Pond (P-3)	2	1	2	5	2	10	5	1	5	5	2	10	8	1	8	**35**
BMP #346	Wet Extended Detention Pond (P-3)	2	2	4	5	2	10	5	1	5	5	2	10	8	1	8	**37**
BMP #458	Wet Extended Detention Pond (P-3)	2	1	2	5	1	5	5	1	5	5	1	5	8	1	8	**25**
BMP #459	Stream Restoration	2	1	2	5	1	5	5	3	15	5	3	15	8	1	8	**45**
BMP #463	Wet Extended Detention Pond (P-3)	2	1	2	5	1	5	5	1	5	5	1	5	8	1	8	**25**
BMP #464	Wet Extended Detention Pond (P-3)	2	1	2	5	1	5	5	1	5	5	1	5	8	1	8	**25**
BMP #591	Wet Extended Detention Pond (P-3)	2	1	2	5	2	10	5	1	5	5	2	10	8	1	8	**35**
BMP #4	Wet Extended Detention Pond (P-3)	2	2	4	5	2	10	5	2	10	5	2	10	8	3	24	**58**
BMP #8	Wet Extended Detention Pond (P-3)	2	2	4	5	2	10	5	1	5	5	1	5	8	1	8	**32**
BMP #394	Wet Extended Detention Pond (P-3)	2	1	2	5	1	5	5	1	5	5	1	5	8	1	8	**25**
BMP #395	Micropool Extended Detention (P-1)	2	2	4	5	1	5	5	1	5	5	1	5	8	1	8	**27**
BMP #403	Micropool Extended Detention (P-1)	2	2	4	5	1	5	5	1	5	5	1	5	8	1	8	**27**
BMP #45	Wet Extended Detention Pond (P-3)	2	1	2	5	2	10	5	1	5	5	1	5	8	1	8	**30**
BMP #52	Wet Extended Detention Pond (P-3)	2	1	2	5	3	15	5	2	10	5	2	10	8	1	8	**45**
BMP #58	Wet Extended Detention Pond (P-3)	2	1	2	5	3	15	5	2	10	5	2	10	8	1	8	**45**
BMP #227	Wet Extended Detention Pond (P-3)	2	1	2	5	2	10	5	1	5	5	1	5	8	1	8	**30**
BMP #353	Micropool Extended Detention (P-1)	2	2	4	5	1	5	5	1	5	5	1	5	8	1	8	**27**
BMP #353 - BMP A	Bioswale (M-8)	2	2	4	5	2	10	5	1	5	5	1	5	8	2	16	**40**
BMP #353 - BMP B	Grass Swale (M-8)	2	3	6	5	3	15	5	2	10	5	2	10	8	3	24	**65**
BMP #353 - BMP C	Bioswale (M-8)	2	2	4	5	1	5	5	1	5	5	1	5	8	2	16	**35**
BMP #353 - BMP D	Bioswale (M-8)	2	2	4	5	2	10	5	1	5	5	1	5	8	2	16	**40**
BMP #412	Wet Extended Detention Pond (P-3)	2	1	2	5	1	5	5	1	5	5	1	5	8	1	8	**25**
BMP #580	Pocket Sand Filter (F-5)	2	2	4	5	1	5	5	1	5	5	1	5	8	1	8	**27**
2-5 & 2-6: BMP #1	Wet Extended Detention Pond (P-3)	2	1	2	5	2	10	5	2	10	5	1	5	8	1	8	**35**
5-7: Ballenger Creek Trail, BMP A	Bioretention (F-6)	2	3	6	5	2	10	5	1	5	5	1	5	8	2	16	**42**
5-7: Ballenger Creek Trail, BMP B	Bioretention (F-6)	2	3	6	5	2	10	5	1	5	5	1	5	8	2	16	**42**
5-7: Ballenger Creek Trail, BMP C	Surface Sand Filter (F-1)	2	2	4	5	2	10	5	1	5	5	1	5	8	2	16	**40**
5-12: Robin Meadows Subdivision, BMP A	Wet Extended Detention Pond (P-3)	2	2	4	5	2	10	5	2	10	5	2	10	8	3	24	**58**
HR101: BMP #600	Micropool Extended Detention (P-1)	2	2	4	5	1	5	5	1	5	5	1	5	8	1	8	**27**

BMP Site	Proposed Practice Type	Cost															TOTAL SCORE (Max = 75)
		Overall Planning Level Costs			Cost/Pound of Nitrogen Removed			Cost/Pound of Phosphorus Removed			Cost/Pound of Sediment Removed			Cost/Impervious Acre Treated			
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
HR103: New Market Elementary/Middle School, BMP A	Micropool Extended Detention (P-1)	2	2	4	5	1	5	5	1	5	5	1	5	8	1	8	**27**
LL216: BMP #309	Wet Extended Detention Pond (P-3)	2	2	4	5	2	10	5	1	5	5	2	10	8	1	8	**37**
LL216: BMP #309 - BMP A	Regenerative Step Pool Conveyance	2	2	4	5	3	15	5	2	10	5	2	10	8	1	8	**47**
LL216: BMP #309 - BMP B	Regenerative Step Pool Conveyance	2	2	4	5	3	15	5	2	10	5	2	10	8	1	8	**47**
NL103: BMP #194	Wet Pond (P-2)	2	2	4	5	2	10	5	1	5	5	2	10	8	1	8	**37**
WB104 & WB113: BMP #487	Stream Restoration	2	2	4	5	1	5	5	3	15	5	3	15	8	1	8	**47**
BA102: Pinecliff Park, BMP A	Grass Swale (M-8)	2	3	6	5	3	15	5	3	15	5	2	10	8	3	24	**70**
BA102: Pinecliff Park, BMP B	Stream Restoration	2	2	4	5	1	5	5	3	15	5	3	15	8	1	8	**47**
NL105: BMP #468	Micropool Extended Detention (P-1)	2	2	4	5	2	10	5	1	5	5	1	5	8	1	8	**32**
Reels Mill	Stream Restoration	2	2	4	5	1	5	5	3	15	5	3	15	8	1	8	**47**
The Greens	Wet Extended Detention Pond (P-3)	2	2	4	5	3	15	5	2	10	5	2	10	8	1	8	**47**
Water Street Road	Micropool Extended Detention (P-1)	2	2	4	5	3	15	5	3	15	5	3	15	8	3	24	**73**
McKaig Road	Regenerative Step Pool Conveyance	2	2	4	5	3	15	5	3	15	5	2	10	8	1	8	**52**
Steamboat Way Subdivision-BMP A	Regenerative Step Pool Conveyance	2	3	6	5	3	15	5	2	10	5	2	10	8	1	8	**49**
Steamboat Way Subdivision-BMP B	Regenerative Step Pool Conveyance	2	2	4	5	2	10	5	1	5	5	1	5	8	1	8	**32**

Nutrient and Impervious Acre Credit Matrix

BMP Site	Proposed Practice Type	Nutrient and Impervious Acre Credit															
		Estimated TN Removed			Estimated TP Removed			Estimated TSS Removed			Impervious Acre Credit			Stormwater Era			TOTAL SCORE (Max = 120)
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
BMP #41	Wet Extended Detention Pond (P-3)	6	3	18	6	2	12	6	3	18	12	3	36	10	2	20	**104**
BMP #42	Wet Extended Detention Pond (P-3)	6	3	18	6	2	12	6	3	18	12	3	36	10	2	20	**104**
BMP #346	Wet Extended Detention Pond (P-3)	6	2	12	6	1	6	6	2	12	12	1	12	10	2	20	**62**
BMP #458	Wet Extended Detention Pond (P-3)	6	2	12	6	2	12	6	3	18	12	3	36	10	2	20	**98**
BMP #459	Stream Restoration	6	1	6	6	3	18	6	3	18	12	2	24	10	2	20	**86**
BMP #463	Wet Extended Detention Pond (P-3)	6	2	12	6	2	12	6	3	18	12	3	36	10	2	20	**98**
BMP #464	Wet Extended Detention Pond (P-3)	6	2	12	6	1	6	6	2	12	12	2	24	10	2	20	**74**
BMP #591	Wet Extended Detention Pond (P-3)	6	3	18	6	2	12	6	3	18	12	3	36	10	2	20	**104**
BMP #4	Wet Extended Detention Pond (P-3)	6	2	12	6	2	12	6	2	12	12	2	24	10	3	30	**90**
BMP #8	Wet Extended Detention Pond (P-3)	6	1	6	6	1	6	6	1	6	12	1	12	10	3	30	**60**
BMP #394	Wet Extended Detention Pond (P-3)	6	2	12	6	1	6	6	2	12	12	2	24	10	3	30	**84**
BMP #395	Micropool Extended Detention (P-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	3	30	**60**
BMP #403	Micropool Extended Detention (P-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	3	30	**60**
BMP #45	Wet Extended Detention Pond (P-3)	6	3	18	6	3	18	6	3	18	12	3	36	10	2	20	**110**
BMP #52	Wet Extended Detention Pond (P-3)	6	3	18	6	3	18	6	3	18	12	3	36	10	2	20	**110**
BMP #58	Wet Extended Detention Pond (P-3)	6	3	18	6	2	12	6	2	12	12	2	24	10	2	20	**86**
BMP #227	Wet Extended Detention Pond (P-3)	6	2	12	6	1	6	6	1	6	12	2	24	10	2	20	**68**
BMP #353	Micropool Extended Detention (P-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
BMP #353 - BMP A	Bioswale (M-8)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
BMP #353 - BMP B	Grass Swale (M-8)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
BMP #353 - BMP C	Bioswale (M-8)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
BMP #353 - BMP D	Bioswale (M-8)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
BMP #412	Wet Extended Detention Pond (P-3)	6	2	12	6	1	6	6	2	12	12	2	24	10	2	20	**74**
BMP #580	Pocket Sand Filter (F-5)	6	1	6	6	1	6	6	1	6	12	1	12	10	3	30	**60**
2-5 & 2-6: BMP #1	Wet Extended Detention Pond (P-3)	6	3	18	6	3	18	6	3	18	12	3	36	10	2	20	**110**
5-7: Ballenger Creek Trail, BMP A	Bioretention (F-6)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
5-7: Ballenger Creek Trail, BMP B	Bioretention (F-6)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
5-7: Ballenger Creek Trail, BMP C	Surface Sand Filter (F-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
5-12: Robin Meadows Subdivision, BMP A	Wet Extended Detention Pond (P-3)	6	2	12	6	2	12	6	2	12	12	3	36	10	2	20	**92**
HR101: BMP #600	Micropool Extended Detention (P-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
HR103: New Market Elementary/Middle School, BMP A	Micropool Extended Detention (P-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	3	30	**60**

BMP Site	Proposed Practice Type	Nutrient and Impervious Acre Credit															
		Estimated TN Removed			Estimated TP Removed			Estimated TSS Removed			Impervious Acre Credit			Stormwater Era			TOTAL SCORE (Max = 120)
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
LL216: BMP #309	Wet Extended Detention Pond (P-3)	6	2	12	6	1	6	6	1	6	12	1	12	10	2	20	**56**
LL216: BMP #309 - BMP A	Regenerative Step Pool Conveyance	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
LL216: BMP #309 - BMP B	Regenerative Step Pool Conveyance	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
NL103: BMP #194	Wet Pond (P-2)	6	2	12	6	1	6	6	2	12	12	2	24	10	2	20	**74**
WB104 & WB113: BMP #487	Stream Restoration	6	1	6	6	3	18	6	3	18	12	2	24	10	2	20	**86**
BA102: Pinecliff Park, BMP A	Grass Swale (M-8)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
BA102: Pinecliff Park, BMP B	Stream Restoration	6	1	6	6	1	6	6	2	12	12	1	12	10	2	20	**56**
NL105: BMP #468	Micropool Extended Detention (P-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
Reels Mill	Stream Restoration	6	1	6	6	1	6	6	2	12	12	1	12	10	2	20	**56**
The Greens	Wet Extended Detention Pond (P-3)	6	3	18	6	2	12	6	2	12	12	2	24	10	2	20	**86**
Water Street Road	Micropool Extended Detention (P-1)	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
McKaig Road	Regenerative Step Pool Conveyance	6	2	12	6	1	6	6	1	6	12	1	12	10	2	20	**56**
Steamboat Way Subdivision-BMP A	Regenerative Step Pool Conveyance	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**
Steamboat Way Subdivision-BMP B	Regenerative Step Pool Conveyance	6	1	6	6	1	6	6	1	6	12	1	12	10	2	20	**50**

Construction Matrix

BMP Site	Proposed Practice Type	Construction																		TOTAL SCORE (Max = 60)
		Utility Conflicts			ROW Requirements/Property Ownership			Constructability/Access			Maintenance Burden			Proximity to Karst			Local/State/Federal Permitting Requirements			
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
BMP #41	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	1	2	4	1	4	**38**
BMP #42	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	2	6	4	3	12	2	3	6	4	1	4	**39**
BMP #346	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	3	6	4	3	12	**50**
BMP #458	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	3	6	4	2	8	**46**
BMP #459	Stream Restoration	2	1	2	5	1	5	3	3	9	4	2	8	2	3	6	4	1	4	**34**
BMP #463	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	2	6	4	3	12	2	3	6	4	3	12	**47**
BMP #464	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	3	6	4	2	8	**46**
BMP #591	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	2	6	4	3	12	2	3	6	4	1	4	**39**
BMP #4	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	1	2	4	2	8	**42**
BMP #8	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	1	2	4	2	8	**42**
BMP #394	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	1	2	4	3	12	**46**
BMP #395	Micropool Extended Detention (P-1)	2	3	6	5	1	5	3	3	9	4	2	8	2	1	2	4	1	4	**34**
BMP #403	Micropool Extended Detention (P-1)	2	3	6	5	1	5	3	3	9	4	2	8	2	1	2	4	3	12	**42**
BMP #45	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	1	3	4	3	12	2	3	6	4	1	4	**36**
BMP #52	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	3	6	4	1	4	**42**
BMP #58	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	3	6	4	1	4	**42**
BMP #227	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	3	6	4	1	4	**42**
BMP #353	Micropool Extended Detention (P-1)	2	3	6	5	1	5	3	1	3	4	3	12	2	3	6	4	2	8	**40**
BMP #353 - BMP A	Bioswale (M-8)	2	3	6	5	1	5	3	2	6	4	3	12	2	3	6	4	1	4	**39**
BMP #353 - BMP B	Grass Swale (M-8)	2	3	6	5	1	5	3	2	6	4	3	12	2	3	6	4	1	4	**39**
BMP #353 - BMP C	Bioswale (M-8)	2	3	6	5	1	5	3	2	6	4	3	12	2	3	6	4	1	4	**39**
BMP #353 - BMP D	Bioswale (M-8)	2	3	6	5	1	5	3	2	6	4	3	12	2	3	6	4	1	4	**39**
BMP #412	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	2	6	4	3	12	2	1	2	4	3	12	**43**
BMP #580	Pocket Sand Filter (F-5)	2	3	6	5	1	5	3	2	6	4	2	8	2	3	6	4	2	8	**39**
2-5 & 2-6: BMP #1	Wet Extended Detention Pond (P-3)	2	3	6	5	2	10	3	3	9	4	3	12	2	1	2	4	1	4	**43**
5-7: Ballenger Creek Trail, BMP A	Bioretention (F-6)	2	3	6	5	3	15	3	3	9	4	2	8	2	1	2	4	1	4	**44**
5-7: Ballenger Creek Trail, BMP B	Bioretention (F-6)	2	3	6	5	3	15	3	3	9	4	2	8	2	1	2	4	1	4	**44**
5-7: Ballenger Creek Trail, BMP C	Surface Sand Filter (F-1)	2	3	6	5	3	15	3	3	9	4	2	8	2	1	2	4	1	4	**44**
5-12: Robin Meadows Subdivision, BMP A	Wet Extended Detention Pond (P-3)	2	3	6	5	3	15	3	3	9	4	3	12	2	1	2	4	1	4	**48**

BMP Site	Proposed Practice Type	Construction																		TOTAL SCORE (Max = 60)
		Utility Conflicts			ROW Requirements/Property Ownership			Constructability/Access			Maintenance Burden			Proximity to Karst			Local/State/Federal Permitting Requirements			
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
HR101: BMP #600	Micropool Extended Detention (P-1)	2	3	6	5	2	10	3	3	9	4	2	8	2	3	6	4	1	4	**43**
HR103: New Market Elementary/Middle School, BMP A	Micropool Extended Detention (P-1)	2	1	2	5	2	10	3	3	9	4	2	8	2	3	6	4	3	12	**47**
LL216: BMP #309	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	1	3	4	3	12	2	3	6	4	3	12	**44**
LL216: BMP #309 - BMP A	Regenerative Step Pool Conveyance	2	3	6	5	1	5	3	1	3	4	2	8	2	3	6	4	3	12	**40**
LL216: BMP #309 - BMP B	Regenerative Step Pool Conveyance	2	3	6	5	1	5	3	1	3	4	2	8	2	3	6	4	3	12	**40**
NL103: BMP #194	Wet Pond (P-2)	2	3	6	5	2	10	3	3	9	4	3	12	2	3	6	4	3	12	**55**
WB104 & WB113: BMP #487	Stream Restoration	2	3	6	5	1	5	3	2	6	4	2	8	2	3	6	4	1	4	**35**
BA102: Pinecliff Park, BMP A	Grass Swale (M-8)	2	3	6	5	3	15	3	3	9	4	3	12	2	1	2	4	1	4	**48**
BA102: Pinecliff Park, BMP B	Stream Restoration	2	3	6	5	3	15	3	3	9	4	2	8	2	1	2	4	1	4	**44**
NL105: BMP #468	Micropool Extended Detention (P-1)	2	3	6	5	2	10	3	2	6	4	2	8	2	3	6	4	2	8	**44**
Reels Mill	Stream Restoration	2	3	6	5	1	5	3	3	9	4	2	8	2	3	6	4	1	4	**38**
The Greens	Wet Extended Detention Pond (P-3)	2	3	6	5	1	5	3	3	9	4	3	12	2	3	6	4	1	4	**42**
Water Street Road	Micropool Extended Detention (P-1)	2	3	6	5	3	15	3	3	9	4	2	8	2	3	6	4	1	4	**48**
McKaig Road	Regenerative Step Pool Conveyance	2	3	6	5	1	5	3	3	9	4	2	8	2	3	6	4	1	4	**38**
Steamboat Way Subdivision-BMP A	Regenerative Step Pool Conveyance	2	3	6	5	1	5	3	1	3	4	2	8	2	3	6	4	1	4	**32**
Steamboat Way Subdivision-BMP B	Regenerative Step Pool Conveyance	2	3	6	5	1	5	3	1	3	4	2	8	2	3	6	4	1	4	**32**

Community and Watershed Impacts Matrix

BMP Site	Proposed Practice Type	Community and Watershed Impacts															TOTAL SCORE (Max = 45)
		Compatibility with Watershed Goals			Public Acceptance			Public Safety			Partnership Opportunities			Public Visibility/Outreach Opportunity			
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
BMP #41	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	2	4	**35**
BMP #42	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	2	4	**35**
BMP #346	Wet Extended Detention Pond (P-3)	5	1	5	3	3	9	3	1	3	2	2	4	2	2	4	**25**
BMP #458	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	2	4	**35**
BMP #459	Stream Restoration	5	2	10	3	2	6	3	3	9	2	2	4	2	2	4	**33**
BMP #463	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	3	6	**37**
BMP #464	Wet Extended Detention Pond (P-3)	5	2	10	3	3	9	3	1	3	2	2	4	2	2	4	**30**
BMP #591	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	3	6	**37**
BMP #4	Wet Extended Detention Pond (P-3)	5	2	10	3	3	9	3	1	3	2	2	4	2	3	6	**32**
BMP #8	Wet Extended Detention Pond (P-3)	5	1	5	3	3	9	3	1	3	2	2	4	2	2	4	**25**
BMP #394	Wet Extended Detention Pond (P-3)	5	2	10	3	3	9	3	1	3	2	2	4	2	3	6	**32**
BMP #395	Micropool Extended Detention (P-1)	5	1	5	3	2	6	3	1	3	2	2	4	2	2	4	**22**
BMP #403	Micropool Extended Detention (P-1)	5	1	5	3	2	6	3	1	3	2	2	4	2	2	4	**22**
BMP #45	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	3	6	**37**
BMP #52	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	2	4	**35**
BMP #58	Wet Extended Detention Pond (P-3)	5	2	10	3	3	9	3	1	3	2	2	4	2	2	4	**30**
BMP #227	Wet Extended Detention Pond (P-3)	5	2	10	3	3	9	3	1	3	2	2	4	2	3	6	**32**
BMP #353	Micropool Extended Detention (P-1)	5	1	5	3	3	9	3	1	3	2	2	4	2	1	2	**23**
BMP #353 - BMP A	Bioswale (M-8)	5	1	5	3	3	9	3	3	9	2	2	4	2	2	4	**31**
BMP #353 - BMP B	Grass Swale (M-8)	5	1	5	3	3	9	3	3	9	2	2	4	2	2	4	**31**
BMP #353 - BMP C	Bioswale (M-8)	5	1	5	3	3	9	3	3	9	2	2	4	2	2	4	**31**
BMP #353 - BMP D	Bioswale (M-8)	5	1	5	3	3	9	3	3	9	2	2	4	2	2	4	**31**
BMP #412	Wet Extended Detention Pond (P-3)	5	2	10	3	3	9	3	1	3	2	2	4	2	1	2	**28**
BMP #580	Pocket Sand Filter (F-5)	5	1	5	3	2	6	3	3	9	2	2	4	2	1	2	**26**
2-5 & 2-6: BMP #1	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	3	6	2	2	4	**37**
5-7: Ballenger Creek Trail, BMP A	Bioretention (F-6)	5	1	5	3	2	6	3	3	9	2	2	4	2	3	6	**30**
5-7: Ballenger Creek Trail, BMP B	Bioretention (F-6)	5	1	5	3	2	6	3	3	9	2	2	4	2	3	6	**30**
5-7: Ballenger Creek Trail, BMP C	Surface Sand Filter (F-1)	5	1	5	3	2	6	3	3	9	2	2	4	2	3	6	**30**
5-12: Robin Meadows Subdivision, BMP A	Wet Extended Detention Pond (P-3)	5	3	15	3	3	9	3	1	3	2	2	4	2	3	6	**37**
HR101: BMP #600	Micropool Extended Detention (P-1)	5	1	5	3	2	6	3	1	3	2	2	4	2	3	6	**24**
HR103: New Market Elementary/Middle School, BMP A	Micropool Extended Detention (P-1)	5	1	5	3	2	6	3	1	3	2	2	4	2	3	6	**24**

BMP Site	Proposed Practice Type	Community and Watershed Impacts															TOTAL SCORE (Max = 45)
		Compatibility with Watershed Goals			Public Acceptance			Public Safety			Partnership Opportunities			Public Visibility/Outreach Opportunity			
		Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	Weight	Rating (1, 2, 3)	Total Score (Rating * Weight)	
LL216: BMP #309	Wet Extended Detention Pond (P-3)	5	1	5	3	3	9	3	1	3	2	2	4	2	1	2	**23**
LL216: BMP #309 - BMP A	Regenerative Step Pool Conveyance	5	1	5	3	2	6	3	3	9	2	2	4	2	2	4	**28**
LL216: BMP #309 - BMP B	Regenerative Step Pool Conveyance	5	1	5	3	2	6	3	3	9	2	2	4	2	2	4	**28**
NL103: BMP #194	Wet Pond (P-2)	5	2	10	3	3	9	3	1	3	2	2	4	2	3	6	**32**
WB104 & WB113: BMP #487	Stream Restoration	5	2	10	3	2	6	3	3	9	2	1	2	2	1	2	**29**
BA102: Pinecliff Park, BMP A	Grass Swale (M-8)	5	1	5	3	3	9	3	3	9	2	3	6	2	3	6	**35**
BA102: Pinecliff Park, BMP B	Stream Restoration	5	1	5	3	2	6	3	3	9	2	3	6	2	3	6	**32**
NL105: BMP #468	Micropool Extended Detention (P-1)	5	1	5	3	2	6	3	1	3	2	2	4	2	2	4	**22**
Reels Mill	Stream Restoration	5	1	5	3	2	6	3	3	9	2	1	2	2	1	2	**24**
The Greens	Wet Extended Detention Pond (P-3)	5	2	10	3	1	3	3	1	3	2	3	6	2	3	6	**28**
Water Street Road	Micropool Extended Detention (P-1)	5	1	5	3	2	6	3	1	3	2	2	4	2	1	2	**20**
McKaig Road	Regenerative Step Pool Conveyance	5	1	5	3	2	6	3	3	9	2	1	2	2	1	2	**24**
Steamboat Way Subdivision-BMP A	Regenerative Step Pool Conveyance	5	1	5	3	2	6	3	3	9	2	2	4	2	1	2	**26**
Steamboat Way Subdivision-BMP B	Regenerative Step Pool Conveyance	5	1	5	3	2	6	3	3	9	2	2	4	2	1	2	**26**

Nutrient Reduction/Impervious Acre Reduction and Cost Backup

BMP Site	Proposed Practice Type	Total Initial Costs	Total Treated Impervious Area	Estimated Reduction (EOS)			Cost/Pound of Nutrient Removed			Cost / Impervious Acre Treated	Total Initial Costs Score	Total Treated Impervious Area Score	Estimated Reduction (EOS) Score			Cost/Pound of Nutrient Removed Score			Cost / Impervious Acre Treated Score
				TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	TN	TP	TSS	
				(lbs/yr)									(lbs/yr)						
BMP #41	Wet Extended Detention Pond (P-3)	$ 2,652,413.50	25.51	601.87	56.09	44,366.56	$ 4,406.96	$ 47,285.13	$ 59.78	$ 103,975.44	1	3	3	2	3	1	1	1	1
BMP #42	Wet Extended Detention Pond (P-3)	$ 1,995,784.95	20.02	753.23	57.08	43,664.74	$ 2,649.63	$ 34,965.44	$ 45.71	$ 99,689.56	1	3	3	2	3	2	1	2	1
BMP #346	Wet Extended Detention Pond (P-3)	$ 631,873.00	5.98	276.56	19.43	14,653.84	$ 2,284.80	$ 32,516.72	$ 43.12	$ 105,664.38	2	1	2	1	2	2	1	2	1
BMP #458	Wet Extended Detention Pond (P-3)	$ 2,054,173.00	19.78	416.99	41.18	32,827.47	$ 4,926.17	$ 49,888.76	$ 62.57	$ 103,851.01	1	3	2	2	3	1	1	1	1
BMP #459	Stream Restoration	$ 1,498,090.00	14.8	111.00	100.64	66,452.00	$ 13,496.31	$ 14,885.63	$ 22.54	$ 101,222.30	1	2	1	3	3	1	3	3	1
BMP #463	Wet Extended Detention Pond (P-3)	$ 1,812,437.00	17.42	422.19	38.83	30,652.19	$ 4,292.93	$ 46,677.85	$ 59.13	$ 104,043.46	1	3	2	2	3	1	1	1	1
BMP #464	Wet Extended Detention Pond (P-3)	$ 1,324,130.50	12.73	253.11	25.79	20,642.75	$ 5,231.49	$ 51,350.83	$ 64.15	$ 104,016.54	1	2	2	1	2	1	1	1	1
BMP #591	Wet Extended Detention Pond (P-3)	$ 1,801,882.50	17.25	599.59	46.88	36,062.39	$ 3,005.17	$ 38,436.74	$ 49.97	$ 104,456.96	1	3	3	2	3	2	1	2	1
BMP #4	Wet Extended Detention Pond (P-3)	$ 804,599.07	14.38	311.74	30.34	19,255.35	$ 2,581.02	$ 26,522.48	$ 41.79	$ 55,952.65	2	2	2	2	2	2	2	2	3
BMP #8	Wet Extended Detention Pond (P-3)	$ 577,478.00	5.48	187.61	14.76	9,068.95	$ 3,078.02	$ 39,117.55	$ 63.68	$ 105,379.20	2	1	1	1	1	2	1	1	1
BMP #394	Wet Extended Detention Pond (P-3)	$ 1,249,088.50	12.01	319.33	28.09	17,569.43	$ 3,911.64	$ 44,473.33	$ 71.09	$ 104,004.04	1	2	2	1	2	1	1	1	1
BMP #395	Micropool Extended Detention (P-1)	$ 639,496.00	6.16	155.03	14.00	8,789.93	$ 4,125.03	$ 45,689.97	$ 72.75	$ 103,814.29	2	1	1	1	1	1	1	1	1
BMP #403	Micropool Extended Detention (P-1)	$ 290,911.50	2.79	54.43	5.60	3,581.62	$ 5,344.72	$ 51,935.38	$ 81.22	$ 104,269.35	2	1	1	1	1	1	1	1	1
BMP #45	Wet Extended Detention Pond (P-3)	$ 3,188,416.00	30.76	1166.21	88.11	44,390.95	$ 2,734.01	$ 36,187.57	$ 71.83	$ 103,654.62	1	3	3	3	3	2	1	1	1
BMP #52	Wet Extended Detention Pond (P-3)	$ 2,370,985.16	23.58	1750.57	108.01	52,178.96	$ 1,354.40	$ 21,950.98	$ 45.44	$ 100,550.69	1	3	3	3	3	3	2	2	1
BMP #58	Wet Extended Detention Pond (P-3)	$ 1,043,431.87	10.23	756.88	46.74	22,584.10	$ 1,378.60	$ 22,323.96	$ 46.20	$ 101,997.25	1	2	3	2	2	3	2	2	1
BMP #227	Wet Extended Detention Pond (P-3)	$ 1,081,135.00	10.3	315.56	26.03	13,314.59	$ 3,426.08	$ 41,536.22	$ 81.20	$ 104,964.56	1	2	2	1	1	2	1	1	1
BMP #353	Micropool Extended Detention (P-1)	$ 487,047.00	4.62	71.00	8.38	4,498.18	$ 6,859.48	$ 58,125.55	$ 108.28	$ 105,421.43	2	1	1	1	1	1	1	1	1
BMP #353 - BMP A	Bioswale (M-8)	$ 122,650.00	1.6	35.40	3.46	1,580.83	$ 3,464.54	$ 35,455.94	$ 77.59	$ 76,656.25	2	1	1	1	1	2	1	1	2
BMP #353 - BMP B	Grass Swale (M-8)	$ 26,180.00	0.44	15.38	1.66	766.54	$ 1,702.67	$ 15,753.32	$ 34.15	$ 59,500.00	3	1	1	1	1	3	2	2	3
BMP #353 - BMP C	Bioswale (M-8)	$ 137,610.00	1.8	33.46	3.67	1,694.17	$ 4,112.80	$ 37,511.73	$ 81.23	$ 76,450.00	2	1	1	1	1	1	1	1	2
BMP #353 - BMP D	Bioswale (M-8)	$ 203,896.00	2.62	66.54	5.97	2,704.01	$ 3,064.44	$ 34,160.50	$ 75.41	$ 77,822.90	2	1	1	1	1	2	1	1	2
BMP #412	Wet Extended Detention Pond (P-3)	$ 1,469,869.50	14.07	281.22	28.57	15,063.95	$ 5,226.85	$ 51,454.30	$ 97.58	$ 104,468.34	1	2	2	1	2	1	1	1	1
BMP #580	Pocket Sand Filter (F-5)	$ 113,850.00	1.32	28.02	2.76	1,449.43	$ 4,063.75	$ 41,253.46	$ 78.55	$ 86,250.00	2	1	1	1	1	1	1	1	1
2-5 & 2-6: BMP #1	Wet Extended Detention Pond (P-3)	$ 3,920,291.10	39.60	1933.24	133.57	66,149.24	$ 2,027.84	$ 29,350.24	$ 59.26	$ 98,997.25	1	3	3	3	3	2	2	1	1
5-7: Ballenger Creek Trail, BMP A	Bioretention (F-6)	$ 81,765.75	1.02	27.16	2.37	1,069.00	$ 3,010.29	$ 34,542.33	$ 76.49	$ 80,162.50	3	1	1	1	1	2	1	1	2
5-7: Ballenger Creek Trail, BMP B	Bioretention (F-6)	$ 25,652.00	0.32	9.17	0.77	344.92	$ 2,797.95	$ 33,433.29	$ 74.37	$ 80,162.50	3	1	1	1	1	2	1	1	2
5-7: Ballenger Creek Trail, BMP C	Surface Sand Filter (F-1)	$ 214,500.00	2.6	87.76	6.95	3528.91	$ 2,444.11	$ 30,878.01	$ 60.78	$ 82,500.00	2	1	1	1	1	2	1	1	2
5-12: Robin Meadows Subdivision, BMP A	Wet Extended Detention Pond (P-3)	$ 962,508.69	17.46	434.52	39.45	20481.95	$ 2,215.12	$ 24,399.55	$ 46.99	$ 55,126.50	2	3	2	2	2	2	2	2	3
HR101: BMP #600	Micropool Extended Detention (P-1)	$ 535,848.50	5.21	129.23	11.75	9261.42	$ 4,146.63	$ 45,599.33	$ 57.86	$ 102,850.00	2	1	1	1	1	1	1	1	1
HR103: New Market Elementary/Middle School, BMP A	Micropool Extended Detention (P-1)	$ 493,680.00	4.80	103.94	10.12	8052.26	$ 4,749.55	$ 48,786.75	$ 61.31	$ 102,850.00	2	1	1	1	1	1	1	1	1

BMP Site	Proposed Practice Type	Total Initial Costs	Total Treated Impervious Area	Estimated Reduction (EOS)			Cost/Pound of Nutrient Removed			Cost / Impervious Acre Treated	Total Initial Costs Score	Total Treated Impervious Area Score	Estimated Reduction (EOS) Score			Cost/Pound of Nutrient Removed Score			Cost / Impervious Acre Treated Score
				TN	TP	TSS	TN	TP	TSS				TN	TP	TSS	TN	TP	TSS	
				(lbs/yr)									(lbs/yr)						
LL216: BMP #309	Wet Extended Detention Pond (P-3)	$ 630,998.50	6.01	244.26	17.97	13669.16	$ 2,583.34	$ 35,120.18	$ 46.16	$ 104,991.43	2	1	2	1	1	2	1	2	1
LL216: BMP #309 - BMP A	Regenerative Step Pool Conveyance	$ 204,050.00	2	138.05	7.78	5016.41	$ 1,478.11	$ 26,228.85	$ 40.68	$ 102,025.00	2	1	1	1	1	3	2	2	1
LL216: BMP #309 - BMP B	Regenerative Step Pool Conveyance	$ 204,050.00	2	149.32	8.19	5283.01	$ 1,366.56	$ 24,903.40	$ 38.62	$ 102,025.00	2	1	1	1	1	3	2	2	1
NL103: BMP #194	Wet Pond (P-2)	$ 909,784.73	9.19	345.87	26.21	20046.47	$ 2,630.41	$ 34,717.19	$ 45.38	$ 98,997.25	2	2	2	1	2	2	1	2	1
WB104 & WB113: BMP #487	Stream Restoration	$ 899,910.00	9	67.50	61.20	40410.00	$ 13,332.00	$ 14,704.41	$ 22.27	$ 99,990.00	2	2	1	3	3	1	3	3	1
BA102: Pinecliff Park, BMP A	Grass Swale (M-8)	$ 52,250.00	0.95	80.35	3.85	1579.61	$ 650.31	$ 13,585.86	$ 33.08	$ 55,000.00	3	1	1	1	1	3	3	2	3
BA102: Pinecliff Park, BMP B	Stream Restoration	$ 328,515.00	3.3	24.75	22.44	14817.00	$ 13,273.33	$ 14,639.71	$ 22.17	$ 99,550.00	2	1	1	1	2	1	3	3	1
NL105: BMP #468	Micropool Extended Detention (P-1)	$ 582,103.83	5.88	162.51	14.04	10978.61	$ 3,582.00	$ 41,464.70	$ 53.02	$ 98,997.25	2	1	1	1	1	2	1	1	1
Reels Mill	Stream Restoration	$ 400,180.00	4	30.00	27.20	17960.00	$ 13,339.33	$ 14,712.50	$ 22.28	$ 100,045.00	2	1	1	1	2	1	3	3	1
The Greens	Wet Extended Detention Pond (P-3)	$ 941,464.54	9.26	567.73	36.78	27267.23	$ 1,658.30	$ 25,597.72	$ 34.53	$ 101,670.04	2	2	3	2	2	3	2	2	1
Water Street Road	Micropool Extended Detention (P-1)	$ 161,520.65	2.93	189.54	12.12	7143.17	$ 852.17	$ 13,332.11	$ 22.61	$ 55,126.50	2	1	1	1	1	3	3	3	3
McKaig Road	Regenerative Step Pool Conveyance	$ 201,080.00	2	289.87	14.42	7241.12	$ 693.69	$ 13,943.93	$ 27.77	$ 100,540.00	2	1	2	1	1	3	3	2	1
Steamboat Way Subdivision-BMP A	Regenerative Step Pool Conveyance	$ 80,630.00	0.8	83.90	4.02	2503.09	$ 961.04	$ 20,081.90	$ 32.21	$ 100,787.50	3	1	1	1	1	3	2	2	1
Steamboat Way Subdivision-BMP B	Regenerative Step Pool Conveyance	$ 177,193.50	1.77	53.00	4.31	2933.30	$ 3,343.50	$ 41,076.55	$ 60.41	$ 100,109.32	2	1	1	1	1	2	1	1	1