Pennsylvania Department of Environmental Protection

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Draft

Model Total Maximum Daily Load and Chesapeake Bay Pollutant Reduction Plan and Guidance

Prepared for

PA DEP

February 2015

The Pennsylvania Department of Environmental Protection (DEP) is soliciting comments on this draft document. Please submit your ideas on how it can be improved via email to RA-EPPAMS4@pa.gov by July 1, 2015.

1. This draft plan is formatted to address the requirements of the 2013 Pennsylvania Municipal Separate Storm Sewer Systems (MS4) permit.
2. It is designed as a tool for use by MS4 permittees with TMDL requirements, but it will need to be adapted by each permittee to reflect individual TMDL requirements, varying local conditions and the preferences of local officials.
3. The preparation of this document was funded by the Pennsylvania Department of Environmental Protection (DEP) and the US Environmental Protection Agency (EPA). Although it was reviewed by DEP it does not necessarily reflect the view of DEP or EPA, and no official endorsement can be inferred.

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Background Introductory Comments from DEP

This draft model TMDL Plan has been developed as an example model plan for Pennsylvania MS4 communities. The information presented here has been developed solely for the purpose of demonstrating how to develop a TMDL Plan. It is not a "fill-in-the-blanks" template; rather it is intended to provide guidance on the concepts which need to be addressed by individual MS4s who are addressing highly variable TMDLs and local conditions.

A separate document provides a model Chesapeake Bay Pollutant Reduction Plan. Not all MS4 s have to do both a TMDL Plan and a Chesapeake Bay Pollution Reduction Plan, which is why the two types of plans are provided separately. MS4s which are obligated to have both plans are encouraged to combine the two plans into one, especially when the pollutants of concern are the same.

Introduction

The hypothetical Muddy River Watershed in Stormyville Township is impaired for sediment and the associated local Total Maximum Daily Load (TMDL) Implementation Plan is required to address these impairments.

This document follows DEP 3800-FM-BPNPSM0493 Commonwealth of Pennsylvania MS4 TMDL Instructions and provides a step by step example approach for Pennsylvania localities to follow. The document contains typical required information including background site conditions, existing and future stormwater management strategies, and additional data that support TMDL compliance. The plan is required to provide the content describe on the 493 form. The information can be submitted on the 493 form or be provided in a stand-alone report (as done in this plan).

Getting Started

Evaluating the TMDL

TMDL documents can be complex and difficult to understand. While it is important to gain a thorough understanding of the TMDL document and how it is was developed, there are some components of the TMDL which should be evaluated early in the process. This information should be compared to local and more recent data.

Concepts to understand from the TMDL:

Date- It is important to understand when the TMDL was written and approved and how the community has grown or changed in the years since.

Model- Most TMDLs were developed using a model. It is important to understand what model was used and if possible what information was included in the model run.

Land-use- Water quality models typically used land use to estimate pollutant loads. Take note of what the land-use estimates are in the TMDL, what data sources were used, and what local or more recent data is now available.

MS4 Area- Compare local MS4 area data with data from the TMDL document. "Regulated MS4" as defined in PAG-13 is the portion of a small MS4 located within a designated Urbanized Area or a small MS4 that is specifically designated by DEP. If municipalities have not already done so they must map the drainage areas to the MS4 outfalls.

Storm Sewershed- The area that drains to an MS4 outfall.

Urbanized Area (UA) - An urbanized area consists of densely developed territory that contains 50,000 or more people. This area could have been used to create the TMDL.

Waste Load Allocation (WLA) - The waste load allocation is essentially the finish line or the maximum allowable load that the municipality may discharge to meet the TMDL requirement. Determine the percent load reduction from Current loads (in the TMDL) required to meet the WLA.

Any significant problems should be brought to the attention of the DEP regional office. Significant differences in data inputs to the model may make it difficult to demonstrate compliance and improvements to water quality. **When significant issues arise with load calculation the key measure is the required % load reduction**.

Mapping Needs

All TMDL plans must map the area which drains to MS4 outfalls. The map must include all of the required elements from MCM #3. If parsing is proposed (see below) mapping must also identify all areas to be parsed out.

Simple Method

MS4 communities may submit paper index map(s) of the area which drains to MS4 outfalls. Note that it is not necessary to delineate the storm sewershed by individual outfall.

GIS Method

GIS can also be used as a mapping tool, although it is not required and GIS mapping may not be necessary if the TMDL provides adequate and up to date information. Permittees may accept the TMDLs required reductions and develop BMPs to reduce loads accordingly. However, GIS mapping may be important if there have been significant changes in the MS4 area or the TMDL is out of date. GIS may also be helpful in determining BMP locations, bulk allocations, and to calculate accurate load reductions- but these can also be done through other methods.

Assembling a variety of GIS layers can ensure that the TMDL is fully understood and that any anomalies are addressed. The table below provides a list of readily available GIS data and where the data can be found.

GIS data for desktop TMDL analysis	
Data	**Source**
Ortho (.sid)	PASDA
Land Use - County	County Planning
Impervious Cover	Woods Hole Research Center
Local Roads	PASDA
State Roads	PASDA
Watersheds	PASDA
County	PASDA
Municipalities	PASDA
Urban Areas	County Planning
Streams	PASDA
NWI	PASDA
Impaired Waters	PASDA
Water Service Area	Water Authority
Sewage District Boundaries	Water Authority
CSO Area	Water Authority
MS4 Area	Local
MS4 Discharges	Local
Zoning	County Planning
Wetlands	County Planning
Water Bodies	County Planning
Steep Slopes	County Planning
Hydric Soils	County Planning
Community Facilities (Institutional, municipal)	County Planning
Floodplain	County Planning
Soils	County Planning

If you don't have access to GIS, PA DEP Geospatial Data Center developed a statewide free online mapping tool called eMap PA that allows users to identify various data on their watersheds including streams and TMDLs. The application is available at http://www.emappa.dep.state.pa.us/emappa/viewer.htm. This application provides data on several data categories including streams and water resources. Available data that are most applicable to developing a TMDL plan include HUC codes, waterbodies with TMDLs, attaining and non-attaining segments of the streams integrated list.

It is also important to locate the first permit term BMPs on a map. They can be shown on the above-discussed MS4 map or separately.

Below is an example of a TMDL plan for the hypothetical Stormyville Township, Pennsylvania. The main text is an example of what would be in a plan, and guidance for completing the plan is in text boxes. Actual TMDL plans may require more detail than is provided in the hypothetical example provided for Stormyville.

Pennsylvania Department of Environmental Protection

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Draft

Model Total Maximum Daily Load Plan

Prepared for

"Stormyville Township," Pennsylvania

February 2015

This report is the Stormyville Township Total Maximum Daily Load (TMDL) Plan/TMDL Design Details. This section outlines methods and plans to meet the TMDL requirement. The format used in this document follows the Pennsylvania Department of Environmental Protection document 3800-FM-BPNPSM043 “MS4 TMDL Plan / Chesapeake Bay Pollution Reduction Plan.” This plan includes recommendations for installing specific types of BMPs at specific locations. Preference was given to publicly owned sites since public ownership will allow for rapid implementation. Private land sites well suited for cost effective BMP implementation or BMP enhancements were also considered and included.

It is understood that this plan will be updated in the future to reflect changed conditions and permit requirements.

Keep in mind that it may take multiple permit cycles to achieve the TMDL obligation.

Below is the permittee information required by the DEP template (3800-FM-BPNPSM0493). The remaining required content of the form follows.

Check all that apply:

☐ TMDL Design Details (Section A) Completed

☒ Chesapeake Bay Pollutant Reduction Plan (Section B) Completed

GENERAL INFORMATION			
Permittee Name:	**Stormyville Township**	NPDES Permit No.:	**PA1234567**
Mailing Address:	**122 Muddy River Lane**	Effective Date:	**March 15, 2013**
City, State, Zip:	**Stormyville, PA 11111**	Expiration Date:	**March 14, 2018**
MS4 Contact Person:	**Dusty Rhodes**	Renewal Due Date:	**September 15, 2017**
Title:	**Township Manager**	Municipality:	**Stormyville, PA**
Phone:	**000-000-0000**	County:	**Stormy**
Email:	**drhodes@stormyville.org**	Consultant Name:	**ABC/123 Engineering Consultants**
Co-Permittees (if applicable): **N/A**			

#1: Summary of the TMDL Strategy Submitted to DEP with NPDES Permit Application or NOI.

Regulated small MS4's that discharge stormwater into a waterbody with a specific Waste Load Allocation in an EPA approved TMDL are required to submit to PA DEP a TMDL strategy (as part of the NOI submittal or IP application as appropriate). Once the NPDES permit is issued, the MS4 has 12 months to develop and submit an MS4 TMDL Design Details. The scenario assumed in this model plan is that a strategy was previously provided, and this plan represents the subsequently prepared Design Details.

The TMDL portion of the Muddy River Watershed is in Stormyville Township. Stormyville Township provided their TMDL strategy in the NPDES permit applications, this strategy is summarized below: "*The best opportunities for reaching the reduction goal established by the TMDL occur mainly through changes in current land use practices, including the incorporation of more stormwater "best management practices" (BMPs). The characteristics of the Muddy River Watershed and Stormyville are favorable for the application of a variety of sediment reducing stormwater BMPs and retrofits. As indicated by the TMDL the majority of the sediment load is attributed to stream bank erosion. Therefore Stormyville's TMDL strategies focuses on BMPs that improve the hydrology of the watershed by reducing storm water flows during rain events. These BMPs include retrofitting older stormwater ponds, converting conveyance systems (i.e. swales and ditches) to run-off reduction practices like vegetated swales, and bioretention where it is cost effective. Stormyville also plans to address the sources of sediment discharge, specifically highly erodible stream banks, using a variety of stream restoration approaches including bank stabilization, natural stream channel design and floodplain reconnection as well as expand and enhance riparian forest buffers where feasible. Finally Stormyville plans to implement land-use change BMPs including removing impervious cover by removing derelict buildings and other areas of excessive impervious and restoring those areas to turf or forest.*

The Waste Load Allocation (WLA) Stormyville is responsible for was developed based on the Urbanized Area (UA) however, since the TMDL was developed Stormyville has mapped its MS4 area. Stormyville has evaluated the impact of using the MS4 area as the area of responsibility vs. using the UA which was the basis for TMDL WLA. This evaluation included investigating hot spots and conducting a retrofit inventory. As a result of this investigation it was determined that a large commercial development with significant impervious areas is discharging large volumes of stormwater directly to the stream and contributing to significant stream bank failure and sediment discharges. By definition this area is not part of the MS4 however failure to address this source of the impairment will make achieving the goals of the TMDL difficult. Additionally this commercial development offers several very cost effective opportunities to implement BMPs to dramatically reduce sediment loads. As a result Stormyville has decided not to parse out this area and is using the WLA and Sediment loads in the TMDL as the basis for this plan.

Approach the creation of your TMDL Plan with the correct philosophy in mind:

The ultimate goal is for impairments to the waterbody to be eliminated. The TMDL represents a global plan for eliminating impairments, but if implementation of the plan does not eliminate the impairments further actions will need to be taken later.

Defining the MS4's Area of Responsibility (Parsing)

Geographic Area of MS4 Responsibility- *The entire area that drains to outfalls in the MS4 urban area (UA).* Municipalities must map their MS4 sewershed as part of their TMDL plan.

Parsing- *An optional process to determine the portion of the TMDL load reduction which is not the responsibility of the MS4 permittee. Land areas within the municipality's portion of the impaired watershed which do not drain into the Municipal Separate Storm Sewer (MS3) can be parsed out of the WLA.* Any parsing that is undertaken must be consistent with the terms and conditions of the applicable TMDL.

The MS4 must define its area of responsibility as part of the TMDL strategy. The jurisdiction must use the entire UA as it was defined in the original TMDL unless it can justify otherwise. However the jurisdiction may choose to use a detailed map of the MS4 area to parse down its area of responsibility to the actual mapped MS4 area and reduce its overall load reduction requirement based on a recalculation of its TMDL load.

There are some significant considerations when making this decision, of particular importance is the requirement that all Control Measures must be implemented in the defined area of responsibility. **Confining the area of responsibility (Parsing) restricts project locations that may be credited to the TMDL to the defined MS4 area**. This may significantly impact control measure selection and the overall cost effectiveness of the potential strategy.

For example, Stormyville is considering parsing out an 86 acre private business park which has no stormwater flow touching municipal streets or other "Municipal Separate Storm Sewer" components prior to discharge to reduce its overall mass load reduction requirement (i.e. the load that corresponds to that area). However, the business park has significant impervious areas which contribute large volumes of stormwater to the stream and has several older stormwater ponds which do not provide much in the way of quantity and quality control but could be cost-effectively converted (and/or have different O&M) to provide significant stormwater volume and sediment reductions. In this example these cost-effective opportunities would be lost to Stormyville and instead they would have to find potentially less cost-effective control measures located inside the MS4 area.

In this case, Stormyville determines that it is in the jurisdictions best interest to NOT parse out the business park and to keep the original load reduction requirement in order to take advantage of these cost-effective projects and the ability to address the source of significant stormwater volume which is causing significant stream bank erosion.

Keep in mind the stream will only be de-listed and removed from the impaired list when the chemistry and biology of the stream returns to an acceptable level. If the largest sources of pollutants or origins of the impairment are not addressed it may become increasingly difficult and costly to achieve the required load reductions.

Parsing and Load Calculations Continued:

- ***Streambank Erosion***- Parsing of streambank erosion loads should attempt to ascertain how land use areas removed from the WLA calculation affect downstream channel scour/degradation. There are however no unit loading rates associated with the streambank erosion loads in TMDL's that will allow for a simple recalculation of that load as would be done for the overland flow component. Ideally a tool that would allow for a re-modeling of the watershed would be used to quantify the impact of parsing on streambank erosion. However, a total land area approach may be used if further modeling is not possible.

➢ Example:
  - Step 1: Locate table in TMDL containing existing loads and loading rates for the impaired watershed.
  - Step 2: If available, provide TMDL Existing Load and WLA for the portion of mapped MS4 within the target watershed (may be same table depending on TMDL).
  - Step 3: Apply the existing loading rates and allowable loading rates to the appropriate land area after parsing to determine revised WLA.

The acreage and associated loading in the following table represents an example parsing scenario where a commercial area represented by 85.8 acres of HI_INT_DEV is parsed out (i.e. area is not draining to the MS4).

Example Recalculation of Sediment Load

From TMDL Document using entire UA

Pollutant Source	TMDL area (acres)	TMDL Unit Area Load (lbs/ac/yr)	TMDL Load (lbs/yr)	TMDL WLA Unit Area Load (lbs/ac/yr)	TMDL WLA Load (lbs/yr)	Percent Reduction
Hay/Past						
Cropland	9.3	3,408	31,753.4	1,840.3	17,146.8	46%
Forest	68.7	26	1,785.0	26.0	1,785.0	0%
Wetland	9.8	14.0	137.3	14.0	137.3	0%
Transition	-	-	-	-	-	0%
LO_INT_DEV	61.8	110	6,796.7	59.4	3,670.2	46%
MD_INT_DEV	784.6	79	61,984.6	42.7	33,471.7	46%
HI_INT_DEV	85.8	79	6,779.6	42.7	3,661.0	46%
Stream Bank			1,052,763.4		644,128.0	39%
Total	**1,020**		**1,162,000**		**704,000**	**39%**

Recalculated using mapped MS4

Pollutant Source	Recalculated MS4 Area (acres)*	TMDL Unit Area Load (lbs/ac/yr)	Recalculated MS4 Load (lbs/yr)	TMDL WLA Unit Area Load (lbs/ac/yr)	Recalculated MS4 WLA Load (lbs/yr)	Percent Reduction
Hay/Past		-	-	-	-	
Cropland	9.3	3,408.0	31,753	1,840	17,147	46%
Forest	68.7	26.0	1,785	26	1,785	0%
Wetland	9.8	14.0	137	14	137	0%
Transition			-	-	-	0%
LO_INT_DEV	61.8	110.0	6,797	59	3,670	46%
MD_INT_DEV	784.6	79.0	61,985	43	33,472	46%
HI_INT_DEV		79.0	-	43	-	
Stream Bank			964,190		588,156	39%
Total	**934**		**1,066,647**		**644,367**	**40%**

#2: Identify name(s) of surface waters that receive storm water discharges from the MS4 UA that are covered by the TMDL.

Surface waters that receive stormwater discharges from the MS4 that are covered by EPA-approved TMDLs are as follows:

- Muddy River Watershed - Sediment

303d listed tributaries that feed into the Muddy River include:

- Mountain Run
- Valley Run

Other tributaries that feed into the Muddy River include:

- Sandy Run
- Stoney Run
- Gravel Run

> The executive summary of the TMDL document often provides the name of the impaired waterbodies regulated under the TMDL. The TMDL document can be found at the PA DEP website http://www.ahs.dep.pa.gov/TMDL/. The website allows users to search by county, TMDL name (watershed, stream name), etc. to identify TMDLs applicable to their jurisdiction. In order to identify the tributaries that drain into the TMDL waterbodies, use GIS or eMap PA.

#3: Identify the total number of discharge points from the MS4 and their identification numbers (e.g., "001") for the discharges identified in No. 2, above. Attach an additional sheet if necessary. A map may also be used to identify the discharge points.

> Regulated Outfall- The specific location where stormwater from a conveyance system (storm drains, pipes, ditches etc.) owned or operated by an MS4 permittee is discharged to surface waters, and is not a combined sewer or publicly owned treatment works.

The Township has mapped and developed GIS layers identifying the discharge points located within the MS4 UA.

All of the outfalls from Stormyville Township's MS4 are shown in Appendix A, including their identification numbers and locations. Attachment A is a map of outfalls.

> This step requires municipalities to identify the location of MS4 UA stormwater outfalls within their municipal boundaries. This information should already be available as it was required in the permit application or NOI submitted to DEP. The municipality is required to provide the total number of discharges from the MS4 UA as was provided to DEP and include any additional discharges discovered since the application or NOI was submitted. For each stormwater outfall, the following information should be provided: the outfall ID, location (latitude/longitude), pipe material (i.e. CMP, RCP, etc.) and tributary.

#4: List applicable TMDL(s) as the name appears on the TMDL Report & #5: Identify the watershed name & 8-digit Hydrologic Unit Code(s) (HUC)

A list of TMDL reports is available at the following website http://www.ahs.dep.pa.gov/TMDL/. This website allows users to search for TMDLs several ways including by TMDL name, county, HUC, etc. Each search will result in a list of TMDLs with weblinks to the TMDL reports and information including the County, cause of impairment, TMDL category (major source of impairment; i.e. AMD, nonpoint source), HUC codes and TMDL approval date.

Each municipality will have a list of applicable TMDLs after completing #4 and will have access to an electronic copy of each TMDL report. Within each TMDL report, the watershed name(s) and associated 8-digit HUC(s) should be identified. If this information is not contained within the TMDL report, the watershed names and 8-digit HUC(s) are provided by stream name at this website http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_009715.pdf.

The TMDL document developed for the Muddy River is titled: "Total Maximum Daily Load (TMDL) Muddy River Watershed". The TMDL report was developed in December 2004. The name of the applicable watershed is the Muddy River watershed, HUC code: ***012034567***

Please note that some TMDLs only provide 7-digit HUC codes; this is an acceptable format to report to DEP. The 8-digit HUC can also be obtained using eMapPA by using the zoom in tool to identify the location of interest and then selecting the HUC layer.

#6: List the names of all the municipalities subject to the TMDL(s) within the area of the same 8-digit HUC.

The municipality subject to the TMDL include is Stormyville Township.

#7: List the pollutant(s) and wasteload allocations (WLAs) that are identified in the TMDL(s) for the MS4.

The pollutant of concern in the watershed is **sediment**. The Stormyville Wasteload Allocation (WLA) for sediment according to the TMDL developed using AVGWLF (ArcView Generalized Watershed Loading Function) is **352 tons/yr**. for 1,020 acres.

Table 2. Impaired Muddy River Wasteload Allocation*			
Jurisdiction	**Total Urban Area (acres) in impaired watershed**	**% of impaired urban area acres**	**Sediment WLA (tons/yr.)**
Stormyville Township	1,020	22.2	352

- *These allocations are usually developed by Pennsylvania DEP using the AVGWLF (ArcView Generalized Watershed Loading) model to establish the existing loading conditions for the impaired watershed and a similar but not impaired reference watershed.*

#8: What is the estimated current TMDL load(s) discharged by the MS4 for the pollutants identified in the TMDL(s).

If the TMDL was recently approved, the original TMDL loads provided in the TMDL document may be accurate enough to be used as the basis for the TMDL Plan. If the TMDL was written at an earlier date, many changes may have occurred in the watershed since the original TMDL load was calculated and additional calculations may be needed.

The input data from the model used to create the TMDL could be updated to reflect the current and most accurate information since the last model run. Typical information updates include:

- Changes in land use (i.e. new development, redevelopment, impervious cover removal)
- New BMPs installed (i.e. stream restoration, buffer plantings other voluntary group/citizen projects).
    - *Load reductions from BMPs installed as a result of development/redevelopment can be credited to the TMDL only if they control more pollution than was caused by the development/redevelopment.*

The predominant model used in the development of most PA TMDLs is the **MapShed model** developed by **Pennsylvania State University**. Penn State developed MapShed, as an advancement to the *AVGWLF model*, which has been used for federally-mandated "total maximum daily load" (TMDL) studies in Pennsylvania since 1999. MapShed is a GIS-based watershed modeling tool that uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to model sediment and nutrient transport within a watershed. When updating current loads, it is recommended to use the same model used in the TMDL document.

Original TMDL loads discharged to Stormyville Township's MS4 system and percent reductions necessary to achieve the WLA are shown in Table 3. Estimates of current TMDL loads were developed with MapShed using default parameter data, and compared to the original TMDL loads. In this plan, the current TMDL load was calculated using new land use GIS data as well as data related BMPs installed since the TMDL was developed. The result is a revised estimate of current loads.

Table 3. Current Loads and Required Reductions in the Impaired Muddy River Watershed						
Jurisdiction	**Original TMDL Load (tons/yr)**	**Percent Reduction to achieve WLA**	**Sediment Load Reduction Requirement (tons/yr) (TMDL)**	**Current TMDL Load (tons/yr)**	**Percent Reduction from current loads to achieve WLA**	**Sediment Load Reduction Requirement (tons/yr) (Remodeled)**
Stormyville Township	**581**	**39[1]**	**229[2]**	**528[3]**	**33[5]**	**176[4]**

[1] *Total TMDL Load (581) – WLA (352) ÷Total TMDL Load (581)*
[2] *TMDL load (581) – WLA (352)*
[3] *Calculated using MapShed, in this example the load documented in the TMDL is higher than the current load because the TMDL was written 10 years ago and changes have occurred in the area to reduce current load.*
[4] *Current Load (528)-WLA (352)*
[5] *Current Load (528)- WLA(352) ÷ Current Load (528)*

#9: Explain how the current load(s) in No.8, were estimated.

If you decided to recalculate your TMDL loads, it's important to document the data used and assumptions made in a narrative and/or table format. This section should describe the model used to estimate current loads (i.e. MapShed), the BMP data used including dates and types of practices installed, and acres treated. In addition, documentation should be provided of land use changes made in the model (i.e. impervious surface removal).

The MapShed model was used to develop this TMDL. The model was updated with new land use GIS data and data for voluntary BMPs installed since the TMDL was written. The Township had very little new development since the TMDL was developed but did complete a small stream restoration and forest buffer project and conducted some impervious removal. The new land use data was imported to the MapShed model and BMP data was entered using the BMP editor into the MapShed and the model was run. As a result in this example the Township has already made some progress towards meeting the TMDL WLA by reducing 53 tons of sediment or about a 9 % reduction from the original TMDL loads. The

The table below provides an example showing the TMDL MS4 current load provided in the TMDL Document, the updated current load from MapShed, and the Waste Load Allocation, and the load reductions required to achieve the TMDL WLA.

TMDL MS4 "Current" Load	New MS4 Current Load	WLA	Required Load Reduction	% Reductions to achieve WLA
100 lbs/yr	75 lbs/yr	50 lbs/yr	25 lbs/yr	25%

updated current load values from MapShed were then compared against the TMDL WLA to calculate the new percent load reduction required to meet the TMDL WLA.

#10: Provide a list of all control measures or BMPs that will be implemented to achieve the required pollutant reductions.

This step will identify the control measures BMPs that will be installed to meet the WLA for the TMDL. Within the PAG-13 NOI instructions, nine example TMDL control measures are provided for permittees to consider in the achieving the reduction of discharges from the MS4. These nine control measures are summarized below.

1. Establish and Protect Riparian Forest Buffers – restore vegetated buffer areas.
2. Disconnection Program – Disconnect impervious areas from your regulated small MS4 system
3. Tree Planting- Plant trees within the area that drains to the regulated small MS4.
4. Construct recharge/Infiltration facilities
5. Stormwater Basin Retrofits – Naturalize or modify for extended detention, and/or modify basins for increased infiltration.
6. Restore Stream banks – restore and/or stabilize degraded and eroded stream banks.
7. Establish Green Infrastructure at facilities that are owned by the municipality and that drain to the regulated small MS4.
8. Develop and implement additional provisions to address TMDLs or a separate MS4 TMDL stormwater management ordinance.
9. Participate in an approved trading and offset program.*

*As of the printing of this document, #9 is not an option because trading and offsetting are not yet approved for MS4s, but may be in the future.

Note: Some TMDLs indicate the mix of loads from stream banks and overland flow from the land area. If that is the case, BMPs must be selected that take source loads into consideration the source of the load (ex. Do not propose street sweeping for stream erosion). BMPs that address watershed hydrology (runoff reduction practices) reduce stream bank erosion in addition to pollutant load reductions from overland flow.

BMP Pollutant Load Reduction Alternatives

In this plan, the TMDL control measures or best management practices (BMPs) that will be implemented to achieve the required pollutant load reductions include stream restoration, impervious surface removal, bioretention, and tree buffer planting. These TMDL strategies focused on BMPs that effectively remove pollutants, are cost effective, and the jurisdiction either included or could include in infrastructure upgrade projects. These BMPs are effective at sediment removal based on the justification provided in Table 4.

Stormyville currently performs street sweeping once a year, but determined significant resources would be needed to increase street sweeping to the levels needed to dramatically decrease load. Street sweeping is not a cost effective BMP for Stormyville, and is therefore not included in this plan.

Table 4. BMP Justification- Simple Method			
Chesapeake Bay Program Scenario Builder BMP Efficiencies			
BMP	***TN Reduction Efficiency***	***TP Reduction Efficiency***	***TSS Reduction Efficiency***
Wet Ponds and Wetlands	20%	45%	60%
Dry Detention Basins	5%	10%	10%
Dry Extended Detention Basins	20%	20%	60%
Hydrodynamic Structures	5%	10%	10%
Infiltration Practices w/o sand, veg	80%	85%	95%
Infiltration Practices w/ sand, veg	85%	85%	95%
Filtering Practices	40%	60%	80%
Bioretention (C/D soils w/ underdrain)	25%	45%	55%
Bioretention (A/B soils w/ underdrain)	70%	75%	80%
Bioretention (A/B soils w/o underdrain)	80%	85%	90%
Vegetated Open Channels (C/D Soils)	10%	10%	50%
Vegetated Open Channels (A/B Soils)	45%	45%	70%
Bioswale and Step Pool Storm Conveyance	70%	75%	80%
Permeable Pavement w/o Sand Veg. (C/D Soils w/ underdrain)	10%	20%	55%
Permeable Pavement w/o Sand Veg. (A/B Soils w/ underdrain)	45%	50%	70%
Permeable Pavement w/o Sand Veg. (A/B Soils w/o underdrain)	75%	80%	85%
Permeable Pavement w/ Sand Veg. (C/D Soils w/ Underdrain)	20%	20%	55%
Permeable Pavement w/ Sand Veg. (A/B Soils w/ Underdrain)	50%	50%	70%
Permeable Pavement w/ Sand Veg. (A/B Soils w/o Underdrain)	80%	80%	85%

In order to estimate the pollutant load reduction from the identified BMP, it's important to obtain information on the drainage area (acres) to the practice including the percent impervious cover and land use within the drainage area. If GIS data is available, the percent impervious cover and land use can be determined using GIS. To calculate the current pollutant loading rate for the land use within the drainage area, multiply the appropriate land use loading rate provided in the TMDL by the land use acres provided in the drainage area. Next, calculate the BMP pollutant reduction value using the approved BMP efficiencies provided by four sources:

- Pennsylvania BMP Manual
- Chesapeake Bay Model Documentation – BMP efficiencies found in the Chesapeake Bay Model
- Chesapeake Bay expert panel reports – BMP efficiencies agreed upon by experts that may be used in the Bay Model in the future.
- Peer reviewed BMP studies – Available local data with more accurate or local BMP efficiencies.

Note: For stream bank restoration, any method for calculating load reductions can be used, as long as details for the method of calculation are provided.

For the Muddy River watershed, a watershed model developed by Pennsylvania State University, which is known as the "Enhanced Generalized Watershed Loading Function" was used to estimate sediment reductions due to potential BMPs highlighted during field work. Otherwise known as "MapShed," the model uses a GIS interface to populate input files to run the Enhanced Generalized Watershed Loading Function (GLWF-E). The GWLF-E model has been used in several academic studies as well as TMDL development for other watersheds in Pennsylvania. Using the MapShed program allows for watershed specific and customized inputs to GWLF-E, which helps ensure model accuracy.

Aside from using a model to determine the best BMPs, other factors to consider during BMP selection include:

- Effectiveness of BMP for pollutant of concern
- Underlying soil type
- Topography
- Local land ownership
- Land use
- Potential Karst area
- BMP cost
- Maintenance requirements
- Utilities

Identify BMP Locations

In order to select the appropriate BMPs to address the TMDL WLA, BMPs were selected based on their effectiveness at addressing the specific pollutant(s) of concern. The TMDL addresses sediment, which is why BMPs with high sediment removal rates were selected first.

> It's important to keep in mind that if your municipality is located in the Chesapeake Bay Watershed you are required to develop a Chesapeake Bay Pollutant Reduction Plan that will address total nitrogen, total phosphorus and total suspended solids. If both the TMDL Plan and CBPRP are required, it is important to consider BMP efficiency to reduce the pollutants of concern for both obligations.

In order to identify the appropriate BMPs, Stormyville Township started with a desktop assessment to identify specific locations for BMP opportunities within the TMDL watershed. Locations considered included:

- Hotspot sites – locations with suspected sources of pollutants (i.e. large impervious areas, etc.)
- Public properties (municipal yards, parks, schools, etc.)
- Right of ways – publicly owned space between the curb and sidewalk.
- Existing stormwater basins (especially older basin and dry ponds) – great opportunity for an upgrade, significant acres treated
- Stream restoration opportunities – if you have the streams already assessed, focus on areas with the highest priority for restoration
- Institutional lands – local schools, large universities, golf courses, etc.
- Retrofits on private property – downspout disconnection programs or rain gardens

> Field reconnaissance should be conducted to identify potential locations of BMPs. While conducting field reconnaissance, use a GPS system to identify the latitude and longitude of the site location. This data can also be obtained using Google Earth or GIS. Other locational information to gather includes street name and/or name of the site (i.e. McDonnell Park or Furland Elementary School).

Permit Term Commitments

Implementation of BMPs was divided into 5-year permit terms. During each 5-year permit cycle Stormyville Township will demonstrate incremental progress towards meeting the load reduction requirement. Stormyville Township will report on progress towards meeting the 5-year permit term goals in the annual NPDES reports. The permit term in which the different BMPs will be implemented is noted in Table 5.

Implementation Schedule

Once the TMDL control measures have been selected the municipality must establish an implementation schedule. This schedule may extend over multiple permit cycles but must demonstrate consistent measureable progress towards achieving the WLA. For the immediate permit term, preliminary designs must be completed. Some may be long range projects due to the amount of permitting and design required (i.e. stream restoration) others may need little or no permitting (i.e. tree planting). Similarly some projects may be relatively inexpensive while others may be part of a long-term capital improvement plan budget. These timelines should be taken into consideration and reflected in the implementation timeline.

When developing the overall implementation schedule keep in mind the issues involved with each project that may make it a short term or long term project. Some of these factors include:

- Land ownership
- Permit requirements
- Funding requirements
- Utilities
- Associate projects (road expansions, building renovations, etc.)
- Future development/redevelopment plans

Stormyville Township Plan Control Measures

Specific information regarding each BMP is displayed in Table 5. The control measures identified and presented here support the Stormyville Township MS4 jurisdiction's efforts to meet TMDL goals. For the Permit Term 1 projects, preliminary designs are provided in Appendix B.

Table 5. Muddy River BMPs to Achieve WLA				
Permit Term	BMP[1,3,4]	Site ID	Location	Sediment Reduction (lbs/yr)[2,3]
4	Floodplain Restoration	RRI-400	Riverside Drive to Valley Road	161,986
1	Bioretention	RRI-401	River Valley Private School	798
4	Floodplain Restoration	RRI-403	W. 14th St. - Main Street	48,825
4	Riparian Buffer Restoration	RRI-503	W. 14th St. - Main Street	916
3	Riparian Buffer Restoration	RRI-26	Peaks View Park	500
2	Floodplain Restoration	SRI-63	Peaks View Park	37,975
3	Wet Pond/retention basin retrofit	RRI-507	Lions Club	926
3	Riparian Buffer Restoration	IB-510	Sports Complex Park	785
2	Constructed Wetland	RRI-412	Sports Complex Park	1,123
3	Floodplain Restoration	SRI-399	Park Blvd. To W. 10th Street	65,100
2	Regenerative stormwater conveyance	OT-118	Ron St. and Spark Lane	2,554
2	Vegetated Swale	RRI-51	St. Patrick's School, 731 Patrick Lane	946
4	Wet Pond/retention basin retrofit	RRI-8	Uptown Elementary School	3,320
3	Wet Pond/retention basin retrofit	RRI-116a	Downtown Middle School	2,888
1	Vegetated Swale	RRI-116b	Pleasant Valley ES	473
2	Impervious cover removal	RRI-409	101 Union Ave	87
2	Impervious cover removal	RRI-411	3290 N. Ridge Rd	70
3	Wet Pond/retention basin retrofit	RRI-406	Happy View Community SWM Pond II	10,726
1	Wet Pond/retention basin retrofit	RRI-407	Happy View Community SWM Pond I	7,470
2	Wet Pond/retention basin retrofit	RRI-408	Township DPW Yard	4,533
Stormyville Township Total				*352,001 lbs.* **176 tons**

A more detailed analysis could include a complete MapShed model scenario for a variety of levels of implementation. The list of projects should be entered into a spreadsheet or database that provides the information listed below and a summary of the pollutant load reduction.

- Project name
- Location (address/street name and/or latitude and longitude)
- Project measurements with appropriate units (acres treated, linear feet of stream restoration, etc.)
- Estimated pollutant load reduction
- BMP implementation schedule

BMP Inspection, Operation and Maintenance Information

Several guidance documents exist on operation and maintenance of BMPs

- Pennsylvania Stormwater Best Management Practices Manual http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-8305
- West Virginia Stormwater Management and Design Guidance Manual http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/Pages/StormwaterManagementDesignandGuidanceManual.aspx
- Center for Watershed Protection's Post Construction Tool (Hirschman and Kosco 2008) provides several checklists including a construction inspection checklist and maintenance inspection checklist. The construction inspection checklist is used to help verify the proper phasing, installation, and initial stabilization of a range of structural and non-structural practices. This checklist is available at http://www.cwp.org/online-watershed-library/doc_download/483-tool-6-bmp-construction-checklist

Maintenance inspection checklists are used during the periodic (annual or semi-annual) inspection of a range of structural practices (e.g. ponds, wetlands, etc.) and non-structural practices (e.g. impervious area disconnection, etc.). They are used to identify routine and non-routine maintenance tasks and repairs that are needed for stormwater BMPs. The maintenance inspection checklist is found at http://www.cwp.org/owl-online-watershed-library/doc_download/484-tool-6-bmp-maintenance-checklist.

To insure that proper O&M is accomplished, the street department staff will maintain the public BMPs. For the BMPs on privately owned land, a written agreement that runs with the land will be completed, as described in the stormwater ordinance. A report form will be sent annually to be completed by land owners. Streets department staff will ensure they are submitted and will perform on-site spot checks for accuracy. If land owners do not perform maintenance in a timely fashion, street staff will do the maintenance and bill the land owners.

The Chesapeake Stormwater Network (CSN) (2013) developed a technical bulletin that provides visual indicators to efficiently inspect and maintain LID practices over their lifecycle. LID practices included are bioretention, grass channels, filter strips and sheet flow to buffers, permeable pavement and infiltration practices. The document is found at http://chesapeakestormwater.net/wp-content/uploads/downloads/2013/10/FINAL-VERSION-BIORETENTION-ILLUSTRATED-102113.pdf

In addition, CSN developed a bioretention inspection app that follows the approach of our bioretention illustrated guide and allows users to conduct rapid inspections of individual bioretention practices in the field. The bioretention inspection app and illustrated guide are available at http://chesapeakestormwater.net/2014/02/inspection-app/

There are several BMP tracking programs available for municipalities to use MS4web Permit Manager by CBI is one option. The program will help track permit requirements and is available for a fee http://www.ms4web.com/MS4StormwaterSoftware/

Code and Ordinances

Jurisdictions can undertake an in-depth review of the standards, ordinances and codes (i.e., the development rules) that shape how development occurs in the community by comparing local development rules against model development principles. Institutional frameworks, regulatory structures, and incentive programs could be included in this review. This review process may result in agreement where local codes and ordinances are changed or adopted and result in the implementation of additional TMDL control measures over time.

Stormyville Township conducted a review of their local development ordinances to identify and remove impediments to LID in their ordinances. Documents reviewed in this process included subdivision regulations, road standards, parking standards, and natural resource regulations such as forest conservation and stream buffer ordinances. The development standards in Stormyville Township were compared to a set of national standards. The evaluation identified several recommended changes to ordinances that will better encourage the use of LID during development listed below.

- Require the use of curb and gutter along residential streets only where necessary and allow for open section roadways when applicable
- Reduce the number of parking spaces required for commercial properties
- Require landscaping in parking islands that can also be used for stormwater treatment
- Require a stream buffer and tree conservation at development sites

> If local ordinances require greater stormwater treatment than the state Chapter 102 requirements, then the increment of additional pollution control may be applied as a credit towards the TMDL-required pollutant load reduction.

Stormwater Financing

Stormyville is aware of the financing requirements needed for these projects to occur. Our methodology is to identify and implement the most cost effective solutions first. For example, LID improvements to municipal upgrades do not add significant additional costs, some even create efficiencies.

The listed BMPs are being done in conjunction with other related projects, so less funding is required than if they were standalone projects. We are considering ordinances that require greater control than the 102 permit. For long term projects, we will look at CIP budgets, infrastructure bonds, low interest revolving loans, and potentially impose a fee.

> Permittees are encouraged to seek funding from the Pennsylvania Infrastructure Investment Authority (PENNVEST). Info available at www.pennvest.pa.gov.

Combining stormwater BMP implementation with other infrastructure improvement projects may result in significant cost savings. One example is located in the City of Lancaster where an intersection prone to flooding and traffic accidents was being addressed. The city decided to realign the intersection, and took the opportunity to install four bioretention basins on each side of the intersection as part of the realignment project to capture stormwater and reduce runoff. A business, located at the intersection, built a cistern to store the rainwater from its roof, further decreasing the flow into the street. The cistern is used to water plants they grow for their restaurant operation. The project also included installing permeable pavers in the patio space and new parking stalls.

Provided below is a list of manuals and reports communities can use to evaluate sources of revenue for financing stormwater management. These resources include a stormwater financing manual for local governments, and two reports on creating financial markets and financing stormwater infrastructure in the City of Philadelphia.

1) Environmental Finance Center. 2014. Local Government Stormwater Financing Manual: A Process for Program Reform. University of Maryland.

http://www.efc.umd.edu/assets/publications/2efc_stormwater_financing_manual_final_(1).pdf

The goal of this manual is to provide local leaders with the foundation for establishing and growing effective stormwater management programs that maximize the value and impact of every dollar invested in their communities.

2) Natural Resources Defense Council. 2012. Financing Stormwater Retrofits in Philadelphia and Beyond.

http://www.nrdc.org/water/files/stormwaterfinancing-report.pdf

This report uses Philadelphia as a test case to explore how cities can attract billions of dollars in private investment in stormwater retrofits, saving on public infrastructure costs while cleaning waterways and greening communities. Drawing lessons from the energy efficiency finance sphere, it explains how Philadelphia's stormwater billing structure lays the groundwork for innovative financing mechanisms that can underwrite the capital costs of green infrastructure retrofits. The report provides recommendations for local and state officials, as well as private firms, to stimulate investment.

3) Natural Resources Defense Council, EKO Asset Management Partners, The Nature Conservancy. 2013. Creating Clean Water Cash Flows Developing Private Markets for Green Stormwater Infrastructure in Philadelphia

http://www.nrdc.org/water/stormwater/files/green-infrastructure-pa-report.pdf

This report provides more detailed analysis and recommendations to stimulate investment in green infrastructure on the part of municipalities and private investors. Although the analysis and recommendations are directed toward the case of Philadelphia, the report provides strategies that other cities can use to identify economical green infrastructure retrofit opportunities and, where possible, leverage private capital in efforts to "green" their urban space.

List the references you use in the development of your plan

References

Chesapeake Stormwater Network (CSN) 2013. Technical Bulletin No. 10. Biotetention Illustrated: A Visual Guide for Constructing, Inspecting, Maintaining and Verifying the Bioretention Practice 2013.

Devereu, O. 2011. Chesapeake Bay Assessment Scenario Model Documentation.

Fraley, L., A. Miller and C. Welty. 2009. Contribution of in-channel processes to sediment yield in an urbanizing watershed. *Journal of American Water Resources Association*. 45(3):748-766.

Hirshman, D., Kosco, J. 2008. Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program. EPA Publication No: 833-R-08-001. Center for Watershed Protection, Ellicott City, MD. http://www.cwp.org/online-watershed-library/doc_download/70-post-construction-manual-managing-stormwater-in-your-community

King, D. and P. Hagan, 2011. Costs of Stormwater Management Practices in Maryland Counties. Prepared for the Maryland Department of the Environment. Technical Report Series No. TS-626-11 of the University of Maryland Center for Environmental Science. Solomons, Maryland.

Land Studies. 2005. Stream bank erosion as a source of pollution: research report.

Pennsylvania Department of Environmental Protection (PA DEP), 2013. Municipal Separate Storm Sewer System (MS4) TMDL Plan/Chesapeake Bay Pollution Reduction Plan Instructions. http://www.elibrary.dep.state.pa.us/dsweb/Get/Version-103707/3800-FM-BPNPSM0493%20Instructions%20and%20Instructions%20-%20Attachment%20A.pdf

Schenk, E., Hupp, C., Gellis, A., and G. Noe. 2012. Developing a new stream metric for comparing stream function using a bank-floodplain sediment budget: a case study of three piedmont streams. Earth Surf. Process. Landforms doi: 10.1002/esp.3314.

Schueler, T., and B. Stack. 2014. Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects. US EPA Chesapeake Bay Program. Annapolis, MD.

Appendix A. MS4 Discharge Identification Numbers

The existing regulated outfalls are provided in Table A1. The City of Stormyville Township was in the process of digitizing all the regulated outfalls at the time of this report.

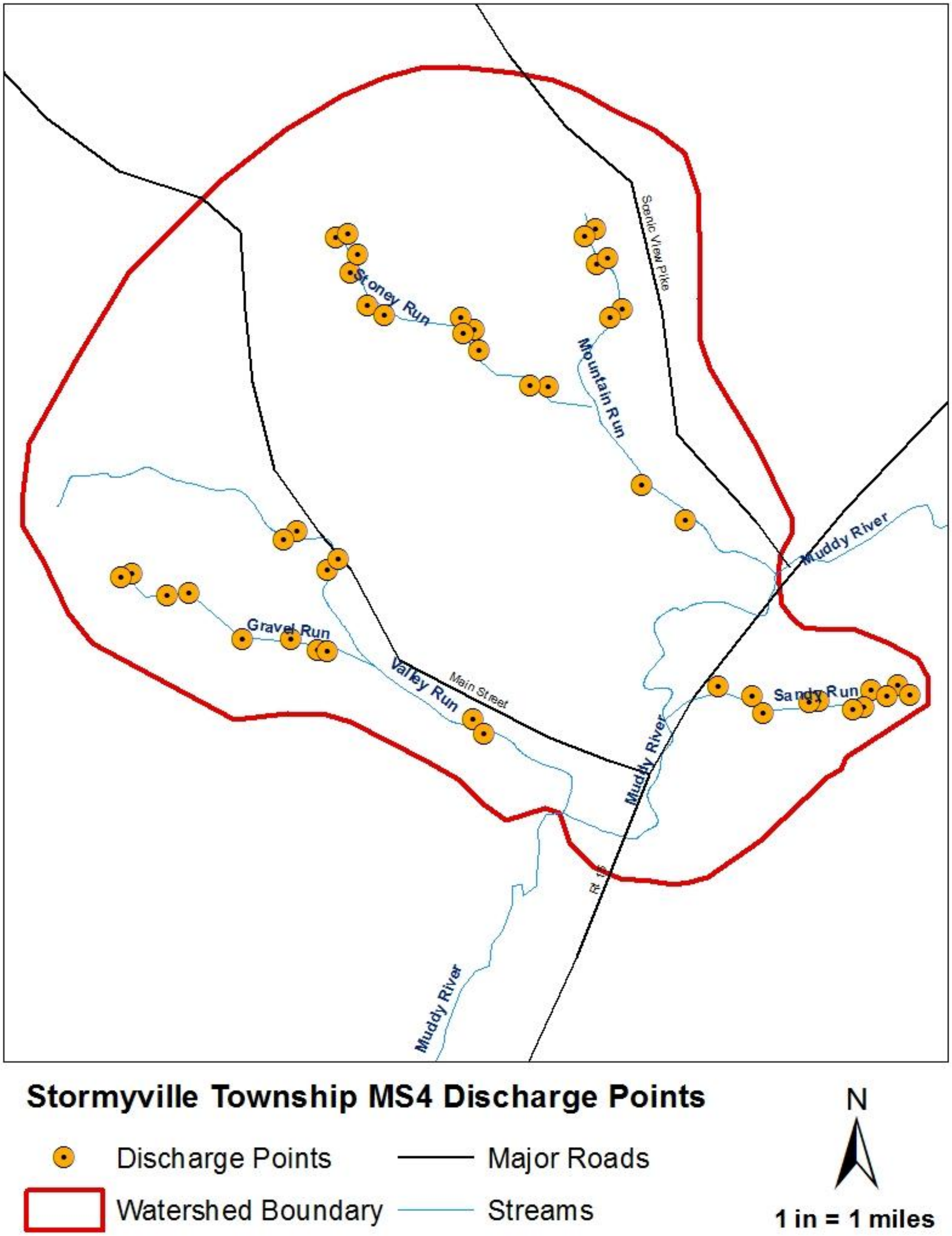
Table A1. Stormyvill Township MS4 Regulated Outfalls

Stormyville Township MS4 Regulated Outfalls				
Identification Number	**Latitude**	**Longitude**	**Pipe Material**	**Tributary**
001	43.54582573	-76.36869373	Corrugated Plastic	Gravel
002	43.54582908	-76.36869155	Corrugated Plastic	Gravel
003	43.55248884	-76.34091778	Swale	Gravel
004	43.54679434	-76.34349563	Corrugated Plastic	Gravel
005	43.54673910	-76.34347845	Corrugated Plastic	Gravel
008	43.54141777	-76.35389531	Concrete	Gravel
001	43.54582573	-76.36869373	Corrugated Plastic	Gravel
002	43.54582908	-76.36869155	Corrugated Plastic	Gravel
009	43.54075291	-78.41112276	Plastic	Mountain
010	43.54131551	-78.41277005	Plastic	Mountain
011	43.54163377	-78.41326534	Corrugated Plastic	Mountain
012	43.54215479	-78.41425725	Concrete	Mountain
013	43.54266114	-78.41591461	Plastic	Valley
014	43.54328945	-78.41778620	Swale	Valley
015	43.54392555	-76.41879924	Swale	Valley
016	43.54511335	-76.41951891	Metal	Valley
017	43.54756916	-76.42446105	Concrete	Valley
018	43.54762188	-76.42459708	Swale	Valley
020	43.55451357	-76.44509813	Concrete	Valley
022	43.52808518	-76.36365067	Concrete	Valley
023	43.52978109	-76.36525916	Concrete	Stoney
024	43.53162829	-76.36802804	Concrete	Stoney
025	43.53157783	-76.36822812	Concrete	Sandy
026	43.53202593	-76.36976385	Corrugated Plastic	Sandy
027	43.53202987	-76.36976158	Plastic	Sandy
028	43.53228526	-76.37059164	Corrugated Plastic	Sandy
029	43.53231921	-76.37161516	Galvanized	Sandy
030	43.53263756	-76.37283657	Plastic	Sandy
031	43.53485876	-76.37539087	Galvanized	Sandy
032	43.53458098	-76.37560805	Corrugated metal	Sandy
033	43.53572151	-76.37473758	Galvanized	Sandy
034	43.53609191	-76.37444925	Box Culvert	Sandy

The above list is provided for conceptual purposes only. A real TMDL Plan would be expected to have a list that matches the discharge point map in Figure A1.

The Figure 1 discharge point map is adequate for general information only; it does not provide the level of detail required for MS4 Minimum Control Measure #3.

Figure A1. Discharge points for Stormyville Township.



Appendix B: Preliminary Designs

Stream Restoration at Sandy Run

Figure B1: Vicinity Map and Site Description

The project at Sandy Run is located between Highway 1 and adjacent farmland (Figure B1). The project reach is a relatively uniform channel with tight meanders. A significant amount of sediment is present throughout, and is rapidly eroding. Using GIS, the contributing drainage area was found to be 420 acres (Figure B2).

Figure B2: Drainage Area

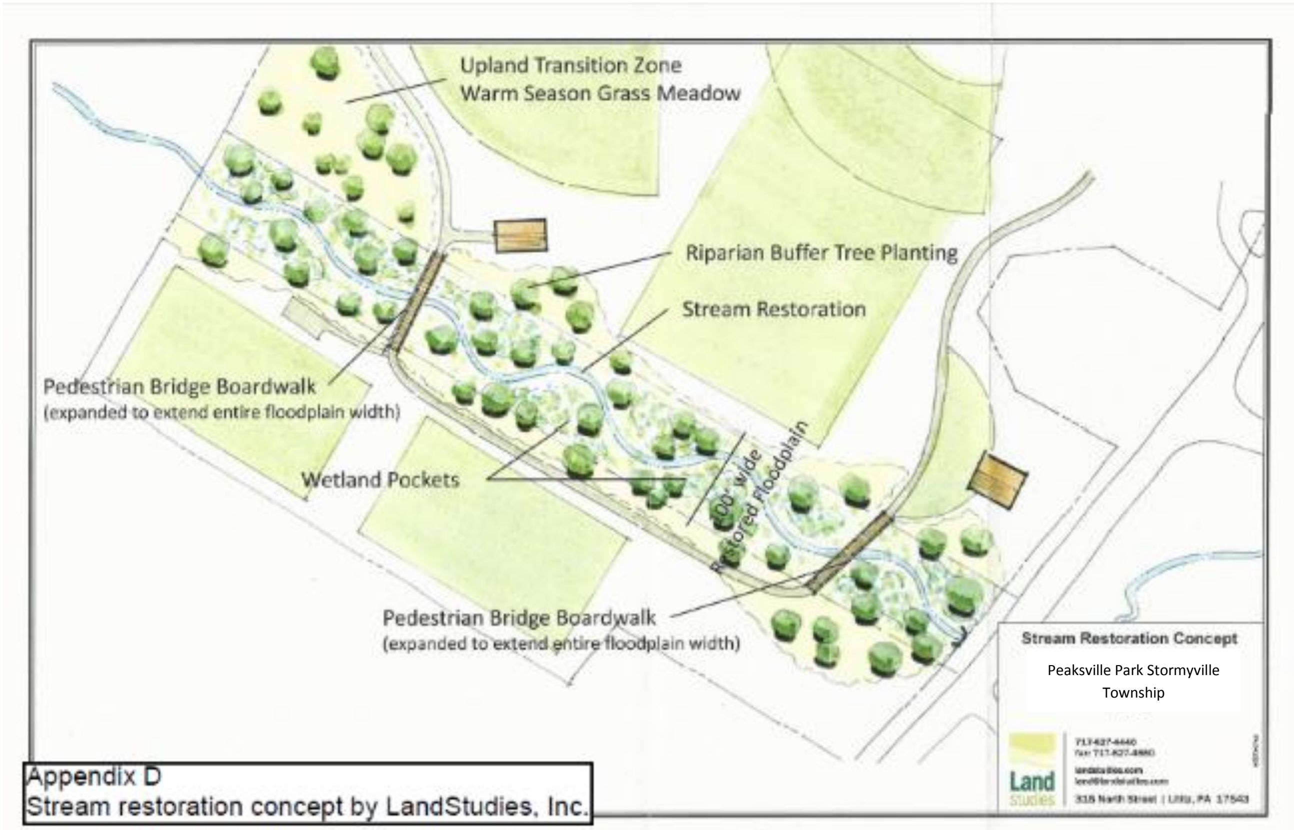


Figure B3: Stream Restoration Concept

Sediment Prevention Calculations

The measured linear feet of restoration at this location is 846 ft (Figure B3). Using the default Chesapeake Bay Program Approved Edge-of-Stream 2011 Interim Approved Removal Rates per Linear Foot of Qualifying Stream Restoration of 44.88 for non-coastal plain (Schueler, Stack, 2014 pg. 13-14), the total load reduction is 846 ft x 44.88 lb/ft/yr= 37,968 lb/yr of sediment.   As the designs process progresses, we anticipate revising this estimate.

In this plan, the Chesapeake Bay Program Expert Panel Recommendations were used to calculate the load reduction. Other methods are allowed, as long as there is an explanation of the method and why it was chosen.

Bioretention at River Valley Private School

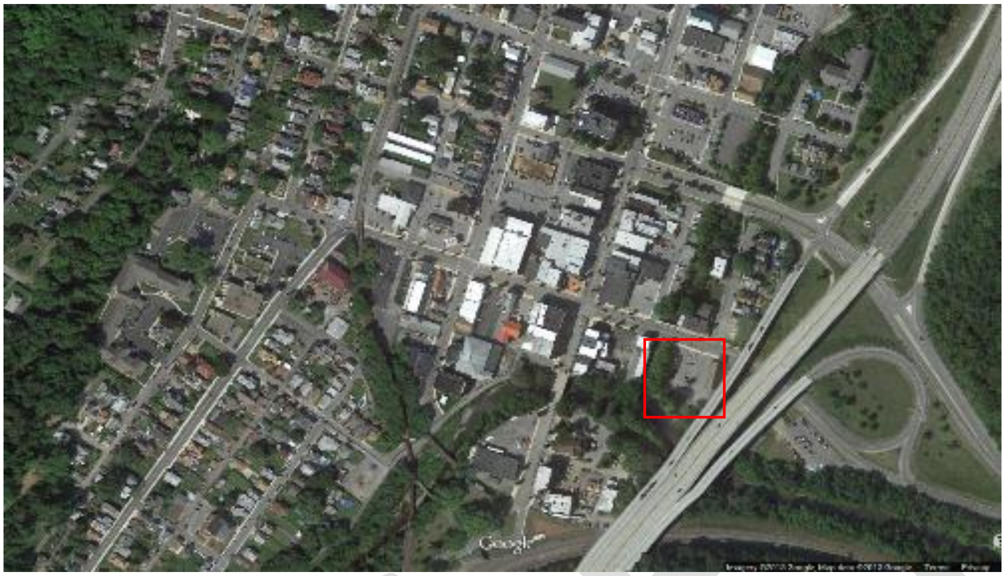


Figure B4: Vicinity Map

The River Valley Private School is located off 100 West Street in Stormyville Township (Figure B4). The site contains the River Valley Private School building and a parking lot serving that building. It has been proposed that a bioretention system be placed at the eastern-most portion of the parking lot (Figures B5 and B6). The roof of the school drains directly to the low point in the parking lot, at the south end of the lot. A bioretention at this location will not interfere with any existing parking space or the flow through the lot, except during construction. The 2200 cubic foot BMP volume will capture approximately a 1.34" storm event, which corresponds to the following removal rate based on the curves in the Chesapeake Bay Expert Panel for Urban Stormwater Retrofits: 80.0% total suspended solids (TSS). These removal rates, combined with the Chesapeake Assessment and Scenario Tool (CAST) land use pollutant loading rates for Stormyville Township give the total reduction rates of 798 lbs/yr of TSS for this BMP.

> In this plan, the Chesapeake Bay Program Expert Panel Recommendations were used to calculate the load reduction. Other methods are allowed, as long as there is an explanation of the method and why it was chosen.

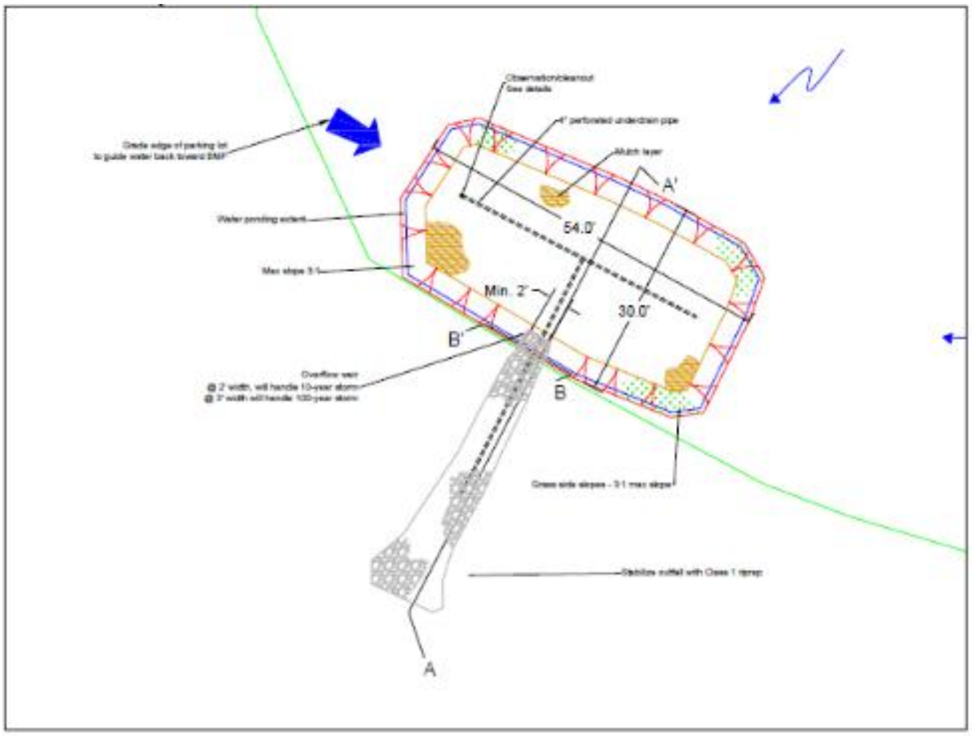


Figure B5: Bioretention Drawing

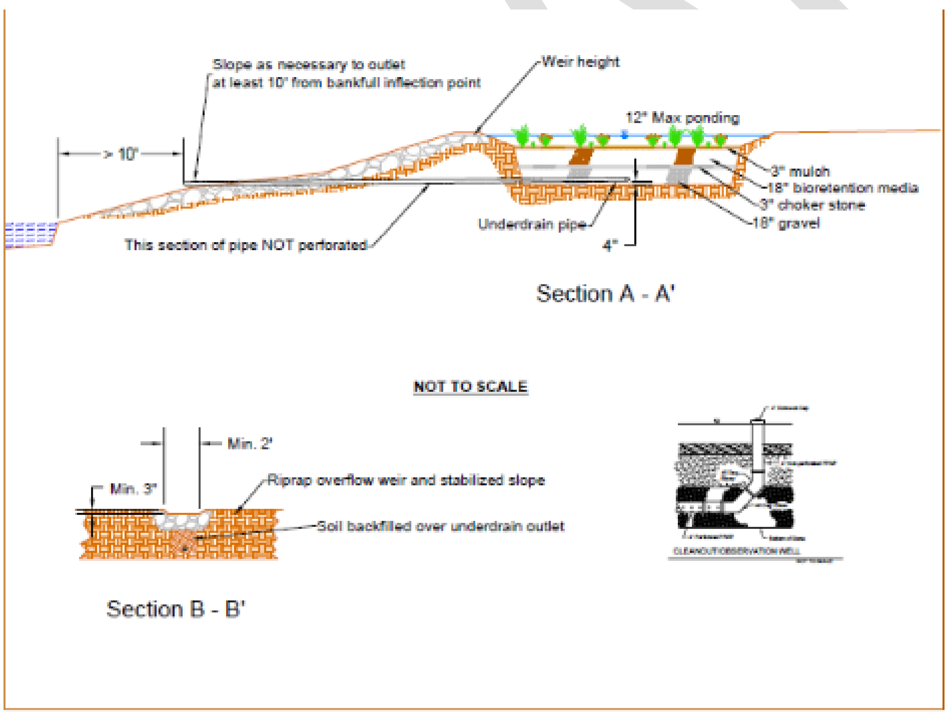


Figure B6: Bioretention Drawing, plan view

Bioretention at River Valley Private School Design Parameters

Parameter	Value	Units	Source
Drainage Area (A)	0.48	acres	GIS, GPS track
Impervious Proportion (Imp)	1.0	decimal percent	Estimate from aerial imagery
Impervious Area	0.48	Acres	A*Imp
Intensity 10-year, 24-hour (i)	1.40	inches per hour	NOAA, peak intensity for type II storm
Runoff Coefficient (C)	0.95		(0.95*impervious) + (0.22*pervious) (0.95*Imp) + (0.22*(1-Imp))
Peak Flow (Q)	0.6	cubic feet per second	Q=CiA
Target Rainfall Event (Pe)	0.7	inches	90^{th} percentile rainfall event for Stormyville Township
Water Quality Volume (WQv)	1159	cubic feet	Pe*C*A*(43,560 sf/12 in)

Stormwater Retention Pond at Happy View Community

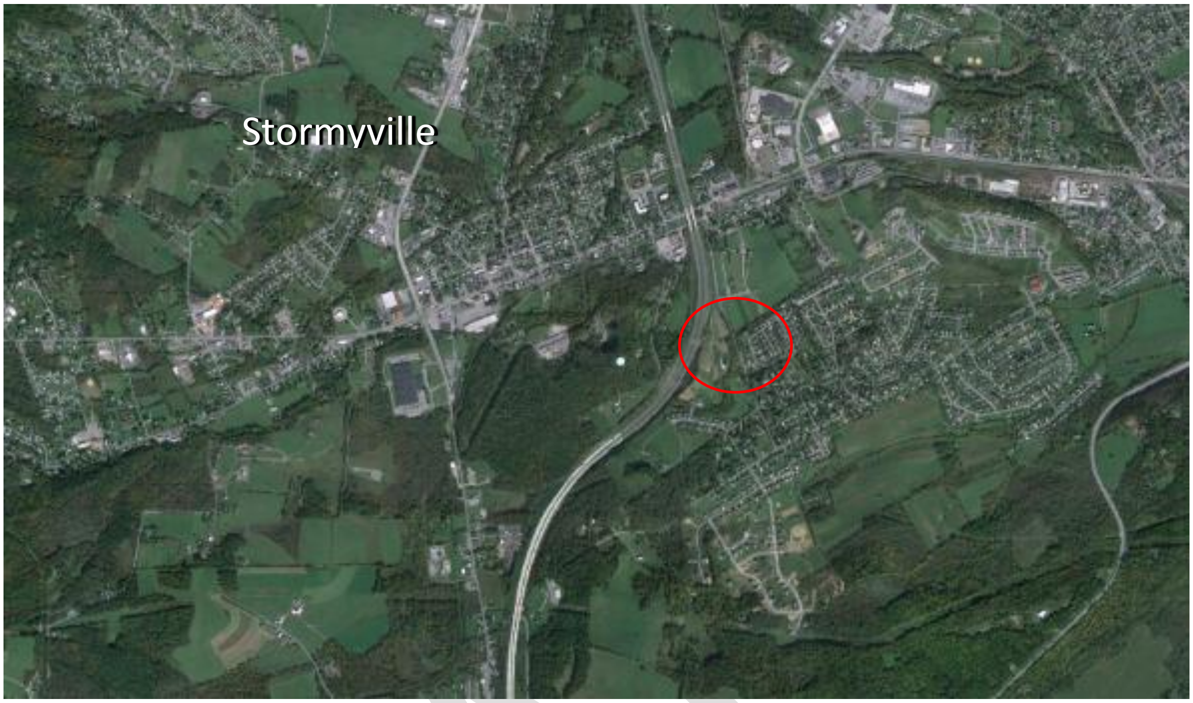


Figure B7: Vicinity Map

The location of the pond retrofit is in the Happy View Community in Stormyville (Figure B7). A dry pond currently functions to provide peak flow control for a range of storms, but does not provide any measureable treatment. A water quality treatment retrofit may add to the functionality of this practice. The neighborhood in which this pond is located is encircled by Happy Street. It is a low to medium-density single-family residential area with small lots and large homes.

The contributing drainage area, delineated using GPS and GIS, is approximately 13.7 acres. Half of this is impervious, consisting of roofs, driveways, and roadways. The pervious area is almost exclusively turf grasses in suburban yards. The only stormwater management practice currently in place is the dry pond at the base of the drainage area. Based on the outflow control structure, this pond provides only peak shaving, reducing downstream erosive flow velocities from the runoff from this neighborhood. The light blue polygon in Figure B8 shows the contributing drainage area, and the pond is outlined in red.

Figure B8: Drainage Area and pond location

The existing dry pond will be converted to have a permanent pool. Wet ponds allow water to be treated through settling and biological uptake through denitrification as well as biomass production. Wet ponds are specified in the Pennsylvania Stormwater BMP Manual in section 6.6.2. Figures B9 and B10 are schematics of the proposed wet pond.

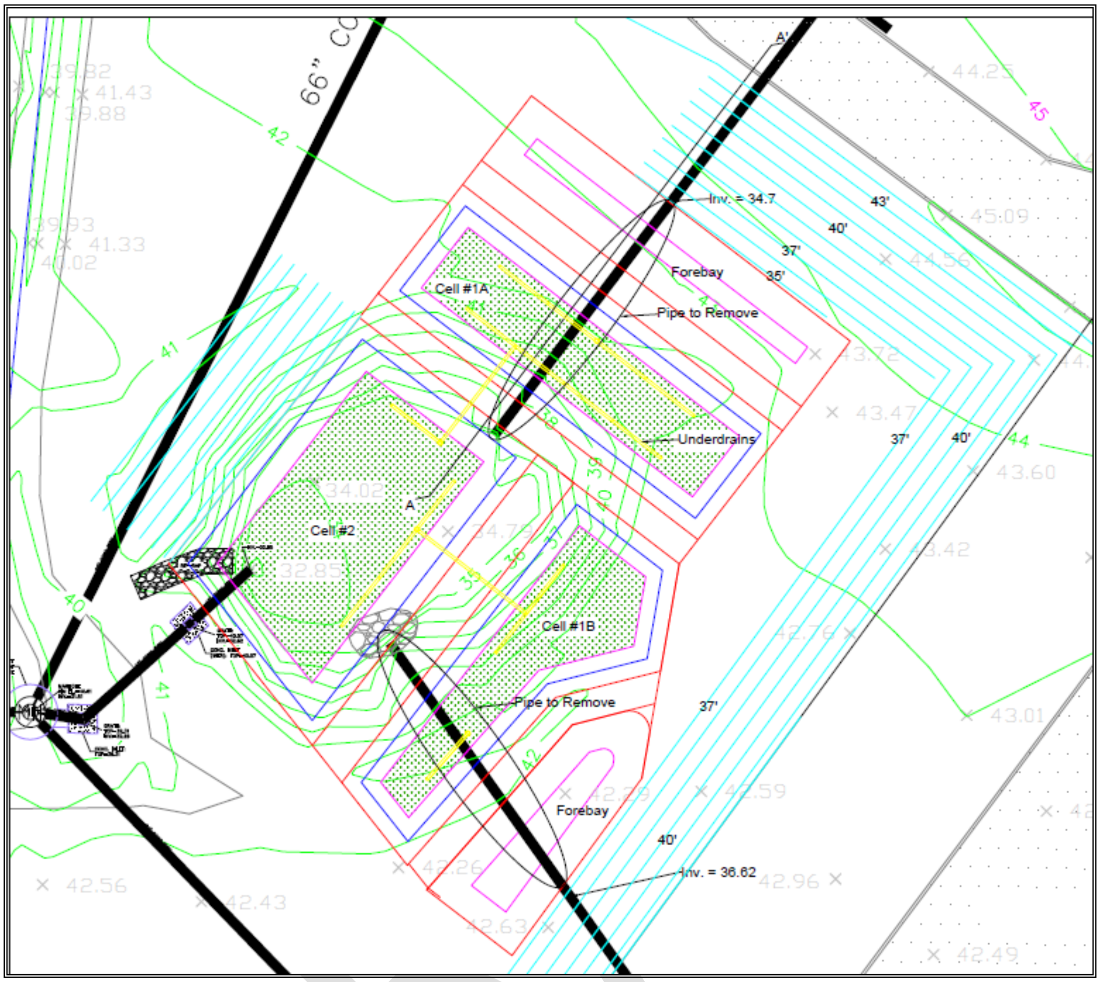


Figure B9: Pond Retrofit Plan View

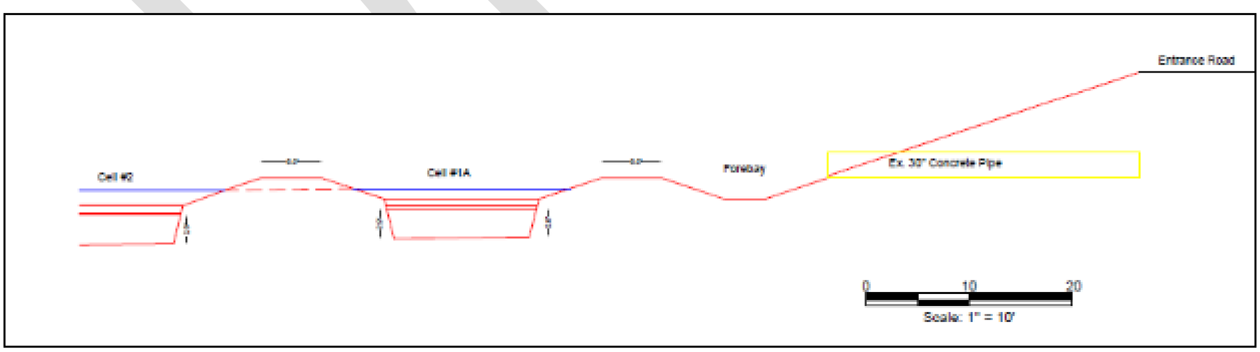


Figure B10: Pond Retrofit Cross Section

Parameter	Value	Units	Source
Drainage Area (A)	13.7	acres	GIS, GPS track
Impervious Proportion (Imp)	0.5	decimal percent	Estimate from aerial imagery
Impervious Area	6.9	acres	A*Imp
Intensity 10-year, 24-hour (i)	1.40	inches per hour	NOAA, peak intensity for type II storm
Runoff Coefficient (C)	0.59		(0.95*impervious) + (0.22*pervious) (0.95*Imp) + (0.22*(1-Imp))
Peak Flow (Q)	11.2	cubic feet per second	Q=CiA
Target Rainfall Event (Pe)	0.7	inches	90^{th} percentile rainfall event for Stormyville Township
Water Quality Volume (WQv)	20538	cubic feet	Pe*C*A*(43,560 sf/12 in)
Volume detained	25888	cubic feet	51'*94'*6'*0.9 - assuming 10% volume lost to forebay construction

Using the Chesapeake Bay Program-approved expert panel reports on stormwater retrofit performance and credit (Schueler, Lane, 2012), and the Chesapeake Assessment and Scenario Tool (CAST) land use loads of urban developed land in Stormyville, the annual benefit gained by installing this practice is expressed as the difference between the benefits provided by the existing pond and the modeling new benefit of an upgraded practice. The removal rate for total suspended solids (TSS) is 7470 lbs/yr.

In a real TMDL Plan, each BMP to be constructed in the first permit term would be expected to have its O&M Plan briefly described as part of the preliminary design.

The same is true for BMPs which are already constructed (constructed after the date of the TMDL but before the first permit term) which the permittee intends to credit to TMDL responsibilities.

Appendix C: Map

Work in progress

Hard copy provided which shows the location of all first permit term BMPs.

Appendix D: BMP O&M Plans

Work in progress

Provided as a separate attachment.

The information below is provided as a general resource to the reader

Resource A. BMP Inspection, Operation, and Maintenance

Rain Garden/Bioretention

A bioretention area (also referred to as a rain garden) is a shallow planted depression designed to retain stormwater before it is infiltrated or discharged downstream. Considerations for effective inspection, operation, and maintenance of bioretention practices are provided below.

- A site specific O&M plan that includes the following considerations should be prepared by the designer prior to putting the bioretention practice into operation:
    - Operating instructions for outlet component
    - Vegetation maintenance schedule
    - Inspection checklists
    - Routine maintenance checklists
- Adequate access to all facilities is required for inspection, maintenance and landscaping upkeep.
- The surface of the bioretention area may become clogged with fine sediment over time. Core aeration or cultivating of non-vegetated areas may be required to ensure adequate filtration.
- Bioretention areas should not be used as dedicated snow storage areas.
    - Areas designed for infiltration should be protected from excessive snow storage where sand and salt is applied.
- In areas of high salt use in the winter, the bioretention area should be planted with salt tolerant and non woody plant species.
    - Bioretention areas should be periodically inspected for sediment build-up on the surface.

Recommended maintenance activities

- During establishment
    - Water plants as needed unless rainfall is adequate
    - Replace dead plant material
- As needed
    - Prune and weed to maintain appearance and plant survival
    - Replace mulch as needed
    - Remove trash and debris
    - Replace vegetation whenever percent cover of acceptable vegetation falls below acceptable levels
- Semi-annually
    - Inspect inflow and overflow points for clogging; remove any sediment and debris
    - Inspect for erosion or gullying as necessary
    - Evaluate the health of plant material and replant as appropriate to meet project goals
    - Remove any dead or severely diseased vegetation
    - Cut back and remove previous year’s plant material and remove accumulated leaves if needed (or controlled burn where appropriate)

Vegetated swale

A bioswale or vegetated swale is a form of bioretention used to treat water quality, attenuate flooding potential, and convey stormwater away from critical infrastructure. These systems are linear, with length and width dimensions much greater than typical bioretention cells. Considerations for effective inspection, operation, and maintenance of bioswale practices are provided below.

- A site specific O&M plan that includes the following considerations should be prepared by the designer prior to putting the bioretention practice into operation:
    - Operating instructions for outlet and inlet components if applicable
    - Vegetation maintenance schedule
    - Inspection checklists
    - Routine maintenance checklists
- Adequate access to all facilities for inspection, maintenance and landscaping upkeep.
- The surface of the ponding area may become clogged with fine sediment over time. Core aeration or cultivating of non-vegetated areas may be required to ensure adequate filtration.
- Bioswale areas should be periodically inspected for sediment build-up on the surface.

Recommended maintenance activities

- During establishment
    - Water plants as needed unless rainfall is adequate
    - Replace dead plant material
- As needed
    - Prune and weed to maintain appearance and plant survival
    - Replace mulch as needed
    - Remove trash and debris
    - Replace vegetation whenever percent cover of acceptable vegetation falls below acceptable levels
- Semi-annually
    - Inspect inflow and overflow points for clogging; remove any sediment and debris
    - Inspect for erosion or gullying as necessary
    - Inspect check dams for erosion, bypass, and stability
    - Evaluate the health of plant material and replanted as appropriate to meet project goals
    - Remove any dead or severely diseased vegetation
    - Cut back and remove previous year's plant material and remove accumulated leaves if needed

Step Pool Storm Conveyance

This information comes from the West Virginia Stormwater Manual, which was recently updated.

Step Pool Storm Conveyance (also referred to as regenerative stormwater conveyance or RSC) are open-channel conveyance structures that convert surface storm flow to shallow groundwater flow through attenuation ponds and a sand seepage filter. These systems safely convey, attenuate, and treat the quality of storm flow. These structures utilize a series of constructed shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/woodchip mix filter bed media. Considerations for effective inspection, operation, and maintenance of step pool storm conveyance practices are provided below.

- A site specific O&M plan that includes the following considerations should be prepared by the designer prior to putting the RSC practice into operation:
  - Vegetation maintenance schedule
  - Inspection checklists
  - Routine maintenance checklists
- Adequate access to all facilities for inspection, maintenance and landscaping upkeep

Recommended maintenance activities

- During establishment
  - Inlet and outlet cleaning
  - Replace dead plant material
  - Remove litter and debris
- As needed
  - Prune and weed to maintain appearance and plant survival
  - Repair of damaged check dams
  - Realignment of rip-rap or cobble
  - Sediment removal
  - Repair erosion areas
- Semi Annual
  - Regular inspections should be undertaken after significant storm events

Wet Pond/Retention Basin (Stormwater Pond Retrofit)

Retrofitting existing stormwater basins to provide additional storage and/or water quality treatment is an effective way to provide additional water quality and downstream benefits. There are a variety of approaches to retrofitting existing basins. Each project may be unique and require its own specific operation and maintenance requirements. However, common considerations for effective inspection, operation, and maintenance of basin retrofit practices are provided below.

- A site specific O&M plan that includes the following considerations should be prepared by the designer prior to putting the bioretention practice into operation:
  - Operating instructions for outlet and inlet components, if applicable
  - Inspection checklists
  - Routine maintenance checklists
- Adequate access to all facilities for inspection, maintenance and landscaping upkeep

Recommended maintenance activities

- Semi-annually
  - Inspect inflow and overflow points for clogging
  - Inspect for erosion or gullying
- As needed
  - Remove sediment and debris from forebay
  - Mow pond buffer to maintain access
  - Remove woody vegetation from embankments
- Periodically
  - Remove sediment from permanent pool every 2-7 years, or after 50 percent of permanent pool capacity has been lost (to prevent rapid release and minimize the discharge of sediments or anoxic water)

Constructed Wetlands

Stormwater wetlands are similar to stormwater wet ponds and can be a form of a retrofit. Stormwater wetlands incorporate vegetation and wetland plants into the design. Similar to bioretention, pollutant removal is achieved through settling and biological uptake within the practice. Stormwater wetlands can also provide aesthetic and habitat benefits. There are many design variations of stormwater wetlands. However, common considerations for effective inspection, operation, and maintenance considerations for basin retrofit practices are provided below.

- A site specific O&M plan that includes the following considerations should be prepared by the designer prior to putting the bioretention practice into operation:
  - Operating instructions for outlet and inlet components, if applicable
  - Vegetation maintenance schedule
  - Inspection checklists
  - Routine maintenance checklists
- Adequate access to all facilities for inspection, maintenance and landscaping upkeep

Recommended maintenance activities

- Semi-annually
  - Inspect inflow and overflow points for clogging
  - Inspect for erosion or gullying
- As needed
  - Remove sediment and debris from forebay before it occupies 50% of the forebay, typically every 3 to 7 years
  - Mow pond buffer to maintain access
  - Remove woody vegetation from embankments
  - Repair slumping, animal burrows, and seepage associated with dam
- Periodically
  - Manage invasive plants
- Others
  - During first growing season, vegetation should be inspected every 2 to 3 weeks
  - During the first two years, inspect at least 3 times per year and after major storms (greater than 2 inches in 24 hours)

Riparian Buffer Restoration

Riparian buffer restoration is planting trees and shrubs next to streams, lakes, ponds and wetlands. Stream buffers add to the quality of the stream and the community by reducing watershed imperviousness, protecting streambanks from erosion, increasing pollutant removal, providing food and habitat for wildlife, and helping with flood control. Considerations for effective inspection, operation, and maintenance of riparian buffer practices are provided below.

- A site specific O&M plan that includes the following considerations should be prepared by the designer prior to putting the riparian buffer practice into operation:
  - Vegetation maintenance schedule
  - Inspection checklists
  - Routine maintenance checklists
- Adequate access to all facilities for inspection, maintenance and landscaping upkeep

Floodplain Restoration

Floodplain restoration, or stream restoration, in the broadest sense is a set of activities that aim to restore the natural state and functioning of the stream system to support, biodiversity, recreation, flood management and landscape development. Stream restoration typically involves the application of fluvial geomorphology to create stable channels that maintain a state of dynamic equilibrium among water, sediment, and vegetation such that the channel does not aggrade or degrade over time. Stream restoration projects may or may not include substantial floodplain connection. While there are a variety of approaches to stream restoration some common considerations for effective inspection, operation, and maintenance considerations for stream restoration are provided below.

- A site specific O&M plan that includes the following considerations should be prepared by the designer prior to putting the floodplain restoration practice into operation:
    - Vegetation maintenance schedule
    - Inspection checklists
    - Routine maintenance checklists
- Adequate access to all facilities for inspection, maintenance and landscaping upkeep.

Recommended maintenance activities

- During establishment
    - Replace dead plant material.
    - Remove litter and debris
- As needed
    - Prune and weed to maintain appearance and plant survival
- Semi Annual
    - Regular inspections should be undertaken after significant storm
        - Inspect structural elements (weirs, rock veins, etc.)