Upper Monocacy River Watershed Carroll County, Maryland Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with the urban wasteload allocation (WLA) for Upper Monocacy River watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative best management practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Annual updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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I. Introduction

The Upper Monocacy River watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for nutrients and sediments in 1996 and again for fecal bacteria in 2002. A Total Maximum Daily Load (TMDL) for Total Suspended Sediments (TSS) and bacteria were developed and approved in December of 2009 with a subsequent TMDL for phosphorus developed and approved in May of 2013 for the Upper Monocacy River watershed.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the City of Taneytown, and the Monocacy Scenic River Citizens Advisory Board.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for the Potomac River and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Upper Monocacy River watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the Stream Corridor Assessment (SCA) that was performed by the BRM and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Upper Monocacy River watershed.

Section III: New Development; this section will discuss the Water Resource Ordinance, Chapter 154 of the County code, and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed. This section will also summarize the build-out analysis done for the watershed and discuss the rural legacy area that encompasses most of the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the BRM and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; describes the Best Management Practices (BMPs) and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Upper Monocacy River watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed, as discussed in Section V, will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered during the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

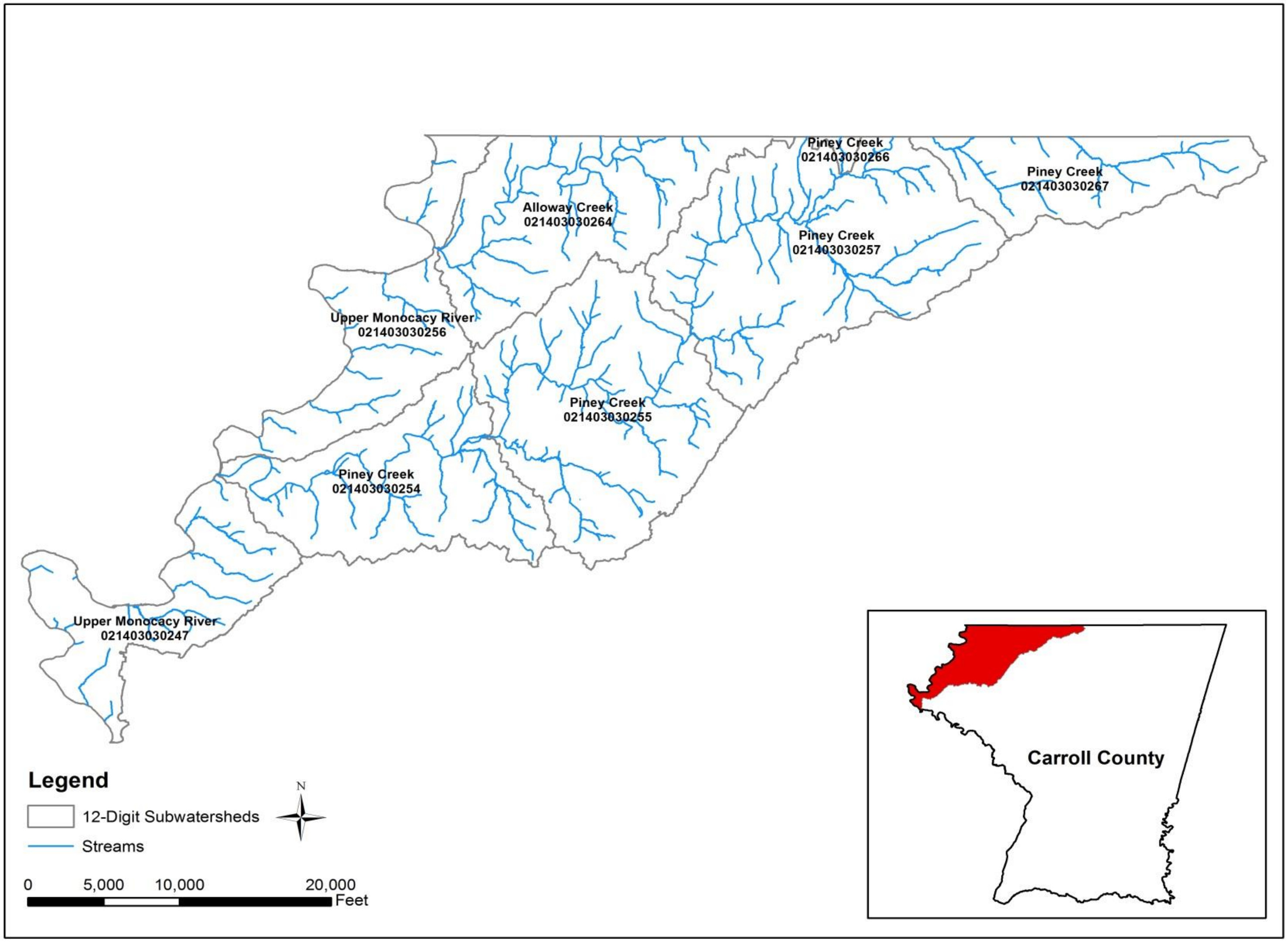

Figure 1: Upper Monocacy River Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

	Use Classes							
Designated Uses	I	I-P	II	II-P	III	III-P	IV	IV-P
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. Upper Monocacy River Water Quality Standards

The entire portion of the Upper Monocacy River watershed within Carroll County is designated as use IV-P, Water Contact Recreation, Protection of Aquatic Life, Recreational Trout Waters and Public Water Supply. The use IV-P waters are not capable of growing and propagating trout, but are capable of supporting adult trout for a put-and-take fishery.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample			
		Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQSs). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources, which are referred to as WLAs. Within the Upper Monocacy River watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. Due to the Memorandum of Agreement (MOA) between the County and each of the Municipalities, this restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Upper Monocacy Watershed as determined by the Maryland Department of Environment (MDE) TMDL data center is 432,969 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 13,855 billion MPN/year, which is a reduction of 419,114 billion MPN/year (96.8%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 3 outlines the bacteria baseline and TMDL for the Carroll County portion of the Upper Monocacy Watershed.

Table 3: Upper Monocacy River 8-digit Watershed Bacteria TMDL

Upper Monocacy Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	432,969	13,855	96.8%
Total	**432,969**	**13,855**	**96.8%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by the MDE TMDL Data Center is 1,427 lbs. /yr., the TMDL for the stormwater WLA was determined to be 1,353 lbs. /yr., which is a reduction of 74 lbs. /yr. (5%) from the current loading (MDE 2012) (Table 4). This stormwater WLA includes all Carroll County jurisdictional MS4s.

Table 4: Upper Monocacy River 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs./yr)	TMDL (lbs./yr)	Percent Reduction
Carroll County	1,427	1,353	5%
Total	**1,427**	**1,353**	**5%**

The TMDLs are based on average annual total phosphorus loads for the simulation period 1991-2000, which includes both wet and dry years, and thus takes into account a variety of hydrological conditions. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease (MDE, 2012).

c. Total Suspended Sediments

The current estimated stormwater baseline load for the Carroll County segments of the Upper Monocacy River watershed as determined by the MDE TMDL Data Center is 657.9 ton /yr., the TMDL for the stormwater WLA was determined to be 371.5 ton /yr., which is a reduction of 286.4 ton /yr. (44%) from the current loading (MDE 2009) (Table 5).

Table 5: Upper Monocacy River 8-digit Watershed TSS TMDL

Jurisdiction	Baseline (Tons/yr)	TMDL (Tons/yr)	Percent Reduction
Carroll County	657.9	371.5	44%
Total	**657.9**	**371.5**	**44%**

In Maryland there are no specific numeric criteria that quantify the impact of sediment on the aquatic health of non-tidal stream systems. The threshold used to determine watershed specific sediment TMDL is the sediment loading threshold from a reference waters based on Maryland's bio-criteria (MDE, 2009).

II. Background

A. Location and Subwatershed Map

The Upper Monocacy River watershed is located in the Potomac River Sub-basin in Frederick and Carroll Counties, Maryland, which lies within the Piedmont physiographic province. The Upper Monocacy River is a free-flowing stream that originates in Pennsylvania and flows 58 miles within Maryland where it finally empties into the Potomac River. The watershed area within Carroll County covers 27,123 acres within eight sub-watersheds. Figure 1 depicts the location of the Upper Monocacy River watershed and its subwatersheds.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Upper Monocacy River watershed, agriculture is the dominant land cover at about 69 percent of the total land, followed by forest which accounts for about 17 percent, and residential, which accounts for about 9 percent of the total land cover. Mixed urban uses account for less than 3 percent of the total land cover which represents the relatively rural nature of the Upper Monocacy River watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 accounting for Stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 5% increase in low-density residential land cover since 2011, which has been incorporated into Table 6.

Table 6 shows the current land cover data for the Upper Monocacy River watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the Upper Monocacy River watershed can be found in Figure 2.

Table 6: Upper Monocacy River Watershed Baseline and Current Land Cover

Land Cover	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	164	<1%	162	<1%	162	<1%	161	<1%
Low-Density Residential	1,492	5.5%	1,471	5.4%	1,474	5.4%	2,323	8.6%
Low-Density Mixed Urban	671	2.5%	663	2.4%	661	2.4%	661	2.4%
Medium-Density Mixed Urban	105	<1%	139	<1%	151	<1%	151	<1%
High-Density Mixed Urban	14	<1%	23	<1%	28	<1%	28	<1%
Barren Land	8	<1%	8	<1%	8	<1%	8	<1%
Forest	4,559	17%	4,548	17%	4,533	16.7%	4,489	16.6%
Shrub/Scrub	39	<1%	39	<1%	39	<1%	36	<1%
Grassland	22	<1%	26	<1%	22	<1%	22	<1%
Pasture/Hay	6,620	24%	6,816	25%	6,838	25%	6,581	24.3%
Cropland	12,953	48%	12,749	47%	12,732	47%	12,195	45%
Wetland	442	1.6%	443	1.6%	442	1.6%	441	1.6%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams; resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Upper Monocacy River watershed is estimated to have 855 acres of total impervious within the catchment and accounts for approximately 3.2 percent of the total land area. The impervious surface area within Upper Monocacy River watershed, by subwatershed can be found in Table 7 and is shown in Figure 3.

Table 7: Upper Monocacy River Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
021403030264	Alloway Creek	3,953	74.3	1.88
021403030254	Piney Creek	3,763	64.2	1.71
021403030255	Piney Creek	5,294	399.7	7.55
021403030257	Piney Creek	5,989	122.2	2.04
021403030266	Piney Creek	95.1	0.81	0.85
021403030267	Piney Creek	2,371	59.1	2.49
021403030247	Upper Monocacy River	2,744	54.0	1.97
021403030256	Upper Monocacy River	2,915	80.9	2.78
Upper Monocacy River Watershed		**27,124**	**855.2**	3.15

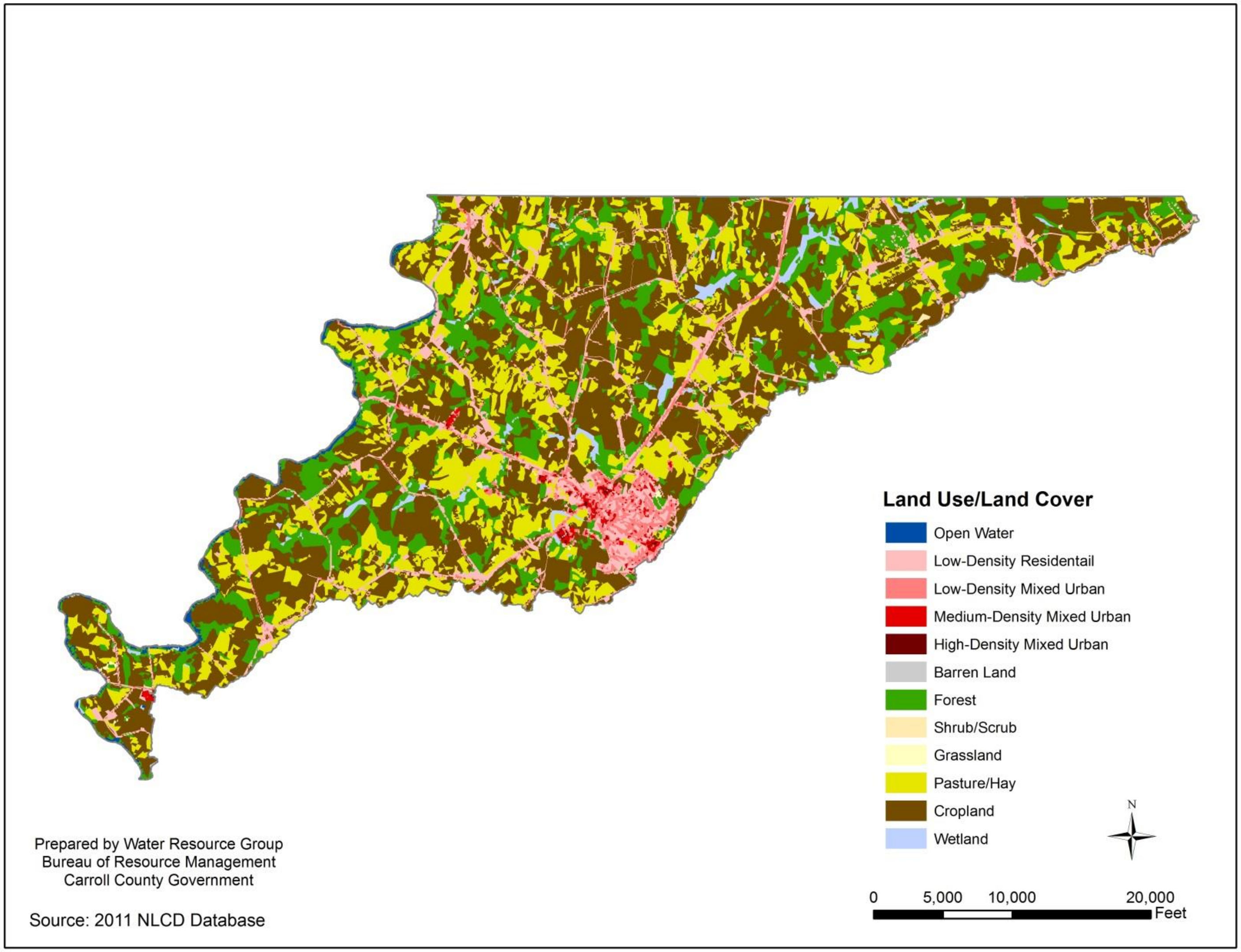

Figure 2: Upper Monocacy River Watershed Land Use/Land Cover

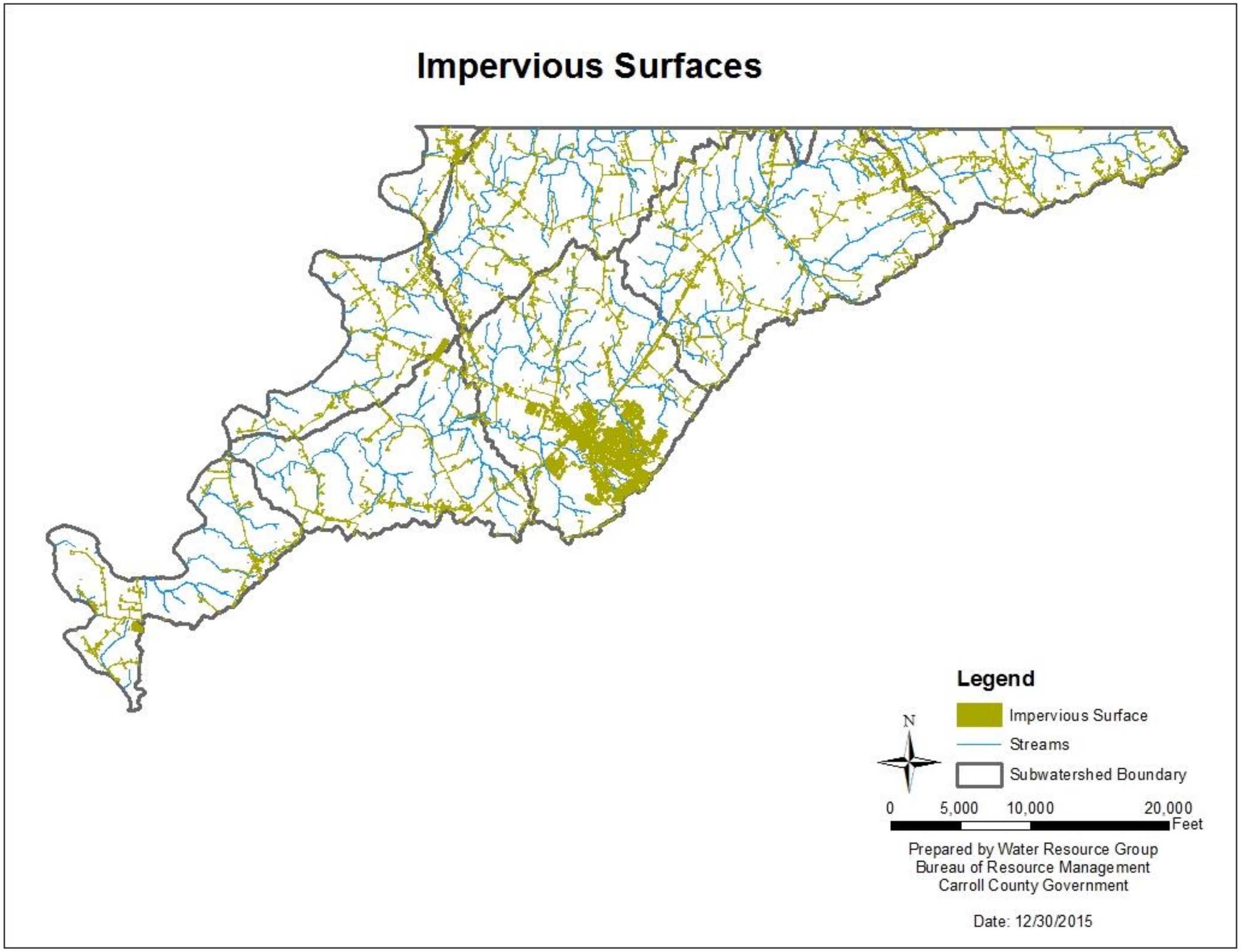

Figure 3: Upper Monocacy River Watershed Impervious Surface Area

C. Watershed Characterization

Following the Upper Monocacy River watershed stream corridor assessment (SCA), completed in 2015, a Watershed Characterization for the Upper Monocacy River watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Upper Monocacy River watershed SCA will be used as the foundation for the watershed restoration and implementation plan. The Upper Monocacy River SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/UpperMonocacy/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/UpperMonocacy/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Upper Monocacy River watershed, there are no listed Tier II waters.

b. Ecologically Sensitive Areas

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. There are approximately 4,348 acres of targeted ecological areas within the Upper Monocacy River watershed, as shown in Figure 4. Targeted ecological areas are a limited number of areas that rank exceptionally high for ecological criteria and that have a practical potential for preservation. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

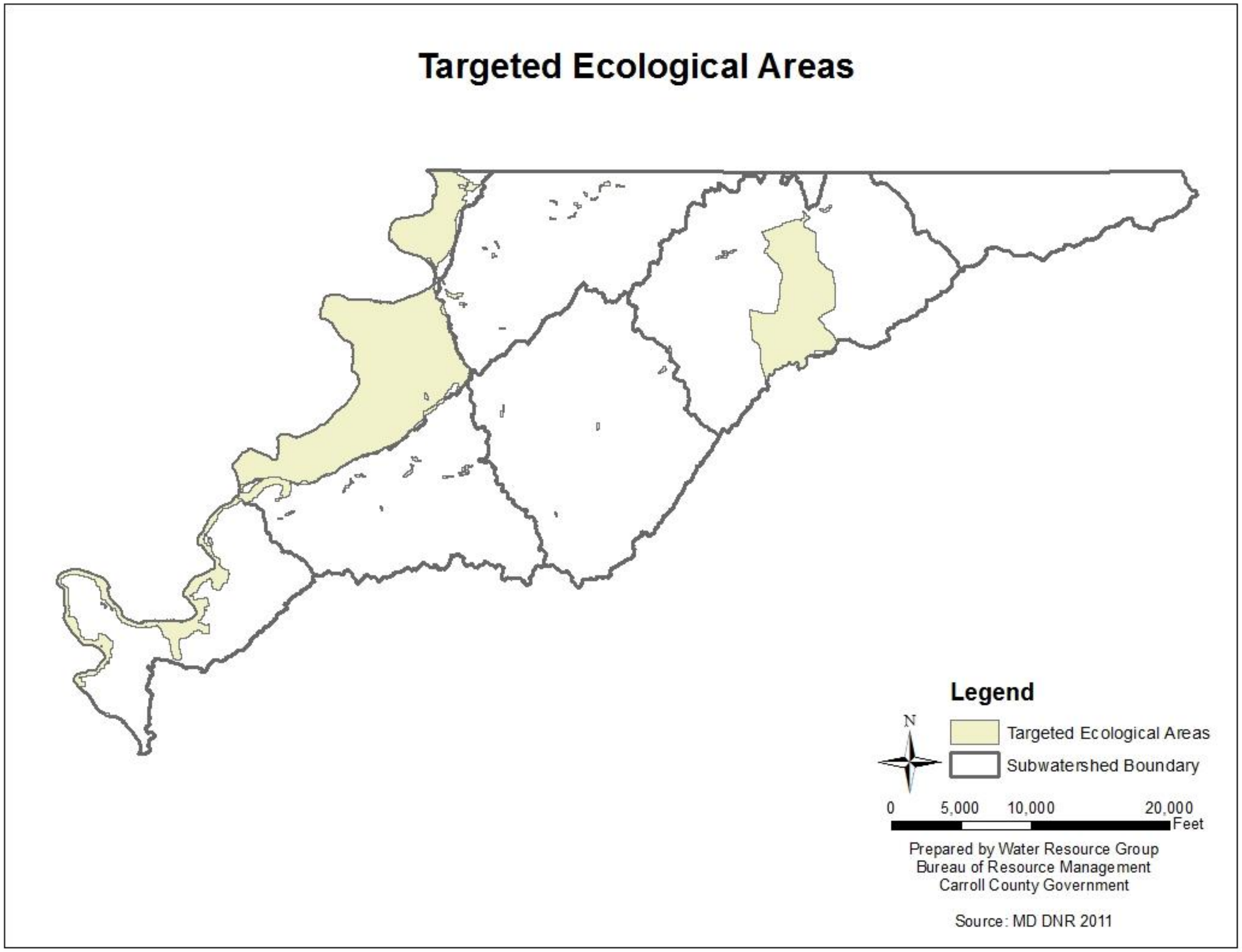

Figure 4: Upper Monocacy River Watershed Targeted Ecological Areas

2. Stream Corridor Assessment

A SCA of the Upper Monocacy River watershed was conducted during the winter of 2014-2015 by Carroll County BRM staff. The Upper Monocacy River SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Upper Monocacy River SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/UpperMonocacy/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along 25,535 linear feet of the corridor, 7% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in Piney Creek (0254). A significant portion of the drainage within Piney Creek originates within the corporate limits of the City of Taneytown. Table 8 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear feet of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area being treated and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

All of the proposed stormwater mitigation practices identified in *Section V.* of this report to address the stormwater WLA are focused in the Piney Creek (0255) subwatershed.

Table 8: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
021403030264	21.29	11.82	3,320	5.32%
021403030254	20.58	6.98	6,185	16.78%
021403030255	27.43	16.82	7,650	8.62%
021403030257	33.38	16.36	4,470	5.17%
021403030266	0.67	0.00	N/A	N/A
021403030267	10.80	3.86	800	3.92%
021403030247	10.10	5.02	2,900	10.94%
021403030256	9.04	5.53	210	0.72%
Total	133.29	66.39	25,535	7.28%

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the Upper Monocacy Watershed there are 630 parcels remaining with potential development on 10,846 acres for an estimated lot yield of 3,143 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 5 shows the remaining parcels in the Upper Monocacy watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

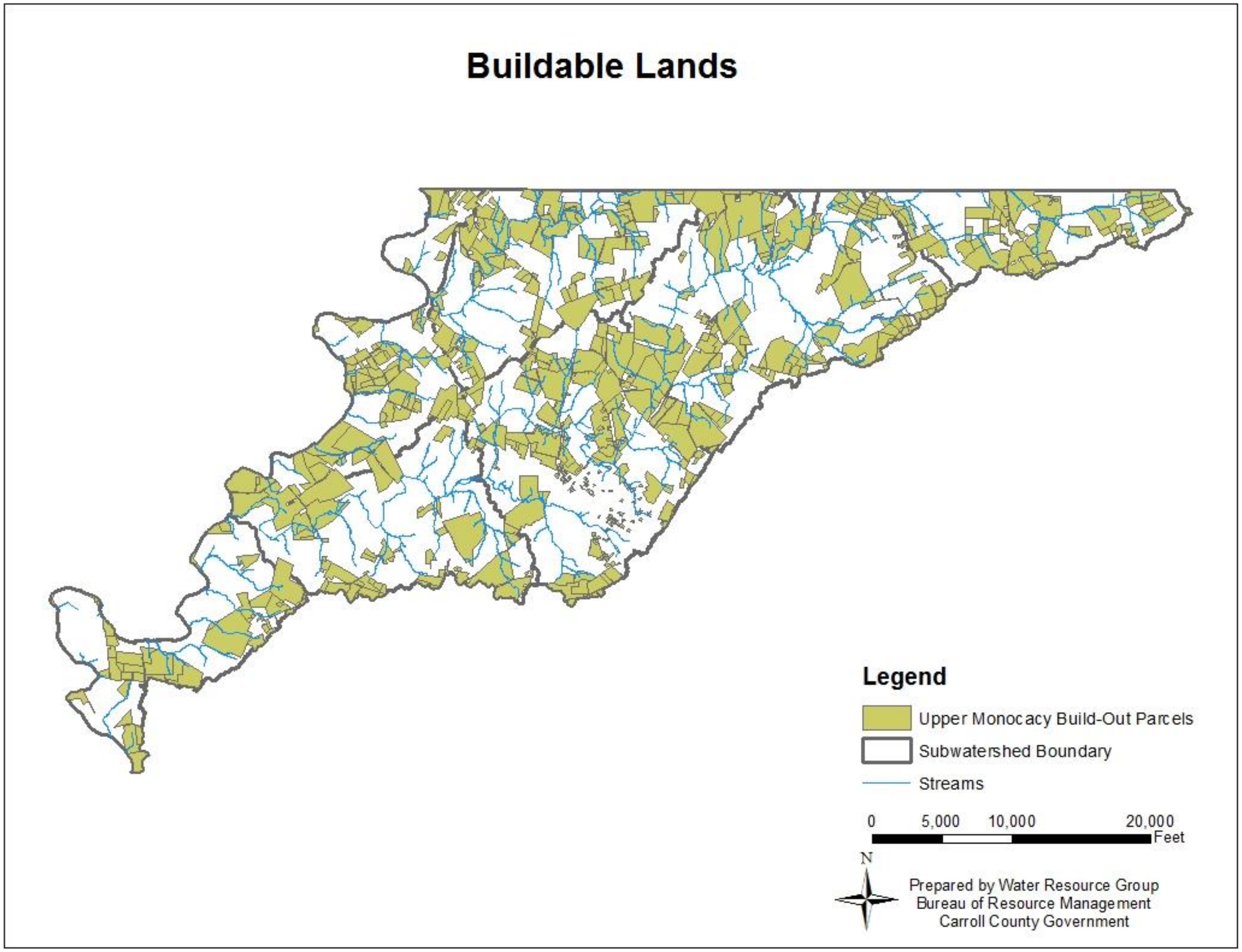

Figure 5: Upper Monocacy River Watershed Build Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Many of these easements overlap with Forest Conservation Easements, which are required through State regulation. There are 21.6 acres of Water Resource Protection easements and 6.1 acres of Floodplain Protection easements within the Upper Monocacy Watershed. Apart from a small 0.02 acre section, the Water Resource Protection easements and Floodplain Protection easements are not coincident. A list of all Water Resource Protection easements and Floodplain Protection easements are located in Appendix B. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway. The locations of Water Resource Protection and Floodplain protection easements within the Upper Monocacy Watershed can be found in Figure 6.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the Rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Upper Monocacy River watershed lies within the Little Pipe Creek Rural Legacy area and encompasses 24,338 acres (90%) of the Upper Monocacy River watershed. The extent of the Rural Legacy Area within Upper Monocacy River can be found in Figure 7.

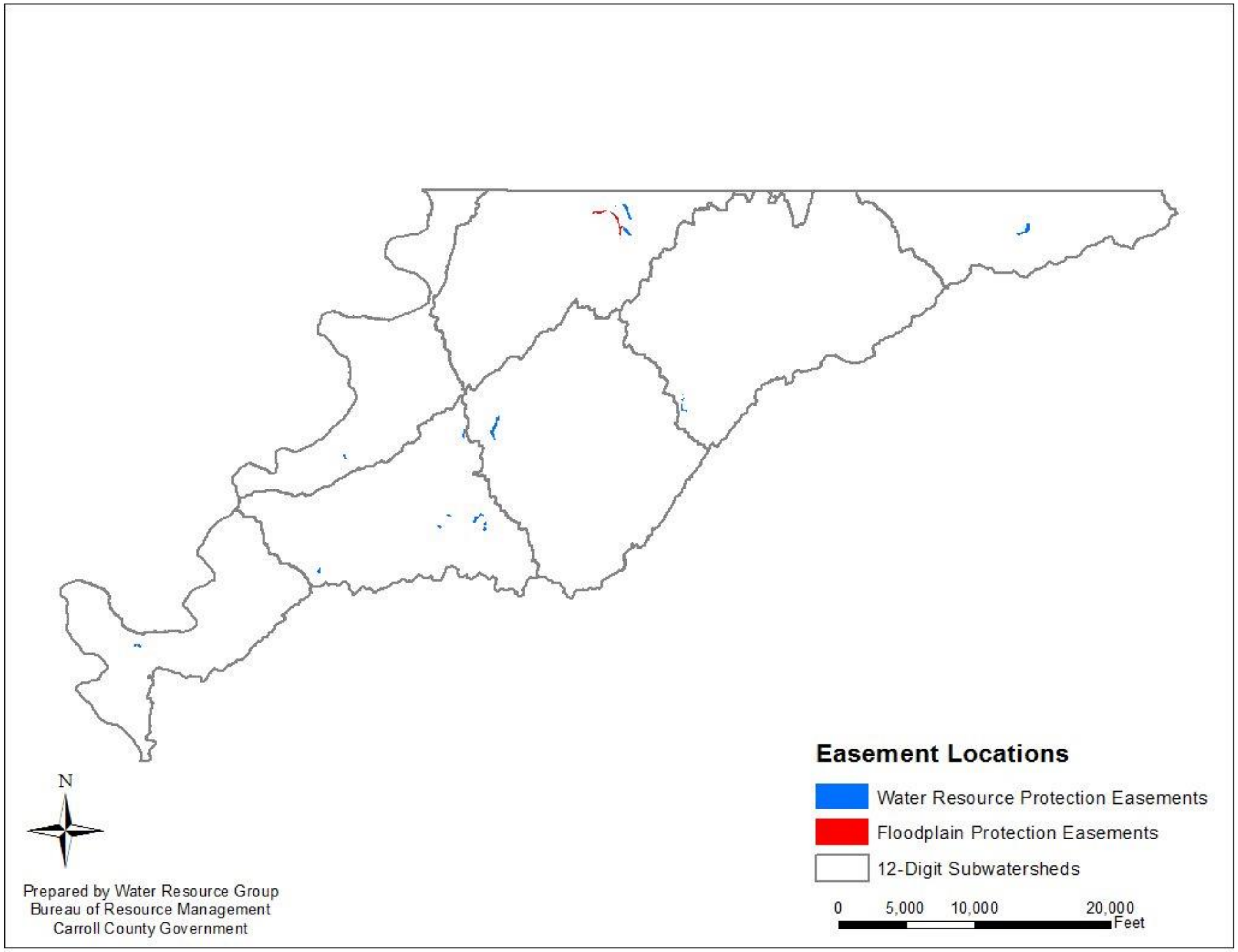

Figure 6: Water Resource and Floodplain Protection Easement Locations

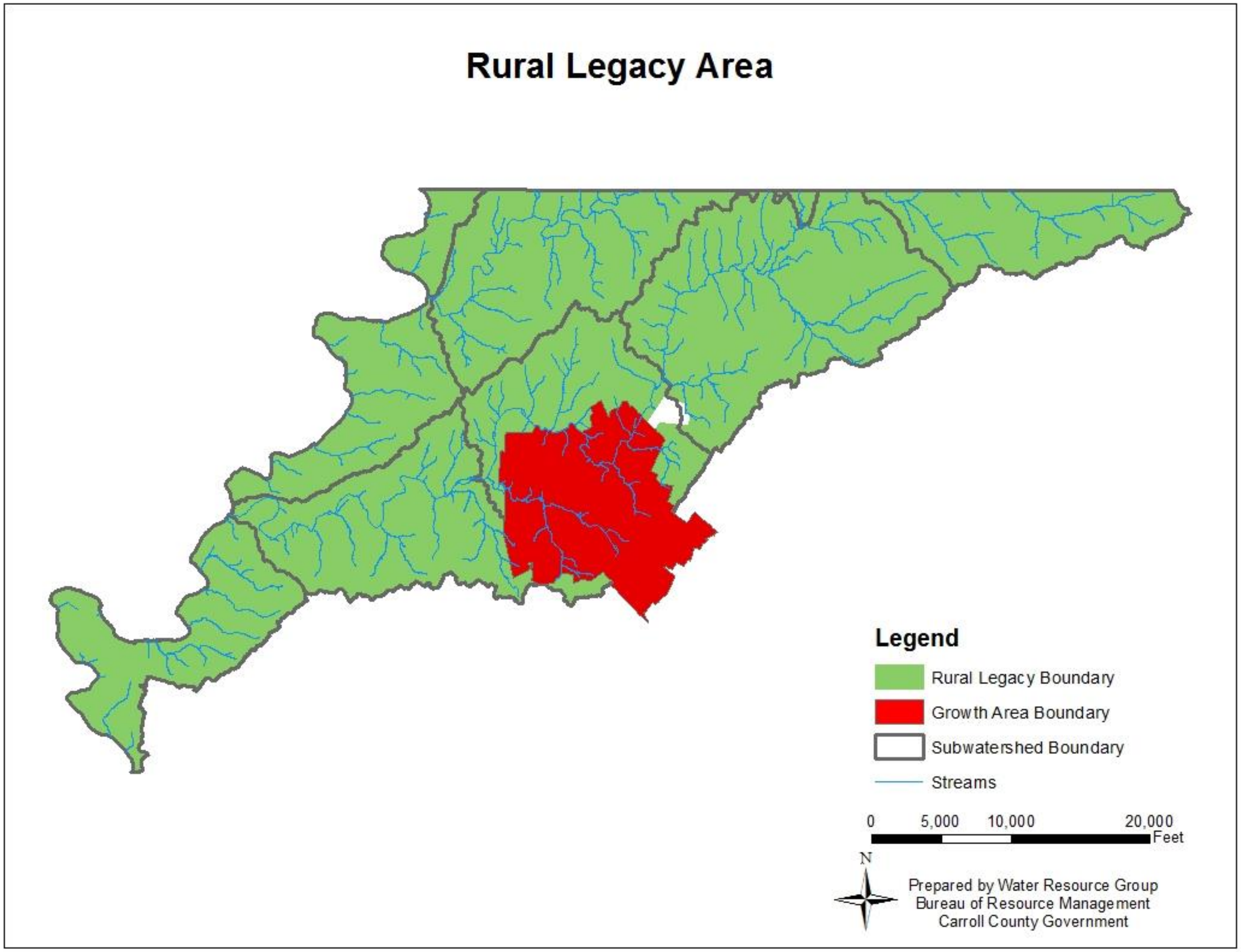

Figure 7: Little Pipe Creek Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland’s Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a MOA to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities’ stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County’s most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from the Department of Land and Resource Management; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as provided at various venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff are continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts.

Educational events that County staff have participated in that are either held within the Upper Monocacy River Watershed or offered to citizens countywide can be found in Table 9.

Table 9: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Bollinger Park and Taneytown Memorial Tree Planting	2014	Upper Monocacy
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide

Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide
Homeowners & Stormwater Workshop	2017	Countywide
Mid-Atlantic Car Wash Association "Wash to Save the Bay"	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Regional Monocacy Scenic River Watershed Clean-Up	2016	Upper Monocacy
Scrap Tire Drop Off Day	2019	Countywide
Taneytown Harvest Festival	2012, 2013, 2014, 2015, 2017	Upper Monocacy
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Upper Monocacy River watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, MDE released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of ESD practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

Properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.) After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

The facilities proposed for implementation to assist in addressing the Upper Monocacy River watershed TMDL's are listed in Table 10. The location of each facility can be found in Figure 8, the practice type and runoff depth treated for each facility can be found in Appendix B.

Table 10: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Implementation Status	Subwatershed
Robert's Mill Area	281.20	87.00	Retrofit	Under Construction	Piney Creek 021403030255
Trevanion Terrace	181.00	52.00	Retrofit	Planned	Piney Creek 021403030255
Meadowbrook	65.89	9.45	Retrofit	Planned	Piney Creek 021403030255
Totals:	**528.09**	**148.45**			

B. Storm Drain Outfalls

During the Upper Monocacy River watershed SCA in winter 2014-2015, erosion sites were documented and rated on severity. Stream Corridor Assessment identified erosion sites were analyzed in GIS to the location of existing SWM facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. One elementary school within the Upper Monocacy River watershed; Taneytown Elementary has planted one garden that treats 23,000 square feet of drainage area.

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Following the completion of the winter 2014-2015 SCA in the Upper Monocacy River watershed, the BRM began a stream buffer initiative. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible.

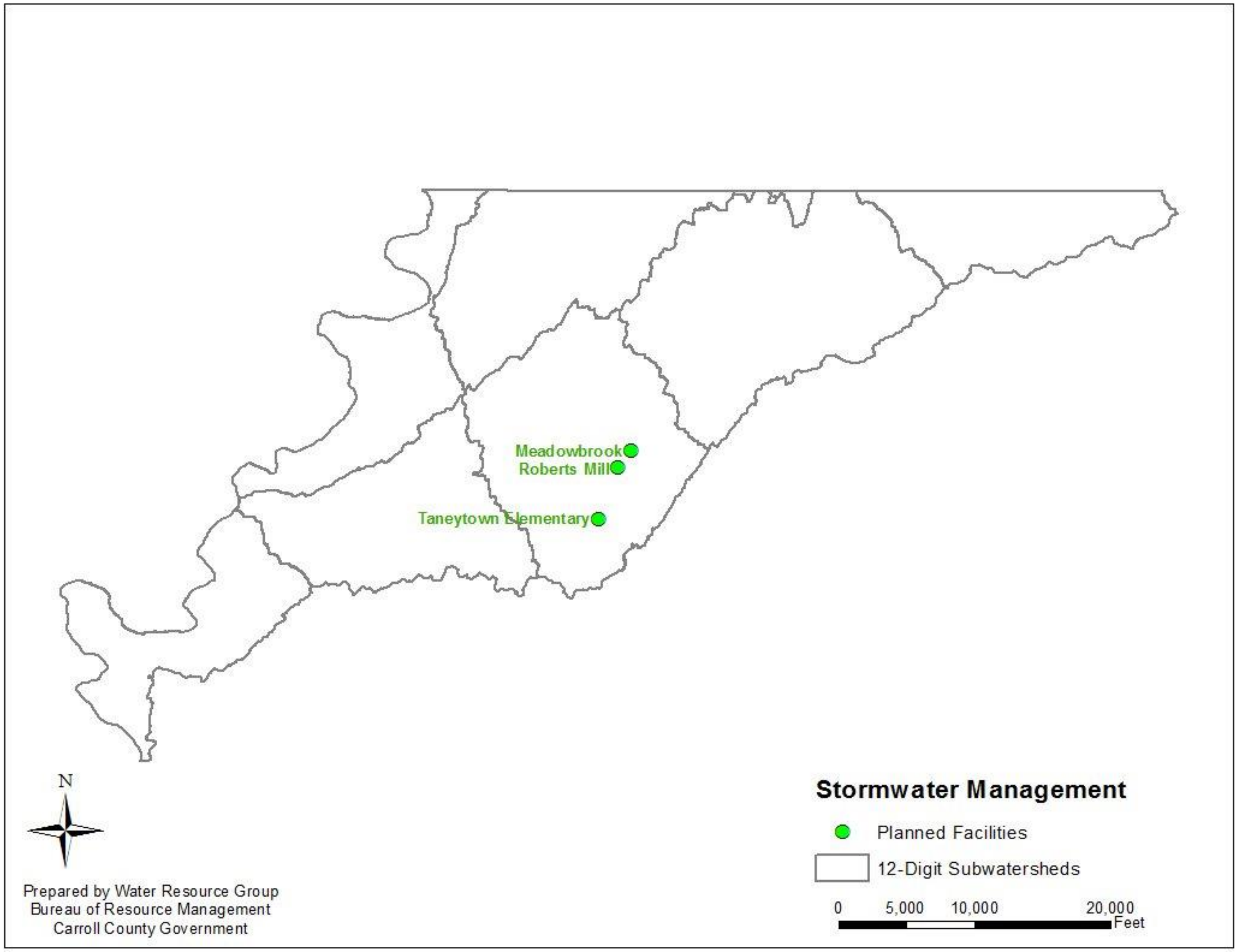

Figure 8: Stormwater Management Locations

1. Residential Buffer Plantings

The winter 2014-2015 Upper Monocacy River watershed SCA determined that approximately 44 percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to the 36 landowners whose properties were identified as having an inadequate buffer during the SCA. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. One municipality participated during the fall of 2014, and five private properties participated in this initiative during the fall of 2015. The acreage planted for each location and the associated subwatershed can be found in Table 11. The approximate locations of the buffer plantings are shown in Figure 9.

2. Municipal Plantings

The City of Taneytown has initiated multiple tree planting efforts within the Upper Monocacy River watershed. These projects include plantings at Bollinger Park, Robert's Mill Park, and Taneytown Memorial Park.

The Bollinger Park project consisted of planting over 3,900 trees at a stocking rate of 300 trees per acre for 13.2 acres to enlarge an existing forest stand. The Robert's Mill Park project planted over 120 trees in an effort to increase the size of existing forest stand. The Taneytown Memorial Park project planted nearly 600 trees on almost 2 acres enhancing a stream buffer along the southern portion of the Park.

Table 11: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	Subwatershed	Date Planted
Planting 1	13.19	700	600	Piney Creek 021403030255	Fall 2014
Planting 2	0.51	200	140	Piney Creek 021403030255	Fall 2014
Planting 3	0.97	1,000	80	Piney Creek 021403030255	2014
Planting 4	0.85	1,000	80	Piney Creek 021403030255	2014
Planting 5	0.95	630	30	Alloway Creek 021403030264	Fall 2015
Planting 6	7	1,700	150	Piney Creek 021403030255	Fall 2015
Planting 7	0.65	500	40	Piney Creek 021403030257	Fall 2015
Planting 8	2.18	1,400	50	Upper Monocacy River 021403030256	Fall 2015
Planting 9	1.9	2,000	40	Piney Creek 021403030255	Fall 2015

a. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau's stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be monitored bi-annually for ten years to ensure the success of the program, and once every three years after the ten-year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

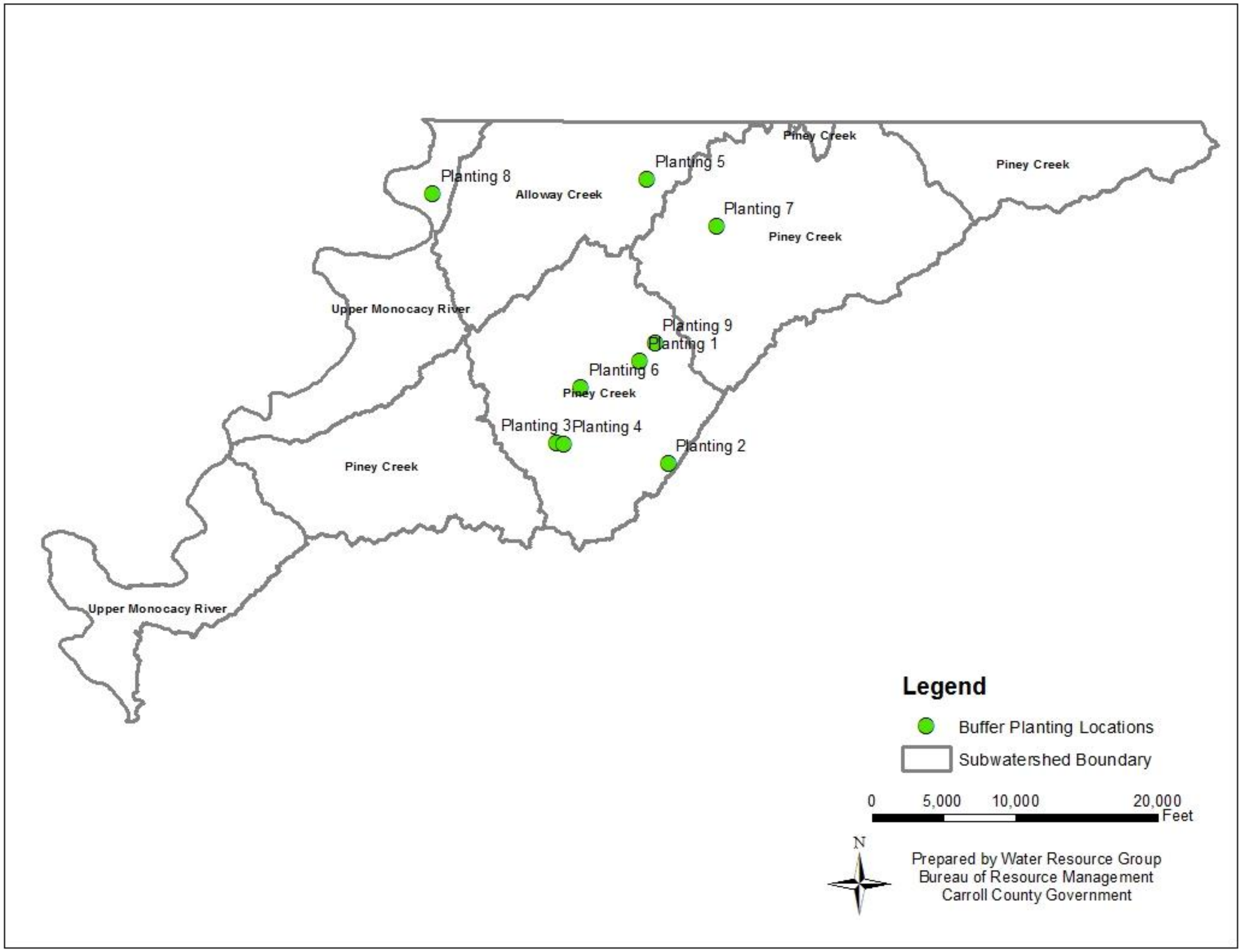

Figure 9: Stream Buffer Initiative Locations

E. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the Upper Monocacy River Watershed are shown in Table 12.

Table 12: Road Maintenance Projects

Management Practice	**Inlet Cleaning**		
Town/City	Tons Removed	12-Digit Watershed	Date of Completion
Taneytown	0.55	021403030255	Annual

F. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2007, eleven septic systems within the Upper Monocacy River watershed have been repaired via the BRF, and seven new systems have been built utilizing BAT. Best available technology has been proven to be effective at nitrogen removal but has not been shown to reduce phosphorus. Any reductions to bacteria loading are also unknown at this time. Septic systems that have been built or repaired utilizing BAT within the Upper Monocacy River watershed are listed in Table 13.

Table 13: Septic Systems

Project Type	Subwatershed	Best Available Technology	Bay Restoration Funding	Completion Date
Repair	021403030247	True	True	7/17/2013
Repair	021403030255	True	True	7/27/2009
Repair	021403030256	True	True	Post-2007
Repair	021403030264	True	True	9/28/2011
New Construction	021403030247	True	False	Post-2007
Sandmound	021403030254	True	False	3/25/2011
New Construction	021403030257	True	False	2/25/2015
New Construction	021403030247	True	False	9/9/2015
Repair	021403030257	True	True	7/28/2015
New Construction	021403030267	True	False	11/10/2015
New Construction	021403030254	True	False	3/14/2016
Repair	021403030267	True	True	1/6/2016
Repair	021403030267	True	True	1/6/2016

Repair	021403030267	True	True	1/6/2016
Repair	021403030267	True	True	1/19/2016
New Construction	021403030257	True	False	7/8/2016
Repair	021403030257	True	True	6/30/2017
New Construction	021403030254	True	False	11/29/2017
Repair	021403030254	True	False	6/10/2019

G. Agricultural Best Management Practices

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

H. Stream Restoration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

Historic land use and more recently, urbanization, has deteriorated the quality of streams within the Piedmont. Booth and Henshaw (2001) documented the increase of sediment yield and channel erosion within urbanizing streams, and research has shown that sediment yields in urban streams are more than an order of magnitude higher when compared to rural streams (Langland and Cronin, 2003).

The County has identified the implementation of stream restoration practices as a method to potentially reduce nutrient and sediment loadings within the watershed.

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix B provides the associated reduction values.

A. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

B. Modeling with Mapshed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix C.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Upper Monocacy River watershed. As described in Section I, bacteria, phosphorus and TSS loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014, and an updated version due out for review in the Fall of 2019.

The local TMDLs suggests an urban TP load reduction of 5% from the 2009 baseline year and TSS load reduction of 43.5% from the 2000 baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Upper Monocacy watershed). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban TP load reductions of 5% and urban TSS load reductions of 43.5% of the local TMDL baseline years. A baseline year of 2011 was used as a proxy for the 2009 baseline year in the local TP TMDL, as land cover data from 2011 was the closest available for that time period. Similarly, a baseline year of 2001 was used as a proxy for the 2000 baseline year in the local TSS TMDL. The modeled baseline scenarios did not include any BMPs and therefore represent the land use loads with no treatment provided. Load reductions from BMPs installed after the 2009 TP TMDL and 2000 TSS TMDL baseline years can be counted toward load reductions necessary to meet the TMDLs, even though 2011 and 2001 were used as the baseline proxy years. For reference, the modeled baseline urban P load using the 2011 land cover was 283.67 lbs, which equates to a 5% reduction of 14.18 lbs. The modeled baseline urban TSS load using the 2001 land cover was 273.65 tons, which equates to a 43.5% reduction of 119.04 tons (Table 14).

The projects completed as of December 2019 are providing 32.97 pounds of TP reduction, and 36.20 tons of TSS reduction. The planned projects would provide another 17.76 lbs. of TP reduction and 26.08 tons of sediment (Table 15). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figures 10 and 11. To achieve remaining TMDL requirements, the county will utilize the MapShed tool to assist in selecting a mix of techniques and practice types for locations identified in future CIP budgets to progress towards fully attaining the Upper Monocacy TMDLs. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, locations, or costs beyond the current CIP.

Table 14: Total Phosphorus and Total Suspended Sediment Load Reduction in the Upper Monocacy Watershed in Carroll County

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs)**	**Reduction from Current BMPs (lbs)**	**Reduction from Planned Strategies (lbs)**	**Total % Reduction Achieved**
283.67	5%	14.18	32.97	17.76	24%
Total Suspended Sediment Load Reduction					
Modeled Baseline Load (tons)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (tons)**	**Reduction from Current BMPs (tons)**	**Reduction from Planned Strategies (tons)**	**Total % Reduction Achieved**
273.65	43.5%	119.04	36.20	26.08	23%

Table 15: Comparison of Total Phosphorus and Total Suspended Sediment Delivered Load Reductions by Restoration Strategies. This table includes both proposed and existing BMPs.

Total Phosphorus Delivered Load Reductions (lbs/yr)				
Status	**Pond Retrofits**	**Buffers**	**Easements**	**Catch Basin/ Inlet Cleaning**
Completed	30.07	2.12	0.75	0.03
Planned	17.76			
Total Suspended Sediment Delivered Load Reductions (tons/yr)				
Completed	31.67	2.32	2.20	0.01
Planned	26.08			

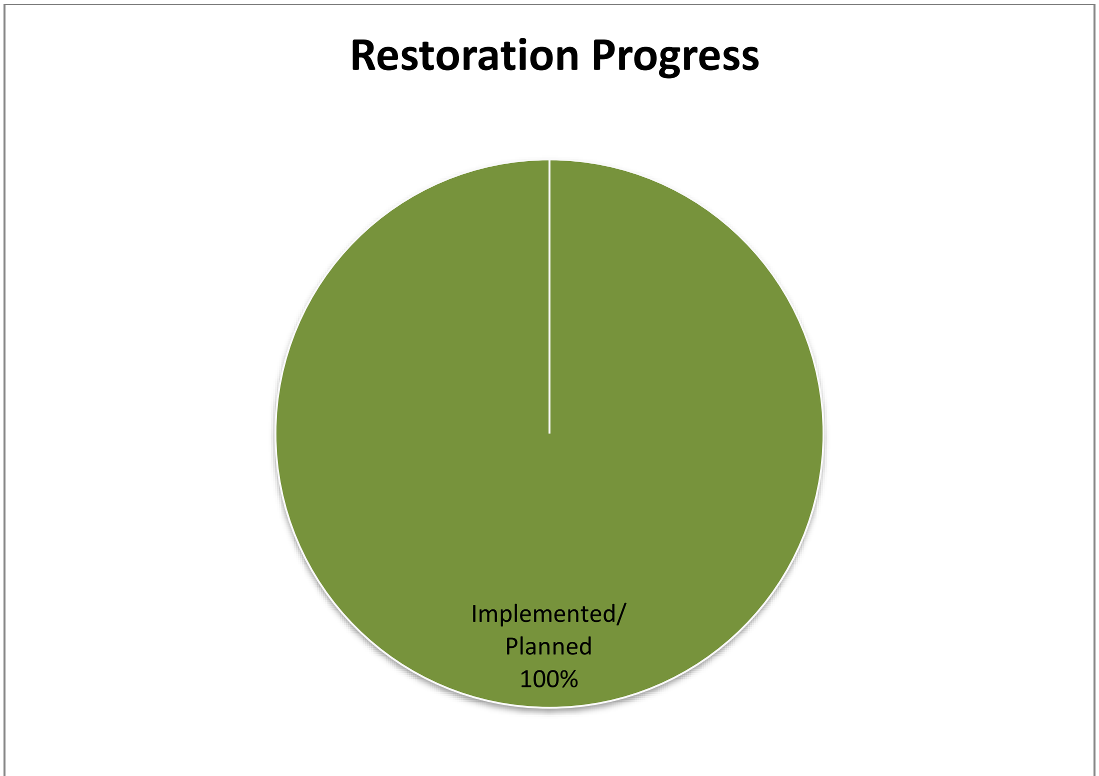

Figure 10: 2019 Restoration Progress - Phosphorus

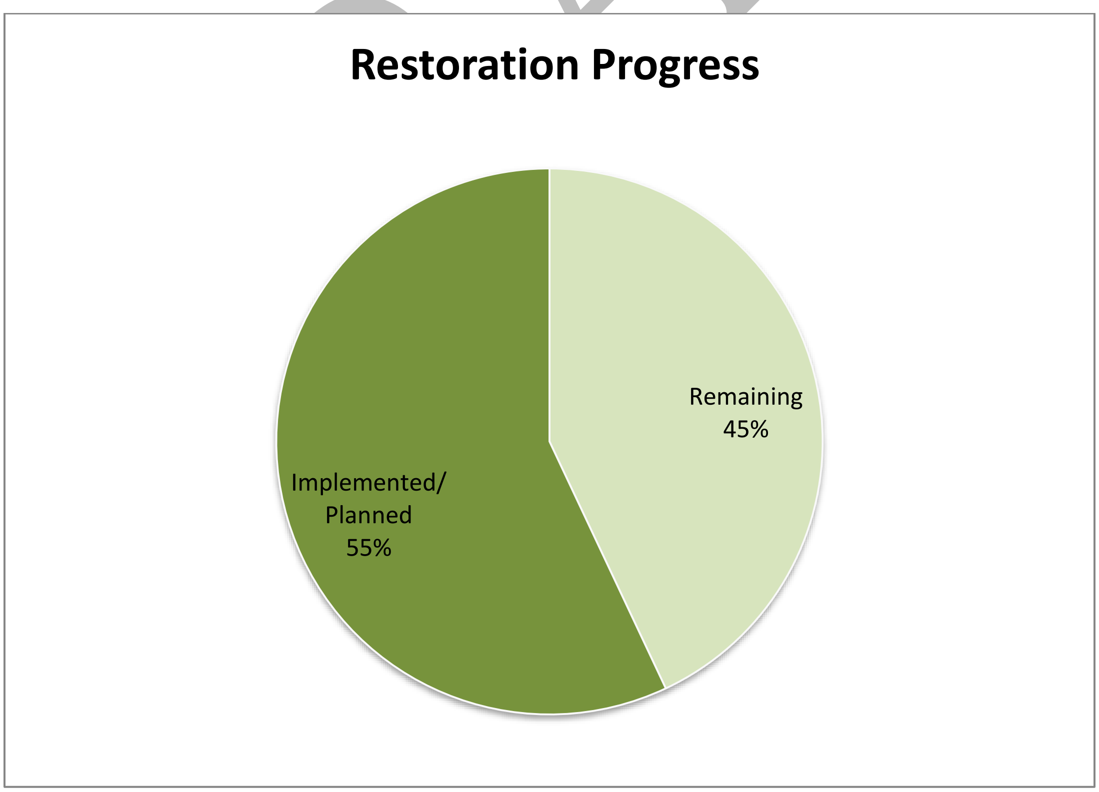

Figure 11: 2019 Restoration Progress – TSS

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

a. Human Source Elimination

Elimination of human sources of bacteria within the Upper Monocacy Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

Table 16 lists infrastructure related measures that have been implemented since the 2004 baseline year that would assist in reducing bacteria counts within the watershed.

Table 16: Waste Collection Infrastructure Upgrades

	County	Taneytown
BAT Upgrades	19	0*
Casings/Linings	n/a	TBD
Lateral line replacements	n/a	TBD
Pump Station upgrade	n/a	TBD

***upgrades occurred within corporate boundaries**

b. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

c. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County's MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

C. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach.

1. Retrofit Monitoring

The BRM currently monitors one retrofit location within the Upper Monocacy River watershed. The Robert's Mill site, shown in Figure 12, is located within the Piney Creek (0255) subwatershed, and is almost entirely within the corporate limits of the City of Taneytown.

The current facility is a dry detention pond that was built the late 1980's. The Robert's Mill location is primarily low-density mixed urban, which encompasses 41% of the land cover, followed by low-density residential at 32% of the land cover. The drainage area to the monitoring site is approximately 274 acres, of which, 83 acres or 30% is impervious.

Bi-weekly monitoring at the Robert's Mill site began in January of 2016 and consists of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Robert's Mill site can be found in Table 17. Additional monitoring at this location includes spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 17: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00
Total Kjeldahl Nitrogen	0.5mg/l	SM 4500-NH3 C97

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Upper Monocacy Watershed began in February of 2018, and is currently performed at two locations, shown in Figure 13. Samples are currently collected on the 3rd Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 18 shows the monitoring results for the entire year, whereas Table 19 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 18: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2018		2019	
		# Samples	MPN	# Samples	MPN
PIC01	Low	10	287	8	163
	High	0	n/a	0	n/a
	All	10	287	8	163
PIC03	Low	n/a	n/a	6	436
	High	n/a	n/a	0	n/a
	All	n/a	n/a	6	436

Table 19: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2018		2019	
		# Samples	MPN	# Samples	MPN
PIC01	Low	3	1133	3	1475
	High	0	n/a	0	n/a
	All	3	1133	3	1475
PIC03	Low	n/a	n/a	3	2021
	High	n/a	n/a	0	n/a
	All	n/a	n/a	3	2021

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 20 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 20: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2018		2019	
			# Samples	% Exceeded	# Samples	% Exceeded
PIC01	576	low	**10**	**40%**	**8**	**25%**
		high	n/a	n/a	n/a	n/a
	410	low	**10**	**50%**	**8**	**38%**
		high	n/a	n/a	n/a	n/a
	298	low	**10**	**60%**	**8**	**38%**
		high	n/a	n/a	n/a	n/a
	235	low	**10**	**60%**	**8**	**50%**
		high	n/a	n/a	n/a	n/a
PIC03	576	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a
	410	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a
	298	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a
	235	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a

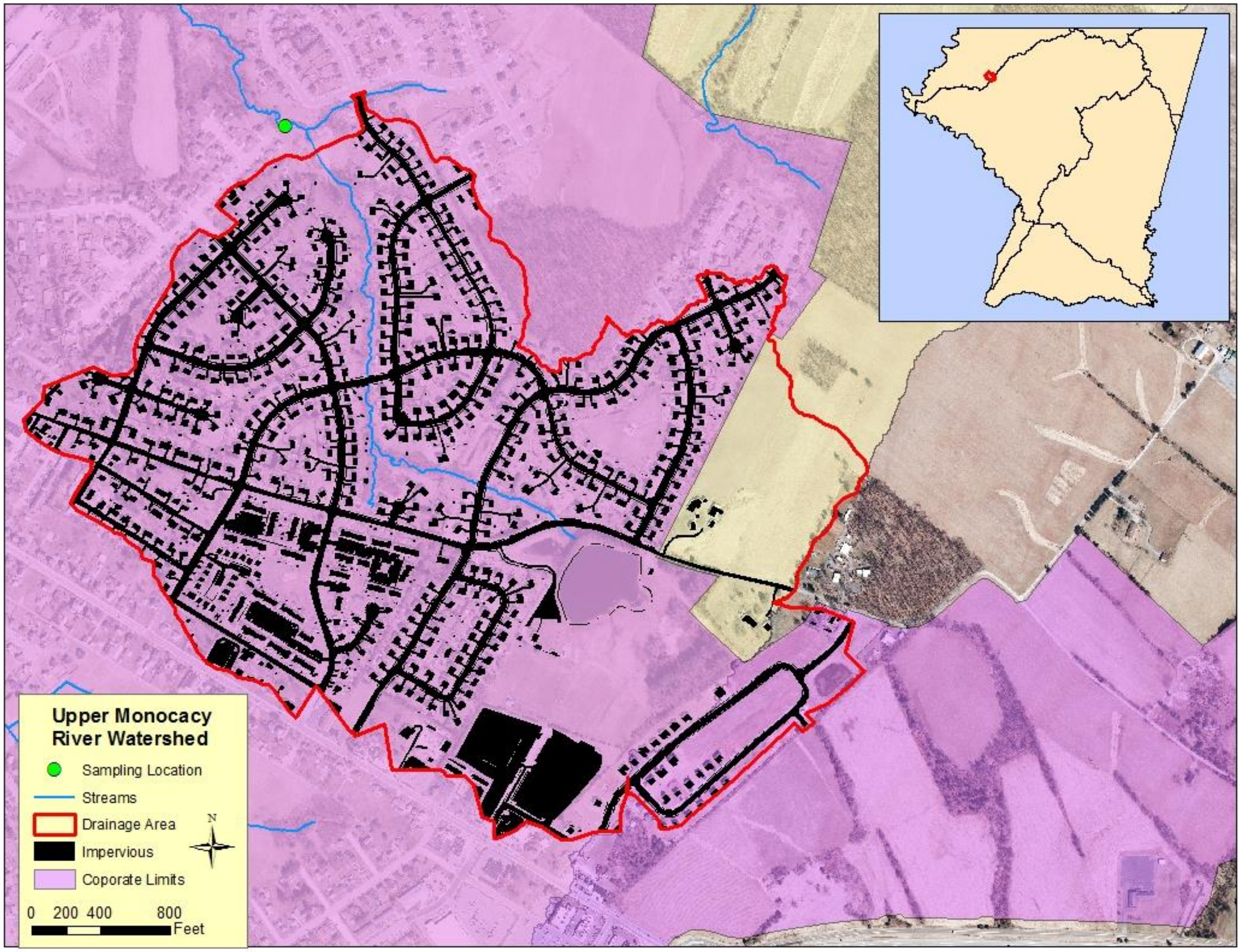

Figure 12: Robert's Mill Monitoring Location

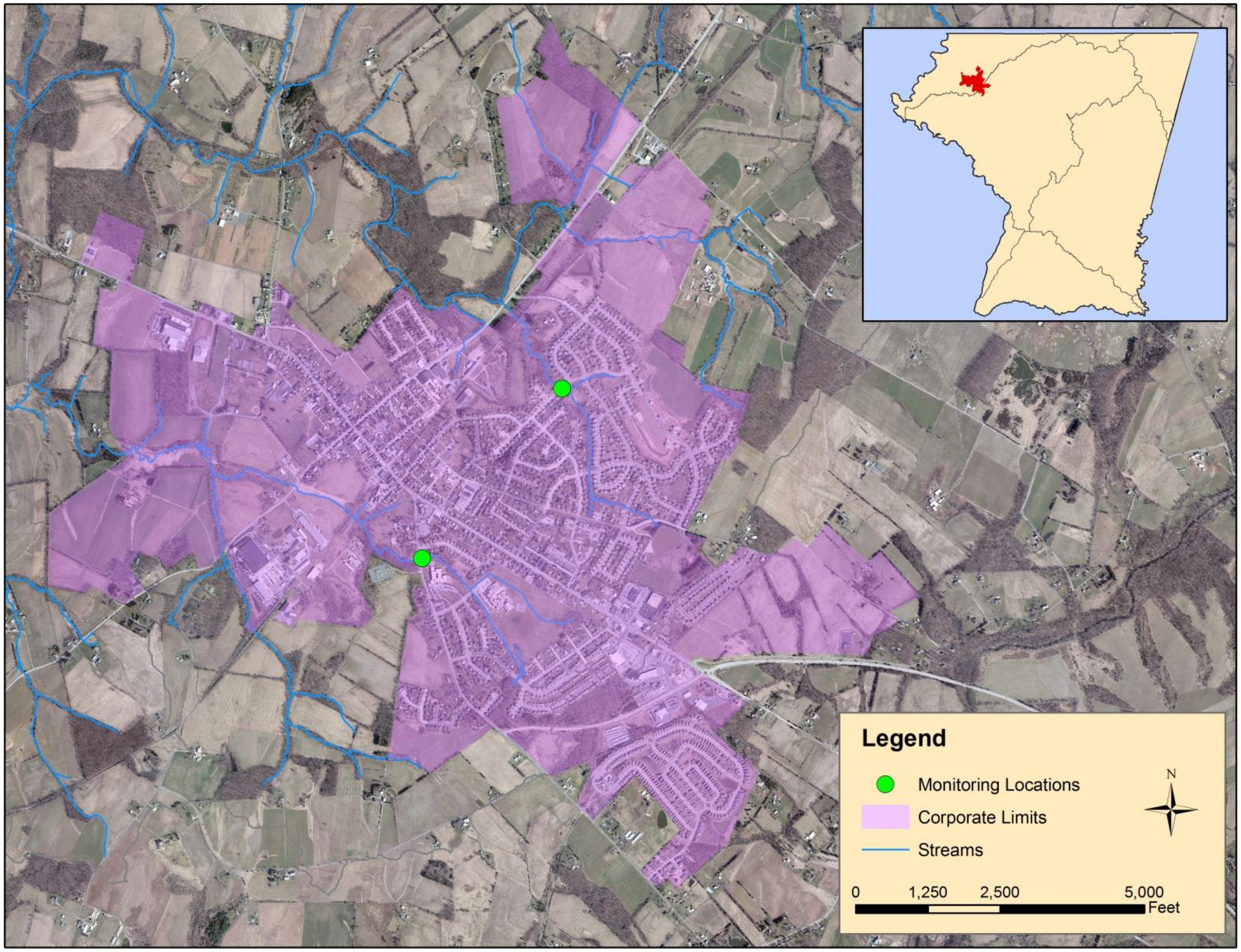

Figure 13: Upper Monocacy Bacteria Monitoring Locations

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 21). Best management practices and restoration projects that have been either completed or proposed to address local TMDLs within the Upper Monocacy River watershed will ultimately reduce loadings to the Chesapeake Bay.

A. River Segment Location

The Upper Monocacy River watershed is located within the Potomac River Basin of the Chesapeake Bay. Within Maryland the Potomac River Basin covers 1,539,973 acres across eight counties. Approximately 137,878 acres (9%) of the Potomac River Basin located in Maryland is within Carroll County, 19.7% of which is located in Upper Monocacy River watershed. The location of the Potomac River Basin segment is shown in Figure 14.

B. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix D) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 21. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Potomac River Basin river segment within the Upper Monocacy River watershed are; 0.30 for nitrogen, 0.47 for phosphorus, and 0.65 for TSS (MAST, 2016). Essentially, if one pound of nitrogen is discharged into a tributary within the Upper Monocacy River portion of the Potomac River Basin river segment, only 30% of that pound is reaching the Bay.

Table 21 shows the Chesapeake Bay TMDL for the Potomac land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Upper Monocacy watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the

Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Potomac land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the Upper Monocacy watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the Potomac segment shed. The Upper Monocacy Watershed covers 19.7% of the Potomac land-river segment within Carroll County.

Table 21: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Upper Monocacy Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]

2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Reduced by BMPs 2009-2025
7,872.04	28.31%	2,228.95	66.07	63.68	5.8%

Total Nitrogen (TN)

2009 Delivered Baseline (lbs.)	% Reduction Required	Required Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Reduced by BMPs 2009-2025
100,429.20	10.19%	10,232.26	437.37	547.69	9.6%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Potomac land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the Upper Monocacy watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

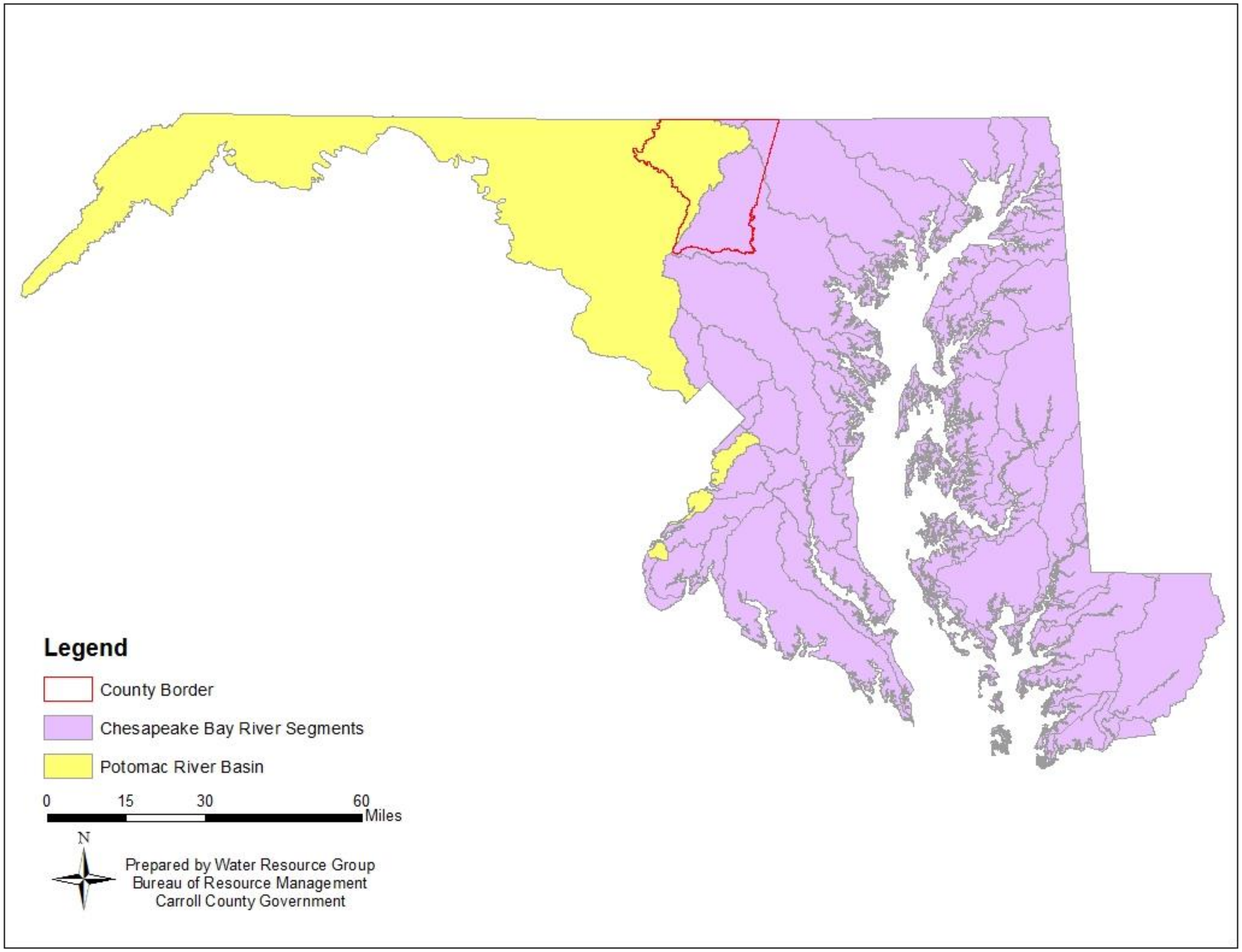

Figure 14: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the Upper Monocacy phosphorus TMDL will be achieved in 2019.

The sediment TMDL through 2019 will have achieved 30% of the required reduction since the baseline year of 2000 and based on current projects is expected to achieve 55% of the required reduction by 2025. The implementation from baseline through the current CIP is achieving approximately 2.2% reduction in the TMDL/year since the baseline.

If the County is able to maintain a 2.2% reduction rate per year until the sediment TMDL is fully implemented, the sediment TMDL in the Upper Monocacy Watershed would be achieved by 2045. To achieve this goal, the County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Table 22 lists the anticipated benchmark for each nutrient TMDL within the Upper Monocacy Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 22: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2045
Phosphorus	100%	100%	100%
Sediment	30%	55%	100%

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be impacted by the watershed plan. Upon draft completion of the Upper Monocacy Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the County's website. During the thirty-day public comment period, input from any stakeholder or others will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

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XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost*	Anticipated Completion
SWM Facilities	County	2140303	Completed	$3,100,000	Completed
Buffer Plantings	County	2140303	Completed	$221,364	Completed
Roads: Street/Inlet Cleaning	Taneytown	2140303	Annual	**	Annual
Water/Floodplain Easement	County	2140303	Completed	N/A	Completed
SWM (Planned)*	County	2140303	Planning/Design	$1,175,000	FY20-FY25
TBD*	Watershed	2140303	Planning	$3,700,000	TBD

***Costs for proposed Stormwater facilities are based on current FY20-FY25 project costs, which may be subject to change.**

****Project Costs not reported**

XIII. Appendix B: Local TMDL Load Reduction Calculations with GWLF-E Land Cover Loading Rates and MDE (2014)

SWM Facilities Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Robert's Mill	Retrofit	281.2	87.00	ST	1.00	14.7786%	35%	465.2195	16.70%	55%	80.7489	11.57%	70%	26.7577
Taneytown Elementary	Retrofit	181	52	RR	1.00	5.0438%	60%	475.3710	6.2623%	70%	61.4281	7.1415%	75%	17.1394
Meadowbrook	Retrofit	64.77	8.7	ST	1.00	1.0557%	35%	46.5219	1.7607%	55%	8.0749	2.3878%	70%	2.6758
	Total:	**526.97**	**147.7**			**20.8781%**		**987.1124**	**24.723%**		**150.2519**	**21.0993%**		**46.5729**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered] (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Loads Reduced [delivered] (Tons)
Taneytown	0.55	3.5	1.925 [0.08]	1.4	0.770 [0.03]	420	231 [26.64]	0.116 [0.01]
		Total:	**1.9250 [0.08]**		**0.7700 [0.03]**		**231 [26.64]**	**0.116 [0.01]**

Water Resource Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)[1]	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
H&K Acres	3.99	4/11/05	0.0558%	30	0.55	0.0790%	40	0.14	0.1157%	55	0.32
Walnut Grove Acres	6.51	8/9/01	0.0911%	30	0.89	0.1289%	40	0.23	0.1888%	55	0.52
Hutchinson Family Ltd Partnership	1.64	5/19/11	0.0229%	30	0.23	0.0325%	40	0.06	0.0476%	55	0.13
Maiden's Point	1.01	12/22/11	0.0141%	30	0.14	0.0200%	40	0.04	0.0293%	55	0.08
Angelina Farms	0.52	9/17/01	0.0073%	30	0.07	0.0103%	40	0.02	0.0151%	55	0.04
Stonesifer Property	0.09	3/22/07	0.0013%	30	0.01	0.0018%	40	0.00	0.0026%	55	0.01
Bullfrog Plateau	1.20	5/13/11	0.0168%	30	0.16	0.0238%	40	0.04	0.0348%	55	0.10
Maiden's Point 2	5.39	6/16/15	0.0754%	30	0.74	0.1067%	40	0.19	0.1564%	55	0.43
Harman, Blaine & Angela Property	1.30	9/10/12	0.0182%	30	0.18	0.0257%	40	0.05	0.0377%	55	0.10
Total:	**21.65**		**0.303%**		**2.97**	**0.429%**		**0.77**	**0.628%**		**1.72**

[1]TP load reductions are calculated for all easements. However, only those recorded after 2009 are counted toward the local TP TMDL required reductions.

Floodplain Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)[1]	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
H&K Acres	0.005	4/11/05	0.0001%	30	0.00	0.0001%	40	0.00	0.0001%	55	0.00
Walnut Grove Acres	6.07	4/10/12	0.0849%	30	0.83	0.1202%	40	0.22	0.1761%	55	0.48
Maiden's Point	0.03	12/22/11	0.0004%	30	0.00	0.0006%	40	0.00	0.0009%	55	0.00
Bullfrog Plateau	0.001	5/13/11	0.0000%	30	0.00	0.0000%	40	0.00	0.0000%	55	0.00
Total:	**6.11**		**0.085%**		**0.83**	**0.121%**		**0.22**	**0.177%**		**0.48**

[1]TP load reductions are calculated for all easements. However, only those recorded after 2009 are counted toward the local TP TMDL required reductions.

Stream Buffer Plantings

Project	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	13.19	0.4060%	66	4.17	0.5027%	77	0.99	0.3965%	57	1.09
Planting 2	0.51	0.0157%	66	0.16	0.0194%	77	0.04	0.0153%	57	0.04
Planting 3	0.97	0.0299%	66	0.31	0.0370%	77	0.07	0.0292%	57	0.08
Planting 4	0.85	0.0262%	66	0.27	0.0324%	77	0.06	0.0256%	57	0.07
Planting 5	0.95	0.0292%	66	0.30	0.0362%	77	0.07	0.0286%	57	0.08
Planting 6	7	0.2155%	66	2.21	0.2668%	77	0.53	0.2104%	57	0.58
Planting 7	0.65	0.0200%	66	0.21	0.0248%	77	0.05	0.0195%	57	0.05
Planting 8	2.18	0.0671%	66	0.69	0.0831%	77	0.16	0.0655%	57	0.18
Planting 9	1.9	0.0585%	66	0.60	0.0724%	77	0.14	0.0571%	57	0.16
Total:	**28.2**	**0.868%**		**8.92**	**1.075%**		**2.12**	**0.848%**		**2.32**

XIV. Appendix C: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Upper Monocacy watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2001 and 2011 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table C-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table C-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest

Mixed Forest	Forest
Shrub/Scrub	Open Land
Herbaceous	Open Land
Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table C-2 below and were based on literature and professional judgement.

Table C-2: Model parameter changes from default to better represent Carroll County.

Parameter	**Default**	**New Value**	**Units**	**Comments**
Practice Factor (pasture/hay)**	0.46	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.46	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation LD Mixed MD Mixed HD Mixed LD Residential	Imp. (Pervious) values 2.8 (0.8) 6.2 (0.8) 2.8 (0.8) 2.5 (1.3)	Imp. (Pervious) values 1.21 (0.19) 2.66 (0.30) 2.66 (0.30) 1.21 (0.19)	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

** The default was area weighted using pasture/hay or cropland area of the subcatchments of this watershed.

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table C-3 for the Upper Monocacy watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table C-3 based on professional judgement.

Table C-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)		TP (lbs/ac)		TSS (lbs/ac)	
			2011	2001	2011	2001	2011	2001
LD Mixed	15	>5 to <30	0.48	0.46	0.10	0.09	336.99	288.65
MD Mixed	52	>=30 to <70	1.52	1.48	0.21	0.19	371.27	322.21
HD Mixed	87	>=70	1.53	1.48	0.21	0.20	371.80	322.94
LD Residential	15	>5 to <30	0.48	0.46	0.10	0.09	336.94	288.61

The local TP TMDL baseline year is 2009 and the local TSS TMDL baseline year is 2000, which means any retrofitted water quality BMPs installed since these years can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated based on the loading rates in Table C-3 (i.e., detention basin retrofits, infiltration, bioretention, etc.) represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Upper Monocacy watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.042, 0.041, and 0.115, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft). Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious).

XV. Appendix D: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

SWM Facilities Impervious Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Robert's Mill	Retrofit	281.2	87	ST	1.00	15.3	1331.1000	35%	465.2195	1.69	147.0300	55%	80.7489	0.44	38.2800	70%	26.7577
Trevanion Terrace	Retrofit	181	52	RR	1.00	15.3	795.6000	60%	475.3710	1.69	87.8800	70%	61.4281	0.44	22.8800	75%	17.1394
Meadowbrook	Retrofit	64.77	8.7	ST	1.00	15.3	133.1100	35%	46.5219	1.69	14.7030	55%	8.0749	0.44	3.8280	70%	2.6758
	Total:	**526.97**	**147.7**				**2259.8100**		**987.1124**		**249.6130**		**150.2519**		**64.9880**		**46.5729**

SWM Facilities Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Robert's Mill	Retrofit	281.2	194.2	ST	1.00	10.8	2097.3600	35%	733.0273	0.43	83.5060	55%	45.8615	0.07	13.5940	70%	9.5022
Trevanion Terrace	Retrofit	181	129	RR	1.00	10.8	1393.2000	60%	832.4370	0.43	55.4700	70%	38.7735	0.07	9.0300	75%	6.7644
Meadowbrook	Retrofit	64.77	56.07	ST	1.00	10.8	605.5560	35%	211.6418	0.43	24.1101	55%	13.2413	0.07	3.9249	70%	2.7435
	Total:	**526.97**	**379.27**				**4096.1160**		**1777.1061**		**163.0861**		**97.8763**		**26.5489**		**19.0101**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Taneytown	0.55	3.5	1.925	1.4	0.770	420	231	0.116
		Total:	**1.9250**		**0.7700**		**231**	**0.116**

Water Resource Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Walnut Grove Acres	6.511	8/7/01	11.7	76.1787	30	22.85361	0.68	4.4275	40	1.7710	0.18	1.1720	55	0.6446
Angelina Farms	0.520	9/17/01	11.7	6.0840	30	1.82520	0.68	0.3536	40	0.1414	0.18	0.0936	55	0.0515
H&K Acres	3.991	4/11/05	11.7	46.6947	30	14.00841	0.68	2.7139	40	1.0856	0.18	0.7184	55	0.3951
Stonesifer Property	0.094	3/22/07	11.7	1.0998	30	0.32994	0.68	0.0639	40	0.0256	0.18	0.0169	55	0.0093
Bullfrog Plateau	1.197	5/13/11	11.7	14.0049	30	4.20147	0.68	0.8140	40	0.3256	0.18	0.2155	55	0.1185
Hutchinson Family Ltd Partnership	1.639	5/19/11	11.7	19.1763	30	5.75289	0.68	1.1145	40	0.4458	0.18	0.2950	55	0.1623
Maiden’s Point	1.010	12/22/11	11.7	11.8170	30	3.54510	0.68	0.6868	40	0.2747	0.18	0.1818	55	0.1000
Harman, Blaine & Angela Property	1.295	9/10/12	11.7	15.1515	30	4.54545	0.68	0.8806	40	0.3522	0.18	0.2331	55	0.1282
Maiden’s Point 2	5.385	6/16/15	11.7	63.0045	30	18.90135	0.68	3.6618	40	1.4647	0.18	0.9693	55	0.5331
	21.642		**Total:**	**253.2114**		**75.96342**		**7.1577**		**2.8631**		**3.8956**		**2.1426**

Floodplain Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
H&K Acres	0.005	4/11/05	11.7	0.0585	30	0.0176	0.68	0.0034	40	0.0014	0.18	0.0009	55	0.0005
Bullfrog Plateau	0.001	5/13/11	11.7	0.0117	30	0.0035	0.68	0.0007	40	0.0003	0.18	0.0002	55	0.0001
Maiden's Point	0.032	12/22/11	11.7	0.3744	30	0.1123	0.68	0.0218	40	0.0087	0.18	0.0058	55	0.0032
Walnut Grove Acres	6.069	4/10/12	11.7	71.0073	30	21.3022	0.68	4.1269	40	1.6508	0.18	1.0924	55	0.6008
	6.107		**Total:**	**71.4519**		**21.4356**		**4.1528**		**1.6597**		**1.0993**		**0.6046**

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	13.19	11.7	154.3230	66	101.8532	0.68	8.9692	77	6.9063	0.18	2.3742	57	1.3533
Planting 2	0.51	11.7	5.9670	66	3.9382	0.68	0.3468	77	0.2670	0.18	0.0918	57	0.0523
Planting 3	0.97	11.7	11.3490	66	7.4903	0.68	0.6596	77	0.5079	0.18	0.1746	57	0.0995
Planting 4	0.85	11.7	9.9450	66	6.5637	0.68	0.5780	77	0.4451	0.18	0.1530	57	0.0872
Planting 5	0.95	11.7	11.1150	66	7.3359	0.68	0.6460	77	0.4974	0.18	0.1710	57	0.0975
Planting 6	7	11.7	81.9000	66	54.0540	0.68	4.7600	77	3.6652	0.18	1.2600	57	0.7182
Planting 7	0.65	11.7	7.6050	66	5.0193	0.68	0.4420	77	0.3403	0.18	0.1170	57	0.0667
Planting 8	2.18	11.7	25.5060	66	16.8340	0.68	1.4824	77	1.1414	0.18	0.3924	57	0.2237
Planting 9	1.9	11.7	22.2300	66	14.6718	0.68	1.2920	77	0.9948	0.18	0.3420	57	0.1949
Total:	**28.2**		**329.9400**		**217.7604**		**19.1760**		**14.7655**		**5.0760**		**2.8933**