Double Pipe Creek Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

MDE Approved: May 2020

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 Double Pipe Creek 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. 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 Double Pipe Creek Watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for nutrients and sediment in 1996, and again for bacteria in 2002. A TMDL for sediment was developed and approved in September of 2008, with a subsequent TMDL for phosphorus developed and approved in August of 2012. The 2003 bacteria listing was addressed with a TMDL that was developed and approved in December of 2009.

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 Towns of Manchester, New Windsor, and Union Bridge, the Cities of Taneytown and Westminster, as well as 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 Double Pipe Creek 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 IV.E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Double Pipe Creek 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 Bureau of Resource Management and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Carroll County portion of the Double Pipe Creek Watershed.

Section III: New Development; this section will discuss the Chapter 154; Water Resource Ordinance 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 County and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; Describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Double Pipe Creek 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 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

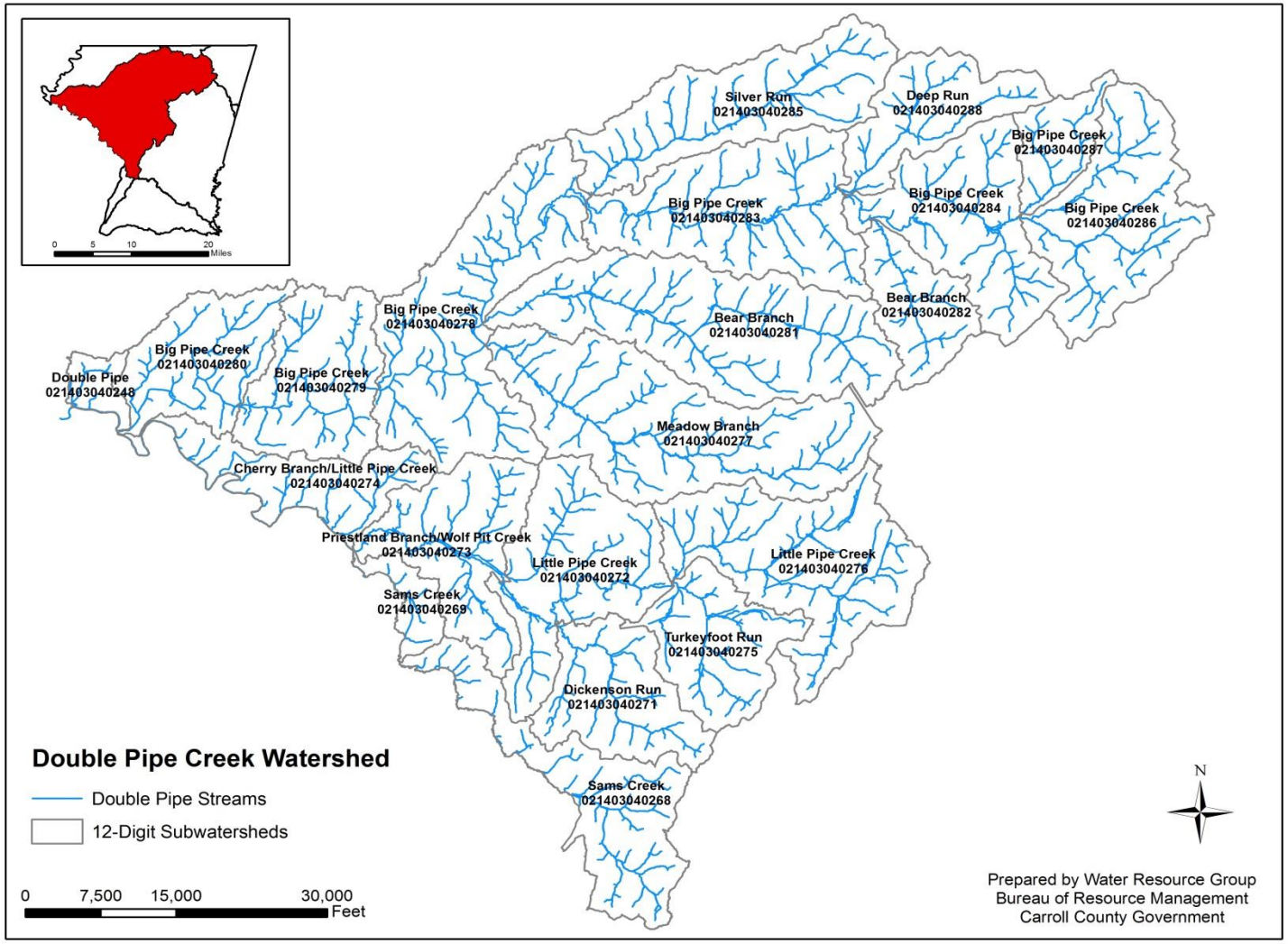

Figure 1: Double Pipe Creek Watershed and Subwatersheds Map

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. Double Pipe Creek Water Quality Standards

The entire portion of the Double Pipe Creek Watershed within Carroll County is designated as use IV-P, Recreational Trout Waters. The use IV-P is capable of supporting adult trout for a put-and-take fishery, but may not be capable for growing and propagating trout.

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 (WQS). 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. Within the Double Pipe Creek Watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. The Memorandum of Agreement (MOA) between the County and each of the Municipalities has combined the jurisdictions into one permit. 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 Double Pipe Creek Watershed was determined by (MDE, 2009) to be 4,423,635 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 67,365 billion MPN/year, which is a reduction of 4,356,270 billion MPN/year (98.5%) 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 Double Pipe Creek Watershed.

Table 3: Double Pipe Creek 8-digit Watershed Bacteria TMDL

Double Pipe Creek Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	4,423,635	67,365	98.5%
Total		**67,365**	**98.5%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County was determined by (MDE, 2012) to be 16,129 lbs. /yr., the TMDL for the stormwater WLA was determined to be 4,441 lbs. /yr., which is a reduction of 11,688 lbs. /yr. (72%) from the current loading (Table 4). The baseline loads for the County and Towns were derived from the TMDL Data Center. These baseline loads were combined and compared to the combined allocations for the County and Towns to derive the total percent reduction required. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2012).

Table 4: Double Pipe Creek 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Carroll County	9,316	2,329	75%
Municipalities	6,813	2,112	69%
Total	**16,129**	**4,441**	**72%**

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.

c. Sediment

The current estimated stormwater baseline load for Carroll County as determined by (MDE, 2008) is 4,759 tons/yr., the TMDL for the stormwater WLA was determined to be 3,149 tons/yr., which is a reduction of 1,610 tons/yr. (34%) from the current loading (Table 5).

Table 5: Double Pipe Creek 8-digit Watershed Sediment TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	4,759	3,149	34%
Total	**4,759**	**3,149**	**34%**

II. Background

A. Location and Subwatershed Map

The Carroll County portion of the Double Pipe Creek Watershed is located along the western portion of the County. The watershed is within the Potomac River Basin, which lies within the Piedmont physiographic province of Maryland. There are twenty one (21) major sub-watersheds in the County that cover a total land area of 105,457 acres. Figure 1 depicts the location of the Double Pipe Creek Watershed and its subwatersheds.

B. Baseline and Current Land Use

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 Double Pipe Creek Watershed, agriculture is the dominant land cover at about 60 percent of the total land, followed by forest which accounts for 20 percent, and residential, which accounts for about 12 percent of the total land cover. Mixed urban accounts for less than 3 percent of the total land cover, which represents the relatively rural nature of the Double Pipe Creek 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 Double Pipe Creek Watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within Double Pipe Creek can be found in Figure 2.

Table 6: Double Pipe Creek Watershed Baseline and Current Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	28	<1%	33	<1%	48	<1%	47	<1%
Low-Density Residential	7,375	7%	7,566	7%	7,636	7%	12,827	12%
Low-Density Mixed Urban	2,234	2%	2,344	2%	2,405	2%	2,405	2%
Medium-Density Mixed	385	<1%	508	<1%	591	<1%	591	<1%
High-Density Mixed Urban	64	<1%	110	<1%	129	<1%	129	<1%
Barren Land	241	<1%	276	<1%	263	<1%	260	<1%
Forest	23,894	23%	23,808	23%	23,742	23%	21,201	20%
Shrub/Scrub	1,057	1%	1,051	1%	1,091	1%	1,014	<1%
Grassland	127	<1%	193	<1%	203	<1%	189	<1%
Pasture/Hay	24,083	23%	23,630	22%	23,596	22%	22,237	21%
Cropland	44,409	42%	44,384	42%	44,192	42%	41,054	39%
Wetland	1,532	1.5%	1,526	1.5%	1,533	1.5%	1,492	1.4%

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 Double Pipe Creek Watershed is estimated to have 3,897 acres of total impervious within the catchment and accounts for approximately 3.7 percent of the total land area. The impervious surface area within Double Pipe, by subwatershed can be found in Table 7 and is shown in Figure 3.

Table 7: Double Pipe Creek Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
0281	Bear Branch	9,158	308.81	3.4%
0282	Bear Branch	2,643	62.18	2.4%
0278	Big Pipe Creek	8,799	261.34	3.0%
0279	Big Pipe Creek	4,582	77.01	1.7%
0280	Big Pipe Creek	3,937	77.09	2.0%

0283	Big Pipe Creek	7,183	217.99	3.0%
0284	Big Pipe Creek	5,568	110.99	2.0%
0286	Big Pipe Creek	6,074	266.68	4.4%
0287	Big Pipe Creek	1,796	36.21	2.0%
0274	Cherry Branch/Ltl Pipe Creek	3,452	77.79	2.3%
0288	Deep Run	3,456	97.99	2.8%
0271	Dickenson Run	4,049	167.61	4.1%
0248	Double Pipe Creek	759	20.63	2.7%
0272	Little Pipe Creek	5,880	141.19	2.4%
0276	Little Pipe Creek	7,442	789.78	10.6%
0277	Meadow Branch	9,490	482.11	5.1%
0273	Priestland/ Wolf Pit Branch	4,760	193.33	4.1%
0268	Sams Creek	5,393	178.31	3.3%
0269	Sams Creek	991	42.25	4.3%
0285	Silver Run	6,212	156.26	2.5%
0275	Turkeyfoot Run	3,833	131.31	3.4%
Double Pipe Creek Watershed		**105,457**	**3,897**	**3.7%**

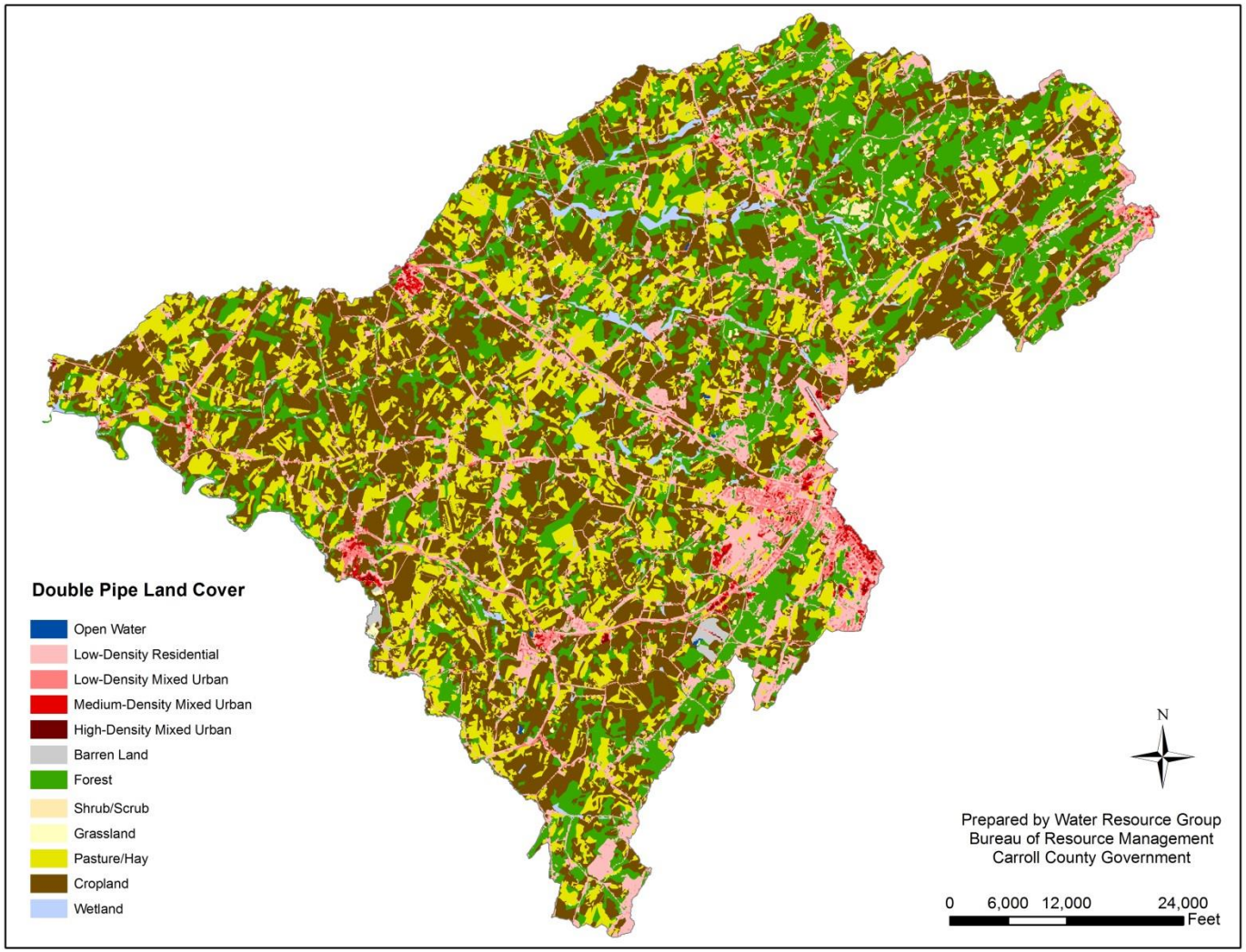

Figure 2: Double Pipe Creek Watershed Land Use/Land Cover from 2011

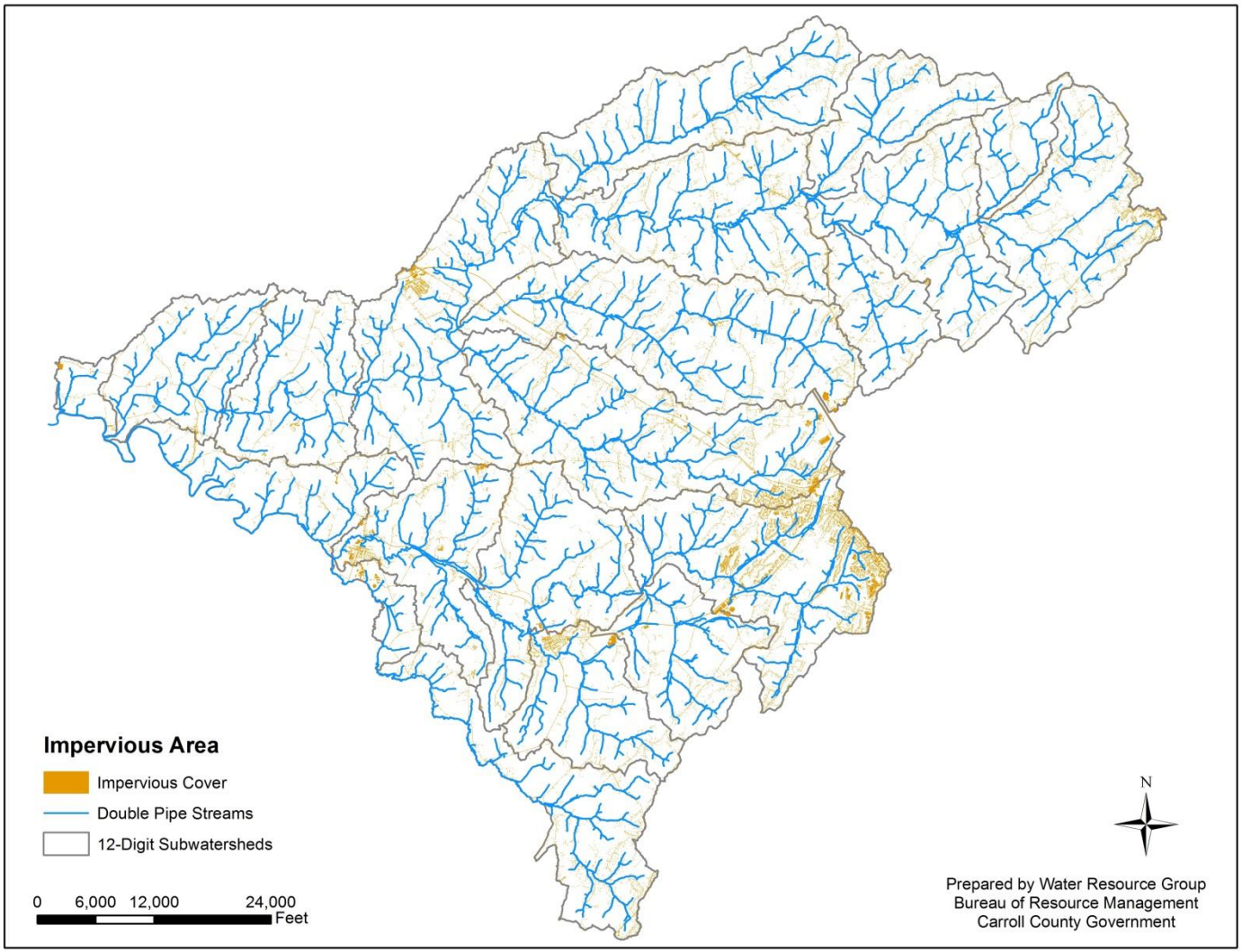

Figure 3: Double Pipe Creek Watershed Impervious Surface Area

C. Watershed Characterization

Following the Double Pipe Creek stream corridor assessment (SCA), completed in 2016, a Watershed Characterization for the Double Pipe Creek 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 Double Pipe Creek Watershed SCA will be used as the foundation for the watershed restoration plan. The Double Pipe Creek SCA and characterization documents can be found at:

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

http://ccgovernment.carr.org/ccg/resmgmt/DoublePipeCreek/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 Double Pipe Creek Watershed, there are no sections designated as Tier II waters.

b. Ecologically Sensitive Areas

Targeted Ecological Areas (TEAs) are lands and watersheds of high ecological value that have been identified as conservation priorities by the Maryland Department of Natural Resources (DNR) for natural resource protection. These areas represent the most ecologically valuable areas in the State (imap.maryland.gov). Targeted ecological areas within the Double Pipe Creek Watershed are shown in Figure 4.

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. 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.

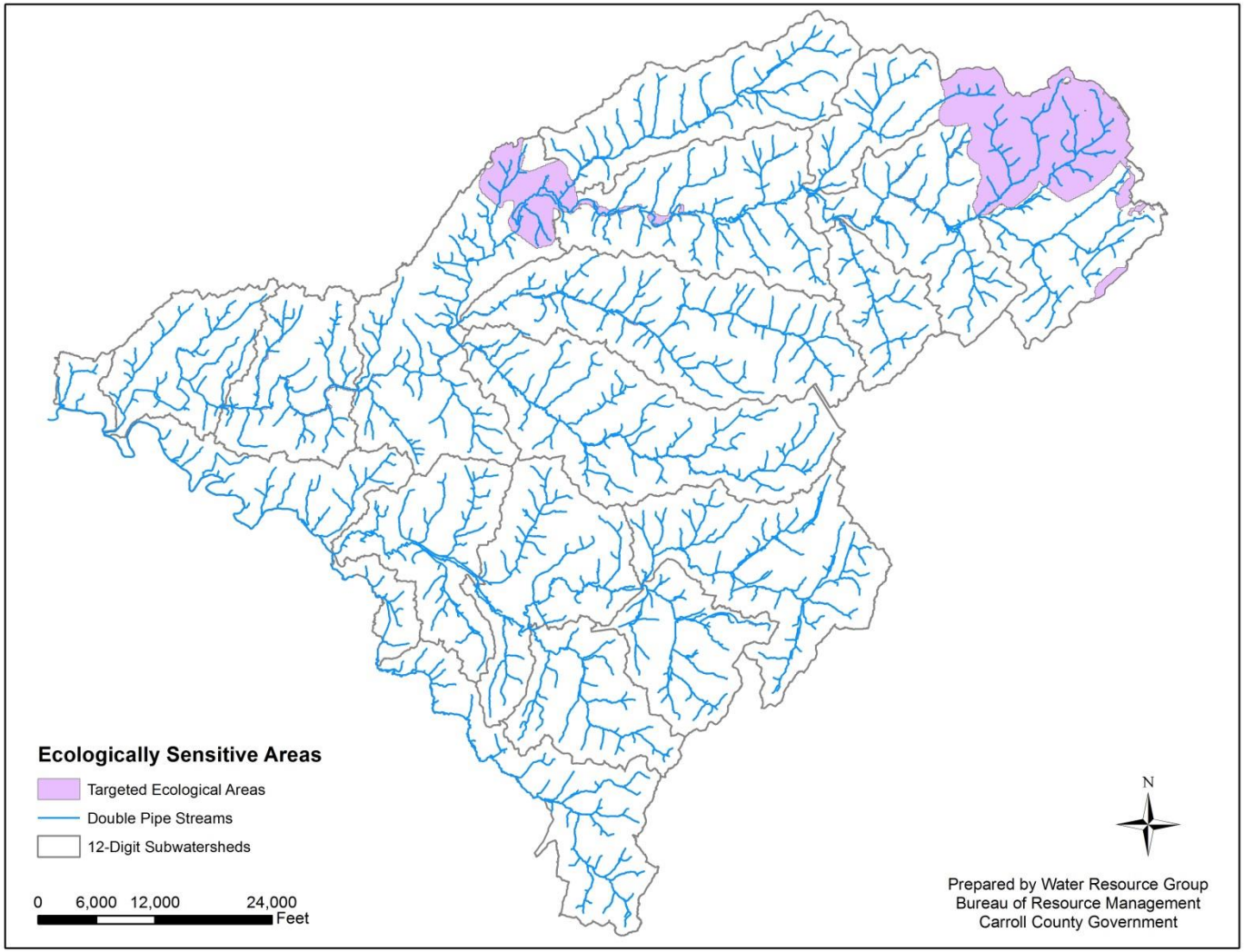

Figure 4: Targeted Ecological Areas

2. Stream Corridor Assessment (SCA)

A Stream Corridor Assessment (SCA) of the Double Pipe Creek Watershed was conducted during the winter of 2016 by Carroll County Bureau of Resource Management staff. The Double Pipe Creek 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 Double Pipe Creek SCA is available at:

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

3. Priority Watersheds

During the SCA, field crews identified erosion problems along approximately 211,310 linear feet of the corridor, 23.72% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in Big Pipe Creek (0286), Little Pipe Creek (0272), Meadow Branch (0277), and Little Pipe Creek (0276). A significant portion of the drainage within Little Pipe Creek (0272), Meadow Branch (0277), and Little Pipe Creek (0276) sub-watersheds originates within the corporate limits of Westminster, whereas, the Big Pipe Creek subwatershed (0286) originates within the corporate limits of Manchester. 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 foot 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 in need of treatment and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

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
Bear Branch (021403040281)	45.68	14.01	6,350	8.59%
Bear Branch (021403040282)	11.33	5.32	7,225	25.73%
Big Pipe Creek (021403040278)	45.71	9.10	10,250	21.34%
Big Pipe Creek (021403040279)	25.30	5.66	3,000	10.03%
Big Pipe Creek (021403040280)	20.57	8.59	10,350	22.82%
Big Pipe Creek (021403040283)	32.82	3.24	3,800	22.25%
Big Pipe Creek (021403040284)	27.25	10.82	13,720	24.01%
Big Pipe Creek (021403040286)	23.86	3.56	7,950	42.34%
Big Pipe Creek (021403040287)	10.04	0.00	N/A	N/A
Cherry Branch/Little Pipe Creek (021403040274)	22.98	7.34	8,400	21.66%
Deep Run (021403040288)	15.45	2.99	4,490	28.46%
Dickenson Run (021403040271)	18.77	8.90	10,750	22.88%
Double Pipe (021403040248)	4.84	0.99	1,300	24.89%
Little Pipe Creek (021403040272)	29.06	12.18	25,050	38.94%
Little Pipe Creek (021403040276)	33.28	19.31	30,240	29.66%
Meadow Branch (021403040277)	43.38	20.43	34,145	31.65%
Priestland Branch/Wolf Pit Creek (021403040273)	22.19	3.76	4,500	22.69%
Sams Creek (021403040268)	29.83	16.56	22,565	25.81%
Sams Creek (021403040269)	5.69	1.27	0	0.00%
Silver Run (021403040285)	27.43	3.40	1,600	8.90%
Turkeyfoot Run (021403040275)	18.47	11.30	5,625	9.43%
Total	**513.93**	**168.72**	**211,310**	**23.72%**

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 Double Pipe Creek Watershed there are 2,695 parcels remaining with potential development on 39,244 acres for an estimated lot yield of 8,343 (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 Double Pipe Creek 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.

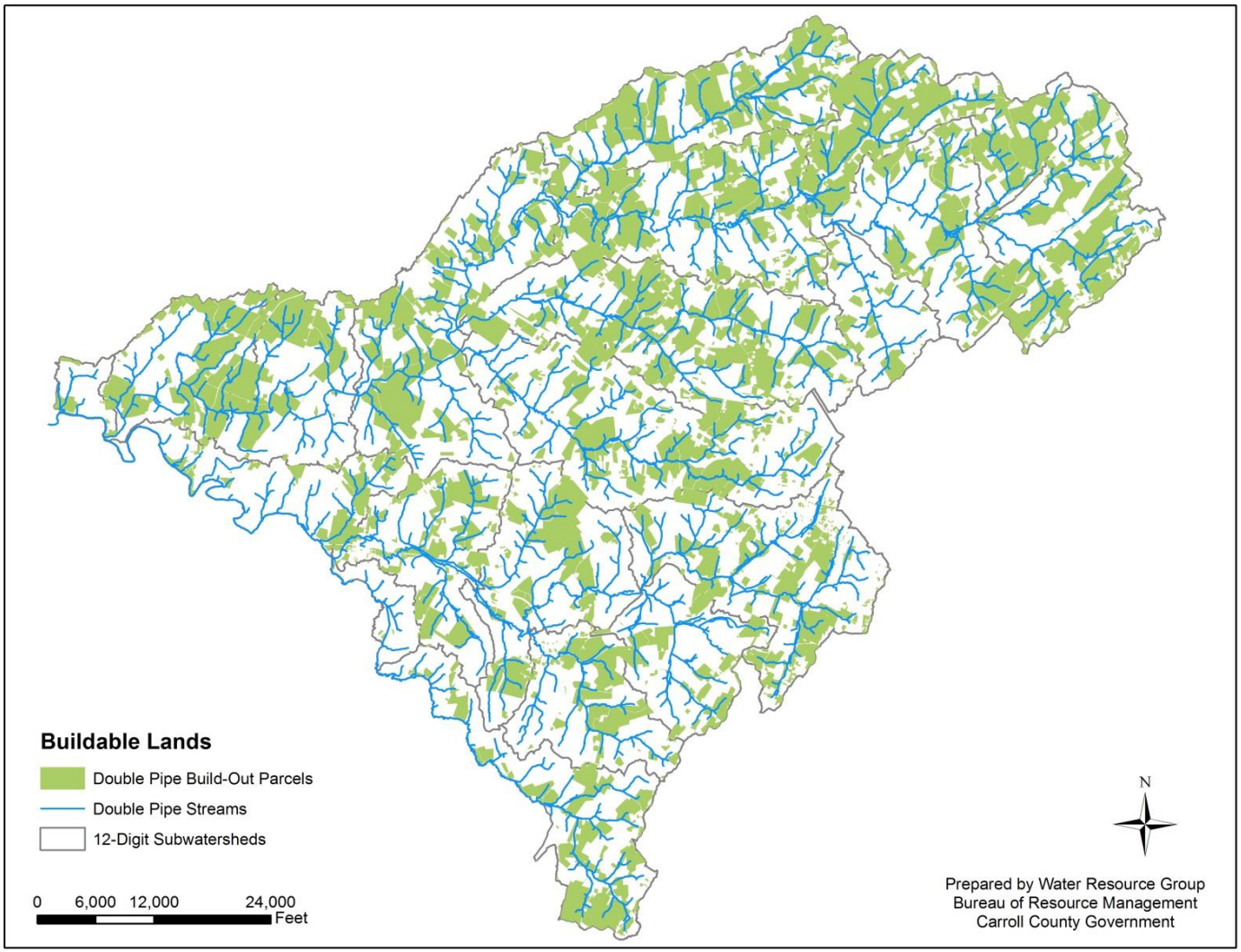

Figure 5: Double Pipe Creek Watershed Build-Out Parcels

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. Within the Double Pipe Creek Watershed there are 199.89 acres of grass buffer and 98.72 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Double Pipe Creek Watershed can be found in Appendix B, and are shown in Figure 6. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

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 Double Pipe Creek Watershed lies within the Little Pipe Creek Rural Legacy Area and encompasses 34,237 acres (32%) of the Double Pipe watershed. The extent of the Rural Legacy Area within Double Pipe can be found in Figure 7.

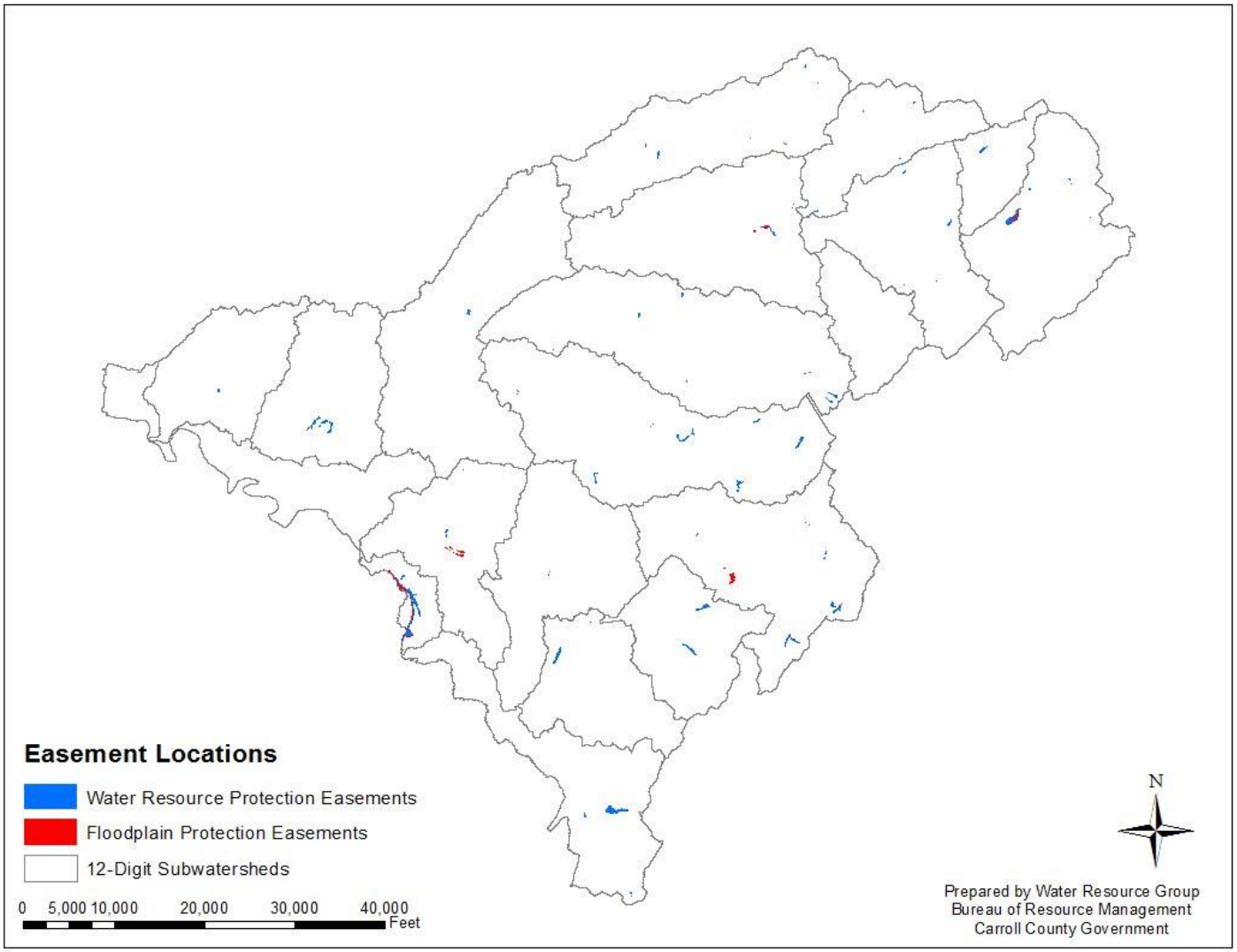

Figure 6: Water Resource and Floodplain Protection Easement Locations

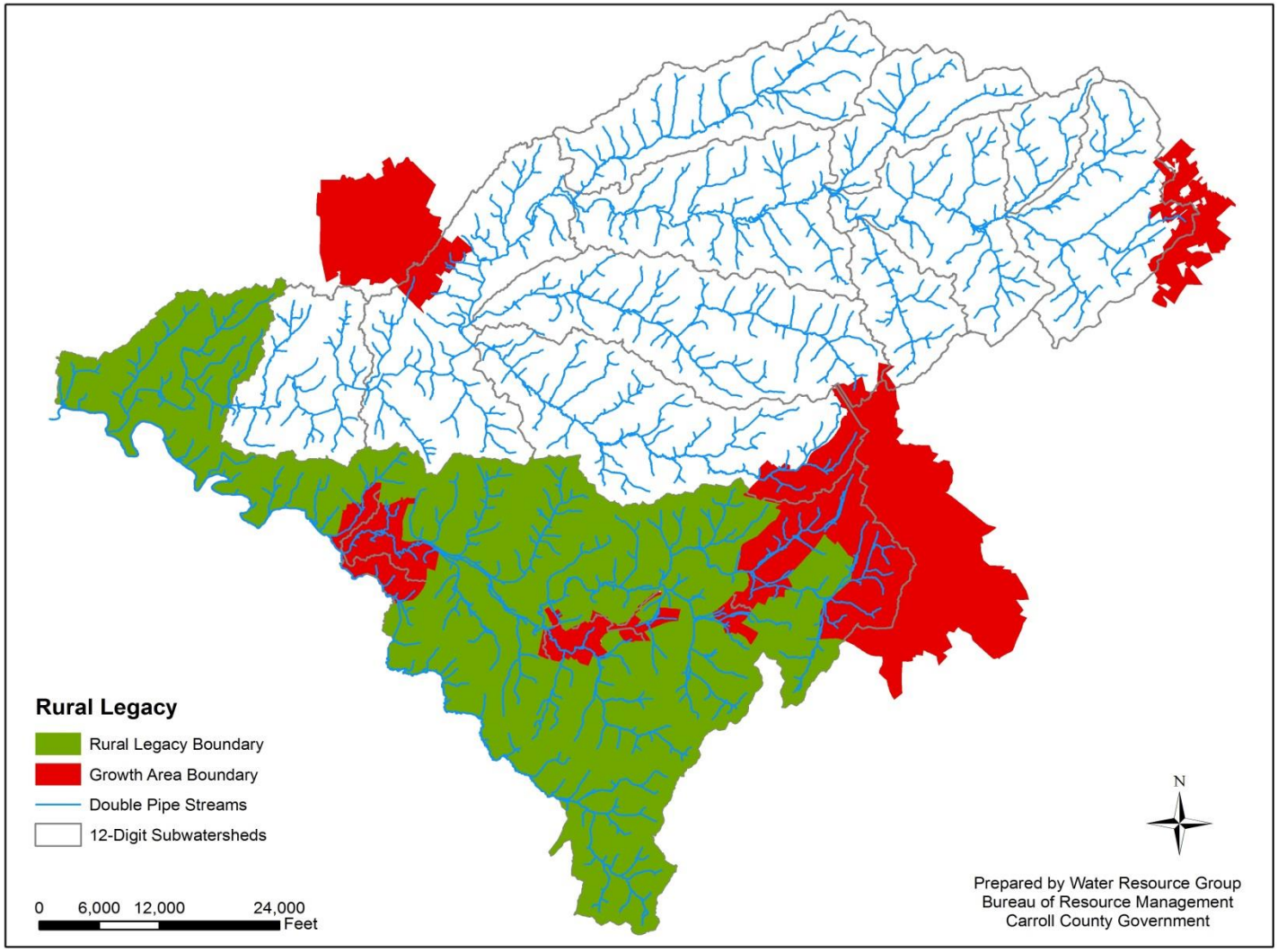

Figure 7: Little Pipe Creek Rural Legacy Area

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 Memorandum of Agreement (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 various other 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 is 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 Double Pipe Creek 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
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
Charlotte's Quest Nature Center Spring Fest	2018, 2019	Double Pipe/Prettyboy/Liberty
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
Longwell Run Earth Day Celebration & Tree Planting	2018	Double Pipe
McDaniel Clean-up Day	2018	Double Pipe
Mid-Atlantic Car Wash Association "Wash to Save the Bay"	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
New Windsor Town Beautification Day	2018	Double Pipe
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Scrap Tire Drop Off Day	2019	Countywide
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 Double Pipe Creek 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, Maryland Department of Environment (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 environmental site design (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 Double Pipe Creek Watershed TMDL's, that have been either completed or planned in current budget, 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
Sunnyside	30.2	2.69	Facility	Completed	0284
Friendship Overlook	82.01	15.88	Retrofit	Completed	0276
Farm Museum	6.44	0.45	Facility	Completed	0276
Farm Museum 1	11.61	2.3	Facility	Completed	0276
Farm Museum 2	0.09	0.05	Facility	Completed	0276
Farm Museum 3	0.79	0.06	Retrofit	Completed	0276
Farm Museum 4	0.03	0.03	Facility	Completed	0276
Farm Museum 5	0.01	0.01	Facility	Completed	0276
CC Maintenance	45.49	25.05	Retrofit	Completed	0281
Langdon	194	92.1	Facility	Under Construction	0276
Blue Ridge Manor	36.28	9.26	Retrofit	Completed	0271
Locust Wetland	35.9	11	Facility	Planned	0273
CC Health Dept.	14.77	6.72	Facility	Planned	0276
Long Valley Rd	98.32	16.64	Facility	Planned	0276
Exceptional Center	46.5	14.7	Retrofit	Completed	0276
Elmer Wolfe	9.78	4.26	Retrofit	Completed	0273
NW RR Track	34.5	15.34	Facility	Planned	0271
Avondale Run Phase 2	7.86	1.84	Retrofit	Planned	0276
CC Airport	38.4	7.4	Retrofit	Planned	0281
Greens of Westminster Sec 6 #2	38.31	12.56	Retrofit	Planned	0277
Meadow Ridge 171	22.1	5.73	Retrofit	Planned	0277
Meadow Ridge 172	18.2	5.35	Retrofit	Planned	0277
Totals:	**771.59**	**249.42**			

B. Storm Drain Outfalls

During the Double Pipe Creek Watershed SCA in 2016, erosion sites were documented and rated on severity. SCA identified erosion sites were analyzed in GIS to the location of existing stormwater management 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. Four elementary schools within the Double Pipe Creek Watershed have planted four gardens with a total drainage area of 1.47 Acres.

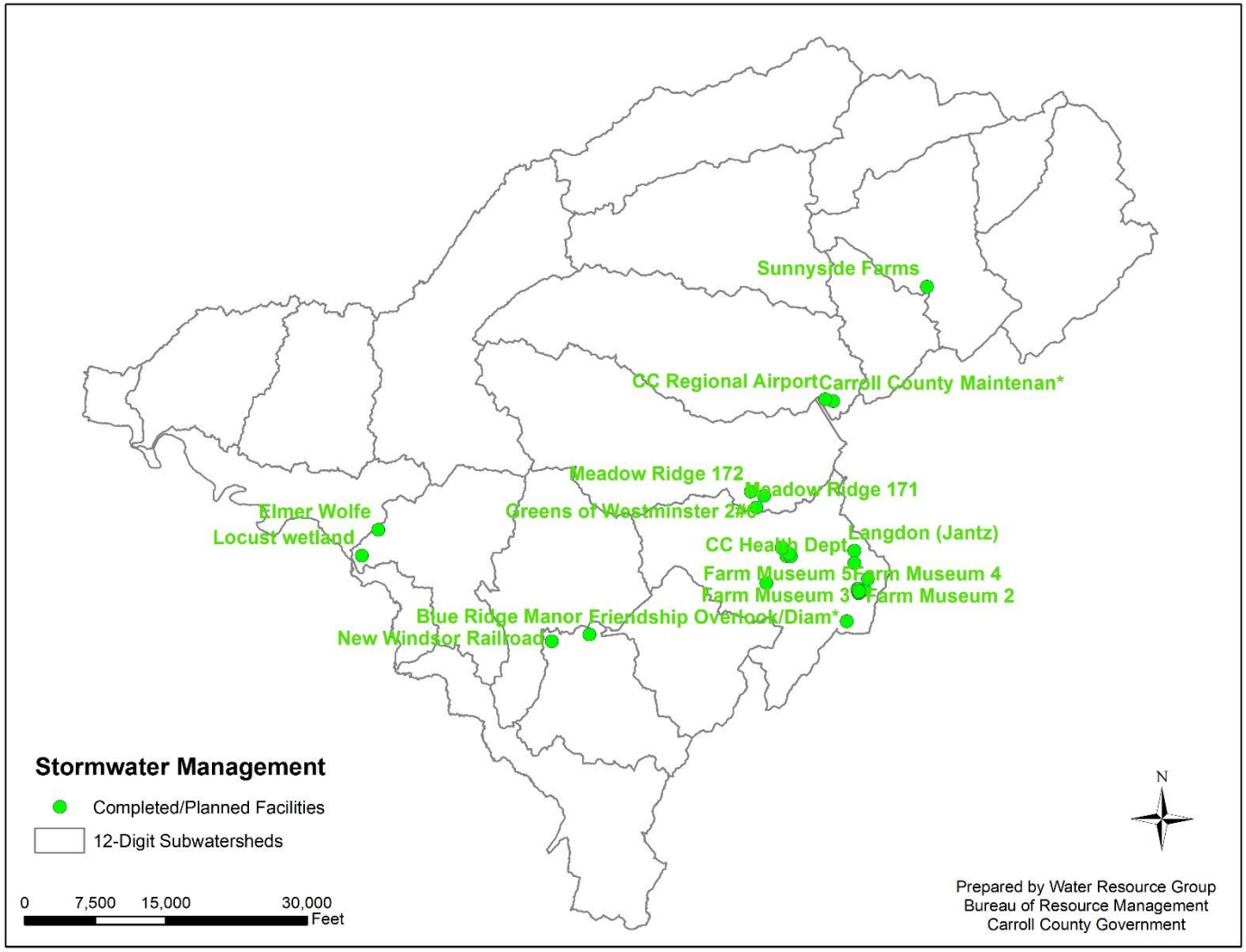

Figure 8: Stormwater Management Locations

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 2011 SCA in the Prettyboy 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 utilizing native tree stocks.

1. Residential Buffer Plantings

The 2016 Double Pipe Creek SCA determined that approximately twenty five (25) percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to landowners whose properties were identified as having an inadequate buffer. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. Twenty six properties participated in this initiative during the spring and fall of 2014 and 2015. The acreage planted for each location and the associated subwatershed can be found in Table 11. The approximate locations of the residential buffer plantings are shown in Figure 9.

Table 11: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	12- Digit Subwatershed	Date Planted
Planting 1	4.13	1,115	225	0274	2013
Planting 2	10.85	4,325	125	0276	2013
Planting 3	0.2	450	20	0273	Spring 2015
Planting 4	1.4	750	50	0272	Spring 2015
Planting 5	0.5	435	30	0283	Spring 2015
Planting 6	0.3	340	40	0286	Spring 2015
Planting 7	0.65	562	50	0277	Spring 2015
Planting 8	2.3	250	200	0285	Spring 2015
Planting 9	0.4	150	50	0281	Spring 2015
Planting 10	2.25	900	50	0286	Spring 2015
Planting 11	0.2	430	10	0283	Spring 2015
Planting 12	0.62	360	50	0286	Spring 2015
Planting 13	1.8	1,600	20	0277	Spring 2015
Planting 14	0.9	310	160	0287	Spring 2015
Planting 15	0.26	200	50	0273	Fall 2015
Planting 16	3	800	300	0285	Fall 2015
Planting 17	9	800	275	0273	Fall 2015
Planting 18	0.13	220	25	0281	Fall 2015

Planting 19	0.6	1,000	20	0272	Fall 2015
Planting 20	0.2	450	25	0285	Fall 2015
Planting 21	1.25	300	50	0272	Fall 2015
Planting 22	0.45	225	75	0278	Fall 2015
Planting 23	2.2	1,150	60	0271	Fall 2015
Planting 24	1.62	200	200	0276	Fall 2015
Planting 25	4.26	1,000	125	0276	Fall 2015
Planting 26	1.8	250	150	0276	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 inspected 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.

2. Municipal Plantings

In addition to the implementation of residential stream buffer plantings, in 2015, the Towns of New Windsor, Union Bridge and the City of Westminster also initiated tree planting projects within the Double Pipe Creek Watershed.

The City of Westminster implemented tree planting projects at three locations that consisted of planting over 2,300 trees to reforest more than 7.5 acres. The Town of New Windsor project consisted of planting 570 trees at a stocking rate of 260 trees per acre to restore a forested buffer along 1,150 feet of stream that is currently leased as cropland. The Town of Union Bridge project involved reforesting over 1,000 feet of stream corridor with over 1,200 trees just north of town in a wellhead protection area.

The Municipal efforts are included in Table 10 above.

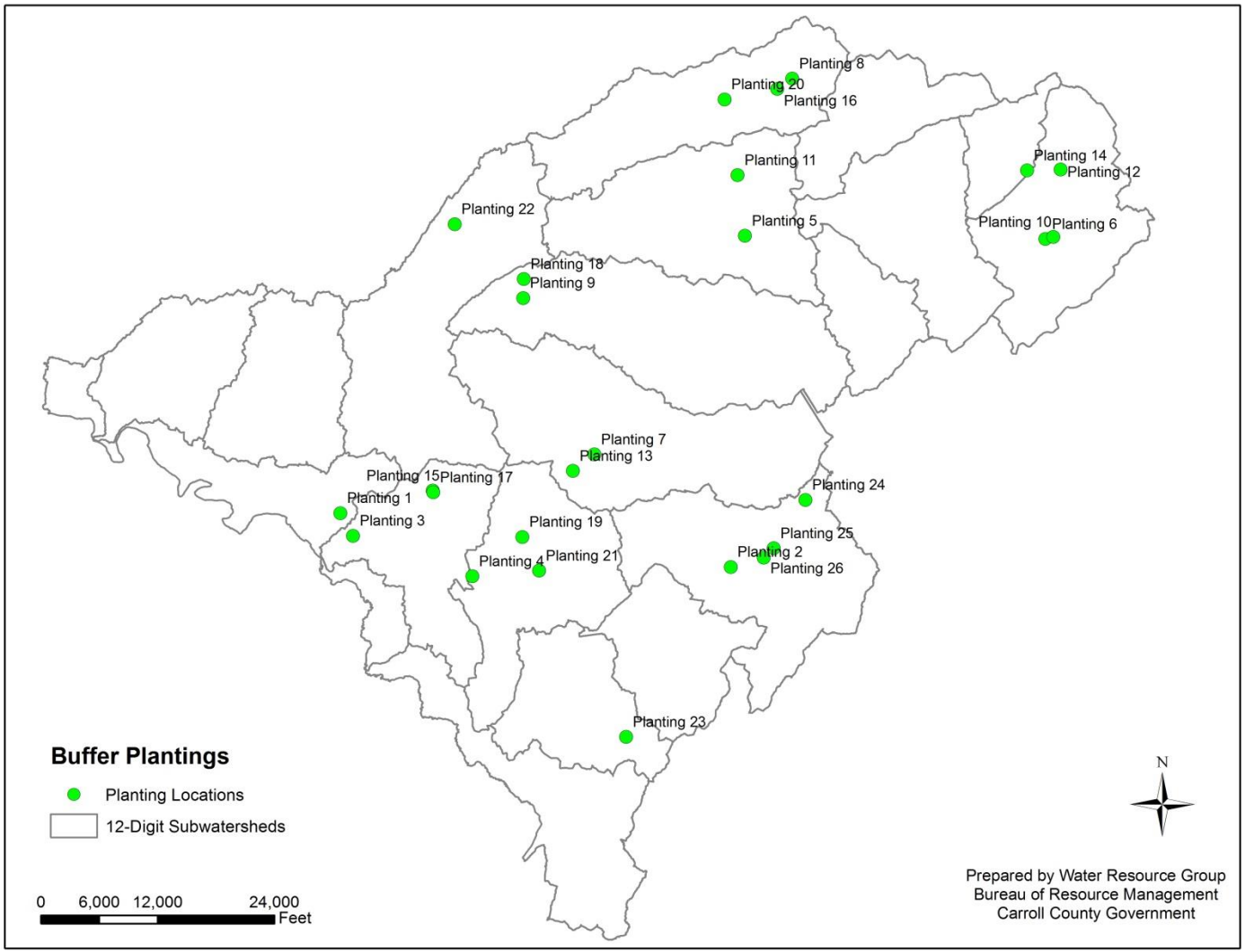

Figure 9: Stream Buffer Initiative Locations

E. 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 considered the implementation of stream restoration practices as a method to potentially reduce nutrient and sediment loadings within the watershed.

F. Streambank Regeneration

Accelerated streambank erosion occurs downstream of inadequately managed impervious from development. The proportion of rain water that previously infiltrated into the ground is reduced. Thus, causing immediate runoff, and increasing the total amount and velocity of flow in the receiving channel, accelerating erosion and resulting in greater sediment loads within the stream corridor.

There are two effective ways to reduce the destabilizing velocity increases in the receiving channel. The first is traditional stream restoration, increasing the plan form and bank resistance. The second is upland stormwater management, storing the total runoff volume and dissipating the acquired kinetic energy as turbulence in the water pool.

In the Piedmont, many residential, institutional, or commercial areas were developed prior to 1982 without any stormwater management or subsequently with peak flow control that matched existing conditions only, not really returning the runoff characteristics to predevelopment, as required by COMAR 26.17.02.01. Matching the existing hydrologic runoff response in these areas does not address existing streambank instability and does nothing to help restore streams or reduce current nutrient and legacy sediment export to the Bay.

Carroll County has been experimenting with the use of enlarged, enhanced, sand filters as primary stormwater management for more than 10 years. In an effort to determine the cause of these unanticipated stormwater management/quality/stream restoration benefits, we reanalyzed the design information. This showed that the Carroll County standard design reduced the two-year storm peak flow below that of an equivalent forested watershed in good condition. This has always been the goal of stormwater management, returning the hydrologic condition to that assumed to exist in pre-contact times.

Since the two-year flow is thought to control bank geometry, it makes sense that this would be an unintended benefit of truly adequate stormwater management. How far downstream the effect extends is site specific and depends on the soil types and land uses in the unmanaged portion of the watershed below the sand filter.

Although streambank regeneration is not currently an approved practice in the 2014 MDE guidance document (MDE, 2014), the guidance states that innovative practices that are not approved under the Maryland Stormwater Design Manual (MDE, 2000) nor have an MDE or CBP assigned pollution removal efficiency can be used to offer jurisdictions additional options toward watershed restoration activities provided that there is proper documentation and monitoring to verify pollutant removal efficiencies acceptable to MDE. The County has developed a paired watershed approach to evaluate the effectiveness of upland stormwater management practices on stream channel protection and will begin a 3-year study in 2016 collecting the necessary data to document the sediment and nutrient reduction benefits associated with this practice. The results will inform recommendations to credit upland stormwater practices as a hydrogeomorphic stream stabilization technique for sediment reductions.

G. 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 Double Pipe Creek Watershed are shown in Table 12.

Table 12: Road Maintenance Projects

Management Practice	**Inlet Cleaning**		
Town	Tons Removed	12-Digit Watershed	Date of Completion
Manchester	n/a		Annual
County	0.4	multiple	Annual
Union Bridge	0.44	0273	Annual
Westminster	0.49	0276/0277	Annual
Management Practice	**Bi-Weekly Mechanical Street Sweeping**		
Town	# Acres Swept	12-Digit Watershed	Date of Completion
Westminster	7.62	0276	Annual

H. 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 2009, twenty (43) septic systems within the Double Pipe Creek Watershed have been repaired and seventeen (35) new systems have been built utilizing Best Available Technology (BAT). Fourteen (33) of these projects have been via the Bay Restoration Fund. BAT 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 Double Pipe Creek Watershed are listed in Appendix C.

I. Agricultural Best Management Practices (BMPs)

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.

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 C 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 D.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Double Pipe Creek 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 72.5% from the 2009 baseline year and TSS load reduction of 33.8% 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. Double Pipe Creek 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 72.5% and urban TSS load reductions of 33.8% 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 938.00 lbs, which equates to a 72.5% reduction of 680.05 lbs. The modeled baseline urban TSS load using the 2001 land cover was 1290.91 tons, which equates to a 33.8% reduction of 432.95 tons (Table 13).

The projects completed as of December 2019 are providing 49.61 pounds of TP reduction, and 72.24 tons of TSS reduction. The planned projects would provide another 61.13 lbs. of TP reduction and another 42.22 tons of sediment (Table 14). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix C 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 Community Investment Program (CIP) budgets to progress towards fully attaining the Double Pipe Creek 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.

It is likely that these projects will also reduce bacteria contributions to the watershed. However, MDE currently does not provide guidance on bacteria reduction efficiencies.

Table 13: Total Phosphorus and Total Suspended Sediment Load Reduction in the Double Pipe Creek 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**
938.00	72.5%	680.05	49.61	61.13	12%
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**
1280.91	33.8%	432.95	72.24	42.22	9%

Table 14: 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**	**Stream Restoration**	**Catch Basin/ Inlet Cleaning**
Completed	40.64	3.38	5.51		0.08
Planned	24.85			36.28	
	Total Suspended Sediment Delivered Load Reductions (tons/yr)				
Completed	47.48	3.95	20.78		0.03
Planned	33.14			9.08	

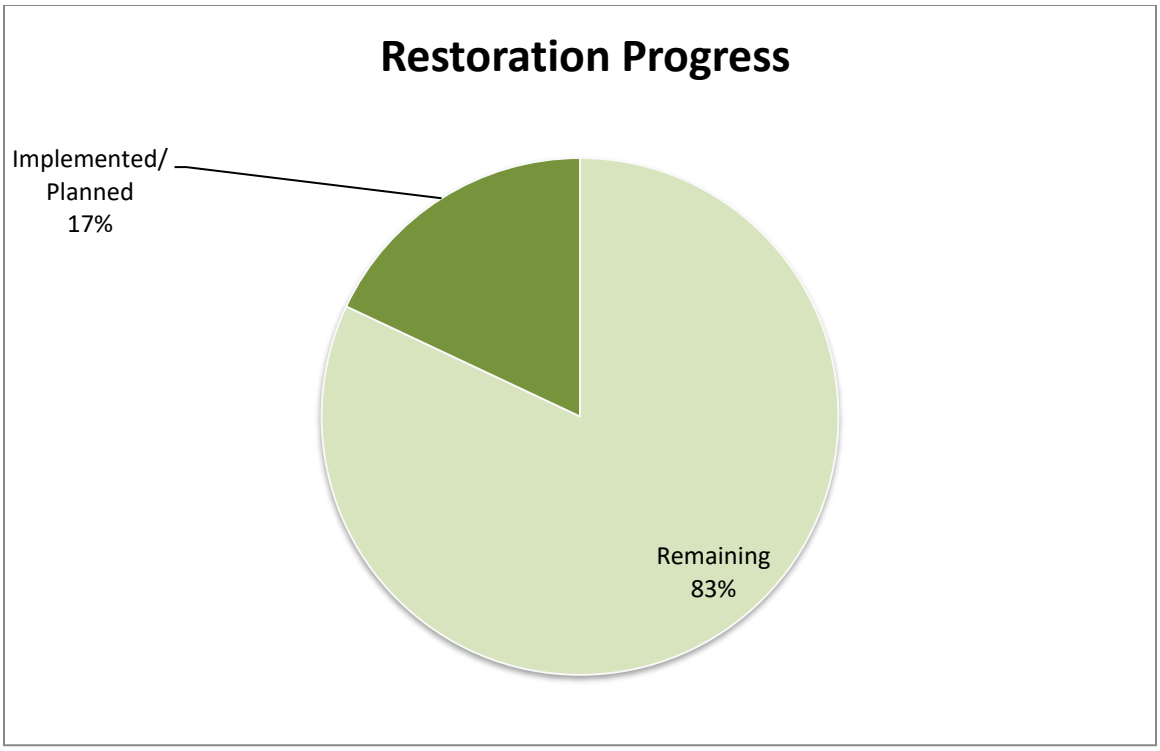

Figure 10: 2019 Restoration Progress Phosphorus

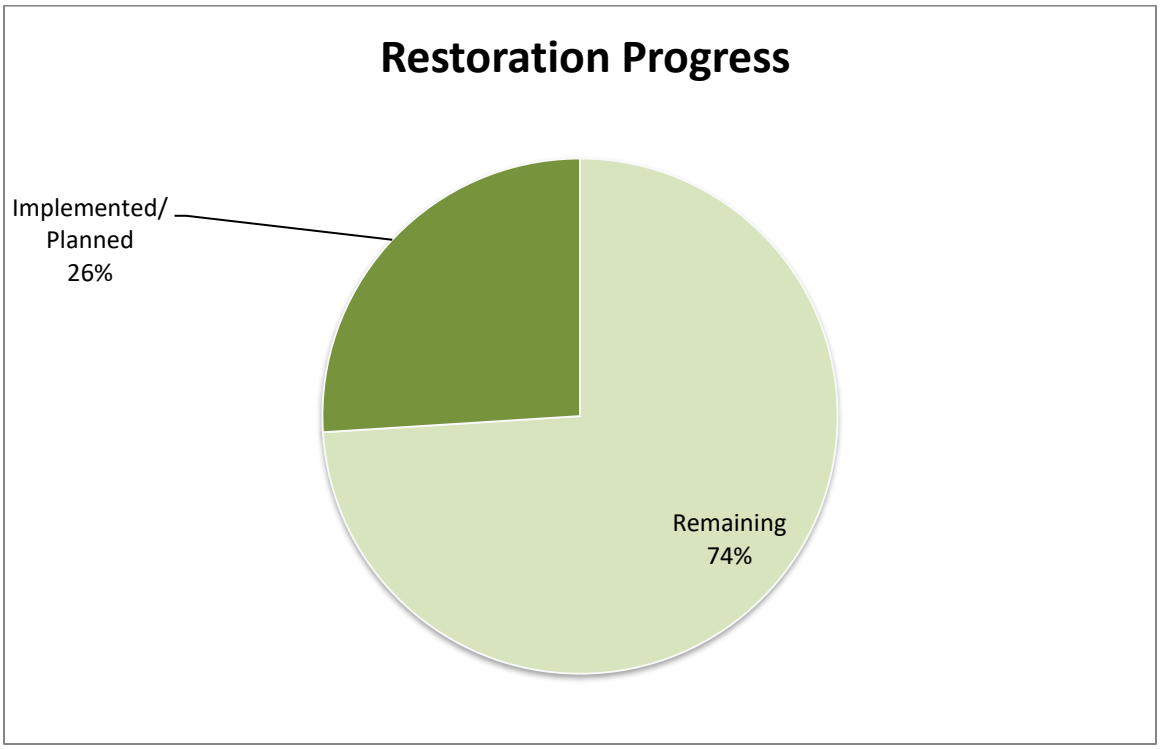

Figure 11: 2019 Restoration Progress Sediment

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 Double Pipe Creek 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 15 lists infrastructure related measures that have been implemented since the baseline year that would assist in reducing bacteria counts within the watershed.

Table 15: Waste Collection Infrastructure Upgrades

	County	Manchester	Westminster	Union Bridge	New Windsor
BAT Upgrades	78	0*	0*	0*	0*
Casings/Linings	n/a	TBD	TBD	TBD	TBD
Lateral line replacements	n/a	TBD	TBD	TBD	TBD
Pump Station upgrade	n/a	TBD	TBD	TBD	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 two locations within the Double Pipe Creek Watershed. The Farm Museum site, shown in Figure 12 is located within the Little Pipe Creek (0276) subwatershed just outside the corporate limits of the City of Westminster. The Greens of Westminster site, shown in Figure 13 is located within the Meadow Branch (0277) subwatershed and is entirely within the corporate limits of the City of Westminster.

The Farm Museum location is a public educational facility owned by the Carroll County Commissioners, with a drainage area of 23 acres, of which 4 acres, or 17% is impervious. The Greens of Westminster location has a drainage area of approximately 41 acres, of which, 15.6 acres or 38% is impervious.

Bi-weekly monitoring at the Farm Museum site began in February of 2015, while monitoring at the Greens of Westminster location started in December of 2017. Both sites involve the collection of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for both sites can be found in Table 16.

Additional monitoring at these locations include spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 16: 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	0.5 mg/l	SM 4500-NH3 C97

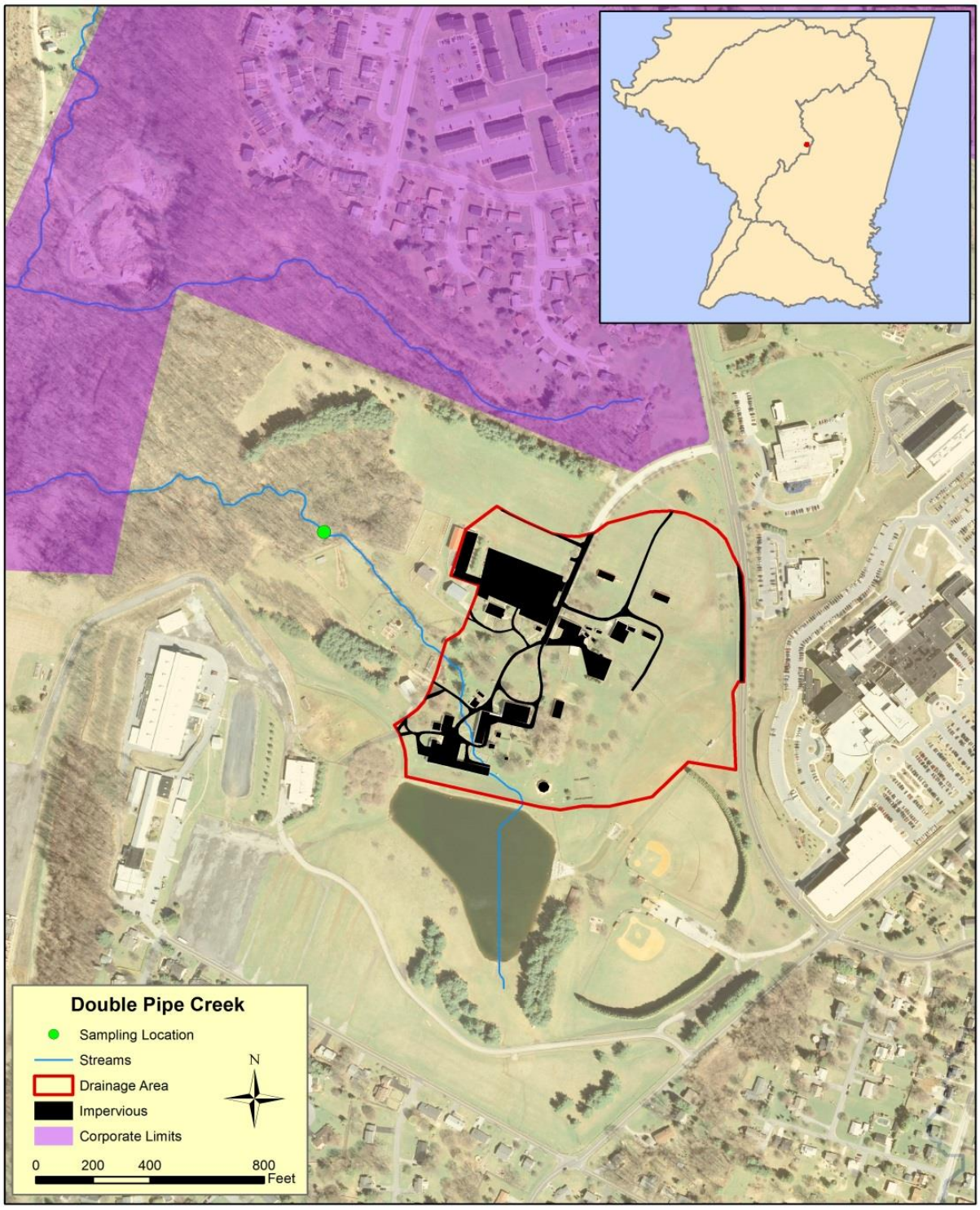

Figure 12: Farm Museum Monitoring Location

Figure 13: Greens of Westminster Monitoring Location

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 Double Pipe Creek Watershed began in December of 2017 at two locations, shown in Figure 14. Monitoring was suspended during a project by the City of Westminster and will resume once concluded. Samples are collected on the 1st Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 17 shows the monitoring results for the entire year, whereas Table 18 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 17: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2017		2018	
		# Samples	MPN	# Samples	MPN
LPC03	Low	1	15	5	29
	High	0	n/a	0	n/a
	All	1	15	5	29
LPC06	Low	1	8	5	35
	High	0	n/a	0	n/a
	All	1	8	5	35

Table 18: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2017		2018	
		# Samples	MPN	# Samples	MPN
LPC03	Low	0	n/a	1	43
	High	0	n/a	0	n/a
	All	0	n/a	1	43
LPC06	Low	0	n/a	1	56
	High	0	n/a	0	n/a
	All	0	n/a	1	56

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 19 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 19: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2017		2018	
			# Samples	% Exceeded	# Samples	% Exceeded
LPC03	576	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	410	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	298	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	235	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
LPC06	576	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	410	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	298	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	235	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a

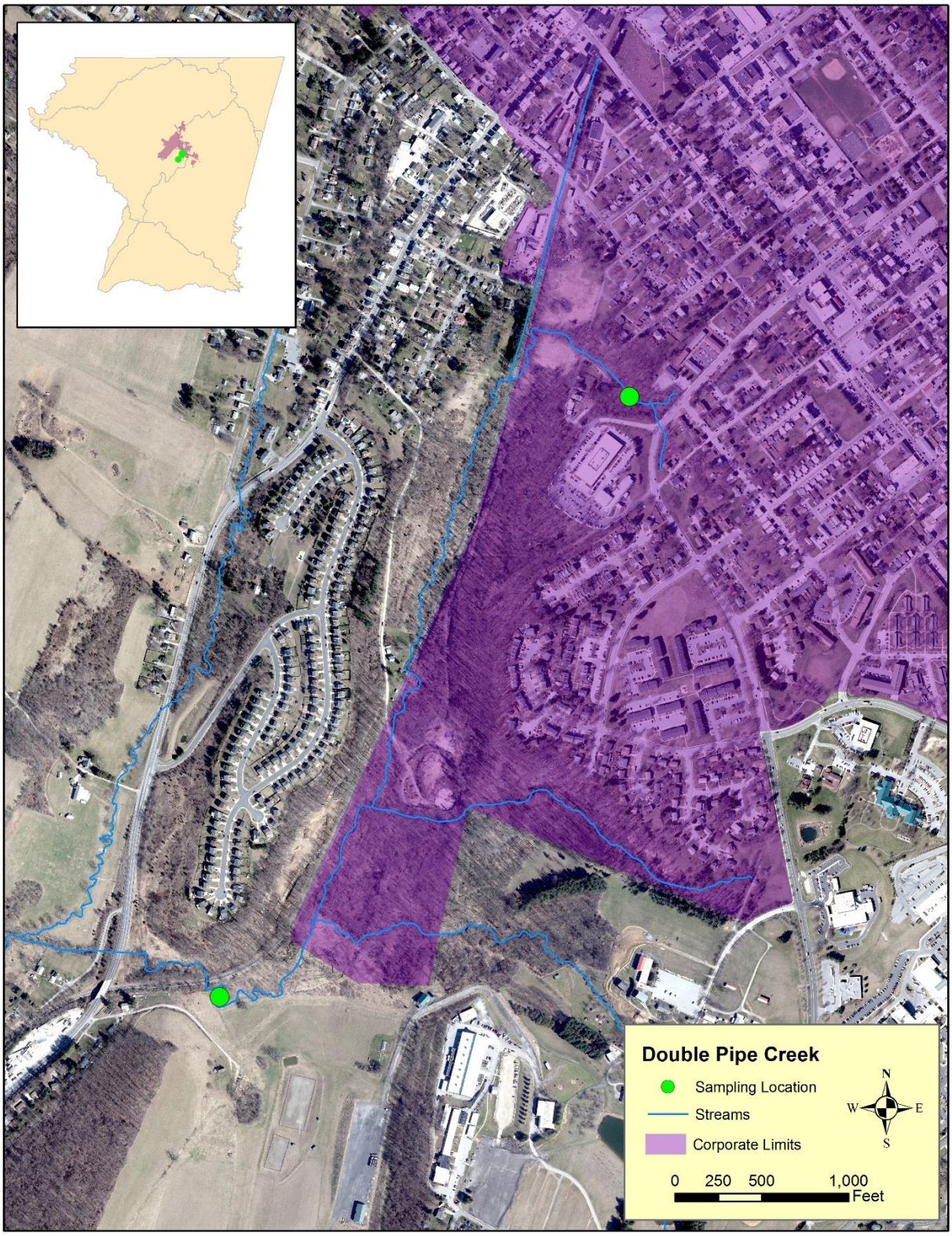

Figure 14: Bacteria Monitoring Location

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). BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Double Pipe Creek Watershed will ultimately reduce loadings to the Chesapeake Bay.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 20, and the tidal water designated use zones are shown in Figure 15.

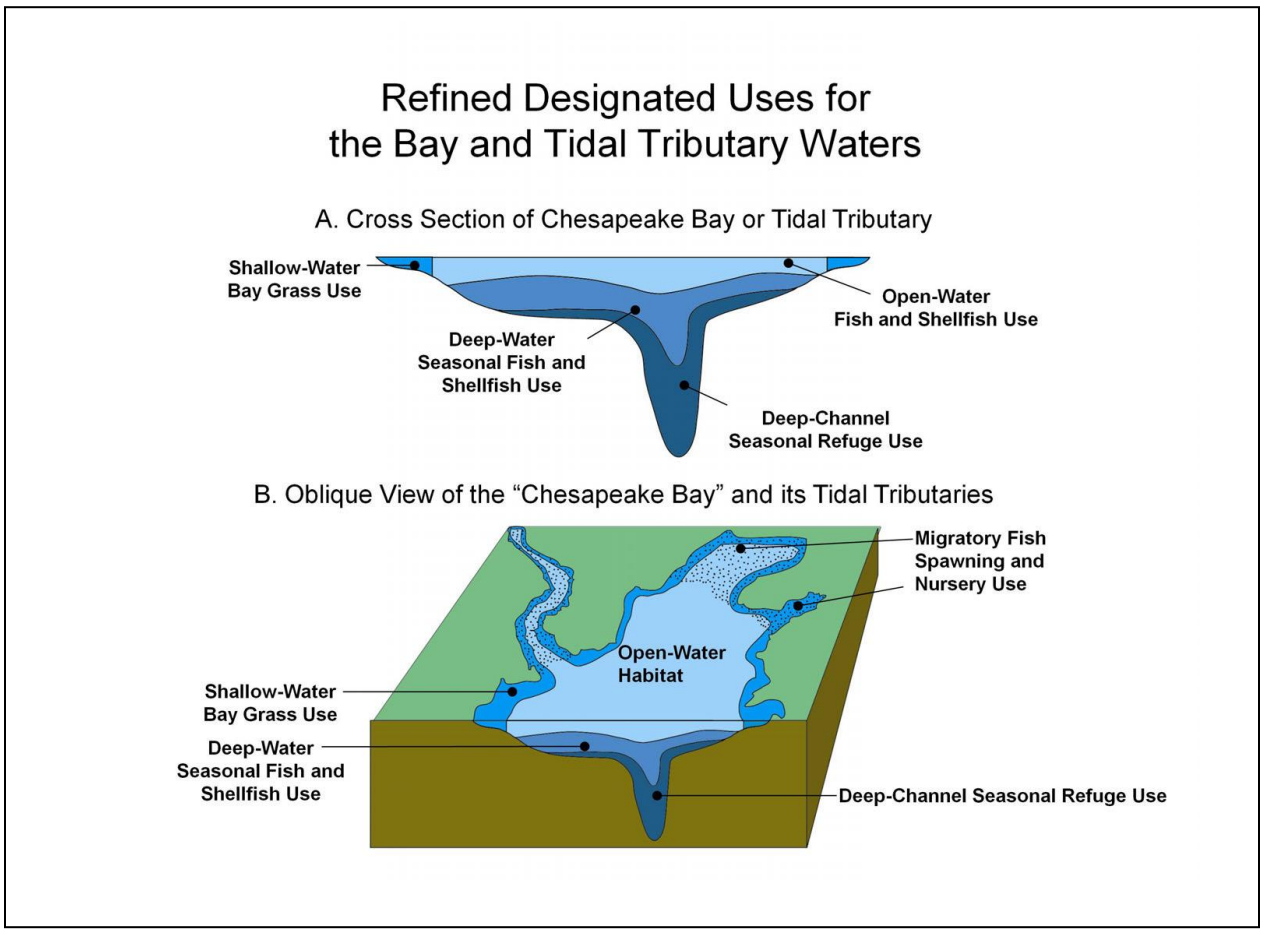

Figure 15: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 20: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The Double Pipe Creek Watershed is located within the Potomac River segment of the Chesapeake Bay. The Potomac River segment within Maryland covers 1,539,973 acres, approximately 137,878 acres (9%) of this river segment is within Carroll County. The location of the Potomac River segment is shown in Figure 16.

D. 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 E) 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 segment within the Double Pipe Creek Watershed are 0.47 for phosphorus and 0.65 for suspended sediment (MAST, 2016). There are three delivery ratios for nitrogen, depending on the river segment: PM1_3120_3400, PM1_3450_3400, and PM3_3040_3340, which are 0.30, 0.25, and 0.23, respectively. Essentially, if one pound of nitrogen is discharged into a tributary within the Double Pipe portion of the Potomac River segment, only 25% of that pound is reaching the Bay.

Table 20 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 Double Pipe Creek 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 Double Pipe Creek Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the

Potomac segment shed. The Double Pipe Creek Watershed covers 76.5% of the Potomac land-river segment within Carroll County.

Table 21: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Double Pipe Creek 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 Red. by BMPs 2009-2025
10,100.99	22.07%	2,228.95	152.95	266.16	18.80%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
110,661.46	9.25%	10,232.26	855.30	593.77	14.16%

[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 Double Pipe Creek Watershed.

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

[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.

Table 22: Carroll County Potomac River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	**Total Phosphorus (TP)[3]**			**Total Nitrogen (TN)**		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Lower Monocacy Watershed	2.11	31.83	1.5%	35.02	307.19	3.34%
Upper Monocacy Watershed	69.73	57.11	5.69%	473.39	469.79	9.22%
Double Pipe Creek Watershed	152.95	266.16	18.80%	855.30	593.77	14.16%
Total	**224.79**	**355.10**	**25.99%**	**1,363.71**	**1,370.75**	**26.72%**

[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.

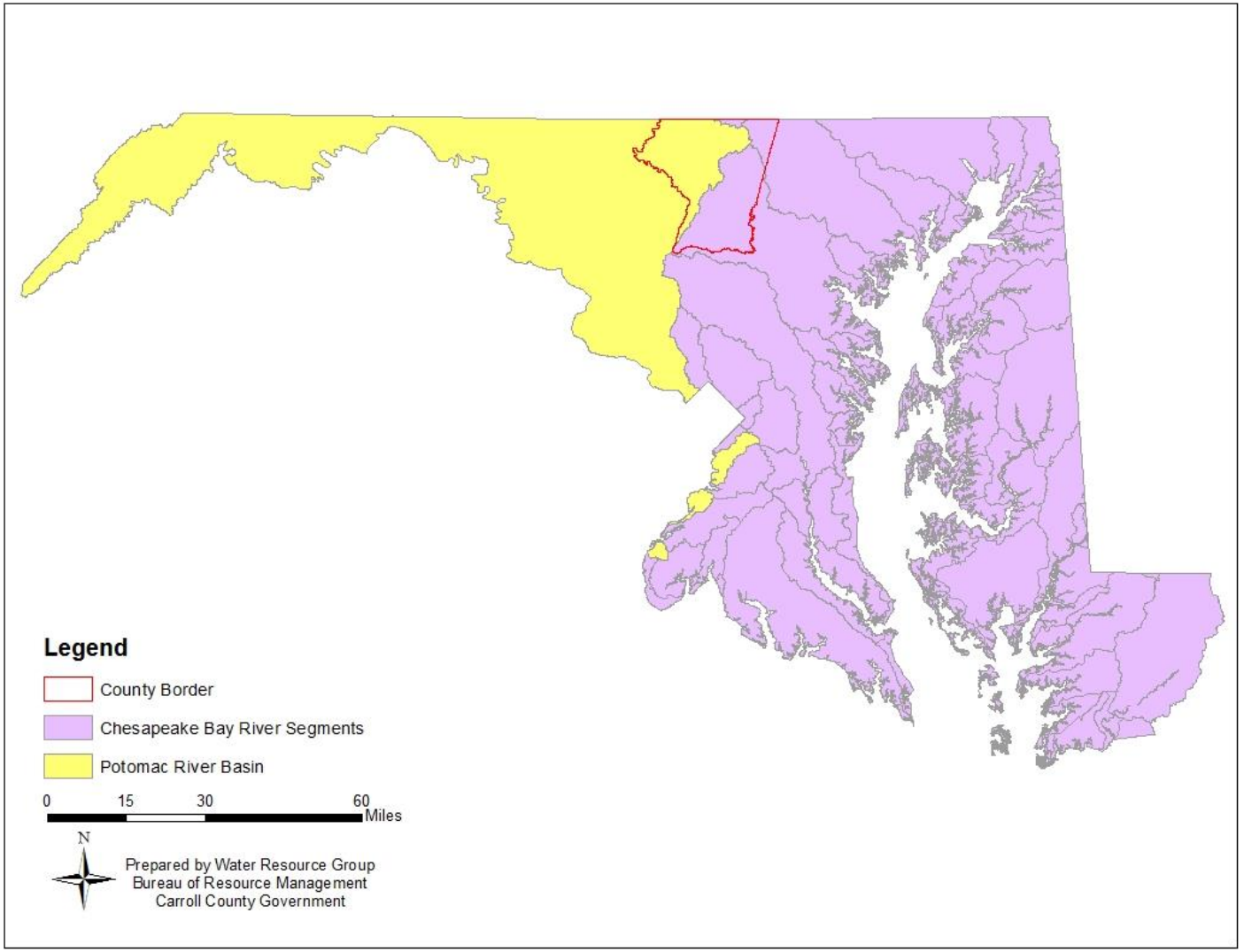

Figure 16: Chesapeake Bay River Segments

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 phosphorus TMDL through 2019 will have achieved 13% of the required reduction since the baseline year of 2009. Based on currently identified projects, the required reduction is expected to achieve 17% by 2025. The implementation from baseline through the current CIP is achieving approximately 1.06% reduction in the TMDL/year since the baseline.

The sediment TMDL through 2019 will have achieved 19% of the required reduction since the baseline year of 2000. Based on current projects is expected to achieve 26% of the required reduction by 2025. The implementation from baseline through the current CIP is achieving approximately 1.04% reduction in the TMDL/year since the baseline.

If the County is able to achieve a 2.75% reduction rate per year for phosphorus and a 2.5% reduction rate per year for sediment, the sediment and phosphorus TMDLs in the Double Pipe Creek Watershed would be achieved by 2055. 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 23 lists the anticipated benchmark for each nutrient TMDL within the Double Pipe Creek 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 23: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2055
Phosphorus	13%	17%	100%
Sediment	19%	26%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

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 affected by the watershed plan. Upon draft completion of the Double Pipe Creek Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the Bureau's website. During the thirty day public comment period inputs from any stakeholder or the public 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	2130907	Completed	$4,318,182	Completed
Buffer Plantings	County	2130907	Completed	$455,344	Completed
Catch Basin/Inlet Cleaning	New Windsor	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Manchester	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Westminster	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Union Bridge	2130907	Completed	**	Annual
Street Sweeping	Westminster	2130907	Completed	**	Annual
Water/floodplain Easement	Watershed	2130907	Completed	N/A	Completed
SWM (Planned)*	County	2130907	Planning/Design	$5,109,885	FY19-25
TBD*	Watershed	2130907	Planning/Design	$28,000,000	TBD

***Costs for proposed Stormwater facilities are based on current FY19-FY25 project costs, which may be subject to change.**

****Project Costs not reported.**

XIII. Appendix B: Forest Buffer and Grass Buffer Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
Silver Run	0.499747	2001
Meadow Branch	4.322408	2001
Meadow Branch	0.031301	2001
Meadow Branch	0.048342	2001
Meadow Branch	0.195628	2002
Meadow Branch	4.604909	2002
Greenwood Overlook	0.020146	2005
Sams Creek	0.021275	2005
Greenwood Overlook	1.5615	2005
Brilhart Property	0.004671	2005
Stone's Throw, Section 2	1.214203	2005
Stone's Throw, Section 2	0.014455	2005
Brilhart Property	0.214226	2005
Camelot Plaza	0.028655	2005
Little Pipe Creek	0.286582	2006
Heather's Land	0.000154	2006
Silver Run	0.16199	2006
Heather's Land	0.031541	2006
Walgarmyr, Section 2	0.103012	2006
Meadow Branch	3.832533	2006
Walgarmyr, Section 2	2.745445	2006
Meadow Branch	0.480212	2006
Big Pipe Creek	15.79883	2006
Hoke Property, OC #2	0.002411	2006
Hoke Property, OC #2	0.005513	2006
Hoke Property, OC #2	0.000001	2006
Heather's Land	0.00226	2006
Silver Run	0.850312	2006
Heather's Land	0.105968	2006
Meadow Branch	0.001036	2006
Hoke Property, OC #2	0.000146	2006
Hoke Property, OC #2	0.000079	2006
Bowling Brook	0.165051	2007
Bowling Brook	0.006586	2007
Bowling Brook	0.003342	2007

Bowling Brook	0.47473	2007
Bowling Brook	0.001163	2007
Bowling Brook	0.122419	2007
Bowling Brook	0.289267	2007
Bowling Brook	0.28219	2007
Arters Mill Estates	0.759966	2007
Cherry Branch/Little Pip*	0.824342	2008
Sterling Ridge Estates	0.002571	2008
Silver Run	0.798376	2008
Sterling Ridge Estates	0.656118	2008
Dutchmans' Bluff	0.537402	2008
Big Pipe Creek	0.039364	2008
Dutchmans' Bluff	1.610619	2008
Dutchmans' Bluff	0.02223	2008
Big Pipe Creek	0.14002	2008
Dutchmans' Bluff	0.000146	2008
Dutchmans' Bluff	0.000079	2008
Lehigh Cement Company	0.815991	2009
Sams Creek	0.207958	2009
Lehigh Cement Company	0.297441	2009
Priestland Branch/Wolf P*	0.770892	2009
Priestland Branch/Wolf P*	0.015621	2009
Sams Creek	0.871106	2009
Lehigh Cement Company	4.710873	2009
Priestland Branch/Wolf P*	0.001046	2009
Priestland Branch/Wolf P*	0.001046	2009
Drifting Snow	0.012816	2010
Big Pipe Creek	0.000976	2010
Drifting Snow	0.001701	2010
Greenvale Mews	0.19557	2010
Little Pipe Creek	0.000364	2010
Little Pipe Creek	2.635458	2010
Greenvale Mews	0.022979	2010
Greenvale Mews	0.232209	2010
Greenvale Mews	0.129904	2010
Meadow Branch	0.632547	2010
Cox Hillside	0.000519	2010
Deep Run	1.096886	2010
Cox Hillside	0.436183	2010
Big Pipe Creek	0.155886	2010
Big Pipe Creek	0.162486	2010

Little Pipe Creek	0.000015	2010
Greenvale Mews	0.004634	2010
Greenvale Mews	0.004634	2010
Greenvale Mews	0.000022	2010
Greenvale Mews	0.000022	2010
Meadow Branch	0.001036	2010
Nadine's Overlook	0.012495	2011
Little Pipe Creek	2.233671	2011
Nadine's Overlook	0.950734	2011
Father's Care, LLC Prope*	0.407079	2011
Little Pipe Creek	0.173619	2011
Father's Care, LLC Prope*	0.885941	2011
Bear Branch	0.158629	2011
Jordans Crossing	0.008824	2012
Jordans Crossing	0.002531	2012
Big Pipe Creek	0.214848	2012
Jordans Crossing	0.246492	2012
Jordans Crossing	0.105036	2012
Big Pipe Creek	0.006038	2012
Big Pipe Creek	0.049611	2012
Sams Creek	21.166948	2015
Sams Creek	0.02894	2015
Was-Mere Acres	0.121091	2015
Was-Mere Acres	0.656231	2015
Was-Mere Acres	0.018013	2015
Big Pipe Creek	1.270809	2015
Big Pipe Creek	0.503489	2015
Was-Mere Acres	1.303992	2015
Was-Mere Acres	1.194162	2015
Sams Creek	0.012083	2015
Sams Creek	0.012083	2015
Bear Branch	0.413334	2016
Medford Quarry Amended	9.217172	2017

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
Meadow Branch	0.291417	2001
Sams Creek	1.506742	2001
Silver Run	0.195684	2001
Meadow Branch	0.356696	2002
Big Pipe Creek	4.303266	2002

Meadow Branch	0.00012	2002
Meadow Branch	2.539834	2002
Doves Crest	0.705711	2003
Doves Crest	2.43664	2003
Little Pipe Creek	0.600093	2003
Doves Crest	0.000831	2003
Doves Crest	0.000716	2003
Sunny View Acres	0.062616	2005
Camelot Plaza	0.59231	2005
Camelot Plaza	12.540144	2005
Naomi's Delight	0.241606	2005
Stone's Throw, Section 2	0.918153	2005
Brilhart Property	0.008496	2005
Greenwood Overlook	0.002037	2005
Snavely Forest	0.022865	2005
Little Pipe Creek	0.444514	2005
Meadow Branch	2.656235	2005
Sams Creek	0.001253	2005
Naomi's Delight	2.342045	2005
Brilhart Property	0.104149	2005
Greenwood Overlook	0.648749	2005
Turkeyfoot Run	4.257514	2005
Snavely Forest	7.397423	2005
Hoke Property, OC #2	3.243872	2006
Walgarmyr, Section 2	0.155932	2006
Walgarmyr, Section 2	0.003029	2006
Meadow Branch	0.731093	2006
Meadow Branch	1.031899	2006
Big Pipe Creek	0.707324	2006
Big Pipe Creek	0.110829	2006
Meadow Branch	0.33284	2006
Big Pipe Creek	5.399041	2006
Walgarmyr, Section 2	2.60639	2006
Walgarmyr, Section 2	0.597048	2006
Hoke Property, OC #2	10.53242	2006
Hoke Property, OC #2	0.004648	2006
Hoke Property, OC #2	0.001288	2006
Hoke Property, OC #2	0.000134	2006
Bowling Brook	0.00185	2007
Bowling Brook	0.000684	2007
Bowling Brook	0.686132	2007

Arters Mill Estates	0.364396	2007
Bear Branch	0.418759	2007
Big Pipe Creek	0.590873	2007
Bowling Brook	0.160364	2007
Bowling Brook	2.032802	2007
Dutchmans' Bluff	4.327792	2008
Big Pipe Creek	0.561355	2008
Big Pipe Creek	0.31053	2008
Cherry Branch/Little Pip*	0.107477	2008
Dickenson Run	0.406619	2008
Dutchmans' Bluff	1.487281	2008
Dutchmans' Bluff	0.865191	2008
Dutchmans' Bluff	0.001288	2008
Dutchmans' Bluff	0.000134	2008
Uniontown Bible Church	1.103603	2009
Uniontown Bible Church	0.552112	2009
Uniontown Bible Church	5.992726	2009
Uniontown Bible Church	3.560872	2009
Lehigh Cement Company	0.674208	2009
Priestland Branch/Wolf P*	0.076308	2009
Priestland Branch/Wolf P*	0.087143	2009
Sams Creek	8.513259	2009
Sams Creek	21.65962	2009
Lehigh Cement Company	1.562524	2009
Silver Run Estates - Lo*	0.802246	2010
Drifting Snow	0.054724	2010
Schatzie's Choice, Secti*	0.046963	2010
Bixler Hangover Parcel	0.039258	2010
Krom's Keep	0.002427	2010
Cox Hillside	0.043399	2010
Greenvale Mews	0.440083	2010
Greenvale Mews	0.072271	2010
Big Pipe Creek	0.024401	2010
Big Pipe Creek	2.081584	2010
Big Pipe Creek	0.300847	2010
Meadow Branch	0.425908	2010
Bear Branch	2.517975	2010
Greenvale Mews	0.010387	2010
Greenvale Mews	0.698816	2010
Greenvale Mews	0.023069	2010
Greenvale Mews	0.029469	2010

Deep Run	0.2606	2010
Little Pipe Creek	1.670127	2010
Little Pipe Creek	0.734495	2010
Drifting Snow	0.782751	2010
Bixler Hangover Parcel	1.186291	2010
Krom's Keep	0.031625	2010
Cox Hillside	0.206525	2010
Little Pipe Creek	0.00983	2010
Greenvale Mews	0.020095	2010
Greenvale Mews	0.020095	2010
Nadine's Overlook	0.662134	2011
Nadine's Overlook	0.079099	2011
Father's Care, LLC Prope*	0.00398	2011
Little Pipe Creek	1.23704	2011
Little Pipe Creek	0.411898	2011
Nadine's Overlook	0.004953	2011
Bear Branch	9.402464	2011
Nadine's Overlook	0.000001	2011
Nadine's Overlook	2.748509	2011
Nadine's Overlook	0.675002	2011
Nadine's Overlook	0.14752	2011
Father's Care, LLC Prope*	0.439079	2011
Little Pipe Creek	0.285468	2011
Nadine's Overlook	0.077379	2011
Nadine's Overlook	0.000831	2011
Nadine's Overlook	0.000716	2011
Nadine's Overlook	0.000007	2011
Nadine's Overlook	0.000007	2011
Jordans Crossing	0.005556	2012
Jordans Crossing	0.006565	2012
Bedford Falls Farm	0.217965	2012
Big Pipe Creek	3.90744	2012
Big Pipe Creek	0.426711	2012
Jordans Crossing	0.250612	2012
Jordans Crossing	0.071328	2012
Bedford Falls Farm	1.477757	2012
Jacob's Ridge 2	0.088561	2013
Jacob's Ridge 3	0.013881	2013
Meadow Branch	0.051278	2013
Meadow Branch	0.05071	2013
Jacob's Ridge 2	5.107377	2013

Jacob's Ridge 3	0.037209	2013
Jacob's Ridge 3	3.243542	2013
Meadow Branch	0.311167	2013
Jacob's Ridge 2	0.000007	2013
Jacob's Ridge 3	0.000007	2013
Jacob's Ridge 3	0.000061	2013
Jacob's Ridge 3	0.000061	2013
Was-Mere Acres	1.404828	2015
Was-Mere Acres	3.809993	2015
Was-Mere Acres	0.23423	2015
Sams Creek	1.56634	2015
Sams Creek	0.078326	2015
Dickenson Run	13.210574	2015
Big Pipe Creek	0.594202	2015
Big Pipe Creek	0.29763	2015
Was-Mere Acres	0.325963	2015
Was-Mere Acres	0.935911	2015
Sams Creek	0.025074	2015
Sams Creek	0.025074	2015
Bear Branch	0.715206	2016
McNemar Property OC #1	0.902456	2017
Wakefield Solar	1.594496	2018
Snader's Summit	0.784605	2019
Snader's Summit	2.658072	2019

XIV. Appendix C: Double Pipe Creek BAT Septic Systems

DNR 12-digit scale	SubWatershed	Project Type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2008-2019
0281	Bear Branch	Septic Repair	0	0	0	0	0	0	0	2	2	0	1	1	0
		New Construction	0	0	0	0	0	1	1	1	1	0	0	0	4
0282	Bear Branch	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	0	1	0	0	0	1
0278	Big Pipe Creek	Septic Repair	1	1	0	0	1	0	0	2	2	0	0	0	7
		New Construction	0	0	0	0	0	0	0	0	2	0	0	0	2
0279	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	1	2	0	0	0	3
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0280	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	0	0	1	0	1	2
		New Construction	0	0	0	0	0	0	0	1	0	0	0	0	1
0283	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	1	1	3	0	0	5
		New Construction	0	0	0	0	0	0	0	1	1	0	0	0	2
0284	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0286	Big Pipe Creek	Septic Repair	0	1	0	0	0	0	0	1	0	1	0	0	3
		New Construction	0	0	0	0	0	0	0	0	2	0	0	0	2
0287	Big Pipe Creek	Septic Repair	0	1	0	0	0	0	1	0	0	0	0	0	2
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0274	Cherry Branch / Little Pipe Creek	Septic Repair	0	0	0	0	0	0	0	1	1	0	0	0	2
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0

0288	Deep Run	Septic Repair	0	0	0	1	0	0	0	0	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	1	0	0	0	1
0271	Dickenson Run	Septic Repair	0	0	0	0	0	0	0	1	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0248	Double Pipe Creek	Septic Repair	0	0	0	1	0	0	0	0	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0272	Little Pipe Creek	Septic Repair	0	0	0	0	0	1	0	0	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0276	Little Pipe Creek	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	2	1	0	0	4	0	0	0	7
0277	Meadow Branch	Septic Repair	0	0	0	0	0	0	0	0	2	0	1	0	3
		New Construction	0	0	0	0	0	0	2	2	1	0	0	1	6
0273	Priestland / Wolf Pit Branch	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	2	0	0	0	0	2
0268	Sams Creek	Septic Repair	0	0	0	0	0	0	0	1	0	0	1	0	2
		New Construction	0	0	0	0	0	0	0	1	2	0	2	0	5
0269	Sams Creek	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0285	Silver Run	Septic Repair	0	0	0	0	0	0	0	0	0	1	0	0	1
		New Construction	0	0	0	0	0	1	0	0	0	0	0	0	1
0275	Turkeyfoot Run	Septic Repair	0	0	0	0	0	0	0	1	1	0	1	0	3
		New Construction	0	0	0	0	0	0	0	1	0	0	0	0	1

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

SWM Facilities

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)
Sunnyside	Facility	30.2	2.69	ST	1.91	0.09449%	39	5.0928	0.15831%	61	1.4849	0.2173%	78	3.07
Friendship Overlook	Retrofit	82.01	15.88	ST	1.68	0.2539%	39	13.68	0.4251%	61	3.99	0.5836%	77	8.24
CC Farm Museum	Facility	6.44	0.45	RR	1.40	0.0333%	64	1.79	0.0414%	75	0.39	0.0478%	80	0.68
Farm Museum 1	Facility	11.61	2.3	RR	1.44	0.0602%	65	3.25	0.0750%	76	0.70	0.0866%	81	1.22
Farm Museum 2	Facility	0.09	0.05	RR	1.00	0.0015%	60	0.08	0.0013%	70	0.01	0.0007%	75	0.01
Farm Museum 3	Facility	0.79	0.06	RR	1.00	0.0038%	60	0.20	0.0047%	70	0.04	0.0055%	75	0.08
Farm Museum 4	Facility	0.03	0.03	RR	1.00	0.0005%	60	0.03	0.0004%	70	0.00	0.0002%	75	0.00
Farm Museum 5	Facility	0.01	0.01	RR	1.00	0.0002%	60	0.01	0.0001%	70	0.00	0.0001%	75	0.00
CC Maintenance	Retrofit	45.49	25.05	ST	2.50	0.4879%	39	26.29	0.5670%	62	5.32	0.3746%	79	5.29
Blue Ridge Manor	Retrofit	36.28	9.26	RR	1.86	0.1940%	67	10.45	0.2416%	78	2.27	0.2790%	83	3.94
Exceptional Center	Retrofit	46.5	14.7	ST	1.51	0.4826%	38	26.01	0.5590%	60	5.24	0.3697%	76	5.22
Langdon	Facility	194	92.1	ST	1.00	1.8495%	35	99.69	2.1422%	55	20.09	1.4169%	70	20.00
Elmer Wolfe	Facility	9.78	4.26	ST	1.40	0.1111%	38	5.32	0.1270%	59	1.07	0.0824%	75	1.06
Locust Wetland	Facility	35.9	11	ST	1.00	0.34%	35%	18.45	0.40%	55%	3.72	0.2622%	70%	3.70

CC Health Dept	Facility	14.77	6.72	RR	2.50	0.27%	68%	14.70	0.23%	79%	2.20	0.1306%	85%	1.84
Long Valley Rd	Facility	98.32	16.64	RR	2.50	0.53%	68%	28.80	0.66%	79%	6.22	0.7679%	85%	10.84
Greens of Westminster Sec6 #2	Retrofit	38.31	12.56	ST	2.11	0.41%	39%	22.03	0.47%	62%	4.45	0.3135%	78%	4.43
New Windsor Railroad Track	Facility	34.5	15.34	ST	1.00	0.33%	35%	17.73	0.38%	55%	3.57	0.2520%	70%	3.56
Avondale Run Phase 2	Retrofit	7.86	1.84	RR	2.50	0.04%	68%	2.30	0.05%	79%	0.50	0.0614%	85%	0.87
Carroll County Airport	Retrofit	38.4	7.4	RR	2.50	0.21%	68%	11.25	0.26%	79%	2.43	0.2999%	85%	4.23
Meadow Ridge 171	Retrofit	22.1	5.73	ST	1.00	0.06%	35%	3.34	0.10%	55%	0.97	0.1425%	70%	2.01
Meadow Ridge 172	Retrofit	18.2	5.35	ST	1.00	0.05%	35%	2.75	0.09%	55%	0.80	0.1174%	70%	1.66

Streambank Regeneration[1]

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Blue Ridge Manor	220	0.03%	1.47	0.14%	1.28	0.016%	441.06	0.22
Total:		**0.03%**	**1.47**	**0.14%**	**1.28**	**0.016%**	**441.06**	**0.22**

[1]A study is currently underway by the County to evaluate streambank regeneration as an innovative practice following the guideline in MDE (2014). In the interim, the default stream restoration credit is combined with equivalent impervious area, as suggested in the 2014 MDE guidance, is used here to estimate nutrient and sediment reductions from this practice. Also see BMP Assumptions in Appendix D.

Floodplain Reconnect

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Mayberry Gun Club	6,000	0.74%	40.05	3.73%	35.00	0.426%	12028.89	6.01
Total:		**0.74%**	**40.05**	**3.73%**	**35.00**	**0.426%**	**12028.89**	**6.01**

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)
Union Bridge	0.44	3.5	1.54 [0.06]	1.4	0.616 [0.02]	420	184.8 [21.58]	0.0107 [0.01]
County	0.4	3.5	1.40 [0.06]	1.4	0.56 [0.02]	420	168.0 [19.62]	0.084 [0.01]
Westminster	0.49	3.5	1.715 [0.07]	1.4	0.686 [0.03]	420	205.8 [24.03]	0.1029 [0.01]
		Total:	**4.655 [0.19]**		**1.862 [0.07]**		**558.6 [65.23]**	**0.1976 [0.03]**

Street Sweeping

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced [delivered] (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced [delivered] (Tons)
Westminster	7.62	11.7	89.154	4	3.56616 [0.14]	0.68	5.1816	4	0.207264 [0.01]	0.18	1.3716	10	0.13716 [0.01]
		Total:	**89.1540**		**3.5662 [0.14]**		**5.1816**		**0.2073 [0.01]**		**1.3716**		**0.1372 [0.01]**

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	4.13	0.0219%	66	1.179	0.0272%	77	0.255	0.0233%	57	0.298
Planting 2	10.85	0.0575%	66	3.099	0.0715%	77	0.670	0.0611%	57	0.783
Planting 3	0.2	0.0011%	66	0.06	0.0013%	77	0.01	0.0011%	57	0.01
Planting 4	1.4	0.0074%	66	0.40	0.0092%	77	0.09	0.0079%	57	0.10
Planting 5	0.5	0.0026%	66	0.14	0.0033%	77	0.03	0.0028%	57	0.04
Planting 6	0.3	0.0016%	66	0.09	0.0020%	77	0.02	0.0017%	57	0.02
Planting 7	0.65	0.0034%	66	0.19	0.0043%	77	0.04	0.0037%	57	0.05
Planting 8	2.3	0.0122%	66	0.66	0.0151%	77	0.14	0.0130%	57	0.17
Planting 9	0.4	0.0021%	66	0.11	0.0026%	77	0.02	0.0023%	57	0.03
Planting 10	2.25	0.0119%	66	0.64	0.0148%	77	0.14	0.0127%	57	0.16
Planting 11	0.2	0.0011%	66	0.06	0.0013%	77	0.01	0.0011%	57	0.01
Planting 12	0.62	0.0033%	66	0.18	0.0041%	77	0.04	0.0035%	57	0.04
Planting 13	1.8	0.0095%	66	0.51	0.0119%	77	0.11	0.0101%	57	0.13
Planting 14	0.9	0.0048%	66	0.26	0.0059%	77	0.06	0.0051%	57	0.06
Planting 15	0.26	0.0014%	66	0.07	0.0017%	77	0.02	0.0015%	57	0.02
Planting 16	3	0.0159%	66	0.86	0.0198%	77	0.19	0.0169%	57	0.22
Planting 17	9	0.0477%	66	2.57	0.0593%	77	0.56	0.0507%	57	0.65
Planting 18	0.13	0.0007%	66	0.04	0.0009%	77	0.01	0.0007%	57	0.01

Planting 19	0.6	0.0032%	66	0.17	0.0040%	77	0.04	0.0034%	57	0.04
Planting 20	0.2	0.0011%	66	0.06	0.0013%	77	0.01	0.0011%	57	0.01
Planting 21	1.25	0.0066%	66	0.36	0.0082%	77	0.08	0.0070%	57	0.09
Planting 22	0.45	0.0024%	66	0.13	0.0030%	77	0.03	0.0025%	57	0.03
Planting 23	2.2	0.0117%	66	0.63	0.0145%	77	0.14	0.0124%	57	0.16
Planting 24	1.62	0.0086%	66	0.46	0.0107%	77	0.10	0.0091%	57	0.12
Planting 25	4.26	0.0226%	66	1.22	0.0281%	77	0.26	0.0240%	57	0.31
Planting 26	1.8	0.0095%	66	0.51	0.0119%	77	0.11	0.0101%	57	0.13
Planting 27	2.05	0.0109%	66	0.59	0.0135%	77	0.13	0.0108%	57	0.15
Planting 28	0.59	0.0031%	66	0.17	0.0039%	77	0.04	0.0031%	57	0.04
Planting 29	0.44	0.0023%	66	0.13	0.0029%	77	0.03	0.0023%	57	0.03
Planting 30	0.17	0.0009%	66	0.05	0.0011%	77	0.01	0.0009%	57	0.01
Planting 31	0.22	0.0012%	66	0.06	0.0014%	77	0.01	0.0012%	57	0.02
Total:	**54.74**									

Grass Buffer 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)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Grass Buffer 2000-2008	82.960	2000-2008	0.2235%	30	10.69	0.3114%	40	2.62	0.4508%	55	5.77
Grass Buffer 2009-Current	116.930	2009 - current	0.3150%	30	15.07	0.4390%	40	3.69	0.6353%	55	8.14
Total:	**199.89**		**0.5385%**		**25.76**	**0.7504%**		**6.31**	**1.0861%**		**13.91**

Forest Buffer 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)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Forest Buffer 2000-2008	43.930	2000-2008	0.1775%	45	8.49	0.1649%	40	1.39	0.2387%	55	3.06
Forest Buffer 2009-Current	54.790	2009 - current	0.2214%	45	10.59	0.2057%	40	1.73	0.2977%	55	3.81
Total:	**98.72**		**0.3989%**		**19.08**	**0.3706%**		**3.12**	**0.5364%**		**6.87**

XVI. Appendix E: 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 Double Pipe Creek 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 D-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table D-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 D-2 below and were based on literature and professional judgement.

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

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)**	0.52	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.52	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 based on dominant watershed parameters

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 D-3 for the Double Pipe Creek 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 D-3 based on professional judgement.

Table D-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	2011	2001
LD Mixed	15	>5 to <30	0.43	0.08	253.09
MD Mixed	52	>=30 to <70	1.47	0.19	287.00
HD Mixed	87	>=70	1.53	0.20	288.84
LD Residential	15	>5 to <30	0.43	0.08	253.03

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 D-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 Double Pipe Creek watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.041, 0.040, and 0.106, respectively. Note the TSS delivery ratio is based on 2001 land use. 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).

XVII. Appendix F: 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)
Sunnyside	Facility	30.2	2.69	ST	1.91	15.3	41.1570	39%	16.0402	1.69	4.5461	61%	2.7862	0.44	1.1836	78%	0.9230
Friendship Overlook	Retrofit	82.01	15.88	ST	1.68	15.3	242.9640	39%	93.6804	1.69	26.8372	61%	16.2656	0.44	6.9872	77%	5.3891
CC Farm Museum	Facility	6.44	0.45	RR	1.40	15.3	6.8850	64%	4.4280	1.69	0.7605	75%	0.5720	0.44	0.1980	81%	0.1597
Farm Museum 1	Facility	11.61	2.3	RR	1.44	15.3	35.1900	65%	22.7374	1.69	3.8870	76%	2.9367	0.44	1.0120	81%	0.8198
Farm Museum 2	Facility	0.09	0.05	RR	1.00	15.3	0.7650	60%	0.4571	1.69	0.0845	70%	0.0591	0.44	0.0220	75%	0.0165
Farm Museum 3	Facility	0.79	0.06	RR	1.00	15.3	0.9180	60%	0.5485	1.69	0.1014	70%	0.0709	0.44	0.0264	75%	0.0198
Farm Museum 4	Facility	0.03	0.03	RR	1.00	15.3	0.4590	60%	0.2743	1.69	0.0507	70%	0.0354	0.44	0.0132	75%	0.0099
Farm Museum 5	Facility	0.01	0.01	RR	1.00	15.3	0.1530	60%	0.0914	1.69	0.0169	70%	0.0118	0.44	0.0044	75%	0.0033
CC Maintenance	Retrofit	45.49	25.05	ST	2.50	15.3	383.2650	39%	150.6806	1.69	42.3345	62%	26.2462	0.44	11.0220	79%	8.6866
Blue Ridge Manor	Retrofit	36.28	9.26	RR	1.86	15.3	141.6780	67%	94.3535	1.69	15.6494	78%	12.1825	0.44	4.0744	84%	3.4041
Exceptional Center	Retrofit	46.5	14.7	ST	1.51	15.3	224.9100	38%	85.5642	1.69	24.8430	60%	14.8537	0.44	6.4680	76%	4.9216
Langdon	Facility	194	92.1	ST	1.00	15.3	1409.1300	35%	492.4909	1.69	155.6490	55%	85.4824	0.44	40.5240	70%	28.3263
Elmer Wolfe	Facility	9.78	4.26	ST	1.40	15.3	65.1780	38%	24.5094	1.69	7.1994	59%	4.2545	0.44	1.8744	75%	1.4097

Locust Wetland	Facility	35.9	11	ST	1.00	15.3	168.3000	35%	58.8209	1.69	18.5900	55%	10.2096	0.44	4.8400	70%	3.3832
CC Health Dept	Facility	14.77	6.72	RR	2.50	15.3	102.8160	68%	69.6064	1.69	11.3568	79%	8.9505	0.44	2.9568	85%	2.5103
Long Valley Rd	Facility	98.32	16.64	RR	2.50	15.3	254.5920	68%	172.3588	1.69	28.1216	79%	22.1632	0.44	7.3216	85%	6.2159
Greens of Westminster Sec6 #2	Retrofit	38.31	12.56	ST	2.11	15.3	192.1680	39%	75.1774	1.69	21.2264	62%	13.0666	0.44	5.5264	78%	4.3278
New Windsor Railroad Track	Facility	34.5	15.34	ST	1.00	15.3	234.7020	35%	82.0283	1.69	25.9246	55%	14.2378	0.44	6.7496	70%	4.7180
Avondale Run Phase 2	Retrofit	7.86	1.84	RR	2.50	15.3	28.1520	68%	19.0589	1.69	3.1096	79%	2.4507	0.44	0.8096	85%	0.6873
Carroll County Airport	Retrofit	38.4	7.4	RR	2.50	15.3	113.2200	68%	76.6499	1.69	12.5060	79%	9.8562	0.44	3.2560	85%	2.7643
Meadow Ridge 171	Retrofit	22.1	5.73	ST	1.00	15.3	87.6690	35%	30.6403	1.69	9.6837	55%	5.3183	0.44	2.5212	70%	1.7623
Meadow Ridge 172	Retrofit	18.2	5.35	ST	1.00	15.3	81.8550	35%	28.6083	1.69	9.0415	55%	4.9656	0.44	2.3540	70%	1.6454
	Total:	**771.59**	**249.42**				**3816.1260**		**1598.8055**		**421.5198**		**256.9755**		**109.7448**		**82.1038**

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)
Sunnyside	Facility	30.2	27.51	ST	1.91	10.8	297.1080	39%	115.7926	0.43	11.8293	61%	7.2500	0.07	1.9257	78%	1.5017
Friendship Overlook	Retrofit	82.01	66.13	ST	1.68	10.8	714.2040	39%	275.3779	0.43	28.4359	61%	17.2345	0.07	4.6291	77%	3.5704

Farm Museum	Facility	6.44	5.99	RR	1.40	10.8	64.6920	64%	41.6061	0.43	2.5757	75%	1.9372	0.07	0.4193	81%	0.3381
Farm Museum 1	Facility	11.61	9.31	RR	1.44	10.8	100.5480	65%	64.9674	0.43	4.0033	76%	3.0246	0.07	0.6517	81%	0.5279
Farm Museum 2	Facility	0.09	0.04	RR	1.00	10.8	0.4320	60%	0.2581	0.43	0.0172	70%	0.0120	0.07	0.0028	75%	0.0021
Farm Museum 3	Facility	0.79	0.73	RR	1.00	10.8	7.8840	60%	4.7107	0.43	0.3139	70%	0.2194	0.07	0.0511	75%	0.0383
Farm Museum 4	Facility	0.03	0	RR	1.00	10.8	0.0000	60%	0.0000	0.43	0.0000	70%	0.0000	0.07	0.0000	75%	0.0000
Farm Museum 5	Facility	0.01	0	RR	1.00	10.8	0.0000	60%	0.0000	0.43	0.0000	70%	0.0000	0.07	0.0000	75%	0.0000
CC Maintenance	Retrofit	45.49	20.44	ST	2.50	10.8	220.7520	39%	86.7886	0.43	8.7892	62%	5.4491	0.07	1.4308	79%	1.1276
Blue Ridge Manor	Retrofit	36.28	27.02	RR	1.86	10.8	291.8160	67%	194.3412	0.43	11.6186	78%	9.0447	0.07	1.8914	84%	1.5802
Exceptional Center	Retrofit	46.5	31.8	ST	1.51	10.8	343.4400	38%	130.6575	0.43	13.6740	60%	8.1757	0.07	2.2260	76%	1.6938
Langdon	Facility	194	101.9	ST	1.00	10.8	1100.5200	35%	384.6317	0.43	43.8170	55%	24.0643	0.07	7.1330	70%	4.9860
Elmer Wolfe	Facility	9.78	5.52	ST	1.40	10.8	59.6160	38%	22.4179	0.43	2.3736	59%	1.4027	0.07	0.3864	75%	0.2906
Locust Wetland	Facility	35.9	24.9	ST	1.00	10.8	268.9200	35%	93.9875	0.43	10.7070	55%	5.8803	0.07	1.7430	70%	1.2184
CC Health Dept	Facility	14.77	8.05	RR	2.50	10.8	86.9400	68%	58.8584	0.43	3.4615	79%	2.7281	0.07	0.5635	85%	0.4784
Long Valley Rd	Facility	98.32	81.68	RR	2.50	10.8	882.1440	68%	597.2115	0.43	35.1224	79%	27.6806	0.07	5.7176	85%	4.8541
Greens of Westminster Sec6 #2	Retrofit	38.31	25.75	ST	2.11	10.8	278.1000	39%	108.7946	0.43	11.0725	62%	6.8160	0.07	1.8025	78%	1.4116
New Windsor Railroad Track	Facility	34.5	19.16	ST	1.00	10.8	206.9280	35%	72.3213	0.43	8.2388	55%	4.5247	0.07	1.3412	70%	0.9375
Avondale Run Phase 2	Retrofit	7.86	6.02	RR	2.50	10.8	65.0160	68%	44.0158	0.43	2.5886	79%	2.0401	0.07	0.4214	85%	0.3578
Carroll County Airport	Retrofit	38.4	31	RR	2.50	10.8	334.8000	68%	226.6596	0.43	13.3300	79%	10.5056	0.07	2.1700	85%	1.8423
Meadow Ridge 171	Retrofit	22.1	16.37	ST	1.00	10.8	176.7960	35%	61.7902	0.43	7.0391	55%	3.8659	0.07	1.1459	70%	0.8010

Meadow Ridge 172	Retrofit	18.2	12.85	ST	1.00	10.8	138.7800	35%	48.5036	0.43	5.5255	55%	3.0346	0.07	0.8995	70%	0.6288
Total:		**771.59**	**522.17**				**5639.4360**		**2633.6925**		**224.5331**		**144.8901**		**36.5519**		**28.1865**

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)
Manchester		3.5	0.000	1.4	0.000	420	0	0.000
New Windsor		3.5	0.000	1.4	0.000	420	0	0.000
Union Bridge	0.44	3.5	1.540	1.4	0.616	420	184.8	0.092
County	0.4	3.5	1.400	1.4	0.560	420	168	0.084
Westminster	0.49	3.5	1.715	1.4	0.686	420	205.8	0.103
		Total:	**4.6550**		**1.8620**		**559**	**0.279**

Street Sweeping

Location	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 (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Westminster	7.62	11.7	89.154	4	3.56616	0.68	5.1816	4	0.207264	0.18	1.3716	10	0.13716
		Total:	**89.1540**		**3.5662**		**5.1816**		**0.2073**		**1.3716**		**0.1372**

Streambank Regeneration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Blue Ridge Manor	220	0.075	16.500	0.068	14.960	44.8	9856	4.928
		Total:	**16.5000**		**14.9600**		**9,856**	**4.928**

Floodplain Reconnect

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Mayberry Gun Club	6,255.00	0.075	469.125	0.068	425.340	44.8	280224	140.112
		Total:	**469.1250**		**425.3400**		**280,224**	**140.112**

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	4.13	10.8	44.6040	66	29.4386	0.43	1.7759	77	1.3674	0.07	0.2891	57	0.1648
Planting 2	10.85	10.8	117.1800	66	77.3388	0.43	4.6655	77	3.5924	0.07	0.7595	57	0.4329
Planting 3	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 4	1.4	10.8	15.1200	66	9.9792	0.43	0.6020	77	0.4635	0.07	0.0980	57	0.0559
Planting 5	0.5	10.8	5.4000	66	3.5640	0.43	0.2150	77	0.1656	0.07	0.0350	57	0.0200

Planting 6	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 7	0.65	10.8	7.0200	66	4.6332	0.43	0.2795	77	0.2152	0.07	0.0455	57	0.0259
Planting 8	2.3	10.8	24.8400	66	16.3944	0.43	0.9890	77	0.7615	0.07	0.1610	57	0.0918
Planting 9	0.4	10.8	4.3200	66	2.8512	0.43	0.1720	77	0.1324	0.07	0.0280	57	0.0160
Planting 10	2.25	10.8	24.3000	66	16.0380	0.43	0.9675	77	0.7450	0.07	0.1575	57	0.0898
Planting 11	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 12	0.62	10.8	6.6960	66	4.4194	0.43	0.2666	77	0.2053	0.07	0.0434	57	0.0247
Planting 13	1.8	10.8	19.4400	66	12.8304	0.43	0.7740	77	0.5960	0.07	0.1260	57	0.0718
Planting 14	0.9	10.8	9.7200	66	6.4152	0.43	0.3870	77	0.2980	0.07	0.0630	57	0.0359
Planting 15	0.26	10.8	2.8080	66	1.8533	0.43	0.1118	77	0.0861	0.07	0.0182	57	0.0104
Planting 16	3	10.8	32.4000	66	21.3840	0.43	1.2900	77	0.9933	0.07	0.2100	57	0.1197
Planting 17	9	10.8	97.2000	66	64.1520	0.43	3.8700	77	2.9799	0.07	0.6300	57	0.3591
Planting 18	0.13	10.8	1.4040	66	0.9266	0.43	0.0559	77	0.0430	0.07	0.0091	57	0.0052
Planting 19	0.6	10.8	6.4800	66	4.2768	0.43	0.2580	77	0.1987	0.07	0.0420	57	0.0239
Planting 20	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 21	1.25	10.8	13.5000	66	8.9100	0.43	0.5375	77	0.4139	0.07	0.0875	57	0.0499
Planting 22	0.45	10.8	4.8600	66	3.2076	0.43	0.1935	77	0.1490	0.07	0.0315	57	0.0180
Planting 23	2.2	10.8	23.7600	66	15.6816	0.43	0.9460	77	0.7284	0.07	0.1540	57	0.0878
Planting 24	1.62	10.8	17.4960	66	11.5474	0.43	0.6966	77	0.5364	0.07	0.1134	57	0.0646
Planting 25	4.26	10.8	46.0080	66	30.3653	0.43	1.8318	77	1.4105	0.07	0.2982	57	0.1700
Planting 26	1.8	10.8	19.4400	66	12.8304	0.43	0.7740	77	0.5960	0.07	0.1260	57	0.0718
Planting 27	2.05	10.8	22.1400	66	14.6124	0.43	0.8815	77	0.6788	0.07	0.1435	57	0.0818
Planting 28	0.59	10.8	6.3720	66	4.2055	0.43	0.2537	77	0.1953	0.07	0.0413	57	0.0235

Planting 29	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 30	0.17	10.8	1.8360	66	1.2118	0.43	0.0731	77	0.0563	0.07	0.0119	57	0.0068
Planting 31	0.22	10.8	2.3760	66	1.5682	0.43	0.0946	77	0.0728	0.07	0.0154	57	0.0088
Total:	**54.74**		**591.1920**		**390.1867**		**23.5382**		**18.1244**		**3.8318**		**2.1841**

Grass Buffer Easements

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 BM Efficie
Grass Buffer 2000-2008	82.960	2000-2008	11.7	970.6320	30	291.18960	0.68	56.4128	40	22.5651	0.18	14.9328	55
Grass Buffer 2009-Current	116.930	2009 -current	11.7	1368.0810	30	410.42430	0.68	79.5124	40	31.8050	0.18	21.0474	55
	199.890		**Total:**	**2338.7130**		**701.61390**		**135.9252**		**54.3701**		**35.9802**	

Forest Buffer Easements

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 BM Efficie
Forest Buffer 2000-2008	43.930	2000-2008	11.7	513.9810	45	231.2915	0.68	29.8724	40	11.9490	0.18	7.9074	55
Forest Buffer 2009-Current	54.790	2009 -current	11.7	641.0430	45	288.4694	0.68	37.2572	40	14.9029	0.18	9.8622	55
	98.720		**Total:**	**1155.0240**		**519.76080**		**67.1296**		**26.8518**		**17.7696**	