2023 Total Maximum Daily Load Stormwater Implementation Plan Carroll County, Maryland

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes completed, proposed, and potential restoration strategies to meet local and Chesapeake Bay Total Maximum Daily Load (TMDL) requirements associated with the urban wasteload allocation (WLA) for watersheds 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 (BMPs), and 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 assessments will be required before any project is considered final or approved.

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I. Introduction

The Carroll County Bureau of Resource Management (BRM) has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLAs) within the County, as required by the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. As co-permittees of the MS4 permit, the eight incorporated municipalities within the County also participate as stakeholders in this planning process. This includes the Towns of Manchester, Hampstead, New Windsor, Union Bridge, Mount Airy, and Sykesville, as well as the Cities of Westminster and Taneytown.

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards through associated TMDL WLAs for developed source types for Carroll County. This TMDL Stormwater Restoration Plan 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.). **Figure 1** below depicts the nine 8-digit watersheds within Carroll County.

A. Regulatory Setting and Requirements

Maryland water quality standards have been adopted to align with the Federal Clean Water Act's objective 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, and water contact recreation, as well as terrestrial wildlife that depend on water.

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 defines any protections necessary to sustain aquatic life there. 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.** **Figure 2** below shows the locations of streams within the County and their various designated use classes, which include I, I-P, III, III-P, IV, and IV-P.

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		✓		✓		✓		✓

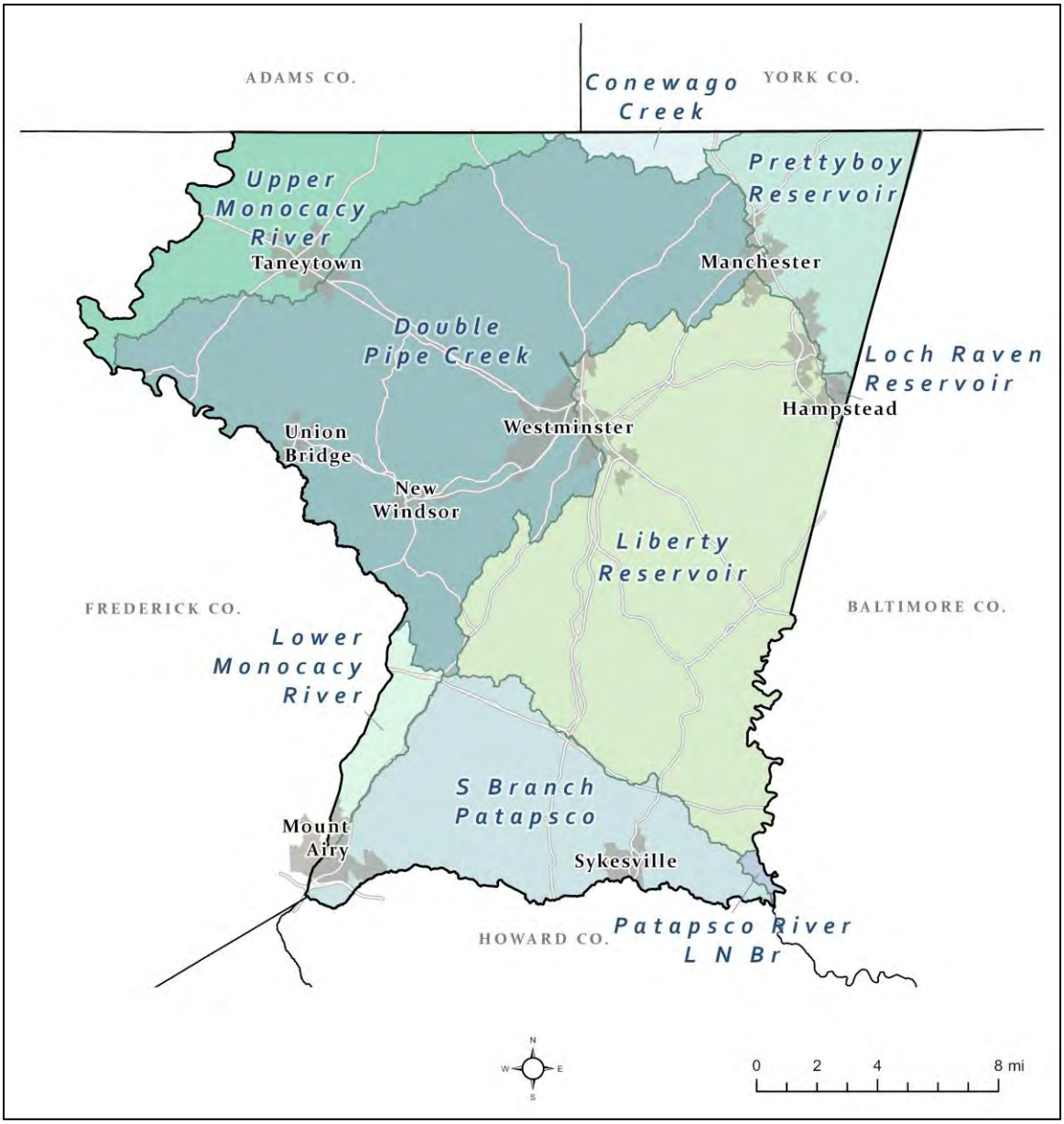

Figure 1: Carroll County 8-Digit Watersheds

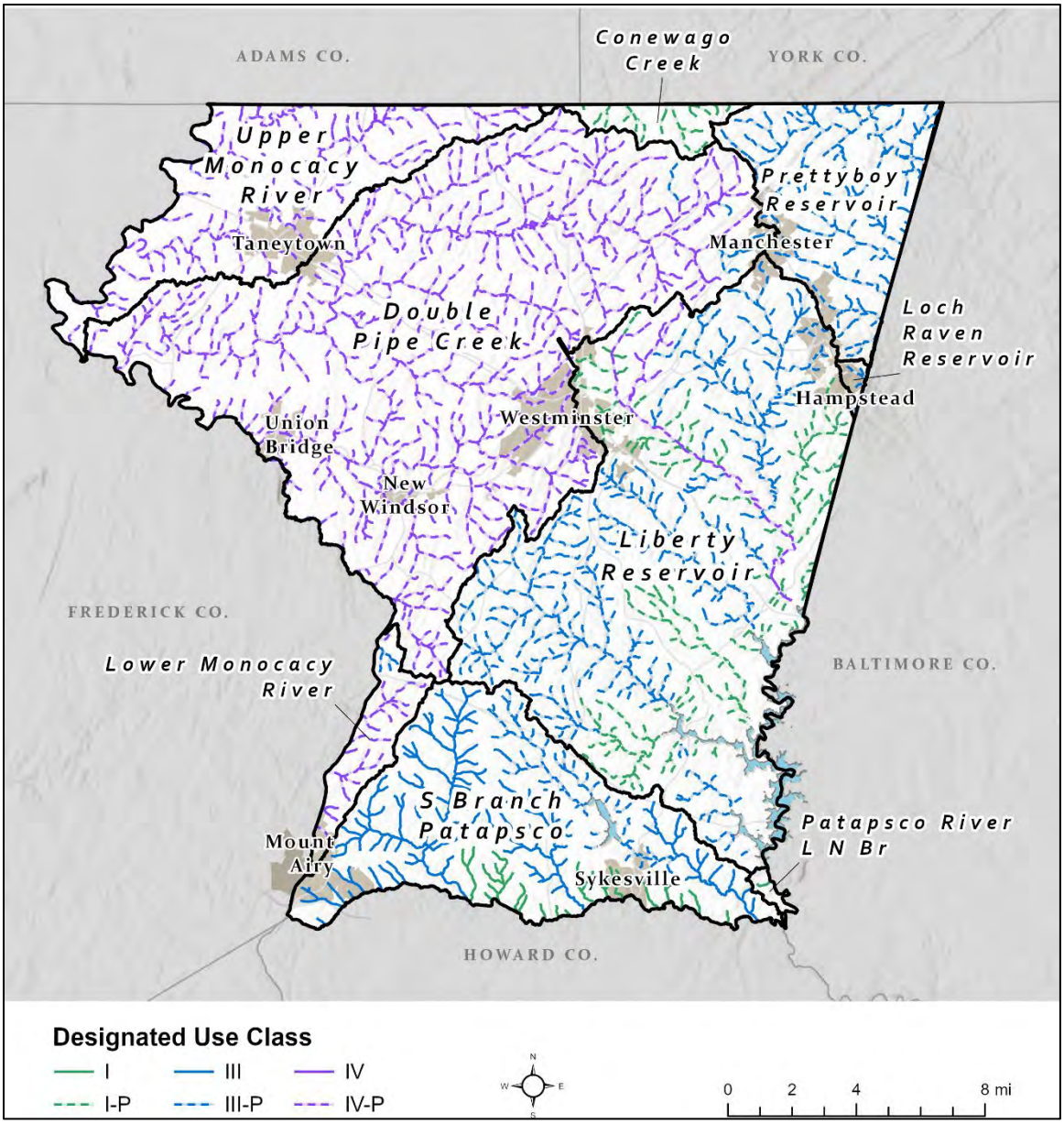

Figure 2: Designated Use Classes for Streams of Carroll County

2. Total Maximum Daily Loads

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. TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources. Within the 8-digit watersheds, these allocations are divided among counties and municipalities and then further divided among sources, including agriculture, wastewater, and stormwater. As the County and each of the municipalities have joined as co-permittees on one

MS4 permit this restoration plan provides joint requirements, strategies, and progress for reducing TMDL loadings associated with the stormwater WLAs.

The County's NPDES MS4 permit requires that a restoration plan for each EPA-approved stormwater WLA 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.

The objective of Maryland's nutrient and sediment TMDLs and their associated implementation plans is to ensure that watershed nutrient and sediment loads are at a level to support aquatic life. Currently in Maryland, there are no specific numeric criteria that quantify the impact of sediment or nutrients on the aquatic life of nontidal streams. MDE's Biological Stressor Identification (BSID) methodology is applied to determine and monitor whether aquatic life is impacted by elevated nutrient and sediment loads.

In addition to nutrient and sediment TMDLs, Attachment B of the County's MS4 permit includes TMDLs for mercury. Based on MDE's *Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan for Mercury Total Maximum Daily Loads* (2014), atmospheric deposition is the major loading source to mercury-impaired waters in Maryland, primarily originating from power plants. While urban stormwater conveyance systems transport the atmospherically deposited mercury downstream, the impervious surfaces and conveyance systems are not the source. For this reason, the guidance document indicates that the majority of TMDL-required mercury load reductions are expected to occur at the state and federal level.

The list of EPA-approved TMDLs for Carroll County also includes bacteria. 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, the focus will be on the reduction of human-related sources associated with the stormwater (SW) WLA.

II. Restoration Plan Development

Of the nine 8-digit watersheds in Carroll County (**Figure 1**), seven watersheds have an associated TMDL WLA for developed source types. The seven watersheds with an approved TMDL are: Prettyboy Reservoir, Liberty Reservoir, Loch Raven Reservoir, Lower Monocacy River, Upper Monocacy River, Double Pipe Creek, and South Branch Patapsco River (Baltimore Harbor). The restoration planning process focuses on addressing these impairments through the implementation of water quality improvement projects.

A. Watershed Assessments

Watershed assessments were completed for each of the nine watersheds within Carroll County. Each assessment was done at the 8-digit level and further divided down to the 12-digit level for subwatershed analyses. Each watershed assessment consisted of a stream corridor assessment (SCA) and a characterization plan.

The County conducted SCAs in accordance with the Stream Corridor Assessment Survey Protocols, developed in 2001 by the Maryland DNR Watershed Restoration Division. Assessments were performed between January and March, in the years assessed, by County staff through cooperation with private landowners and municipalities. Landowner permission for access to stream corridors was obtained through a mailing detailing the purpose and timing of the assessment with a return response postcard. The County received permission to assess 786 of the 1,464 stream miles, or approximately 54% of all stream miles within the County (**Table 2**).

During each SCA, field teams collected information related to eroded streambanks, channel alterations, exposed utility pipes, drainage pipe outfalls, fish barriers, inadequate streamside buffers, trash dumps, and construction activities that were in or near the stream. Any unusual conditions were also noted. Each impairment was then ranked on a scale of one to five in relation to the impairment's severity, accessibility, and correctability. The goal of the numeric ranking was to identify and classify current impairments within the watershed to assist in prioritizing locations for restoration implementation.

In addition to the on-the-ground field assessments, County staff also conducted a desktop analysis of each of the nine 8-digit watersheds in a characterization plan. Each watershed's characterization plan described the unique background of the watershed, including the natural and anthropogenic characteristics of the watershed, and any water quality and living resource data that had been collected there.

Table 2: Stream Corridor Assessments (SCAs) by Watershed

8-Digit Watershed	Major Basin	Year Assessed	Miles Assessed	Total Miles	% Assessed
Prettyboy	Gunpowder	2011	80	97	82%
Liberty	Patapsco	2012	255	458	56%
South Branch Patapsco	Patapsco	2013	156	218	72%
Lower N. Branch	Patapsco	2014	6	6	100%
Lower Monocacy	Monocacy/Potomac	2014	10	23	43%
Conewago Creek	Susquehanna	2014	11	18	61%
Upper Monocacy	Monocacy/Potomac	2015	71	128	55%
Double Pipe	Monocacy/Potomac	2016	266	514	52%
Loch Raven	Gunpowder	2016	2	3	66%
		Total:	***786***	***1,464***	***54%***

B. Restoration Planning Timeline

Watershed restoration plans for the seven watersheds with approved TMDLs were first sent to MDE for review in August of 2016. In addition to the restoration plans, this submission also included watershed characterizations and SCA summaries for each watershed. The SCAs assisted in the restoration planning process, focusing on impacts and findings documented during the assessments.

In September 2017, the County received written comments from the Sediment, Stormwater, and Dam Safety Program and the Water and Science Administration at MDE, highlighting various points and deficiencies related to the submitted restoration plans. Following another review of the restoration plans by MDE's Integrated Water Planning Program (IWPP) in 2018, the County revised the seven watershed restoration plans and began releasing them for public comment in October of 2019.

C. Public Participation

As part of the watershed restoration efforts, Carroll County solicited input from the public regarding development of the County's TMDL restoration plans. Public involvement occurred following interim submissions of the restoration plans to MDE, which provided feedback and subsequent revisions to the plans. Interim submissions to MDE included Watershed Characterizations, Stream Corridor Assessment summaries, and Watershed Restoration Plans for the seven 8-digit watersheds in Carroll County with an approved TMDL WLA for developed source types.

Following two rounds of review by MDE, the County began releasing the restoration plans for public comment in the fall of 2019. Notice of this release was sent to the Carroll County Times on September 26, 2019, and posted on the Carroll County webpage. Hard copies of the plans were made available for review and comment at the BRM, and digital versions were posted on the Bureau's webpage to allow for submission of electronic comments.

The Watershed Restoration Plans were released for 30-day public comment in a staggered method beginning on October 1, 2019. Upper and Lower Monocacy Watersheds were open for public comment from October 1 to October 30, Prettyboy and Loch Raven Watersheds were open for public comment from October 14 to November 14, and Double Pipe Creek and Liberty Watersheds were open for public comment from October 28 to November 28.

The County received extremely limited feedback from the public related to the seven restoration plans. Feedback from the public was incorporated into the restoration plans prior to the final submission to MDE in December of 2019, and a discussion of the feedback and its applicability to the restoration plans were provided in the County's 2019 MS4 Annual Report.

In May 2020, the County received correspondence from MDE that all watershed restoration plans were approved, as they met the required technical aspects and included all necessary watershed planning components.

III. Carroll County TMDL Watersheds

A. Liberty Reservoir

The Carroll County portion of the Liberty Reservoir Watershed is located along the eastern part of the County, and consists of seventeen 12-digit subwatersheds that cover a total land area of 87,249 acres. The watershed is within the Patapsco River Basin, part of the Piedmont physiographic province of Maryland. **Figure 3** depicts the location of the Liberty Reservoir Watershed and its streams, symbolized by use class.

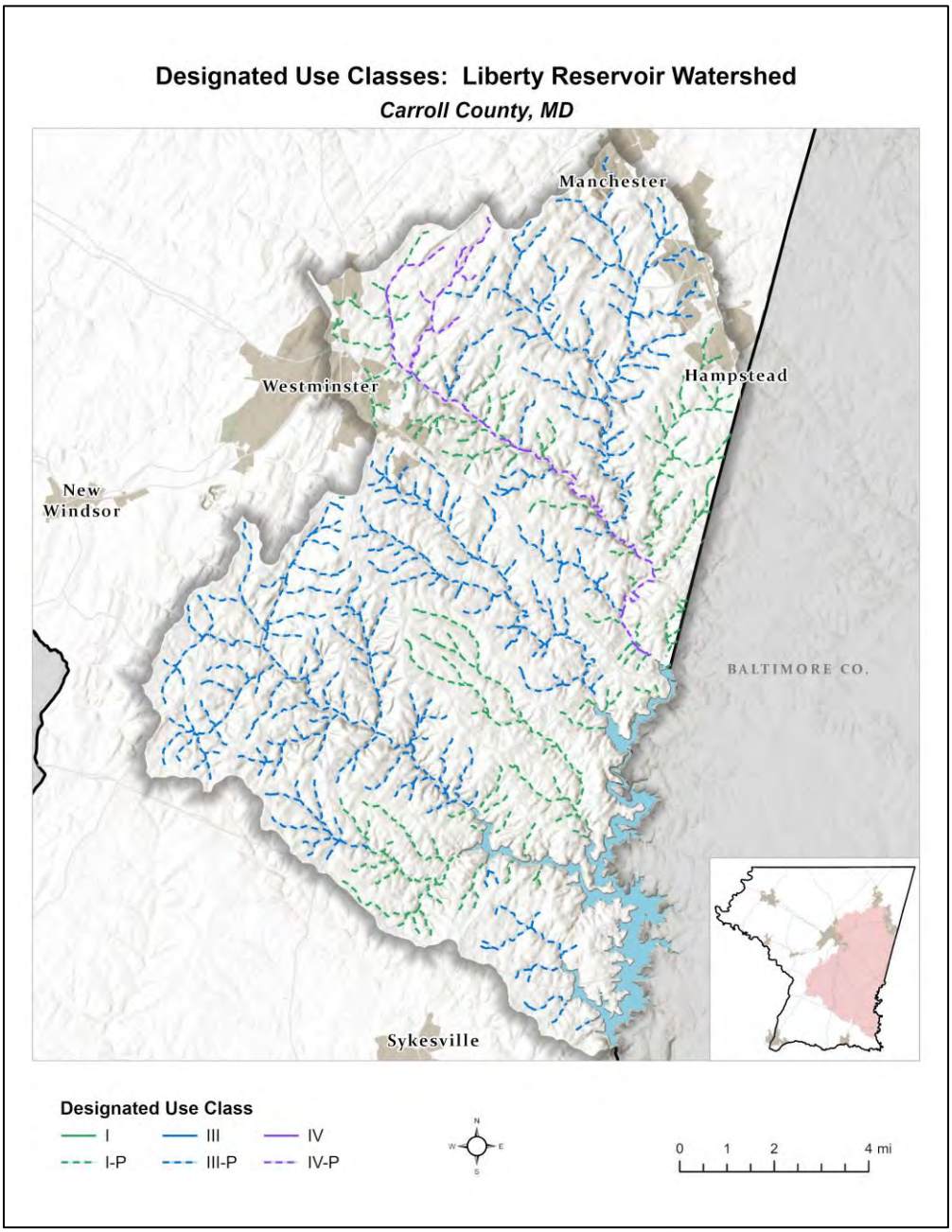

Figure 3: Liberty Reservoir 8-Digit Watershed Map

1. Liberty Watershed Water Quality Standards

The Liberty Reservoir Watershed within Carroll County consists of streams with a variety of designated uses, ranging from Use I (non-tidal warm water) to Use IV-P (recreational trout waters and public water supply). The Liberty Reservoir Watershed was placed on Maryland's 303(d) list of impaired waters for bacteria in 2002; a TMDL for bacteria was developed and approved in December of 2009. MDE identified Liberty Reservoir on the State's 2010 Integrated Report as impaired by sediments - sedimentation/siltation (1996) and nutrients - phosphorus (1996). A TMDL for phosphorus and sediment was developed and approved in May of 2014.

2. Liberty Watershed SW-WLA TMDLs

The current estimated stormwater baseline load for phosphorus within the Carroll County portion of the Liberty Reservoir Watershed was derived from the MDE TMDL Data Center. **Table 3** outlines the bacteria baseline, TMDL, and required percent reduction for jurisdictions within the Liberty Reservoir Watershed. The phosphorus baseline, TMDL, and required percent reduction are shown in **Table 4**. The sediment baseline, TMDL, and required percent reduction are listed in **Table 5.**

Table 3: Liberty Reservoir 8-digit Watershed Bacteria TMDL

Liberty Reservoir Watershed			Percent Reduction Required
Jurisdiction	**Baseline (billion MPN/yr)**	**TMDL (billion MPN/yr)**	
Carroll County	67,250	7,263	89.2%
Municipalities	19,102	2,063	89.2%
Total	*86,352*	*9,326*	*89.2%*

Table 4: Liberty Reservoir 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction Required
Carroll County	12,204	6,102	50%
Municipalities	1,685	893	47%
Total	*13,889*	*6,995*	*50%*

Table 5: Liberty Reservoir 8-digit Watershed Sediment TMDL

Jurisdiction	Baseline (tons/yr)	TMDL (tons/yr)	Percent Reduction Required
Carroll County	4,016	2,530	37%
Municipalities	614	350	43%
Total	*4,630*	*2,880*	*38%*

B. Prettyboy Reservoir

The Carroll County portion of the Prettyboy Reservoir Watershed is located in the northeast corner of the County, and consists of five 12-digit subwatersheds that cover a total land area of 21,025 acres. The watershed is within the Gunpowder River Basin, part of the Piedmont physiographic province of Maryland. **Figure 4** depicts the location of the Prettyboy Reservoir Watershed and its streams, symbolized by use class.

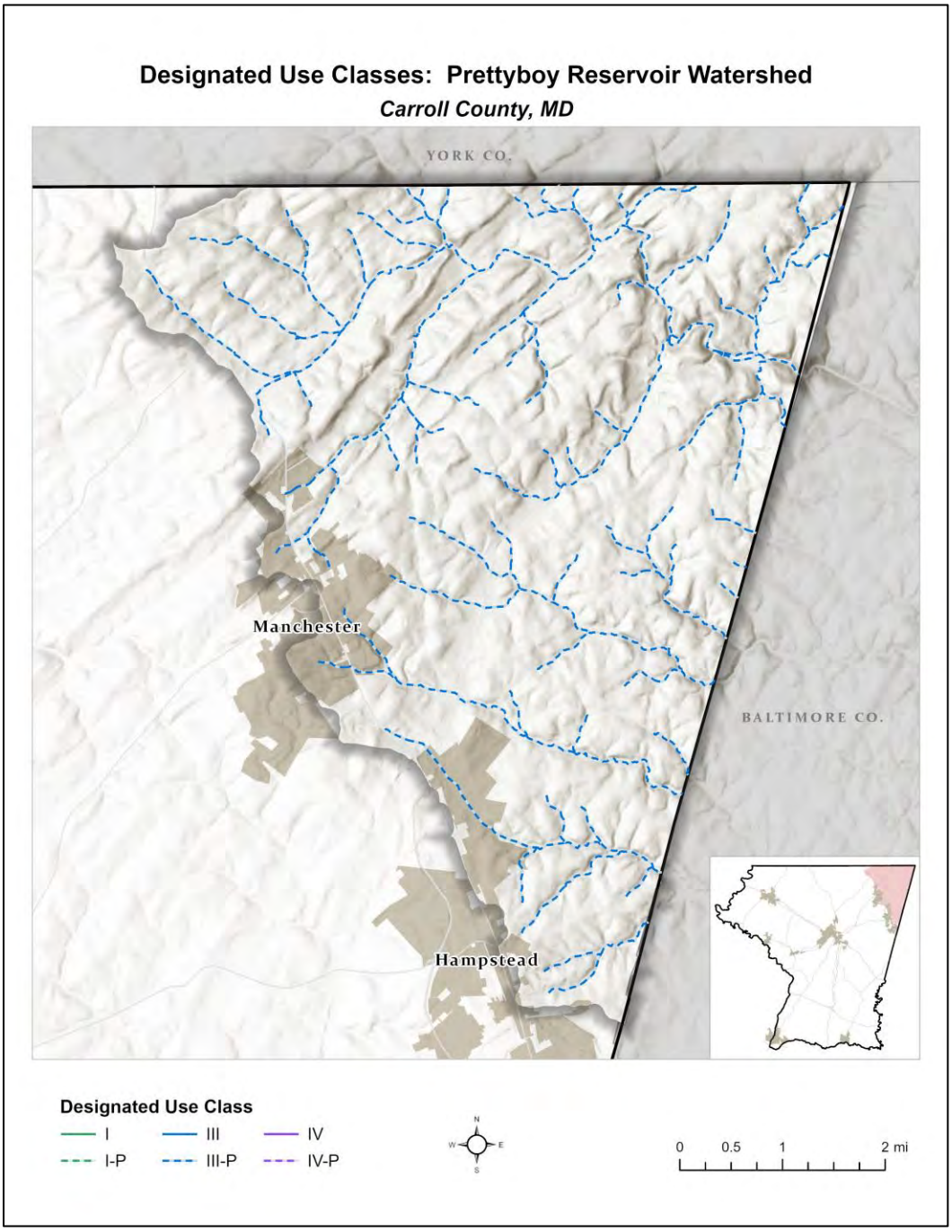

Figure 4: Prettyboy Reservoir Watershed 8-Digit Watershed Map

1. Prettyboy Watershed Water Quality Standards

The entire portion of the Prettyboy watershed within Carroll County is designated as Use III-P (Non-tidal Cold Water and Public Water Supply). The Prettyboy Reservoir Watershed was placed on Maryland's 303(d) list of impaired waters for nutrients in 1996 and for bacteria in 2002. A TMDL for phosphorus was developed and approved in March of 2007, and a subsequent TMDL for bacteria was developed and approved in October of 2009.

2. Prettyboy Watershed SW-WLA TMDLs

The estimated stormwater baseline loads in the Carroll County portion of the Prettyboy Reservoir Watershed were derived from the MDE TMDL Data Center. These stormwater WLAs are an aggregate of the municipal and industrial stormwater, including the loads from construction activity. **Table 6** lists the bacteria stormwater WLA baseline, TMDL, and required percent reduction for jurisdictions within the Prettyboy Reservoir Watershed. The phosphorus stormwater WLA baseline, TMDL, and required percent reduction for phosphorus within the Prettyboy Watershed is listed in **Table 7**.

Table 6: Prettyboy Reservoir 8-digit Watershed Bacteria TMDL

Prettyboy Reservoir Watershed			Percent Reduction Required
Jurisdiction	**Baseline (billion MPN/yr)**	**TMDL (billion MPN/yr)**	
Carroll County[1]	N/A	N/A	N/A
Muncipalities	37,268	5,650	84.8
Total	*37,268*	*5,650*	*84.8%*

[1] There is no stormwater WLA for the County, as the Prettyboy Reservoir watershed is essentially outside the reach of the County's stormwater system management plan. The predominate zoning and land use in the watershed is agriculture and, as such, it is not served by an organized storm sewer system. There is one area of urban development in the Prettyboy Watershed, represented by the incorporated Towns of Manchester and Hampstead (MDE, 2008).

Table 7: Prettyboy Reservoir 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction Required
Carroll County	1,843	1,572	15%
Total	*1,843*	*1,572*	*15%*

C. Loch Raven Reservoir

The Carroll County portion of the Loch Raven Reservoir Watershed is located in the northeast corner of the County, and covers a total land area of 592 acres. The watershed is within the Gunpowder River Basin, part of the Piedmont physiographic province of Maryland. **Figure 5** depicts the location of the Loch Raven Reservoir Watershed and its streams, symbolized by use class.

Figure 5: Loch Raven Reservoir 8-Digit Watershed Map

1. Loch Raven Watershed Water Quality Standards

The entire portion of the Loch Raven watershed within Carroll County is designated as Use III-P (Non-tidal Cold Water and Public Water Supply). The Loch Raven Reservoir Watershed was placed on Maryland's 303(d) list of impaired waters for nutrients and sediments in 1996. A TMDL for phosphorus and sediment was developed and approved in March of 2007.

2. Loch Raven SW-WLA TMDLs

The estimated stormwater baseline loads in the Carroll County portion of the Loch Raven Reservoir Watershed were derived from the MDE TMDL Data Center. **Table 8** outlines the bacteria baseline, TMDL, and required percent reductions for jurisdictions within the Loch Raven Watershed. The phosphorus stormwater baseline, TMDL, and required percent reduction within the Loch Raven Reservoir Watershed is listed in **Table 9.**

Table 8: Loch Raven Reservoir 8-digit Watershed Bacteria TMDL

Loch Raven Reservoir Watershed			Percent Reduction Required
Jurisdiction	**Baseline (billion MPN/yr)**	**TMDL (billion MPN/yr)**	
Carroll County	426	21	95%
Municipalities	4,714	104	98%
Total	*5,140*	*125*	*98%*

Table 9: Loch Raven Reservoir 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction Required
Carroll County	472	401	15%
Total	*472*	*401*	*15%*

D. Upper Monocacy River Watershed

The Monocacy River is a free-flowing stream that originates in Pennsylvania and flows 58 miles within Maryland, where it finally empties into the Potomac River. The Carroll County portion of the Upper Monocacy River Watershed is located in the northwest corner of the County, and consists of eight 12-digit subwatersheds that cover a total land area of 27,123 acres. The watershed is within the Potomac River Basin, part of the Piedmont physiographic province of Maryland. **Figure 6** depicts the location of the Upper Monocacy Watershed and its streams, symbolized by use class.

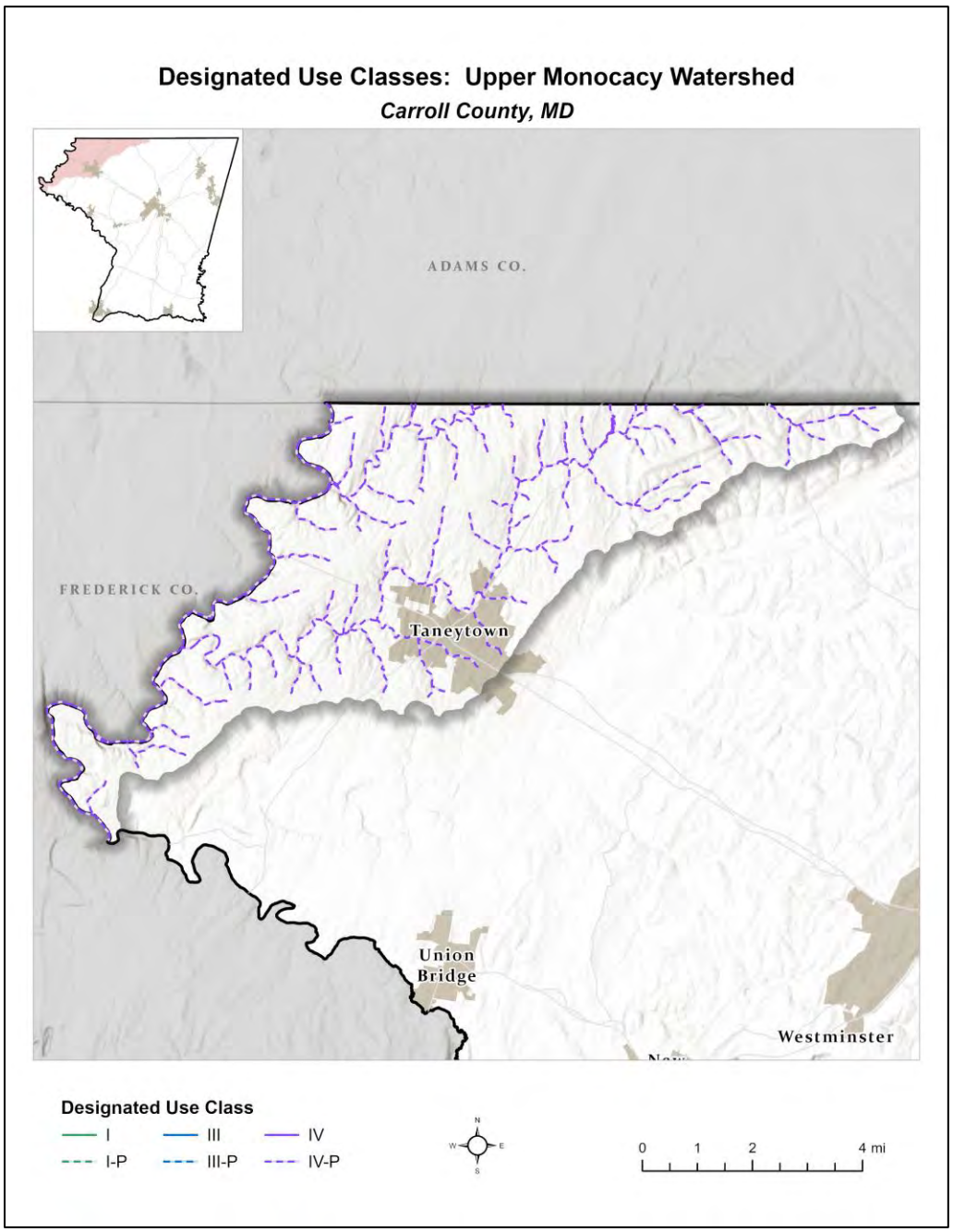

Figure 6: Upper Monocacy River 8-Digit Watershed Map

1. Upper Monocacy Watershed Water Quality Standards

The entire portion of the Upper Monocacy River watershed within Carroll County is designated as Use IV-P (Water Contact Recreation, Protection of Aquatic Life, Recreational Trout Waters, and Public Water Supply). The Upper Monocacy River watershed was placed on Maryland's 303(d) list of impaired waters for nutrients and sediments in 1996 and fecal bacteria in 2002. TMDLs for both Total Suspended Sediments (TSS) and bacteria were developed and approved in December of 2009. A TMDL for phosphorus was developed and approved in May of 2013.

2. Upper Monocacy SW-WLA TMDLs

The estimated stormwater baseline loads in the Carroll County portion of Upper Monocacy Watershed were derived from the MDE TMDL Data Center. **Table 10** outlines the bacteria baseline, TMDL, and required percent reduction for jurisdictions within the Upper Monocacy River watershed. The phosohorus baseline, TMDL, and required percent reduction are shown in **Table 11**, and the sediment baseline, TMDL, and required percent reduction are listed in **Table 12.**

Table 10: Upper Monocacy River 8-digit Watershed Bacteria TMDL

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

Table 11: Upper Monocacy River 8-digit Watershed Phosphorus TMDL

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

Table 12: Upper Monocacy River 8-digit Watershed Sediment TMDL

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

E. Lower Monocacy River Watershed

The Monocacy River is a free-flowing stream that originates in Pennsylvania and flows 58 miles within Maryland, where it finally empties into the Potomac River. The Carroll County portion of the Lower Monocacy River Watershed is located in the southwest corner of the County, and consists of two 12-digit subwatersheds that cover a total land area of 5,463 acres. The watershed is within the Potomac River Basin, part of the Piedmont physiographic province of Maryland. **Figure 7** depicts the location of the Lower Monocacy Watershed and its streams, symbolized by use class.

Figure 7: Lower Monocacy River 8-Digit Watershed Map

1. Lower Monocacy Watershed Water Quality Standards

The entire portion of the Lower Monocacy River watershed within Carroll County is designated as Use IV-P (Water Contact Recreation, Protection of Aquatic Life, Recreational Trout Waters, and Public Water Supply). The Lower Monocacy River watershed was placed on Maryland's 303(d) list of impaired waters for nutrients in 1996 and fecal bacteria in 2002. A TMDL for bacteria was developed and approved in 2009 and for phosphorus in 2013.

2. Lower Monocacy SW-WLA TMDLs

The estimated stormwater baseline loads in the Carroll County portion of the Lower Monocacy Watershed were derived from the MDE TMDL Data Center. **Table 13** lists the bacteria stormwater WLA baseline, TMDL, and required percent reduction for jurisdictions within the Lower Monocacy River Watershed. The phosphorus stormwater WLA baseline, TMDL, and required percent reduction for jurisdictions within the Lower Monocacy River Watershed are listed in **Table 14**.

Table 13: Lower Monocacy River 8-digit Watershed Bacteria TMDL

Lower Monocacy Watershed			Percent Reduction Required
Jurisdiction	**Baseline (billion MPN/yr)**	**TMDL (billion MPN/yr)**	
Carroll County	116,000	1,856	98.4%
Total	*116,000*	*1,856*	*98.4%*

Table 14: Lower Monocacy River 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction Required
Carroll County	1,155	806	30%
Total	*1,155*	*806*	*30%*

F. Double Pipe Creek Watershed

The Carroll County portion of the Double Pipe Creek Watershed is located along the western portion of the County, and consists of twenty-one 12-digit subwatersheds that cover a total land area of 105,457 acres. The watershed is within the Potomac River Basin, part of the Piedmont physiographic province of Maryland. **Figure 8** depicts the location of the Double Pipe Creek Watershed and its streams, symbolized by use class.

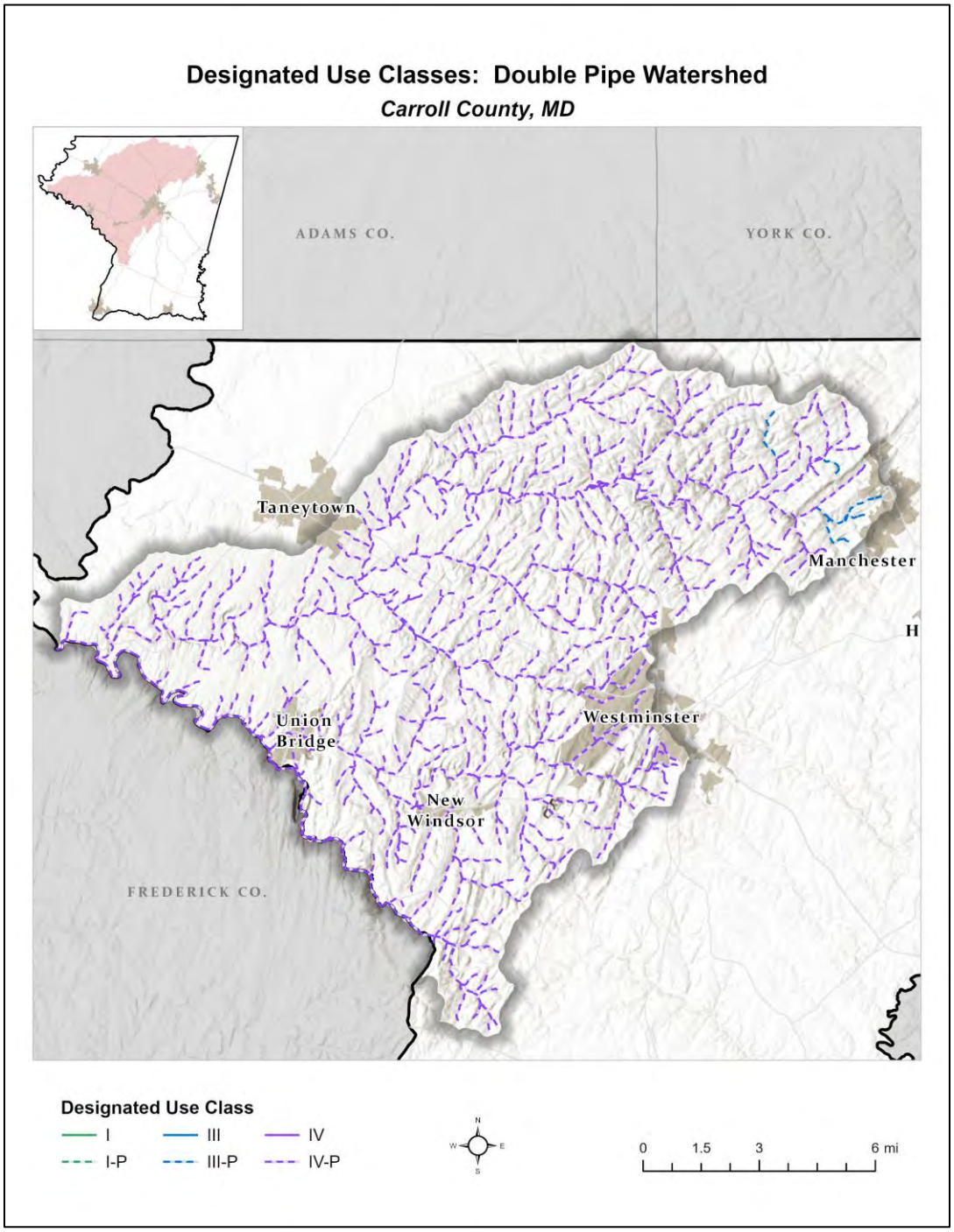

Figure 8: Double Pipe Creek 8-Digit Watershed Map

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

2. Double Pipe Creek SW-WLA TMDLs

The estimated stormwater baseline loads in the Carroll County portion of Double Pipe Creek Watershed were derived from the MDE TMDL Data Center. **Table 15** outlines the bacteria baseline, TMDL, and required percent reduction for jurisdictions within the Double Pipe Creek watershed. The phosohorus baseline, TMDL, and required percent reduction are shown in **Table 16**, and the sediment baseline, TMDL, and required percent reduction are listed in **Table 17**.

Table 15: Double Pipe Creek 8-digit Watershed Bacteria TMDL

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

Table 16: Double Pipe Creek 8-digit Watershed Phosphorus TMDL

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

Table 17: Double Pipe Creek 8-digit Watershed Sediment TMDL

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

G. Baltimore Harbor (South Branch Patapsco)

The Carroll County portion of the Baltimore Harbor Watershed is located along the southern portion of the County and consists of eleven 12-digit subwatersheds that cover a total land area of 38,735 acres. The watershed is within the Patapsco River Basin, part of the Piedmont physiographic province of Maryland. **Figure 9** depicts the location of the Baltimore Harbor Watershed and its streams, symbolized by use class.

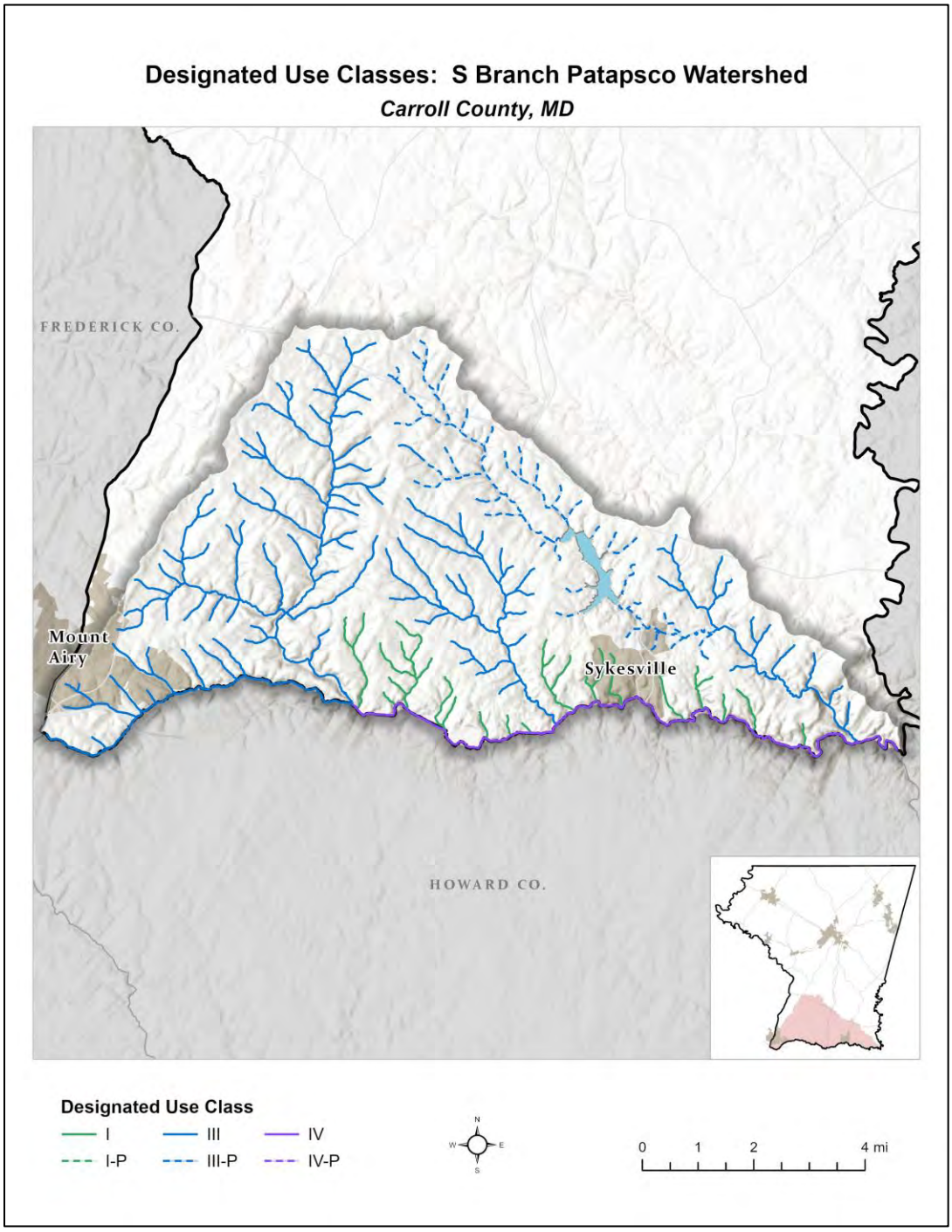

Figure 9: South Branch Patapsco River 8-Digit Watershed Map

1. Baltimore Harbor (S. Branch Patasco) Watershed Water Quality Standards

The South Branch Patapsco Watershed within Carroll County has surface waters with a variety of designated uses, ranging from Use I (non-tidal warm water) to Use IV-P (recreational trout waters and public water supply). The Baltimore Harbor was identified on the State's 1996 list of water quality limited segments (WQLSs) submitted to the U.S. EPA by MDE as impaired by nutrients. The Baltimore Harbor has also been identified on the 303(d) list as impaired by bacteria (fecal coliform) (1998), toxics (polychlorinated biphenyls, or PCBs) (1998), metals (chromium, zinc and lead) (1998), suspended sediments (1996), and impacts to biological communities (2004). As part of the Baltimore Harbor TMDL, Carroll County has an approved SW-WLA for phosphorus and sediment in the South Branch Patapsco watershed.

2. Baltimore Harbor (S. Branch Patasco) SW-WLA TMDLs

The estimated stormwater baseline loads in the Carroll County portion of the South Branch Patapsco watershed were derived from the MDE TMDL Data Center. **Table 18** lists the phosphorus stormwater WLA baseline, TMDL, and required percent reduction within the South Branch Patapsco (Baltimore Harbor) Watershed. The nitrogen stormwater WLA baseline, TMDL, and required percent reduction within the South Branch Patapsco Watershed are listed in **Table 19**.

Table 18: Baltimore Harbor Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction Required
Carroll County	7,889	6,706	15%
Total	*7,889*	*6,706*	*15%*

Table 19: Baltimore Harbor Watershed Nitrogen TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction Required
Carroll County	72,890	61,957	15%
Total	*72,890*	*61,957*	*15%*

IV. Programmatic Initiatives

A. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). Throughout the year, County staff help inform the public of the importance of stormwater management and protecting water resources through a variety of outreach channels.

Across County and municipal websites, information is available to the general public on the MS4 program, stormwater management, and how to report pollution incidents. Various newsletters, such as the quarterly Bureau of Resource Management newsletter, and the *Carroll Environment* Facebook page provide updates on restoration projects, monitoring efforts, and outreach events to the public.

The County and municipalities also provide outreach at local events, where an information booth is set up to provide materials and displays on homeowner stewardship, restoration efforts, volunteer opportunities, and other related topics. Staff engage with the public to answer questions and help connect them with their local watersheds and natural resources. Other hosted events, such as stream clean-ups or tree plantings, provide additional opportunities for involving the public in stewardship and restoration directly.

Carroll County also works with students to introduce concepts of stream health, watershed protection, restoration, and monitoring into their curriculum. These types of events range from in-classroom presentations to full field days with students and from pre-school through college-level groups.

The County's *MS4 Public Outreach Plan* is iteratively updated and provides a roadmap for public education and outreach development for each MS4 permit term. The County continues to expand its education and outreach efforts within all watersheds, regularly seeking additional opportunities to engage the public in water resource-related issues.

B. Stormwater Management

When runoff from precipitation flows over impervious surfaces, it can accumulate debris, chemicals, sediment, and other pollutants that may adversely affect the water quality of a stream. Additionally, the volume and velocity of the runoff can erode the stream banks, which results in habitat degradation and sediment mobilization. Together, these physical and chemical stressors create a high potential for stream degradation.

The State of Maryland began requiring stormwater management for new development in the mid-1980s to manage the quantity of runoff. In 2000, MDE released a new design manual for stormwater (MDE, 2000) that increased water quality and quantity control requirements and included stormwater management for subdivisions with lots greater than two 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 either implement Chapter 151 or have their own stormwater management code. The purpose of this chapter is to protect, maintain, and enhance public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts of increased stormwater runoff. This code applies to all development and establishes minimum requirements to control the adverse impacts associated with 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; reduce stream channel erosion, pollution, and sedimentation; and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 helps to restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce the impacts of land development.

The current chapter was adopted in 2010 and was written to include 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 undeveloped hydrologic conditions.

C. Water Resource Protection Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts to these sources during and after construction. 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. The Carroll County Floodplain Code (Chapter 153) also provides a unified, comprehensive approach to floodplain management. Floodplains are important assets that provide vital natural functions such as temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion.

These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients and other pollutants entering the waterways. Easement locations associated with Carroll County's Chapters 153 and 154 are shown in **Figure 10**.

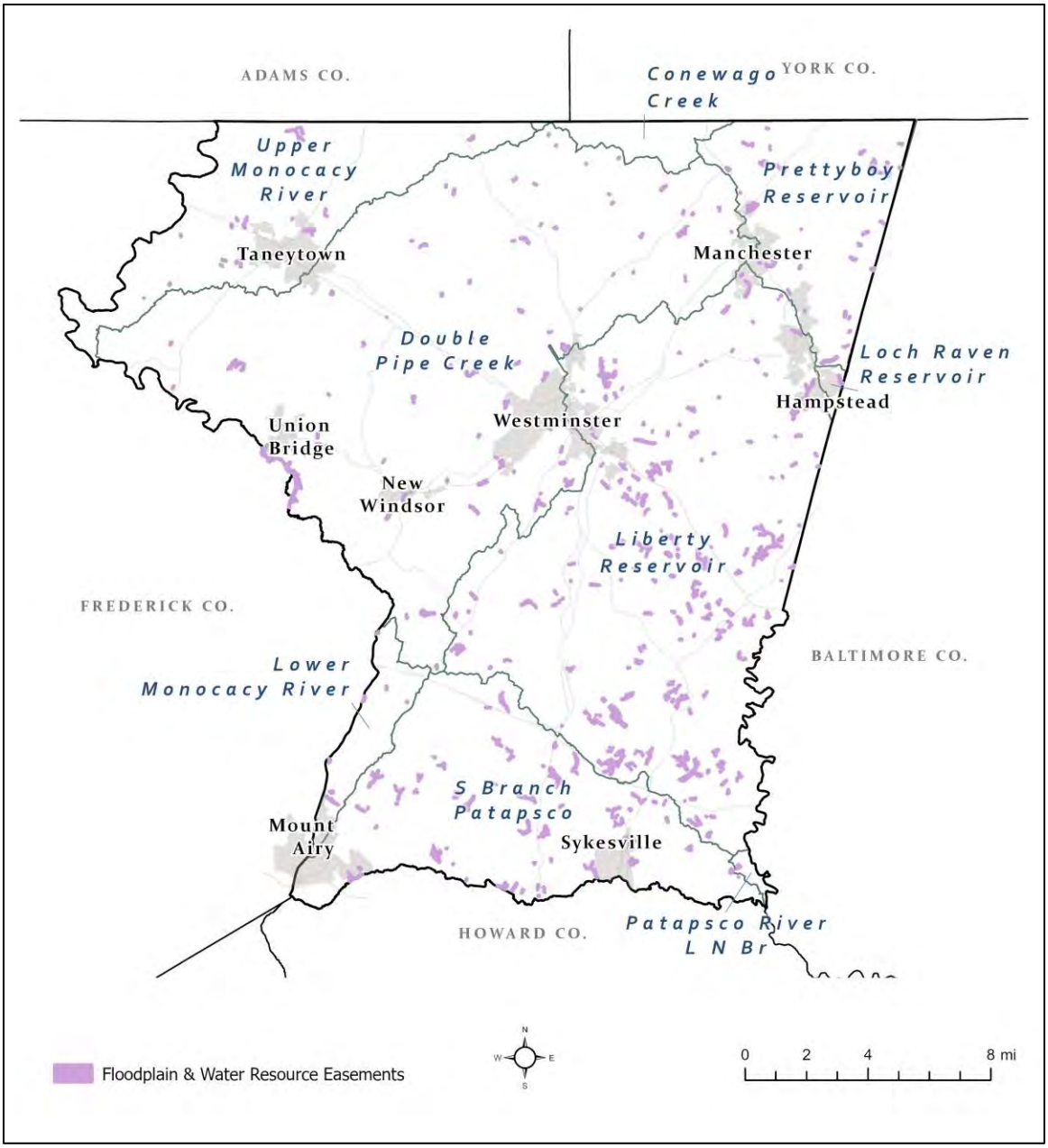

Figure 10: Carroll County Floodplain and Water Resource Protection Easements

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 (https://dnr.maryland.gov/land/pages/rurallegacy/home.aspx).

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.

Carroll County includes the Little Pipe Creek Rural Legacy Area and part of the Upper Patapsco Rural Legacy Area. These areas within Carroll County account for 98,745 acres, which is nearly 40% of the land outside of the growth area boundaries. The extent of the Rural Legacy Areas within Carroll County can be found in **Figure 11.**

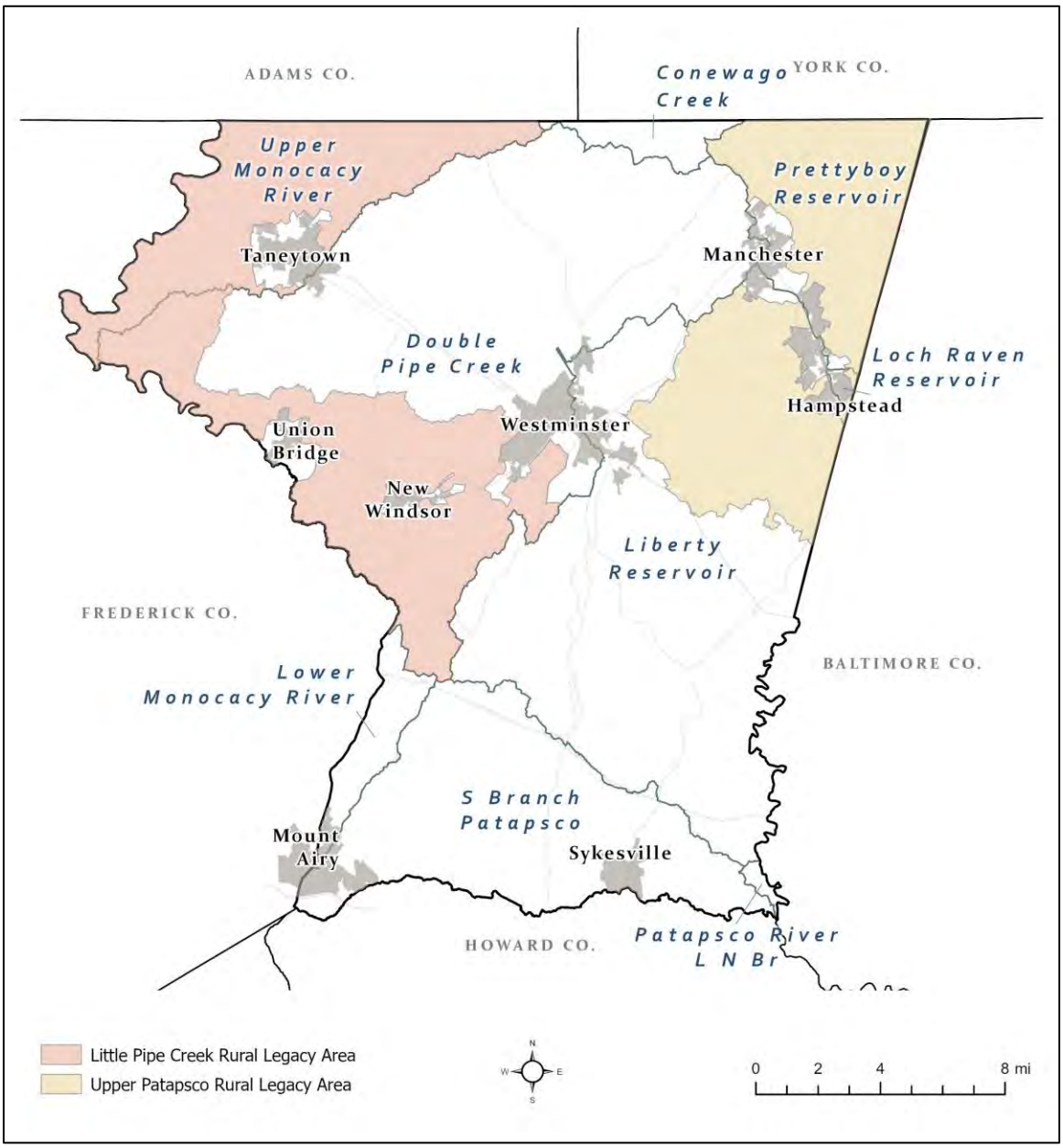

Figure 11: Carroll County Rural Legacy Areas

E. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the Carroll County Commissioners, the 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. Monthly meetings, attended by representatives from the eight municipalities, the County, and the Carroll County Health Department, provide an excellent opportunity to discuss pertinent issues related to drinking water, wastewater, and stormwater management.

The WRCC led the effort to coordinate and develop the joint Water Resources Element (WRE), which was first adopted in 2010 and is currently being updated by the County and 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 FY2013 and FY2014, the WRCC collaborated to develop and sign a Memorandum of Agreement (MOA) to implement NPDES permit requirements, with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater restoration requirements. The WRCC acts as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the restoration program. The MOA was subsequently updated and re-affirmed on October 7, 2021.

F. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County's fourth-generation MS4 permit, which became effective on December 29, 2014. The team meets quarterly to discuss goals and progress related to MS4 permit compliance. The team consists of personnel from the Department of Planning and Land Management, including administration, water resources, stormwater, grading, engineering, and compliance.

G. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is a Commissioner-appointed citizen board that provides an open forum on environmental issues and concerns. Monthly meetings 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 acts in the best interest of County residents by promoting effective environmental protection and management principles. The EAC is briefed regularly on NPDES permit specifics and implementation.

In its role to promote environmental awareness and outreach, the EAC accepts nominations for Environmental Awareness Awards every other year. 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 and distributed at various other venues. The booklet

describes efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater restoration, management projects, and progress.

H. Monocacy River Board

The Carroll County Monocacy River Board advocates for the Monocacy River, its watershed, and the varied resources contained within. The Board is charged with promoting best management practices, advocating for sustainable land uses, and encouraging the restoration and enhancement of the natural resources within the Monocacy River Watershed. This mission is accomplished through public education, volunteer opportunities, and encouraging multi-jurisdictional partnerships that will maintain and improve the river's water quality and ecological health, while respecting the property rights of landowners within the watershed.

V. Restoration Implementation

Carroll County continues to aggressively and consistently pursue measures to improve water quality and work towards meeting applicable stormwater WLAs. The County fully supports achieving pollutant load reductions through strong fiscal commitments, staff resources to implement the stormwater and water quality improvements program, and coordination between co-permittees. The County's fiscal expenditures and capital budgeting – historical, current, and planned – demonstrate the implementation of this commitment. The County completed the impervious restoration goals of both the third- and fourth-generation MS4 permits and has made significant effort toward the current fifth-generation permit restoration requirement as well. These achievements demonstrate the County's determined approach to meeting permit goals and improving water quality.

This document will be updated each year to track and summarize progress toward meeting all applicable TMDLs, as per section E.4 of the County's NPDES MS4 permit, for each 8-digit watershed with an approved SW-WLA TMDL.

The County tracks and documents pollution load reductions from all completed structural and nonstructural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives. Project information is maintained within a geodatabase to track implementation data over time, such as location, drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance.

A. Stormwater Management Facilities

Stormwater management facilities provide controls on water quantity (e.g. downstream channel protection or flood management), water quality (e.g. nutrient and sediment removal), or a combination of both. Older stormwater facilities that were constructed to provide quantity management only can be modified to also provide water quality treatment. Other stormwater facilities that were constructed to provide only partial water quality treatment (i.e. less than 1") can also be modified to provide a higher level of treatment, thereby increasing the pollutant removal capacity of the facility. Additionally, in areas where no stormwater management currently exists, a new facility can be built to control and treat the stormwater runoff there. The retrofit process and the construction of new stormwater facilities offer significant opportunities to reduce pollutant loads in support of progress toward TMDL attainment.

In 2007, the Department of Public Works provided BRM with a list of County-owned SWM facilities that had existing maintenance issues (e.g. 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 whether or not 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 through 2013. This process, the SCAs, and the

continued identification of existing facilities as retrofit candidates have aided BRM in establishing projects for the restoration program.

B. Storm Drain Outfalls

During the County's SCAs that occurred from 2011-2016, in-stream and stormdrain outfall erosion sites were documented and rated for severity. The erosion sites were then analyzed in GIS to identify any associated existing stormwater management facilities and contributing storm drain networks. Storm drain outfalls lacking stormwater controls or where stormwater management was below current standards were identified as potential locations for stormwater BMP implementation. Providing stormwater management within these drainage networks reduces erosive flows and, consequently, allows for stabilization and natural regeneration of vegetation within the stream corridors.

C. Tree Planting and Reforestation

Riparian stream buffers and upland reforestation assist in reducing erosion, sedimentation, and overall stream temperatures. Following the completion of the first SCA in 2011 in the Prettyboy Watershed, the BRM began a tree planting program. This initiative focuses on reforesting open County, municipal, and private properties and is completely voluntary to landowners, with a goal of re-establishing forested upland and riparian corridors utilizing native tree stocks.

Plantings through this program are implemented at a stocking rate of 200-300 trees per acre, with successful plantings requiring a survival rate of 100 trees per acre. The tree planting initiative includes a three-year maintenance term, which consists of mowing, stake repair, and shelter maintenance, as well as a 75% survival requirement, guaranteed by the contractor awarded the project. Each planting is inspected annually for the first three years to ensure contractor compliance, and triennially thereafter to meet BMP inspection requirements. Additionally, private homeowners sign a Landowner Stewardship Agreement to ensure that the planting areas are maintained, protected, and able to be inspected by BRM staff.

D. Stream Restoration

Streams are dynamic systems that adjust to the tectonic, climatic, and environmental changes imposed upon them (Dollar, 2000). A stream system adapts 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 urbanization have deteriorated the quality of streams within the Piedmont physiographic region. Booth and Henshaw (2001) documented the increase of sediment yield and channel erosion within urbanizing streams, and Langland and Cronin (2003) have shown that sediment yields in urban streams are more than an order of magnitude higher than in rural streams.

The County has implemented various stream restoration projects as a method to reduce nutrient and sediment loadings within the watersheds.

E. Streambank Regeneration

Stormwater runoff from inadequately managed impervious surfaces can cause accelerated streambank erosion in downstream channels. As pervious land is converted to impervious, the proportion of rainwater that infiltrates into the ground decreases. This, in turn, causes an increase in runoff and an increase in the volume and velocity of flow in downstream receiving channels. The increase in volume and velocity intensifies erosion and increases sediment loads within the stream corridor.

There are two approaches to reducing the destabilizing velocities in the receiving channel. The first is traditional stream restoration, which involves increasing the plan form and bank resistance. The second is upland stormwater management, which can include storing the total runoff volume and dissipating the acquired kinetic energy as turbulence in the water pool.

In the Piedmont region, where Carroll County is located, many areas that were developed prior to 1982 were constructed without stormwater management. Subsequently, developments were designed with peak flow controls that only matched existing conditions but did not return runoff characteristics to predevelopment conditions, as required now by COMAR 26.17.02.01. Meeting only the existing runoff conditions failed to address existing streambank instability, restore streams, and reduce nutrient and sediment export to the Bay.

A foremost goal of stormwater management is to maintain or return to pre-development hydrologic conditions. For over 10 years, Carroll County has been experimenting with the use of enlarged, enhanced sand filters as primary stormwater management practices. An analysis of the County's standard design determined that these practices reduce the two-year storm peak flow to below that of the equivalent forested watershed in good condition. The potential stormwater management, water quality, and stream restoration benefits resulting from this are substantial.

Because the two-year flow is thought to control bank geometry, the ability to achieve pre-development two-year hydrologic conditions using sand filters holds high potential for improving downstream bank conditions. The extent to which these effects stretch downstream is dependent on various additional factors, including soil type and land use in the unmanaged portion of the watershed below the sand filter.

In November 2002, BRM initiated fieldwork with the Center for Watershed Protection, who received funding from the Chesapeake Bay Trust's Restoration Research Program to continue evaluating the impact of hydraulic-controlling BMPs on the self-recovery of stream channel stability in urban watersheds. The original restoration research grant was awarded to Carroll County in May of 2016 to study the effect of stormwater retrofits on the hydrogeomorphology of downstream channels and associated nutrient and sediment load reductions. The grant concluded in December of 2020. During the four-year pre- and post-restoration paired watershed study, the retrofits performed as designed to reduce the magnitude, duration, and frequency of erosive flows, substantially decreasing the measured runoff curve numbers and simulating a hydrologic regime close to that of the "woods in good condition" performance standard. Therefore, it is likely that these channels will begin to stabilize, show less erosion potential, and reconnect to the floodplain over time.

Data collected during the original study indicate that the downstream channels are on a trajectory towards stabilization. Because bank stability and geomorphic response will take longer to develop than the duration of the original grant, the County has continued monitoring the study sites to provide documentation of a definitive stream channel response. During the next four-year study, a stage-discharge relationship will continue to be generated, but the primary focus will shift to the geomorphic component through annual cross-section surveys, pebble counts, and longitudinal profiles.

Although streambank regeneration is not currently an approved practice in the Wasteload Allocation Guidance Document (MDE, 2020), the guidance states that innovative practices can be used to provide jurisdictions additional options for watershed restoration activities. These include practices that are not listed in the Maryland Stormwater Design Manual (MDE, 2000) and without an assigned pollution removal efficiency from MDE or CBP, provided there is sufficient documentation and monitoring to verify pollutant removal efficiencies acceptable to MDE. The goal is that these long-term monitoring results will inform recommendations to credit upland stormwater practices as a hydrogeomorphic stream stabilization technique for sediment reductions.

F. 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, removes buildup of pollutants that have been deposited along the street or curb. Additionally, the removal of impervious surfaces improves water quality by improving the hydrologic conditions within the watershed.

G. 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 major contributors of nutrients to the Bay, such as effluent discharges, 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. 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.

H. Bacteria Load Reduction

It is likely that these nutrient- and sediment-focused projects will also reduce bacteria contributions to surface waters. However, MDE's *Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan for Bacteria Total Maximum Daily Loads* (2014) does not provide a quantifiable methodology for tracking and measuring bacteria pollutant load reductions.

In lieu of guidance from MDE on bacteria reduction efficiencies or loading rates by land use, Carroll County has implemented a trend monitoring program for bacteria. This program began in December 2017 and documents long-term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the WLA. Additional sites have subsequently been added, expanding the monitoring program to include all 8-digit watersheds with an approved bacteria TMDL. The County currently monitors 20 trend sites on a monthly basis across six 8-digit watersheds.

Carroll County's bacteria trend monitoring program is performed year-round. Results are differentiated by flow rate (low vs. high) and analyzed for both annual and seasonal (May – September) geometric means. Each individual sample is also analyzed against the single sample exceedance standards for full-body contact.

The County continues to focus on retrofitting older facilities through the use of enhanced infiltration and filtration, bringing facilities up to current standards or higher, maintaining existing facilities that prevent wildlife sources of bacteria from entering the County's MS4 network, and implementing alternative practices (e.g. street sweeping and inlet cleaning) that minimize potential bacteria loads.

VI. Restoration Progress: FY2023

The restoration projects listed in this plan and any future progress towards meeting the stormwater WLAs will be documented through a combination of modeling and BMP reductions, calculated based on the 2020 MDE guidance document, *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. The current 2020 guidance document was an update of the August 2014 version, which was originally released as a draft document in June 2011.

A. TMDL Compliance

To address remaining TMDL requirements, the County will utilize a mix of techniques and practice types for locations identified in future Community Investment Program (CIP) budgets to progress towards fully attaining all approved SW-WLA TMDLs. It is not feasible, nor fiscally possible, to identify or specify the exact projects, locations, or costs beyond the current approved CIP.

Appendix A consists of tables summarizing the net change in pollutant load reductions from all completed structural and nonstructural water quality improvement projects and alternative stormwater measures. The tables also demonstrate how work associated with restoration efforts translates into requirements associated with meeting local WLA and Chesapeake Bay TMDL reductions. Edge-of-stream (EOS) load reductions and their associated Chesapeake Bay reductions are also provided by segment shed.

B. Modeling with MapShed

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

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).

Supplemental information about model inputs and BMP assumptions can be found in **Appendix B.**

1. Liberty Reservoir Watershed Progress

As described in Section III, phosphorus, sediment, and bacteria loads within the Liberty Reservoir Watershed must be reduced in order to meet water quality standards. The local TMDL includes an urban TP load reduction of 50% and TSS load reduction of 38% from the 2009 baseline year.

Load reductions for phosphorus and sediment associated with completed projects since the TMDL baseline year, as well as future projects planned through the County's current CIP, are shown in **Table 20**. The total percent TMDL reductions listed in the following tables include all completed and currently planned CIP projects.

Table 20: Total Phosphorus and Total Suspended Solids Load Reductions in the Liberty Reservoir Watershed

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs/yr)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs/yr)**	**Reduction from Current BMPs (lbs/yr)**	**Reduction from Planned Strategies (lbs/yr)**	**Total % Reduction (Achieved + Planned)**
1,793.45	50%	896.72	288.98	164.30	25%
Total Suspended Solids Load Reduction					
Modeled Baseline Load (tons/yr)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (tons/yr)**	**Reduction from Current BMPs (tons/yr)**	**Reduction from Planned Strategies (tons/yr)**	**Total % Reduction (Achieved + Planned)**
3,415.0	37%	1,263.6	506.97	217.06	21%

The current progress of implemented and CIP-planned projects for the Liberty Reservoir Watershed since the TMDL baseline year is shown below in **Figures 12** and **13**.

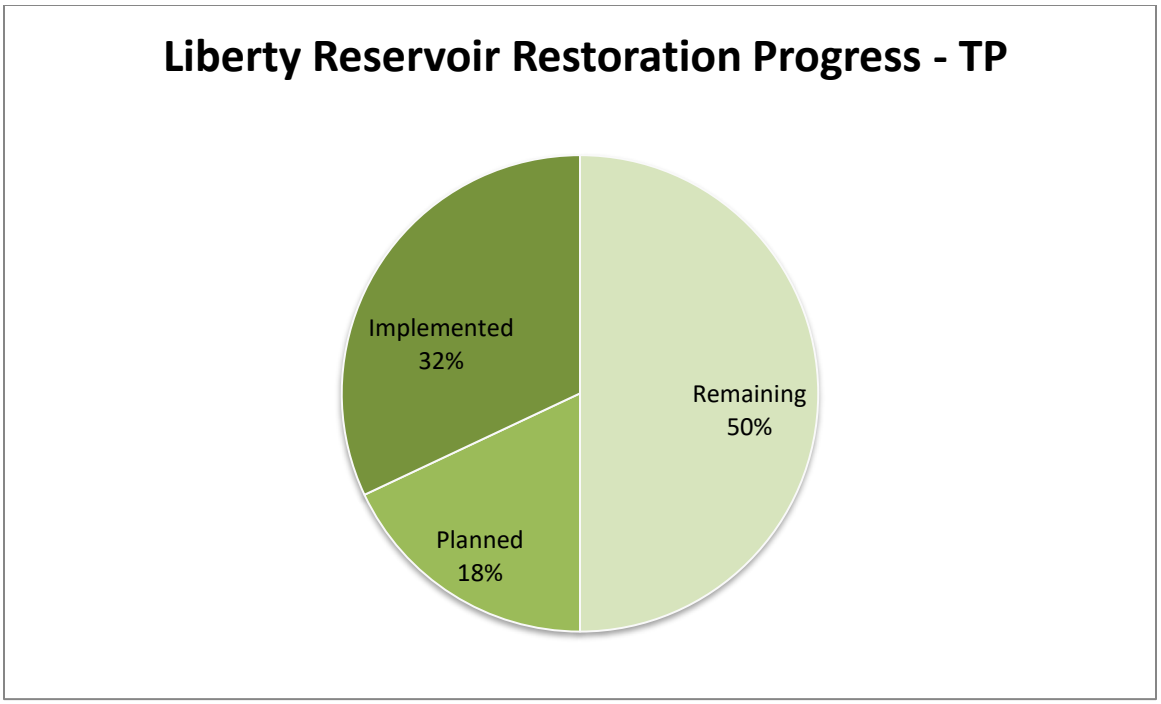

Figure 12: Liberty Watershed Restoration Progress for Total Phosphorus

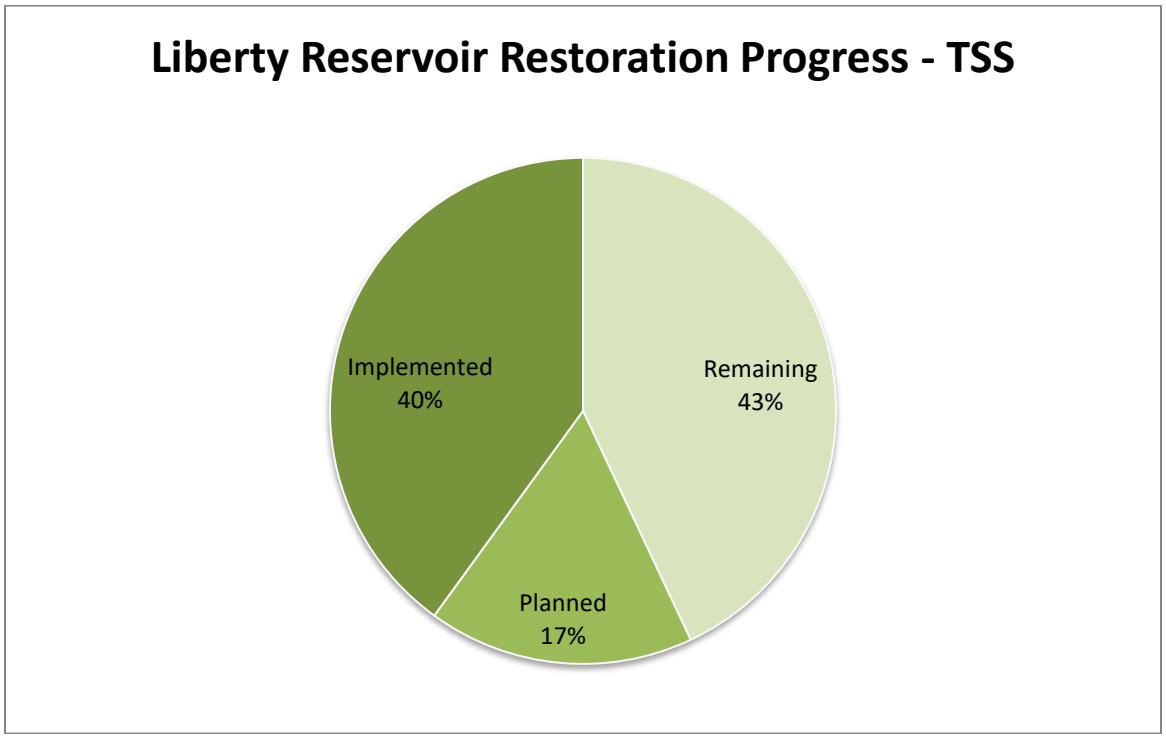

Figure 13: Liberty Watershed Restoration Progress for Total Suspended Solids

2. Prettyboy Reservoir Watershed Progress

As described in Section III, phosphorus and bacteria loads within the Prettyboy Reservoir Watershed must be reduced in order to meet water quality standards. The local TMDL for TP includes an urban load reduction of 15% from the 1995 baseline year.

Load reductions for TP associated with completed projects since the TMDL baseline year, as well as projects planned through the County's current CIP, are shown in **Table 21**. The total percent TMDL reduction listed in the following table includes all completed and currently planned CIP projects.

Table 21: Total Phosphorus Load Reduction in the Prettyboy Reservoir Watershed

Modeled Baseline Load (lbs/yr)	% Required Reduction from TMDL	Required Load Reduction based on Modeled Baseline (lbs/yr)	Reduction from Current BMPs (lbs/yr)	Reduction from Restoration Plan Strategies (lbs/yr)	Total % Reduction (Achieved + Planned)
204.18	15%	30.63	15.16	20.88	18%

The current progress of implemented and CIP-planned projects for the Prettyboy Reservoir Watershed since the TMDL baseline year is shown below in **Figure 14**.

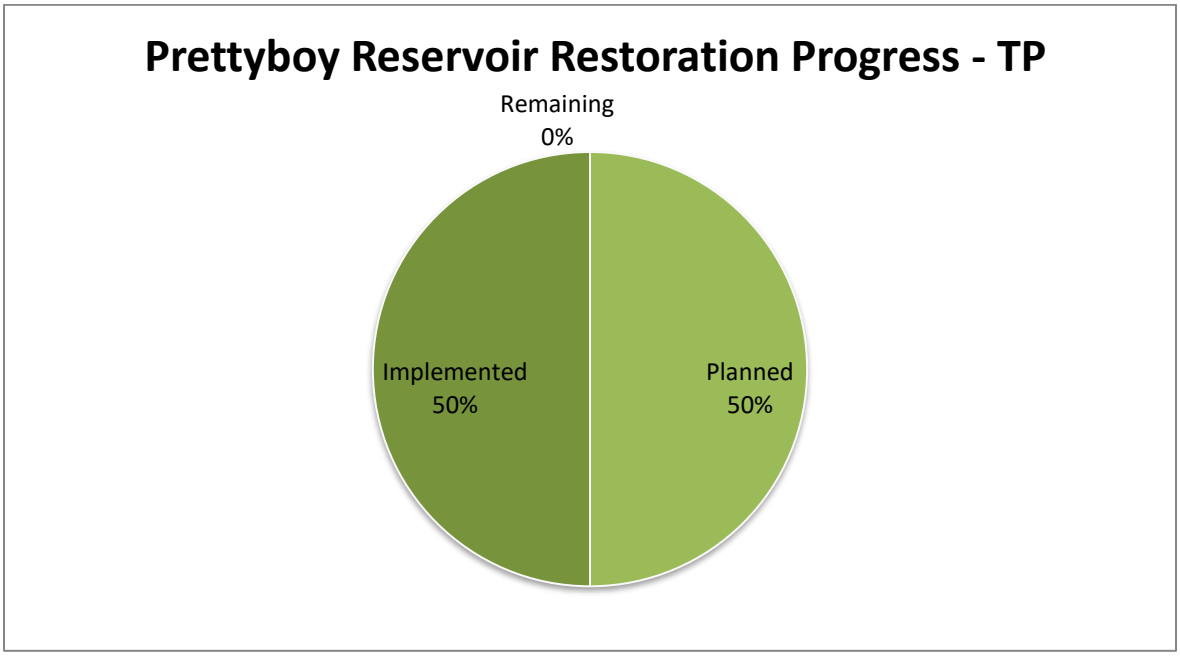

Figure 14: Prettyboy Reservoir Restoration Progress for TP

3. Loch Raven Reservoir Watershed

As described in Section III, phosphorus and bacteria loads within the Loch Raven Reservoir Watershed must be reduced in order to meet water quality standards. The local TMDL includes an urban TP load reduction of 15% from the 1995 baseline year.

Load reductions for TP associated with completed projects since the TMDL baseline year, as well as projects planned through the County's current CIP are shown in **Table 22**. The total percent TMDL reduction listed in the following table includes all completed and currently planned CIP projects.

Table 22: Total Phosphorus Load Reduction in the Loch Raven Reservoir Watershed

Modeled Baseline Load (lbs/yr)	% Required Reduction from TMDL	Required Load Reduction based on Modeled Baseline (lbs/yr)	Reduction from Current BMPs (lbs/yr)	Reduction from Restoration Plan Strategies (lbs/yr)	Total % Reduction (Achieved + Planned)
24.89	15%	3.73	6.93	30.30	150%

The current progress of implemented and CIP planned projects for the Loch Raven Reservoir Watershed since the TMDL baseline year is shown below in **Figure 15**.

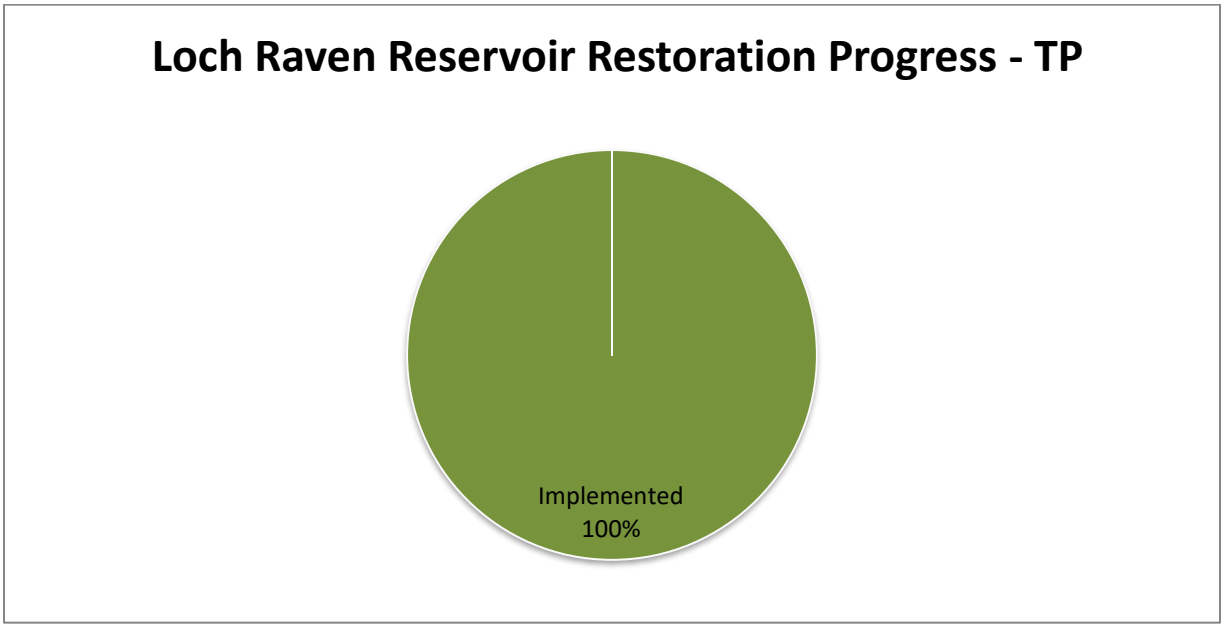

Figure 15: Loch Raven Reservoir Restoration Progress for TP

4. Upper Monocacy River Watershed

As described in Section III, phosphorus, sediment, and bacteria loads within the Upper Monocacy River Watershed must be reduced in order to meet water quality standards. The local TMDL includes an urban TP load reduction of 5% from the 2009 baseline year and a TSS load reduction of 44% from the 2000 baseline year.

Load reductions for TP and TSS associated with completed projects since the TMDL baseline year, as well as projects planned through the County's current CIP within the Upper Monocacy River Watershed are shown in **Table 23**. The total percent TMDL reduction listed in the following table includes all completed and currently planned CIP projects.

Table 23: Total Phosphorus and Total Suspended Solids Load Reductions in the Upper Monocacy Watershed

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs/yr)	**% Required Reduction from TMDL**	**Required Load Reduction Based on Modeled Baseline (lbs/yr)**	**Reduction from Current BMPs (lbs/yr)**	**Reduction from Planned Strategies (lbs/yr)**	**Total % Reduction (Achieved + Planned)**
283.67	5%	14.18	28.83	3.41	16%
Total Suspended Solids Load Reduction					
Modeled Baseline Load (tons/yr)	**% Required Reduction from TMDL**	**Required Load Reduction Based on Modeled Baseline (tons/yr)**	**Reduction from Current BMPs (tons/yr)**	**Reduction from Planned Strategies (tons/yr)**	**Total % Reduction (Achieved + Planned)**
273.65	43.5%	119.04	59.68	3.01	20%

The current progress of implemented and CIP-planned projects for the Upper Monocacy River Watershed since the TMDL baseline year is shown below in **Figures 16** and **17**.

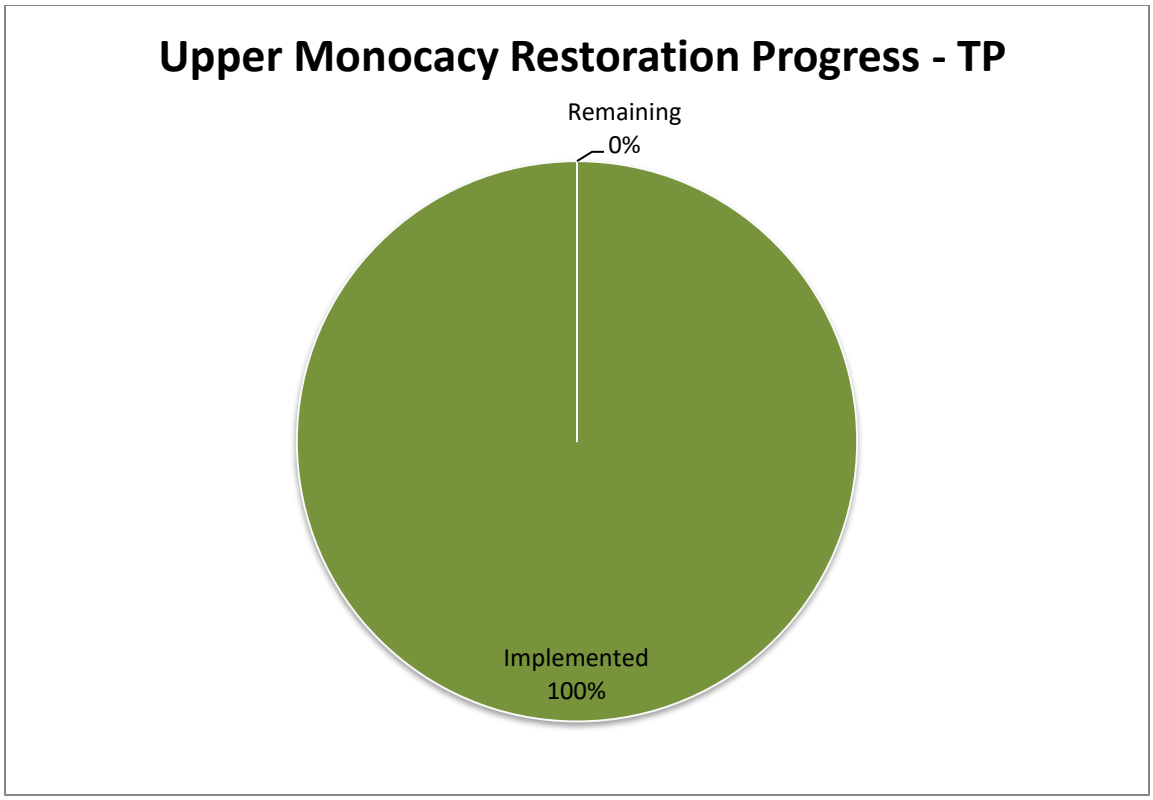

Figure 16: Upper Monocacy River Restoration Progress for TP

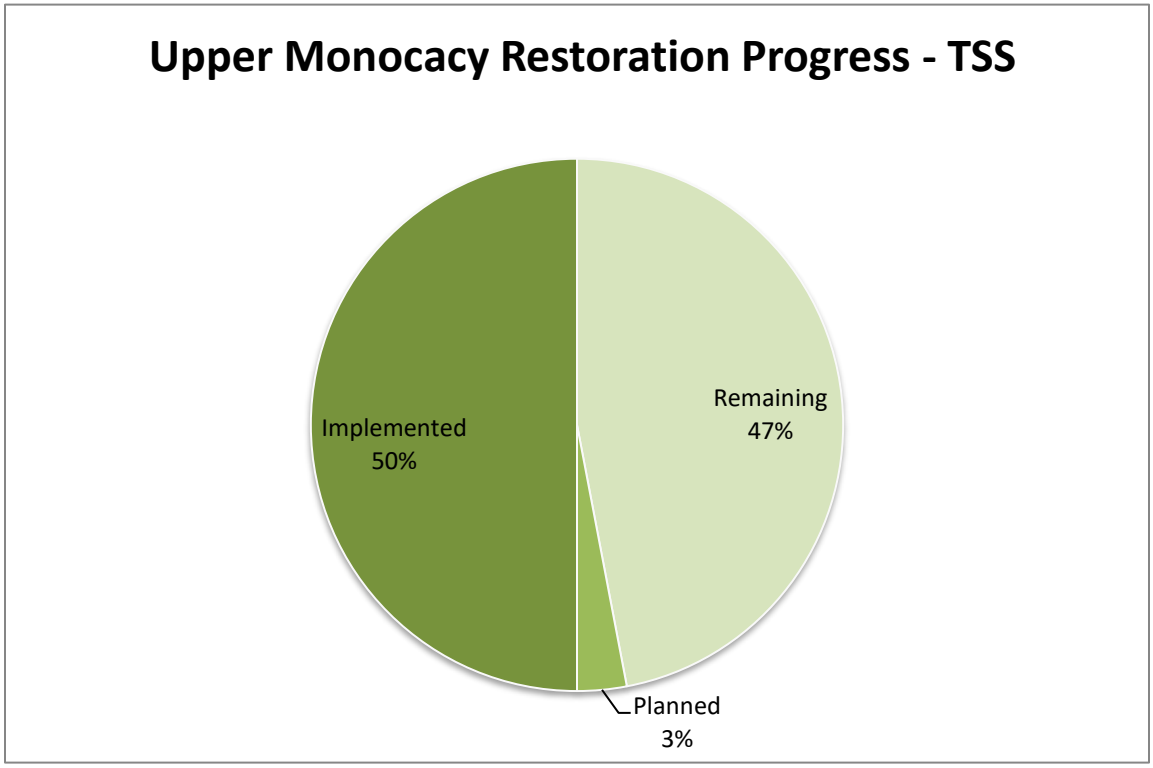

Figure 17: Upper Monocacy River Restoration Progress for TSS

5. Lower Monocacy River Watershed

As described in Section III, phosphorus and bacteria loads within the Lower Monocacy River Watershed must be reduced in order to meet water quality standards. The local TMDL includes an urban TP load reduction of 30% from the 2009 baseline year.

Load reductions for TP associated with completed projects since the TMDL baseline year, as well as projects planned through the County's current CIP within the Lower Monocacy River Watershed are shown in **Table 24**. The total percent TMDL reduction achieved listed in the following table includes all completed and currently planned CIP projects.

Table 24: Total Phosphorus Load Reduction in the Lower Monocacy Watershed

Modeled Baseline Load (lbs/yr)	% Required Reduction from TMDL	Required Load Reduction based on Modeled Baseline (lbs/yr)	Reduction from Current BMPs (lbs/yr)	Reduction from Restoration Plan Strategies (lbs/yr)	Total % Reduction (Achieved + Planned)
180.66	30%	54.20	0.96	8.92	5%

The current progress of implemented and CIP planned projects for the Lower Monocacy River Watershed since the TMDL baseline year is shown below in **Figure 18**.

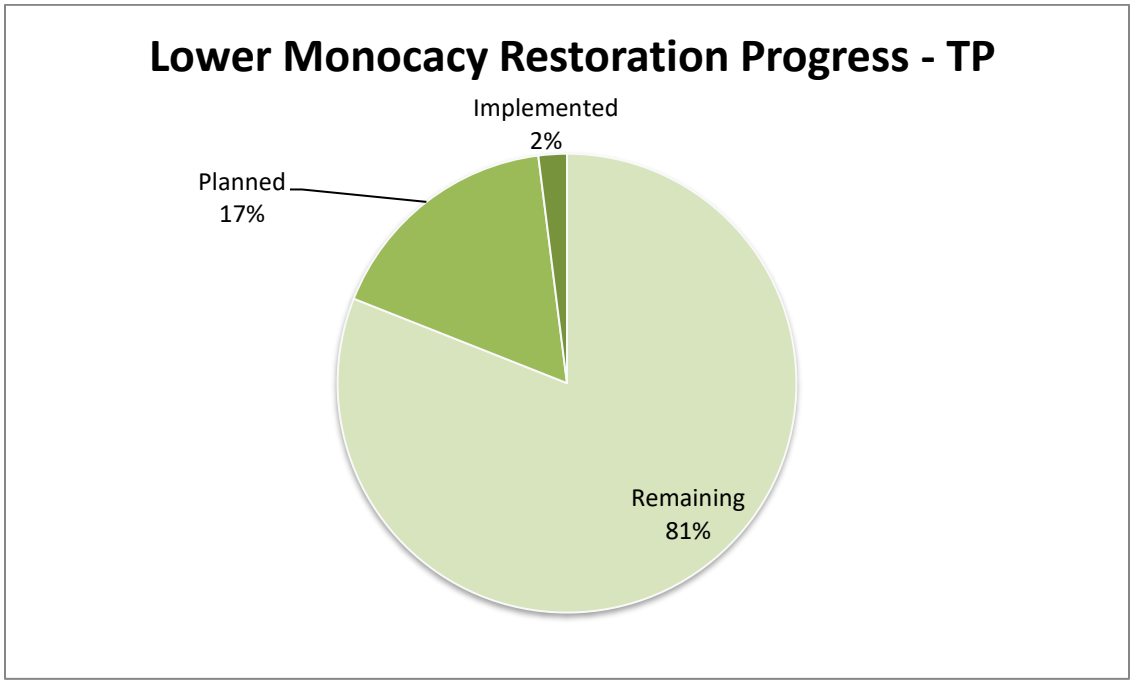

Figure 18: Lower Monocacy River Restoration Progress for TP

6. Double Pipe Creek Watershed

As described in Section III, phosphorus, sediment, and bacteria loads within the Double Pipe Creek Watershed must be reduced in order to meet water quality standards. The local TMDL includes an urban TP load reduction of 73% from the 2009 baseline year and a TSS load reduction of 34% from the 2000 baseline year.

Load reductions for TP and TSS associated with completed projects since the TMDL baseline year, as well as projects planned through the County's current CIP within the Double Pipe Creek Watershed are shown in **Table 25**. The total percent TMDL reductions listed in the following table include all completed and currently planned CIP projects.

Table 25: Total Phosphorus and Total Suspended Solids Load Reductions in the Double Pipe Creek Watershed

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs/yr)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs/yr)**	**Reduction from Current BMPs (lbs/yr)**	**Reduction from Planned Strategies (lbs/yr)**	**Total % Reduction (Achieved + Planned)**
938.00	72.5%	680.05	96.10	17.61	12%
Total Suspended Solids Load Reduction					
Modeled Baseline Load (tons/yr)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (tons/yr)**	**Reduction from Current BMPs (tons/yr)**	**Reduction from Planned Strategies (tons/yr)**	**Total % Reduction (Achieved + Planned)**
1280.91	33.8%	432.95	94.31	25.96	9%

The current progress of implemented and CIP-planned projects for the Double Pipe Creek Watershed since the TMDL baseline year is shown below in **Figures 19** and **20**.

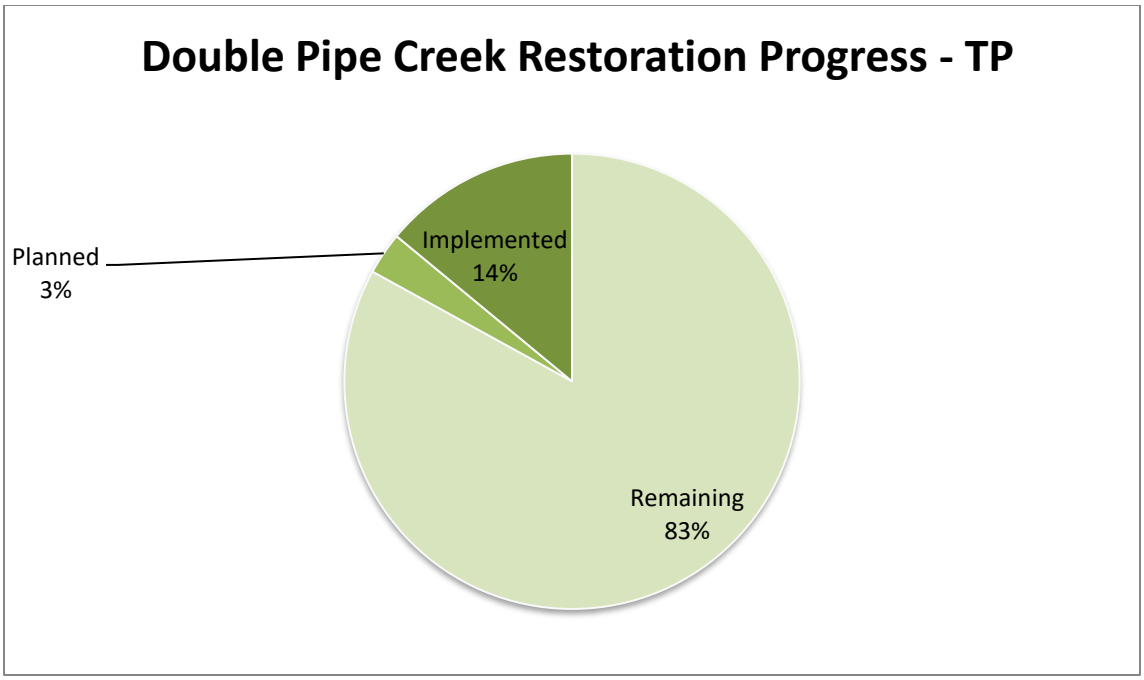

Figure 19: Double Pipe Creek Restoration Progress for TP

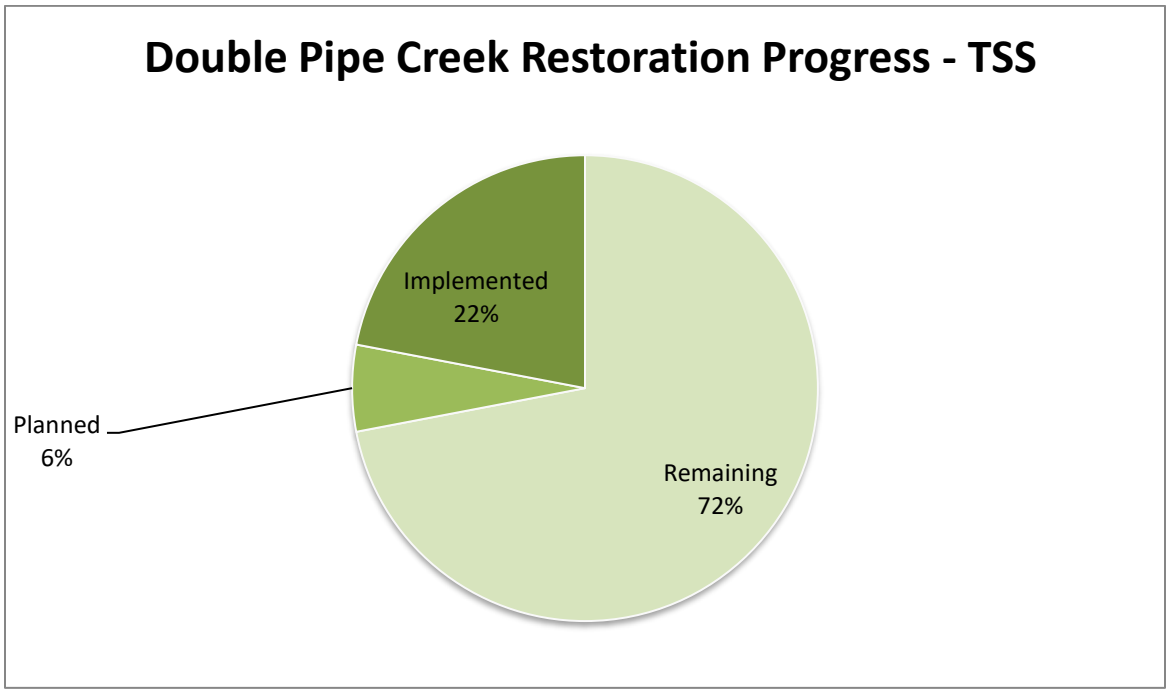

Figure 20: Double Pipe Creek Restoration Progress for Total Suspended Solids

7. Baltimore Harbor (South Branch Patapsco River) Watershed

As described in Section III, phosphorus and nitrogen loads within the Baltimore Harbor (South Branch Patapsco River) Watershed must be reduced in order to meet water quality standards. The local TMDL includes urban TP and urban TN load reductions of 15% from the 1995 baseline year.

Load reductions for TP and TN associated with completed projects since the TMDL baseline year, as well as projects planned through the County's current CIP, within the South Branch Patapsco Watershed are shown in **Table 26**. The total percent TMDL reductions listed in the following table include all completed and currently planned CIP projects.

Table 26: Total Phosphorus and Total Nitrogen Load Reductions in the Baltimore Harbor (South Branch Patapsco River) Watershed

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs/yr)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs/yr)**	**Reduction from Current BMPs (lbs/yr)**	**Reduction from Planned Strategies (lbs/yr)**	**Total % Reduction (Achieved + Planned)**
861.77	15%	129.26	120.67	27.77	17%
Total Nitrogen Load Reduction					
Modeled Baseline Load (lbs/yr)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs/yr)**	**Reduction from Current BMPs (lbs/yr)**	**Reduction from Planned Strategies (lbs/yr)**	**Total % Reduction (Achieved + Planned)**
4,815.23	15%	722.28	505.83	153.63	14%

The current progress of implemented and CIP-planned projects for the Baltimore Harbor (South Branch Patapsco) Watershed since the TMDL baseline year is shown below in **Figures 21** and **22**.

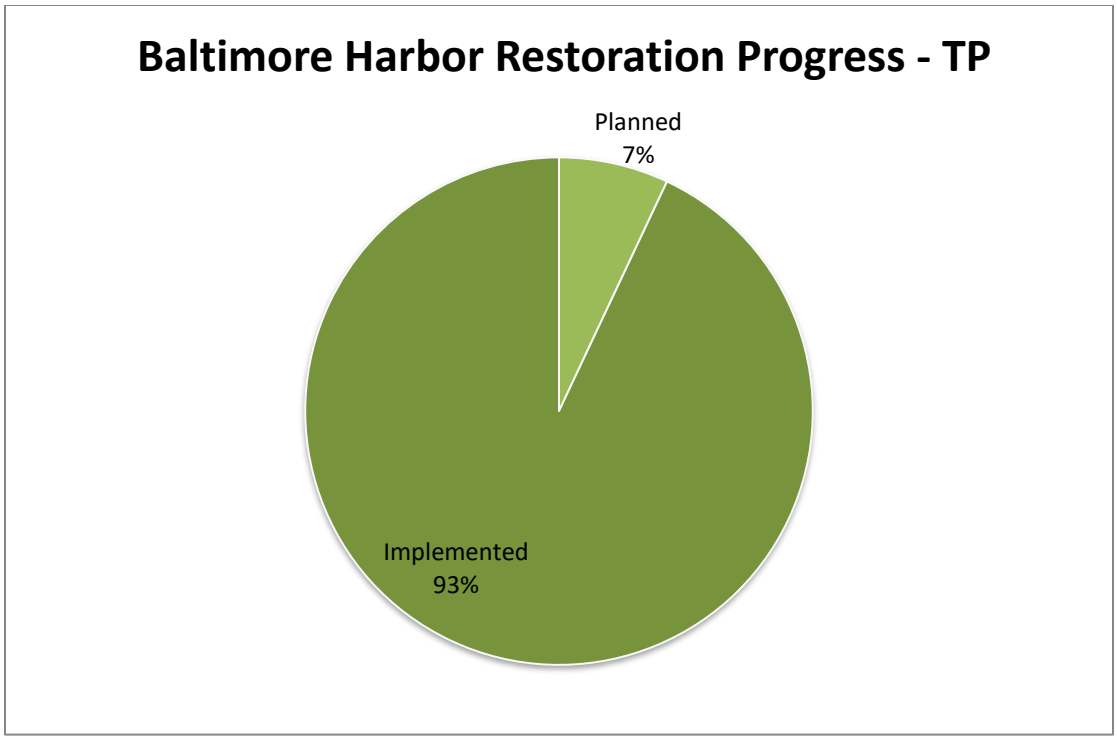

Figure 21: Baltimore Harbor (South Branch Patapsco River) Restoration Progress for Total Phosphorus

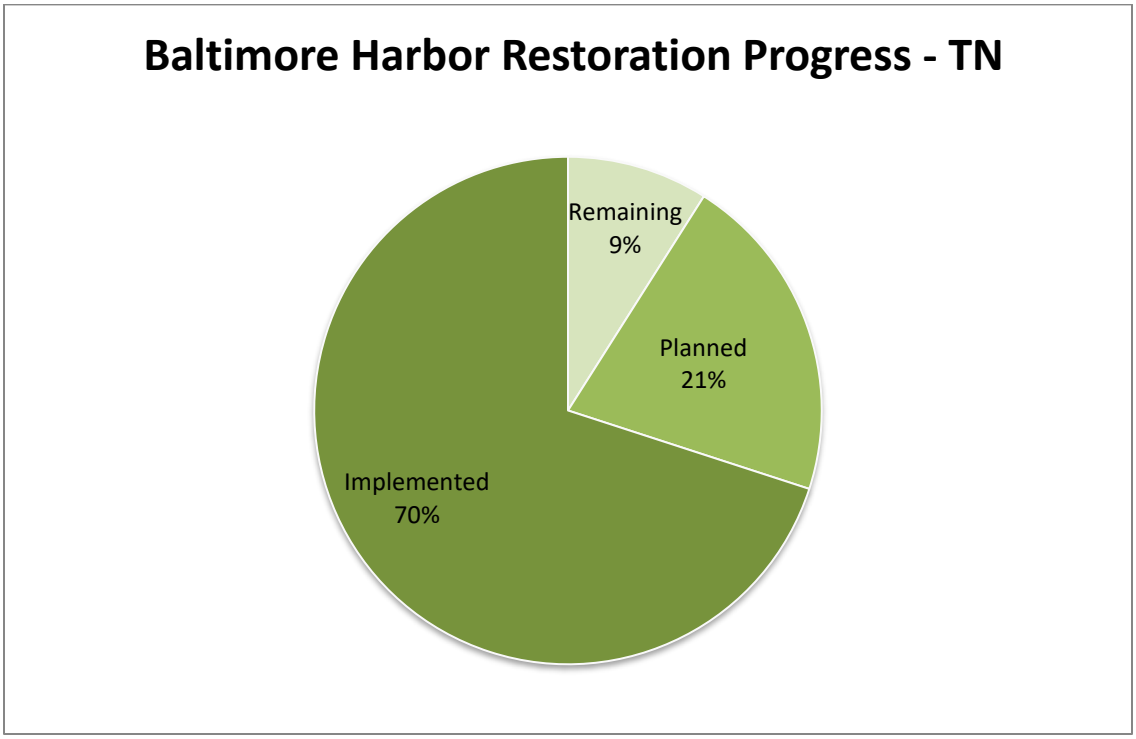

Figure 22: Baltimore Harbor (South Branch Patapsco River) Restoration Progress for Total Nitrogen

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. BMPs and restoration projects that have either been completed or proposed to address local TMDLs will ultimately reduce loadings to the Chesapeake Bay. The exception to this is the Liberty Reservoir Watershed, which has a delivered load factor of zero due to the reservoir's impoundment; reductions in this watershed have no effect on reducing loadings for the Chesapeake Bay TMDL.

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 several decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake Bay TMDL. The Chesapeake Bay TMDL identified the 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, 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. This reflects a 25% reduction in nitrogen, a 24% reduction in phosphorus, and a 20% reduction in sediment.

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 27**, and the tidal water designated use zones are shown in **Figure 23**.

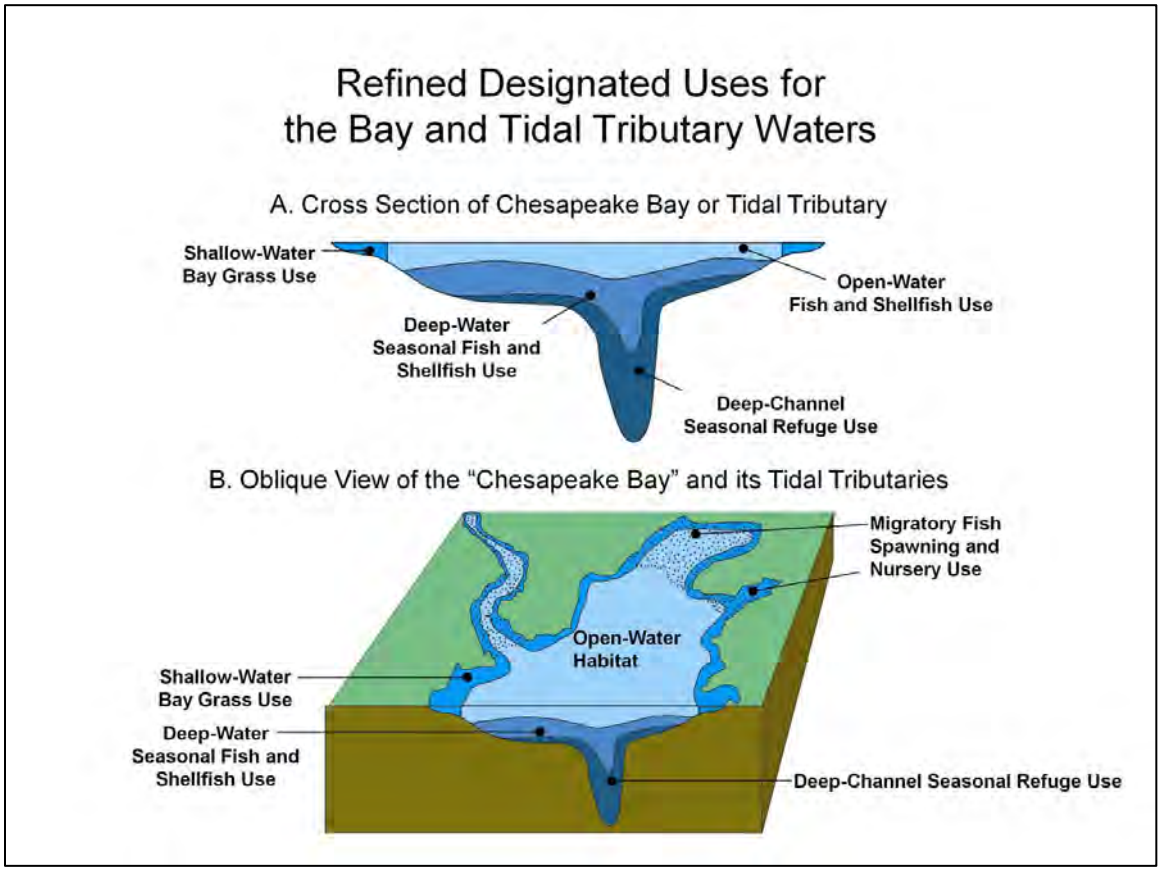

Figure 23: Chesapeake Bay Tidal Water Designated Use Zones (USEPA, 2003b)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003b, 2004, 2010). 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 27: 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 Locations

Carroll County is a headwater county, and as such it contains multiple Chesapeake Bay river segments. The eastern portion of the County drains into the upper part of the Bay via the Gunpowder and Patapsco River segments, while the western part drains into the southern Bay via the Potomac River segment.

1. Gunpowder River Segment

The Gunpowder River segment covers 283,263 acres across four counties within Pennsylvania and Maryland. Approximately 21,600 acres (7%) of the river segment is within Carroll County and includes both the Loch Raven Reservoir (592 acres) and Prettyboy Reservoir (21,025 acres) 8-digit watersheds.

2. Patapsco River Segment

The Patapsco River segment covers 374,186 acres across four counties within Maryland. Approximately 126,000 acres (34%) of this river segment is within Carroll County and includes the Liberty Reservoir (87,249 acres) and South Branch Patapsco (38,735 acres) 8-digit watersheds.

3. Potomac River Segment

The Potomac River Basin is the second largest Chesapeake Bay River Segment, extending into Pennsylvania, Viginia and West Virginia. Within Maryland, the Potomac River segment covers 1,539,973 acres across eight counties. Approximately 138,000 acres (9%) of the Potomac River Basin located in Maryland is within Carroll County, and includes the 8-digit watersheds of Double Pipe Creek (105,457 acres), Upper Monocacy River (27,123 acres), and Lower Monocacy River (5,463 acres).

The Chesapeake Bay river segments and their extents within Carroll County are shown in **Figure 24**.

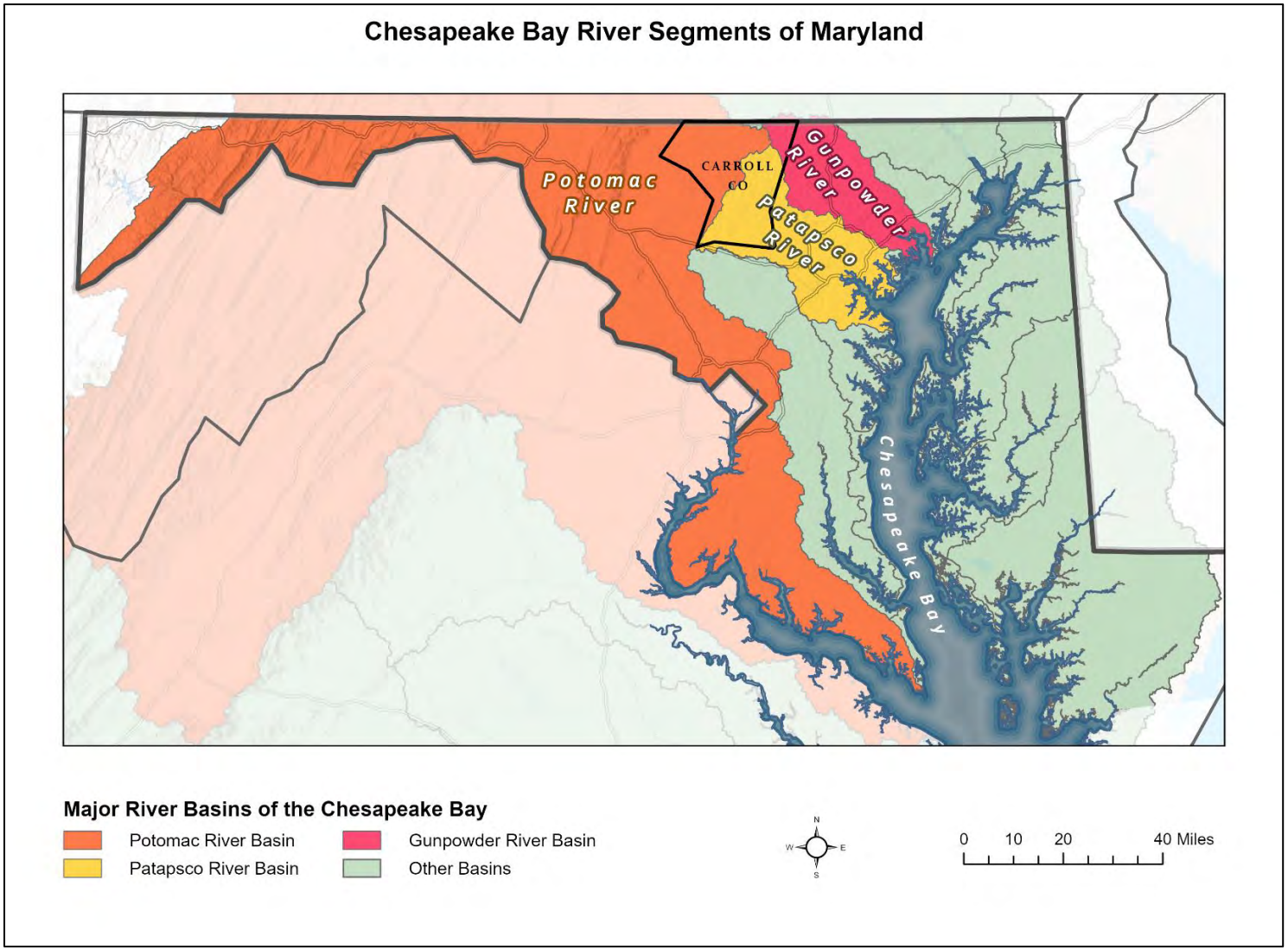

Figure 24: Chesapeake Bay River Segments of Maryland

D. Chesapeake Bay Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2020 MDE Guidance document, *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, 2020) 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 with the broader accounting procedure used by the Chesapeake Bay Watershed Model.

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. 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. **Table 28** lists the delivery factor of each land-river segment within Carroll County by HUC-8 watershed. Note that the Liberty Reservoir Watershed has a delivery factor of 0.00 for TN, TP, and TSS due to the reservoir impoundment.

Table 28: Chesapeake Bay Delivery Factors for Carroll County Land-River Segments by HUC-8 Watershed

Cheseapeake Bay Land-River Segment	Carroll County HUC-8 Watershed	TN Delivery Factor	TP Delivery Factor
Patapsco River Segment	Liberty Reservoir Watershed	0.00	0.00
	South Branch Patapsco River Watershed	0.11	0.27
Potomac River Segment	Double Pipe Creek Watershed	0.25	0.47
	Upper Monocacy River Watershed	0.30	0.47
	Lower Monocacy River Watershed	0.37	0.47
Gunpowder River Segment	Prettyboy Reservoir Watershed	0.05	0.08
	Loch Raven Reservoir Watershed	0.16	0.36

Delivered load ratios were applied to BMP load reductions and calculated using the 2020 MDE Accounting Guidance document in order to correspond with the Bay TMDL delivered load allocations and reductions. Chesapeake Bay TMDL progress is summarized for each of the County's three land-river segment in **Tables 29** through **31** and shown in **Figures 25** through **30.** The tables provide the Chesapeake Bay TMDLs, progress achieved through implemented BMPs, and future CIP-planned projects for each portion of the land-river segment watersheds within the County.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II values, based on the MOA between the County and each of the municipalities that combines the jurisdictions into one MS4 permit. The aggregated load allocations for municipalities within all land-river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

Table 29: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Patapsco River Segment based on Delivered Loads[2]

Total Phosphorus (TP) [3]						
8-digit Watershed	**2009 Delivered Baseline (lbs/yr)**	**% Reduction**	**Reduction (lbs/yr)**	**Reduction from BMPs implemented 2009-2023 (lbs/yr)**	**Reduction from Planned BMPs (lbs/yr)**	**% Bay TMDL Reduced (Completed + Planned)**
Liberty Reservoir Watershed	1,752.52	35.26%	618.00	0	0	0%
South Branch Patapsco Watershed				239.20	99.19	19.31%
			Total:	**239.20**	**99.19**	**19.31%**
Total Nitrogen (TN)						
8-digit Watershed	**2009 Delivered Baseline (lbs/yr)**	**% Reduction**	**Reduction (lbs/yr)**	**Reduction from BMPs implemented 2009-2023 (lbs/yr)**	**Reduction from Planned BMPs (lbs/yr)**	**% Bay TMDL Reduced (Completed + Planned)**
Liberty Reservoir Watershed	16,038.74	13.79%	2,212.59	0	0	0%
South Branch Patapsco Watershed				837.28	207.18	6.51%
			Total:	**837.28**	**207.18**	**6.51%**

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Patapsco land-river segment of Carroll County. The BMP load reductions represent the combined reductions for County and municipal projects in the Liberty Reservoir and South Branch Patapsco Watersheds.

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

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

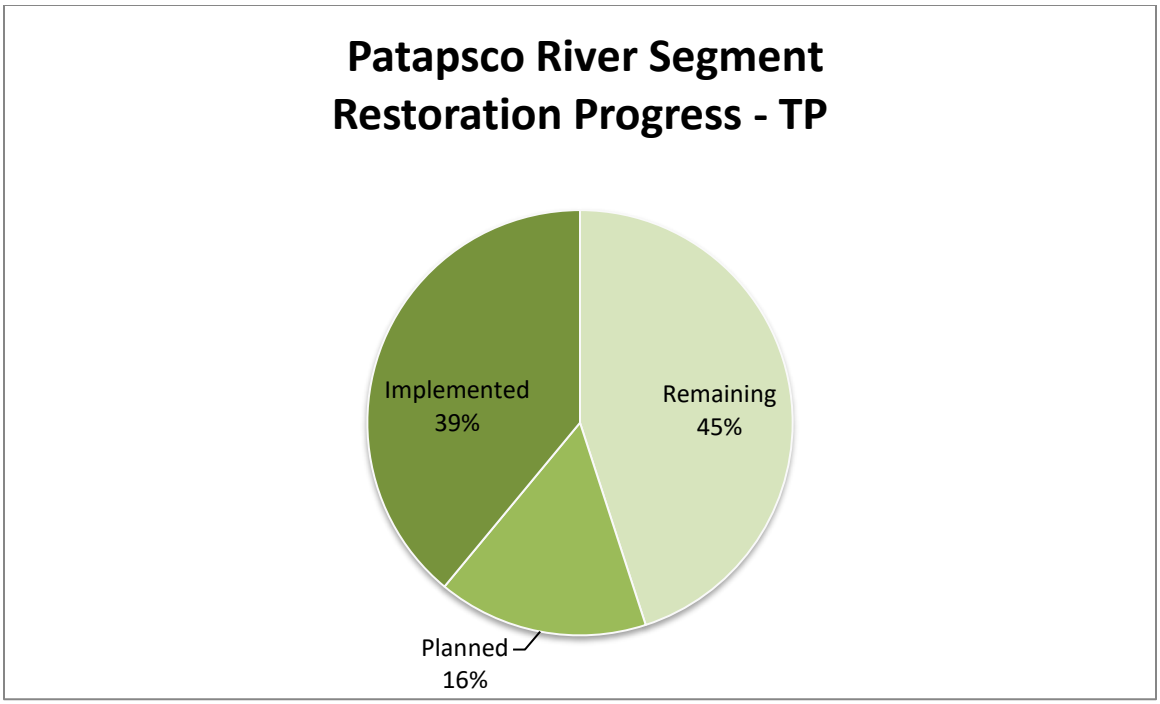

Figure 25: Patapsco River Segment Restoration Progress for Total Phosphorus

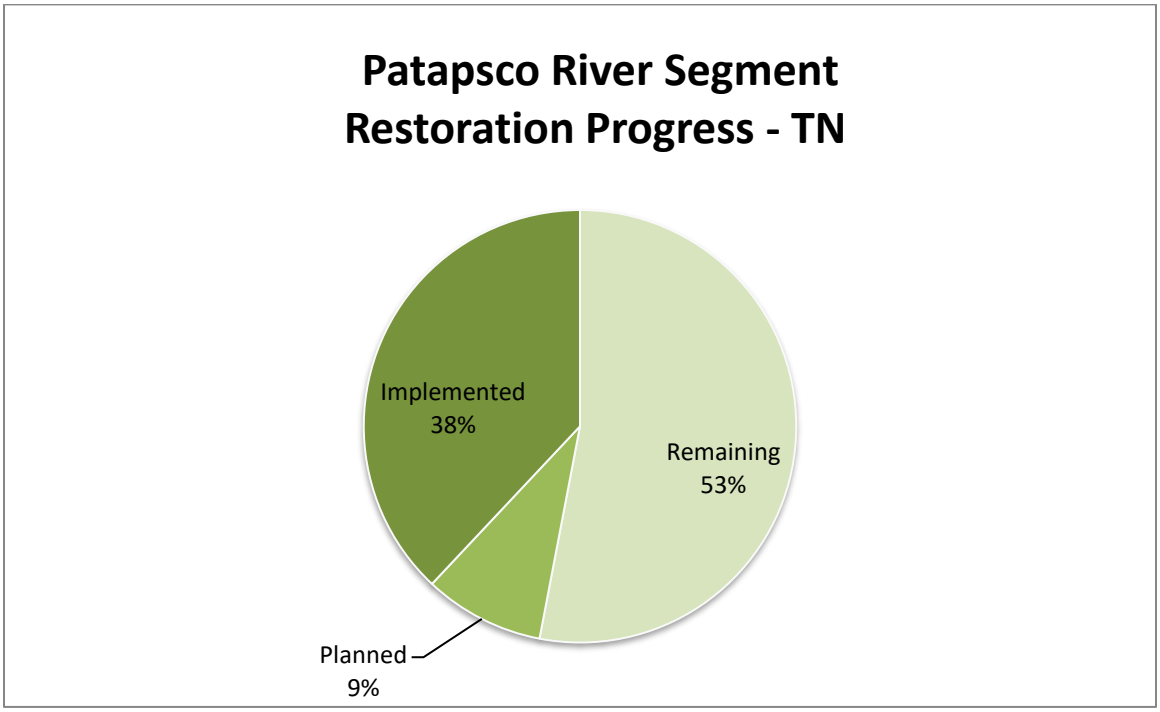

Figure 26: Patapsco River Segment Restoration Progress for Total Nitrogen

Table 30: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Potomac River Segment based on Delivered Loads[2]

Total Phosphorus (TP) [3]						
8-digit Watershed	**2009 Delivered Baseline (lbs/yr)**	**% Reduction**	**Reduction (lbs/yr)**	**Reduction from BMPs implemented 2009-2023 (lbs/yr)**	**Reduction from Planned BMPs (lbs/yr)**	**% Bay TMDL Reduction (Completed + Planned)**
Double Pipe Creek Watershed	10,100.99	22.07%	2,228.95	567.73	135.69	6.97%
Upper Monocacy River Watershed				159.72	19.62	1.78%
Lower Monocacy River Watershed				18.95	74.13	0.92%
			Total:	**746.40**	**229.44**	**9.66%**
Total Nitrogen (TN)						
8-digit Watershed	**2009 Delivered Baseline (lbs/yr)**	**% Reduction**	**Reduction (lbs/yr)**	**Reduction from BMPs implemented 2009-2023 (lbs/yr)**	**Reduction from Planned BMPs (lbs/yr)**	**% Bay TMDL Reduction (Completed + Planned)**
Double Pipe Creek Watershed	110,661.46	9.25%	10,232.26	2,815.22	316.22	2.83%
Upper Monocacy River Watershed				713.14	82.49	0.72%
Lower Monocacy River Watershed				34.32	229.21	0.24%
			Total:	**3,562.68**	**627.92**	**3.79%**

[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, Upper Monocacy River, and Lower Monocacy River Watersheds.

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

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

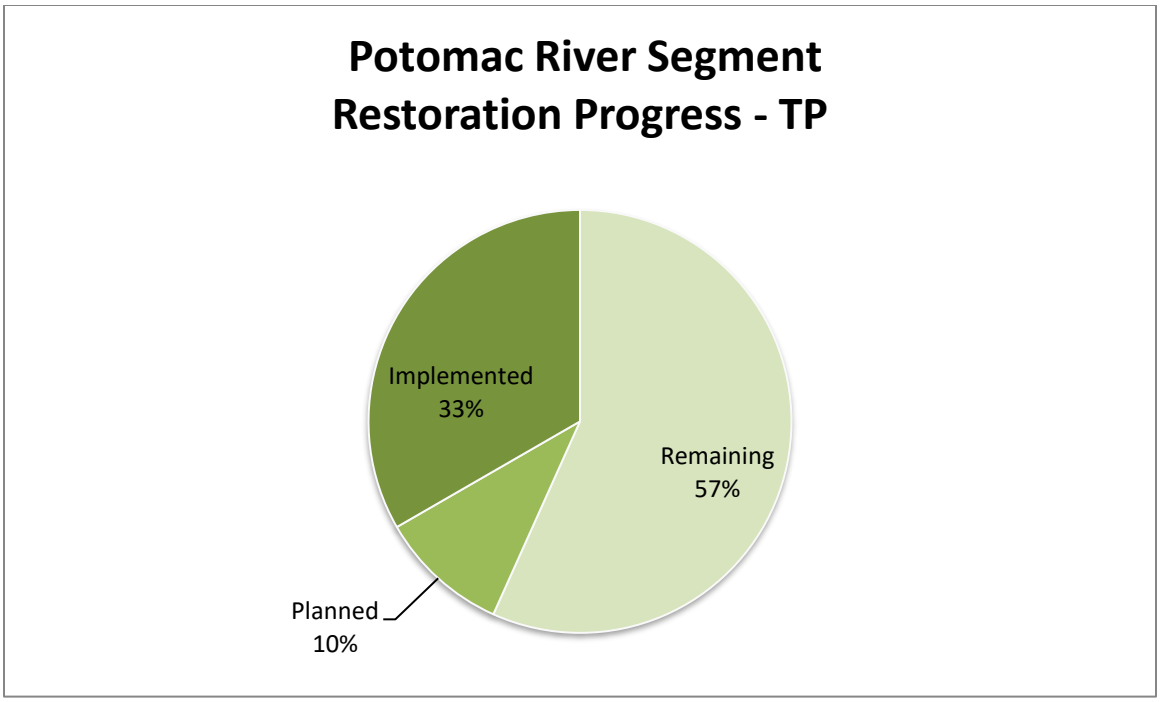

Figure 27: Potomac River Segment Restoration Progress for Total Phosphorus

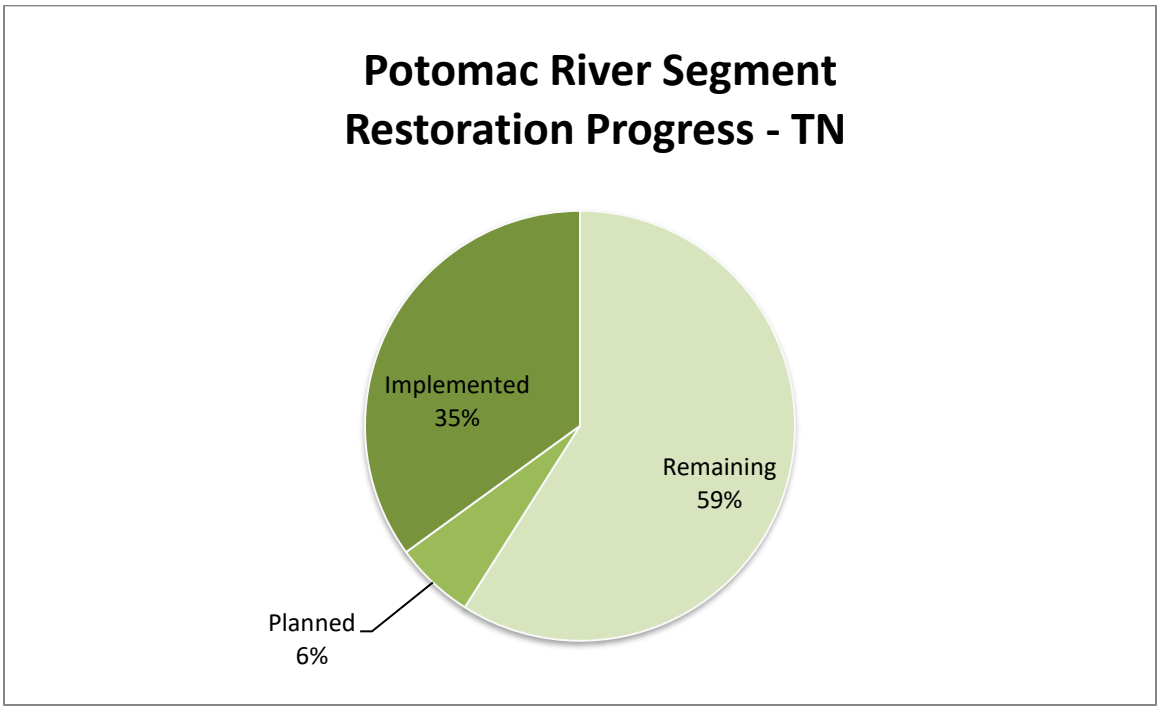

Figure 28: Potomac River Segment Restoration Progress for Total Nitrogen

Table 31: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Gunpowder River Segment based on Delivered Loads[2]

Total Phosphorus (TP) [3]						
8-digit Watershed	**2009 Delivered Baseline (lbs/yr)**	**% Reduction**	**Reduction (lbs/yr)**	**Reduction from BMPs implemented 2009-2023 (lbs/yr)**	**Reduction from Planned BMPs (lbs/yr)**	**% Bay TMDL Reduction (Completed + Planned)**
Prettyboy Reservoir Watershed	315.36	17.19%	54.21	7.43	17.80	8.00%
Loch Raven Reservoir Watershed				8.63	123.59	41.94%
			Total:	**16.06**	**141.39**	**49.85%**
Total Nitrogen (TN)						
8-digit Watershed	**2009 Delivered Baseline (lbs/yr)**	**% Reduction**	**Reduction (lbs/yr)**	**Reduction from BMPs implemented 2009-2023 (lbs/yr)**	**Reduction from Planned BMPs (lbs/yr)**	**% Bay TMDL Reduction (Completed + Planned)**
Prettyboy Reservoir Watershed	4,010.75	9.59%	384.55	68.37	59.79	3.20%
Loch Raven Reservoir Watershed				25.21	180.44	5.13%
			Total:	**93.58**	**240.23**	**8.33%**

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Gunpowder land-river segment of Carroll County. The BMP load reductions represent the combined reductions for County and municipal projects in the Prettyboy Reservoir and Loch Raven Reservoir Watersheds.

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

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

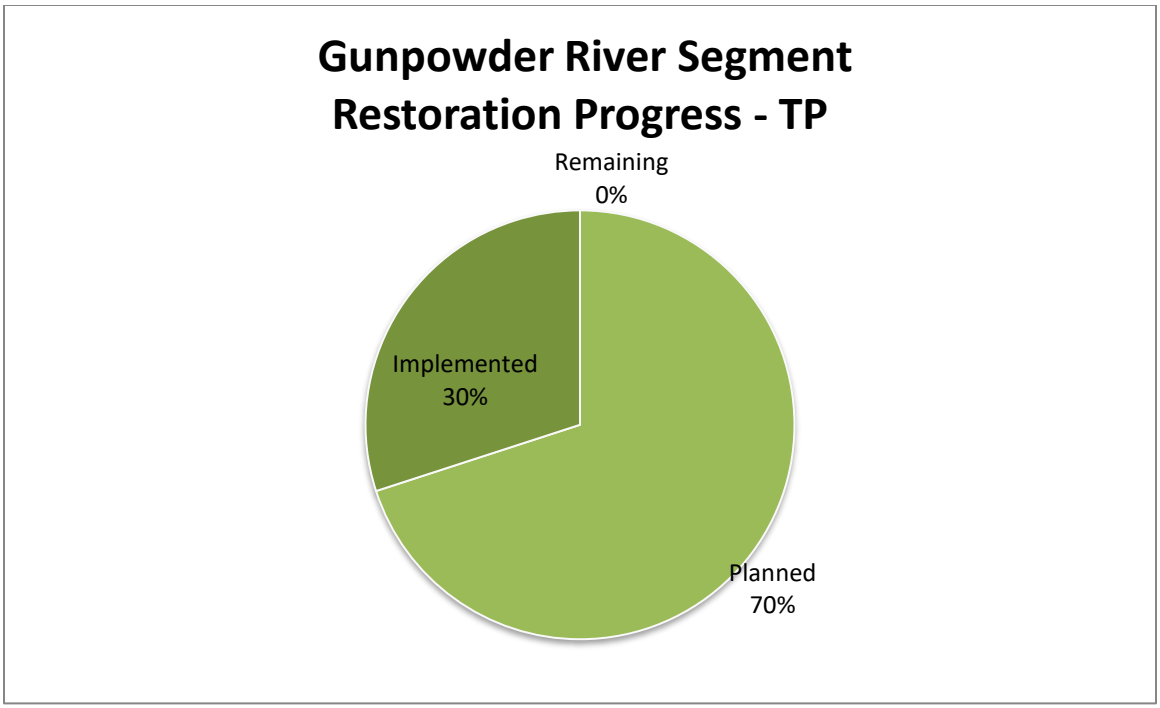

Figure 29: Gunpowder River Segment Restoration Progress for Total Phosphorus

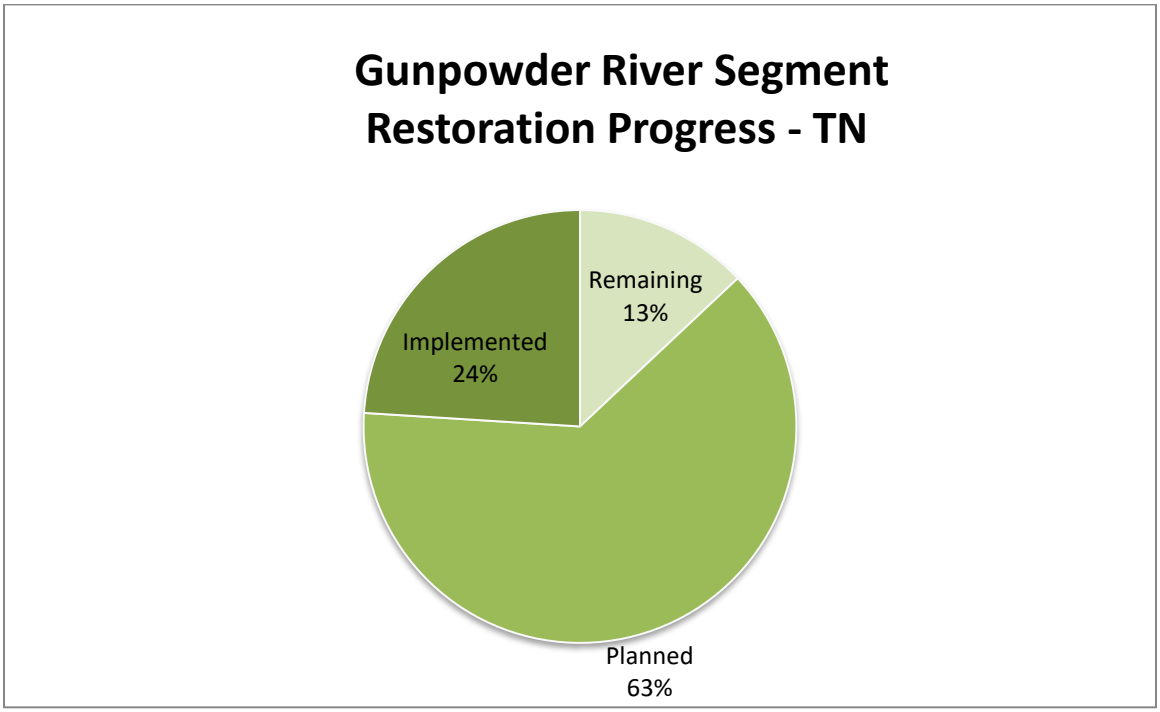

Figure 30: Gunpowder River Segment Restoration Progress for Total Nitrogen

VIII. TMDL Benchmarks

Through the continued implementation of stormwater management projects and alternative BMPs, Carroll County continues to make progress toward TMDL attainment at both the local and Bay levels. In order to develop a timeline for those attainments, benchmark tables have been created to provide current progress, CIP-approved planned progress, and the estimated year that TMDL attainment is projected to be reached (i.e. the year in which 100% of the required reductions will be met). To estimate the TMDL end date, the percent completed since the baseline year for each TMDL was determined with an assumption that progress will continue at that percent reduction per year. To achieve these goals, the County will continue to focus primarily on stormwater retrofits, streamside buffer plantings, street sweeping and inlet cleaning, and stream restoration opportunities.

Table 32 lists the current progress through the 2023 permit year, the expected progress from CIP-approved projects through 2029, and the projected end date of full implementation for each TMDL within Carroll County.

Table 32: TMDL Benchmarks for Carroll County Watersheds

Watershed HUC-8	TMDL Pollutant	Current Progress (FY2023)	CIP-Planned Progress (FY2029)	Projected TMDL End Date
Liberty Reservoir	Phosphorus	32%	50%	2049
	Sediment	40%	57%	2045
Prettyboy Reservoir	Phosphorus	50%	50%	2029
Loch Raven Reservoir	Phosphorus	100%	100%	Complete
Upper Monocacy River	Phosphorus	100%	100%	Complete
	Sediment	50%	3%	2047
Lower Monocacy River*	Phosphorus	2%	19%	2065
Double Pipe Creek*	Phosphorus	14%	17%	2066
	Sediment	22%	28%	2061
South Branch Patapsco River	Phosphorus	93%	7%	2029
	Sediment	70%	91%	2032
Chesapeake Bay Land-River Segments				
Watershed Land-River Segment	**TMDL Pollutant**	**Current Progress (FY2023)**	**CIP-Planned Progress (FY2029)**	**Projected TMDL End Date**
Patapsco River Segment (Bay TMDL)	Phosphorus	39%	55%	2046
	Nitrogen	38%	47%	2052
Potomac River Segment (Bay TMDL)	Phosphorus	33%	43%	2056
	Nitrogen	35%	41%	2058
Gunpowder River Segment (Bay TMDL)	Phosphorus	30%	70%	2038
	Nitrogen	24%	63%	2041

*Assumes 2.25% reduction rate/year

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Appendix A: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

Prettyboy Watershed

SWM Facility Impervious Treatment (2014) – Prettyboy Watershed

Project	Project Type	Drainage Area (Ac)	Impervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Whispering Valley	Retrofit	88.3	20.9	RR	2.12	15.3	319.7700	67%	214.1899	1.69	35.3210	78%	27.6635	0.44	9.1960	84%	7.7383
Small Crossings	Retrofit	26.73	9.07	RR	1.86	15.3	138.7710	67%	92.4176	1.69	15.3283	78%	11.9325	0.44	3.9908	84%	3.3342
Small Crossings	Bio-Retention	1.15	0.51	RR	1.00	15.3	7.8030	60%	4.6623	1.69	0.8619	70%	0.6025	0.44	0.2244	75%	0.1681
Total:		**116.18**	**30.48**				**466.3440**		**311.2698**		**51.5112**		**40.1985**		**13.4112**		**11.2407**

SWM Facility Pervious Treatment (2014) – Prettyboy Watershed

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Whispering Valley	Retrofit	88.3	67.4	RR	2.12	10.8	727.9200	67%	487.5789	0.43	28.9820	78%	22.6988	0.07	4.7180	84%	3.9701
Small Crossings	Retrofit	26.73	17.66	RR	1.86	10.8	190.7280	67%	127.0195	0.43	7.5938	78%	5.9115	0.07	1.2362	84%	1.0328
Small Crossings	Bio-Retention	1.15	0.64	RR	1.00	10.8	6.9120	60%	4.1299	0.43	0.2752	70%	0.1924	0.07	0.0448	75%	0.0336
Total:		**116.18**	**85.7**				**925.5600**		**618.7283**		**36.8510**		**28.8027**		**5.9990**		**5.0365**

SWM Facilities Treatment (2020) – Prettyboy Watershed

Project	Project Type	Drainage Area (ac)	Impervious Area (ac)	Pervious Area (ac)	Practice Type	Runoff Depth Treated (in.)	TN Pollutant Load (lbs/yr)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs/yr)	TP Pollutant Load (lbs/yr)	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs/yr)	TSS Pollutant Load (tons/yr)	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (lbs/yr)
North Carroll Library	New Construction	0.68	0.47	0.21	ST	3.00	8.15	40%	1.33	1.03	63%	0.45	2.27	79%	1.77

Forest Buffer Easements (2014) – Prettyboy Watershed

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)
42.58	11.7	498.1860	45%	149.45580	0.68	28.9544	40%	11.5818	0.18	7.6644	55%	4.2154

Grass Buffer Easements (2014) – Prettyboy Watershed

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)
28.5	11.7	333.4500	30%	100.03500	0.68	19.3800	40%	7.7520	0.18	5.1300	55%	2.8215

Stream Buffer Plantings (2014) – Prettyboy Watershed

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	0.53	10.8	5.7240	66	3.7778	0.43	0.2279	77	0.1755	0.07	0.0371	57	0.0211
Planting 3	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 4	0.35	10.8	3.7800	66	2.4948	0.43	0.1505	77	0.1159	0.07	0.0245	57	0.0140
Planting 5	1.95	10.8	21.0600	66	13.8996	0.43	0.8385	77	0.6456	0.07	0.1365	57	0.0778
Charlotte's Quest	0.52	10.8	5.6160	66	3.7066	0.43	0.2236	77	0.1722	0.07	0.0364	57	0.0207
Manchester Streetscapes*	0.41	10.8	4.4280	66	2.9225	0.43	0.1763	77	0.1358	0.07	0.0287	57	0.0164

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 6	2.48	10.8	26.7840	66	17.6774	0.43	1.0664	77	0.8211	0.07	0.1736	57	0.0990
Planting 7	1.77	10.8	19.1160	66	12.6166	0.43	0.7611	77	0.5860	0.07	0.1239	57	0.0706
Planting 8	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
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	0.41	10.8	4.4280	66	2.9225	0.43	0.1763	77	0.1358	0.07	0.0287	57	0.0164
Planting 11	0.5	10.8	5.4000	66	3.5640	0.43	0.2150	77	0.1656	0.07	0.0350	57	0.0200
Planting 12	0.78	10.8	8.4240	66	5.5598	0.43	0.3354	77	0.2583	0.07	0.0546	57	0.0311
Total:	**10.92**		**117.9360**		**77.8378**		**4.6956**		**3.6156**		**0.7644**		**0.4357**

Catch Basin/inlet Cleaning (2020) – Prettyboy Watershed

Location	Tons	Material Removed	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)
Hampstead	10.74	Organic	4.44	47.686	0.48	5.155	400	4296	2.148
Manchester	0.195	Organic	4.44	0.866	0.48	0.094	400	78	0.039
			Total:	**48.5514**		**5.2488**		**4,374**	**2.187**

Street Sweeping (2020) – Prettyboy Watershed

Lane Miles	Frequency	Method	TN Lbs Reduced/lane mile	TN Pollutant Loads Reduced (Lbs)	TP Lbs Reduced/lane mile	TP Pollutant Loads Reduced (Lbs)	TSS Lbs Reduced/lane mile	TSS Pollutant Loads Reduced (Lbs)	TSS Pollutant Loads Reduced (Tons)
5	Spring/Fall 1 pass/1-2 weeks else monthly	Vacuum	0.73	3.65	0.34	1.70	2005	10025	5.01

Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

Loch Raven Watershed

Forest Buffer Easements (2014) – Loch Raven Watershed

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)
0.213	11.7	2.4921	45%	1.1214	0.68	0.1448	40%	0.0579	0.18	0.0383	55%	0.0211

Grass Buffer Easements (2014) – Loch Raven Watershed

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)
2.48	11.7	29.0160	30%	8.70480	0.68	1.6864	40%	0.6746	0.18	0.4464	55%	0.2455

Catch Basin/inlet Cleaning (2020) – Loch Raven Watershed

Location	Tons	Material Removed	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)
Hampstead	14.77	organic	4.44	65.579	0.48	7.090	400	5908	2.954

Street Sweeping (2020) – Loch Raven Watershed

Lane Miles	Frequency	Method	TN Lbs Reduced/lane mile	TN Pollutant Loads Reduced (Lbs)	TP Lbs Reduced/lane mile	TP Pollutant Loads Reduced (Lbs)	TSS Lbs Reduced/lane mile	TSS Pollutant Loads Reduced (Lbs)	TSS Pollutant Loads Reduced (Tons)
11.4	Spring/Fall 1 pass/1-2 weeks else monthly	Vacuum	0.73	8.32	0.34	3.88	2005	22857	11.43

Tree Plantings Upland (2020) – Loch Raven Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Hampstead WWTP (2020)	2.56	11.12	28.4672	1.78	4.5568	2805	7180.8000

Tree Plantings Riparian (2020) – Loch Raven Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	Total Loads (lbs)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	Total Loads (lbs)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	Total Loads (Lbs.)	TSS Pollutant Loads Reduced (Lbs.)
Hampstead WWTP (2020)	3.21	35.6952	114.5816	46.0314	5.7138	18.3413	7.9929	9,004.05	28,903.00	14,159.31

Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

Lower Monocacy Watershed

Stream Buffer Plantings (2014) – Lower Monocacy Watershed

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	0.51	10.8	5.5080	66	3.6353	0.43	0.2193	77	0.1689	0.07	0.0357	57	0.0203
Planting 2	0.58	10.8	6.2640	66	4.1342	0.43	0.2494	77	0.1920	0.07	0.0406	57	0.0231
Planting 3	1.2	10.8	12.9600	66	8.5536	0.43	0.5160	77	0.3973	0.07	0.0840	57	0.0479
Planting 4	5.8	10.8	62.6400	66	41.3424	0.43	2.4940	77	1.9204	0.07	0.4060	57	0.2314
Planting 5	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 6	0.43	10.8	4.6440	66	3.0650	0.43	0.1849	77	0.1424	0.07	0.0301	57	0.0172
Planting 7	0.53	10.8	5.7240	66	3.7778	0.43	0.2279	77	0.1755	0.07	0.0371	57	0.0211
Planting 8	1.44	10.8	15.5520	66	10.2643	0.43	0.6192	77	0.4768	0.07	0.1008	57	0.0575
Planting 9	0.28	10.8	3.0240	66	1.9958	0.43	0.1204	77	0.0927	0.07	0.0196	57	0.0112
Planting 10	0.61	10.8	6.5880	66	4.3481	0.43	0.2623	77	0.2020	0.07	0.0427	57	0.0243
Planting 11	0.18	10.8	1.9440	66	1.2830	0.43	0.0774	77	0.0596	0.07	0.0126	57	0.0072
Planting 12	0.22	10.8	2.3760	66	1.5682	0.43	0.0946	77	0.0728	0.07	0.0154	57	0.0088
Total:	**12.22**		**131.9760**		**87.1042**		**5.2546**		**4.0460**		**0.8554**		**0.4876**

Grass Buffer Easements (2014) – Lower Monocacy Watershed

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)
1.47	11.7	17.1990	30%	5.15970	0.68	0.9996	40%	0.3998	0.18	0.2646	55%	0.1455

Forest Buffer Easements (2014) – Lower Monocacy Watershed

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)
0.19	11.7	2.2230	45%	1.0004	0.68	0.1292	40%	0.0517	0.18	0.0342	55%	0.0188

Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

Upper Monocacy Watershed

Stream Buffer Plantings (2014) – Upper Monocacy Watershed

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	13.19	10.8	142.4520	66	94.0183	0.43	5.6717	77	4.3672	0.07	0.9233	57	0.5263
Planting 2	0.51	10.8	5.5080	66	3.6353	0.43	0.2193	77	0.1689	0.07	0.0357	57	0.0203
Planting 3	0.97	10.8	10.4760	66	6.9142	0.43	0.4171	77	0.3212	0.07	0.0679	57	0.0387
Planting 4	0.85	10.8	9.1800	66	6.0588	0.43	0.3655	77	0.2814	0.07	0.0595	57	0.0339
Planting 5	0.95	10.8	10.2600	66	6.7716	0.43	0.4085	77	0.3145	0.07	0.0665	57	0.0379
Planting 6	7	10.8	75.6000	66	49.8960	0.43	3.0100	77	2.3177	0.07	0.4900	57	0.2793
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	2.18	10.8	23.5440	66	15.5390	0.43	0.9374	77	0.7218	0.07	0.1526	57	0.0870
Planting 9	1.9	10.8	20.5200	66	13.5432	0.43	0.8170	77	0.6291	0.07	0.1330	57	0.0758
Total:	**28.2**		**304.5600**		**201.0096**		**12.1260**		**9.3370**		**1.9740**		**1.1252**

Grass Buffer Easements (2014) – Upper Monocacy Watershed

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)
13.78	11.7	161.2260	30%	48.36780	0.68	9.3704	40%	3.7482	0.18	2.4804	55%	1.3642

Forest Buffer Easements (2014) – Upper Monocacy Watershed

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)
11.82	11.7	138.2940	45%	62.2323	0.68	8.0376	40%	3.2150	0.18	2.1276	55%	1.1702

Stormwater Facility Impervious Treatment (2014) – Upper Monocacy Watershed

Project	Project Type	Drainage Area (Ac)	Impervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Robert's Mill	Retrofit	303.6	88.48	ST	1.15	15.3	1353.7440	36%	489.9540	1.69	149.5312	57%	85.0424	0.44	38.9312	72%	28.1800
Total:		**303.6**	**88.48**				**1353.7440**		**489.9540**		**149.5312**		**85.0424**		**38.9312**		**28.1800**

Stormwater Facility Pervious Treatment (2014) – Upper Monocacy Watershed

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Robert's Mill	Retrofit	303.6	215.12	ST	1.15	10.8	2323.2960	36%	840.8592	0.43	92.5016	57%	52.6081	0.07	15.0584	72%	10.8999
Total:		**303.6**	**215.12**				**2323.2960**		**840.8592**		**92.5016**		**52.6081**		**15.0584**		**10.8999**

Stormwater Facilities Treatment (2020) – Upper Monocacy Watershed

Project	Project Type	Drainage Area (ac)	Impervious Area (ac)	Pervious Area (ac)	Practice Type	Runoff Depth Treated (in.)	TN Pollutant Load (lbs/yr)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs/yr)	TP Pollutant Load (lbs/yr)	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs/yr)	TSS Pollutant Load (tons/yr)	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (lbs/yr)
Trevanion Terrace	Retrofit	171.93	43.00	128.93	ST	1.44	1932.78	38%	730.42	313.37	59%	186.11	418.05	76%	315.98

Street Sweeping (2020) – Upper Monocacy Watershed

Location	Lane Miles	Frequency	Method	TN Lbs Reduced/lane mile	TN Pollutant Loads Reduced (Lbs)	TP Lbs Reduced/lane mile	TP Pollutant Loads Reduced (Lbs)	TSS Lbs Reduced/lane mile	TSS Pollutant Loads Reduced (Lbs)	TSS Pollutant Loads Reduced (Tons)
Taneytown	5.8	1 pass/4weeks	Vacuum	0.36	2.09	0.21	1.22	1203	6977	3.49

Conservation Easements (2020) – Upper Monocacy Watershed

Easement BMP	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Riparian Conservation Landscaping	0.180	0.9432	1.2330	0.0936	0.1575	0.00	0.00
Non-Riparian Conservation Landscaping	1.450	19.4735	7.5980	3.0450	0.7540	5,150.40	0.00
Forest Conservation Buffer	0.260	3.3488	2.7482	0.3692	0.2860	835.12	640.90

Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

Double Pipe Creek Watershed

Stormwater Facility Impervious Treatment (2014) – Double Pipe Creek Watershed

Project	Project Type	Drainage Area (Ac)	Impervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
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
Elmer Wolfe	Facility	9.78	4.26	ST	1.55	15.3	65.1780	38%	24.8862	1.69	7.1994	60%	4.3203	0.44	1.8744	76%	1.4315
Total:		**269.23**	**74.74**				**1143.5220**		**493.7419**		**126.3106**		**80.3404**		**32.8856**		**25.7849**

Stormwater Facility Pervious Treatment (2014) – Double Pipe Creek Watershed

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
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
Elmer Wolfe	Facility	9.78	5.52	ST	1.55	10.8	59.6160	38%	22.7625	0.43	2.3736	60%	1.4244	0.07	0.3864	76%	0.2951
Total:		**269.23**	**194.49**				**2100.4920**		**937.2627**		**83.6307**		**53.7715**		**13.6143**		**10.6752**

Stormwater Facilities Treatment (2020) – Double Pipe Creek Watershed

Project	Project Type	Drainage Area (ac)	Impervious Area (ac)	Pervious Area (ac)	Practice Type	Runoff Depth Treated (in.)	TN Pollutant Load (lbs/yr)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs/yr)	TP Pollutant Load (lbs/yr)	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs/yr)	TSS Pollutant Load (tons/yr)	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (lbs/yr)
Greens of Westminster	Retrofit	38.31	12.56	25.75	RR	2.23	466.99	67%	313.18	72.71	78%	57.00	100.95	84%	85.08
Langdon (Jantz)	New Construction	198.98	91.35	107.63	ST	1.10	2744.04	36%	982.96	402.99	56%	226.84	592.75	72%	424.66
Locust Wetland	New Construction	38.76	11.90	26.86	RR	1.34	462.62	64%	295.19	72.78	75%	54.32	100.02	80%	80.02

Grass Buffer Protection Easements (2014) – Double Pipe Creek Watershed

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)
96.11	11.7	1124.4870	30	337.34610	0.68	65.3548	40	26.1419	0.18	17.2998	55	9.5149

Forest Buffer Protection Easements (2014) – Double Pipe Creek Watershed

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)
48.31	11.7	565.2270	45%	254.3522	0.68	32.8508	40%	13.1403	0.18	8.6958	55%	4.7827

Impervious to Pervious (2014) – Double Pipe Creek Watershed

Location	Acres	Total Loads (lbs)	TN BMP Efficiency (&)	TN Pollutant Loads Reduced (lbs)	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Manchester Skatepark	0.13	1.521	13	0.19773	0.0884	72	0.063648	0.0234	84	0.019656

Conservation Easements (2020) – Double Pipe Creek Watershed

Easement BMP	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Riparian Conservation Landscaping	7.080	6.75	47.79	0.74	5.2392	0.00	0.00
Non-Riparian Conservation Landscaping	10.330	5.24	54.1292	0.53	5.4749	0.00	0.00
Forest Conservation Buffer	23.840	10.57	251.9888	1.1	26.224	2,465.00	58,765.60

Street Sweeping (2020) – Double Pipe Creek Watershed

Location	Lane Miles	Frequency	Method	TN Lbs Reduced/lane mile	TN Pollutant Loads Reduced (Lbs)	TP Lbs Reduced/lane mile	TP Pollutant Loads Reduced (Lbs)	TSS Lbs Reduced/lane mile	TSS Pollutant Loads Reduced (Lbs)	TSS Pollutant Loads Reduced (Tons)
Westminster	26.1	1pass/week	Vacuum	1.09	28.45	0.55	14.36	3209	83755	41.88
	1.4	1pass/4weeks	Vacuum	0.36	2.09	0.21	1.22	1203	6977	3.49
Manchester	2.1	1pass/4weeks	Mechanical	0.00	0.00	0.00	0.00	20	42	0.02
Union Bridge	0.9	1pass/week	Vacuum	1.09	0.98	0.55	0.50	3209	2888	1.44
					31.52		**16.08**			**46.83**

Catch Basin/Inlet Cleaning (2020) – Double Pipe Creek Watershed

Location	Tons	Material Removed	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	0.05	Organic	4.44	0.222	0.48	0.024	400	20	0.010
Union Bridge	0.38	Organic	4.44	1.687	0.48	0.182	400	152	0.076
Westminster	1.1	Organic	4.44	4.884	0.48	0.528	400	440	0.220
			Total:	**6.7932**		**0.7344**		**612**	**0.306**

Stream Restoration (2020) – Double Pipe Creek Watershed

Location	Linear Feet	TN lbs reduced per linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced per linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced per linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Mayberry	5497	1.23	6761.310	0.11	604.670	283.21	1556805.37	778.40
		Total:	**6761.3100**		**604.6700**		**1,556,805**	**778**

Tree Plantings (2014) – Double Pipe Creek Watershed

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

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 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	0.5	10.8	5.4000	66	3.5640	0.43	0.2150	77	0.1656	0.07	0.0350	57	0.0200
Planting 28	2.05	10.8	22.1400	66	14.6124	0.43	0.8815	77	0.6788	0.07	0.1435	57	0.0818

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 29	0.59	10.8	6.3720	66	4.2055	0.43	0.2537	77	0.1953	0.07	0.0413	57	0.0235
Planting 30	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 31	0.17	10.8	1.8360	66	1.2118	0.43	0.0731	77	0.0563	0.07	0.0119	57	0.0068
Planting 32	0.22	10.8	2.3760	66	1.5682	0.43	0.0946	77	0.0728	0.07	0.0154	57	0.0088
Total:	**55.24**		**596.5920**		**393.7507**		**23.7532**		**18.2900**		**3.8668**		**2.2041**

Tree Plantings Upland (2020) – Double Pipe Creek Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Lindsell	0.31	11.12	3.4472	1.78	0.5518	2805	869.5500
Bradford	1.03	11.12	11.4536	1.78	1.8334	2805	2889.1500
Wakefield #1	18.99	11.12	211.1688	1.78	33.8022	2805	53266.9500
Total:	**20.33**		**226.0696**		**36.1874**		**57025.6500**

Tree Plantings Riparian (2020) – Double Pipe Creek Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Lindsell	0.09	14.3	1.2870	2.5	0.2250	4,411	396.99
Bradford	1.59	14.3	22.7370	2.5	3.9750	4,411	7,013.49
Wakefield #1	3.6	14.3	51.4800	2.5	9.0000	4,411	15,879.60
Total:	**5.28**		**75.5040**		**13.2000**		**23290.0800**

Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

South Branch Patapsco Watershed

Tree Plantings (2014) – South Branch Patapsco Watershed

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	4.9	10.8	52.9200	66	34.9272	0.43	2.1070	77	1.6224	0.07	0.3430	57	0.1955
Planting 2	3.45	10.8	37.2600	66	24.5916	0.43	1.4835	77	1.1423	0.07	0.2415	57	0.1377
Planting 3	0.16	10.8	1.7280	66	1.1405	0.43	0.0688	77	0.0530	0.07	0.0112	57	0.0064
Planting 4	3.2	10.8	34.5600	66	22.8096	0.43	1.3760	77	1.0595	0.07	0.2240	57	0.1277
Planting 5	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 6	3	10.8	32.4000	66	21.3840	0.43	1.2900	77	0.9933	0.07	0.2100	57	0.1197
Planting 7	0.23	10.8	2.4840	66	1.6394	0.43	0.0989	77	0.0762	0.07	0.0161	57	0.0092
Planting 8	0.13	10.8	1.4040	66	0.9266	0.43	0.0559	77	0.0430	0.07	0.0091	57	0.0052
Planting 9	0.13	10.8	1.4040	66	0.9266	0.43	0.0559	77	0.0430	0.07	0.0091	57	0.0052
Total:	**15.5**		**167.4000**		**110.4840**		**6.6650**		**5.1321**		**1.0850**		**0.6185**

Tree Plantings Upland (2020) – South Branch Patapsco Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Gillis Falls	12.94	11.12	143.8928	1.78	23.0332	2,805	36,296.70
King Property	0.7	11.12	7.7840	1.78	1.2460	2,805	1,963.50
Shannon Run	0.46	11.12	5.1152	1.78	0.8188	2,805	1,290.30
Total:	**14.1**		**156.7920**		**25.0980**		**39,550.50**

Tree Plantings Riparian (2020) – South Branch Patapsco Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Gillis Falls	10.22	113.6464	1161.4662	146.5548	18.1916	185.9182	25.4478
King Property	1.79	19.9048	35.6296	25.6686	3.1862	5.7033	4.4571
Shannon Run	0.75	8.34	6.2550	10.7550	1.335	1.0013	1.8675
Total:	**12.76**		**1203.3508**	**182.9784**		**192.6227**	**31.7724**

Grass Buffer Protection Easements (2014) – South Branch Patapsco Watershed

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)
82.51	11.7	965.3670	30%	289.61010	0.68	56.1068	40%	22.4427	0.18	14.8518	55%	8.1685

Forest Buffer Protection Easements (2014) – South Branch Patapsco Watershed

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)
97.14	11.7	1136.5380	45%	511.4421	0.68	66.0552	40%	26.4221	0.18	17.4852	55%	9.6169

Conservation Easements (2020) – South Branch Patapsco Watershed

Easement BMP	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Riparian Conservation Landscaping	1.690	6.75	11.4075	0.74	1.2506	0.00	0.00
Non-Riparian Conservation Landscaping	0.150	5.24	0.786	0.53	0.0795	0.00	0.00
Forest Conservation Buffer	6.920	10.57	73.1444	1.1	7.612	2,465.00	17,057.80

Street Sweeping (2020) – South Branch Patapsco Watershed

Location	Lane Miles	Frequency	Method	TN Lbs Reduced/lane mile	TN Pollutant Loads Reduced (Lbs)	TP Lbs Reduced/lane mile	TP Pollutant Loads Reduced (Lbs)	TSS Lbs Reduced/lane mile	TSS Pollutant Loads Reduced (Lbs)	TSS Pollutant Loads Reduced (Tons)
Mount Airy	11.7	1pass/4weeks	Mechanical	0.36	0.00	0.21	0.00	1203	234	0.12

Stream Restoration (2020) – South Branch Patapsco Watershed

Location	Linear Feet	TN lbs reduced/linear feet	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear feet	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear feet	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Woodsyde	1874	0.13	729	0.04	207	66.71	366692	183.3
		Total:	**729**		**207**		**366692**	**183.3**

Stormwater Facility Impervious Treatment (2014) – South Branch Patapsco Watershed

Project	Project Type	Drainage Area (Ac)	Impervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Arthurs Ridge	Retrofit	51.17	5.14	ST	2.13	15.3	78.6420	39%	30.7707	1.69	8.6866	62%	5.3487	0.44	2.2616	78%	1.7715
South Carroll High-Fine Arts	New construction	24.22	12.94	RR	1.00	15.3	197.9820	60%	118.2942	1.69	21.8686	70%	15.2862	0.44	5.6936	75%	4.2651
Brimfield	Retrofit	34.69	9.15	RR	2.50	15.3	139.9950	68%	94.7766	1.69	15.4635	79%	12.1871	0.44	4.0260	85%	3.4180
Harvest Farms 1A	Retrofit	43.8	15.47	ST	2.50	15.3	236.6910	39%	93.0551	1.69	26.1443	62%	16.2087	0.44	6.8068	79%	5.3646
Parrish Park	Retrofit	94.23	18.2	ST	1.00	15.3	278.4600	35%	97.3218	1.69	30.7580	55%	16.8923	0.44	8.0080	70%	5.5976
Clipper Hills Gardenia	Retrofit	33.19	11.08	ST	2.50	15.3	169.5240	39%	66.6484	1.69	18.7252	62%	11.6091	0.44	4.8752	79%	3.8422
Clipper hills Hilltop	Retrofit	80.17	18.54	ST	2.50	15.3	283.6620	39%	111.5217	1.69	31.3326	62%	19.4253	0.44	8.1576	79%	6.4292
Carroltowne 2B	Retrofit	34.61	10.38	ST	2.50	15.3	158.8140	39%	62.4377	1.69	17.5422	62%	10.8757	0.44	4.5672	79%	3.5995
Carroltowne 2A	Retrofit	87.73	34.43	ST	2.49	15.3	526.7790	39%	207.0259	1.69	58.1867	62%	36.0580	0.44	15.1492	79%	11.9343
Benjamins Claim	Retrofit	47.1	15.78	ST	2.21	15.3	241.4340	39%	94.5156	1.69	26.6682	62%	16.4347	0.44	6.9432	78%	5.4426
Eldersburg Estates 3-5	Retrofit	34.91	8.16	ST	2.50	15.3	124.8480	39%	49.0840	1.69	13.7904	62%	8.5497	0.44	3.5904	79%	2.8297
Braddock Manor West	Retrofit	49.3	7.65	ST	2.50	15.3	117.0450	39%	46.0162	1.69	12.9285	62%	8.0153	0.44	3.3660	79%	2.6528
Benjamins Claim Basin B	Retrofit	1.33	0.55	ST	1.04	15.3	8.4150	35%	2.9721	1.69	0.9295	56%	0.5159	0.44	0.2420	71%	0.1709
Hawks Ridge	Retrofit	63.48	19.8	ST	2.07	15.3	302.9400	39%	118.4601	1.69	33.4620	62%	20.5866	0.44	8.7120	78%	6.8188
Merridale Gardens	Retrofit	81	23.81	RR	1.77	15.3	364.2930	66%	241.6521	1.69	40.2389	78%	31.1985	0.44	10.4764	83%	8.7152
Shannon Run	Retrofit	213.5	34.1	ST	2.50	15.3	521.7300	39%	205.1181	1.69	57.6290	62%	35.7284	0.44	15.0040	79%	11.8249
Winfield Fire Dept.	Facility	0.22	0.22	RR	1.14	15.3	3.3660	62%	2.0784	1.69	0.3718	72%	0.2686	0.44	0.0968	77%	0.0749
Benjamins Claim - Jacobs	Retrofit	7.86	2.11	RR	0.97	15.3	32.2830	59%	19.1258	1.69	3.5659	69%	2.4713	0.44	0.9284	74%	0.6895
	Total:	**982.51**	**247.51**				**3,786.90**		**1,660.87**		**418.29**		**267.66**		**108.90**		**85.44**

Stormwater Facility Pervious Treatment (2014) – South Branch Patapsco Watershed

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Arthurs Ridge	Retrofit	51.17	46.03	ST	2.13	10.8	497.1240	39%	194.5127	0.43	19.7929	62%	12.1873	0.07	3.2221	78%	2.5238
South Carroll High-Fine Arts	New construction	24.22	11.28	RR	1.00	10.8	121.8240	60%	72.7898	0.43	4.8504	70%	3.3904	0.07	0.7896	75%	0.5915
Brimfield	Retrofit	34.69	25.54	RR	2.50	10.8	275.8320	68%	186.7383	0.43	10.9822	79%	8.6553	0.07	1.7878	85%	1.5178
Harvest Farms 1A	Retrofit	43.8	28.33	ST	2.50	10.8	305.9640	39%	120.2897	0.43	12.1819	62%	7.5524	0.07	1.9831	79%	1.5629
Parrish Park	Retrofit	94.23	76.03	ST	1.00	10.8	821.1240	35%	286.9828	0.43	32.6929	55%	17.9549	0.07	5.3221	70%	3.7201
Clipper Hills Gardenia	Retrofit	33.19	22.11	ST	2.50	10.8	238.7880	39%	93.8795	0.43	9.5073	62%	5.8943	0.07	1.5477	79%	1.2198
Clipper hills Hilltop	Retrofit	80.17	61.63	ST	2.50	10.8	665.6040	39%	261.6822	0.43	26.5009	62%	16.4298	0.07	4.3141	79%	3.4000
Carroltowne 2B	Retrofit	34.61	24.23	ST	2.50	10.8	261.6840	39%	102.8811	0.43	10.4189	62%	6.4594	0.07	1.6961	79%	1.3367
Carroltowne 2A	Retrofit	87.73	53.3	ST	2.49	10.8	575.6400	39%	226.2284	0.43	22.9190	62%	14.2028	0.07	3.7310	79%	2.9392
Benjamins Claim	Retrofit	47.1	31.32	ST	2.21	10.8	338.2560	39%	132.4190	0.43	13.4676	62%	8.2996	0.07	2.1924	78%	1.7186
Eldersburg Estates 3-5	Retrofit	34.91	26.75	ST	2.50	10.8	288.9000	39%	113.5810	0.43	11.5025	62%	7.1312	0.07	1.8725	79%	1.4758
Braddock Manor West	Retrofit	49.3	41.65	ST	2.50	10.8	449.8200	39%	176.8467	0.43	17.9095	62%	11.1034	0.07	2.9155	79%	2.2978
Benjamins Claim Basin B	Retrofit	1.33	0.78	ST	1.04	10.8	8.4240	35%	2.9753	0.43	0.3354	56%	0.1861	0.07	0.0546	71%	0.0386
Hawks Ridge	Retrofit	63.48	43.68	ST	2.07	10.8	471.7440	39%	184.4683	0.43	18.7824	62%	11.5554	0.07	3.0576	78%	2.3932
Merridale Gardens	Retrofit	81	57.19	RR	1.77	10.8	617.6520	66%	409.7167	0.43	24.5917	78%	19.0667	0.07	4.0033	83%	3.3303
Shannon Run	Retrofit	213.5	179.4	ST	2.50	10.8	1937.5200	39%	761.7360	0.43	77.1420	62%	47.8259	0.07	12.5580	79%	9.8972
Winfield Fire Dept.	Facility	0.22	0	RR	1.14	10.8	0.0000	62%	0.0000	0.43	0.0000	72%	0.0000	0.07	0.0000	77%	0.0000
Benjamins Claim - Jacobs	Retrofit	7.86	5.75	RR	0.97	10.8	62.1000	59%	36.7907	0.43	2.4725	69%	1.7135	0.07	0.4025	74%	0.2989
	Total:	**982.51**	**735.00**				**7,938.00**		**3,364.52**		**316.05**		**199.61**		**51.45**		**40.26**

Stormwater Facilities Treatment (2020) – South Branch Patapsco Watershed

Project	Project Type	Drainage Area (ac)	Impervious Area (ac)	Pervious Area (ac)	Practice Type	Runoff Depth Treated (in.)	TN Pollutant Load (lbs/yr)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs/yr)	TP Pollutant Load (lbs/yr)	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs/yr)	TSS Pollutant Load (tons/yr)	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (lbs/yr)
Woodsyde One	Retrofit	63.79	14.02	49.77	RR	3.00	693.48	69%	475.66	114.39	79%	90.59	150.03	86%	128.74
Woodsyde Two	Retrofit	9.28	2.11	7.17	RR	0.73	88.67	54%	41.57	13.29	63%	7.06	16.35	67%	9.14
Patapsco Valley Overlook	Retrofit	13.61	4.13	9.48	RR	3.00	118.64	69%	67.79	20.97	79%	15.67	33.71	86%	28.74

Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

Liberty Watershed

Stream Buffer Plantings (2014) – Liberty Watershed

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	0.14	10.8	1.5120	66	0.9979	0.43	0.0602	77	0.0464	0.07	0.0098	57	0.0056
Planting 2	1.43	10.8	15.4440	66	10.1930	0.43	0.6149	77	0.4735	0.07	0.1001	57	0.0571
Planting 3	1.19	10.8	12.8520	66	8.4823	0.43	0.5117	77	0.3940	0.07	0.0833	57	0.0475
Planting 4	0.6	10.8	6.4800	66	4.2768	0.43	0.2580	77	0.1987	0.07	0.0420	57	0.0239
Planting 5	0.32	10.8	3.4560	66	2.2810	0.43	0.1376	77	0.1060	0.07	0.0224	57	0.0128
Planting 6	0.31	10.8	3.3480	66	2.2097	0.43	0.1333	77	0.1026	0.07	0.0217	57	0.0124
Planting 7	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 8	0.16	10.8	1.7280	66	1.1405	0.43	0.0688	77	0.0530	0.07	0.0112	57	0.0064
Planting 9	1.02	10.8	11.0160	66	7.2706	0.43	0.4386	77	0.3377	0.07	0.0714	57	0.0407
Planting 10	0.84	10.8	9.0720	66	5.9875	0.43	0.3612	77	0.2781	0.07	0.0588	57	0.0335
Planting 11	3.18	10.8	34.3440	66	22.6670	0.43	1.3674	77	1.0529	0.07	0.2226	57	0.1269
Planting 12	2.92	10.8	31.5360	66	20.8138	0.43	1.2556	77	0.9668	0.07	0.2044	57	0.1165
Planting 13	1.15	10.8	12.4200	66	8.1972	0.43	0.4945	77	0.3808	0.07	0.0805	57	0.0459
Planting 14	0.24	10.8	2.5920	66	1.7107	0.43	0.1032	77	0.0795	0.07	0.0168	57	0.0096
Planting 15	0.52	10.8	5.6160	66	3.7066	0.43	0.2236	77	0.1722	0.07	0.0364	57	0.0207
Planting 16	1.41	10.8	15.2280	66	10.0505	0.43	0.6063	77	0.4669	0.07	0.0987	57	0.0563

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 17	0.1	10.8	1.0800	66	0.7128	0.43	0.0430	77	0.0331	0.07	0.0070	57	0.0040
Planting 18	4.06	10.8	43.8480	66	28.9397	0.43	1.7458	77	1.3443	0.07	0.2842	57	0.1620
Planting 19	1.22	10.8	13.1760	66	8.6962	0.43	0.5246	77	0.4039	0.07	0.0854	57	0.0487
Planting 20	0.21	10.8	2.2680	66	1.4969	0.43	0.0903	77	0.0695	0.07	0.0147	57	0.0084
Planting 21	0.87	10.8	9.3960	66	6.2014	0.43	0.3741	77	0.2881	0.07	0.0609	57	0.0347
Planting 22	0.1	10.8	1.0800	66	0.7128	0.43	0.0430	77	0.0331	0.07	0.0070	57	0.0040
Planting 23	0.76	10.8	8.2080	66	5.4173	0.43	0.3268	77	0.2516	0.07	0.0532	57	0.0303
Planting 24	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 25	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
Planting 26	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 27	0.16	10.8	1.7280	66	1.1405	0.43	0.0688	77	0.0530	0.07	0.0112	57	0.0064
Planting 28	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 29	0.9	10.8	9.7200	66	6.4152	0.43	0.3870	77	0.2980	0.07	0.0630	57	0.0359
Planting 30	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
Planting 31	0.11	10.8	1.1880	66	0.7841	0.43	0.0473	77	0.0364	0.07	0.0077	57	0.0044
Planting 32	2.07	10.8	22.3560	66	14.7550	0.43	0.8901	77	0.6854	0.07	0.1449	57	0.0826
Planting 33	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
Planting 34	4	10.8	43.2000	66	28.5120	0.43	1.7200	77	1.3244	0.07	0.2800	57	0.1596
Planting 35	1.88	10.8	20.3040	66	13.4006	0.43	0.8084	77	0.6225	0.07	0.1316	57	0.0750
Planting 36	0.54	10.8	5.8320	66	3.8491	0.43	0.2322	77	0.1788	0.07	0.0378	57	0.0215
Total:	**34.79**		**375.7320**		**247.9831**		**14.9597**		**11.5190**		**2.4353**		**1.3881**

Tree Plantings Upland (2020) – Liberty Reservoir Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Cornias	9.11	11.12	101.3032	1.78	16.2158	2,805	25,553.5500
Shugars	0.86	11.12	9.5632	1.78	1.5308	2,805	2,412.3000
Commerce Center	5.1	11.12	56.7120	1.78	9.0780	2,805	14,305.5000
Willow Pond	3.61	11.12	40.1432	1.78	6.4258	2,805	10,126.0500
	18.68		**207.72**		**33.25**		**52,397.40**

Tree Plantings Riparian (2020) – Liberty Reservoir Watershed

Project	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Cornias	5.84	14.3	83.5120	2.5	14.6000	4,411	25,760.24
Shugars	2.14	14.3	30.6020	2.5	5.3500	4,411	9,439.54
Commerce Center	0.85	14.3	12.1550	2.5	2.1250	4,411	3,749.35
Total:	**8.83**		**126.27**		**22.08**		**38949.13**

Stream Restoration (2014) – Liberty Watershed

Location	Linear Feet	TN lbs reduced/linear feet	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear feet	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear feet	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Willow Pond	1304	0.075	751.10	0.068	73.00	44.88	83,000	41.50

Grass Buffer Easements (2014) – Liberty Reservoir Watershed

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)
148.72	11.7	1740.0240	30	522.00720	0.68	101.1296	40	40.4518	0.18	26.7696	55	14.7233

Forest Buffer Easements (2014) – Liberty Reservoir Watershed

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)
268.59	11.7	3142.5030	45	1414.1264	0.68	182.6412	40	73.0565	0.18	48.3462	55	26.5904

Conservation Easements (2020) – Liberty Reservoir Watershed

Easement BMP	Acres	TN Pollutant Load (lbs/acre/yr)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load (lbs/acre/yr)	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (lbs/acre/yr)	TSS Pollutant Loads Reduced (Lbs.)
Riparian Conservation Landscaping	8.990	6.75	60.6825	0.74	6.6526	0.00	0.00
Non-Riparian Conservation Landscaping	10.660	5.24	55.8584	0.53	5.6498	0.00	0.00
Forest Conservation Buffer	14.770	10.57	156.1189	1.1	16.247	2,465.00	36,408.05

Street Sweeping (2020) – Liberty Reservoir Watershed

Location	Lane Miles	Frequency	Method	TN Lbs Reduced/lane mile	TN Pollutant Loads Reduced (Lbs)	TP Lbs Reduced/lane mile	TP Pollutant Loads Reduced (Lbs)	TSS Lbs Reduced/lane mile	TSS Pollutant Loads Reduced (Lbs)	TSS Pollutant Loads Reduced (Tons)
Westminster	11.6	1pass/week	Vacuum	1.09	12.64	0.55	6.38	3209	37224	18.61
	2.9	1pass/4weeks	Vacuum	0.36	1.04	0.21	0.61	1203	3489	1.74
Hampstead	12.7	Spring/Fall 1 pass/1-2 weeks else monthly	Vacuum	0.73	9.27	0.34	4.32	2005	25464	12.73

Catch Basin/Inlet Cleaning (2020) – Liberty Reservoir Watershed

Location	Tons	Material Removed	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	0.00056	Organic	4.44	0.002	0.48	0.000	400	0.224	0.000
Hampstead	7.64	Organic	4.44	33.922	0.48	3.667	400	3056	1.528
Westminster	0	Organic	4.44	0.000	0.48	0.000	400	0	0.000
			Total:	**33.924**		**3.668**		**3,056**	**1.528**

Stormwater Facility Impervious Treatment (2014) – Liberty Reservoir Watershed

Project	Project Type	Drainage Area (Ac)	Impervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Hickory Ridge	Retrofit	23.75	4.8	ST	2.50	15.3	73.4400	39%	28.8729	1.69	8.1120	62%	5.0292	0.44	2.1120	79%	1.66
Bateman SW Pond	Facility	47.25	4.52	RR	2.50	15.3	69.1560	68%	46.8186	1.69	7.6388	79%	6.0203	0.44	1.9888	85%	1.69
Marriot Wood 1 Facility #2	Retrofit	7.12	2.04	ST	2.50	15.3	31.2120	39%	12.2710	1.69	3.4476	62%	2.1374	0.44	0.8976	79%	0.71
Marriot Wood II	Retrofit	7.51	1.38	ST	2.50	15.3	21.1140	39%	8.3010	1.69	2.3322	62%	1.4459	0.44	0.6072	79%	0.48
Elderwood Village	Retrofit	7.64	2.47	ST	2.50	15.3	37.7910	39%	14.8575	1.69	4.1743	62%	2.5879	0.44	1.0868	79%	0.86
Westminster Airport Pond	Retrofit	204.84	85	ST	1.40	15.3	1300.5000	38%	489.0375	1.69	143.6500	59%	84.8894	0.44	37.4000	75%	28.13

Project	Project Type	Drainage Area (Ac)	Impervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Oklahoma II Foothills	Retrofit	23.72	6.06	ST	2.35	15.3	92.7180	39%	36.3301	1.69	10.2414	62%	6.3218	0.44	2.6664	78%	2.09
Oklahoma Phase I	Retrofit	24.44	7.27	ST	2.50	15.3	111.2310	39%	43.7305	1.69	12.2863	62%	7.6172	0.44	3.1988	79%	2.52
Edgewood	Retrofit	38	12.12	ST	2.50	15.3	185.4360	39%	72.9042	1.69	20.4828	62%	12.6988	0.44	5.3328	79%	4.20
Upper Patapsco Phase 1	Facility	24.6	10.1	ST	2.50	15.3	154.5300	39%	60.7535	1.69	17.0690	62%	10.5823	0.44	4.4440	79%	3.50
Upper Patapsco Phase 2	Facility	101.8	2.98	ST	2.50	15.3	45.5940	39%	17.9253	1.69	5.0362	62%	3.1223	0.44	1.3112	79%	1.03
Quail Meadowns	Retrofit	111.97	23.25	ST	1.00	15.3	355.7250	35%	124.3259	1.69	39.2925	55%	21.5794	0.44	10.2300	70%	7.15
Heritage Heights	Retrofit	21.38	4.1	ST	1.00	15.3	62.7300	35%	21.9241	1.69	6.9290	55%	3.8054	0.44	1.8040	70%	1.26
Westminster High School	Retrofit	117.25	32.59	ST	2.50	15.3	498.6270	39%	196.0352	1.69	55.0771	62%	34.1463	0.44	14.3396	79%	11.30
Westminster Comm. Pond	Facility	250.22	63.89	ST	2.50	15.3	977.5170	39%	384.3108	1.69	107.9741	62%	66.9409	0.44	28.1116	79%	22.16
Diamond Hills Section 5	Retrofit	51.8	12.94	ST	2.03	15.3	197.9820	39%	77.3732	1.69	21.8686	61%	13.4445	0.44	5.6936	78%	4.45
Wilda Drive	Facility	6.75	1.6	ST	1.07	15.3	24.4800	36%	8.7093	1.69	2.7040	56%	1.5117	0.44	0.7040	71%	0.50
Collins Estates	Retrofit	16.34	3.18	ST	1.87	15.3	48.6540	39%	18.9371	1.69	5.3742	61%	3.2891	0.44	1.3992	78%	1.09
High Point	Retrofit	4.7	0.91	RR	1.00	15.3	13.9230	60%	8.3190	1.69	1.5379	70%	1.0750	0.44	0.4004	75%	0.30
Finksburg Industrial Park	Retrofit	67.8	22.12	ST	1.04	15.3	338.4360	35%	119.5339	1.69	37.3828	56%	20.7477	0.44	9.7328	71%	6.88
Elderwood/ Village #2	Retrofit	144	61	ST	1.01	15.3	933.3000	35%	327.0777	1.69	103.0900	55%	56.7714	0.44	26.8400	70%	18.81
Oklahoma 4	Retrofit	56.93	14.52	RR	2.50	15.3	222.1560	68%	150.3996	1.69	24.5388	79%	19.3395	0.44	6.3888	85%	5.42
Miller/Watts	Retrofit	39.65	25.63	ST	2.50	15.3	392.1390	39%	154.1694	1.69	43.3147	62%	26.8539	0.44	11.2772	79%	8.89
Central MD (Wet)	Retrofit	92.72	25.83	ST	2.50	15.3	395.1990	39%	155.3725	1.69	43.6527	62%	27.0634	0.44	11.3652	79%	8.96
Randomhouse	Retrofit	41.8	16.38	ST	2.50	16.3	266.9940	39%	104.9687	2.69	44.0622	62%	27.3173	1.44	23.5872	79%	18.59
Central MD (Dry)	Retrofit	61.89	29.19	RR	2.50	15.3	446.6070	68%	302.3529	1.69	49.3311	79%	38.8788	0.44	12.8436	85%	10.90
Eldersburg Business Center	Retrofit	97.98	52.7	ST	2.34	15.3	806.3100	39%	315.9077	1.69	89.0630	62%	54.9680	0.44	23.1880	78%	18.20
Feeser Property	Facility	4.38	1.72	RR	1.00	15.3	26.3160	60%	15.7238	1.69	2.9068	70%	2.0319	0.44	0.7568	75%	0.57
Shiloh Middle	Retrofit	83.83	25.64	RR	1.81	15.3	392.2920	66%	260.7220	1.69	43.3316	78%	33.6614	0.44	11.2816	83%	9.40
Aspen Run	Retrofit	14.4	1.7	RR	1.37	15.3	26.0100	64%	16.6659	1.69	2.8730	75%	2.1529	0.44	0.7480	80%	0.60
	Total:	**1,796.46**	**557.63**				**8,548.12**		**3,594.63**		**958.77**		**598.03**		**261.74**		**202.31**

Stormwater Facility Pervious Treatment (2014) – Liberty Reservoir Watershed

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Hickory Ridge	Retrofit	23.75	18.95	ST	2.50	10.8	204.6600	39%	80.4621	0.43	8.1485	62%	5.0518	0.07	1.3265	79%	1.05
Bateman SW Pond	Facility	47.25	42.73	RR	2.50	10.8	461.4840	68%	312.4247	0.43	18.3739	79%	14.4808	0.07	2.9911	85%	2.54
Marriot Wood 1 Facility #2	Retrofit	7.12	5.08	ST	2.50	10.8	54.8640	39%	21.5698	0.43	2.1844	62%	1.3543	0.07	0.3556	79%	0.28
Marriot Wood II	Retrofit	7.51	6.13	ST	2.50	10.8	66.2040	39%	26.0281	0.43	2.6359	62%	1.6342	0.07	0.4291	79%	0.34
Elderwood Village	Retrofit	7.64	5.17	ST	2.50	10.8	55.8360	39%	21.9519	0.43	2.2231	62%	1.3783	0.07	0.3619	79%	0.29
Westminster Airport Pond	Retrofit	204.84	119.84	ST	1.40	10.8	1294.2720	38%	486.6955	0.43	51.5312	59%	30.4521	0.07	8.3888	75%	6.31
Oklahoma II Foothills	Retrofit	23.72	17.66	ST	2.35	10.8	190.7280	39%	74.7337	0.43	7.5938	62%	4.6875	0.07	1.2362	78%	0.97
Oklahoma Phase I	Retrofit	24.44	17.17	ST	2.50	10.8	185.4360	39%	72.9042	0.43	7.3831	62%	4.5773	0.07	1.2019	79%	0.95
Edgewood	Retrofit	38	25.88	ST	2.50	10.8	279.5040	39%	109.8870	0.43	11.1284	62%	6.8993	0.07	1.8116	79%	1.43
Upper Patapsco Phase 1	Facility	24.6	14.5	ST	2.50	10.8	156.6000	39%	61.5673	0.43	6.2350	62%	3.8655	0.07	1.0150	79%	0.80
Upper Patapsco Phase 2	Facility	101.8	98.82	ST	2.50	10.8	1067.2560	39%	419.5917	0.43	42.4926	62%	26.3442	0.07	6.9174	79%	5.45
Quail Meadowns	Retrofit	111.97	88.72	ST	1.00	10.8	958.1760	35%	334.8825	0.43	38.1496	55%	20.9518	0.07	6.2104	70%	4.34
Heritage Heights	Retrofit	21.38	17.28	ST	1.00	10.8	186.6240	35%	65.2251	0.43	7.4304	55%	4.0808	0.07	1.2096	70%	0.85
Westminster High School	Retrofit	117.25	84.66	ST	2.50	10.8	914.3280	39%	359.4681	0.43	36.4038	62%	22.5693	0.07	5.9262	79%	4.67
Westminster Comm. Pond	Facility	250.22	186.33	ST	2.50	10.8	2012.3640	39%	791.1609	0.43	80.1219	62%	49.6733	0.07	13.0431	79%	10.28
Diamond Hills Section 5	Retrofit	51.8	38.86	ST	2.03	10.8	419.6880	39%	164.0180	0.43	16.7098	61%	10.2730	0.07	2.7202	78%	2.13
Wilda Drive	Facility	6.75	5.15	ST	1.07	10.8	55.6200	36%	19.7880	0.43	2.2145	56%	1.2380	0.07	0.3605	71%	0.26
Collins Estates	Retrofit	16.34	13.16	ST	1.87	10.8	142.1280	39%	55.3190	0.43	5.6588	61%	3.4633	0.07	0.9212	78%	0.72
High Point	Retrofit	4.7	3.79	RR	1.00	10.8	40.9320	60%	24.4569	0.43	1.6297	70%	1.1392	0.07	0.2653	75%	0.20
Finksburg Industrial Park	Retrofit	67.8	45.68	ST	1.04	10.8	493.3440	35%	174.2466	0.43	19.6424	56%	10.9016	0.07	3.1976	71%	2.26
Elderwood/ Village #2	Retrofit	144	83	ST	1.01	10.8	896.4000	35%	314.1460	0.43	35.6900	55%	19.6544	0.07	5.8100	70%	4.07
Oklahoma 4	Retrofit	56.93	42.41	RR	2.50	11.8	500.4380	68%	338.7965	1.43	60.6463	79%	47.7965	1.07	45.3787	85%	38.53
Miller/Watts	Retrofit	39.65	14.02	ST	2.50	10.8	151.4160	39%	59.5292	0.43	6.0286	62%	3.7376	0.07	0.9814	79%	0.77
Central MD (Wet)	Retrofit	92.72	66.89	ST	2.50	10.8	722.4120	39%	284.0163	0.43	28.7627	62%	17.8321	0.07	4.6823	79%	3.69
Randomhouse	Retrofit	41.8	25.42	RR	2.50	10.8	274.5360	39%	107.9338	0.43	10.9306	62%	6.7767	0.07	1.7794	79%	1.40
Central MD (Dry)	Retrofit	61.89	32.7	RR	2.50	10.8	353.1600	68%	239.0893	0.43	14.0610	79%	11.0817	0.07	2.2890	85%	1.94

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	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)
Eldersburg Business Center	Retrofit	97.98	45.28	ST	2.34	10.8	489.0240	39%	191.5969	0.43	19.4704	62%	12.0168	0.07	3.1696	78%	2.49
Feeser Property	Facility	4.38	2.66	RR	1.00	10.8	28.7280	60%	17.1650	0.43	1.1438	70%	0.7995	0.07	0.1862	75%	0.14
Shiloh Middle	Retrofit	83.83	58.19	RR	1.81	10.8	628.4520	66%	417.6768	0.43	25.0217	78%	19.4377	0.07	4.0733	83%	3.40
Aspen Run	Retrofit	14.4	12.7	RR	1.37	10.8	137.1600	64%	87.8854	0.43	5.4610	75%	4.0922	0.07	0.8890	80%	0.71
	Total:	**1,796.46**	**1,238.83**				**13,421.77**		**5,734.22**		**575.11**		**368.24**		**129.13**		**103.23**

Stormwater Facilities Treatment (2020) – Liberty Reservoir Watershed

Project	Project Type	Drainage Area (ac)	Impervious Area (ac)	Pervious Area (ac)	Practice Type	Runoff Depth Treated (in.)	TN Pollutant Load (lbs/yr)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs/yr)	TP Pollutant Load (lbs/yr)	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs/yr)	TSS Pollutant Load (tons/yr)	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (lbs/yr)
Willow Pond	Retrofit	349.61	77.17	272.44	ST	2.50	3804.74	39%	1495.78	627.24	62%	388.85	823.12	79%	648.69
Stone Manor	Retrofit	19.37	5.63	13.74	RR	3.00	227.30	69%	155.91	36.06	79%	28.56	49.15	86%	42.18

Appendix B: GWLF-E Modeling Assumptions

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 8-Digit 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) depending on the TMDL baseline year. 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

NLCD (2001) Classification	Corresponding GWLF-E Classification
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 (https://www.nrcs.usda.gov/resources/data-and-reports/soil-data-viewer) 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 parameter.

BMP Assumptions

The assumptions listed here are intended to align the information available for each BMP (e.g. 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**. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were translated 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)
LD Mixed	15	>5 to <30	0.49	0.10	412.24
MD Mixed	52	>=30 to <70	1.60	0.21	446.90
HD Mixed	87	>=70	1.63	0.22	447.44
LD Residential	15	>5 to <30	0.49	0.10	412.24

Each TMDL has a baseline year, and any BMPs or alternative practices implemented since that baseline year can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from MDE's Wasteload Allocation guidance documents (2014 and 2020).

The load reductions from BMPs calculated based on the loading rates in **Table D-3** represent delivered load reductions. 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. The load weighted average for TN, TP and TSS delivery ratios are shown in **Table D-4.** 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.

Table D-4 GWLF-E Load Weighted Average Delivery Ratios

Watershed	GWLF-E Delivery Ratios		
	TN	TP	TSS
Liberty Reservoir	0.041	0.040	0.130
Prettyboy Reservoir	0.037	0.036	0.094
Loch Raven Reservoir	0.049	0.046	0.160
Double Pipe Creek	0.041	0.040	0.106
Upper Monocacy River	0.042	0.041	0.115
Lower Monocacy River	0.042	0.041	0.093
South Branch Patapsco (Baltimore Harbor)	0.041	0.040	0.130