Liberty Reservoir Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

MDE Approved: May 2020

Forward

This document summarizes proposed and potential restoration strategies to meet local Total Maximum Daily Load (TMDL) requirements associated with the urban wasteload allocation (WLA) for Liberty Watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative Best Management Practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

Table of Contents

Liberty Reservoir Watershed Restoration Plan

Figures

Tables

Appendices

I. Introduction

The Liberty Reservoir Watershed (Figure 1) 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. The Maryland Department of the Environment (MDE) identified Liberty Reservoir on the State's 2010 Integrated Report as impaired by sediments - sedimentation/siltation (1996), nutrients - phosphorus (1996). A Total Maximum Daily Load (TMDL) for phosphorus and sediment was developed and approved in May of 2014.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the Towns of Manchester, Westminster and Hampstead, and the Patapsco Chapter of Trout Unlimited.

A. Purpose and Scope

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

1. Document Organization

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

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the stream corridor assessment (SCA) that was performed by the Bureau of Resource Management and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Carroll County portion of the Liberty Watershed.

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

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

Section V: Restoration Implementation; Describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Liberty Watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

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

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

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

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

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

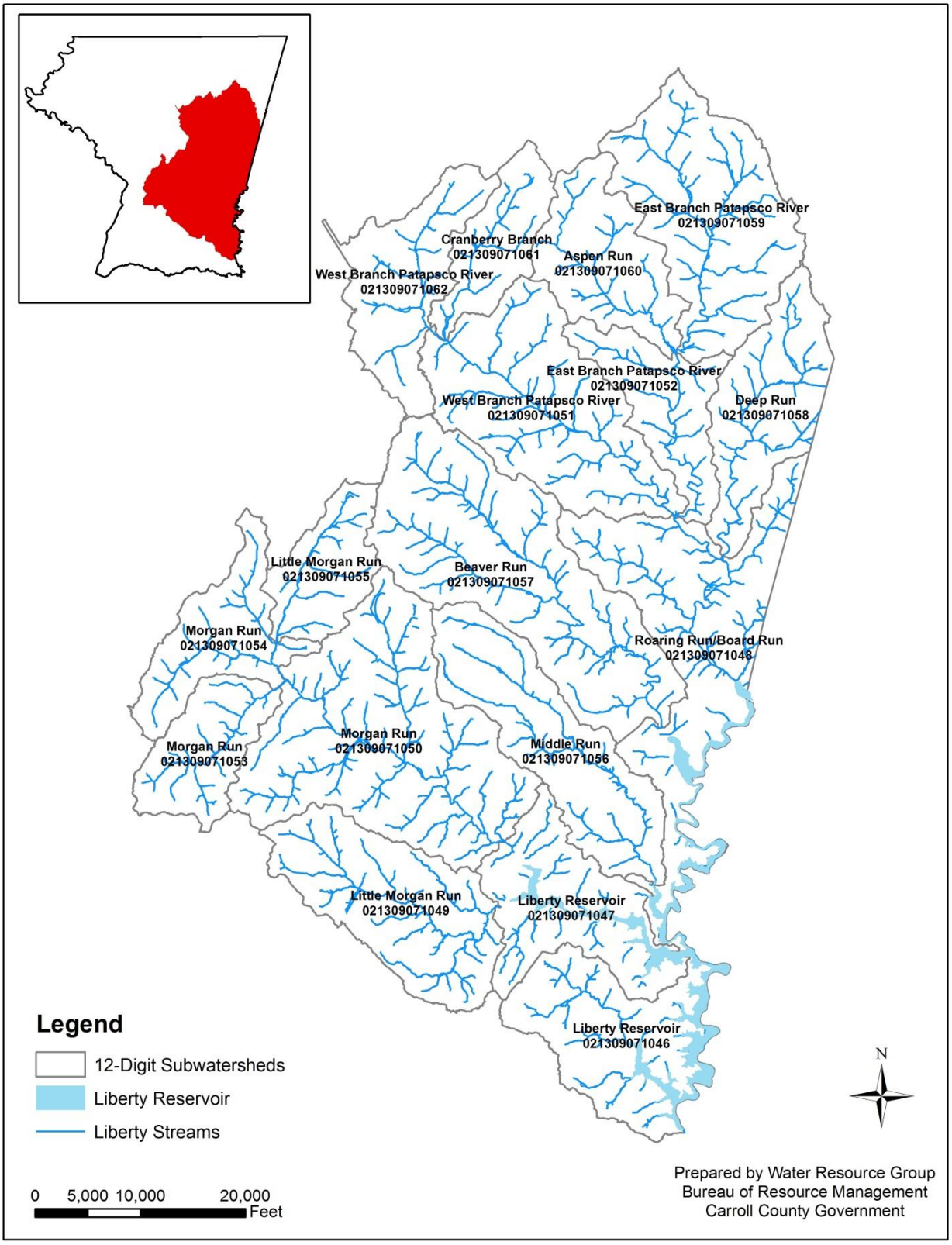


Figure 1: Liberty Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

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

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

1. Use Class Designations and Water Quality Standards

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

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

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

Table 1: Maryland Designated Uses

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

a. Liberty Watershed Water Quality Standards

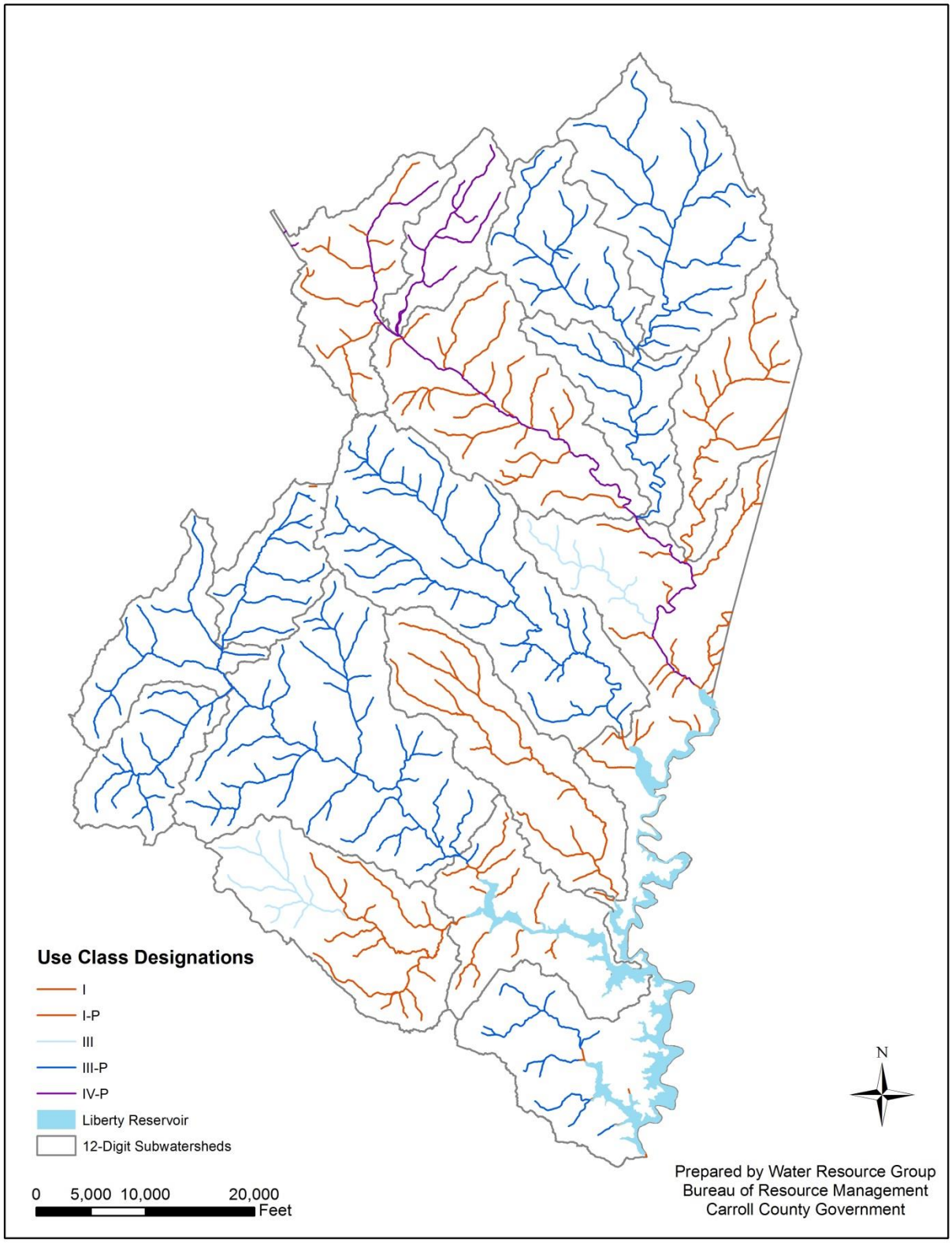
The Liberty Watershed within Carroll County has multiple designated uses throughout the watershed and range from use I; non-tidal warm water to use IV-P; recreational trout waters and public water supply. The use III-P is capable of growing and propagating trout, but may not be capable of supporting adult trout for a put-and-take fishery. The designated use for each stream segment within the Liberty Watershed as determined by MDE can be found in Figure 2.

2. Water Quality Criteria

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

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

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



Source: MDE

Figure 2: Liberty Watershed Designated Uses

3. Total Maximum Daily Loads (TMDLs)

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

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Liberty Reservoir Watershed was determined by (MDE, 2009) to be 86,352 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 9,326 billion MPN/year, which is a reduction of 77,026 billion MPN/year (89.2%) from the current estimated loading.

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

Table 3: Liberty Reservoir 8-digit Watershed Bacteria TMDL

Liberty Reservoir Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	67,250	7,263	89.2%
Hampstead	4,241	458	89.2%
Manchester	2,250	243	89.2%
Westminster	12,611	1,362	89.2%
Total	**86,352**	**9,326**	**89.2%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 13,889 lbs. /yr., the TMDL for the stormwater WLA was determined to be 6,995 lbs. /yr., which is a reduction of 6,934 lbs. /yr. (50%) from the current loading (Table 4). The baseline loads for the County and Towns were derived from the TMDL Data Center. These baseline loads were combined and compared to the combined allocations for the County and Towns to derive the total percent reduction required. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2012).

Table 4: Liberty 8-digit Watershed Phosphorus TMDL

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

The purpose of phosphorus reductions is to reduce high chlorophyll a (Chla) concentrations that reflect excessive algal blooms and to maintain dissolved oxygen (DO) at a level supportive of the designated uses for Liberty Reservoir. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

c. Sediment

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 4,630 tons/yr., the TMDL for the stormwater WLA was determined to be 2,880 tons/yr., which is a reduction of 1,750 tons/yr. (38%) from the current loading (Table 5).

Table 5: Liberty 8-digit Watershed Sediment TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	4,016	2,530	37%
Municipalities	614	350	43%
Total	**4,630**	**2,880**	**38%**

II. Background

A. Location and Subwatershed Map

The Carroll County portion of the Liberty Watershed is located along the Eastern portion of the County. The watershed is within the Patapsco River Basin, which lies within the Piedmont physiographic province of Maryland. There are seventeen (17) major sub-watersheds in the County that cover a total land area of 87,249 acres. Figure 1 depicts the location of the Liberty Watershed and its subwatersheds.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Liberty Watershed, agriculture is the dominant land cover at about 37 percent of the total land, followed by forest which accounts for 31 percent, and residential, which accounts for about 22 percent of the total land cover. Mixed urban accounts for less than 5 percent of the total land cover, which represents the relatively rural nature of the Liberty Watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 Accounting for Stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 8% increase in low-density residential land cover since 2011, which has been incorporated into Table 5.

Table 6 shows the current land cover data for the Liberty Watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the Liberty Watershed can be found in Figure 3.

Table 6: Liberty Watershed Baseline and Current Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	1,097	1%	1,284	1%	1,290	1%	1,289	1%
Low-Density Residential	11,711	13%	11,733	13%	11,904	14%	19,080	22%
Low-Density Mixed Urban	2,684	3%	2,720	3%	2,795	3%	2,795	3%
Medium-Density Mixed Urban	1,067	1%	1,205	1%	1,323	1.5%	1,323	1.5%
High-Density Mixed Urban	284	<1%	371	<1%	412	<1%	412	<1%
Barren Land	246	<1%	228	<1%	201	<1%	197	<1%
Forest	27,748	32%	27,606	32%	27,616	32%	26,804	31%
Shrub/Scrub	1,796	2%	1,774	2%	1,786	2%	1,476	1.7%
Grassland	177	<1%	289	<1%	276	<1%	224	<1%
Pasture/Hay	14,686	17%	14,277	16%	14,195	16%	12,078	14%
Cropland	24,275	28%	24,427	28%	24,116	28%	20,323	23%
Wetland	1,453	2%	1,309	1.5%	1,308	1.5%	1,286	1.5%

Source: National Land Cover Database

1. Impervious Surfaces

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

The Liberty Watershed is estimated to have 5,770 acres of total impervious within the catchment and accounts for approximately 6.6 percent of the total land area. The impervious surface area within Liberty, by subwatershed can be found in Table 7 and is shown in Figure 4.

Table 7: Liberty Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
1060	Aspen Run	3,668	128	3.5
1057	Beaver Run	9,322	752	8.0
1061	Cranberry Branch	2,337	165	7.1
1058	Deep Run	4,154	220	5.3
1052	East Branch Patapsco	2,937	124	4.2
1059	East Branch Patapsco	6,781	468	6.9
1046	Snowden's Run	5,142	564	11.0
1047	Liberty Reservoir	4,509	214	4.7
1049	Little Morgan Run	5,529	395	7.1
1055	Little Morgan Run	2,406	95	3.9
1056	Middle Run	5,472	266	4.9
1053	Morgan Run	2,698	95	3.5
1054	Morgan Run	3,169	103	3.3
1050	Morgan Run	10,153	415	4.1
1048	Roaring Run	8,085	489	6.0
1051	West Branch Patapsco	7,065	442	6.3
1062	West Branch Patapsco	3,822	835	21.8
Liberty Watershed		**87,249**	**5,770**	**6.6**

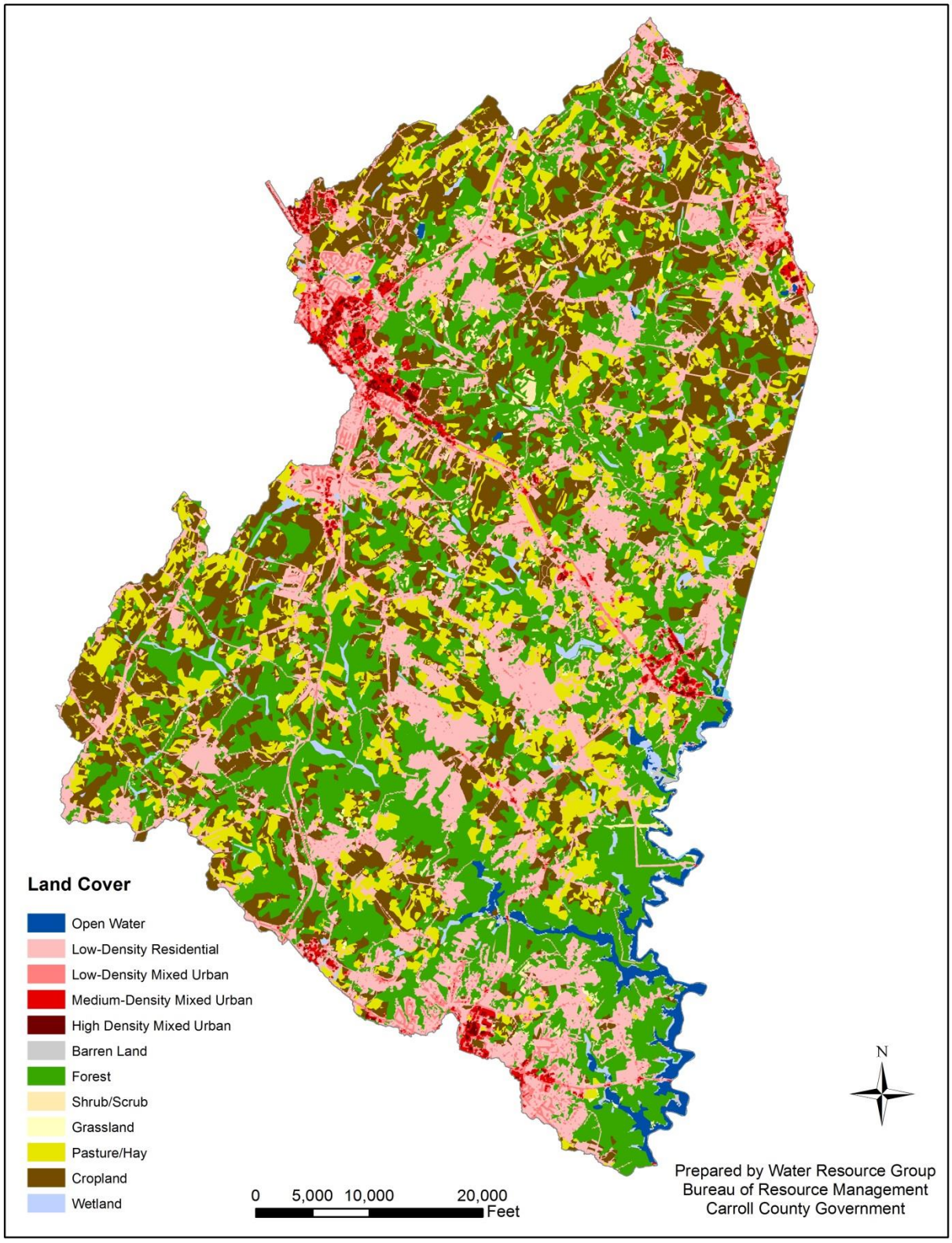


Figure 3: Liberty Watershed Land Use/Land Cover

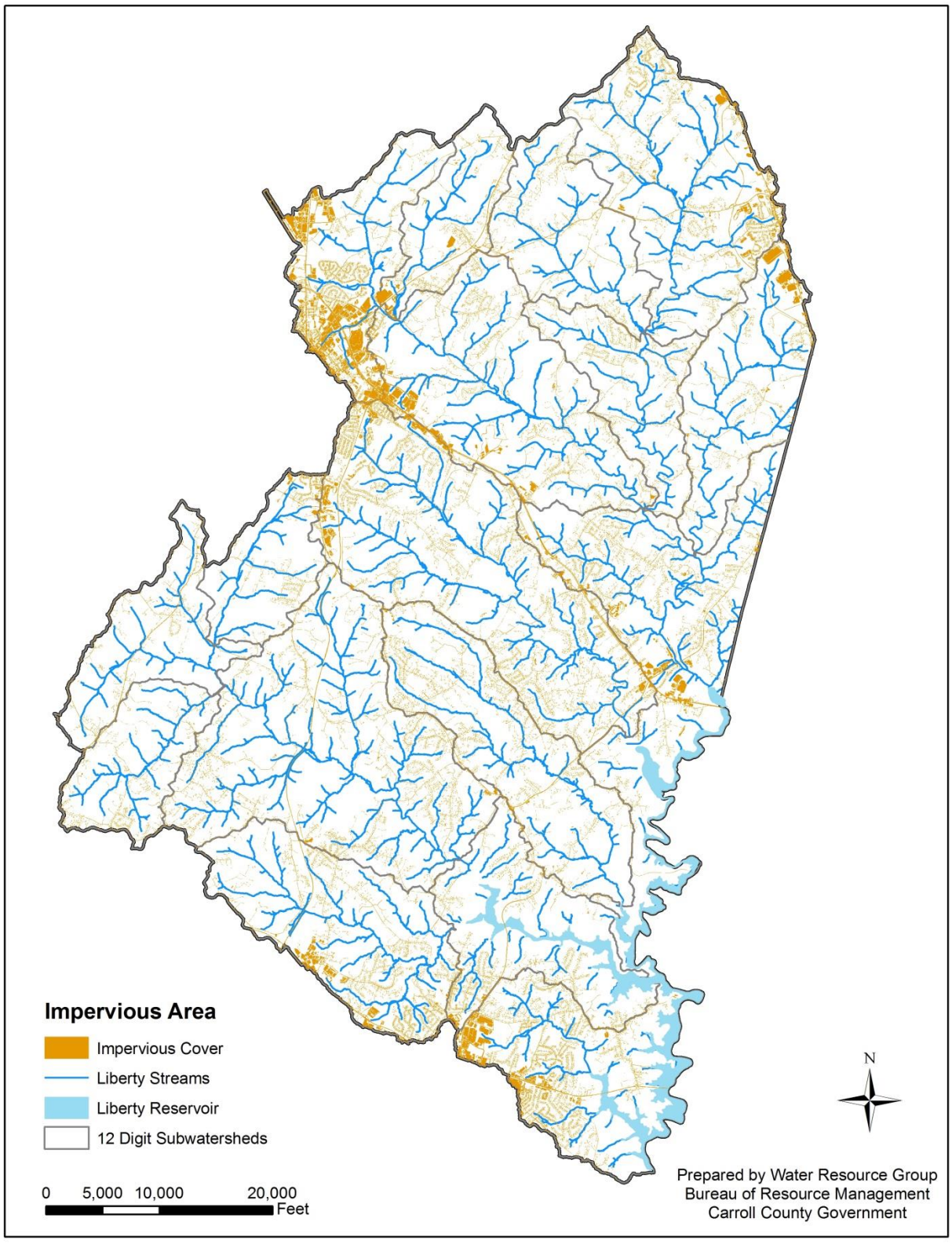


Figure 4: Liberty Watershed Impervious Surface Area

C. Watershed Characterization

Following the Liberty stream corridor assessment (SCA), completed in 2012, a Watershed Characterization for the Liberty Watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Liberty Watershed SCA will be used as the foundation for the watershed restoration plan. The Liberty SCA and characterization documents can be found at:

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

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

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Liberty Watershed, sections of Roaring Run, Beaver Run, Middle Run, Morgan Run, and Little Morgan Run are listed as Tier II waters. Tier II designated stream segments for the Liberty Watershed can be found in Figure 5.

b. Ecologically Sensitive Areas

Targeted Ecological Areas (TEAs) are lands and watersheds of high ecological value that have been identified as conservation priorities by the Maryland Department of Natural Resources (DNR) for natural resource protection. These areas represent the most ecologically valuable areas in the State (imap.maryland.gov). Targeted ecological areas within the Liberty Watershed are shown in Figure 6.

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

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

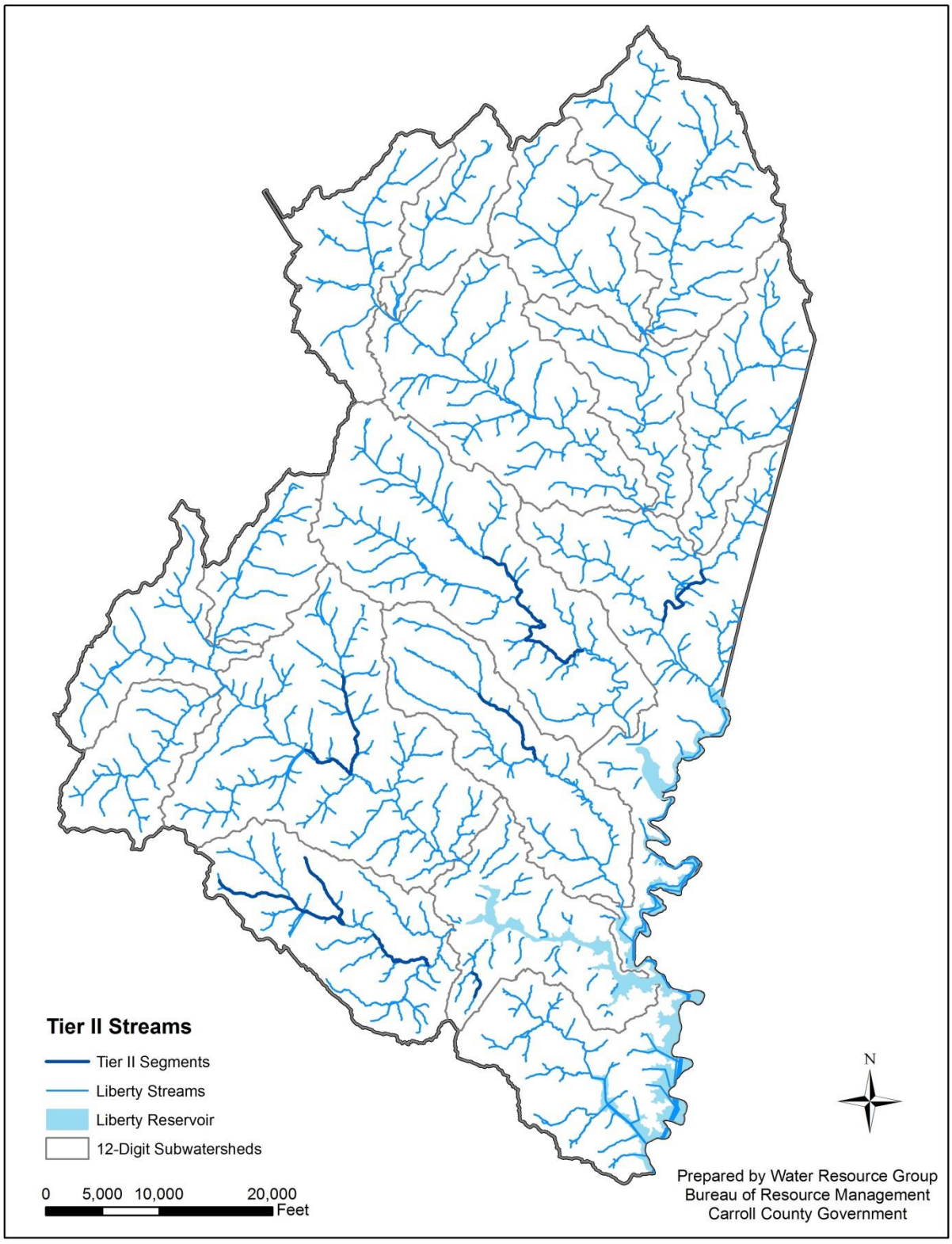


Figure 5: Tier II Waters

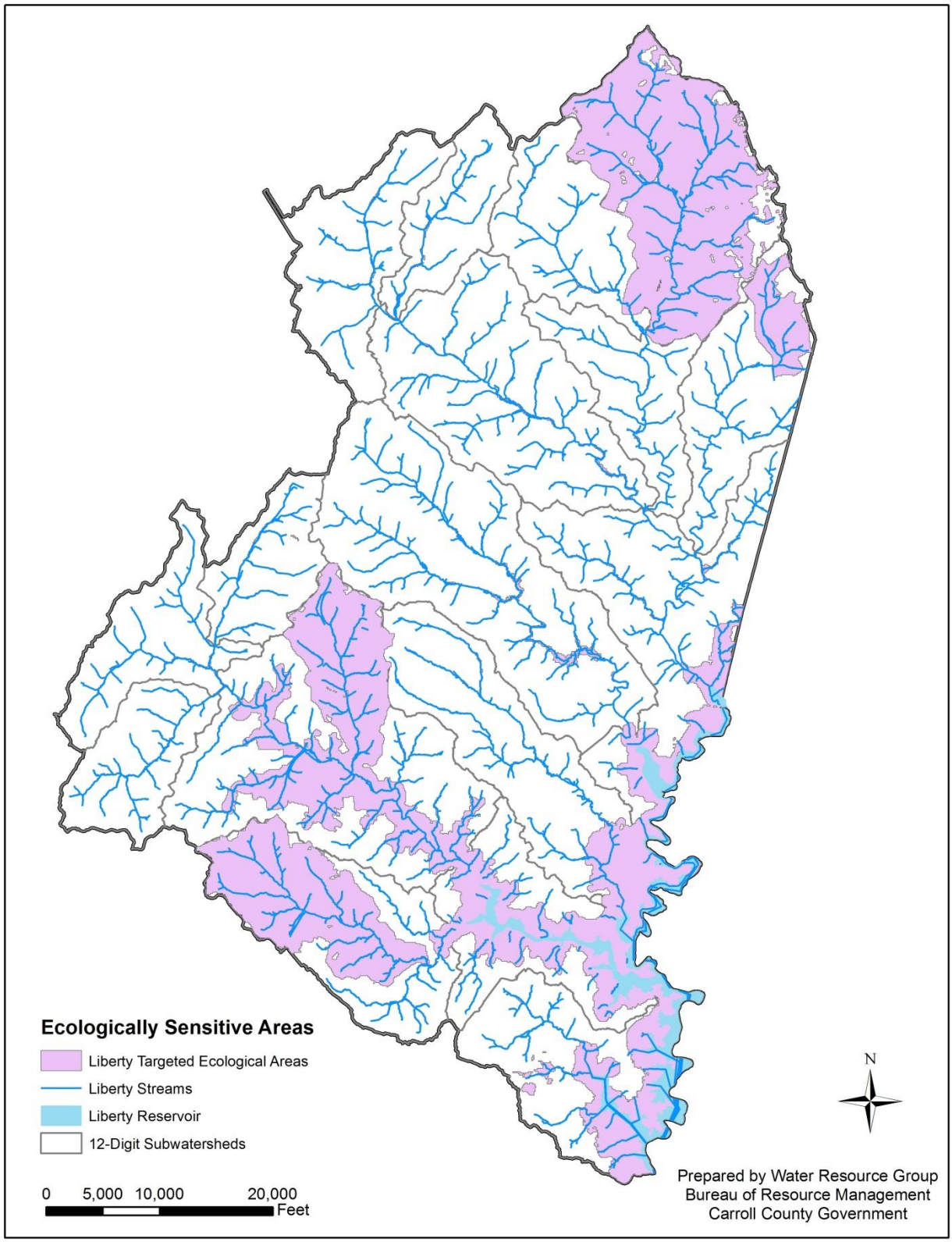


Figure 6: Targeted Ecological Areas

2. Stream Corridor Assessment (SCA)

A Stream Corridor Assessment (SCA) of the Liberty Watershed was conducted during the winter of 2012 by Carroll County Bureau of Resource Management staff. The Liberty SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Liberty SCA is available at:

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

3. Priority Watersheds

During the SCA, field crews identified erosion problems along approximately 81,000 linear feet of the corridor, 4.95% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in Little Morgan Run (1049) and East Branch Patapsco (1059). A significant portion of the drainage within the East Branch Patapsco (1059) sub-watershed originates within the corporate limits of Manchester and Hampstead. The Little Morgan Run watershed has the fourth highest impervious percentage of all the subwatersheds within Liberty and sixty nine percent (69%) of the watershed is located within the Freedom Growth Area Boundary (GAB). Table 8 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear foot of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

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

Table 8: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
Aspen Run (021309071060)	15.37	7.12	1,500	3.99%
Beaver Run (021309071057)	45.23	23.51	7,825	6.30%
Cranberry Branch (021309071061)	10.35	6.43	1,950	5.74%
Deep Run (021309071058)	21.56	13.87	2,060	2.81%
East Branch Patapsco (021309071052)	14.22	6.43	70	0.21%
East Branch Patapsco (021309071059)	33.25	20.60	11,975	11.01%
Snowden's Run (021309071046)	16.74	0.00	0	0.00%
Liberty Reservoir (021309071047)	13.83	11.29	2,570	4.31%
Little Morgan Run (021309071049)	29.50	17.25	10,460	11.48%
Little Morgan Run (021309071055)	11.37	7.23	1,410	3.69%
Middle Run (021309071056)	25.05	0.24	0	0.00%
Morgan Run (021309071053)	13.17	9.10	1,340	2.79%
Morgan Run (021309071054)	14.21	8.26	1,050	2.41%
Morgan Run (021309071050)	56.09	43.42	20,720	9.04%
Roaring Run (021309071048)	34.87	33.72	3,521	1.98%
West Branch Patapsco	36.01	20.09	9,332	8.80%
West Branch Patapsco	13.15	10.35	5,200	9.51%
Total	**403.97**	**238.93**	**80,983**	**4.95%**

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the Liberty Watershed there are 2,965 parcels remaining with potential development on 32,448 acres for an estimated lot yield of 9,975 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 7 shows the remaining parcels in Liberty Watershed where residential units could be built.

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

B. Stormwater Management

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

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

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

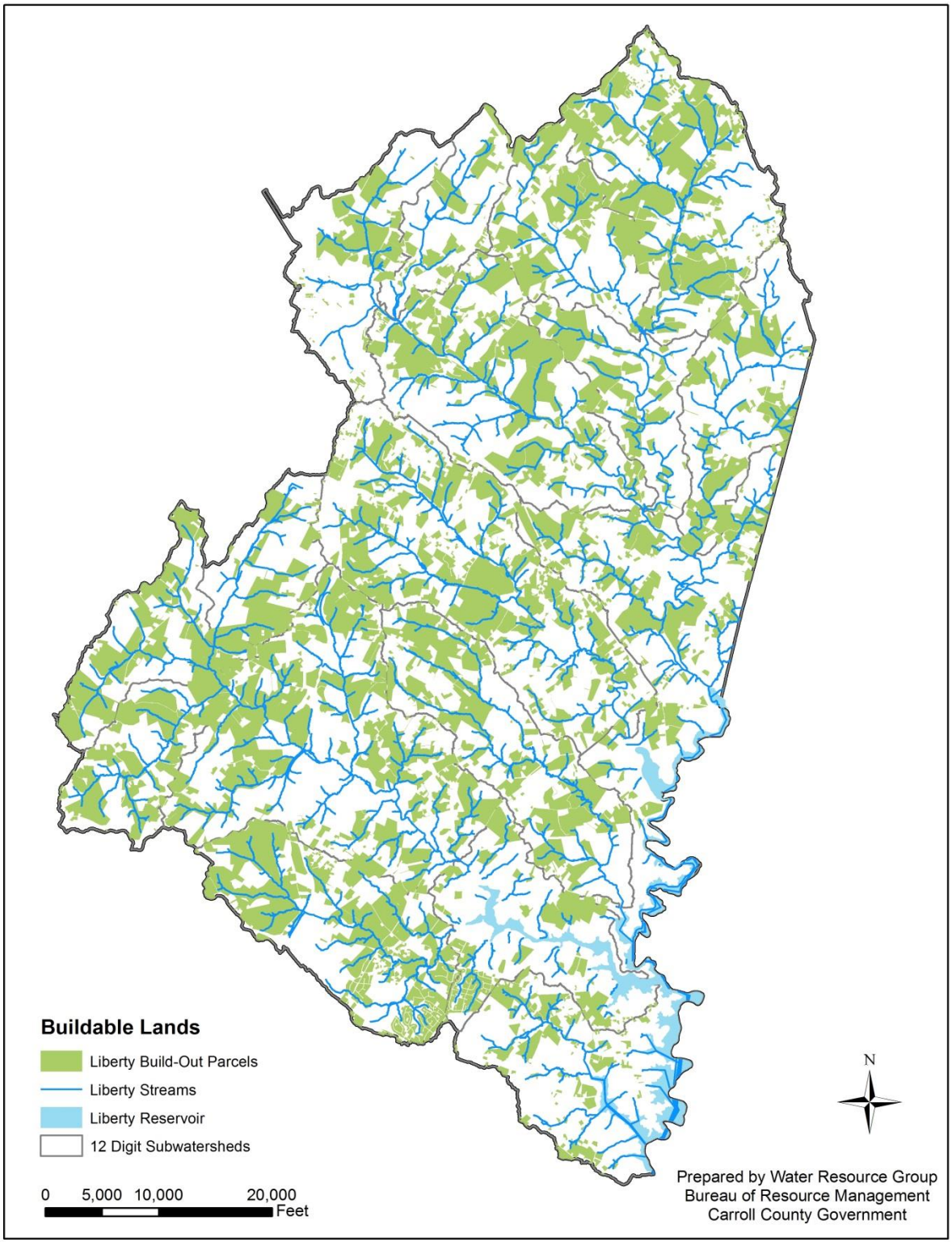


Figure 7: Liberty Watershed Build-Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the Liberty Reservoir Watershed there are 215.47 acres of grass buffer and 273.49 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Liberty Reservoir Watershed can be found in Appendix B, and are shown in Figure 8. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

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

The goals of the rural Legacy Program are to:

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

The Liberty Watershed lies within the Upper Patapsco Rural Legacy area and encompasses 21,541 acres (25%) of the Liberty watershed. The extent of the Rural Legacy Area within Liberty can be found in Figure 9.

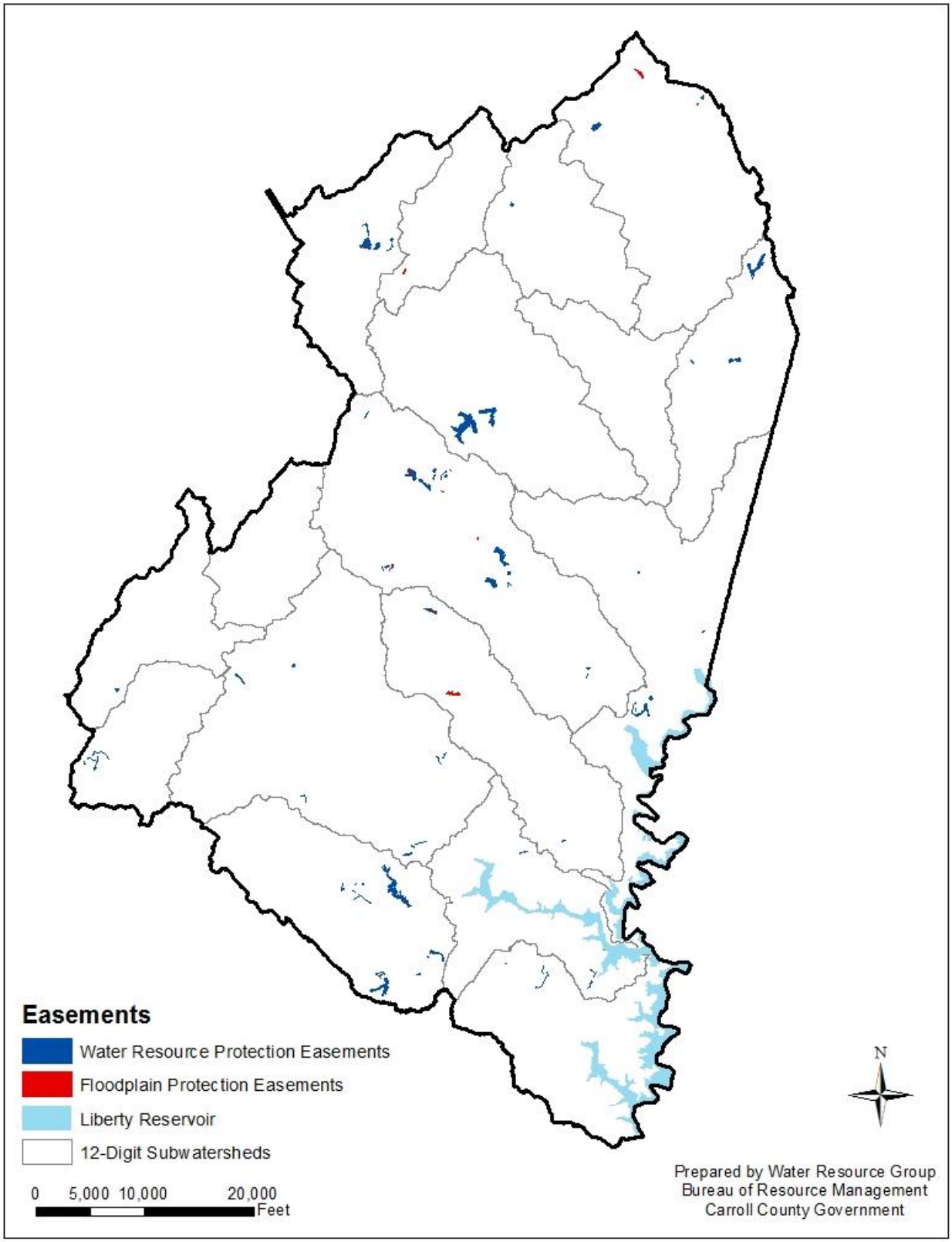


Figure 8: Water Resource and Floodplain Protection Easement Locations

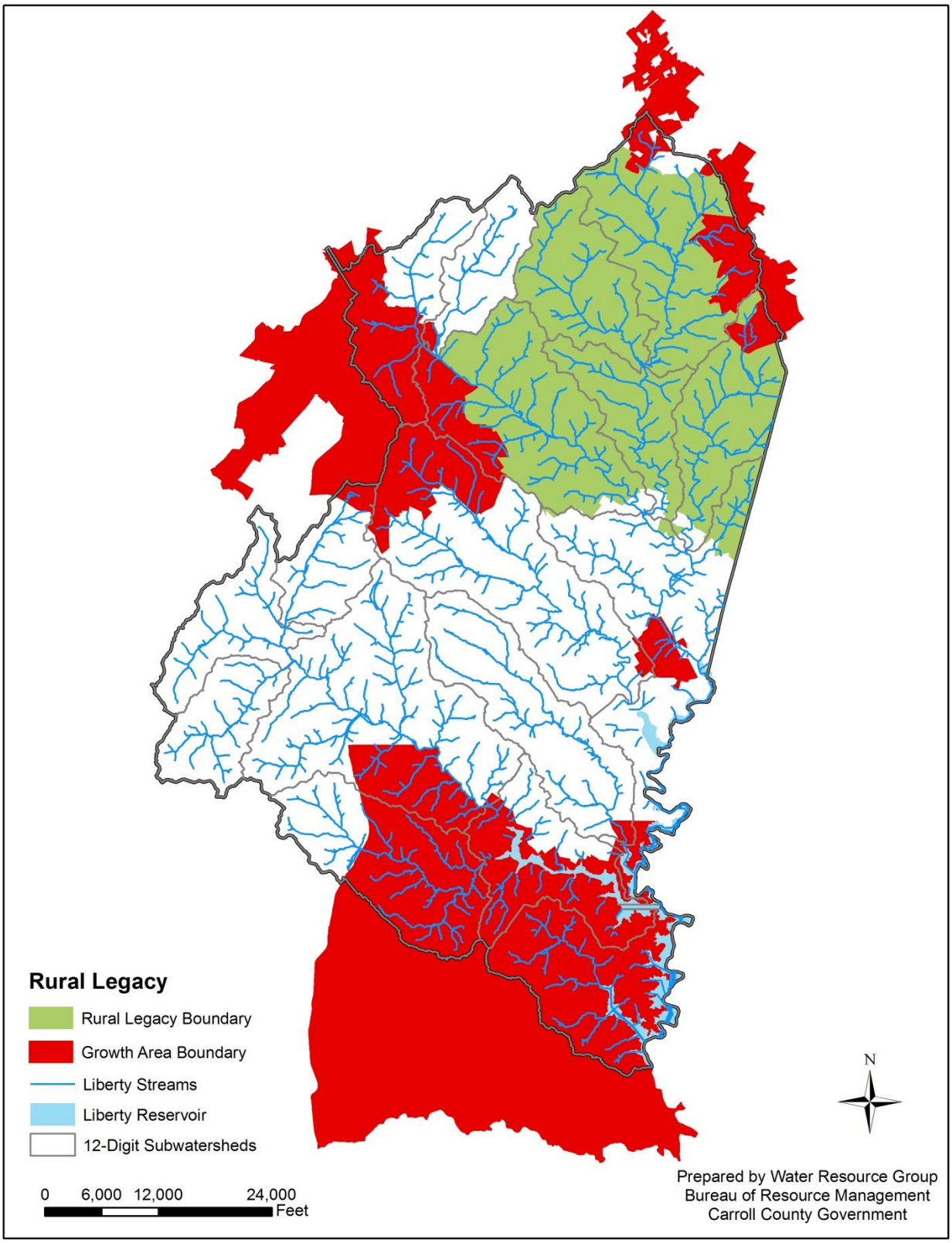


Figure 9: Upper Patapsco Rural Legacy Area

IV. Public Outreach and Education

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

A. Water Resources Coordination Council

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

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

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

1. Carroll County NPDES MS4 Team

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

B. Environmental Advisory Council (EAC)

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

1. Community Outreach

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

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

C. Public Outreach Plan

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

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

D. Educational Venues

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

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

Table 9: MS4 Public Outreach Events

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

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

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

V. Restoration Implementation

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

A. Stormwater Management Facilities

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

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

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

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

The facilities proposed for implementation to assist in addressing the Liberty Watershed TMDL's, that have been either completed or planned, are listed in Table 10. The location of each facility can be found in Figure 10, the practice type and runoff depth treated for each facility can be found in Appendix C.

Table 10: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Implementation Status	Subwatershed
Marriot Wood 1 Facility #1	2.5	0.56	Retrofit	C	1046
Hickory Ridge	23.75	4.8	Retrofit	C	1051
Bateman SW Pond	47.25	4.52	Facility	C	1051
Marriot Wood 1 Facility #2	7.12	2.04	Retrofit	C	1046
Marriot Wood II	7.51	1.38	Retrofit	C	1046
Elderwood Village	7.64	2.47	Retrofit	C	1046
Westminster Airport Pond	204.84	85	Retrofit	C	1062
Oklahoma II Foothills	23.72	6.06	Retrofit	C	1046
Oklahoma Phase I	24.44	7.27	Retrofit	C	1046
Edgewood	38	12.12	Retrofit	C	1049
Upper Patapsco Phse 1	24.6	10.1	Facility	C	1051
Upper Patapsco Phase 2	101.8	2.98	Facility	C	1051
Quail Meadows	111.97	23.25	Retrofit	C	1046
Heritage Heights	21.38	4.1	Retrofit	C	1046
Westminster High School	117.25	32.59	Retrofit	C	1057
Westminster Comm. Pond	250.22	63.89	Facility	C	1062
Diamond Hills Section 5	51.8	12.94	Retrofit	C	1055
Wilda Drive	6.75	1.6	Facility	C	1050
Collins Estates	16.34	3.18	Retrofit	C	1049
High Point	4.7	0.91	Retrofit	C	1046
Randomhouse	41.8	16.38	Retrofit	C	1061
Aspen Run	14.4	1.7	Retrofit	C	1052

Eldersburg Business Center	97.98	52.7	Retrofit	C	1046
Finksburg Industrial Park	67.8	22.12	Retrofit	C	1048
Elderwood village Parcel	144	61	Retrofit	C	1046
Oklahoma 4	56.93	14.52	Retrofit	C	1046
Miller/Watts	39.65	25.63	Retrofit	C	1048
Central MD (Wet)	92.72	25.83	Retrofit	C	1049
Feeser Property	4.38	1.72	Facility	C	1062
Shiloh Middle	83.83	25.64	Retrofit	UC	1059
Willow Pond	601	72.75	Retrofit	UC	1062
Central MD (Dry)	63.35	45	Retrofit	UC	1049
Stone Manor	17.81	3.97	Retrofit	P	1047
Winters St. Pond	79.4	36.01	Retrofit	P	1062
Black and Decker	160.31	50.33	Facility	P	1058
Linton Springs	53.43	25.8	Retrofit	P	1049
W. Branch Trade Center	58.75	19.77	Retrofit	P	1062
Squires	36.8	10	Retrofit	P	1046
Hampstead Regional	350	85	Facility	P	1059
Solo Cup	64	34.44	Retrofit	P	1058
Brynwood	95.5	21.7	Facility	P	1049
Springmount Estaes	60	20	Retrofit	P	1046
Winters Mill High School	58.3	21.8	Retrofit	P	1062
East Middle School Wetland	10.18	10.18	Retrofit	P	1062
Eldersburg Marketplace	54.78	35.16	Retrofit	P	1046
Westminster Marketplace	52.07	40.4	Retrofit	P	1051
Town Mall of Westminster	172.66	65.82	Retrofit	P	1062
Totals:	**3,725.41**	**1,127.13**			

B. Storm Drain Outfalls

During the Liberty Watershed SCA in 2012, erosion sites were documented and rated on severity. SCA identified erosion sites were analyzed in GIS to the location of existing stormwater management facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. Nine elementary schools within the Liberty Watershed have planted ten gardens with a total drainage area of 2.66 acres.

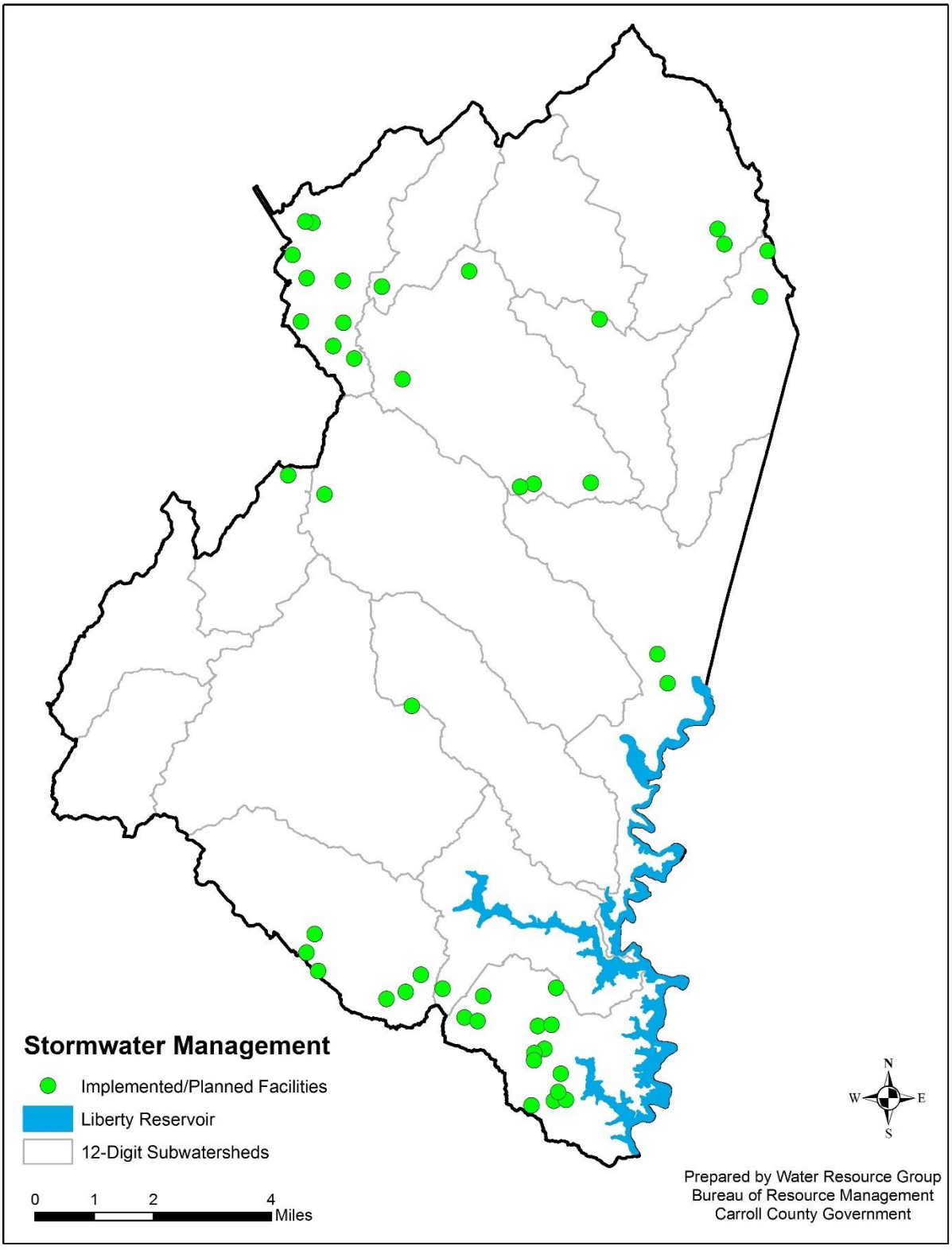


Figure 10: Stormwater Management Locations

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Following the completion of the 2011 SCA in the Prettyboy Watershed, the BRM began a stream buffer initiative. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks.

1. Residential Buffer Plantings

The 2012 Liberty SCA determined that approximately 25 percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to landowners whose properties were identified as having an inadequate buffer. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. Thirteen properties participated in this initiative during the spring and fall of 2014. The acreage planted for each location and the associated subwatershed can be found in Table 11. The approximate locations of the residential buffer plantings are shown in Figure 11.

Table 11: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	12- Digit Subwatershed	Date Planted
Planting 1	0.14	125	45	1050	Spring 2014
Planting 2	1.43	400	210	1059	Spring 2014
Planting 3	1.19	380	100	1053	Spring 2014
Planting 4	0.6	485	50	1050	Spring 2014
Planting 5	0.32	180	80	1057	Spring 2014
Planting 6	0.31	280	40	1048	Spring 2014
Planting 7	0.3	285	40	1049	Spring 2014
Planting 8	0.16	155	45	1054	Spring 2014
Planting 9	1.02	560	60	1061	Spring 2014
Planting 10	0.84	500	80	1062	Fall 2014
Planting 11	3.18	600	200	1062	Fall 2014
Planting 12	2.92	650	150	1059	Fall 2014
Planting 13	1.15	400	115	1059	Fall 2014
Planting 14	0.24	170	60	1049	Fall 2017
Planting 15	0.52	200	65	1051	Fall 2017
Planting 16	1.41	650	55	1048	Spring 2017
Planting 17	0.1	140	10	1049	Fall 2017
Planting 18	4.06	1,000	200	1057	Fall 2017

Planting 19	1.22	400	150	1046	Fall 2017
Planting 20	0.21	360	40	1058	Fall 2017
Planting 21	0.87	250	160	1057	Fall 2017
Planting 22	0.1	90	60	1049	Fall 2017
Planting 23	0.76	460	70	1059	Fall 2017
Planting 24	0.44	250	80	1056	Fall 2017
Planting 25	0.38	250	50	1049	Fall 2017
Planting 26	0.3	250	45	1047	Fall 2017
Planting 27	0.16	180	40	1049	Fall 2017
Planting 28	0.2	140	60	1058	Fall 2017
Planting 29	0.9	700	60	1057	Fall 2017
Planting 30	0.38	360	40	1058	Fall 2017
Planting 31	0.11	150	20	1048	Fall 2017
Planting 32	2.07	950	50	1053	Fall 2018
Planting 33	0.38	150	100	1050	Fall 2018
Planting 34	4	250	400	1050	Fall 2018
Planting 35	1.88	480	125	1057	Fall 2018
Planting 36	0.54	150	80	1048	Fall 2018

a. Monitoring Schedule & Implementation Assurance

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

2. Municipal Plantings

In addition to the implementation of residential stream buffer plantings, the Westminster Rescue Mission, as well as the Town of Manchester and City of Westminster initiated tree planting projects within the Liberty Watershed during 2014.

The Westminster Rescue Mission project consisted of planting 960 trees at a stocking rate of 302 trees per acre to restore a forested buffer along 600 feet of stream that was previously mowed as lawn. The City of Westminster project is immediately adjacent to the Rescue Mission property and consisted of planting 253 trees at the same 302 trees per acre stocking rate. The Manchester project planted over 1,200 trees to establish a forested stream buffer for approximately 1,000 feet within the Manchester Farms subdivision.

The Municipal efforts are included in Table 11 above.

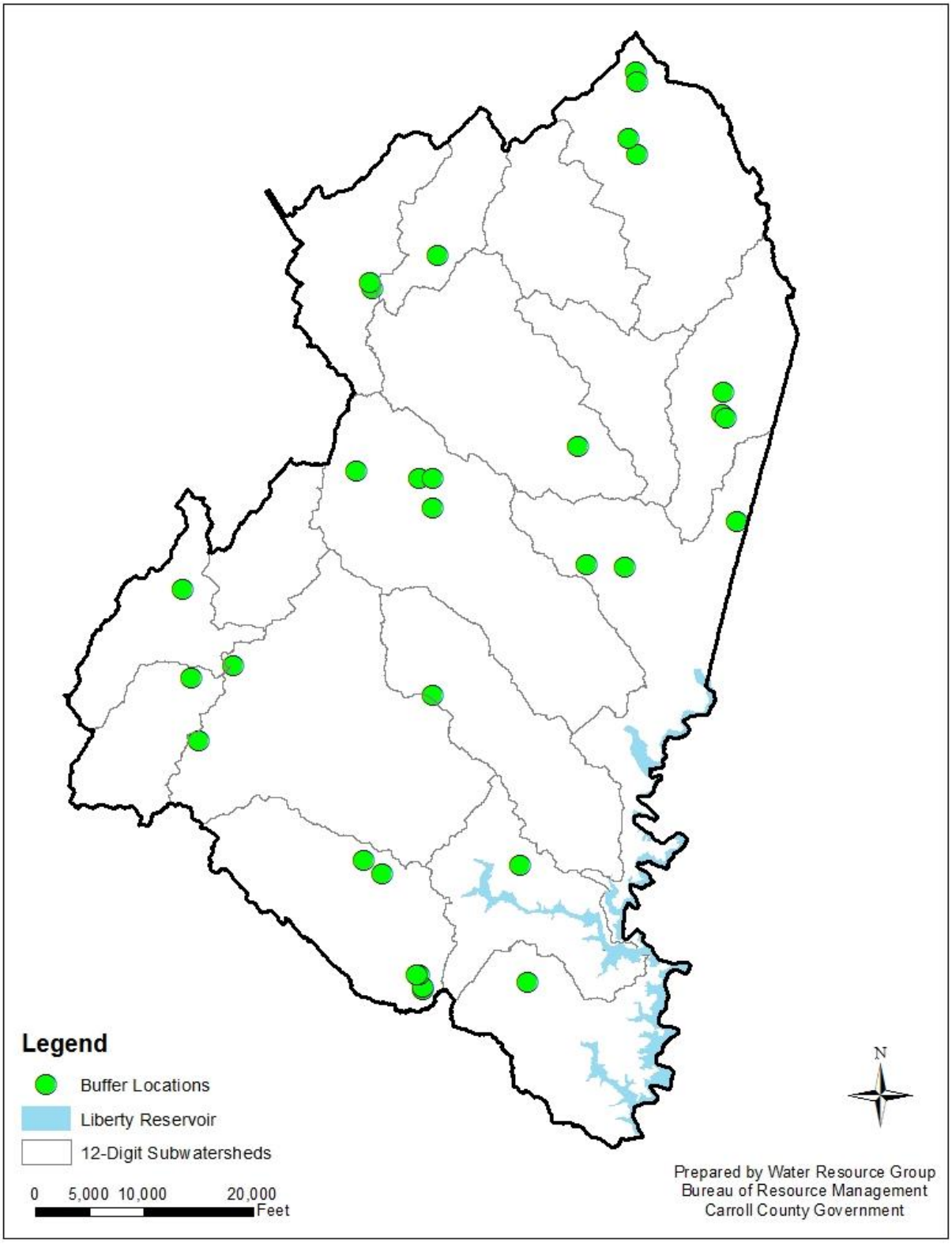


Figure 11: Stream Buffer Initiative Locations

E. Stream Restoration

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

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

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

F. Streambank Regeneration

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

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

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

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

Since the two-year flow is thought to control bank geometry, it makes sense that this would be an unintended benefit of truly adequate stormwater management. How far downstream

the effect extends is site specific and depends on the soil types and land uses in the unmanaged portion of the watershed below the sand filter.

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

Interim nutrient reductions associated with streambank regeneration are included in Appendix C in anticipation of the study results and are derived from the default stream restoration credit included in the 2014 MDE guidance.

G. Road Maintenance Projects

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

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

Table 12: Road Maintenance Projects

Management Practice	**Inlet Cleaning**		
Town	Tons Removed	12-Digit Watershed	Date of Completion
Hampstead	8.64	1058/1059	Annual
Manchester	0.674	1059	Annual
Westminster	0.49	1051/1057/1062	Annual
Management Practice	**Bi-Weekly Mechanical Street Sweeping**		
Town	# Acres Swept	12-Digit Watershed	Date of Completion
Westminster	5.28	1062	Annual

H. Septic Systems

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

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2009, seventy two (72) septic systems within the Liberty Watershed have been repaired and eighty (175) new systems have been built utilizing Best Available Technology (BAT). Seventy (70) of these projects have been via the Bay Restoration Fund. BAT has been proven to be effective at nitrogen removal but has not been shown to reduce Phosphorus. Any reductions to bacteria loading are also unknown at this time. Septic systems that have been built or repaired utilizing BAT within the Liberty Reservoir Watershed are listed in Appendix C.

I. Agricultural Best Management Practices (BMPs)

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

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

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

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

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

A. Data Reporting

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

B. Modeling with Mapshed

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

1. Model Description

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

2. Restoration Progress: December 2019

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

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

The local TMDL suggests an urban P load reduction of 50% and TSS load reduction of 38% from the 2009 baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Liberty Reservoir). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban load reductions from the baseline year. A baseline year of 2011 was used as a proxy for the 2009 baseline year in the TMDL, as land cover data from 2011 was the closest available for that time period. The modeled 2011 baseline scenario did not include any BMPs and therefore represents the land use loads with no treatment provided. Load reductions from BMPs installed after the 2009 TMDL baseline year can be counted toward load reductions necessary to meet the TMDL, even though 2011 was used as the baseline proxy year. For reference, the modeled baseline urban P load using the 2011 land cover was 1,793.45 lbs, which equates to a 50% reduction of 896.72 lbs and the modeled TSS load was 3,415 tons, which equates to a 37% reduction of 1,298 tons (Table 13).

The projects completed as of December, 2019 are providing 305.05 pounds of TP reduction, and 520.08 tons of TSS reduction. The planned projects, would provide another 158.41 lbs of TP reduction and 227.22 tons of sediment reduction (Table 14). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figures 12 and 13. To achieve remaining TMDL requirements, the county will utilize the MapShed tool to assist in selecting a mix of techniques and practice types for locations identified in future Community Investment Program (CIP) budgets to progress towards fully attaining the Liberty TMDL. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, locations, or costs beyond the current CIP.

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

Table 13: Total Phosphorus and Total Suspended Sediment Load Reduction in the Liberty Watershed in Carroll County.

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs)**	**Reduction from Current BMPs (lbs)**	**Reduction from Planned Strategies (lbs)**	**Total % Reduction Achieved**
1,793.45	50%	896.72	305.05	158.41	26%
Total Suspended Sediment Load Reduction					
Modeled Baseline Load (tons)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (tons)**	**Reduction from Current BMPs (tons)**	**Reduction from Planned Strategies (tons)**	**Total % Reduction Achieved**
3,415.0	37%	1,263.6	520.08	227.22	22%

Table 14: Comparison of Total Phosphorus and Total Suspended Sediment Delivered Load Reductions by Restoration Strategies. This table includes both proposed and existing BMPs.

Total Phosphorus Delivered Load Reductions (lbs/yr)					
Status	**Pond Retrofits**	**Buffers**	**Stream Restoration**	**Catch Basin/ Inlet Cleaning**	**Easements**
Completed	263.22	2.60	19.69	0.56	18.97
Planned	150.54		7.87		
Total Suspended Sediment Delivered Load Reductions (tons/yr)					
Completed	457.03	4.09	3.25	0.28	55.43
Planned	225.93		1.30		

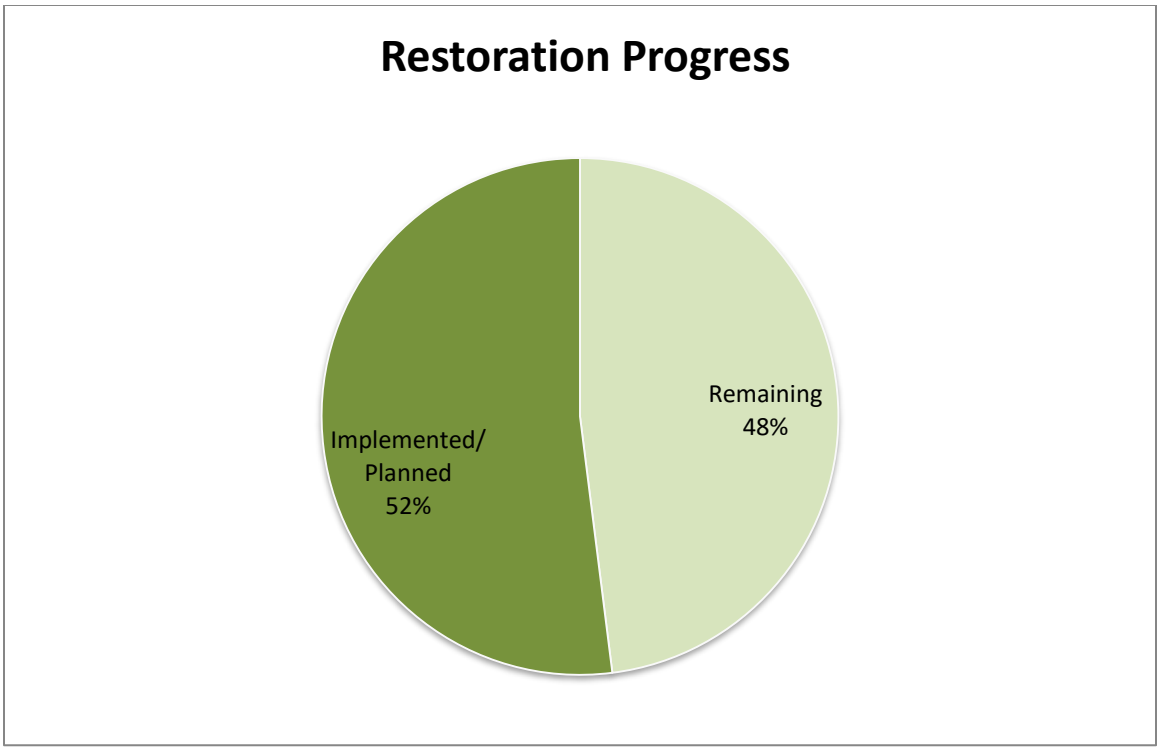


Figure 12: 2019 Restoration Progress-Phosphorus

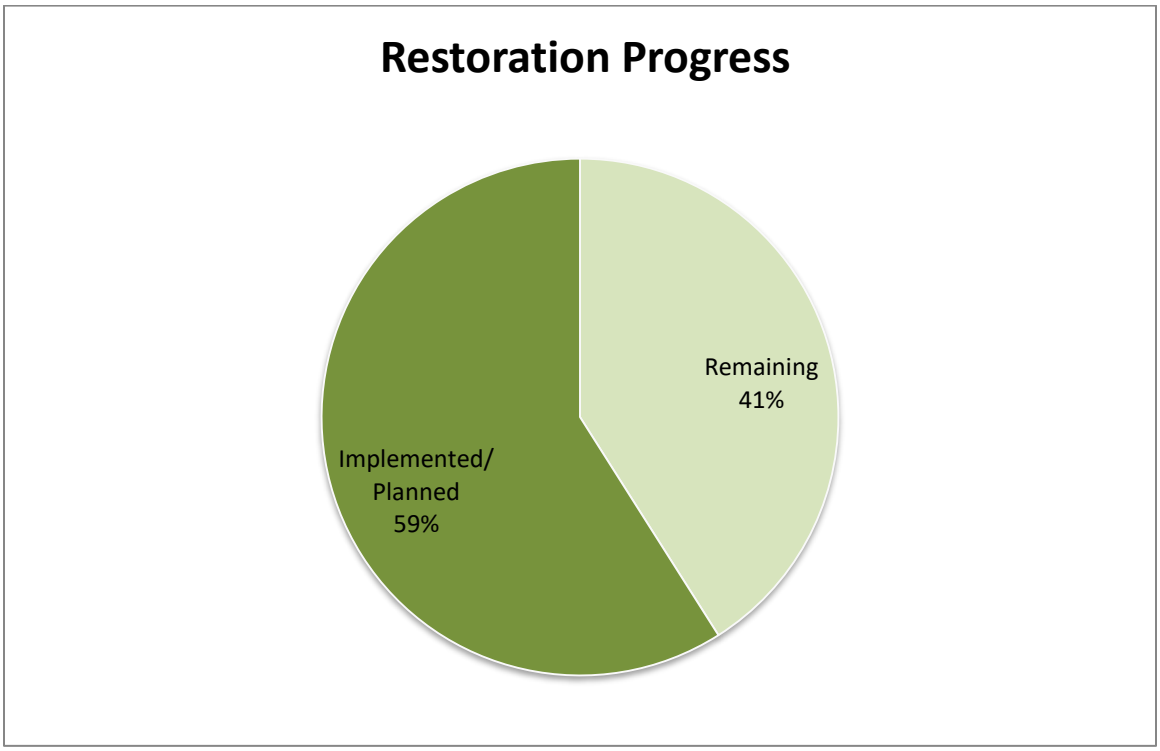


Figure 13: 2019 Restoration Progress-Sediment

3. Bacteria Load Reduction

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

d. Human Source Elimination

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

The Carroll County Bureau of Utilities is in the process of completely updating their Regulations and Standard Specifications and Design Details for water and sewer infrastructure for the first time since 1992.

Changes that shall be implemented with this update include increasing required sewer main encasements at all proposed stream crossings.

This shall include both more comprehensives encasement design requirements as well as an increase in the distance encasement shall be required to be extended beyond the edges of the stream crossing. Additionally, manhole design requirements shall now include factory installed epoxy coatings on new manholes to be installed on proposed or upgraded sewer mains.

Table 15 lists infrastructure related measures that have been implemented since the 2003 baseline year that would assist in reducing bacteria counts within the watershed.

Table 15: Waste Collection Infrastructure Upgrades

	County	Hampstead	Manchester	Westminster
BAT Upgrades	247	0*	0*	0*
Casings/Linings	TBD	TBD	TBD	TBD
Lateral line replacements	TBD	TBD	TBD	TBD
Pump Station upgrade	TBD	TBD	TBD	TBD

***upgrades occurred within corporate boundaries**

e. Domestic Pet Source Elimination

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

f. Stormwater Source Elimination

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

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

C. Water Quality Monitoring

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

1. Retrofit Monitoring

The Bureau of Resource Management currently monitors one location within the Liberty reservoir watershed. The Air Business Center regional stormwater management facility, shown in Figure 14, is used as the County's monitoring location for NPDES reporting, and is located within the West Branch Patapsco river subwatershed.

This stormwater management facility was originally constructed as a wet pond in 1979 and was retrofitted in 2008 as a wet pond with a forebay to provide water quality, recharge volume, and channel protection volume. The drainage area is approximately 562 acres, of which, 128 acres or 23% is impervious.

Chemical monitoring began at the Air Business site in August of 2000 and consists of; eight storm events at each location sampled throughout the year. All sampling is completed with automated equipment so that each limb of the storm; ascending, peak, and descending can be characterized. The chemical monitoring parameters, methods, and detection limits required for calculating event mean concentrations (EMC's) for NPDES reporting are listed in Table 16. Additional monitoring at this location includes geomorphic channel surveys as well as spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 16: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
First Flush Sample		
pH	-	EPA 150.1
Temperature	-	EPA 170.1
Specific Conductance	1.0 µmhos/cm	SM 2510 B-97
Total Petroleum Hydrocarbons	5.0 mg/L	EPA 1664
Escherichia Coli	1.0 organisms/ 100mL	SM 9223 B-94
Limb Samples		
Nitrate/Nitrite Nitrogen	0.05 mg/L	SM 4500NO3-H00
Biological Oxygen Demand	2.0 mg/L	SM 5210 B-01
Total Copper	2.0 µg/L	EPA 200.8
Total Lead	2.0 µg/L	EPA 200.8

Total Zinc	20.0 µg/L	EPA 200.8
Total Kjeldahl Nitrogen	0.5 mg/L	SM 4500NH3 C-97
Total Phosphorus	0.01 mg/L	SM 4500P-P E-99
Total Suspended Solids	3.0 mg/L	SM 2540 D-97

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Liberty Reservoir Watershed began in April of 2019, and is currently performed at one location, shown in Figure 13. Samples are currently collected on the 4th Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 17 shows the monitoring results for the entire year, whereas Table 18 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 17: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
WPU04	Low	7	312
	High	0	n/a
	All	7	312

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

Location	Flow Type	2019	
		# Samples	MPN
WPU04	Low	6	442
	High	0	n/a
	All	6	442

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 19 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 19: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2019	
			# Samples	% Exceeded
WPU04	576	low	**7**	**14%**
		high	n/a	n/a
	410	low	**7**	**71%**
		high	n/a	n/a
	298	low	**7**	**71%**
		high	n/a	n/a
	235	low	**7**	**71%**
		high	n/a	n/a

b. Historic Monitoring

The County performed monthly bacteria trend monitoring in conjunction with Baltimore County in the Liberty reservoir watershed on the first Thursday of each month from 2012-2016. Sampling was performed at 5 selected locations near the reservoir and collection occurred on the first Thursday of each month (Figure 13).

Sample results are reported in MPN/100mL. Table 20 shows the monitoring results for the entire year, whereas Table 21 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means.

Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 20: Historic Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2012		2013		2014		2015		2016	
		# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN
Lib-1	Low	5	97.95	8	39.89	7	39.22	8	77.04	8	105.96
	High	3	206.59	2	2,192.3	4	441.99	4	203.87	4	53.94
	All	8	129.58	10	88.91	11	81.11	12	109.75	12	80.88
Lib-2	Low	5	137.09	8	36.91	7	99.21	8	66.92	8	174.76
	High	3	162.29	2	816.46	4	462.65	4	446.97	4	29.07
	All	8	146.05	10	68.57	11	165.75	12	133.49	12	96.11
Lib-3	Low	5	464.19	8	168.88	7	324.7	8	336.5	8	507.25
	High	3	682.89	2	1,030.75	4	1,371.63	4	901.78	4	471.03
	All	8	536.49	10	242.49	11	500.28	12	481.58	12	492.44
Lib-4	Low	6	138.47	8	24.59	7	115.64	8	82.83	8	132.04
	High	2	171.7	2	365.58	4	390.24	4	404.79	4	193.47
	All	8	146.12	10	42.19	11	166.56	12	147.48	12	153.84
Lib-5	Low	6	220.45	8	35.68	7	155.28	8	132.17	8	326.2
	High	2	379.61	2	1,155.21	4	524.41	4	604.11	4	181.78
	All	8	252.53	10	77.27	11	223.71	12	242.73	12	258.17

Table 21: Historic Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2012		2013		2014		2015		2016	
		# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN
Lib-1	Low	4	164.15	4	104.70	3	86.43	4	133.48	3	136.52
	High	1	108.1	1	1,986.3	1	579.4	0	n/a	1	24.3
	All	5	150.99	5	188.61	4	139.07	4	133.48	4	88.67
Lib-2	Low	4	308.11	4	71.85	3	158.58	4	132.82	3	138.72
	High	1	41.4	1	275.5	1	344.8	0	n/a	1	77.6
	All	5	206.24	5	94.00	4	192.57	4	132.82	4	119.97
Lib-3	Low	4	865.56	4	260.45	3	553.9	4	628.53	4	510.54
	High	1	141.4	1	1,732.9	1	1,553.1	0	n/a	0	n/a
	All	5	602.46	5	380.48	4	716.75	4	628.53	4	510.54
Lib-4	Low	4	171.82	4	83.72	3	172.66	4	194.31	4	151.68
	High	1	74.3	1	410.6	1	387.3	0	n/a	0	n/a
	All	5	145.3	5	115.06	4	211.3	4	194.31	4	151.68
Lib-5	Low	4	356.93	3	215.98	3	381.24	4	239.2	4	330.63
	High	1	156.5	1	770.1	1	613.1	0	n/a	0	n/a
	All	5	302.67	4	296.78	4	429.32	4	239.2	4	330.63

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 22 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 22: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2012		2013		2014		2015		2016	
			# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded
Lib-1	576	low	0	0%	0	0%	0	0%	0	0%	0	0%
		high	0	0%	2	100%	2	66%	1	25%	1	25%
	410	low	0	0%	0	0%	0	0%	0	0%	1	17%
		high	1	33%	2	100%	2	66%	2	50%	1	25%
	298	low	0	0%	0	0%	0	0%	0	0%	2	33%
		high	1	33%	2	100%	2	66%	2	50%	1	25%
	235	low	0	0%	0	0%	0	0%	1	14%	2	33%
		high	1	33%	2	100%	2	66%	2	50%	1	25%

Location	MPN Criteria	Flow Type	2012		2013		2014		2015		2016	
			# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded
Lib-2	576	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	1	50%	1	33%	2	50%	0	0%
	410	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	1	50%	1	33%	2	50%	0	0%
	298	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	1	50%	2	66%	3	75%	0	0%
	235	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	2	100%	2	66%	3	75%	0	0%
Lib-3	576	low	4	66%	2	25%	1	14%	2	29%	3	50%
		high	1	50%	2	100%	3	100%	3	75%	2	50%
	410	low	4	66%	2	25%	4	57%	3	43%	3	50%
		high	1	50%	2	100%	3	100%	3	75%	2	50%
	298	low	5	83%	2	25%	5	71%	3	43%	4	66%
		high	1	50%	2	100%	3	100%	3	75%	2	50%
	235	low	5	83%	4	50%	5	71%	5	71%	5	83%
		high	1	50%	2	100%	3	100%	3	75%	2	50%

Location	MPN Criteria	Flow Type	2012		2013		2014		2015		2016	
			# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded
Lib-4	576	low	0	0%	0	0%	0	0%	0	0%	0	0%
		high	0	0%	0	0%	1	33%	2	50%	2	50%
	410	low	1	17%	0	0%	1	14%	1	14%	0	0%
		high	0	0%	1	50%	1	33%	2	50%	2	50%
	298	low	1	17%	0	0%	1	14%	1	14%	2	33%
		high	1	50%	2	100%	2	66%	2	50%	2	50%
	235	low	2	33%	0	0%	2	29%	2	29%	2	33%
		high	1	50%	2	100%	2	66%	2	50%	2	50%
Lib-5	576	low	0	0%	1	14%	0	0%	1	17%	1	17%
		high	1	50%	2	100%	2	66%	2	50%	1	25%
	410	low	1	17%	1	14%	1	14%	1	17%	1	17%
		high	1	50%	2	100%	2	66%	2	50%	2	50%
	298	low	4	66%	1	14%	3	50%	1	17%	2	33%
		high	1	50%	2	100%	2	66%	3	75%	2	50%
	235	low	4	66%	1	14%	4	66%	2	33%	4	66%
		high	1	50%	2	100%	2	66%	3	75%	2	50%

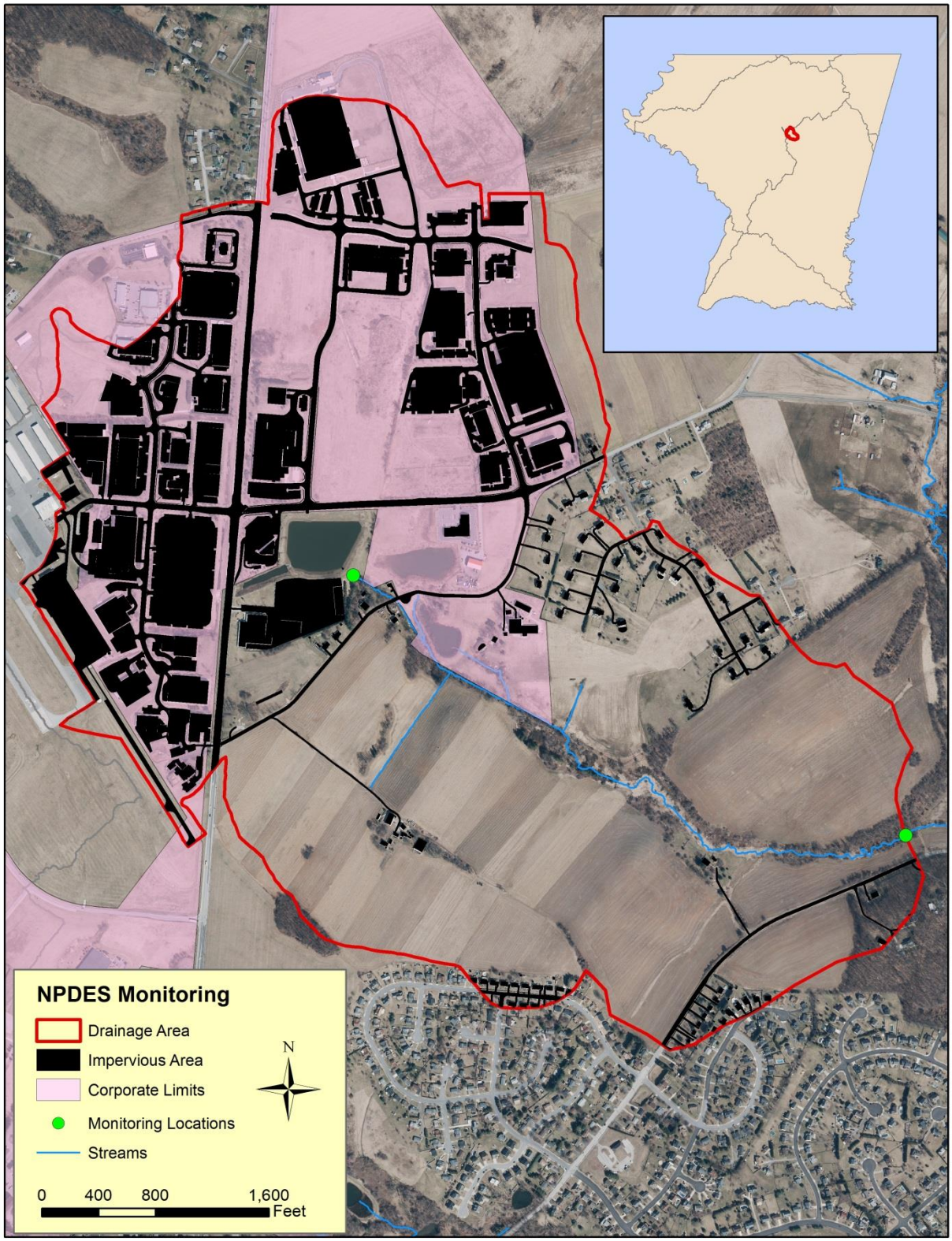


Figure 14: NPDES Monitoring Location

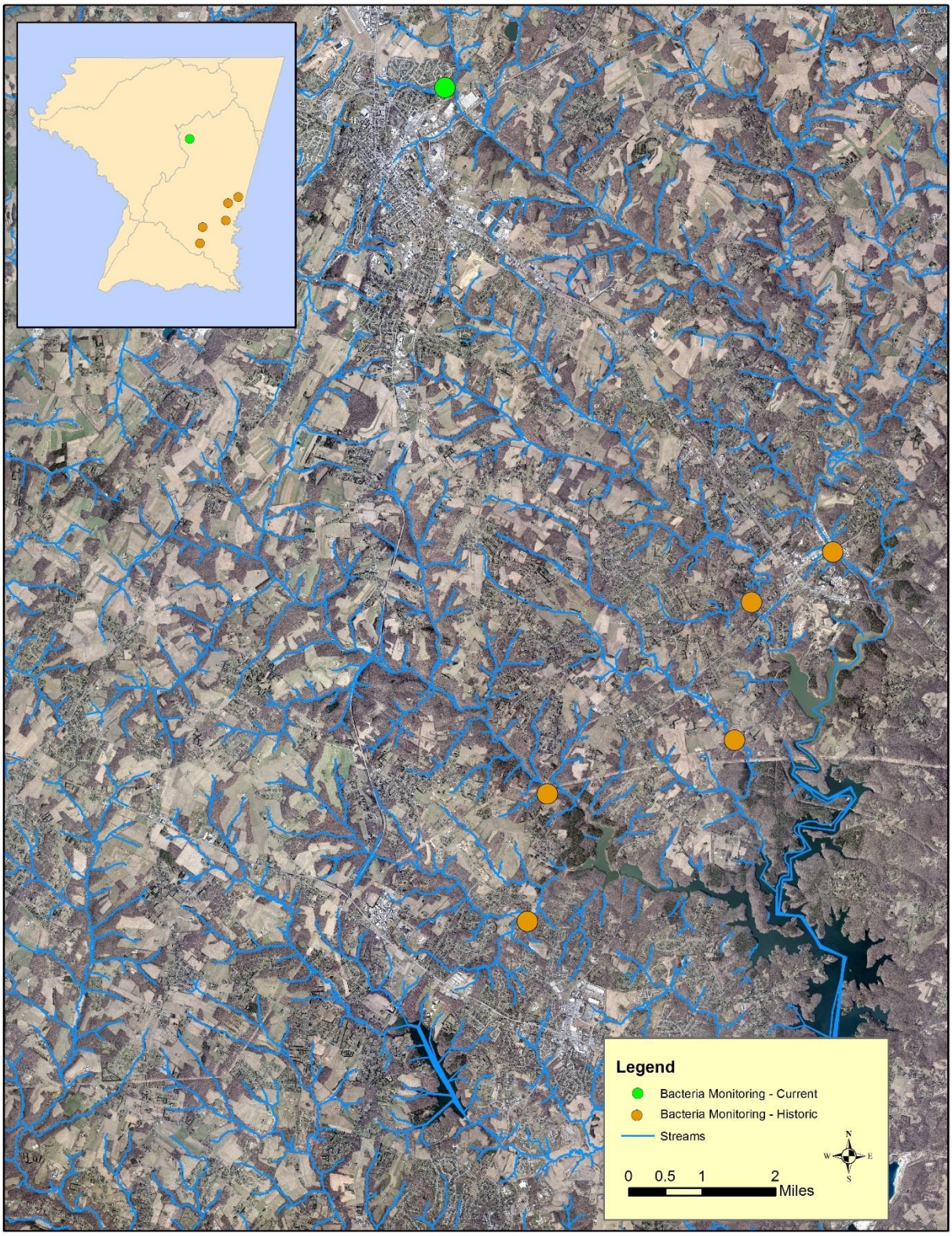


Figure 15: Bacteria Monitoring Location

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 23). BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Liberty Watershed will have no effect on reducing loadings to the Chesapeake Bay, because of the edge of stream vs. the delivered load factor.

A. Purpose and Scope

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

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

B. Background

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

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

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

1. Water Quality Standards and Designated Uses

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

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 23, and the tidal water designated use zones are shown in Figure 16.

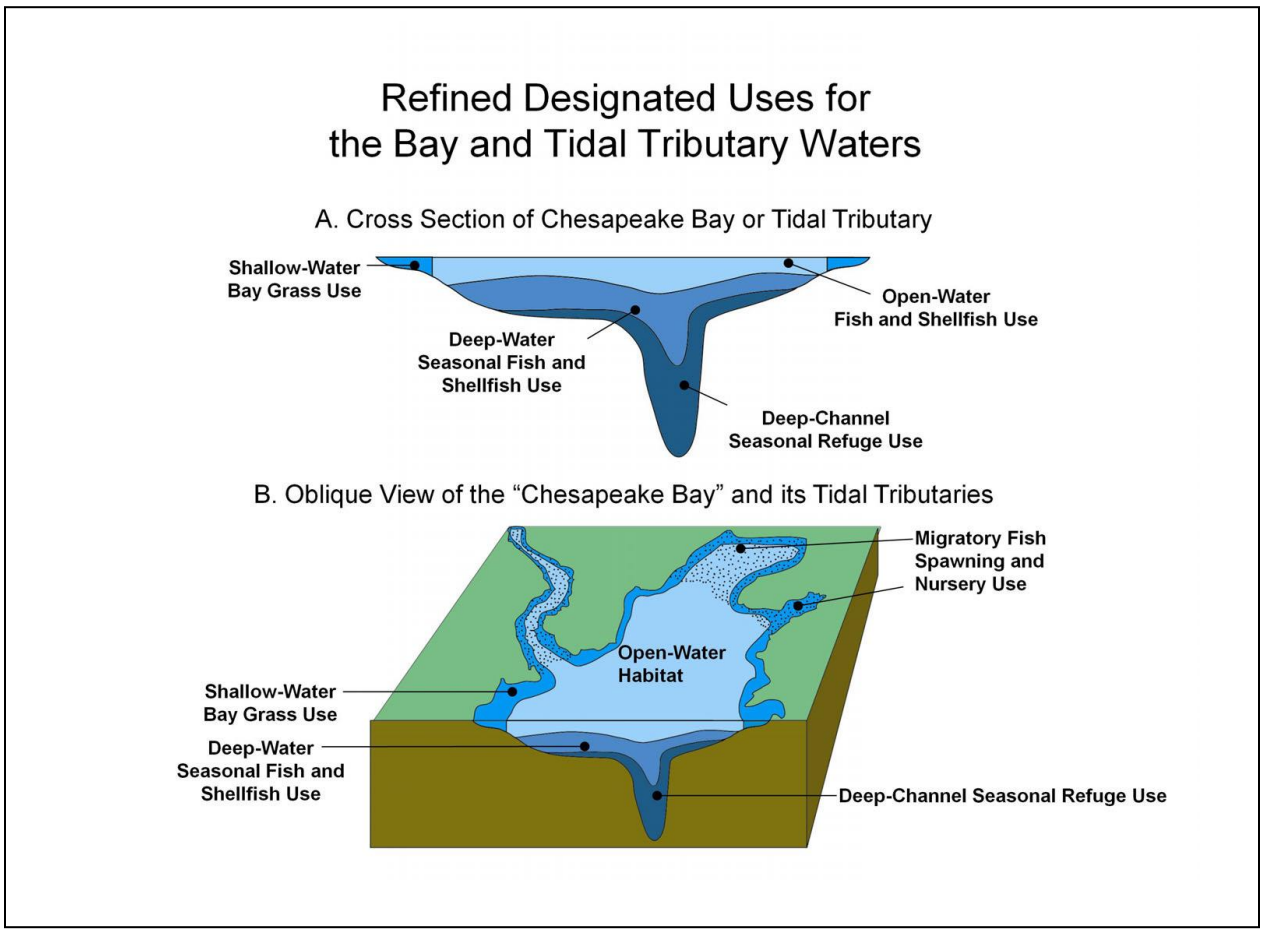


Figure 16: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

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

Table 23: Chesapeake Bay Designated Uses

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

C. River Segment Location

The Liberty Watershed is located within the Patapsco River segment of the Chesapeake Bay. The Patapsco segment covers 374,186 acres, approximately 126,716 acres (34%) of this river segment is within Carroll County. The location of the Patapsco River segment is shown in Figure 17.

D. Restoration Progress

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

Delivered load ratios were applied to BMP load reductions (Appendix E) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 24. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Patapsco River segment within the Liberty Watershed are; 0.00 for nitrogen, 0.00 for phosphorus, and 0.00 for suspended sediment. Essentially, if one pound of nitrogen is discharged into a tributary within the Liberty portion of the Patapsco River segment, none of that pound is reaching the Bay due to the impoundment from the Liberty Reservoir dam.

Table 15 shows the Chesapeake Bay TMDL for the Patapsco land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Liberty Reservoir Watershed.

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

The load reductions from BMPs implemented in the Liberty Reservoir Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the Patapsco segment shed. The Liberty Reservoir Watershed covers 68.9% of the Patapsco land-river segment within Carroll County.

Note that the extent of BMPs implemented and planned for this watershed has no effect on the County's ability to meet the Chesapeake Bay TMDL requirement due to delivered load ratios of 0.00 for this river segment.

Table 24: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Liberty Reservoir Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2019-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
1,752.52	35.26%	618.00	0	0	0%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2019-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
16,038.74	13.79%	2,212.59	0	0	0%

[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 Watershed.

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

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

Table 25: Carroll County Patapsco River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	**Total Phosphorus (TP)[3]**			**Total Nitrogen (TN)**		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Liberty Reservoir Watershed	0	0	0%	0	0	0%
South Branch Patapsco Watershed	181.53	104.41	46.27%	663.32	285.73	42.89%
Total	**181.53**	**104.41**	**46.27%**	**663.32**	**285.73**	**42.89%**

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

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

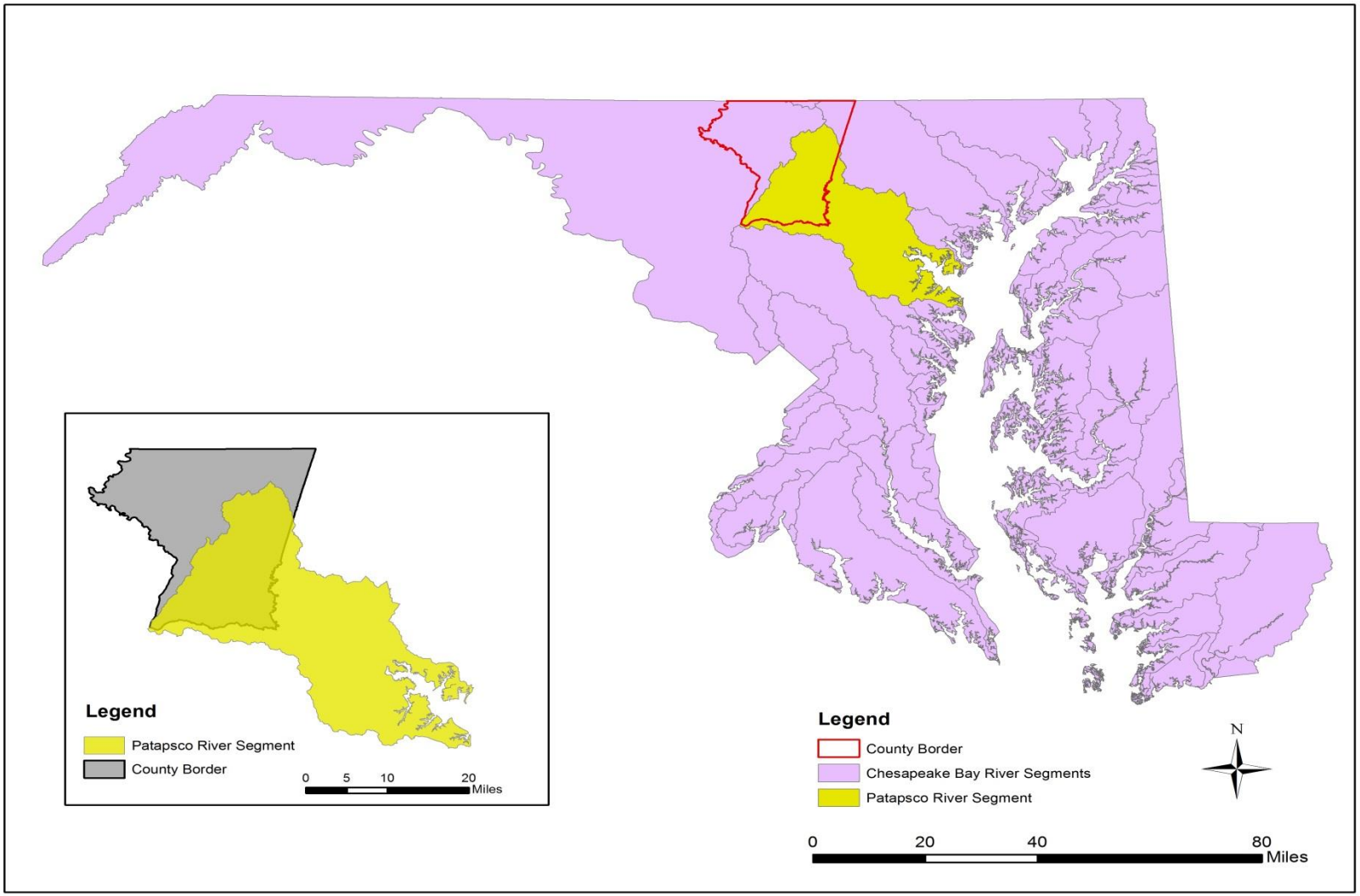


Figure 17: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the phosphorus TMDL through 2019 will have achieved 35% of the required reductions since the baseline year of 2009. Based on currently identified projects, the required reduction is expected to achieve 52% by 2025. The implementation from baseline through the current CIP is achieving approximately 3.25% reduction in the TMDL/year since the baseline.

The sediment TMDL through 2019 will have achieved 41% of the required reduction since the baseline year of 2009. Based on current projects is expected to achieve 59% of the required reduction by 2025. The implementation from baseline through the current CIP is achieving approximately 3.69% reduction in the TMDL/year since the baseline.

If the County is able to maintain an approximate 3.0% reduction rate per year for sediment and phosphorus, the sediment and phosphorus TMDLs in the Liberty Reservoir Watershed would be achieved by 2041. To achieve this goal, the County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Table 26 lists the anticipated benchmark for each nutrient TMDL within the Liberty Reservoir Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 26: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2041
Phosphorus	35%	52%	100%
Sediment	41%	59%	100%

A. Bacteria Implementation

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

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

IX. Caveats

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

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

X. Public Participation

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

XI. References

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XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost	Anticipated Completion
SWM Facilities	County	2130907	Completed	$14,385,491	Completed
Streambank Regeneration	County	2130907	Completed	N/A	Completed
Buffer Plantings	County	2130907	Completed	$227,181	Completed
Catch Basin/Inlet Cleaning	Hampstead	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Manchester	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Westminster	2130907	Completed	**	Annual
Street Sweeping	Westminster	2130907	Completed	**	Annual
Water/floodplain Easement	Watershed	2130907	Completed	N/A	Completed
SWM (Planned)	County	2130907	Planning/Design	$15,153,278	FY20-25
TBD	Watershed	8-Digit	Planning	$27,500,000	TBD

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

****Project Costs not reported**

XIII. Appendix B: Liberty BAT Septic Systems

DNR 12-digit scale	SubWatershed	Project Type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2009-2019
1060	Aspen Run	Septic Repair	1	0	0	0	1	0	0	0	0	0	0	2
		New Construction	0	0	0	0	0	0	1	0	1	1	0	3
1057	Beaver Run	Septic Repair	1	0	0	0	1	0	2	4	0	0	0	8
		New Construction	0	0	0	1	2	4	5	4	3	1	1	21
1061	Cranberry Branch	Septic Repair	0	0	0	0	0	0	0	0	1	1	0	11
		New Construction	0	0	0	0	0	0	1	0	0	0	0	1
1058	Deep Run	Septic Repair	0	0	0	0	0	0	0	1	1	1	0	3
		New Construction	0	0	0	0	0	0	1	1	3	0	0	5
1052	East Branch Patapsco	Septic Repair	3	0	0	0	0	0	0	0	0	0	0	3
		New Construction	1	0	0	0	0	0	0	0	1	0	0	2
1059	East Branch Patapsco	Septic Repair	1	1	0	0	2	0	3	1	1	0	0	9
		New Construction	0	0	0	0	0	0	2	1	2	1	0	11
1046	Liberty Reservoir	Septic Repair	0	0	0	0	0	0	0	0	0	2	1	3
		New Construction	0	0	0	0	0	0	1	1	0	0	0	2
1047	Liberty Reservoir	Septic Repair	1	1	0	0	1	0	0	1	0	0	0	4
		New Construction	0	0	0	0	0	0	15	8	0	0	0	23
1049	Little Morgan Run	Septic Repair	1	0	0	1	0	0	0	1	1	0	0	4
		New Construction	1	0	0	0	1	0	15	21	3	0	2	43
1055	Little Morgan Run	Septic Repair	0	0	0	0	0	0	1	0	0	0	1	2
		New Construction	0	0	0	0	0	0	1	0	0	0	0	1
1056	Middle Run	Septic Repair	2	0	0	0	0	0	1	0	0	1	0	4
		New Construction	0	0	0	0	0	1	2	0	0	0	0	3
1053	Morgan Run	Septic Repair	0	0	0	0	1	0	1	1	0	0	0	3

		New Construction	0	0	0	0	0	0	3	1	0	0	0	4
1054	Morgan Run	Septic Repair	0	0	0	0	1	0	1	0	0	0	0	2
		New Construction	0	0	0	0	0	0	1	3	0	0	0	4
1050	Morgan Run	Septic Repair	3	0	0	1	0	0	3	1	0	1	1	10
		New Construction	0	0	0	0	0	0	11	14	0	0	0	25
1048	Roaring Run	Septic Repair	5	0	0	0	0	2	0	1	0	0	0	8
		New Construction	0	0	0	0	0	1	3	11	6	0	0	21
1051	West Branch Patapsco	Septic Repair	1	1	0	0	0	1	0	1	1	0	0	5
		New Construction	0	0	0	0	1	1	2	2	3	0	0	9
1062	West Branch Patapsco	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	2	1	0	0	0	3

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

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Marriot Wood 1 Facility #1	Retrofit	2.5	0.56	ST	1.00	0.0043%	35%	0.42	0.0074%	55%	0.13	0.0105%	70%	0.36
Hickory Ridge	Retrofit	23.75	4.8	ST	2.50	0.0458%	39%	4.54	0.0796%	62%	1.43	0.1130%	79%	3.86
Bateman SW Pond	Facility	47.25	4.52	RR	2.50	0.1568%	68%	15.56	0.2014%	79%	3.61	0.2414%	85%	8.24
Marriot Wood 1 Facility #2	Retrofit	7.12	2.04	ST	2.50	0.0137%	39%	1.36	0.0239%	62%	0.43	0.0339%	79%	1.16
Marriot Wood II	Retrofit	7.51	1.38	ST	2.50	0.0145%	39%	1.44	0.0252%	62%	0.45	0.0357%	79%	1.22
Elderwood Village	Retrofit	7.64	2.47	ST	2.50	0.0485%	39%	4.81	0.0562%	62%	1.01	0.0394%	79%	1.35
Westminster Airport Pond	Retrofit	204.84	85	ST	1.40	1.2437%	38%	123.43	1.4367%	59%	25.77	1.0080%	75%	34.42
Oklahoma II Foothills	Retrofit	23.72	6.06	ST	2.35	0.0455%	39%	4.52	0.0792%	62%	1.42	0.1124%	78%	3.84
Oklahoma Phase I	Retrofit	24.44	7.27	ST	2.50	0.0471%	39%	4.67	0.0820%	62%	1.47	0.1163%	79%	3.97
Edgewood	Retrofit	38	12.12	ST	2.50	0.2412%	39%	23.94	0.2796%	62%	5.01	0.1960%	79%	6.69
Upper Patapsco Phase 1	Facility	24.6	10.1	ST	2.50	0.1562%	39%	15.50	0.1810%	62%	3.25	0.1269%	79%	4.33
Upper Patapsco Phase 2	Facility	101.8	2.98	ST	2.50	1.4051%	39%	139.45	3.6266%	62%	65.04	2.3023%	79%	78.63
Quail Meadowns	Retrofit	111.97	23.25	ST	1.00	0.1918%	35%	19.03	0.3326%	55%	5.97	0.4724%	70%	16.13
Heritage Heights	Retrofit	21.38	4.1	ST	1.00	0.0366%	35%	3.63	0.0635%	55%	1.14	0.0902%	70%	3.08
Westminster High School	Retrofit	117.25	32.59	ST	2.50	0.2259%	39%	22.42	0.3932%	62%	7.05	0.5577%	79%	19.05

Westminster Comm. Pond	Facility	250.22	63.89	ST	2.50	0.4821%	39%	47.84	0.8391%	62%	15.05	1.1902%	79%	40.65
Diamond Hills Section 5	Retrofit	51.8	12.94	ST	2.03	0.0992%	39%	9.85	0.1723%	61%	3.09	0.2445%	78%	8.35
Wilda Drive	Facility	6.75	1.6	ST	1.07	0.0118%	36%	1.17	0.0204%	56%	0.37	0.0290%	71%	0.99
Collins Estates	Retrofit	16.34	3.18	ST	1.87	0.0312%	39%	3.09	0.0541%	61%	0.97	0.0768%	78%	2.62
High Point	Retrofit	4.7	0.91	ST	1.00	0.0080%	35%	0.80	0.0140%	55%	0.25	0.0198%	70%	0.68
Willow Pond	Retrofit	601	72.75	ST	2.50	1.1579%	39%	114.91	2.0155%	62%	36.15	2.8588%	79%	97.63
Finksburg Industrial Park	Retrofit	67.8	22.12	ST	1.04	0.3866%	35%	38.37	0.4466%	56%	8.01	0.3134%	71%	10.70
Elderwood Village Parcel	Retrofit	144	61.00	ST	1.01	0.8148%	35%	80.87	0.9412%	55%	16.88	0.6604%	70%	22.55
Oklahoma 4	Retrofit	56.93	14.52	RR	2.5	0.1889%	68%	18.74	0.2427%	79%	4.35	0.2909%	85%	9.93
Miller/Watts	Retrofit	39.65	25.63	ST	2.50	0.2517%	39%	24.98	0.2917%	62%	5.23	0.2045%	79%	6.98
Central MD (Wet)	Retrofit	92.72	25.83	ST	2.50	0.1786%	39%	17.73	0.3109%	62%	5.58	0.4410%	79%	15.06
Randomhouse	Retrofit	41.8	16.38	ST	2.50	0.2653%	39%	26.33	0.3076%	62%	5.52	0.2156%	79%	7.36
Eldersburg Business Center	Retrofit	97.98	52.7	ST	2.34	0.6198%	39%	61.51	0.7177%	62%	12.87	0.5032%	78%	17.18
Feeser Property	Facility	4.38	1.72	RR	1.00	0.0423%	60%	4.19	0.0363%	70%	0.65	0.0214%	75%	0.73
Central MD (Dry)	Retrofit	63.35	45	RR	2.50	0.7038%	68%	69.85	0.6002%	79%	10.76	0.3513%	85%	12.00
Shiloh Middle	Retrofit	83.83	25.64	RR	1.32	0.8615%	64%	85.50	0.7407%	74%	13.28	0.4370%	80%	14.92
Aspen Run	Retrofit	14.4	1.7	RR	1.30	0.0448%	63%	4.44	0.0578%	74%	1.04	0.0690%	79%	2.36
Squires	Retrofit	36.8	10	ST	2.50	0.071%	39%	7.04	0.123%	62%	2.21	0.175%	79%	5.98
Springmount Estates	Retrofit	60	20	RR	2.50	0.656%	68%	65.09	0.561%	79%	10.07	0.332%	85%	11.35

Winters St. Pond	Retrofit	79.4	36.01	ST	1.00	0.448%	35%	44.47	0.518%	55%	9.28	0.363%	70%	12.40
Black and Decker	Facility	160.31	50.33	RR	2.50	1.752%	68%	173.91	1.499%	79%	26.89	0.888%	85%	30.32
Limton Springs	Retrofit	53.43	25.8	RR	2.50	0.584%	68%	57.96	0.500%	79%	8.96	0.296%	85%	10.11
W. Branch Trade Center	Retrofit	58.75	19.77	RR	2.50	0.642%	68%	63.73	0.550%	79%	9.86	0.325%	85%	11.11
Solo Cup	Retrofit	64	34.44	ST	1.00	0.3611%	35%	35.84	0.4172%	55%	7.48	0.2927%	70%	10.00
Hampstead Regional	Facility	350	85	ST	2.50	1.1612%	39%	115.24	1.4921%	62%	26.76	1.7882%	79%	61.07
Brynwood	Facility	95.5	21.7	RR	2.50	0.3168%	68%	31.44	0.4071%	79%	7.30	0.4879%	85%	16.66
Winters Mill High School	Retrofit	58.3	21.8	ST	1.00	0.3290%	35%	32.65	0.3800%	55%	6.82	0.2666%	70%	9.11
East Middle School Wetland	Retrofit	10.18	10.18	ST	1.00	0.0584%	35%	5.79	0.0672%	55%	1.21	0.0466%	70%	1.59
Eldersburg Marketplace	Retrofit	54.78	35.16	St	1.00	0.3091%	35%	30.68	0.3571%	55%	6.40	0.2505%	70%	8.56
Westminster Marketplace	Retrofit	52.07	40.4	ST	1.00	0.2987%	35%	29.64	0.3438%	55%	6.17	0.2384%	70%	8.14
Stone Manor	Retrofit	17.81	3.97	ST	1.00	0.031%	35%	3.03	0.053%	55%	0.95	0.075%	70%	2.57
Town Mall of Westminster	Retrofit	172.66	65.82	ST	1.00	0.9743%	35%	96.70	1.1254%	55%	20.18	0.7897%	70%	26.97

Stream Buffer Plantings

Project	Acres	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Load Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Load Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	0.14	0.0005%	66	0.0449	0.0006%	77	0.0105	0.0005%	57	0.016
Planting 2	1.43	0.0046%	66	0.4590	0.0060%	77	0.1068	0.0049%	57	0.168
Planting 3	1.19	0.0038%	66	0.3820	0.0050%	77	0.0889	0.0041%	57	0.140
Planting 4	0.6	0.0019%	66	0.1926	0.0025%	77	0.0448	0.0021%	57	0.070
Planting 5	0.32	0.0010%	66	0.1027	0.0013%	77	0.0239	0.0011%	57	0.038
Planting 6	0.31	0.0010%	66	0.0995	0.0013%	77	0.0232	0.0011%	57	0.036
Planting 7	0.3	0.0010%	66	0.0963	0.0012%	77	0.0224	0.0010%	57	0.035
Planting 8	0.16	0.0005%	66	0.0514	0.0007%	77	0.0120	0.0006%	57	0.019
Planting 9	1.02	0.0033%	66	0.3274	0.0042%	77	0.0762	0.0035%	57	0.120
Planting 10	0.84	0.0027%	66	0.2696	0.0035%	77	0.0627	0.0029%	57	0.099
Planting 11	3.18	0.0103%	66	1.0207	0.0132%	77	0.2375	0.0109%	57	0.374
Planting 12	2.92	0.0094%	66	0.9373	0.0122%	77	0.2181	0.0100%	57	0.343
Planting 13	1.15	0.0037%	66	0.3691	0.0048%	77	0.0859	0.0040%	57	0.135
Planting 14	0.24	0.0008%	66	0.0770	0.0010%	77	0.0179	0.0008%	57	0.03
Planting 15	0.52	0.0017%	66	0.1669	0.0022%	77	0.0388	0.0018%	57	0.06
Planting 16	1.41	0.0046%	66	0.4526	0.0059%	77	0.1053	0.0049%	57	0.17
Planting 17	0.1	0.0003%	66	0.0321	0.0004%	77	0.0075	0.0003%	57	0.01
Planting 18	4.06	0.0131%	66	1.3032	0.0169%	77	0.3033	0.0140%	57	0.48
Planting 19	1.22	0.0039%	66	0.3916	0.0051%	77	0.0911	0.0042%	57	0.14

Planting 20	0.21	0.0007%	66	0.0674	0.0009%	77	0.0157	0.0007%	57	0.02
Planting 21	0.87	0.0028%	66	0.2793	0.0036%	77	0.0650	0.0030%	57	0.10
Planting 22	0.1	0.0003%	66	0.0321	0.0004%	77	0.0075	0.0003%	57	0.01
Planting 23	0.76	0.0025%	66	0.2439	0.0032%	77	0.0568	0.0026%	57	0.09
Planting 24	0.44	0.0014%	66	0.1412	0.0018%	77	0.0329	0.0015%	57	0.05
Planting 25	0.38	0.0012%	66	0.1220	0.0016%	77	0.0284	0.0013%	57	0.04
Planting 26	0.3	0.0010%	66	0.0963	0.0012%	77	0.0224	0.0010%	57	0.04
Planting 27	0.16	0.0005%	66	0.0514	0.0007%	77	0.0120	0.0006%	57	0.02
Planting 28	0.2	0.0006%	66	0.0642	0.0008%	77	0.0149	0.0007%	57	0.02
Planting 29	0.9	0.0029%	66	0.2889	0.0037%	77	0.0672	0.0031%	57	0.11
Planting 30	0.38	0.0012%	66	0.1220	0.0016%	77	0.0284	0.0013%	57	0.04
Planting 31	0.11	0.0004%	66	0.0353	0.0005%	77	0.0082	0.0004%	57	0.01
Planting 32	2.07	0.0067%	66	0.66	0.0086%	77	0.15	0.0071%	57	0.24
Planting 33	0.38	0.0012%	66	0.12	0.0016%	77	0.03	0.0013%	57	0.04
Planting 34	4	0.0129%	66	1.28	0.0167%	77	0.30	0.0138%	57	0.47
Planting 35	1.88	0.0061%	66	0.60	0.0078%	77	0.14	0.0065%	57	0.22
Planting 36	0.54	0.0017%	66	0.17	0.0022%	77	0.04	0.0019%	57	0.06
Total:	**34.79**	**0.1125%**		**11.1671**	**0.1449%**		**2.5987**	**0.1197%**		**4.087**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered] (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Loads Reduced [delivered] (Tons)
Hampstead	8.64	3.5	30.24 [1.2524]	1.4	12.096 [0.4884]	420	3,629 [472.99]	1.815 [0.237]
Manchester	0.674	3.5	2.359 [0.0977]	1.4	0.944 [0.0381]	420	283.08 [36.90]	0.142 [0.0184]
Westminster	0.49	3.5	1.715 [0.0710]	1.4	0.686 [0.0277]	420	205.8 [26.82]	0.103 [0.0134]
Total:			**34.314 [1.4211]**		**13.726 [0.5542]**		**4,117.88 [536.71]**	**2.06 [0.269]**

Street Sweeping

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced [delivered] (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced [delivered] (Tons)
Westminster	5.28	11.7	61.776	4	2.47104 [0.1023]	0.68	3.5904	4	0.143616 [0.0058]	0.18	0.9504	10	0.09504 [0.0124]
Total:			**61.7760**		**2.4710 [0.1023]**		**3.5904**		**0.1436 [0.0058]**		**0.9504**		**0.0950 [0.0124]**

Stream Restoration

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Eden Farms	1,304	0.092%	9.10	0.439%	7.87	0.038%	2,598.09	1.30
Total:		**0.092%**	**9.10**	**0.439%**	**7.87**	**0.038%**	**2,598.09**	**1.30**

Streambank Regeneration[1]

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Hickory Ridge	165	0.012%	1.15	0.056%	1.00	0.005%	328.75	0.16
Marriot Wood 1 Facility #2	150	0.011%	1.05	0.050%	0.91	0.004%	298.86	0.15
Edgewood Section 1	240	0.017%	1.68	0.081%	1.45	0.007%	478.18	0.24
Heritage Heights	510	0.036%	3.56	0.172%	3.08	0.015%	1016.13	0.51
Westminster High School	416	0.029%	2.90	0.140%	2.51	0.012%	828.84	0.41
Central MD	960	0.0007%	6.70	0.0032%	5.79	0.0003%	1912.71	0.96
Hoff Pond	822	0.058%	5.74	0.277%	4.96	0.024%	1637.76	0.82
Total:		**0.164%**	**22.78**	**0.779%**	**19.70**	**0.067%**	**6,501.23**	**3.25**

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

Forest Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (tons)
Forest Buffer 2009-Current	273.490	0.6031%	45	59.85	0.5917%	40	10.61	0.9079%	55	31.00
Total:	**273.490**	**0.6031%**		**59.85**	**0.5917%**		**10.61**	**0.9079%**		**31.00**

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (tons)
Grass Buffer 2009-Current	215.470	0.3168%	30	31.44	0.4662%	40	8.36	0.7153%	55	24.43
Total:	**215.470**	**0.3168%**		**31.44**	**0.4662%**		**8.36**	**0.7153%**		**24.43**

XV. Appendix D: GWLF-E Modeling Assumptions

1. Model Inputs

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

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

Table D-1: NLCD Reclassification into MapShed Input

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

Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

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

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

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

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)**	0.52	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.52	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation LD Mixed MD Mixed HD Mixed LD Residential	Imp. (Pervious) values 2.8 (0.8) 6.2 (0.8) 2.8 (0.8) 2.5 (1.3)	Imp. (Pervious) values 1.21 (0.19) 2.66 (0.30) 2.66 (0.30) 1.21 (0.19)	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.

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

** The default was based on dominant parameter.

2. BMP Assumptions

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

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

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

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)	TP (lbs/ac)	TSS (lbs/ac)
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

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

The load reductions from BMPs calculated based on the loading rates in Table D-3 (i.e., detention basin retrofits, infiltration, bioretention, etc.) represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Liberty Reservoir watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.041, 0.040, and 0.130, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

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

Water Resource, Floodplain Easements

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

Buffer Strips

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

Stream Stabilization

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

Infiltration and Bioretention

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

Constructed Wetlands

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

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing. For qualifying street sweeping programs (25 times a year), TN, TP, and TSS reductions are 4%, 4%, and 10% respectively. Delivery ratios were also used to adjust these reductions.

Impervious Surface Reduction

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

XVI. Appendix E: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

SWM Facilities
Impervious
Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Marriot Wood 1 Facility #1	Retrofit	2.5	0.56	ST	1.00	15.3	8.5680	35%	2.9945	1.69	0.9464	55%	0.5198	0.44	0.2464	70%	0.1722
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%	1.6645
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%	1.6885
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%	0.7074
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%	0.4785
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%	0.8565
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%	28.1282
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%	2.0930
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%	2.5210
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%	4.2029
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%	3.5024
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%	1.0334
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%	7.1508

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%	1.2610
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%	11.3013
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%	22.1553
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%	4.4534
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%	0.5009
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%	1.0896
High Point	Retrofit	4.7	0.91	ST	1.00	15.3	13.9230	35%	4.8661	1.69	1.5379	55%	0.8446	0.44	0.4004	70%	0.2799
Willow Pond	Retrofit	601	72.75	ST	2.50	15.3	1113.0750	39%	437.6054	1.69	122.9475	62%	76.2240	0.44	32.0100	79%	25.2277
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%	6.8751
Elderwood/ Village Parcel	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%	18.8123
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%	5.4240
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%	8.8878
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%	8.9571
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%	18.5895
Squires	Retrofit	36.8	10	ST	2.50	15.3	153.0000	39%	60.1520	1.69	16.9000	62%	10.4775	0.44	4.4000	79%	3.4677
Central MD (Dry)	Retrofit	63.35	45	RR	2.50	15.3	688.5000	68%	466.1145	1.69	76.0500	79%	59.9364	0.44	19.8000	85%	16.8098
Springmount Estates	Retrofit	60	20	RR	2.50	15.3	306.0000	68%	207.1620	1.69	33.8000	79%	26.6384	0.44	8.8000	85%	7.4710
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%	18.1993
Winters St. Pond	Retrofit	79.4	36.01	ST	1.00	15.3	550.9530	35%	192.5581	1.69	60.8569	55%	33.4226	0.44	15.8444	70%	11.0752

Black and Decker	Facility	160.31	50.33	RR	2.50	15.3	770.0490	68%	521.3232	1.69	85.0577	79%	67.0356	0.44	22.1452	85%	18.8009
Limton Springs	Retrofit	53.43	25.8	RR	2.50	15.3	394.7400	68%	267.2390	1.69	43.6020	79%	34.3636	0.44	11.3520	85%	9.6376
W. Branch Trade Center	Retrofit	58.75	19.77	RR	2.50	15.3	302.4810	68%	204.7796	1.69	33.4113	79%	26.3321	0.44	8.6988	85%	7.3851
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%	0.5669
Hampstead Regional	Facility	350	85	ST	2.50	15.3	1300.5000	39%	511.2916	1.69	143.6500	62%	89.0590	0.44	37.4000	79%	29.4756
Solo Cup	Retrofit	64	34.44	ST	1.00	15.3	526.9320	35%	184.1627	1.69	58.2036	55%	31.9654	0.44	15.1536	70%	10.5924
Brynwood	Facility	95.5	21.7	RR	2.50	15.3	332.0100	68%	224.7708	1.69	36.6730	79%	28.9027	0.44	9.5480	85%	8.1061
Shiloh Middle	Retrofit	83.83	25.64	RR	1.32	15.3	392.2920	64%	249.6827	1.69	43.3316	74%	32.2576	0.44	11.2816	80%	9.0031
Aspen Run	Retrofit	14.4	1.7	RR	1.30	15.3	26.0100	63%	16.5073	1.69	2.8730	74%	2.1327	0.44	0.7480	80%	0.5952
Winters Mill High School	Retrofit	58.3	21.8	ST	1.00	15.3	333.5400	35%	116.5722	1.69	36.8420	55%	20.2336	0.44	9.5920	70%	6.7048
East Middle School Wetland	Retrofit	10.18	10.18	ST	1.00	15.3	155.7540	35%	54.4360	1.69	17.2042	55%	9.4485	0.44	4.4792	70%	3.1310
Eldersburg Marketplace	Retrofit	54.78	35.16	ST	1.00	15.3	537.9480	35%	188.0128	1.69	59.4204	55%	32.6337	0.44	15.4704	70%	10.8138
Westminster Marketplace	Retrofit	52.07	40.4	ST	1.00	15.3	618.1200	35%	216.0329	1.69	68.2760	55%	37.4972	0.44	17.7760	70%	12.4254
Stone Manor	Retrofit	17.81	3.97	ST	1.00	15.3	60.7410	35%	21.2290	1.69	6.7093	55%	3.6847	0.44	1.7468	70%	1.2210
Town Mall of Westminster	Retrofit	172.66	65.82	ST	1.00	15.3	1007.0460	35%	351.9626	1.69	111.2358	55%	61.0907	0.44	28.9608	70%	20.2436
Total:		**3,669.01**	**1,112.62**				**17,039.47**		**7,348.26**		**1,896.71**		**1,187.08**		**505.93**		**388.25**
Planned Facilities																	

SWM Facilities

Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Marriot Wood 1 Facility #1	Retrofit	2.5	1.94	ST	1.00	10.8	20.9520	35%	7.3227	0.43	0.8342	55%	0.4581	0.07	0.1358	70%	0.0949
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%	1.0454
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%	2.5394
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%	0.2803
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%	0.3382
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%	0.2852
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%	6.3091
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%	0.9704
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%	0.9472
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%	1.4278
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%	0.7999
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%	5.4517
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%	4.3411
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%	0.8455

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%	4.6705
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%	10.2795
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%	2.1277
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%	0.2565
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%	0.7174
High Point	Retrofit	4.7	3.79	ST	1.00	10.8	40.9320	35%	14.3057	0.43	1.6297	55%	0.8950	0.07	0.2653	70%	0.1854
Willow Pond	Retrofit	601	528.25	ST	2.50	10.8	5705.1000	39%	2242.9601	0.43	227.1475	62%	140.8251	0.07	36.9775	79%	29.1427
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%	2.2587
Elderwood/ Village Parcel	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%	4.0723
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%	38.5257
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%	0.7735
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%	3.6902
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%	1.4024
Squires	Retrofit	36.8	26.8	ST	2.50	10.8	289.4400	39%	113.7933	0.43	11.5240	62%	7.1446	0.07	1.8760	79%	1.4785
Central MD (Dry)	Retrofit	63.35	18.35	RR	2.50	10.8	198.1800	68%	134.1679	0.43	7.8905	79%	6.2187	0.07	1.2845	85%	1.0905
Springmount Estates	Retrofit	60	40	RR	2.50	10.8	432.0000	68%	292.4640	0.43	17.2000	79%	13.5556	0.07	2.8000	85%	2.3771
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%	2.4877
Winters St. Pond	Retrofit	79.4	43.39	ST	1.00	10.8	468.6120	35%	163.7799	0.43	18.6577	55%	10.2468	0.07	3.0373	70%	2.1231
Black and Decker	Facility	160.31	109.98	RR	2.50	10.8	1187.7840	68%	804.1298	0.43	47.2914	79%	37.2712	0.07	7.6986	85%	6.5360

Limton Springs	Retrofit	53.43	27.63	RR	2.50	10.8	298.4040	68%	202.0195	0.43	11.8809	79%	9.3636	0.07	1.9341	85%	1.6420
W. Branch Trade Center	Retrofit	58.75	38.98	RR	2.50	10.8	420.9840	68%	285.0062	0.43	16.7614	79%	13.2100	0.07	2.7286	85%	2.3165
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%	0.1395
Hampstead Regional	Facility	350	265	ST	2.50	10.8	2862.0000	39%	1125.1953	0.43	113.9500	62%	70.6458	0.07	18.5500	79%	14.6196
Solo Cup	Retrofit	64	29.56	ST	1.00	10.8	319.2480	35%	111.5772	0.43	12.7108	55%	6.9808	0.07	2.0692	70%	1.4464
Brynwood	Facility	95.5	73.8	RR	2.50	10.8	797.0400	68%	539.5961	0.43	31.7340	79%	25.0102	0.07	5.1660	85%	4.3858
Shiloh Middle	Retrofit	83.83	58.19	RR	1.32	10.8	628.4520	64%	399.9918	0.43	25.0217	74%	18.6270	0.07	4.0733	80%	3.2506
Aspen Run	Retrofit	14.4	12.7	RR	1.30	10.8	137.1600	63%	87.0486	0.43	5.4610	74%	4.0539	0.07	0.8890	80%	0.7074
Winters Mill High School	Retrofit	58.3	36.5	ST	1.00	10.8	394.2000	35%	137.7729	0.43	15.6950	55%	8.6197	0.07	2.5550	70%	1.7859
East Middle School Wetland	Retrofit	10.18	0	ST	1.00	10.8	0.0000	35%	0.0000	0.43	0.0000	55%	0.0000	0.07	0.0000	70%	0.0000
Eldersburg Marketplace	Retrofit	54.78	19.62	St	1.00	10.8	211.8960	35%	74.0577	0.43	8.4366	55%	4.6334	0.07	1.3734	70%	0.9600
Westminster Marketplace	Retrofit	52.07	11.67	ST	1.00	10.8	126.0360	35%	44.0496	0.43	5.0181	55%	2.7559	0.07	0.8169	70%	0.5710
Stone Manor	Retrofit	17.81	13.84	ST	1.00	10.8	149.4720	35%	52.2405	0.43	5.9512	55%	3.2684	0.07	0.9688	70%	0.6772
Town Mall of Westminster	Facility	172.66	106.84	ST	1.00	10.8	1153.8720	35%	403.2783	0.43	45.9412	55%	25.2309	0.07	7.4788	70%	5.2277
Total:		**3,669.01**	**2,556.39**				**27,609.01**		**11,823.92**		**1,099.25**		**692.78**		**178.95**		**139.01**
Planned Facilities																	

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	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

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**

Catch Basin/inlet Cleaning

Location	Tons*	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Hampstead	8.64	3.5	30.240	1.4	12.096	420	3628.8	1.814
Manchester	0.674	3.5	2.359	1.4	0.944	420	283.08	0.142
Westminster	0.49	3.5	1.715	1.4	0.686	420	205.8	0.103
		Total:	**34.3140**		**13.7256**		**4,118**	**2.059**

Street Sweeping

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Westminster	5.28	11.7	61.776	4	2.47104	0.68	3.5904	4	0.143616	0.18	0.9504	10	0.09504
		Total:	**61.7760**		**2.4710**		**3.5904**		**0.1436**		**0.9504**		**0.0950**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS Effi
Grass Buffer 2009-Current	215.470	2009 -current	11.7	2520.9990	30	756.29970	0.68	146.5196	40	58.6078	0.18	38.7846	
	215.470		**Total:**	**2520.9990**		**756.29970**		**146.5196**		**58.6078**		**38.7846**	

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS Effi
Forest Buffer 2009-Current	273.490	2009 -current	11.7	3199.8330	45	1439.9249	0.68	185.9732	40	74.3893	0.18	49.2282	
	273.490		**Total:**	**3199.8330**		**1439.92485**		**185.9732**		**74.3893**		**49.2282**	

Stream Restoration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Eden Farms	1304	0.075	97.800	0.068	88.672	44.88	58523.52	29.262
		Total:	**97.8000**		**88.6720**		**58,524**	**29.262**

Streambank Regeneration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Hickory Ridge	165	0.075	12.375	0.068	11.220	44.88	7405.2	3.703
Marriot Wood 1 Facility #2	150	0.075	11.250	0.068	10.200	44.88	6732	3.366
Edgewood Section 1	240	0.075	18.000	0.068	16.320	44.88	10771.2	5.386
Heritage Heights	510	0.075	38.250	0.068	34.680	44.88	22888.8	11.444
Westminster High School	416	0.075	31.200	0.068	28.288	44.88	18670.08	9.335
Central MD	960	0.075	72.000	0.068	65.280	44.88	43084.8	21.542
Hoff Pond	822	0.075	61.650	0.068	55.896	44.88	36891.36	18.446
		Total:	**244.7250**		**221.8840**		**146,443**	**73.222**

XVII. Appendix F: Forest Buffer and Grass Buffer Protection Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
Morgan Run	0.782061	2009
Plat of Anderson Farm	0.708874	2009
Liberty Reservoir	3.188138	2009
Derby Farms	0.235171	2009
Poignant Acres 6	0.107064	2009
Morgan Run	0.085616	2009
Poignant Acres 6	23.24688	2009
Beaver Run	0.491324	2009
Callier Property	0.561908	2009
East Branch Patapsco Riv*	3.713047	2009
Sterner Property	1.603185	2009
Liberty Reservoir	0.019775	2009
Poignant Acres 6	0.053046	2009
Poignant Acres 6	0.053046	2009
Poignant Acres 6	0.000022	2009
Poignant Acres 6	0.000445	2009
Poignant Acres 6	0.003395	2009
Poignant Acres 6	0.003635	2009
Poignant Acres 6	0.003635	2009
Beaver Run	0.000628	2009
East Branch Patapsco Riv*	0.00021	2009
Morgan Run	0.79768	2010
Beaver Run	1.587809	2010
Liberty Exchange	0.112335	2010
Little Morgan Run	4.156734	2010
Liberty Exchange	1.082034	2010
Flat Bush	0.052705	2010
Middle Run	0.919051	2010
Flat Bush	1.66202	2010
Wilmot Manor, Section 8	0.00595	2010
Beaver Run	0.172947	2010
Wilmot Manor, Section 8	0.114073	2010
Avalon Forest Estates	0.017078	2010
The Enclave at Morgan Run	0.023357	2010
Liberty Reservoir	0.399593	2010

Morgan Run	1.633522	2010
Morgan Run	0.140967	2010
Avalon Forest Estates	0.042696	2010
The Enclave at Morgan Run	0.002384	2010
The Enclave at Morgan Run	0.53877	2010
Harris-Bowlsbey Property	0.007672	2010
Harris-Bowlsbey Property	0.413521	2010
Wheatley Property	0.110294	2010
Manchester Farms, Sectio*	0.000834	2010
Harris-Bowlsbey Property	0.000239	2010
Beaver Run	0.288808	2010
Harris-Bowlsbey Property	0.166085	2010
Manchester Farms, Sectio*	0.241854	2010
Little Morgan Run	0.002768	2010
Clayton Woods, Section 2	0.018117	2011
West Branch Patapsco Riv*	1.615125	2011
Deep Run	3.965218	2011
West Branch Patapsco Riv*	10.205521	2011
West Branch Patapsco Riv*	12.022427	2011
Clayton Woods, Section 2	0.002688	2011
Morgan Run	0.01962	2011
Clayton Woods, Section 2	0.281747	2011
Roaring Run/Board Run	0.32936	2011
Little Morgan Run	2.859697	2011
Morgan Run	0.001187	2011
Clayton Woods, Section 2	0.430055	2011
The Mill at Clearfield	0.005983	2012
Beaver Run	8.02584	2012
The Mill at Clearfield	3.18837	2012
Marabrooke Farm	0.010777	2012
Marabrooke Farm	1.03191	2012
Little Morgan Run	8.255103	2012
Marabrooke Farm	0.767975	2012
Marabrooke Farm	4.244635	2012
Poignant Acres 7	0.014771	2012
Morgan Run	0.001826	2012
Poignant Acres 7	1.400599	2012
Windy Hills Farm, Phase 1	0.007806	2012
West Branch Patapsco Riv*	1.798007	2012
West Branch Patapsco Riv*	1.052197	2012
Windy Hills Farm, Phase 1	0.005463	2012

Windy Hills Farm, Phase 1	5.575906	2012
Marabrooke Farm	0.02462	2012
Little Morgan Run	1.51406	2012
Marabrooke Farm	1.239456	2012
Marabrooke Farm	0.001395	2012
Little Morgan Run	0.124773	2012
Marabrooke Farm	0.073075	2012
Poignant Acres 7	0.053046	2012
Poignant Acres 7	0.053046	2012
Poignant Acres 7	0.000022	2012
Poignant Acres 7	0.000445	2012
Poignant Acres 7	0.003395	2012
Windy Hills Farm, Phase 1	0.002487	2012
West Branch Patapsco Riv*	0.021029	2013
Beaver Run	0.036671	2013
Beaver Run	0.159299	2013
Pinewood	0.006133	2013
Liberty Reservoir	1.4474	2013
Pinewood	0.036143	2013
Beaver Run	0.078749	2013
Beaver Run	12.185722	2013
Beaver Run	8.777147	2013
Beaver Run	0.027141	2013
Beaver Run	0.004369	2013
Beaver Run	1.206841	2013
Beaver Run	0.018832	2013
Beaver Run	0.014478	2013
Beaver Run	0.011298	2013
Beaver Run	0.164839	2013
Beaver Run	0.565165	2013
Southview, Section 2	0.000393	2014
Beaver Run	0.160753	2014
Beaver Run	0.616088	2014
Southview, Section 2	0.710231	2014
Southview, Section 2	0.185555	2014
Cliff's Legacy	0.338343	2014
Beaver Run	0.707145	2014
Cliff's Legacy	2.384544	2014
Southview, Section 2	0.001391	2014
Southview, Section 2	0.000319	2014
Windy Hills Farms, Phase*	0.022382	2014

Windy Hills Farms, Phase*	0.009268	2014
West Branch Patapsco Riv*	0.050964	2014
Estates at Liberty Reser*	0.210023	2014
Liberty Reservoir	12.314665	2014
Estates at Liberty Reser*	2.832982	2014
Pooledale 3	0.154344	2014
Morgan Run	4.398078	2014
Pooledale 3	1.612706	2014
Pooledale 3	0.316697	2014
Pooledale 3	0.044913	2014
Little Morgan Run	0.950479	2014
Morgan Run	5.722444	2014
Pooledale 3	0.984824	2014
Pooledale 3	1.461143	2014
Roaring Run/Board Run	0.275957	2014
Pooledale 3	0.002312	2014
Little Morgan Run	0.000875	2014
Morgan Run	9.210315	2014
Pooledale 3	3.257559	2014
Windy Hills Farms, Phase*	0.031568	2014
West Branch Patapsco Riv*	1.849264	2014
West Branch Patapsco Riv*	0.162451	2014
Windy Hills Farms, Phase*	3.725261	2014
Hidden Valley, Sec. 2, L*	0.007335	2014
Aspen Run	0.090423	2014
Hidden Valley, Sec. 2, L*	0.046387	2014
Little Morgan Run	0.002809	2014
Morgan Run	0.019894	2014
Pooledale 3	0.000845	2014
Pooledale 3	0.002036	2014
Pooledale 3	0.002036	2014
Beaver Run	0.004793	2014
Beaver Run	0.004793	2014
Southview, Section 2	0.024037	2014
Southview, Section 2	0.024037	2014
West Branch Patapsco Riv*	0.003721	2014
West Branch Patapsco Riv*	0.003721	2014
Windy Hills Farms, Phase*	0.002487	2014
Pooledale 3	0.0014	2014
Pooledale 3	0.0014	2014
Little Morgan Run	7.283972	2015

Middle Run	0.270124	2015
Middle Run	0.238102	2015
Hewitt's Landing	0.001035	2015
Hewitt's Landing	0.006983	2015
Hewitt's Landing	0.002114	2015
Roaring Run/Board Run	7.23965	2015
Roaring Run/Board Run	1.061936	2015
Hewitt's Landing	1.490899	2015
Hewitt's Landing	0.415683	2015
Hewitt's Landing	0.000114	2015
Hewitt's Landing	1.095643	2015
Hewitt's Landing	0.000229	2015
Little Morgan Run	0.00971	2015
Bollinger Estates Amended	0.194409	2016
Liberty Reservoir	14.62958	2016
Nipkow Property	4.104625	2017
Hidden Creek	3.36733	2017
Hidden Creek	0.000799	2017
Morgan Creek	0.45514	2017
Windy Hill 4A	5.824233	2018
Windy Hill 4A	6.524907	2018
CAB LLC	0.233727	2018
Windy Hill 4A	0.033245	2018
Windy Hill 4A	0.410443	2018
Peng. Rand. House	0.687511	2018
Adms Pardise Snr Housing	1.395287	2018
Rustic Rising	1.879093	2018
Rustic Rising	0.018177	2018
Windy Hill 4A	0.619297	2018
Windy Hill 4A	0.619297	2018
Windy Hill 4A	6.723576	2018
Windy Hill 4A	6.723576	2018
Rustic Rising	0.200849	2018
Rustic Rising	0.200849	2018
Adms Pardise Snr Housing	0.019778	2018
Rustic Rising	0.019778	2018
Rustic Rising	0.000027	2018
Adms Pardise Snr Housing	0.000027	2018
Rustic Rising	0.000027	2018

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
Sterner Property	0.002884	2009
Plat of Anderson Farm	0.009366	2009
Poignant Acres 6	0.000233	2009
Westminster Toyota IP, L*	0.523984	2009
Callier Property	0.10821	2009
Beaver Run	0.338896	2009
East Branch Patapsco Riv*	1.865879	2009
Morgan Run	0.038347	2009
Morgan Run	0.025347	2009
Deep Run	13.517339	2009
Deep Run	2.459505	2009
Plat of Anderson Farm	0.130476	2009
Poignant Acres 6	0.306813	2009
Liberty Reservoir	1.015207	2009
Sterner Property	0.157617	2009
Callier Property	0.48065	2009
Beaver Run	0.004482	2009
East Branch Patapsco Riv*	0.000029	2009
Morgan Run	0.00007	2009
Poignant Acres 6	0.00032	2009
Poignant Acres 6	0.00044	2009
Poignant Acres 6	0.00044	2009
Poignant Acres 6	0.003118	2009
Poignant Acres 6	0.003118	2009
Wilmot Manor, Section 8	0.042979	2010
Wheatley Property	0.367085	2010
Manchester Farms, Sectio*	2.282511	2010
HM Associates Property	0.089461	2010
Avalon Forest Estates	0.001434	2010
Flat Bush	0.000515	2010
McGrew Property, Section*	0.012376	2010
Morgan Run	1.425432	2010
Morgan Run	0.620868	2010
Beaver Run	4.489322	2010
East Branch Patapsco Riv*	1.046448	2010
Liberty Reservoir	1.253551	2010
Middle Run	0.322897	2010
Morgan Run	0.194324	2010

Avalon Forest Estates	0.161089	2010
Liberty Exchange	0.327901	2010
Flat Bush	0.019818	2010
Little Morgan Run	1.698223	2010
Wilmot Manor, Section 8	2.523888	2010
McGrew Property, Section*	0.671003	2010
The Enclave at Morgan Run	0.001612	2010
Bollinger Estates	0.174002	2011
West Branch Patapsco Riv*	3.764639	2011
Deep Run	0.661675	2011
West Branch Patapsco Riv*	31.196581	2011
Little Morgan Run	0.311453	2011
The Mill at Clearfield	0.004426	2012
My Ladies Manor 2	5.926913	2012
Poignant Acres 7	0.080246	2012
Windy Hills Farm, Phase 1	0.002121	2012
Morgan Run	0.08952	2012
Morgan Run	0.145117	2012
Little Morgan Run	0.242378	2012
Little Morgan Run	0.117432	2012
Beaver Run	1.48046	2012
Beaver Run	3.456276	2012
West Branch Patapsco Riv*	0.212161	2012
West Branch Patapsco Riv*	0.11209	2012
The Mill at Clearfield	2.188986	2012
Poignant Acres 7	4.401239	2012
Windy Hills Farm, Phase 1	0.637354	2012
Morgan Run	0.00007	2012
Poignant Acres 7	0.00032	2012
Poignant Acres 7	0.000035	2012
Poignant Acres 7	0.000035	2012
Poignant Acres 7	0.003118	2012
Poignant Acres 7	0.003118	2012
Beaver Run	0.036104	2013
Beaver Run	0.004704	2013
Liberty Reservoir	0.008262	2013
West Branch Patapsco Riv*	0.720815	2013
Beaver Run	0.04177	2013
Beaver Run	1.019242	2013
Beaver Run	0.292169	2013
Liberty Reservoir	0.000953	2013

Windy Hills Farms, Phase*	0.363587	2014
West Branch Patapsco Riv*	5.453712	2014
Pooledale 3	0.924753	2014
Southview, Section 2	2.868927	2014
Hidden Valley, Sec. 2, L*	0.005714	2014
West Branch Patapsco Riv*	1.342323	2014
Aspen Run	1.045301	2014
Beaver Run	0.640699	2014
Beaver Run	0.130472	2014
Beaver Run	1.965799	2014
Morgan Run	1.404154	2014
Roaring Run/Board Run	0.095855	2014
Little Morgan Run	3.8573	2014
Morgan Run	15.452228	2014
Windy Hills Farms, Phase*	4.389447	2014
Pooledale 3	4.342928	2014
Pooledale 3	4.218294	2014
Cliff's Legacy	0.080433	2014
Southview, Section 2	3.229968	2014
Hidden Valley, Sec. 2, L*	0.267086	2014
Little Morgan Run	0.119733	2014
Morgan Run	0.000346	2014
West Branch Patapsco Riv*	0.003208	2014
West Branch Patapsco Riv*	0.003208	2014
Hewitt's Landing	0.001203	2015
Bull Estates	0.000204	2015
Little Morgan Run	0.22432	2015
Little Morgan Run	0.00793	2015
Little Morgan Run	0.000241	2015
Roaring Run/Board Run	2.471159	2015
Roaring Run/Board Run	2.319319	2015
Little Morgan Run	2.263954	2015
Little Morgan Run	5.261483	2015
Hewitt's Landing	0.000357	2015
Hewitt's Landing	0.583775	2015
Hewitt's Landing	0.018246	2015
Bull Estates	0.326194	2015
Bull Estates	0.001911	2015
Bollinger Estates Amended	1.840054	2016
Liberty Reservoir	1.183807	2016
Emray Acres Lot 1	1.684728	2017

Hidden Creek	0.012349	2017
Hidden Creek	0.019792	2017
Penguin Random House Amd	2.817853	2017
Windy Hill 4A	22.363571	2018
Windy Hill 4A	3.087919	2018
Rustic Rising	0.200876	2018
CAB LLC	0.558854	2018
Windy Hill 4A	0.652542	2018
Windy Hill 4A	11.148652	2018
Peng. Rand. House	2.097179	2018
Peng. Rand. House	0.051098	2018
Peng. Rand. House	0.108934	2018
Peng. Rand. House	0.005448	2018
Peng. Rand. House	0.004106	2018
Basler Homestead	0.595949	2018
Adms Pardise Snr Housing	3.035072	2018
Adms Pardise Snr Housing	0.101125	2018
Rustic Rising	2.245364	2018
Rustic Rising	0.0857	2018